Arctic Ports: Local Community Development Issues

Brooks Kaiser, Julia Pahl and Chris Horbel

Abstract Climate and economic forces are both transforming Arctic communities. Restructured governance of marine transportation and community development investment should work to promote economic growth and development within frameworks that accommodate sustainable resource use and community cultures. Marine ports are vital community links and components of this infrastructure. This paper discusses historical lessons as well as Arctic community demands initiating from resource extraction, tourism, fishing and culture for successful port development.

1 Introduction

Climate change is reducing ice cover on land and sea, and melting permafrost in the Arctic. This is increasing the pressures on economic opportunities for Arctic communities that are already shifting due to globalization. The resulting transformation of transportation options and needs will be significant. Furthermore, the transformations will be endogenous to decisions regarding access to Arctic communities. Port infrastructure and other investment decisions will be made that have lasting impacts on where and how economic development in the Arctic will proceed (Newton et al. (2016)).

This chapter is a companion piece to Chapter xxx on port infrastructure. Arctic marine communities have varied uses for ports. These uses encompass resource extraction, tourism, fishing and cultural heritage. Dependence on destination shipping (i.e. imported cargo to and exported natural resources from northern communities) is also important in most locations and has grown with globalization. Decisions on port in-

Brooks Kaiser
Management and Economics of Resources and the Environment Group, Department of Sociology, Environmental and Business Economics,
University of Southern Denmark, Niels Bohrs Vej 9, DK-6700 Esbjerg, Denmark e-mail: baka@sam.sdu.dk

Julia Pahl
Center for Engineering Operations Management, Department of Technology and Innovation,
University of Southern Denmark, Campusvej 55, DK-5230 Odense, Denmark, e-mail: julp@iti.sdu.dk

Chris Horbel
Markets, Organization and Behavior Group, Department of Sociology, Environmental and Business Economics, University of Southern Denmark, Niels Bohrs Vej 9, DK-6700 Esbjerg, Denmark, e-mail: horbel@sam.sdu.dk

frastructure investment need to respond to climate change and they must be made under highly uncertain economic futures. This paper uses past experience with large scale infrastructure development in North America to elicit useful lessons for the region's continuing development.

Port infrastructure decisions should consider the complex economic and environmental uncertainties ahead in the Arctic. Historical context, gathered from other large scale and cumulative transport infrastructure decisions, provides some guidance over these uncertainties. A useful analytical question is, how the boom and bust of railroad expansion in the US can be used as an analogy in terms of the lessons to be drawn for port infrastructure investments. Particularly insightful lessons can be drawn by considering how different rates of change in accessibility (as conditions vary for changing sea- and land-fast ice across ports) will affect the optimal investment patterns across the two shore-based routes. These differential changes will interact with the different end uses (oil and gas, mining, fishing, tourism, shipping) to affect Arctic communities. The two shore-based maritime routes traversing the Arctic marine environments are the Northern Sea Route (NSR), which crosses from the North Atlantic and Barents Sea into the North Pacific along Russian shores, and the Northwest Passage (NWP), which crosses from the North Pacific to the North Atlantic along American, Canadian and Danish (Greenlandic) shores. The (as yet hypothetical) Trans Polar Route (TPR) crosses the Central Arctic Ocean in the middle.

The TPR presents a more complicated aspect of the story, and parallels more closely the impact of highway bypasses on cities than it does the completion of the transcontinental railroad. This chapter does not address the TPR further than to note that it serves as a limit to ambitions for Arctic activities based on trans-Arctic shipping. The three routes present very different economic, social, political, safety, and environmental concerns that will shift differently with climate changes. As such, they present very different opportunities as well. Furthermore, the impacts of the differential rates of change may also vary with differences in institutional structures, policy, and governance decisions.

Arctic ports are typically anticipated to provide economic opportunity by servicing resource extractors. These extractive industries include both non-renewables such as mining and oil and gas, and renewables such as fishing (see Jørgensen-Dahl and Wergeland (2013)). However, short seasons and limited and volatile demand could result in the same sort of over-capitalization seen in open access resource extraction directly. In such cases, stakeholders, e.g., fishermen with time-limited (derby style) harvest windows, may over-invest in capital (e.g., vessels) and infrastructure that might become idle or stranded much of the time. Changes to the economic landscape of local communities in such a setting could have far-reaching impacts. A discussion of the impacts of historical extraction of whale and walrus (renewable resources) provides insight into these challenges.

The chapter focuses on the shore based routes comparatively and the different conditions that these face for the development of the communities. The different opportunities that they provide (especially for destination shipping, resource extraction, Arctic tourism and fishery) and the economic, social, political, safety and environmental consequences that arise will be discussed. This will also include cross-industry considerations. The sparsely populated NWP remains a too-costly alternative for trans-Arctic shipping, while the NSR is becoming increasingly viable due to less ice. This advantage to the NSR is only expected to last as long as the TPR is not also viable. Resource extraction of both renewable and non-renewable resources provides a strong driver of activity on both the NSR and NWP routes. The NWP has higher percentages of indigenous populations and greater emphasis on tourism, so that the number of social conflicts being addressed directly is currently higher along the NWP. The outcomes for these conflicts will be reflected in port decisions that can be expected to create lasting impacts on the direction of change in Arctic marine community development.

2 Effects of Climate Change on Arctic Maritime Activity

The Arctic is especially sensitive to to fluctuating and warming temperatures; see, e.g., the report of the Intergovernmental Panel on Climate Change (2001). In fact, the Arctic is experiencing warming at a greater rate than any other parts of the planet. This has been the case for many years (see Johannessen et al. (1999)). Moreover, the rate of change in the Arctic is expected to continue to diverge from the global rate of change. This will intensify the effects and hasten warming further (see, e.g., Koenigk et al. (2013)). Scientists continue to find new indications of this change that surpass their forecasts. In 2016, the amounts of difficult-to-navigate multi-year ice fell dramatically in volume and coverage compared to expectations (see Richter-Menge et al. (2016)). This changing landscape in the Arctic increasingly creates questions and concerns about navigational safety. Most recently, Aksenov et al. (2016) has integrated climate forecasts for ice, wind, and other climate variables to estimate how climate changes will physically change the possibilities of Arctic routes for navigation.

2.1 The Arctic Communities

Arctic communities often have or desire connections to global economic activity that are fraught with challenges. These connections and the communities themselves are often little understood by outsiders (Nuttall (2012)). There exist multiple definitions of the Arctic, so that population estimates vary from about 400,000 to 4,000,000 people.

Figure 2 illustrates how this population is distributed. The sparse dot densities indicate low population densities overall, with extremely sparse populations from Eastern Russia to Greenland along the NWP. Large portions of the population are small indigenous subsistence communities which are not well incorporated into global market economies. Along the NWP, American, Canadian and Greenlandic (Danish) Inuit communities have long-standing trade and communications, particularly in the winter months, over ice; see Kaiser and Parchomenko, Chapter xxx this volume. In Iceland, Norway and western Russia, relatively ice-free waters and the effects of the Gulf Stream have produced long-standing coastal communities that rely heavily on local and commercial fisheries. Distances remain great and marine transportation is vital. In central Arctic Russia, for centuries efforts to develop the region have involved transplanting people from southern communities in order to build infrastructure and develop resource extraction. The region is currently heavily investing in oil and gas exploration and development. To enable this, they are importing transient labor at high rates, with attendant community conflicts (Saxinger (2016)).

Figure 1 illustrates some of the demographics of the Arctic. Regional data compiled under the ECONOR project (Glomsröd and Aslaksen (2008)) are mapped and show the percentage of the population that is aboriginal as well as area population densities. Port information is also included to show the size and ice conditions of existing ports. Much of the total population lives in Norway and western Russia, where climate has been more moderate than other parts of the Arctic. The Barents Sea waters are now virtually ice free most of the year. Murmansk is the largest regional port. It connects Russia to its close neighbor to the west, Norway, and on the eastern side, to the NSR.

The low levels of population and infrastructure along the NWP, as well as stretches of the NSR, are also obvious. One can see that the NSR is likely to exhibit quite different demands from their ports than the NWP. In particular, differences in indigenous population shares should be expected to result in significantly different outcomes for social welfare from any increases in port development and use that are based primarily in resource extraction.

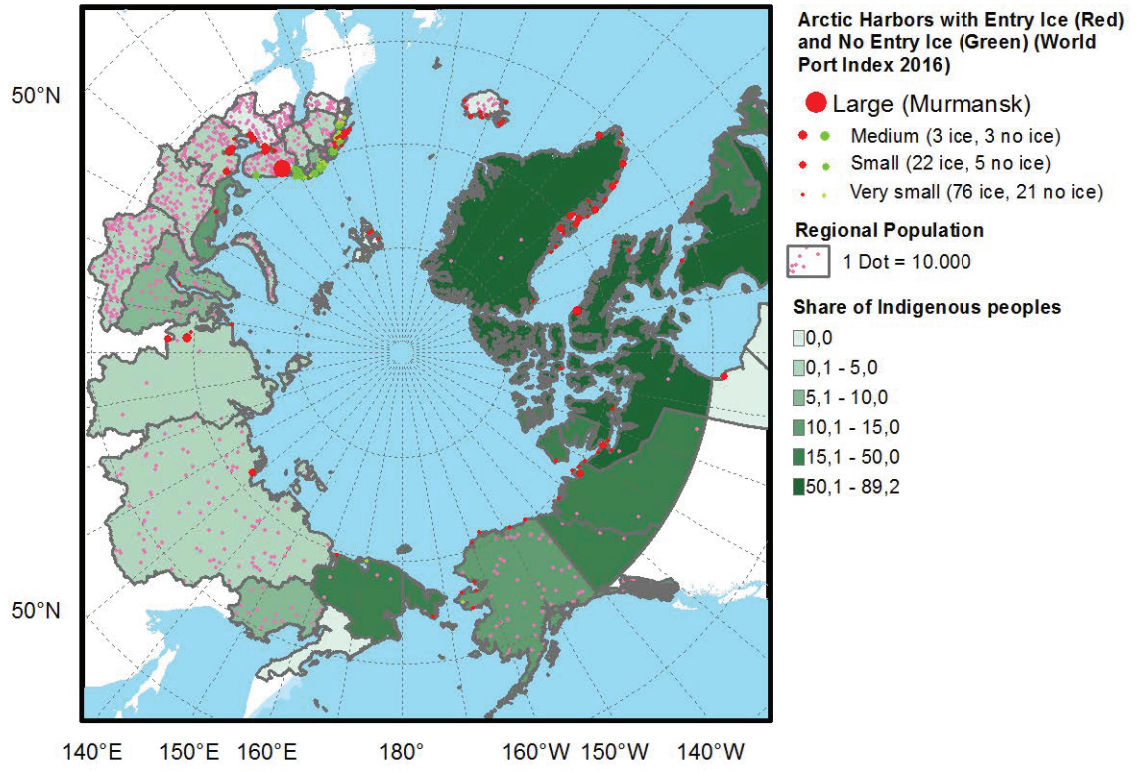

Fig. 1 Demographics of Arctic regions (Population and Ports) (Sources: ArcticStat and World Port Index 2016

The Arctic is not, as many imagine, an empty frontier (Steinberg (2015)); its populations have long adapted to the climate and seasonal constraints successfully, with considerable circumpolar trade (Aporta (2009), Morrison (1991), Stuhl (2016)). The economic and environmental changes under way are, however, requiring new transformation of the region (Newton et al. (2016)). The next section of the paper explores historical analogies that may shed light on how best to manage and support these transformations.

2.2 Historical analogy for the current day: 19th Century Western Railroad Expansion

Western U.S. rail expansion consisted of boom-bust activity whose advantages and pitfalls economic historians and economists are still trying to understand fully today. One of the most famous controversies of economic history is over the role that railroad expansion played in 19th Century U.S. economic growth (see Majewski (2016)). Some have argued the railroads acted as a major engine of growth, expanding opportunities by ”growing ahead of demand” and leading development. Others suggest that railroads were mainly built only where they would be almost immediately profitable through transportation of natural resources or existing products to larger markets. Which of these theories is correct matters in helping understand future Arctic economic developments; the disagreement also highlights the potential challenges for the Arctic. Cli-

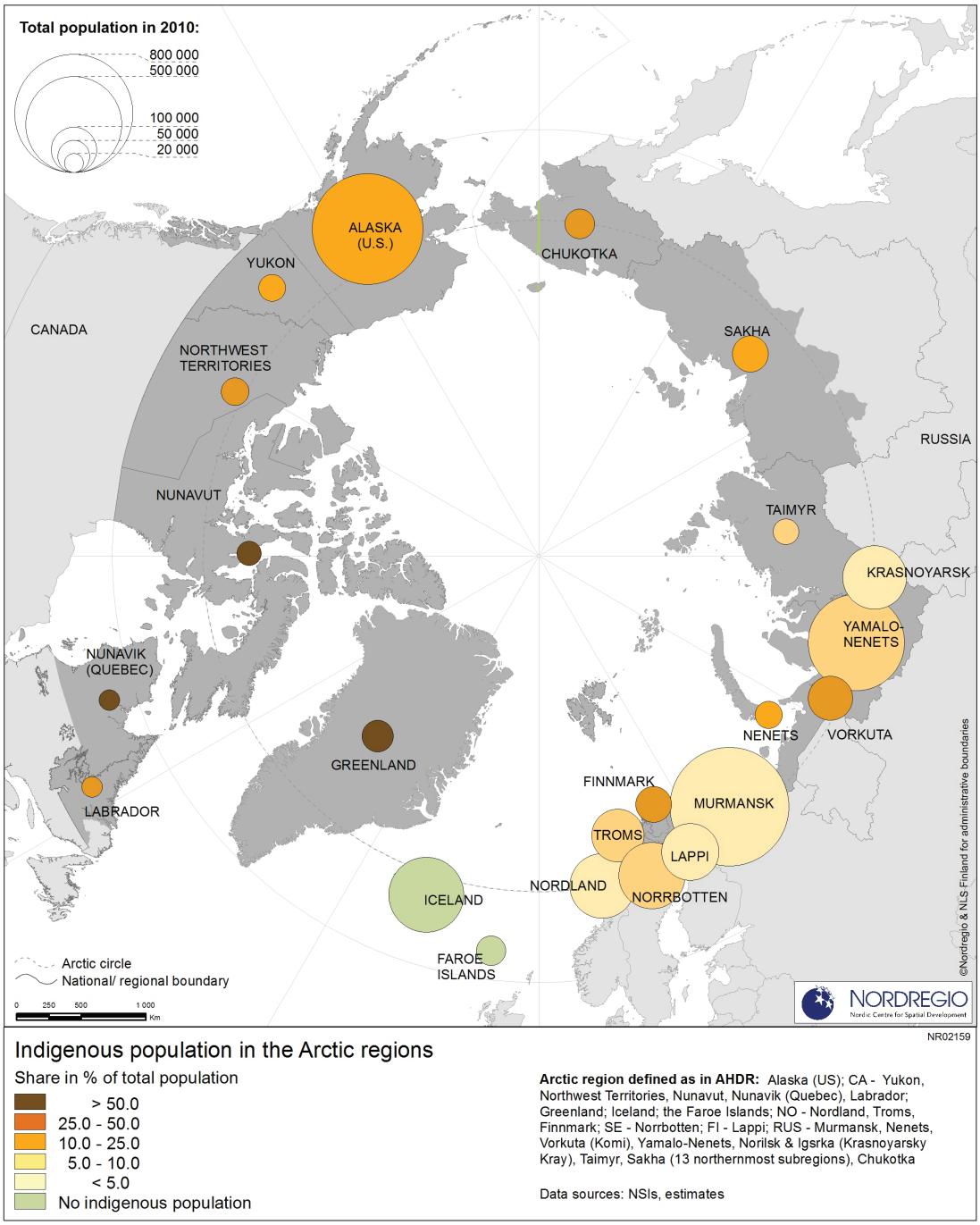

Fig. 2 Arctic Population; Source: Nordregio at www.nordregio.se; image credit Johanna Roto

mate changes will increase the roles of ports in overall community connectivity. This will occur as maritime trade and transport grow in response to less ice cover, while land-based transport is threatened by melting permafrost. Thus decisions about where to develop the ports further and how to incorporate them into networks will impact the future of the region directly.

The positive effects of national transport connectivity, e.g. through transcontinental railroads, were anticipated to be substantial even from earliest times. Advocates for federal support in assisting the development of these connections are present from the earliest days of the American Republic (see Atack et al. (2010)). This was a time where both federal revenues and expenditures were extremely, and purposefully, limited (see Peacock (2004)), so the advocacy demonstrates the perceived importance of transportation networks in American development and their need for public support. The call for public support and/or regulatory protection from competition is a common and appropriate one when high fixed costs of infrastructure are followed by low marginal costs of serving an additional customer. Without such interventions one is willing to lower price until it is equal to these low marginal costs, reducing the ability to cover (private) fixed costs. Incentives for private provision of the networked good are inefficient. Avoiding this situation provides impetus for public spending and/or regulation of ports. Such intervention might lead to prices that cover a fair return on investment or to having the public absorb some of the infrastructure cost in order to obtain positive spillover effects from the development. The advocacy for federal funding particularly assisted the early construction of roads and canals at the state and federal levels.

Railroads, however, primarily entered the landscape in a later period of the Republic, with the biggest expansions occurring after 1850 (see, e.g., Taylor and Neu (1956)). Much railroad expansion was privately financed and poorly organized. In fact, railroad development was so poorly organized that series of collusions and subsequent price wars along competing railways reduced profitability and created industry losses. The losses grew to such an extent that eventually the industry asked for government intervention in the form of the first federal industry regulatory agency, the Interstate Commerce Commission (ICC); see Ulen (1980). That this boom-bust of cartelization and competition resulted in government regulation and eventual nationalization of the passenger railroad system in the U.S. is unsurprising in light of the high fixed cost, low marginal cost problem already described. Arctic port development efforts should heed this lesson and carefully coordinate within the region.

The research insight of greatest relevance for Arctic development from studying the railroad troubles, however, is possibly from Green and Porter (1984) and Porter (1983). Cartelization, where firms collude to act like a monopoly, collapsed with unexpected drops in demand for rail service. Thus periods of low prices through demand drops were exacerbated by failed collusion that pushed prices lower. Extending this result to infrastructure developments in Arctic communities, one sees highly volatile uncertainty surrounding returns on resource extraction in the Arctic. Port investments dependent on these returns should be expected to suffer similarly from the toll the volatility will take on profitability. As ports suffer from downturns in extractive industries, the intensity of competition between the ports is also likely to increase. This in turn may reduce profitability further. The railroad analogy strengthens understanding of how and why government cooperation across regions and ports will be vital to dampening the costly cyclical patterns of port activity in the future.

Recent research that attempts to reconcile the debate over railroads' contributions to growth suggests that when a community gained rail access to the national network during the late Antebellum Period (1850-1860), this had only a small positive impact on population density. On the other hand, it had a much larger impact on urbanization. Access to faraway markets concentrated the population by incentivizing it to move closer to depots (see Atack et al. (2010)). The railroads served to concentrate rather than expand population. If such an impact extends to current Arctic communities, as early signs suggest, the effects on the economic and social conditions and outcomes of the communities will be significant. Communities closer to well-

developed and integrated ports will continue to grow and become more globally market-oriented at the expense of more remote communities. Coordinated investments not only in ports and resource extraction, but also in community building, must evolve to avoid disastrous correlated losses like those the port of Churchill, Manitoba is currently facing, see the discussion below.

The ways in which rail networks chose where to locate in relation to the scarcely populated frontier reflected a mix of influences that relied on expectations of a highly uncertain future. This is similar to the uncertain future that Arctic communities face today. In many cases, rail investment, with its high fixed capital costs of development, resulted in financial ruin as competing lines and lack of coordination meant overcapacity and pricing wars.

Social costs were also high. Imported labor, primarily from Asia, was needed when local populations were insufficient. This has required long periods of social adjustment, and created a period of discriminatory history so unpleasant that it is frequently washed from the historical record altogether (see Takaki (2012)). Similar problems appear to be growing both in practice (see, e.g., Amnesty International (2016) for evidence of correlations between violence toward indigenous women and resource extraction) and in theory (see, e.g., discussions of proposed Greenland mining; see Hansen et al. (2016); Nuttall (2013)). Port infrastructure that is highly integrated with the needs of the local community presents a strong option for moving forward in the least cost manner to society.

In any case, one thing is certain: being "off the railroad path" was a difficult position for communities wishing to be included and prosper; this is also true in the Arctic today. Thus, it is important that policy making considers these complex network issues pertaining to the substitutability and complementarity of Arctic port development. In particular, the high investment costs for Arctic communities' port developments mean that financing assistance is likely to be an important factor in the ability of the scarcely populated indigenous regions to maintain connectivity in the face of reduced ice coverage. This assistance should be coupled with greater integration of governance covering the range of effects that will ensue as market forces and urbanization increase. Financing alone is insufficient as competitive market forces are likely to generate boom-bust cycles rather than balanced growth that considers full social costs.

2.3 Rail and Port Linkages: The Case of Churchill, Manitoba

The Port of Churchill, Manitoba on Hudson Bay is Canada's only Arctic deep-water port. Conceived and granted charters in the late 19th Century (1880), it was opened in 1931 and intended to stake Canada's claim in the Arctic as a strategic gateway to Europe, with the first grain shipments starting at that time (Port of Churchill (2016)).

Analysis of railroad development in the 19th Century again provides insight. Canadian railroadization came slightly after U.S. railroad expansion; the Canadians thought they had learned how to avoid the boom-bust outcomes of the U.S. The Canadian government at the time played a more direct role in planning and financing than had the U.S. government in its railroad development, and initial expectations for profit were high. Nevertheless Canadian railroad expansion resulted in financial distress and eventually nationalization in 1917. Subsequent research has shown that part of the failure could have been avoided if some of the investment in the Grand Trunk Railroad had been redirected to the Great Western Railroad instead (Carlos and Lewis (1992)). As is frequently the case in high fixed cost (and in this case only seasonally accessible) investments, we might safely assume that the 50 year delay between the initial charters (made in 1880 during the frenzy for railroads) and the actual implementation of the port project at Churchill, completed in 1931, highlights the marginal financial returns to be expected on the route. This is because funds will first go to

the projects with the highest expected returns. Projects with more uncertain, lower expected returns or that invite controversy over external costs will be delayed. As social objectives transition over time, delays may become even more prolonged. This occurs as new tradeoffs in land use and development become apparent (see Cain and Kaiser (2016)). The Churchill port and connecting infrastructure have always been for social gains rather than economic ones.

The port serviced the prairies' wheat production and did lower transportation costs from the Canadian Western Prairies. Canadian wheat is in general at a significant global disadvantage due to high transportation costs. For this reason Canada created the Canadian Wheat Board to orchestrate the development of supporting infrastructure. Decentralization of the Board's activities, in combination with the industrial concentration in grain trade (there are five main companies) and rail transport (there are two companies) has significantly reduced Churchill's already limited competitiveness in recent years (Larsen (2016)).

The Port of Churchill was privatized in 1997 and is currently owned by Omnitrax, a Denver-based U.S. company who also owns the railroad to the port. The company unexpectedly closed the port in 2016. The town has a population of 800 people, with 10 percent of the population working seasonally at the port (see Thompson Citizen (2016)). Its mayor estimates that the port accounts for about 30% of the town's tourism revenues and 60% of the direct economic activity altogether, due to the historical average shipments of about $500,000$ tonnes of grain shipped through the port. This figure has decreased in recent years, with only $280,000$ tonnes shipped in 2015. The loss in shipping is directly related to the closure of the Canadian Wheat Board. This closure means that there is less direct governance of the industry. This has increased freedom of movement of goods to cheaper ports (see CBS News (2016)).

The loss of Churchill as a functioning port is not expected to noticeably affect world trade in grain, either in price or quantity. It will however dramatically affect the local economic landscape. Though the port only operated seasonally, this seasonality fit with the timing of wheat harvests to render the port competitive. It could provide jobs and regional cash-based economic activity. The closure is in line with short term economic decisions for profit that often follow privatization and neglect the social and historical components of well-being. As Arctic port development goes forward in this global climate for economic profitability, northern communities will need to consider public investment goals broadly to carefully assess the best ways in which to promote long run social welfare. Connectivity generated by ports and transport infrastructure are vital components of economic security and trade. Public investment in port infrastructure must be supported.

2.4 Past and Present Use of the Arctic

Prior to 1969, a ship would complete a trip through the Northwest Passage on average once every ten years, with the rate beginning to increase in the 1950s (MacFarlane (2012)). In 2012 alone, 30 known ships transited through the Northwest Passage and 17 ships are known to have done so in 2014 (Headland (2014)). Yet, the Arctic is not a frontier. It has been used by Inuit for trade and communications over at least a thousand years. Its cultural heritage is part of the reasoning keeping people in the North. More recently, but still with long histories, are centuries of resource extraction. Examples on land include Spitsbergen (Svalbard) mining and the North American and Siberian fur trades, and at sea, whaling and walrus ivory. Boom and bust resource extraction for everything from fur seals and whales to coal, oil and minerals throughout the Arctic have transformed local economies and the environments upon which they depend. This has had both positive and negative consequences. Trade and broader global contact have increased goods, information, and technologies available in the Arctic. Some traded goods, including alcohol and tobacco, have had dramatic negative consequences for indigenous populations in particular. Other negative consequences stem from

resource depletion and ecosystem damages that affect the productivity of the landscape and the lives of those who depend upon it. How, then, will these economies continue to evolve?

In places like Svalbard, there have been no local indigenous populations to consider. In much of the Arctic, however, the extraction of renewable and non-renewable resources has directly impacted traditional food supply, food security, and options for substitution from imported items (see Kaiser and Parchomenko, Chapter xxx this volume and Bockstace (1986). Without well-provisioned and organized ports, year-round access, or thoroughly considered governance of marine activities, transitions from indigenous hunter-gatherer communities to new forms of economic activity have been both slow and uneven as they are at the mercy of these boom-bust cycles. In the following sections, we examine past and present uses of Arctic port facilities to bring out trends and concerns for the broader social costs that will likely accompany economic development in the region. We address resource extraction, tourism, and fishing. Cargo shipping is treated within the context of resource extraction. This is due to the current relative importance of destination shipping as well as to the expectation that the TPR might soon altogether outcompete either shore-based route for the purpose of trans-Arctic shipping.

2.5 Destination Shipping and Resource Extraction

In this section, we analyze cargo and its impact on Arctic societies. Inbound cargo supplies remote Arctic communities with the many commercial goods that cannot be produced locally. These include any building and construction materials for consumer or industrial use. Outbound cargo carries resources extracted from communities to processing facilities and end-users.

2.5.1 Cargo

Trans-Arctic shipping of cargo through the NSR or the NWP is unlikely to become a substantial portion of economic activity (see Buixadé Farré et al. (2014)). On the other hand, destination shipping, or shipping goods to and from locations in the Arctic itself, is likely to be a significant part of the Arctic ports' future. Cargo transport in the NSR is not a new phenomenon (see Figure 3 and Pavlov and Selin (2015)). Resource booms and busts in conjunction with political impetus to develop the Russian Arctic in the early 20th Century, followed by the collapse of the unifying political regime of the USSR, mean that the peak of NSR cargo shipping actually occurred in 1987, when 6,579 thousand tonnes of cargo transited the NSR (Pavlov and Selin (2015)).

In contrast, cargo shipping, and data on cargo shipping, in Arctic Alaskan and Canadian ports are virtually non-existent, see Table 1. As discussed above, the port of Churchill, Manitoba, was closed in 2016. It was the only deep-water (and yet seasonal) port in the Canadian Arctic. It handled a little over 500,000 tonnes/year. A few ports in Nunavut do have a sprinkling of data on cargo movement in the last decade. Still, for the ports that are identified and tracked by Statistics Canada, data is often not available and volumes are low, even for destination shipping.

Changes in climate and technology are lowering the costs and related barriers of access. This is once again increasing interest in Arctic activities. Consequential changes in technology range from ship characteristics like fuel types and ice-breaking capabilities to information processing like ice detectability and weather forecasting. Local and global stakeholders in Arctic activities can highly benefit from greater understanding of the interconnected socio-ecological systems and the needs and goals of the communities responding to

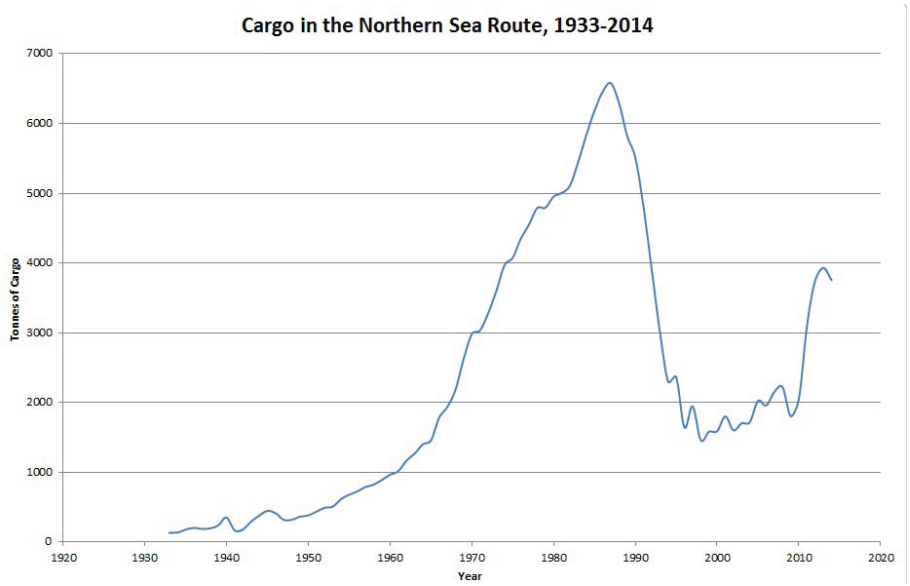

Fig. 3 Cargo in the NSR, 1933-2014; see Pavlov and Selin (2015)

Table 1 Cargo table for Canadian ports; Source Statistics Canada

Province	Port	Total Tonnage Handled (1000 t)				
		2007	2008	2009	2010	2011
Manitoba	Churchill	539.9	439.6	N/A	656.3	509.9
Nunavut	Chesterfield Inlet/Igluligaarjuk	5.0	17.9	N/A	28.1	96.7
Nunavut	Frobisher Bay/Iqaluit	N/A	N/A	39.7	38.5	41.3
Nunavut	Pangnirtung/Pannirtuuq	N/A	N/A	N/A	N/A	0.0
Nunavut	Nanisivik	N/A	N/A	N/A	2.6	4.4
Nunavut	Roberts Bay	N/A	N/A	N/A	18.6	0.0

these changes to avoid yet another boom-bust cycle. Shifts in perspective and opportunity are requiring rethinking of the infrastructure and technology demanded in Arctic communities, particularly ports, along with the goals of their use (see Kaiser et al. (2016)).

2.5.2 Impacts on Societies

Resource extraction is likely to remain one of the highest sources of revenue and activity for many ports in the Arctic due to increasing (though volatile) global demands for resources. This perceived profitability is increasing public and private investment in port infrastructure. The new and prospering (or soon expecting to be prospering) ports of Novy, Sabetta, and Varandey in the Russian Arctic are all fully or partially owned by private hydrocarbon interests in cooperation with the Russian government (Staalesen (2017)). At the same time, boom-bust cycles of resource extraction are likely accompanied by greater socially negative than positive impacts. The potential for these negative impacts in the North is high. Resource extraction in

remote, inhospitable regions tends to impose high costs on indigenous populations. These costs may result in part from direct damages to wildlife and ecosystems that provide food supply. The costs are exacerbated when the indigenous populations are supplanted by imported labor rather than trained to take high paying positions in related industries. This creates inequality and other social consequences. An additional serious, but often overlooked, concern is that increased gender disparities should be expected to occur. A new report from Amnesty International (2016) on the increased violence against indigenous women in Fort John, British Columbia, for example, illustrates significant negative effects on populations.

2.6 Arctic Tourism

One option that is frequently presented for the continued viability of traditional resource-based communities that are trying to evolve within an encroaching outside world is *sustainable tourism*. Certainly, the month-long voyage of the Crystal Serenity cruise ship in 2016 through the Northwest passage serves as a precursor of potential growth for future tourism. Is it more attractive to develop port infrastructure for the demands of coastal and/or trans-Arctic marine tourism than resource extraction? What would growth in this Arctic tourism entail? How would such a tourism influence Northern communities? What is the role of Arctic port infrastructure, present and future, in determining these options?

In order to investigate these issues, we analyze the marine tourism (cruise) shipping demand and assess which companies already have plans for accessing the Arctic. Pashkevich et al. (2015) provide a recent overview of pan-Arctic tourism that highlights the fragmentation of governance and the concerns and hopes of many in the region. Demand for Arctic tourism might generate actions and policies that result in any of four possible states: *Arctic Race*, *Polar Preserve*, *Polar Lows*, or *Arctic Saga*. Underlying Arctic tourism is the reality that it should also be treated as a source of resource use and depletion. Tourism will have an uncertain net effect through the combination of market-measured economic growth with less quantifiable external economic and ecological damages. The role of governance in determining which state prevails, and whether harmonization is possible for the entire circumpolar region, is paramount. This governance should extend well beyond many existing definitions of tourism governance to include balanced growth in the use of underlying natural resources, labor and capital capacities of the region.

2.6.1 Arctic Race

The *Arctic Race* state is one with high demand for resource use with unstable governance that fosters competition between locations. It is likely to result in over-capitalization, increased risk, and increased damages. An example of such a situation might be tourism based on wildlife watching where regulations across locations differ significantly in either content or enforcement. If tourists vote with their feet based on the wildlife experience promised, they will often choose the least regulated environment that provides the closest access to marine mammals and other wildlife and/or landscape viewing. This can result in significant harm to both humans and wildlife, such as the loss of life that ensued when a gray whale crashed into a tourist boat in Mexico in 2015 (see Tuckman (2015)).

2.6.2 Polar Preserve

The *Polar Preserve* state has low demand with stable governance. This generates slow growth where the Arctic functions not as a set of developing economies but instead as an eco-preserve. The Polar Preserve state may match global demands for use of the Arctic well, using the region primarily as a biological and ecological reserve with high value, particularly to wealthy nations and individuals such as comprise the eight Arctic countries. This, however, will do little to meet the needs of local and regional communities in need of economic transition due to the changing climate.

2.6.3 Polar Lows

The *Polar Lows* state combines low demand with unstable governance. This is a particularly poor combination that not only results in underdevelopment of the region, as with the Polar Preserve, but also foregoes the benefits of reduced development. This is because the lack of governance means that activities are poorly regulated, and are likely to impose significant damages on the community and environment.

2.6.4 Arctic Saga

The *Arctic Saga* state preserves Arctic ecosystem services for present and future use. The Arctic Saga state is expected to meet weak sustainability outcomes. These are outcomes where resources are used in a dynamically efficient manner to leave future generations no worse off than present ones, given the ability to substitute forms of natural, physical, and human capital for one another (Heal (2012)). Furthermore, it may also meet stronger sustainability criteria. These stronger criteria recognize constraints in the substitutability amongst various forms of capital. This is particularly important in the development of Arctic transportation infrastructure due to the significant interrelations between cultural, ecological, and economic services in the North. Arctic communities are in many cases not developed market societies. Cash economy activities are viewed distinctly differently than other economic choices that remain embedded in cultural and ecological contexts. Policies that enhance the likelihood of the *Arctic Saga* scenario should be pursued as providing a balanced growth path of development.

2.6.5 Maritime governance and investment efforts toward *Arctic Saga* outcomes

In 2008, the Ilulissat Declaration was adopted by the ministers of the five coastal states of the Arctic Ocean, i.e., Denmark/Greenland, Canada, Norway, Russia, and the U.S. (see Ministry of Foreign Affairs Denmark et al. (2011)). Its aim was to send a strong political signal that these five states will act responsibly and in a collaborative manner with respect to the future developments in the marine Arctic. In general, maritime cooperation takes place within the framework of the eight nation Arctic Council (the five coastal states plus Sweden, Finland and Iceland) and the UN's *International Maritime Organization* (IMO), as well as through daily bilateral operations on *Search and Rescue* (SAR), environmental protection, and navigational safety.

The Arctic Council's few successes regarding pan-Arctic cooperation do help the region's governance. Two treaties with high relevance to marine tourism are the most significant accomplishments of the political organization in its 20 years of existence. The first, known as the 2011 Nuuk Declaration, is on the cooperation for Aeronautical and Maritime SAR (see Arctic Council (2011)). The second, known as the 2013 Kiruna

Declaration, is in Marine Oil Pollution Preparedness and Response (see Arctic Council (2013)). Cooperation in governance that will assist in achieving an ”Arctic Saga” outcome includes but is not limited to agreements on strict efforts toward wildlife protection, such as the U.S. Marine Mammal Act of 1972. This act requires vessels not to pursue marine mammals to within 50 yards of the animal. Subsequent higher voluntary standards in place e.g. in parts of Alaska (see NOAA (2016)) are also evolving. International agreements include the 1973 Agreement for the Conservation of Polar Bears made between the U.S., Russia, Canada, Denmark and Norway.

As the need for international agreements for polar bear protection might suggest, there are some particularly important safety and security issues for cruising in the Arctic. Cruise ships face incentives based on customer demands that increase the risks of accidents to both humans and wildlife. These include demands for visually appealing sites as well as marine wildlife. Arctic marine wildlife includes large, endangered marine mammals for whom human-animal interactions can easily result in injury or death. Floating ice, particularly icebergs, are also attractive to tourists (and polar bears), but risk damage to vessels. Furthermore, customers are willing to pay a premium for access to spots that other vessels may not be willing to risk visiting. Cruise ships therefore face a significant risk-reward tradeoff in designing cruise itineraries that other marine vessels may not.

Serious accidents already have occurred in recent years in Arctic waters. These accidents include the August 2016 sinking of a vessel off Ilulissat, Greenland carrying 23 cruise passengers and 3 crew members. This vessel was a private, local one that was serving as a tender, bringing passengers from a luxury cruise ship to shore. Several other local vessels were providing the same service, and were at hand for a quick rescue of all involved. The sunk vessel was loaded above its 22 passenger capacity (see The Arctic Journal (2016)).

The sort of informal arrangement described here is used frequently to accommodate larger cruise vessels and engage the entire community in earning extra income. The risks are considerable, however, and port development must prepare more effectively for loading and unloading passengers in small remote communities. The number of Greenland cruise tourists to Ilulissat in 2015 was only $8,250$, which still makes it the third-most visited port of call in the country (Statistics Greenland (2016)). Tourism numbers are still low, and infrastructure will need to grow rapidly if tourism growth is to be successful and identifiable risks are to be mitigated. Figure 4 shows a similar pattern to the Alaska cruise data (see Figure 5). It further extends to more recent years and shows that there was a downturn after 2011, for Greenland at least. This 2011 downturn was more significant than the effect of the financial crisis in 2009. This downturn has been explained as “due primarily to external market conditions beyond Greenlands control (Mustafanezhad et al. (2016)). In other words, the high demand elasticity for cruise tourism due to the many substitutes for cruise and travel activities can have significant impacts in small Arctic communities.

In 2015 Greenland acted to counter some of these forces by reducing taxes affecting cruise pricing (Arctic Cluster of Raw Materials (2016)). This is credited with bringing up the 2015 tourism numbers and more gains are expected (VisitGreenland (2016)). The tax shifts also favor larger vessels more than small vessels (VisitGreenland (2015)). This could alter the risk factors either to the better or the worse. Larger ships mean greater impact overall and lower levels of maneuverability, but they may also allow greater safety and redundancy at sea.

For tourists, an Arctic cruise remains an expensive and less certain option, particularly in terms of weather, than many other locations. Any Arctic cruise faces competition not only amongst Arctic locations, but also from other cruise destinations presented by the global cruise industry. The Greenland data attest this.

The data from Alaska also suggest that the industry is highly susceptible to economic downturns. There is little overcapacity in the Arctic as ships can be moved to alternative destinations in response to global demand shifts. Thus capacity and passenger nights track each other fairly well - voyages sell or are moved

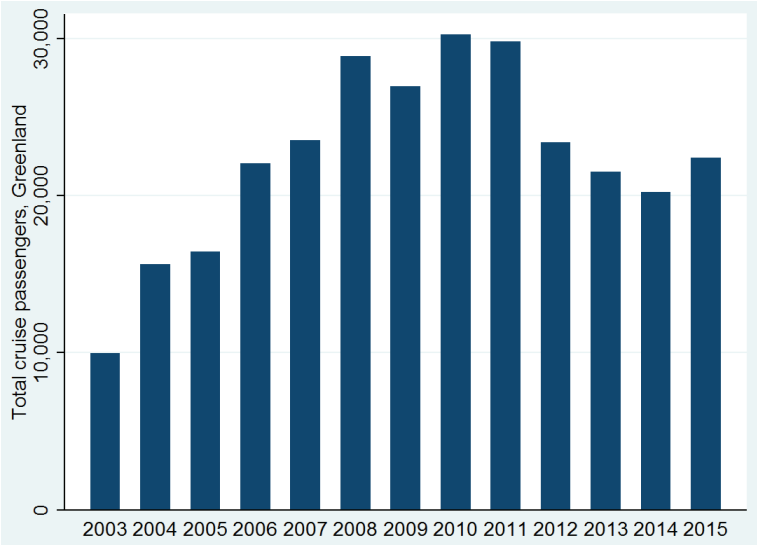

Fig. 4 Greenland Cruise Passengers, 2003-2015 (Source: bank.stat.gl)

to another location. Figure 5 shows Alaskan cruise capacities by month from 2004 to 2011 (United States Department of Transportation (2017)). Two patterns of interest emerge from the data. The first is the effect of the financial crisis creating a downturn after growth from 2004-2009. This downturn may have been further exacerbated by a set of new taxes levied on passengers and cruise ships from 2007-2010 (Resource Development Council (2017)). This highlights the sensitivity of the industry to price fluctuations and unilateral cost-raising regulation for a destination. Thus straightforwardly prescribed economic tools such as a tax to recoup damages from external costs to e.g. the environment may be ineffective in fostering community development. The high elasticity of demand makes such a tax a deterrent. No tax revenue is earned, plus the initial base of activity is reduced, if mobile capital departs for less costly locations.

The second pattern is the connection between the length of the season and the economic conditions. April, May and September capacities have more room to expand and contract than June, July and August. The summer months appear to have a top capacity of about 225,000 passengers/month. Excess demand is then met with more shoulder season offerings. These shoulder season periods, particularly April and May, have greater weather risk and may result in lower consumer satisfaction. This will be especially true if, e.g., the timing of wildlife migrations is not in synchronization with the cruising. The weather risks also impact safety and security, increasing the likelihood of accidents.

For comparison, we also return to the Greenlandic cruise data and include the passenger days by month in Figure 6. Here we see a similar expansion into the shoulder seasons. These are actually longer in Greenland than they are in Alaska, extending into October in some years. Greenland has also seen a small shift to August and September passengers over July.

Adding capacity in the high season brings its own problems. Port infrastructure is certainly one of these. Figure 7 shows the large cruise ships that serve as floating hotels and dominate the landscape. There may be up to 5 of these ships in the Ketchikan port at once. The cruise terminal itself is in large part a creation of the cruise line companies. The companies have created a tourist village staffed by seasonal workers selling trinkets from around the world. We provide data on seasonal employment in Ketchikan in year 2015 as an example, see Table 2.

Table 2 2015 Labor Force Data Ketchikan, AK; Source: State of Alaska Department of Labor and Work Force Development (laborstats.alaska.gov)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Labor Force	6,410	6,397	6,474	6,687	7,313	7,697	8,124	7,946	7,530	6,702	6,471	6,528	7,023
Employment	5,851	5,809	5,922	6,199	6,881	7,227	7,720	7,561	7,137	6,236	5,977	6,034	6,546
Unemployment	559	588	552	488	432	470	404	385	393	466	494	494	477
Unemployment Rate	8.70%	9.20%	8.50%	7.30%	5.90%	6.10%	5.00%	4.80%	5.20%	7.00%	7.60%	7.60%	6.80%

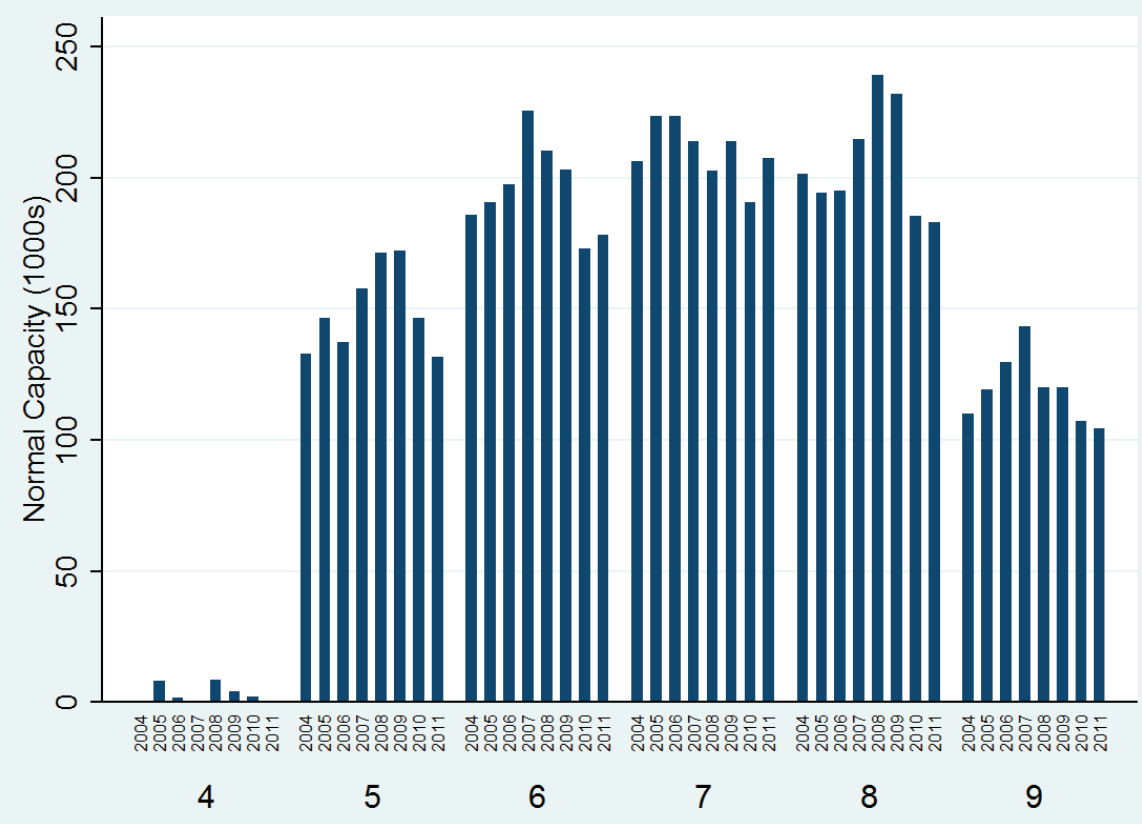

Fig. 5 Alaskan Cruise Capacity by month and year, 2004-2011 (Source: MARAD)

The labor force increased by 27% for the July peak over February in 2015, with much of of this increase coming from imported seasonal labor. This expansion requires infrastructure as well as governance that protects the rights of locals and visiting workers alike. The imported tourism labor force is not expected to have the same levels of consequence as extractive industries because the pay differential and the gender disparities are not as great. Planning of port infrastructure is still essential, however. In June, 2016, for example, a mildly windy approach to a berth on the Ketchikan docks resulted in a crash estimated to cost the facility $2-3 million dollars (see Shedlock (2016)). Additional costs came from required repairs to the ship.

Currently, Russian Arctic marine tourism levels are very low. Efforts are under way to increase the numbers. These efforts, to some extent, reflect the sorts of port developments we suggest are best suited to the Arctic economy. These efforts include the establishment of, and investment in, the 1.5 million hectare Russian Arctic National Park encompassing parts of the Kara and Barents sea around Novaya Zemlya. Approximately 60% of the park territory is marine (see Pashkevich and Stjernström (2014)).

The efforts also highlight failures in Russian and Pan-Arctic governance. Corrections of these failures could reduce impediments to the cruise industry. Pashkevich and Stjernström (2014) cite these as the ”unpredictable nature of state control influencing tourism destination development, lack of coordination among the stakeholders on all levels of governance, [and the] overall low level of expertise in hospitality and tourism management.” The role of the state in Russian Arctic development has not facilitated multi-use activities.

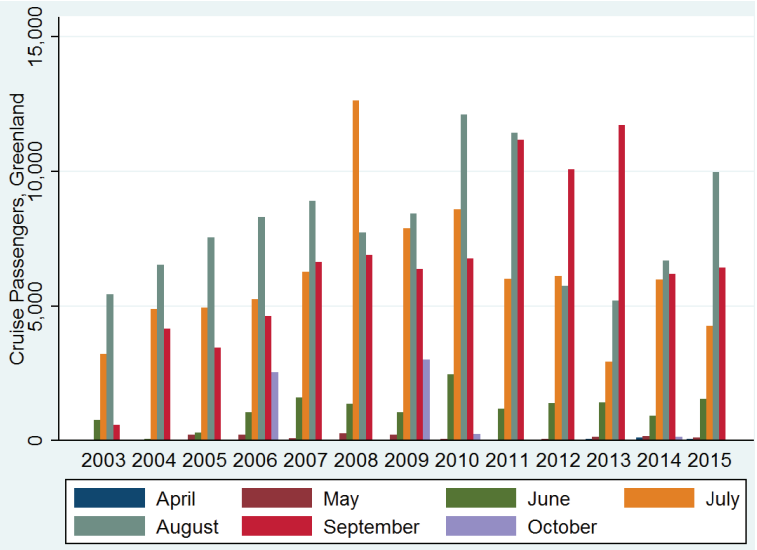

Fig. 6 Greenlandic Cruise passengers by month and year, 2003-2015. Source: bank.stat.gl

Fig. 7 Cruise Terminal, Port of Ketchikan, AK. (Photo Credit: Barek, 4 Jul 2008, Wikimedia Commons.)

Many nature preserves that have come into place in the last century that do not allow for much human activity. In these locations, Russia is primarily on a path to the Polar Preserve outcome described above. Rather than utilizing synergies from Russian Arctic investment in, e.g., cargo and military transportation, Russian institutional settings keep much of the Arctic out-of-bounds either for foreigners or for all potential tourists, including Russians. Thus despite the significantly higher levels of infrastructure in the Russian Arctic, tourism is far behind other areas in the region.

Small impositions are also costly. The number of cruise vessels that visited Franz Josef Land and Novaya Zemlya from 2000-2013 only totals 62 - an average of 4 or 5 per year. The high elasticity of demand lowers the ability to impose non-price tariffs as well as higher prices. Deterrents to more vessels include requirements that cruise ships accommodate, free of charge, 3 to 5 park officials and bear guards to serve

as guides and protection. This requirement is followed because the bear guards are the only participants allowed to carry guns. The cost of the extra officials is increased due to the fact that they often have no tourism experience that enhances the passengers' enjoyment. Integrated tours with, e.g., Svalbard are made prohibitively costly by requirements to stop in Murmansk for visa clearance. These requirements also involve uncertainties and extra costs to secure. Both the overall cruise passage and every tourist on board must have their full itineraries cleared months in advance of the trip. This lengthy and inflexible process is due in part to the fact that all permits must be signed by the prime minister directly (Pashkevich and Stjernström (2014)).

2.7 Fishing in the Arctic

Fishing in the Arctic is both commercial and local. Local fishing consists both of fishing tourism and subsistence fishing. There remains significant subsistence use in indigenous communities, particularly in areas of the NWP. Commercial use, particularly in the North Atlantic, Barents Sea, and Bering Sea, provides seafood to customers throughout the world. The Barents and Bering Seas also serve as entrances or exits to Central Arctic Ocean navigation. Fishing is also an important draw for Arctic tourism throughout the Arctic. Some locations, such as Iceland, currently have their fishing tourism more focused on their inland and shore-based fishing of anadromous species than coastal fishing. This is changing as excess capacity in the Icelandic coastal fleet combines with rapidly increasing tourism to draw tourists to the sea as well. Port infrastructure will need to respond accordingly, with access to shore-based tourists as well as cruise-ship based ones. As fishing tourism grows, recreational limits - and facilities at ports for monitoring these limits - are also likely to need increased development.

Subsistence consumption includes marine mammals. Fishing efforts led the push from southern areas into the Arctic centuries ago, in both the Pacific and the Atlantic. Vikings in Greenland followed the walrus in the Atlantic (Kintisch (2016)); Asian fishermen followed fish and marine mammals north into the Bering Sea (McGhee (2017)). Southern-based fishermen and Inuit alike had extensive knowledge about Arctic navigation from which many Arctic explorers failed to learn. As Barry Lopez elegantly puts it in his book *Arctic Dreams*, fishermen were "no doubt off the coast of Newfoundland before Cabot, in Frobisher Bay before Frobisher, in Hudson Strait before Hudson, and in Lancaster Sound before Ross arrived" (see Lopez (1999)). Today, fishing is a less profitable pursuit in the Arctic than non-renewable resource extraction. Adages like fish are measured in pennies, while oil and gas are measured in dollars highlight the relative interest of the two industries to economic development efforts. This sort of expression clearly and erroneously ignores cultural and ecological values. Recently, even the basic economic arguments it relies upon have been shifting. An average (4.5 kg) Norwegian farmed salmon fetched a higher price than a barrel of Norwegian North Sea crude oil in January 2016 (see Berglund (2016)). Given the multifaceted fishing interests in the Arctic, future port infrastructure in most cases must consider these combined subsistence, tourist, and commercial fishing interests.

Fishing vessel presence in Arctic waters from 2012 to the end of 2016 are revealed in Figure 8. Panels 1-6 show voyages of vessels flagged to the five Arctic coastal countries (Denmark, Iceland, Norway, Russian Federation, United States) as well as Iceland. Panel 7 shows all vessel voyages with *Automatic Information System* (AIS) technology. The vessel tracks are the lightest shading on the maps; the more intense the light, the more vessels this represents. The data come from Global Fishing Watch (globalfishingwatch.org), one of a growing number of information outlets where fishermen and the public now have free information about vessel activities. AIS trackers are required by *International Maritime Organization* (IMO) SOLAS 19 regulations on all "vessels over of 300 gross tonnage and upwards engaged on international voyages, cargo ships

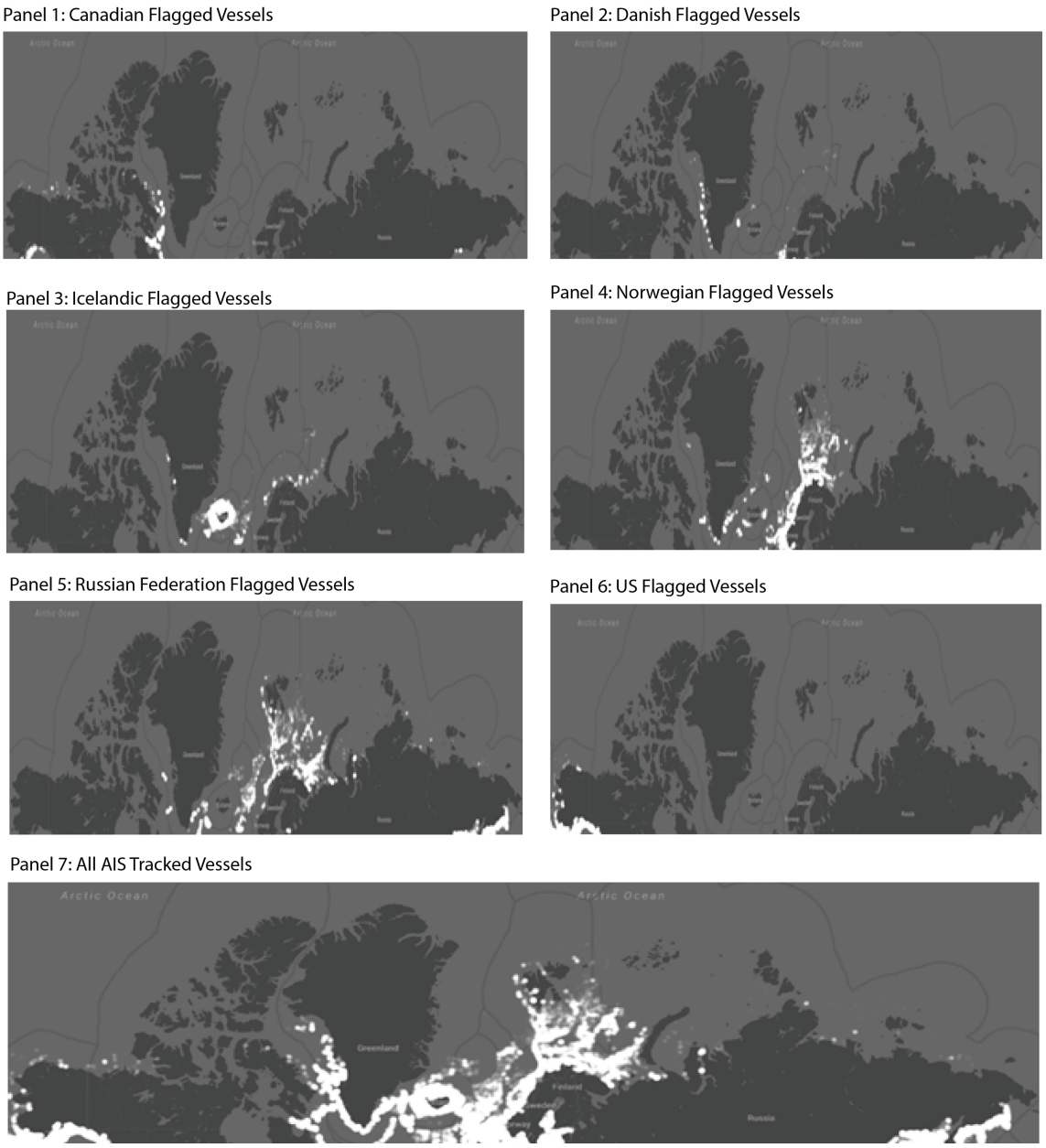

Fig. 8 AIS tracks of fishing vessel traffic in the north, 2012-2016. Source: globalfishingwatch.org

of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size" (see IMO (2016)). The requirement came into force at the end of 2004. With the data, one can follow individual vessels or correlated trends in fishing fleet behavior. This allows one to better understand and regulate the fisheries industry. For example, one could see if a port was being used heavily by vessels trying to participate in illegal, undocumented or unregulated (IUU) fishing. With this information in hand, regulators could position inspectors at ports, or otherwise adjust regulation and enforcement accordingly. The availability of the data lowers the cost of enforcement and increases the possibility of achieving improved growth outcomes that successfully conserve fisheries for long term sustainable use.

In this chapter, we use the agglomerated data to illustrate the density and locations of fishing vessels in the past four years for the different regions of the Arctic. From the first 6 panels of Figure 8, we can see that Arctic flagged vessels, to a great extent, fish the sovereign waters of their *Exclusive Economic Zones* (EEZs). Comparison to the final panel, where vessels of all flags are shown, suggests that other vessels are using these fishing grounds as well. This is visible in that there are more areas that show fishing activity than in the individual panels showing only that nation's fleet. The increased vessel presence is particularly noticeable in the Barents Sea loophole and in the international waters surrounding Svalbard, along the Greenlandic coast, and to a lesser extent in the Chuckchi and Beaufort Seas north of Alaska and Canada. The overall intensity of use, evidenced by the density of voyages within the EEZs, does not appear to be much higher in total than for each country in its own waters. Thus EEZs in the north appear to be effective in limiting entry to own-state-flagged vessels. This is in accordance with the generally strong governance of these states in protecting their domestic fishing interests.

The images in Figure 8 highlight the current absence of significant fishing activity in the northernmost waters. The five coastal Arctic states agreed to a moratorium on fishing in the Central Arctic Ocean in summer 2015 (see Canada et al. (2015)). The countries took this step to try to preempt actions by fishermen interested in opening up new fishing grounds as the costs of access decrease. There is also the expectation that existing fishery species ranges will expand northward. This is already happening for some species and locations, including for northern shrimp (*Pandalus borealis*) in Greenland. These shifts will include new demands on port infrastructure. For instance, the case of the introduction of the Red King Crab into the Barents sea highlights how demands for Arctic port infrastructure are likely to change with climate change impacts and related invasion of species; these crabs are most profitable if they can be exported live, which requires rapid and thorough connectivity from crab pot to a landing and processing facility, and then on to ground and air transportation to markets.

The commercial value of the fisheries are not the only consideration. Small vessel coastal fishing fleets, such as the Norwegian fleet, are not just a way to provide tax revenues to the state. These fleets form the fabric of local communities in the Arctic. Changes in Arctic climate and species presence are transforming opportunities for these fishermen and their communities.

In the case of the Red King Crab, the Russians and the Norwegians are taking two different approaches. The Russians are fishing the species with large vessels capable of on-board processing, bypassing shore infrastructure needs to a large extent. The Norwegians, on the other hand, want to gain high marginal value on the crab through live year-round export incentivized on world markets. They see the crab as a way of supporting the declining northern coastal fishing fleet. The long decline has slowed with a recent tapering off in Finnmark, the northernmost Norwegian county and the only one whose residents are allowed to fish for Red King Crab. This stemming of the decline is not occurring in the next most northern counties, Troms and Nordland. This is illustrated by their continuing decline in vessel registrations in Figure 9.

To date, the crab is confined mainly to Eastern Finnmark, a situation which the Norwegian authorities would like to maintain. This is because it has determined the crab to be an invasive species that should be contained from spreading (see Sundet and Hoel (2016)). The abundance of the crab is creating a boon for

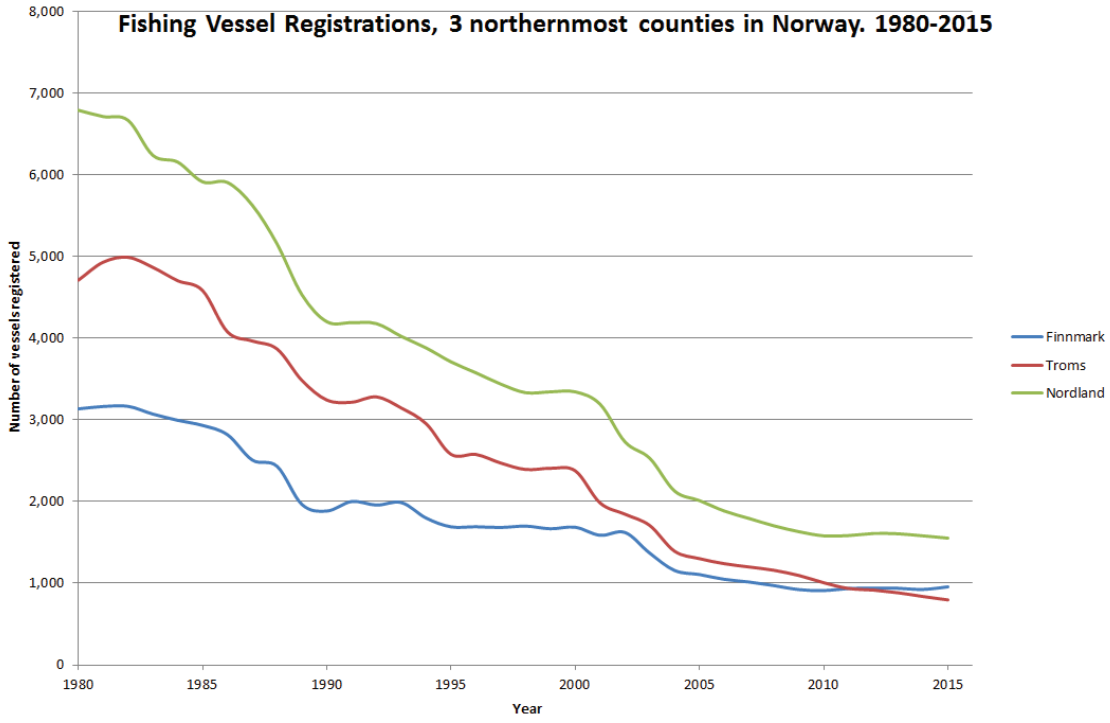

Fig. 9 Vessels registered in Northern Norway. (Source: Norwegian Maritime Authority)

the fishermen, but the remoteness of Finnmark and the special demands of live crab have meant that shore facilities for handling live crab must be located very near to the road and air transport, *and* to the crab pots, in order to minimize total travel times to distant foreign markets. New facilities employing 4-5 on-site workers, such as the one pictured in Figure 10 are being added in otherwise remote and isolated parts of Finnmark.

This decentralization of facilities is counter to the general consolidation of community services that is simultaneously occurring in Norway. National policies are downsizing or eliminating schools, hospitals and other public infrastructure in return for more concentrated services in the bigger towns. At the same time, the most profitable maritime activities are requiring more dispersion of the fishermen. This mismatch increases the challenges of decision-making for investments and the difficulties for recruitment of new fishers to the industry (see Sønvisen (2013)). The development of port infrastructure, even in the most developed and wealthy of Arctic locations, requires thorough integration with social policy if it is to succeed.

Regarding Iceland, Figure 8 panel 3 (Iceland) clearly shows Icelandic coastal fishing activity is significant. It is well known that commercial fishing plays a substantial part in the Icelandic economy. In Arctic waters, however, there are two types of commercial fishing. These are fishing by coastal fleets and large scale offshore fishing. Just as the opening of the TPR can be seen as bypassing shore-based Arctic routes and reducing demand for their services, high capacity fishing vessels with on-board processing capacity can bypass Arctic ports and take products to larger markets directly. This was the case with 19th century whaling, and it is the case with much northern fishing today. The adoption of high capacity vessels around much of

Fig. 10 Red King Crab landing facility in Trollbukt, Laksefjord. (Photo: Brooks Kaiser, 2016)

the world was exacerbated by well-intentioned open access fishing regulations. Examples include seasonal restrictions that promoted capitalization of the fleet in order to harvest as many fish as quickly as possible.

Since the failures of these open access regulations have become known, *Individually tradeable quotas* (ITQs) are now presented as a preferable regulatory method. This permit system does manage the stock of fish in a more efficient manner with less overcapitalization of the fleet. The effect on ports, however, is unclear, and there is no better example of this than Iceland. Iceland moved to ITQs in the mid 1980s and experienced a rapid decrease in the number of fishermen holding quota. Concentration of quota into a few hands also increased. This has generated increasing inequality amongst remaining fishermen, turning formerly independent fishermen into laborers for others. Shore-based jobs in the ports decreased by a third - from about $10,500$ to $7,000$ employees - as processing moved to on-board operations (Olsen (2011)). Net outcomes have been contentious, since distributional impacts have been so diverse (Eythórsson (2000)).

3 Cross-industry Considerations

In this chapter, we consider two important impacts that affect all countries and industries operating in the Arctic. These are seasonal constraints and the role of information.

3.1 Seasonalities: Development Impacts

As should be apparent, climate - particularly, but not only, sea ice - has played an important role in shaping transformations of Arctic communities. 19th Century marine activities in the Arctic focused on harvests of whales and other food sources. Demands for infrastructure were limited since the whaling and walrusing ships generally functioned as self-contained offshore factories. Even so, the southerners' whaling fleets wreaked havoc on local communities' sustainability, and the boom in whaling created whale, walrus, and then Inuit population busts throughout the Inuit Arctic (see Bockstace (1986)). Winter survival became more difficult with lower food supplies, and no newcomers remained in the area to trade imported goods or technologies to assist survival and transitions; they departed with their ships in the fall before ice destroyed their ship-factories. Summer and early fall were the "open" seasons for North-South communication by ship in much of the Arctic. These seasons are, however, to a large extent the "closed" seasons for trade and transport amongst indigenous communities (circumpolar communication). This is because they use the sea ice for hunting and transportation amongst small scattered communities. Thus simultaneous seasonal resource extraction and the continuation of traditional indigenous lifestyles could and did coincide to a greater degree than in many other developing regions, despite devastating population impacts (see Bockstace (1986)). When resource extraction switched from those that had important competing uses as subsistence to non-renewables that had little local use, these population pressures on whales, walrus and men eased up to some extent.

Today, the resources have shifted to oil, gas, minerals or tourism services, but overall extraction pressures and impacts on indigenous lifestyles are rising again. When looking at data from NORDREG, an increase in traffic through the Northeast and Northwest Passages is evident (see Environment and Natural Resources (2015)). Furthermore, Arctic ports stand to play an increasingly important role in communications with the rest of the world as land-based travel is expected to deteriorate significantly. This deterioration is primarily due to melting permafrost (see, e.g., Stephenson et al. (2011)). The magnitude of this loss ranges from a reduction of 11% in winter-road-accessible land area in Greenland (where road travel is already scarce) to 82% in Iceland, with an overall loss in Arctic regions of 14%. The expected gain in maritime access totals 23%. This comes mostly from increased access to the high seas (a 406% increase). Still, Canada, Greenland and the Russian Federation all are expected to gain over 15% in area. Iceland, Norway, and the U.S. on the other hand stand to gain little or no additional area (see Stephenson et al. (2011)).

The loss of land transport options due to melting ice roads and the gain of marine traffic zones are seasonal. For instance, during July-September, the Arctic is projected to be open for maritime shipping in the NWP, NSR, and TPR routes (see Stephenson et al. (2011)). Studies conducted by Stephenson et al. (2011) suggest that a substantial increase in maritime traffic will occur for Canada, Greenland, Russia, and the United States, although ships will still require their own ice-breaking capacity or ice-breaking services from another vessel.

3.2 The Role of Information

Information about environmental conditions, ship locations, and their activity is rapidly becoming more and more available to shipowners, government regulators, and the public around the world, including the Arctic. The rate of change of use for remote sensing tools is formidable. Live and historical AIS data is available from sites such as *marinetraffic.com* and *vesselfinder.com*, with live data freely available and historical data available at fairly low cost. This reduction in the costs of information can be expected to have significant

positive effects on safety and security, as intended by the regulations. There are larger consequences as well. Some remote sensing products combine AIS information with self-reporting and other remote-sensing inputs such as weather. An example of this is BarentsWatch (*barentswatch.no/en*). BarentsWatch is primarily a tool to aid the fishing industry in the Barents sea. On the website one can easily identify fishing locations in use and what type of fishing is occurring through differentiated markers. New species moving north at record rates. Fishermen will be some of the first and most influential observers of these shifts. Thus tools like BarentsWatch will serve to inform the fishermen and those who process the fish and make shore investments based on predictions regarding fish stocks. These tools can also inform about their need for regulation and/or compliance with that regulation.

Still, the Arctic region is lacking in much basic information about its economies and prospects. There is significant uncertainty surrounding the biggest hope of the past decades - oil and gas reserves. This uncertainty only partly stems from world forces creating highly volatile prices. It also comes from the challenges of accurately identifying new resources. The U.S. Department of the Interior (see U.S. Department of the Interior (2008)) public estimates of reserves of both oil and gas are quite large. The subsequent activity in e.g. the Beaufort (Shell) and off the Greenland coast (Cairns) has, however, resulted in disappointment. This disappointment has been increased by lower global prices and profit expectations. The departure of Shell from the Arctic proved a devastating blow for port development aims in Northern Alaska.

4 Conclusions

This chapter describes past and current conditions in the Arctic as they pertain to port infrastructure and use. The chapter looks at the resource extraction, tourism and fishing industries in particular. In so doing, we find that economic incentives in northern communities have tendencies that generate cyclical economic outcomes that require governance to mitigate if balanced growth is to develop for the region. Trans-Arctic shipping is not investigated in large part because it is expected to provide only short term opportunities for local communities at best, due to the lower-cost potential of the TPR that can bypass the shore-based NWP and NSR routes.

Of these tendencies, we find that resource extraction has the most risk of creating negative social costs for communities. These social costs range from stranded investments to gender-based violence and inequality. Price fluctuations outside of the control of Arctic communities dictate demand for the resources and leave the communities vulnerable to boom-bust cycles. Skills needed in the industry do not match skills available in the local populations, so job creation for local communities is expected to be low. At the same time, outside labor, sometimes with significant cultural differences, is arriving or anticipated to arrive. This brings additional social conflicts and challenges as market-based activity grows and favors high wage earners over local subsistence on the marine environment. The profitability of oil and gas resources in Russia has invited private investment in several ports. This will serve the industry but diversified communities cannot easily be built on such foundations, and local stakeholders stand to be disenfranchised.

Arctic fisheries, which operate on four intertwined levels of subsistence, recreational, coastal commercial and offshore commercial, have long histories throughout the area. Most are currently well regulated. Climate changes are affecting the stability of these regulations and outcomes, however. The introduction of new species and the movement of existing commercial species into new areas are shifting the port infrastructure needs. There have been recent positive and negative developments. The privatization of Icelandic fisheries through ITQs has increased overall Icelandic wealth, but left many fishing communities and their ports with few economic prospects as property rights move to larger vessels offshore and citizens move to bigger

towns. In Norwegian waters, the introduction of the Red King Crab is creating ecological damages as well as economic benefits for coastal fishermen. The requirements of the live crab industry, however, are demanding a diffusion of facilities at a time when cost savings and economies of scale from government planners have been trying to move in the opposite direction, consolidating facilities.

Arctic marine tourism is profitable and growing, but demand elasticity for Arctic cruises is high as capacity can be rapidly adjusted by moving vessels. Demands by tourists for shopping and entertainment in ports are leading to imbalances in what the local population can provide (and staff), and what the cruise companies will do to supplement this capacity with e.g. outside labor or internal training. This imbalance may strain local relations in similar ways to resource extraction if imported labor is seasonal and used to supplant local populations rather than support them. As cruise vessels become larger to accommodate more passengers, port facilities must invest in capacity that will only be used for a few visits a year, or use higher risk methods for bringing passengers to shore in order to avoid being bypassed altogether.

The challenges for Arctic port development are significant. The choices made over both port infrastructure and industry regulation will have long-ranging impacts on the available development paths in the region. Past experiences with high-fixed-cost, low-marginal-cost transportation networks like North American railroads provide cautionary lessons. These lessons suggest that public investment in port infrastructure can improve the likelihood of positive outcomes but that it should also be accompanied by regulatory oversight of the industries that develop along the transportation networks. This regulatory oversight should work to reduce overcapitalization. It should seek to promote social equality where resource extraction is prominent. It should also seek to enhance cooperation for the provision of networked tourism opportunities to support both of the aforementioned goals. It should conserve its living marine resource base of marine mammals and fisheries to meet a wide variety of interests and uses in the present and future. The realization of these goals will require cooperation within and across Arctic nations.

References

Y. Aksenov, E.E. Popova, A. Yool, A.J.G Nurser, T.D. Williams, L. Bertino, and J. Bergh. On the future navigability of arctic sea routes: High-resolution projections of the Arctic ocean and sea ice. *Marine Policy*, 75:330–317, 2016.

Amnesty International. Canada: Out of sight, out of mind: Gender, indigenous rights and energy development in northeast British Columbia. Internet Source: https://www.amnesty.org/en/documents/amr20/4872/2016/en/, 2016. Last call: 19.01.2017.

C. Aporta. The trail as home: Inuit and their pan-Arctic network of routes. *Human Ecology*, 37(2):131–146, 2009.

Arctic Cluster of Raw Materials. Greenland and benchmarking report 2016. Internet Source, 2016. URL http://acrm.dk/?knowledge-center=greenland-benchmarking-report. Last call: 30.03.2017.

Arctic Council. Nuuk declaration (2011). Internet Source: http://hdl.handle.net/11374/92, 2011. Last call: 19.01.2017.

Arctic Council. Kiruna declaration (2013). Internet Source: http://hdl.handle.net/11374/93, 2013. Last call: 19.01.2017.

J. Atack, F. Bateman, M. Haines, and R. Margo. Did railroads induce or follow economic growth? Urbanization and population growth in the American Midwest, 18501860. *Social Science History*, 34(2):171–197, 2010.

N. Berglund. Salmon worth more than a barrel of oil. Internet Source: http://www.newsinenglish.no/2016/01/15/salmon-worth-more-than-oil/, 2016. Last call: 19.01.2017.

J.R. Bockstace. *Whales, Ice, and Men: The History of Whaling in the Western Arctic*. University of Washington Press, 1986.

A. Buixadé Farré, S.R. Stephenson, L. Chen, M. Czub, Y. Dai, D. Demchev, Y. Efimov, P. Graczyk, H. Grythe, K. Keil, N. Kivekas, N. Kumar, N. Liu, I. Matelenok, M. Myksvoll, D. O'Leary, J. Olsen, S.A.P. Pavithran, E. Petersen, A. Raspotnik, I. Ryzhov, J. Solski, L. Suo, C. Troein, V. Valeeva, J. van Rijckevorsel, and J. Wighting. Commercial Arctic shipping through the Northeast Passage: Routes, resources, governance, technology, and infrastructure. *Polar Geography*, 37(4):298–324, 2014. URL http://www.enr.gov.nt.ca/state-environment/73-trends-shipping-northwest-passage-and-beaufort-sea.

L.P Cain and B.A. Kaiser. A century of environmental legislation. In S. Wolcott and C. Hanes, editors, *Research in Economic History*, volume 32, chapter 1, pages 1–71. Emerald Insight, 2016.

Canada, Denmark, Norway, Russian Federation, and United States of America. Declaration concerning the prevention of unregulated high seas fishing in the central Arctic ocean. Internet Source: https://www.regjeringen.no/globalassets/departementene/ud/vedlegg/folkerett/declaration-on-arctic-fisheries-16-july-2015.pdf, 2015. The countries of Canada, Denmark, Norway, Russian Federation and the United States of America; Last call: 19.01.2017.

A.M. Carlos and F. Lewis. The profitability of early canadian railroads: Evidence from the grand trunk and great western railway companies. In *Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel*, NBER Chapters, pages 401–426. National Bureau of Economic Research, Inc, 1992.

CBS News. Churchill port closure could mean small shipment bump for thunder bay. Internet Source: http://www.cbc.ca/news/canada/thunder-bay/churchill-port-closure-thunder-bay-1.3697342, 2016. Last call: 16.12.2016.

Environment and Natural Resources. State of the environment: 7.3 Trends in shipping in the Northwest passage and the Beufort sea. Internet Source: http://www.enr.gov.nt.ca/state-environment/73-trends-shipping-northwest-Passage-and-beaufort-sea, 2015. Last call 13.05.2016.

E. Eythórsson. A decade of ITQ-management in Icelandic fisheries: consolidation without consensus. *Marine Policy*, 24(6):483–492, 2000.

S. Glomsröd and I. Aslaksen. Presenting the economy of the north 2008. Internet Source: https://www.ssb.no/a/publikasjoner/pdf/sa112_en/sa112_en.pdf, 2008. Last call: 11.11.2016.

E.J. Green and R.H. Porter. Noncooperative collusion under imperfect price information. *Econometrica: Journal of the Econometric Society*, 52(1):87–100, 1984.

A.M. Hansen, F. Vanclay, P. Croal, and A.-S. Hurup Skjervedal. Managing the social impacts of the rapidly-expanding extractive industries in Greenland. *The Extractive Industries and Society*, 3(1):25–33, 2016.

R.K. Headland. Transits of the Northwest Passage to end of the 2014 navigation season. Internet Source, 2014. URL http://www.americanpolar.org/wp-content/uploads/2014/10/NWP-2014-X-5-layout-for-PDF.pdf. Scott Polar Research Institute, University of Cambridge, UK, Last call: 03.04.2017.

G. Heal. Reflections-defining and measuring sustainability. *Review of Environmental Economics and Policy*, 6(1):147–163, 2012.

IMO. AIS transponders. Internet Source: http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx, 2016. Last call: 19.01.2017.

Intergovernmental Panel on Climate Change. Climate change 2001: The scientific basis - a report of working group I of the intergovernmental panel on climate change. Internet Source: http://www.grida.no/climate/ipcc_tar/wg1/pdf/WG1_TAR-Front.pdf, 2001. 2.2.5-2.2.6; Last call: 19.01.2017.

O.M. Johannessen, E.V. Shalina, and M.W. Miles. Satellite evidence for an Arctic sea ice cover in transformation. *Science*, 286(5446):1937–1939, 1999.

A. Jørgensen-Dahl and T. Wergeland. Shipping, resources, economic trends and alternative means of transport. In W. Østreng, K.M. Eger, B. Fløistad, A. Jørgensen-Dahl, L. Lothe, M. Mejlænder-Larsen, and T. Wergeland, editors, *Shipping in Arctic Waters: A Comparison of the Northeast, Northwest and Trans Polar Passages*, chapter 4, pages 83–145. Springer, 2013.

B.A. Kaiser, L.M. Fernandez, and N. Vestergaard. The future of the marine Arctic: Environmental and resource economic development issues. *The Polar Journal*, 6(1):152–168, 2016.

E. Kintisch. The lost norse. *Science*, 354(6313):696–701, 2016.

T. Koenigk, L. Brodeau, R.G. Graversen, J. Karlsson, G. Svensson, M. Tjernström, U. Willen, and K. Wyser. Arctic climate change in 21st century CMIP5 simulations with EC-Earth. *Climate Dynamics*, 40(11-12): 2719–2743, 2013.

L. Larsen. An evaluation of the present situation for western Canadian grain farmers within a historical context. a report prepared for the Canadian Wheat Board Alliance. Internet Source, 2016. URL http://www.cwbafacts.ca/wp-content/uploads/2016/04/Evaluation-of-present-situation-for-Western-Canadian-grain-farmers_revised.pdf. Last call: 27.03.2017.

B. Lopez. *Arctic dreams: Imagination and desire in a northern landscape*. Vintage, 1999.

J.M. MacFarlane. Full transits of the canadian northwest passage. Internet Source: Nauticapedia, 2012. URL http://nauticapedia.ca/Articles/NWP_Fulltransits.php. Last call: 03.04.2017.

J. Majewski. American railroads and the transformation of the antebellum economy classic reviews in economic history. Internet Source: http://www.eh.net/?s=American+railroads+and+the+transformation, 2016. Last call: 19.01.2017.

R. McGhee. The archaeological construction of aboriginality. In C. Hillerdal, A. Karlstrom, and C.G. Ojala, editors, *Archaeologies of "Us" and "Them": Debating History, Heritage and Indigeneity*. Routledge, 2017.

Ministry of Foreign Affairs Denmark, Department of Foreign Affairs Greenland, and Ministry of Foreign Affairs Faroes. Kingdom of Denmark strategy for the Arctic 2011-2020. Internet Source: http://www.uniset.ca/microstates/mss-denmark_en.pdf, 2011. ISBN: 561-5, Last call: 10.12.2016.

D. Morrison. The copper Inuit soapstone trade. *Arctic*, 44(3):239–246, 1991.

M. Mustafanezhad, R. Norum, E.J. Shelton, and A. Thompson-Carr, editors. *Political Ecology of Tourism. Community, power and the environment*. Routledge, 2016.

R. Newton, S. Pfirman, P. Schlosser, B. Tremblay, M. Murray, and R. Pomerance. White Arctic vs. blue Arctic: A case study of diverging stakeholder responses to environmental change. *Earth's Future*, 4(8): 396–405, 2016.

NOAA. Marine mammal viewing guidelines and regulations Alaska regional office. Internet Source: https://alaskafisheries.noaa.gov/pr/mm-viewing-guide, 2016. Last call: 19.01.2017.

M. Nuttall. The circumpolar north: Locating the Arctic and sub-Arctic. In R. Fardon, O. Harris, T.H.J. Marchand, M. Nuttall, C. Shore, V. Strang, and R.A. Wilson, editors, *The SAGE Handbook of Social Anthropology*, chapter 1.2, pages 270–285. SAGE Knowledge, 2012.

M. Nuttall. Zero-tolerance, uranium and Greenland's mining future. *The Polar Journal*, 3(2):368–383, 2013.

J. Olsen. Understanding and contextualizing social impacts from the privatization of fisheries: an overview. *Ocean & Coastal Management*, 54(5):353–363, 2011.

A. Pashkevich and O. Stjernström. Making Russian Arctic accessible for tourists: analysis of the institutional barriers. *Polar Geography*, 37(2):137–156, 2014.

A. Pashkevich, J. Dawson, and E.J. Stewart. Governance of expedition cruise ship tourism in the Arctic: A comparison of the Canadian and Russian Arctic. *Tourism in Marine Environments*, 1+(3-4):225–240, 2015.

K. V. Pavlov and V.S Selin. Problems of development of freight traffic of the northern sea route and methods of their decision. *Bulletin UGUES. Science, education, the economy. Series: Economy*, 2(12), 2015.

A.T. Peacock. The growth of public expenditure. In C.K. Rowley and F. Schneider, editors, *The Encyclopedia of Public Choice*, pages 3–31. Springer, 2004. URL http://link.springer.com/book/10.1007%2Fb108558.

Port of Churchill. History: Port of Churchill Hudson Bay Port Company. Internet Source: www.portofchurchill.ca/about/history, 2016. Last call: 16.12.2016.

R.H. Porter. A study of cartel stability: the joint executive committee, 1880-1886. *The Bell Journal of Economics*, 14(2):301–314, 1983.

Resource Development Council. Alaska's tourism industry. Internet Source, 2017. URL http://www.akrdc.org/tourism. Last call: 24.03.2017.

J. Richter-Menge, J.E. Overland, and J.T. Mathis. Arctic report card 2016. Internet Source: http://www.arctic.noaa.gov/Report-Card, 2016. Last call: 30.12.2016.

G. Saxinger. Lured by oil and gas: labour mobility, multi-locality and negotiating normality & extreme in the Russian far north. *The Extractive Industries and Society*, 3(1):50–59, 2016.

J. Shedlock. Video: Cruise ship crashes into Ketchikan Dock. Internet Source: https://www.adn.com/alaska-news/2016/06/03/video-cruise-ship-crashes-into-ketchikan-dock/, 2016. Alaska Dispatch News; Last call: 19.01.2017.

S.A. Sønvisen. Recruitment to the Norwegian fishing fleet: storylines, paradoxes, and pragmatism in norwegian fisheries and recruitment policy. *Maritime Studies*, 12(1):1–8, 2013.

A. Staalesen. Russian Arctic ports have best year ever. Internet Source: The Barents Observer, 2017. URL https://thebarentsobserver.com/en/industry-and-energy/2017/01/russian-arctic-ports-have-best-year-ever. Last call: 24.03.2017.

Statistics Greenland. Cruise ship statistics. Internet Source, 2016. URL http://www.stat.gl/dialog/main.asp?lang=en&sc=TU&version=201606. Last call: 24.03.2017.

P.E. Steinberg. *Contesting the Arctic - Politics and Imaginaries in the Circumpolar North*. International Library of Human Geography. I.B.Tauris, 2015.

S.R. Stephenson, L.C. Smith, and J.A. Agnew. Divergent long-term trajectories of human access to the Arctic. *Nature Climate Change*, 1:156–160, 2011.

A. Stuhl. *Unfreezing the Arctic*. The University of Chicago Press, 2016.

J.H. Sundet and A. Håkon Hoel. The Norwegian management of an introduced species: the Arctic red king crab fishery. *Marine Policy*, 72:278–284, 2016.

R. Takaki. *Strangers from a different shore: A history of Asian Americans*. Little, Brown and Company, revised and updated edition edition, 2012.

G.R. Taylor and I.D. Neu. *The American Railroad Network, 1861-1890*. University of Illinois Press, 1956.

The Arctic Journal. Inuk and Sunk: Quick action prevented serious tour-boat accident. Internet Source: http://arcticjournal.com/business/2512/quick-action-prevented-serious-tour-boat-accident, 2016. Last call: 19.01.2017.

Thompson Citizen. Ashton asks government to stop catering to billionaires and save the port of Churchill. Internet Source: http://www.thompsoncitizen.net/news/nickel-belt/ashton-asks-government-to-stop-catering-to-billionaires-and-save-the-port-of-churchill-1.3531622, 2016. Last call: 16.12.2016.

J. Tuckman. Tourist dies and two injured after whale crashes into sightseeing boat off Mexico. Internet Source: https://www.theguardian.com/world/2015/mar/12/jumping-whale-kills-canadian-woman, 2015. Last call: 19.01.2017.

T.S. Ulen. The market for regulation: The ICC from 1887 to 1920. *The American Economic Review*, 70(2): 306–310, 1980.

United States Department of Transportation. Maritime administration (MARAD) resources. Internet Source, 2017. URL https://www.marad.dot.gov/resources/data-statistics/. Last call: 24.03.2017.

U.S. Department of the Interior. Circum-Arctic resource appraisal: Estimates of undiscovered oil and gas north of the Arctic circle. Internet Source: USGS Fact Sheet 2008-3049: https://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf, 2008. Last call: 04.12.2016.

VisitGreenland. Tourism report q3-q4 2015. Internet Source, 2015. URL http://tourismstat.gl/?lang=en. Last call: 30.03.2017.

VisitGreenland. Tourism strategy 2016-2019. Internet Source, 2016. URL http://corporate.greenland.com/en/about-visit-greenland/strategi-2016-2019/. Last call: 30.03.2017.