

Local-level responses to sea ice change and cruise tourism in Arctic Canada's Northwest Passage

E.J. Stewart, J. Dawson, S.E.L. Howell, M.E. Johnston, T. Pearce & H. Lemelin

To cite this article: E.J. Stewart, J. Dawson, S.E.L. Howell, M.E. Johnston, T. Pearce & H. Lemelin (2013) Local-level responses to sea ice change and cruise tourism in Arctic Canada's Northwest Passage, *Polar Geography*, 36:1-2, 142-162, DOI: [10.1080/1088937X.2012.705352](https://doi.org/10.1080/1088937X.2012.705352)

To link to this article: <https://doi.org/10.1080/1088937X.2012.705352>



Published online: 12 Jul 2012.



Submit your article to this journal [↗](#)



Article views: 1516



View related articles [↗](#)



Citing articles: 9 View citing articles [↗](#)



Local-level responses to sea ice change and cruise tourism in Arctic Canada's Northwest Passage

E.J. STEWART^{a*}, J. DAWSON^b, S.E.L. HOWELL^c, M.E. JOHNSTON^d,
T. PEARCE^e and H. LEMELIN^d

^a*Faculty of Environment, Society & Design, Lincoln University, PO Box 84, Lincoln 7647, Canterbury, New Zealand;*

^b*Department of Geography, Canada Research Chair in Environment, Society & Policy, University of Ottawa, ON, Canada;*

^c*Climate Research Division, Climate Processes Section, Environment Canada, 4905 Dufferin Street, Toronto, ON, Canada M3H 5T4;*

^d*School of Outdoor Recreation, Parks and Tourism, Lakehead University, Thunder Bay, ON, Canada;*

^e*Department of Geography, Global Environmental Change Group, University of Guelph, Guelph, ON, Canada*

This article examines the interactions between sea ice change and patterns of cruise ship tourism through the Northwest Passage of Arctic Canada and how local communities are responding to this change. During the period 2006–2010, the Passage has emerged as the most popular expedition cruise area in the Canadian Arctic with an increase in planned cruises by 70%. This dramatic increase in cruise traffic has been, in part, facilitated by improved access as a result of decreases in sea ice. Since 1968, total sea ice area in northern route of the Northwest Passage has decreased by 11% per decade and total sea ice area in the southern of the Northwest Passage has decreased by 16% per decade. Integrating research from both social and geophysical science, this article presents an analysis of changing cruise tourism patterns through the Northwest Passage and analyses resident responses from Passage communities including Ulukhaktok, Gjoa Haven, and Pond Inlet. Discussion is focused on issues associated with infrastructure, security, protection of the marine environment, human safety, and search and rescue. This research is important to help prepare communities, policy makers, as well as the cruise sector itself, to be responsive to change in these remote locations.

Introduction

The Arctic Marine Shipping Assessment (2009) report highlights that cruise ships now represent a significant proportion of shipping activity in the Arctic and that the sector is continuing to grow. The dramatic growth of cruise ship activity through the Northwest Passage is evidence of the report's claim for Arctic Canada. The Passage has emerged as the most popular expedition cruise area in the Canadian Arctic with an increase in planned cruises by 70% over the period 2006–2010 (Stewart *et al.* 2010). The catalyst for this growth is thought to be, in part, related to

*Corresponding author. Email: emma.stewart@Lincoln.ac.nz

climate change and significant decreases in sea ice across the Arctic (Kaltenstein 2011; Lamars and Amelung 2010). Over the period 1979–2011, the rate of decrease in minimum September ice extent is -12.0% per decade (Perovich *et al.* 2011) and as a result, the Arctic Ocean could be sea ice free within 30 years (Wang and Overland 2009). Regionally in the Canadian Arctic, sea ice that spans the Northwest Passage has reduced by 5.2% per decade in the Beaufort Sea, 2.9% per decade in the Canadian Arctic Archipelago, and 8.9% per decade in Baffin Bay (Tivy *et al.* 2011).

While cruise operators have been quick to capitalize on these changes in sea ice conditions, the rapidity of such growth is something policy makers and local residents cannot ignore (Byers and Lalonde 2009; Dawson *et al.* 2007; Furgal and Prowse 2008). Marquez and Eagles (2007) examined Nunavut's cruise sector from a stakeholder perspective and indicated that it was critical to assess local-level responses to the growth in the tourism industry. Only a few research projects have assessed resident attitudes toward tourism including Baffin Island (Keller 1982, 1987), the communities of Clyde River (Nickels *et al.* 1991), Baker Lake (Woodley 1994), and Pond Inlet (Grekin and Milne 1996) and later Stewart (2009) whose study included Pond Inlet, Churchill, and Cambridge Bay. This small body of research indicated that for those hamlets, tourism was endorsed, in the most part, and accepted as an important part of the new mixed social and economic environment of the north, and a tool for economic and cultural exchange. However, the majority of the research pre-dates 2007; this point is critical because after this date, the Northwest Passage experienced multiple summer seasons whereby the Passage was ice-free, and communities along the Passage hosted increasing numbers of cruise visitors.

Considering the absence of understanding of local-scale tourism change in Arctic Canada, and since the effects of change are likely to manifest at the local level, this article integrates research from both geophysical and social science and presents an analysis of resident responses toward the localized effects of increased cruise activity in the Northwest Passage under changing conditions. At the eastern entrance to the Northwest Passage is the hamlet of Pond Inlet on Baffin Island (Nunavut), which has been and continues to be one of the most visited community cruise destinations in Arctic Canada. Located on King William Island more or less in the centre of the Passage is Gjoa Haven (Nunavut), which has emerged more recently as an important destination for an increasing number of passengers traveling the Northwest Passage. At the western end of the Passage is Ulukhaktok (Northwest Territories), a hamlet that also has witnessed an increase of cruise visitors in recent years as the Northwest Passage becomes more accessible. The article begins with a brief overview of cruise tourism development in the Northwest Passage. This is followed by an analysis of sea ice trends through the region to help contextualize our findings from community-based research conducted in the hamlets located along the Northwest Passage.

Cruise tourism and the Northwest Passage

By connecting the Atlantic and Pacific Oceans, the Northwest Passage provides a considerably shorter sea route between Europe and Asia than sailing through the Panama Canal or around Cape Horn (Figure 1). The first successful transit of the Passage came in 1906 when the Norwegian explorer Roald Amundsen, after two winters trapped in sea ice near Gjoa Haven, finally sailed the waters from east to

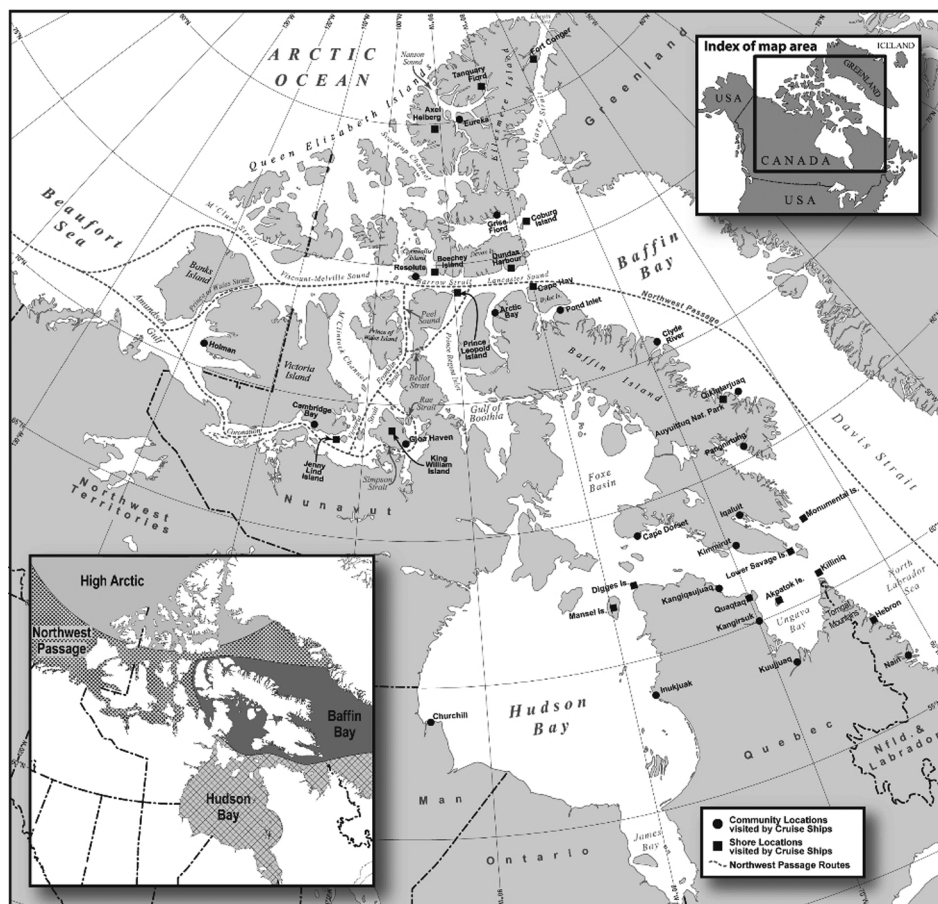


Figure 1. The Northwest Passage in the Canadian Arctic.

west. Given the opportunities to witness relics associated with this historical exploration of the Passage, as well as good wildlife viewing and opportunities to meet local Inuit, it is not surprising that the Northwest Passage has been a region of significant interest to the cruise sector since passenger vessels first began visiting the Canadian Arctic in 1984 (Grenier 2004; Stewart *et al.* 2007). Indeed, the Northwest Passage was the location for the first cruise in 1984, made by the *MS Explorer* (Jones 1999; Marsh and Staple 1995), a ship that later sank in Antarctic waters (Stewart and Draper 2008).

There continued to be sufficient tourist interest in the fabled Northwest Passage through the late 1980s to warrant similar crossing attempts; however, only two crossings were successful during the next four years (Marsh and Staple 1995). Despite these modest early developments, a more regular pattern of cruise activity through the Northwest Passage emerged from 1992 to 2005, with between one and three successful voyages being completed each year (Headland 2004). A watershed came in 2006 when the number of cruises to the region dramatically doubled to 22, up from 11 in the previous season (Buhasz 2006). During the 2006 cruise season, three traverses of the Northwest Passage were made by the *Akademik Ioffe*, the

Bremen, and the *Kapitan Khlebnikov* – a retro-fitted former Russian ice breaker. The elevated levels of cruise activity experienced in 2006 continued during the 2007 season, with 23 separate cruises organized by six different companies, collectively bringing approximately 2110 visitors to the Canadian Arctic (Maher and Meade 2008). The 2008 cruise season was the busiest to date when six vessels operating in the Canadian Arctic carrying passengers on 26 separate cruises, with at least four of those cruises advertised as Northwest Passage tours (Stewart *et al.* 2011). During 2009, despite deepening concerns about the global economy, seven different ships transited Canadian Arctic waterways on 25 separate cruises. Communities along the Passage hosted more cruises in 2009 than in previous years (Stewart *et al.* 2011).

Similarly, the 2010 cruise season saw 25 separate cruises across Arctic Canada between the end of May and the start of October. The 2010 season is distinguished because a total of 10 cruise ships were in operation through Arctic Canadian waters, the most vessels present in a single season. However, because of a merger between Adventure Canada and Cruise North (both prominent operators in the Canadian Arctic) (Cruise North Expeditions 2010), the bankruptcy of Polar Star Expeditions, and because one of the regularly available ice-strengthened Arctic cruise vessels failed an annual ship inspection the region only hosted 16 cruises in 2011. But of note is that 10 of those tours were destined for the Northwest Passage. The communities of Ulukhaktok, Cambridge Bay, and Gjoa Haven each expected to host four cruise ships during the 2011 season. Initial indications about the 2012 cruise season show a similar number of planned Northwest Passage tours as in 2011.

Of the variety of existing routes through the Northwest Passage (Figure 1), by far the most commonly traversed route for tourism vessels is the southern route which passes through Lancaster Sound and Barrow Strait then southward through Peel Sound, along Franklin Strait and Victoria Strait before heading west into the Coronation Gulf and Amundsen Gulf. The route through the Coronation Gulf and Amundsen Gulf is popular because there are opportunities to visit the historically important communities of Cambridge Bay and Ulukhaktok. The more northerly routes are the domain of the ice breakers, with the *Kapitan Klebnikov* traversing in 1994 and again in 2001 through Viscount Melville Sound, McClure Strait and into the Beaufort Sea in both easterly and westerly directions (Headland 2004). The *MS Explorer* successfully navigated the Rae and Simpson Straits, around King William Island on her maiden voyage through the Northwest Passage in 1984, a voyage that has more recently found favor with cruise operators allowing passengers to visit Gjoa Haven on King William Island. Another route for cruise vessels sailing through the Northwest Passage courses along the Prince Regent Inlet, through the narrow Bellot Strait into the Franklin and Victoria Straits, and out to the Coronation Gulf and Amundsen Gulf. The *Kapitan Khlebnikov* completed this route in an easterly direction in both 1995 and 2004, and the *Kapitan Dranitsyn* successfully traversed this route in 1996.

This brief overview of cruise tourism reveals that the Northwest Passage has enduring appeal for cruise visitors. Not only was the Passage chosen for the first cruise to the region in 1984, but in more recent times as the region has garnered international exposure due to the condition of sea ice and those communities and species dependent on it, the Northwest Passage continues to capture the interest of the tourism industry. Even during the current global economic downturn cruises through the Northwest Passage appear to be holding steadfast. A catalyst for growth in this region may be related to the phenomenon of ‘last chance tourism,’

whereby tourists are motivated by last opportunities to see, for example, glaciers before they recede, and polar bears before they are locally extinct (Adams and Carwardine 1992; Carwardine 2009; Lemelin and Johnston 2008; Lemelin *et al.* 2011). As the Northwest Passage transitions to lighter ice conditions during the summer months and enters a new chapter in its development, we turn to a review of sea ice variability in the region as a basis for understanding this transformation, and the local-level responses to it.

Sea ice in Canada's Northwest Passage

The Northwest Passage lies at the center of Canadian Arctic Archipelago (Figure 1). The Canadian Arctic Archipelago is an intricate series of islands located on the North American continental shelf that are separated by the Parry Channel (Figure 1). Sea ice within the Archipelago is a mix of seasonal first-year ice and multi-year ice with the latter component often making up more than 50% of its area (Canadian Ice Service 2011). The majority of the multi-year ice is located in the Queen Elizabeth Islands, the Western Parry Channel, and M'Clintock Channel regions (Canadian Ice Service 2011).

The Canadian Arctic Archipelago is almost entirely landfast sea ice (i.e. no ice motion) during the winter months before it breaks-up in July only to then re-freeze again in October (Canadian Ice Service 2011; Falkingham *et al.* 2001). Most of the variability during winter is found in Lancaster Sound and Amundsen Gulf where winter polynya formation is common (Canadian Ice Service 2011). Sea ice within the Queen Elizabeth Islands is primarily multi-year ice that can cover over 70% of the region (Melling 2002). Sea ice export from the Queen Elizabeth Islands to the Parry Channel can be minor during the summer or can be extensive during the late summer and autumn months (Melling 2002) with Byam-Martin Channel being the main exit point (Howell *et al.* 2009). Sea ice exported from the Queen Elizabeth Islands to the Parry Channel drifts south into M'Clintock Channel and Peel Sound, east into Lancaster Sound, or west toward M'Clure Strait (Alt *et al.* 2006; Howell *et al.* 2006; Melling 2002).

The Canadian Arctic Archipelago generates multi-year ice from seasonal first-year ice being promoted to multi-year ice after the melt season but it also exchanges ice with the Arctic Ocean to the west and Baffin Bay to the east. Both Agnew *et al.* (2008) and Kwok (2006) find that on average, sea ice is exported from the M'Clure Strait and Amundsen Gulf in the west, imported from the Queen Elizabeth Islands, and exported via Jones and Lancaster Sound in the east.

Changing sea ice conditions in the Northwest Passage: 1968 to 2011

The Arctic has been warming at a rate of 1.36°C per century since 1875 and has accelerated in the last decade to 1.35°C per decade (Bekryaev *et al.* 2010). One of the impacts of the increased Arctic warming trend is the gradual reduction in sea ice extent that is most visible during the months of August and September (Serreze *et al.* 2007; Stroeve *et al.* 2011), which coincides with the peak of cruise ship activity in the region. Future Arctic warming is expected to increase between 2 and 9°C by mid-century (IPCC 2007) and as a result, the marine Arctic will become more accessible to transiting vessels, and not those only associated with recreational travel (Stephenson *et al.* 2011). This has important implications for cruise tourism in

Canadian Arctic waters because the Northwest Passage has historically been congested with sea ice. Recently, the northern route was virtually clear of sea ice in 2007, 2008, 2010, and 2011 and the southern route has been navigable every summer since 2006. An historical investigation pertaining to sea ice conditions within the Northwest Passage can provide useful information for future cruise planning under a warmer Arctic scenario.

The Canadian Ice Service Digital Archive (CISDA) is used to investigate sea ice conditions within both the northern and southern routes of the Northwest Passage from 1968 to 2011. The CISDA is an integration of remotely sensed data, surface observations, airborne and ship reports, operational model results, and expertise of ice forecasters. A complete description of the CISDA including data quality, error and uncertainty can be found in Tivy *et al.* (2011). The CISDA extends back to 1960 for some regions of the Canadian Arctic that is almost 20-years longer than satellite passive microwave observations, however, complete and reliable coverage of all Canadian Arctic regions began in 1968. We confined our study period to the months of August and September because this is when the majority of Arctic cruises take place (Stewart *et al.* 2011). For the months of August and September total and multi-year ice area (km^2) and concentration (tenths) were extracted from the CISDA. Trend analysis was performed on mean August through September total and multi-year ice area for the both routes of the Northwest Passage using the method of least squares fit regression from 1968 to 2011. The significance of each trend was tested using a standard F-test at the 95% confidence level. Significant trends were tested for normality and autocorrelation and they were found to be sufficiently low to allow for use of parametric analysis.

Over the period of 1968 to 2011, mean August through September total sea ice area in the northern route of the Northwest Passage has decreased by 11% per decade and in the southern route of the Northwest Passage it has decreased by 16% per decade (Figure 2). No statistically significant trends in multi-year ice area were found for either route. The lack of statistically significant decreases in multi-year ice area within the routes of the Northwest Passage is related to how the sea ice regime of Canadian Arctic Archipelago that contains both routes of the Northwest Passage responds to variability and change. The oldest and thickest multi-year ice in the world lies on the north facing coast of the Canadian Arctic Archipelago and this multi-year ice flows through Archipelago (and Northwest Passage) during the summer; a considerable amount of seasonal first-year ice is also promoted to multi-year ice within the Canadian Arctic Archipelago (Melling 2002). Both these sources act as a recovery mechanism for the Archipelago's multi-year ice whereby following a light ice year there has been historically a period of recovery (Howell *et al.* 2008). Under increased warming and/or a longer melt season, first-year ice promotion is reduced but the resulting increased open water areas facilitate increased multi-year ice dynamic import from the Arctic Ocean into the Canadian Arctic Archipelago (Howell *et al.* 2009). Figure 2 clearly shows this recovery from 1968 to 2004 but there is a gradual decline in multi-year ice since 2005 for the northern route which suggests recovery may not be as prominent as it was in the past. However, even in low amounts, multi-year ice is a serious hazard to transiting ships and the recovery mechanism will continue to supply the Northwest Passage with multi-year ice from the Arctic Ocean as long as it remains on the north face of the Canadian Arctic Archipelago. As of 2011, the latter region still contained a considerable inventory of multi-year ice (Maslanik *et al.* 2011). Indeed, ice

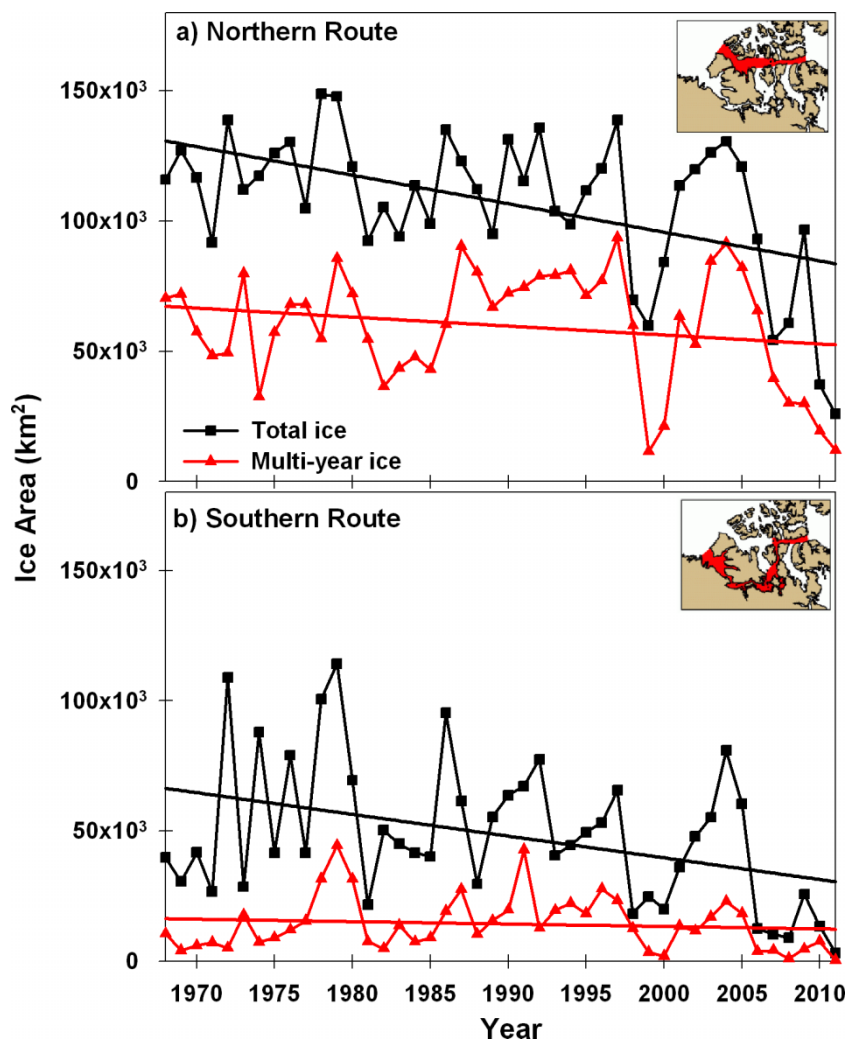


Figure 2. Time series of mean August through September total ice and multi-year ice in (a) the northern route of the Northwest Passage and (b) southern route of the Northwest Passage from 1968 to 2011.

conditions within the Northwest Passage will likely be lighter in upcoming years as a result of a warmer Arctic but the Archipelago's ability to recover multi-year ice makes the complete removal of sea ice within the Northwest Passage physically difficult. This recovery mechanism is the reason why Stephenson *et al.* (2011) and other predictive studies (e.g. Sou and Flato 2009) found that the Northwest Passage will not be fully accessible by mid-century compared to the other major shipping routes such as the Northern Sea Route, Arctic Bridge, and the Transpolar Route.

Examining the light ice years within the Northwest Passage reveals where the difficult navigation regions are located because of the recovery mechanism. These locations can provide insight with respect to future cruise planning under lighter ice conditions within the Northwest Passage. Figure 3 shows the mean August through September total ice concentration for the 1981–2010 climatology as well the light

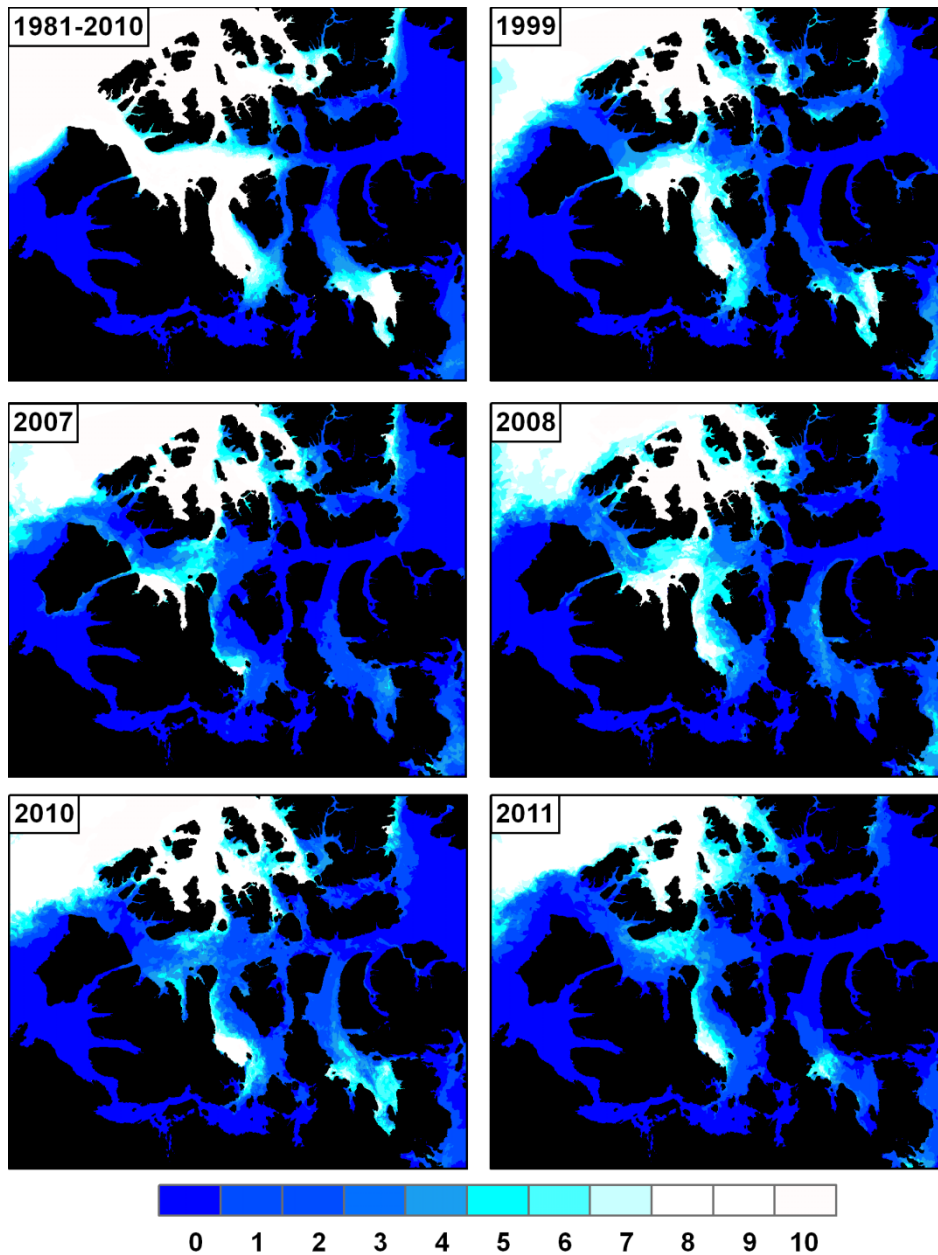


Figure 3. Spatial distribution of mean August through September total sea ice concentration (in tenths) within the Northwest Passage for the 1981–2010 climatology and selected light years.

ice years of 1999, 2007, 2008, 2010, and 2011. Figure 4 is the same as Figure 3 except for multi-year ice. During light years sea ice tends to remain in high concentration within the central Western Parry Channel (i.e. northern routes). Slightly lower concentrations remain within the M'Clintock Channel which is in close proximity of the southern Northwest Passage routes. Multi-year ice streams from the Queen

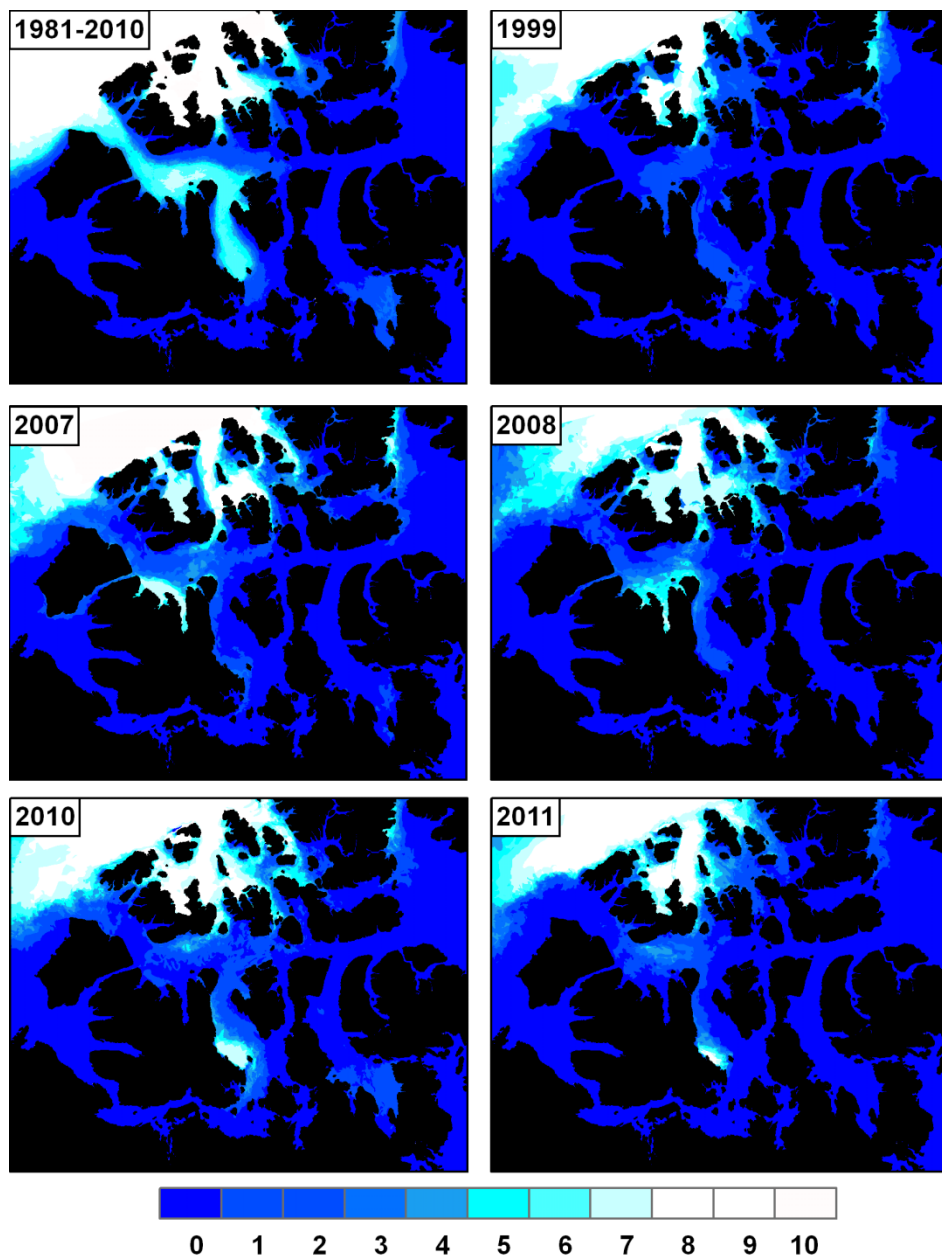


Figure 4. Same as Figure 3 except for multi-year ice.

Elizabeth Islands directly crossing the northern route of the Northwest Passage (Figures 3 and 4). Sea ice also drifts from the northern route to the southern route via M'Clintock Channel albeit in less concentration (Figures 3 and 4). If a warmer Arctic continues to facilitate light ice years within the Northwest Passage as observed in recent years, the southern routes may be a more attractive, and safer, cruise routes compared to their northern counterparts.

Community-based research

Due to their location along, or near to, the various southern routes of the Northwest Passage the three hamlets of Ulukhaktok, Gjoa Haven, and Pond Inlet have been selected to provide insight into how residents are responding to the localized effects of sea ice transformation, and the consequential increase in cruise traffic. Since understanding the effects of change occurring within communities, and the attitudes local people have toward change, is best achieved through engaging residents directly and recording local knowledge (Berkes 1999; Ford *et al.* 2008) researchers connected to the 'Cruise Tourism in Arctic Canada' (C-TAC) study, a project that focuses on the increasing number of cruise ships in the Canadian Arctic (C-TAC 2011), conducted a series of semi-structured interviews with community residents during 2010 (Ulukhaktok [UL] $n = 22$; Gjoa Haven [GH] $n = 52$; Pond Inlet [PI] $n = 47$). The semi-structured interviews consisted of a series of open-ended questions largely guided by themes (role and experiences in tourism, perceptions of climate change, challenges, opportunities, and adaptations). The majority of interviewees had past and/or current experiences in tourism as managers, educators, guides, or operators (e.g. through the local hamlet office, Royal Canadian Mounted Police (RCMP), Government of Nunavut, Visitor Centre Manager, and local cooperatives). The majority of interviews were recorded, and if this was not possible, comprehensive notes were taken, with all interviews being transcribed. Each transcript was analyzed using open and focused coding (Lofland and Lofland 1984) with codes compared across the three communities.

Located on the west coast of Victoria Island in the Inuvialuit Settlement Region at the western end of the Passage is the hamlet of Ulukhaktok, formerly



Figure 5. The Inuvialuit hamlet of Ulukhaktok in the Northwest Territories (photo credit T. Pearce).

known as Holman (see Figure 5). With a population of approximately 400, of whom 90% are Inuit; this is one of the smaller communities in the region. The community experienced its first cruise ship visit in 2007 and since that time Ulukhaktok has hosted between two and four cruise vessels each year. Located on King William Island in the heart of the Northwest Passage is Gjoa Haven with a population of approximately 1100 people (see Figure 6). The hamlet has a long association with exploration of the Passage, with the hamlet being named after Amundsen's vessel, the *Gjoa*. This historic legacy is a major draw for cruise visitors, and was first visited by the German cruise ship, the *Hanseatic* in 1996, which unfortunately grounded in the Simpson Strait that same year. However, since 2008 the hamlet has hosted between two and four cruise ships each year. At the eastern entrance of the Passage, with a population of 1315 is the community of Pond Inlet (see Figure 7). The community is the most regularly visited community destination in the Canadian Arctic – in part because it is conveniently located close to the entrance of the Northwest Passage and is an accessible entry point for international cruise ships arriving from Greenland – but also because of its scenic beauty (i.e. the mountains and glaciers of Sirmilik National Park). Each year since 2006, between 5 and 12 cruise ships have visited the community.

Drawing on the interviews conducted in each of these three hamlets, the remainder of the article discusses local-level responses to changing cruise patterns through the Northwest Passage as Arctic temperatures continue to increase (Bekryaev *et al.* 2010) and the Arctic melt season continues to lengthen (Markus *et al.* 2009). While the interviews with local residents revealed a range of risks and opportunities associated with the opening up of the Arctic waters, including economic, socio-cultural, political, and environmental issues (for this broader discussion see C-TAC 2011), the data that emerged specifically in relation to sea ice change are explored here. Discussion is focused on the significant challenges posed by the continued increase in traffic related to increased access, including issues associated with



Figure 6. The Inuit hamlet of Gjoa Haven (photo credit: Jackie Dawson).



Figure 7. The *Kapitan Khlebnikov* ice-breaker cruise visiting the Inuit community of Pond Inlet in August 2010 (photo credit: Emma J. Stewart).

infrastructure, security, protection of the marine environment, human safety, and search and rescue (SAR).

Community-based responses to increased cruise tourism

Sea ice is sometimes characterized within the framework of social-ecological systems, as it not only provides geophysical and biological services to climate and oceans but also provides services to local people and industry (Eicken *et al.* 2009). As a homeland to the local people in the Canadian Arctic sea ice is an extension of land, and by association culture (Aporta *et al.* 2011). As an Inuit woman in Pond Inlet pointed out, ‘the loss of ice is drastic; it will change our lives entirely. We love ice . . . if it goes it will affect our livelihood, our culture, our diets’ (PI #09). Change was regarded by many as the ‘new normal,’ and that climate warming was now inevitable and unfolding in front them, with little ‘choice but to accept it, and go with the change’ (PI #1). Residents had observed tangible changes in sea ice conditions in recent seasons with one Pond Inlet resident claiming that ‘the ice melts earlier in the spring and it forms again later, much later than before’ (PI #1). Similarly, in Gjoa Haven, an elder reported that ‘it’s different from the past . . . the ice disappears very early and right away’ (GH #2), and another resident claimed that she was ‘scared’ of the increasing temperatures since ‘we never used to have warm summers’ (GH #1).

As rising temperatures and changing sea ice regimes transform the Canadian Arctic, local people are grappling with the implications of increased accessibility to their homeland. One of the most immediate manifestations of greater access is a tangible increase in cruise traffic through the Northwest Passage, evidenced in each of the three Hamlets. One Gjoa Haven resident suggested that in the past the community might host ‘a cruise ship maybe once every five or six years, but now we’re seeing two, three or four a year; it’s common for tourist ships to be coming every year’ (GH #9). The ‘international exposure’ of the Northwest

Passage (GH #3) was regarded as a catalyst for promoting the region to potential visitors, as was pointed out in Pond Inlet:

now with global warming and less ice especially in the Passage...people are attracted to the lure of the challenge of getting through the Northwest Passage, sort of like climbing Mt Everest. It one of those old Arctic adventure stories that people may have heard of, and it's a challenge and people just want to try it. (PI #22)

As Johnson (2006) points out 'the primary challenge to such an increase [in cruise ship access] is an infrastructural one' (p. 48). There is limited infrastructure available for marine activities across the Canadian Arctic and small Arctic hamlets such as Ulukhaktok, Gjoa Haven, and Pond Inlet have no docking facilities, and harbors are too shallow to support cruise vessels. As was pointed out in Pond Inlet, 'lack of infrastructure is one of the main challenges, we don't have a specific docking area where we can safely handle cruise ship guests' (PI #22). Cruise operators currently anchor offshore and use small inflatable boats (zodiacs) to ferry passengers to shore where they land on beaches. Although the Government of Nunavut has plans to construct floating docks in several communities (including Gjoa Haven), which would greatly assist elderly tourists transition between zodiac to shore, none are currently installed. Furthermore, as was identified in Pond Inlet, 'the floating docks [are temporary] and don't take away the need for the community to have a [permanent] dock' (PI #9). There is also limited tourism infrastructure available directly in the communities. 'Small communities have difficulty now in accommodating the needs of cruise tourists when ships visit their communities. Without substantial capital input, the opportunities [associated with increased cruise tourism] will be hard to access' (Johnson 2006, p. 48).

Despite infrastructural challenges experienced by cruise ships, smaller vessels including private yachts can easily navigate to the shores of Canadian Arctic communities, and are at liberty to do so under current regulations. For example, in 2009 four yachts reportedly sailed the Passage (Orams 2010). Residents in each of the three communities reported a recent increase in the number of reported sailings of small craft through the Northwest Passage, 'we get a lot of the small crew like sail boats; we had ten of them last year so I'm expecting some to show up within the next month, unannounced as usual' (GH #3) and 'I can see the lure [of the Northwest Passage] so I think we'll continue to see more of those small boats' (PI #24). For the small craft in particular it was noted in Gjoa Haven that travel depends on the weather and ice conditions so things can 'change quickly,' as one resident goes onto explain:

2007 was the year that the ice was just out really early, and we had five sail boats and we had cruise ships in as well (that people weren't set up for). [The ice conditions were right so] all of a sudden there was a jump and the guys that were on the sail boats were just thrilled; they were just so pumped. A couple of them had tried to make this passage for ten years and they were finally able to make it through. (GH #4)

However, the fact that small vessels (those under 300 tonnes) such as yachts are not required to register with NORDREG (northern Canada vessel traffic services), as was alluded to in Gjoa Haven, gave rise to a sense of unease about security breaches, and the sometimes ill-prepared nature of the expeditions. For example,

the threat to local security was raised by many of the residents in Gjoa Haven, for example:

I'm concerned about the substantial increase in other [small] ships coming through the Arctic. There have been instances where they've taken locals out on to the boats with them as guests and they've shared their alcohol and other things with them which has lead to problems on the boat and on the shore . . . but its [also about] making sure that there aren't terrorists or illegal immigrants or just unsavoury people. (GH #14)

Furthermore, that small vessel expeditions arrived unprepared to deal with Arctic conditions was highlighted in Pond Inlet:

I had two guys come in to the hamlet [office] yesterday requesting information about going through the Passage because they didn't bring any guns with them they them they only brought bear spray. (PI #22)

In addition to issues associated with infrastructure and security, local residents are also highly concerned about the potential impacts of both large and small cruise vessels on the marine environment. While subject to the same environmental regulations as other vessels, residents thought cruise ships provided the 'potential to pollute, and disturb the water' (PI #21) as well as to engage in less than desirable activities such as 'ships dumping their grey water' (PI #17) and 'toxins being dumped by ships into the water' (UL #13). However, at the forefront was the concern about the impact of increased shipping on marine mammals. 'Ships may be affecting wildlife if they are dumping contaminants in the water' (UL #22). An elder in Ulukhaktok said that 'the marine life travels away from the area when the cruise ships come because of the scent the ship leaves behind,' and similarly in Pond Inlet, elders often talked of narwhal 'fleeing' because of advancing cruise vessels; other species were also mentioned, for example:

I am concerned about the ships always looking for animals . . . I heard this year there are not so many seals, maybe because of the ships. (PI #29)

In both Ulukhaktok and Pond Inlet, as a consequence of this added stress, there was a concern that there would be negative consequences for hunting, in that 'we have to go further away to hunt and fish' (UL #14):

with the more cruise ships there are there is more damage to the marine life . . . with more disturbance the marine life are going to be all stressed out, and changing their migration area, and routes. (PI #17)

As one elder put it, the cruise ships are 'scaring off the meat.' This situation exacerbated already difficult hunting conditions whereby hunters were 'hunting one month less now because the ice melting' (PI #1). Inuvialuit have wildlife monitors who oversee activities on the land, ocean or ice that could affect wildlife and for many of the residents in Ulukhaktok, Inuit wildlife monitors should be present on cruise ships to ensure 'nothing can go wrong for the animals. Monitors should also be there to monitor waste from food, garbage, fuel and sewage' (UL #3).

It was clear from residents that there was tangible concern over marine pollution and the devastating implications of a cruise ship encountering problematic ice, grounding, or worse still, a sinking in Arctic waters. In Gjoa Haven, one resident was 'scared' about the prospect of cruise ships encountering hazards that might

lead to 'oil spills, and things like that' (GH #9). Similarly, the environmental effects of such a catastrophe were also stressed in Pond Inlet:

The environment is a concern for everyone in all the communities because there is that tie to the land they don't want to see an environmental disaster...when you're looking down into the ocean you can still see the bottom through forty feet of water you know that's nice, it's what we grew up with, it's what we've had all our lives and we just don't like to see it changed. (PI #22)

The same resident raised a concern about whether or not the region would be prepared for such a catastrophe:

Is the territory prepared for a ship sinking or leaking copious amounts of fluids? Well, I would have to say *no*... (PI #22)

Unfortunately, there have been a number of incidents involving cruise ships in the Passage that have been a grim reminder that ice and other environmental hazards are an ever-present danger. For instance, as stated earlier, the *Hanseatic* grounded on a sand bar in the Simpson Strait after a visit to Gjoa Haven in 1996. The incident was relatively benign with no reports of pollution or injury to passengers or crew (Transportation Safety Board of Canada 1996). However, the later grounding of the *Clipper* in August 2010 in the Coronation Gulf is evidence that the Canadian Arctic is still not immune from shipping accidents. The *Clipper* had departed Gjoa Haven and was en route to Ulukhaktok but it never arrived after grounding on a known hazard, an underwater island chain, known as the Coronation Sills. Probably as a response to the groundings of both these two cruise ships in relatively close proximity to Gjoa Haven, a number of residents noted that 'charting [of the sea bed for hazards] is a key component that has to be done in the Arctic for safe travel of the cruise ships' (GH #3).

Although hazardous ice was not a factor in either of the grounding, incidents may accelerate as this stretch of water is subject to greater unpredictability in ice conditions as the Passage transitions to an ice free summer (Kaltenstein 2011). As we noted earlier, the prevalence of multi-year ice may be particularly problematic for transiting vessels. This concern was articulated in Pond Inlet. 'I am surprised that we haven't lost more ships up here you know' (PI #22) and, 'I think there is false belief out there that the Northwest Passage is going to be an easy passage; that is not the case...we are starting to get more choke points which can cause hazards' (PI #24). In Ulukhaktok a resident cautioned that the 'changing sea ice and weather conditions [were] a risk and a potential disaster' (UL #23). An ominous connection was made to the sinking of the *MS Explorer* in Antarctica in 2007, a frequent visitor to the Arctic (and the cruise ship that had made the first passenger voyage through the Passage in 1984):

I don't mean anything negative towards the Antarctic but I'm glad it happened down there and not up here you know for the environment; all the gas and oil that was spilled. (PI #22)

As Byers and Lalonde (2009, p. 1198) have also pointed out this cruise ship 'could just as easily have sunk in the Northwest Passage in rough seas with no help within hours or days.'

Guaranteeing the close proximity of the Canadian Coast Guard (CCG) to provide SAR services to stricken cruise ships is clearly impossible in the vast and increasingly busy waterways of the Canadian Arctic. Under normal circumstances the CCG's response time could be 10 hours or more depending on ice, weather, hydrographical, and other conditions (CCG 2007, 2008). While six icebreakers are deployed to the Arctic in summer, and while SAR operations take precedence in CCG operations, expecting this small fleet of icebreakers to cover such a vast watermass is unrealistic, as was confirmed in Pond Inlet, '...we don't have a lot of resources up here [for search and rescue]' (PI #24). Similarly, in Ulukhaktok, questions were posed: 'What happens if a ship gets caught in bad weather or hits rocks or ice and needs help? Who is going to help?' (UL #10). Furthermore, it was clear from residents in Gjoa Haven that it was felt that 'we don't have the capacity or the auxiliary units to help out if a disaster happens in respect to the tourism ships' (GH #9).

Conclusion

Survival in the Arctic environment over the millennia has demonstrated that indigenous people have high adaptive capacity, facilitated by extensive local environmental knowledge and experience, and strong local networks (Ford and Smit 2004). But while indigenous people 'have historically demonstrated adaptability to a variety of stresses, their coping abilities have been put under considerable strain by recent climatic and environmental changes' (Ford and Smit 2004, p. 395). This is clearly the case with the increase in the number of cruise ships in the Arctic. This research has demonstrated that at the community level there was an overriding sense of uncertainty about the future of cruise (and other small vessel) activity in the Northwest Passage, as one Gjoa Haven resident mentioned:

Who knows what's going to happen. I mean with an increased sea with less ice in the summer time you could be seeing an explosion [in cruise ships] because it is the Northwest Passage. (GH #4)

We cannot confirm the claim of an 'explosion' in cruise traffic since there are other factors at play that may mitigate against this kind of development, but our analysis does confirm that the routes of the Northwest Passage are experiencing lighter ice conditions during the summer months. Caution should still be taken because thicker and more hazardous multi-year ice will continue to be problematic for cruise vessels, and other ships, entering the Passage. Even with the continued presence of multi-year ice the likelihood of moderate growth in the cruise sector will continue. The prospect of other types of vessels, more akin to large-liners seen cruising elsewhere in the world, that are non-ice strengthened and may carry in excess of a 1000 passengers are possible developments that will need to be taken into account as the Arctic enters a new, more accessible future. With these developments in mind it is critical to continue to monitor local-level responses to the cruise sector, so that concerns are addressed, and benefits are maximized. It is also critical to streamline the complex array of polar shipping rules and regulations that apply to cruise vessels so that uncertainty at the local level can be minimized, and ultimately cruise visits to the region managed more effectively (Kaltenstein 2011).

Although this article focused on concerns relating principally to the marine environment (see Lück 2010) it is already clear that concerns of a socio-cultural and

economic nature are prevalent in the new destinations of Arctic Canada (for a discussion of these wider issues see Stewart *et al.* 2011). As noted in this article, increasing ship access facilitated by the changing sea ice regime has left residents feeling concerned about the potential impact cruise ships may have on the marine environment, and the animals that reside there. With the grounding of the *Clipper Adventurer* still a recent memory, there was a sense of trepidation about how the region would cope with a shipping disaster, and what capability might exist to respond to issues of both human and environmental safety.

The Northwest Passage is one of the key locations for cruising in the Canadian Arctic. No doubt, the extraordinary media attention on the polar north, and 'last opportunities to see' may have stimulated and accelerated visitor demand to travel this remote waterway, but it is the receding ice that has facilitated access. The transformation of the sea ice in this region is nothing short of remarkable. In the most part, residents of communities that, in a relatively short period of time, have become destinations, have welcomed the opportunity to host cruise tourists not least because of the opportunity to meet new people, and to showcase the local culture and landscape. However, this optimism and enthusiasm is tempered by concerns such as the adverse environmental consequences for the marine environment should cruise vessels run aground, or worse.

Recent groundings and other incidents involving cruise, and other types of ship in the region are reminders that dangers exist (Lück 2010). It is clear that cruise ships are heading into 'riskier areas,' and there is a tendency for cruise ships to divert 'off the safe shipping lanes where there is more dramatic topography or stunning wildlife' (Hydro International 2010), as was claimed to be the case with the grounding of the *Clipper Adventurer*. Although sea ice was not the hazard in this instance, the prevalence of thicker multi-year ice particularly in the northern reaches of the Passage should not be underestimated. Although we do not wish to sensationalize the possibility of further incident, a hazardous encounter with sea ice cannot be dismissed (Stewart and Dawson 2011) and this concern was clearly articulated by residents in each of the three hamlets.

While not all eventualities can be managed for in this remote polar environment, there is little doubt that increased attention is required to understand the dynamic nature of sea ice and the safety implications associated with travel in the Northwest Passage as the region transitions to an ice free summer. While human and environmental safety may be of paramount concern, it is also clear from this research that understanding how residents respond to an increased level of cruise activity in the region is important to ensure that benefits to local communities are maximized while risks are minimized. After all, it is the local level where the effects of change will be, and are, manifested. As the ice has started to recede, local residents have started to express both optimism and concern about the rapid emergence of cruise tourism in their community. Understanding these local-level responses and adaptations to this transformation is critical to help prepare communities, policy makers, as well as the cruise sector itself, to be responsive to change in this remote location.

Acknowledgments

This research was funded by a grant from the Social Sciences and Humanities Research Council of Canada under the Northern Communities: Toward Social and

Economic Prosperity program. We would like to thank Robin Poitras, cartographer at the University of Calgary for creating the map used in this article, as well as the three anonymous reviewers for useful comments. Most importantly, we would like to thank the residents of Ulukhaktok, Gjoa Haven and Pond Inlet who kindly contributed to the C-TAC project (<http://www.arctictourismandclimate.lakeheadu.ca/>).

References

- ADAMS, D., and CARWARDINE, M., 1992, *Last Chance to See* (New York, NY: Ballantine Books).
- AGNEW, T., LAMBE, A., and LONG, D., 2008, Estimating sea ice area flux across the Canadian Arctic Archipelago using enhanced AMSR-E. *Journal of Geophysical Research*, **113**(C10011), pp. 1–12, doi:10.1029/2007JC004582
- ALT, B., WILSON, K., and CARRIERES, T., 2006, A case study of old ice import and export through Peary and Sverdrup channels in the Canadian Arctic Archipelago: 1998–2004. *Annals of Glaciology*, **44**, pp. 329–338, doi:10.3189/172756406781811321
- APORTA, C., TAYLOR, F., and LAIDLER, G.J., 2011, Geographies of Inuit sea ice use: Introduction. *The Canadian Geographer/Le Geographe Canadien*, **55**(1), pp. 1–5, doi: 10.1111/j.1541-0064.2010.00339
- ARCTIC MARINE SHIPPING ASSESSMENT, 2009, *Report*. Tromsø, Norway: Arctic Council.
- BEKRYAEV, R.V., POLYAKOV, I.V., and ALEXEEV, V.A., 2010, Role of polar amplification in long-term surface air temperature variations and modern arctic warming. *Journal of Climate*, **23**, pp. 3888–3906, doi: 10.1175/2010JCLI3297.1
- BERKES, F., 1999, *Sacred Ecology: Traditional Ecological Knowledge and Resource Management* (Philadelphia, PA: Taylor and Francis).
- BUHASZ, L., 2006, Northern underexposure. *Globe & Mail*. July 1.
- BYERS, M., and LALONDE, S., 2009, Who controls the Northwest passage? *Vanderbilt Journal of Transnational Law*, **42**, pp. 1133–1210.
- CANADIAN COAST GUARD (CCG), 2007, *Canadian Coast Guard Levels of Service and Service Standards*. Available online at: www.ccg-gcc.gc.ca/folios/00022/docs/los-and-ss-v4-2-eng.pdf [accessed 9 December 2011].
- CANADIAN COAST GUARD (CCG), 2008, *Service Standards*. Available online at: www.ccg-gcc.gc.ca/eng/Ice_Service_Standards [accessed 9 December 2011].
- CANADIAN ICE SERVICE, 2011, *Sea Ice Climatic Atlas, Northern Canadian Waters, 1981 to 2010* (Ottawa: Canadian Ice Service).
- CARWARDINE, M., 2009, *Last Chance to See: In the Footsteps of Douglas Adams* (London: HarperCollins Publishers).
- CRUISE NORTH EXPEDITIONS, 2010, *A New Chapter in Arctic Polar Cruising: Adventure Canada Takes Majority Stake in a New Partnership with Cruise North Expeditions*. Available online at: http://www.cruisenorthexpeditions.com/press_release/CNE_AC_NewChapter.pdf [accessed 19 December 2011].
- C-TAC, 2011, *Cruises Tourism in Arctic Canada*. Available online at: <http://www.arctictourismandclimate.lakeheadu.ca/> [accessed 13 March 2012].
- DAWSON, J., MAHER, P., and SLOCOMBE, S., 2007, Climate change, tourism and systems theory in the Canadian Arctic. *Tourism in Marine Environments*, **4**(2), pp. 69–83.
- EICKEN, H., LOVECRAFT, A.L., and DRUCKENMILLER, M., 2009, Sea ice system services: A framework to help identify and meet information needs relevant for Arctic observing networks. *Arctic*, **62**, pp. 119–136.
- FALKINGHAM, J., CHAGNON, R., and MCCOURT, S., 2001, Sea ice in the Canadian Arctic in the 21st century. Paper presented at the *Ports and Ocean Arctic Conference, National Research Council of Canada*, Ottawa, Ontario, Aug 12–17.

- FORD, J.D., SMIT, B., WANDEL, J., ALLURUT, M., SHAPPA, K., ITTUSARJUAT, H., and QRUNNUT, K., 2008, Climate change in the Arctic: Current and future vulnerability in two Inuit communities in Canada. *The Geographical Journal*, **174**(1), pp. 45–62.
- FORD, J., and SMIT, B., 2004, A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. *Arctic*, **57**(4), pp. 389–400.
- FURGAL, C., and PROWSE, T.D., 2008, Northern Canada. In *From Impacts to Adaptation: Canada in a Changing Climate*, D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush (Eds.), pp. 57–118 (Ottawa: Government of Canada).
- GREKIN, J., and MILNE, S., 1996, Towards sustainable tourism development: The case of Pond Inlet, NWT. In *Tourism and Indigenous Peoples*, R.W. Butler and T.D. Hinch (Eds.), pp. 76–106 (London: International Thomson Press).
- GRENIER, A.A., 2004, *The Nature of Nature Tourism* (Rovaniemi: University of Lapland).
- HEADLAND, R., 2004, Northwest passage voyages. In *Arctic Marine Transport Workshop*, L. Brigham and B. Ellis (Eds.) (Cambridge: Scott Polar Research Institute, Cambridge University).
- HOWELL, S.E.L., TIVY, A., YACKEL, J.J., and SCHARIEN, R. 2006, Application of a SeaWinds/QuikSCAT sea ice melt algorithm for assessing melt dynamics in the Canadian Arctic Archipelago. *Journal of Geophysical Research*, **111**, C07025, doi:10.1029/2005JC003193
- HOWELL, S.E.L., TIVY, A., YACKEL, J.J., MCCOURT, S. 2008, Multi-year sea ice conditions the western Canadian Arctic Archipelago region of the Northwest Passage: 1968–2006. *Atmosphere-Ocean*, **46**(2), pp. 229–242, doi:10.3137/ao.460203
- HOWELL, S.E.L., DUGUAY, C.R., and MARKUS T., 2009, Sea ice conditions and melt season duration variability within the Canadian Arctic Archipelago: 1979–2008. *Geophysical Research Letters*, **36**, L10502, doi:10.1029/2009GL037681
- HYDRO INTERNATIONAL, 2010, *Arctic Rescue*. Available online at: www.hydro-international.com/news/id4176-Arctic_Rescue.html [accessed 9 December 2011].
- IPCC, 2007, *IPCC Climate Change 2007: The Physical Science Basis* (Cambridge: Cambridge University Press).
- JOHNSON, M.E., 2006, Impacts of global environmental change on tourism in the Polar Regions. In *Tourism and Global Environmental Change: Ecological, Social, Economic and Political Interrelationships*, S. Gossling and C.M. Hall (Eds.), pp. 37–53 (New York, NY: Routledge).
- JONES, C.S., 1999, Arctic ship tourism: An industry in adolescence. *The Northern Raven*, **13**(1), pp. 28–31.
- KALTENSTEIN, J., 2011, *The Case for a Strong Polar Code*. Available online at: http://libcloud.s3.amazonaws.com/93/94/6/1010/1/Friends_of_the_Earth_The_case_for_a_strong_Polar_Code_December_2011.pdf [accessed 13 March 2012].
- KELLER, C.P., 1982, The development of peripheral tourism destinations: Case study Baffin Island. Unpublished MA thesis, Department of Geography, University of Western Ontario, Ontario.
- KELLER, C.P., 1987, Stages of peripheral tourism development – Canada's Northwest Territories. *Tourism Management*, **8**(1), pp. 20–32.
- KWOK, R., 2006, Exchange of sea ice between the Arctic Ocean and the Canadian Arctic Archipelago. *Geophysical Research Letters*, **33**, L16501, doi:10.1029/2006GL027094
- LAMARS, M., and AMELUNG, B., 2010, Climate change and its implications for cruise tourism in the Polar Regions. In *Cruise Tourism in the Polar Regions: Promoting Environmental and Social Sustainability?* M. Lück, P.T. Maher and E.J. Stewart (Eds.), pp. 147–163 (London: Earthscan).
- LEMELIN, H., and JOHNSTON, M., 2008, Northern protected areas and parks. In *Parks and Protected Areas in Canada: Planning and Management*, 3rd edition, P. Dearden and R. Rollins (Eds.), pp. 294–313 (New York: Oxford University Press).

- LEMELIN, H., DAWSON, J., and STEWART, E.J. Eds., 2011, *Last Chance Tourism: Opportunities in a Changing World* (Abingdon: Routledge).
- LOFLAND, J., and LOFLAND, L.H., 1984, *Analyzing Social Settings: A Guide to Qualitative Observation and Analysis* (Belmont: Wadsworth Publishing Company).
- LÜCK, M., 2010, Environmental impacts of polar cruises. In *Cruise Tourism in the Polar Regions: Promoting Environmental and Social Sustainability?* M. Lück, P.T. Maher and E.J. Stewart (Eds.), pp. 133–145 (London: Earthscan).
- MAHER, P.T., and MEADE, D., 2008, *Cruise Tourism in Auyuittuq, Sirmilik and Quttinirpaaq National Parks*. Technical Report – ORTM Publication Series 2008–02 (Prince George: UNBC ORTM Program).
- MARKUS, T., STROEVE, J.C., and MILLER, J., 2009, Recent changes in Arctic sea ice melt onset, freezeup, and melt season length. *Journal of Geophysical Research*, **114**, C12024, doi:10.1029/2009JC005436
- MARQUEZ, J.R., and EAGLES, P.F.J., 2007, Working towards policy creation for cruise ship tourism in parks and protected areas of Nunavut. *Tourism in Marine Environments*, **4**(2–3), pp. 85–96.
- MARSH, J., and STAPLE, S., 1995, Cruise tourism in the Canadian Arctic and its implications. In *Polar Tourism: Tourism in the Arctic and Antarctic Regions*, C.M. Hall and M.E. Johnston (Eds.), pp. 63–72 (Chichester: John Wiley and Sons Ltd).
- MASLANIK, J., STROEVE, J., FOWLER, C., and EMERY, W. 2011, Distribution and trends in Arctic sea ice age through spring 2011. *Geophysical Research Letters*, **38**, L13502, doi:10.1029/2011GL047735
- MELLING, H., 2002, Sea ice of the northern Canadian Arctic Archipelago. *Journal of Geophysical Research*, **107**(C11), 3181, doi:10.1029/2001JC001102
- NICKELS, S., MILNE, S., and WENZEL, G., 1991, Inuit perceptions of tourism development: The case of Clyde River, Baffin Island. *Etudes Inuit*, **15**(1), pp. 157–169.
- ORAMS, M., 2010, Polar yacht cruising. In *Cruise Tourism in the Polar Regions: Promoting Environmental and Social Sustainability?* M. Lück, P.T. Maher and E.J. Stewart (Eds.), pp. 133–145 (London: Earthscan).
- PEROVICH, D., MEIER, W., MASLANIK, J., and RICHTER-MENGE, J., 2011, *Arctic Report Card: Update for 2011, Sea Ice*. Available online at: http://www.arctic.noaa.gov/reportcard/sea_ice.html [accessed 9 December 2011].
- SERREZE, M.C., HOLLAND, M.M., and STROEVE, J., 2007, Perspectives on the Arctic's shrinking sea-ice cover. *Science*, **315**(5818), pp. 1533–1536, doi:10.1126/science.1139426
- SOU, T., and FLATO, G., 2009, Sea Ice in the Canadian Arctic Archipelago: Modeling the Past (1950–2004) and the Future (2041–60). *Journal of Climate*, **22**, 2181–2198, doi: 10.1175/2008JCLI2335.1
- STEPHENSON, S.R., SMITH, L.C., and AGNEW, J.A., 2011, Divergent long-term trajectories of human access to the Arctic. *Nature Climate Change*, **1**, pp. 156–160
- STEWART, E.J., HOWELL, S.E.L., DRAPER, D., YACKEL, J., and TIVY, A., 2007, Sea ice in Canada's Arctic: Implications for cruise tourism in the Northwest Passage. *Arctic*, **60**(4), pp. 370–380.
- STEWART, E. J. 2009, Comparing resident attitudes toward tourism: Community-based cases from Arctic Canada. Unpublished PhD, University of Calgary, Calgary, Alberta, Canada.
- STEWART, E.J., and DRAPER, D., 2008, The sinking of the *MS Explorer*: Implications for cruise tourism in Arctic Canada. *Arctic*, **61**(2), pp. 224–231.
- STEWART, E.J., DAWSON, J., and DRAPER, D., 2010, Monitoring patterns of cruise tourism across Arctic Canada. In *Cruise Tourism in the Polar Regions: Promoting Environmental and Social Sustainability?* M. Lück, P.T. Maher and E.J. Stewart (Eds.), pp. 133–145 (London: Earthscan).
- STEWART, E.J., and DAWSON, J., 2011, A matter of good fortune? The grounding of the Clipper Adventurer in the Northwest Passage, Arctic Canada. *Arctic*, **64**(20), pp. 263–267.

- STEWART, E.J., DAWSON, J., and DRAPER, D., 2011, Cruise tourism and residents in Arctic Canada: Development of a resident attitude typology. *Journal of Hospitality and Tourism Management*, **18**, 95–106, doi 10.1375/jhtm.18.1.95
- STROEVE, J.C., SERREZE, M.C., KAY, J.E., HOLLAND, M.M., MEIER, W.N., and BARRETT, A.P., 2011, The Arctic's rapidly shrinking sea ice cover: A research synthesis. *Climatic Change*, doi:10.1007/s10584-011-0101-1
- TIVY, A., HOWELL, S.E.L., ALT, S., MCCOURT, S., CHAGNON, R., CROCKER, G., CARRIERES, T., and YACKEL, J.J., 2011, Trends and variability in summer sea ice cover in the Canadian Arctic based on the Canadian Ice Service Digital Archive, 1960–2008 and 1968–2008. *Journal of Geophysical Research*, **116**, C03007, doi:10.1029/2009JC005855
- TRANSPORTATION SAFETY BOARD OF CANADA, 1996, *Marine reports – 1996 – M96H0016*. Available online at: <http://www.tsb.gc.ca/eng/rapports-reports/marine/1996/m96h0016/m96h0016.asp> [accessed 9 December 2011].
- WANG, M., and OVERLAND, J.E., 2009, A sea ice free summer Arctic within 30 years? *Geophysical Research Letters*, **36**, L07502, doi:10.1029/2009GL037820
- WOODLEY, A., 1994, Culture, perceptions and community-based tourism: The case of Baker Lake, NWT. Unpublished Master of Arts, University of Waterloo, Waterloo, Canada.