

Sea Ice in Canada's Arctic: Implications for Cruise Tourism

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ABSTRACT. Although cruise travel to the Canadian Arctic has grown steadily since 1984, some commentators have suggested that growth in this sector of the tourism industry might accelerate, given the warming effects of climate change that are making formerly remote Canadian Arctic communities more accessible to cruise vessels. Using sea-ice charts from the Canadian Ice Service, we argue that Global Climate Model predictions of an ice-free Arctic as early as 2050–70 may lead to a false sense of optimism regarding the potential exploitation of all Canadian Arctic waters for tourism purposes. This is because climate warming is altering the character and distribution of sea ice, increasing the likelihood of hull-penetrating, high-latitude, multi-year ice that could cause major pitfalls for future navigation in some places in Arctic Canada. These changes may have negative implications for cruise tourism in the Canadian Arctic, and, in particular, for tourist transits through the Northwest Passage and High Arctic regions.

Key words: Canadian Arctic, Northwest Passage, sea ice, tourism, polar tourism, cruise tourism

RÉSUMÉ. Bien que le nombre de voyages de croisières se soit accru régulièrement depuis 1984, certains commentateurs ont laissé entendre que la croissance de ce secteur de l'industrie touristique pourrait s'intensifier en raison des effets de réchauffement du changement climatique qui rendent des lieux de l'Arctique canadien autrefois éloignés plus accessibles aux navires de croisière. En nous appuyant sur les cartes de la fréquence de présence de glace de mer du Service canadien des glaces, nous soutenons que les prédictions du modèle climatique mondial selon lesquelles il n'y aurait plus de glace dans l'Arctique dès les années 2050 à 2070 pourraient engendrer un faux sens d'optimisme en ce qui a trait à l'exploitation éventuelle de toutes les eaux de l'Arctique canadien à des fins touristiques. Cela s'explique par le fait que le réchauffement climatique modifie le caractère et la répartition de la glace de mer, ce qui a pour effet d'augmenter la possibilité de la présence de glace de haute latitude datant de nombreuses années et capable de pénétrer les coques, glace qui pourrait présenter des pièges importants en matière de navigation future dans certains endroits de l'Arctique canadien. Ces changements pourraient avoir des incidences négatives sur le tourisme de croisière dans l'Arctique canadien et, en particulier, sur les transits touristiques dans le passage du Nord-Ouest et les régions de l'Extrême-Arctique.

Mots clés : Arctique canadien, passage du Nord-Ouest, glace de mer, tourisme, tourisme polaire, tourisme de croisière

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INTRODUCTION

The number of cruise ships visiting the Canadian Arctic has steadily increased since 1984. In 2006, the number of cruise ships doubled to 22 ships, up from 11 ships in the previous season (Buhasz, 2006), confirming observations from elsewhere that the ocean environment has become one of the fastest growing areas of the world's tourism industry (Miller and Auyong, 1991; Orams, 1999; Hall, 2001; Dowling, 2006). While the evidence of climate change continues to mount and the debate about whether it results from anthropogenic forcing or natural variability continues (Serreze and Francis, 2006), what is almost certain is that Arctic regions are exhibiting the first signs of change (IPCC, 2007): these signs include reported increases in Arctic surface air temperatures (Rigor et al., 2000; Wang and Key,

2003), which are accompanied by reported decreases in sea-ice extent (Parkinson et al., 1999; Stroeve et al., 2005; Serreze et al., 2007) and thickness (Rothrock et al., 1999; Lindsay and Zhang, 2005).

Climate-induced changes in the Arctic could have significant environmental and economic impacts: economic sectors that can better adapt to a changing climate will prosper, and those that cannot adapt may decline, relocate, or disappear (ACIA, 2004). Given the reported decreases in Northern Hemispheric sea-ice extent in every month of the year since 1979 (Serreze et al., 2007), some commentators suggest that Arctic regions will see continued increases in cruise activity (Huebert, 2001; Scott, 2003; ACIA, 2004; Brigham and Ellis, 2004). These observations regarding growth of Arctic cruise tourism have also led to the generalization that cruise tourism might be one

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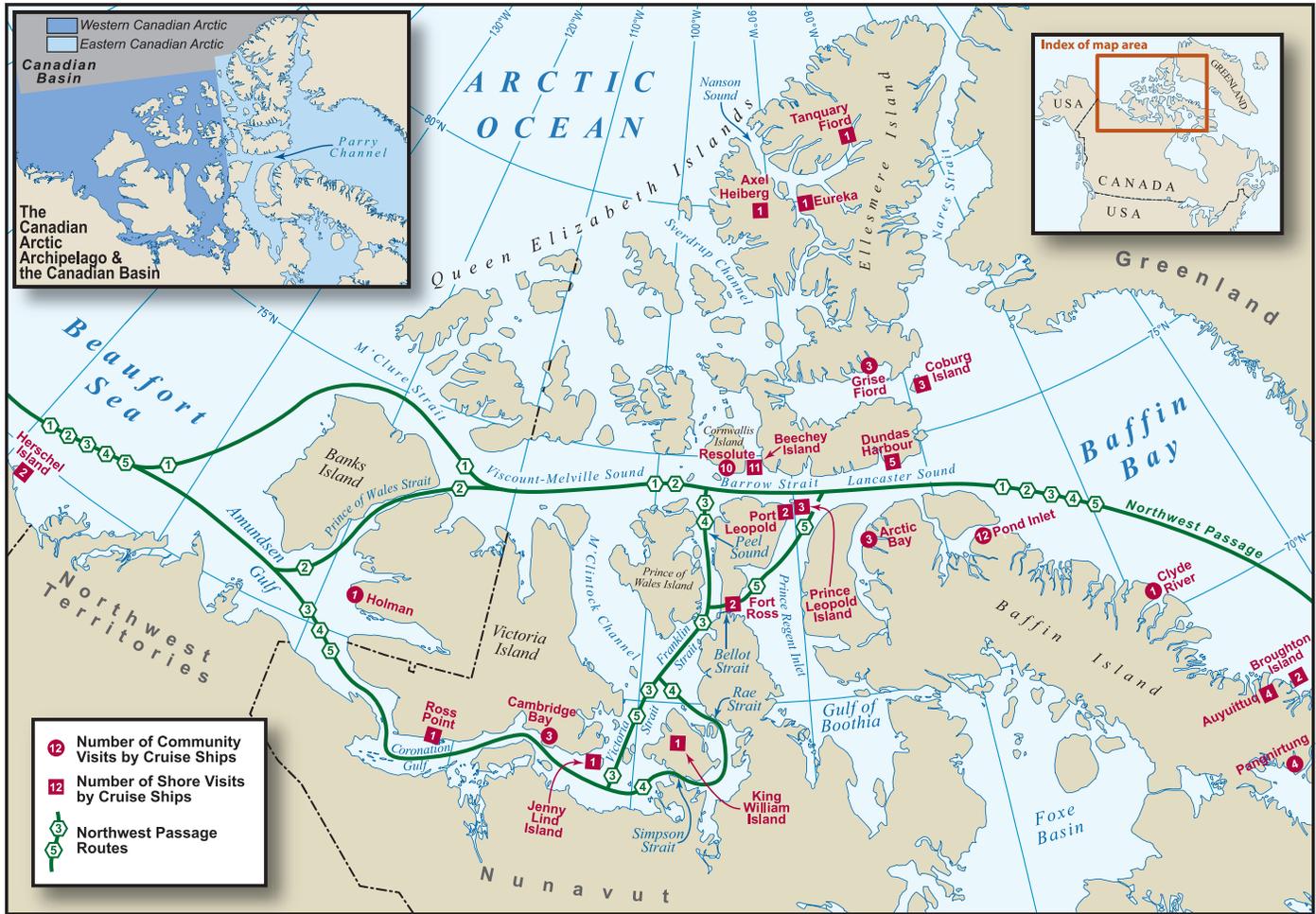


FIG. 1. The Canadian Arctic Archipelago: Routes through the Northwest Passage and tourism cruises planned for 2006.

of the few positive outcomes associated with climate change in the Arctic (Pagnan, 2003; Scott, 2003; ACIA, 2004; Johnston, 2006). While the specific effects of climate change on human activities such as tourism are discussed only rarely in the literature (Johnston, 2006), research about the warming effects of climate on tourism has been noted to be of critical importance in the polar context (Stewart et al., 2005).

This paper examines ice regimes in the Canadian Arctic to help us understand past, present, and possible future cruise activity in the region. We briefly describe the sea-ice regimes of the Canadian Arctic and review past and current trends in cruise tourism in the region, with a particular focus on the Northwest Passage. Using the Canadian Ice Service digital ice charts, we examine changes in sea conditions over the past 37 years to provide the basis for discussing the future of cruise tourism in these regions.

SEA-ICE REGIMES IN THE CANADIAN ARCTIC

The Canadian Arctic Archipelago is often divided into western and eastern subregions, which together encompass the Queen Elizabeth Islands (Fig. 1 inset). The North-

west Passage spans the ice-congested regions of the Canadian Arctic Archipelago and the pack ice of the Arctic Ocean found in the adjacent Canadian Basin (Fig. 1). During the winter, both seasonal first-year landfast ice and multi-year ice cover the Canadian Arctic Archipelago. The seasonal ice remains until breakup begins in July, and these waters refreeze again in October (Falkingham et al., 2001, 2002; Melling, 2002). While first-year sea ice grows and decays seasonally, multi-year sea ice has survived at least one summer's melt. In the absence of ridging, the first-year ice is typically no more than 2 m thick, whereas multi-year sea ice can be 3 to 4 m thick (Maykut and Untersteiner, 1971).

Regions in the Western Canadian Arctic Archipelago can contain as much as 50% multi-year ice because of the influx from the Canadian Basin and in situ formation (McLaren et al., 1984; Falkingham et al., 2002; Howell et al., 2006; Kwok, 2006). In contrast, sea ice in the Eastern Canadian Arctic Archipelago is mainly seasonal first-year ice, and conditions are less severe (Maxwell, 1981; Falkingham et al., 2001). Sea ice in the Queen Elizabeth Islands is a mix of first-year ice and multi-year ice that remains landfast for more than half the year until breakup in late summer or early autumn (Melling, 2002; Alt et al.,

2006; Howell et al., 2006). In a typical year, less than 20% of multi-year ice and 50% of first-year ice melts in the Queen Elizabeth Islands; thus, sea-ice concentrations are high during summer. Sea ice within the Canadian Basin is not landfast; instead, this perennial multi-year ice circulates according to the predominately anti-cyclonic circumpolar gyre (also known as the Beaufort Gyre) centered about 80°N, 155°W (Thorndike, 1986). As a result, sea ice is continuously forced up against the Queen Elizabeth Islands and becomes heavily ridged. This process creates some of the oldest and thickest sea ice in the world, reaching thicknesses of 6–8 m and potentially more (Bourke and Garrett, 1987; Agnew et al., 2001; Melling, 2002).

Cruise ships have traveled through these varying ice regimes of the Canadian Arctic in the past and are expected to continue to do so, in increasing numbers, in the future. The 2006 summer cruise season (end of July to mid September) recorded the highest number of cruise vessels (22) ever seen in Canadian Arctic waters (Buhasz, 2006). Drawing on reviews of published literature and polar travel websites, we present below a brief overview of past and current cruise tourism activity in the Canadian Arctic.

CRUISE TOURISM IN THE CANADIAN ARCTIC

Knowledge about cruise tourism in the Canadian Arctic is somewhat limited and often appears to be based on anecdotal reports and speculation (Stewart and Draper, 2006a). Exceptions are research by Grekin and Milne (1996) regarding effects of the cruise industry on the community of Pond Inlet, Baffin Island; work by Marquez and Eagles (in press) on the policy implications of cruise tourism in Nunavut; analysis by Dawson et al. (in press) of cruise tourism in the context of systems and complexity approaches; and reflections by Thomson and Sproull Thomson (2006) on cruise ship operations in the Canadian North. A small literature on cruise tourism elsewhere in the polar regions is emerging. For example, Grenier (1998, 2004) and Cervený (2004) examine the social aspects of cruise tourism in both the Arctic and Antarctic regions; Viken (2006) documents the changing nature of cruise tourism on Svalbard; and Ringer (2006) assesses the environmental, social, and economic effects of the Alaskan cruise industry.

The decline in the Soviet Union's economy in the mid 1980s increased the availability of ice-breaking and ice-rated ships, which benefited polar travel by allowing tourists to visit polar places in relative safety and comfort (Jones, 1999). With the final collapse of the Soviet Union in 1991, the availability of vessels for ship-based polar tourism increased rapidly (Grenier, 2004). In the Canadian Arctic, as in other polar regions, cruise travel has evolved into a style of "expedition cruising" that includes brief shore visits (including community visits) and education (Mason and Legg, 1999; Splettstoesser, 2000). Arctic

cruise tourists are generally well educated and well traveled people in their more advanced years, with high levels of disposable income (Jones, 1999; Grenier, 2004). Visitor statistics exist for many specific places and regions in Arctic Canada (Hall and Johnston, 1995), but there is little agreement on actual overall visitor numbers. This lack of agreement is due in part to variability across the region in the particular economic and social resources available for tourism; the nature of infrastructure, demand, and access; and the challenging nature of the northern environment (Johnston, 1995).

The Northwest Passage was chosen for the first tourist cruise in the Canadian Arctic in 1984. Connecting the Atlantic and Pacific oceans, the Passage provides a considerably shorter sea route between Europe and Asia than sailing through the Panama Canal or around Cape Horn. From as early as the end of the 15th century, the commercial advantage of a shorter route prompted many explorers to navigate the intricate islands and passageways of the Canadian Arctic in pursuit of the Northwest Passage. But a successful passage was not achieved until 1906, when Norwegian explorer Roald Amundsen finally sailed the Northwest Passage from east to west. Seventy-six years later, with 98 passengers on board, the cruise ship *Explorer* traversed the Passage in 23 days, only the 33rd full passage ever, thus ushering in the Arctic cruise industry (Marsh and Staple, 1995; Jones, 1999).

That there was sufficient tourist interest in the fabled Northwest Passage to warrant similar crossing attempts is not surprising, given that the Passage offers "the image of wide open spaces, filled with wildlife, scenic landscapes, islands of aboriginal culture, and, for English Canadians at least, a national heritage in terms of history" (Grenier, 2004:311). However, only two crossings were successful during the four years following 1984 (Marsh and Staple, 1995). These modest early attempts developed into a more regular pattern of cruise activity through the Northwest Passage from 1992 to 2004, with one to three successful voyages completed each year (Table 1). Thirty-seven percent of all Northwest Passage transits (1984–2004) were completed by passenger vessels such as that veteran of polar travel, the *Kapitan Khlebnikov* (Fig. 2) (Headland, 2004). This ice-breaking vessel has continued to dominate polar cruise travel, but the Canadian Arctic has also been traveled by ice-strengthened or ice-class ships such as the *Frontier Spirit* and the *Bremen*.

Of the variety of existing routes through the Northwest Passage (Fig. 1), by far the most commonly traversed route for tourism vessels is route 3 (see Table 1). This route passes through Lancaster Sound and Barrow Strait then southward, through Peel Sound, along Franklin Strait and Victoria Strait, before heading west into Coronation Gulf and Amundsen Gulf. Cruise ship passengers have visited various communities and other places of natural, historic, or cultural interest, depending on the chosen route through the Passage, taking part in excursions to the communities of Holman, Cambridge Bay, Resolute, and Pond Inlet, as

TABLE 1. Cruise ship transits through the Northwest Passage, 1984–2004 (after Headland, 2004).

No.	Year	Ship	Vessel type	Route through Northwest Passage ¹	Ship registry
1	1984	<i>Explorer</i>	Ice-strengthened	4	Sweden
2	1985	<i>World Discoverer</i>	Ice-strengthened	4	Singapore
3	1988	<i>Society Explorer</i> (formerly <i>Explorer</i>)	Ice-strengthened	3	Bahamas
4	1992	<i>Frontier Spirit</i>	Ice-strengthened	3	Bahamas
5	1992	<i>Kapitan Khlebnikov</i>	Ice-breaker	3	Russia
6	1993	<i>Kapitan Khlebnikov</i>	Ice-breaker	3	Russia
7	1993	<i>Frontier Spirit</i>	Ice-strengthened	3	Bahamas
8	1994	<i>Kapitan Khlebnikov</i>	Ice-breaker	2	Russia
9	1994	<i>Kapitan Khlebnikov</i>	Ice-breaker (return voyage)	2	Russia
10	1994	<i>Hanseatic</i>	Ice-strengthened	3	Bahamas
11	1995	<i>Kapitan Khlebnikov</i>	Ice-breaker	5	Russia
12	1996	<i>Kapitan Dranitsyn</i>	Ice-breaker	5	Russia
13	1996	<i>Hanseatic</i>	Ice-strengthened (grounded in Simpson Strait)	3	Bahamas
14	1997	<i>Hanseatic</i>	Ice-strengthened (escorted to Victoria Strait)	3	Bahamas
15	1997	<i>Kapitan Khlebnikov</i>	Ice-breaker	3	Russia
16	1998	<i>Kapitan Khlebnikov</i>	Ice-breaker	3	Russia
17	1998	<i>Hanseatic</i>	Ice-strengthened (escorted to Victoria Strait)	3	Bahamas
18	1999	<i>Kapitan Dranitsyn</i>	Ice-breaker	3	Russia
19	2000	<i>Hanseatic</i>	Ice-strengthened	3	Bahamas
20	2000	<i>Kapitan Dranitsyn</i>	Ice-breaker (circumnavigated Arctic)	3	Russia
21	2001	<i>Kapitan Khlebnikov</i>	Ice-breaker	1	Russia
22	2001	<i>Kapitan Khlebnikov</i>	Ice-breaker (return voyage)	1	Russia
23	2002	<i>Kapitan Khlebnikov</i>	Ice-breaker	3	Russia
24	2002	<i>Hanseatic</i>	Ice-strengthened	3	Bahamas
25	2003	<i>Bremen</i> (formerly <i>Frontier Spirit</i>)	Ice-strengthened	3	Bahamas
26	2003	<i>Bremen</i> (formerly <i>Frontier Spirit</i>)	Ice-strengthened	3	Bahamas
27	2004	<i>Kapitan Khlebnikov</i>	Ice-breaker	5	Russia

¹ See text and Figure 1 for a description of the routes through the Northwest Passage.

well as shore landings at places such as Beechey Island, Herschel Island, and King William Island (Fig. 1). The route through Coronation Gulf and Amundsen Gulf is popular, as there is an opportunity to visit the historically important community of Cambridge Bay.

In 2001, the *Kapitan Khlebnikov* traversed route 1, the northerly route through Viscount Melville Sound, M'Clure Strait and into the Beaufort Sea, in both easterly and westerly directions. Earlier, in 1994, the *Kapitan Khlebnikov* had traversed route 2, again in both easterly and westerly directions, passing through Viscount Melville Sound and transiting into the Prince of Wales Strait before emerging in the Beaufort Sea via Amundsen Gulf. The *Explorer* successfully navigated route 4, through the Rae and Simpson straits around King William Island, on her maiden voyage through the Northwest Passage in 1984; however, this route has not been completed successfully in subsequent years. Route 5, the final route for cruise vessels sailing through the Northwest Passage, courses along Prince Regent Inlet, through the narrow Bellot Strait into the Franklin and Victoria straits, and out to 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 it in 1996, also in an easterly direction.

More favorable ice conditions, allied with spectacular scenery, good wildlife viewing, and opportunities to visit Greenland, mean that the Eastern Canadian Arctic has continued to receive the most cruises. Baffin Island, for example, has been circumnavigated many times, and its

communities, such as Pangnirtung and Pond Inlet, host cruise passengers regularly (Fig. 1). By contrast, the ice-congested conditions of the Queen Elizabeth Islands usually deter cruise ship travel. Since the Beaufort Sea is considered the entry and exit point of the Northwest Passage, shore visits are uncommon along Canada's northern mainland coast. Although Herschel Island has hosted cruise vessels in the past, ships passing through this region usually are inbound or outbound to Alaska via the Bering Strait.

As Figure 1 illustrates, the frequency of community and shore visits varies throughout the region. During the 2006 cruise season, three traverses of the Northwest Passage were made. The *Akademik Ioffe*, an ice-strengthened vessel built in Finland in 1989, sailed the Passage via Peel Sound, as did the *Bremen*, an ice-strengthened ship that also successfully completed this voyage in 2003. The *Kapitan Khlebnikov* cruised through the Passage from west to east, but heavy ice conditions near Barrow, Alaska, delayed its arrival into Cambridge Bay, the first scheduled community visit. This situation is not uncommon, as ice, weather or operational difficulties sometimes force operators to change plans, often at the last minute. In such circumstances, vessels might bypass communities that were prepared for a visit or arrive in other communities without notice (Dobson et al., 2002). As Johnston (2006:46) states, "as attractive as increased tourism might be, it nonetheless represents an economic, social, political and environmental agent of change that must be addressed within the context of a particular community." Consequently, not all communities have welcomed cruise ships.



FIG. 2. The *Kapitan Khlebnikov* cruise ship visiting Cambridge Bay, Nunavut, in July 2005 (photograph by Emma J. Stewart).

Clyde River on Baffin Island, for example, has decided that the positive effects of cruise visitation do not counter the negative effects, although one cruise ship did schedule a visit in 2006. For Clyde River the question remains: How are cruise visitors managed if the community has decided they are not welcome?

During the 2006 cruise season, communities on Baffin Island hosted as many as 12 cruise ships over a three-month period, and a number of these vessels made back-to-back sailings. For example, 12 cruise ships docked at Pond Inlet over a 41-day period, including the *Hanseatic*, based in Germany (Fig. 3). Resolute, on Cornwallis Island, hosted 10 cruise ships during the 2006 season. Resolute is an entry and exit point for the Canadian High Arctic, and regularly scheduled flights operate between Resolute, Cambridge Bay, Iqaluit, and Ottawa. The community of Pangnirtung hosted four cruise ships; the hamlet of Arctic Bay, home base of the *Explorer*, hosted three cruise ships; and Grise Fiord on the southern shore of Ellesmere Island, the most northerly community in Canada, hosted three cruise ships. Also in 2006, the *Kapitan Khlebnikov* ventured as far north as Tanquary Fiord on her Ellesmere Island tour.

This brief overview of cruise tourism in Arctic Canada reveals that the industry has moved beyond its infancy, and is now entering a maturing phase with increased numbers of vessels, more demanding routes, and more regular and predictable patterns of activity. The range of factors likely to support this maturing phase of the industry includes increasing tourist demand for travel to remote places, overall popularity of cruising worldwide, more sophisticated promotional activities by tour agencies, and increasing awareness at the political and community levels about the benefits of cruise tourism. However, the extent, condition, and behaviour of sea ice may well be crucial in dictating where cruise ships travel in the Canadian Arctic in the future. The following review of sea-ice variability in the Canadian Arctic will serve as a basis for discussion of future Arctic cruise activity.

SEA-ICE VARIABILITY IN THE CANADIAN ARCTIC: 1968–2005

Both the media and scientific communities have expressed considerable interest in the potential for an ice-free Arctic, predicted by some global climate models to occur as early as 2050 (Walsh and Timlin, 2003; Holland et al., 2006). Improving our understanding of future patterns of cruise activity in the Canadian Arctic requires an examination of the historical variability of sea ice in this region. Regional digital ice charts, one of the primary climatological products issued by the Canadian Ice Service, provide information on Canadian Arctic ice conditions. We used these charts to examine changes in open water and sea-ice concentration during the past 37 years. These weekly charts are derived by integrating data from a variety of sources, including surface observations and aerial and satellite reconnaissance; they represent the best estimate of ice conditions based on all available information at the time (Canadian Ice Service, 2006).

We confined our study to a 17-week time window (25 June to 15 October) in 1968–2005 that represents the optimal navigation season for cruise ships (Falkingham et al., 2001; Howell and Yackel, 2004). To provide an indicator of the amount of open water present each year, we calculated the total open water (in km²) accumulated during this time window by summing open water for each of the weekly ice charts. This parameter is relatively insensitive to anomalies on individual ice charts and is the most stable and robust parameter in the database to represent long-term climate change (Falkingham et al., 2001, 2002; Canadian Ice Service, 2006). In addition, we calculated the rates of change in sea-ice concentration for both total and multi-year ice for each year from 1968 to 2005.

Total accumulated open water is increasing for all regions, with a greater proportion found in the Eastern Canadian Arctic compared to the Western Canadian Arctic (Fig. 4). This is because the eastern ice regime consists of a greater proportion of seasonal ice, whereas the Western Canadian Arctic has considerably more perennial ice. In the high-latitude region of the Queen Elizabeth Islands, total accumulated open water is also increasing. Despite these observed increases in total accumulated open water for all regions, light-ice years are still interspersed with heavy-ice years. During 1998, an extreme high in open-water conditions existed within the Western Canadian Arctic and the Queen Elizabeth Islands subregion because anomalously warm air temperatures contributed to a substantial loss of multi-year ice (Agnew et al., 2001; Jeffers et al., 2001). Since 1998, the Eastern Canadian Arctic has experienced several successive years of more open water, whereas the Western Canadian Arctic and the Queen Elizabeth Islands have returned to normal heavy-ice conditions (Fig. 4). The return to heavy-ice conditions is facilitated by in situ growth and by large-scale sea-ice dynamics that continually force multi-year ice in the Canadian Basin up against, and subsequently into, the western



FIG. 3. The *Hanseatic* cruise ship visiting Pond Inlet, Nunavut, in August 2006 (photograph by Emma J. Stewart).

portion of the archipelago (Agnew et al., 2001; Alt et al., 2006; Howell et al., 2006).

While the Eastern and Western Canadian Arctic regions are experiencing increases in total accumulated open water, a more detailed spatial examination reveals regional variations in increases or decreases of sea-ice concentration (Fig. 5). This variability has important implications for cruise ship operations throughout the Canadian Arctic because certain routes may be subject to heavier-than-normal ice conditions as a result of ice movement. This highlights the major pitfall for ships navigating the Northwest Passage—invasion of the cruise channels of the Northwest Passage by multi-year ice from the Canadian Basin or the Queen Elizabeth Islands, or both (Falkingham et al., 2001; Melling, 2002; Howell and Yackel, 2004; Howell et al., 2006). Multi-year ice is thicker, stronger, and takes longer to break up than seasonal first-year ice and thus presents a serious navigation threat to transiting ships.

Statistically significant decreases in sea-ice concentration during the 1968–2005 period are apparent in Baffin Bay (Fig. 5), suggesting that entrance to the Northwest Passage from Baffin Bay likely would be feasible. However, difficulties arise in the vicinity of Lancaster Sound, where there is an observable increase in ice concentration that is likely multi-year ice from the Canadian Basin being exported through Nares Strait. Once in the Northwest Passage, many multi-year ice navigation hazards or “choke points” are present for each route of the Passage. Choke points first present themselves at Barrow Strait, southern Peel Sound, and Franklin Strait, as these regions are susceptible to multi-year ice invasions from the Queen Elizabeth Islands (Howell and Yackel, 2004; Howell et al., 2006). Certain regions within the Queen Elizabeth Islands exhibited both increases and decreases in sea-ice concentration from 1968 to 2005 (Fig. 5). The more northerly of the Queen Elizabeth Islands contain very high concentrations of thick multi-year ice. When warming perturbations

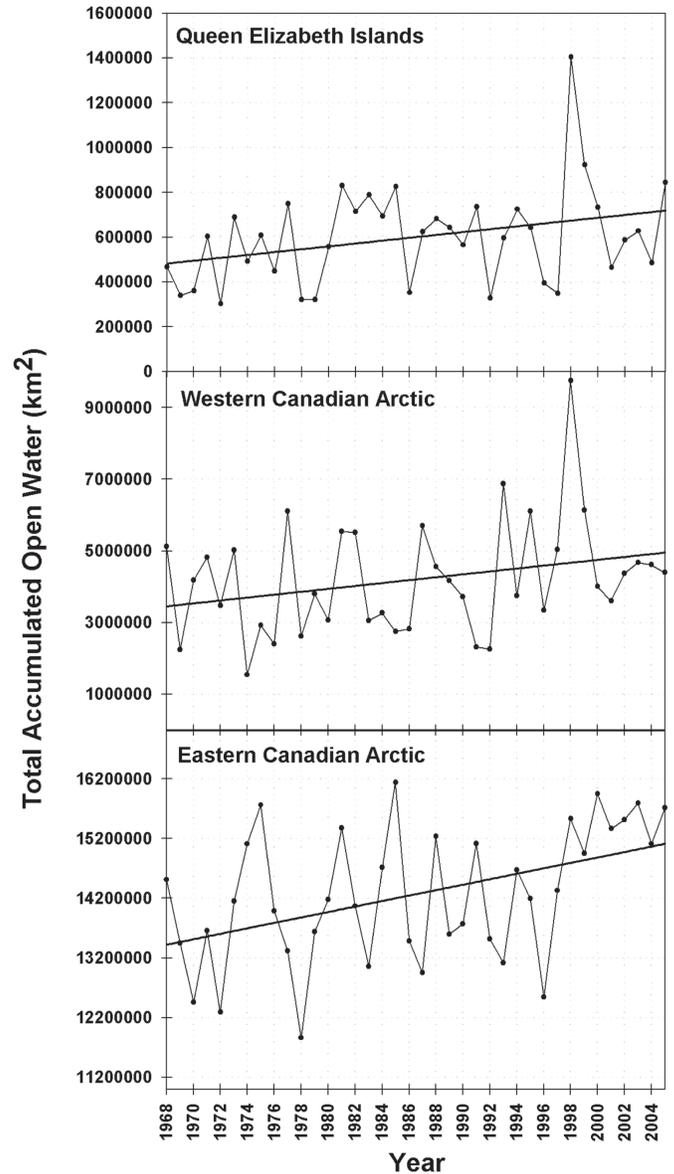


FIG. 4. Total accumulated open water in the Queen Elizabeth Islands, Western Canadian Arctic, and Eastern Canadian Arctic.

reach this region, multi-year ice can flow into the Parry Channel and subsequently into the lower-latitude regions of the Canadian Arctic Archipelago, creating more choke points (Melling, 2002; Howell and Yackel, 2004; Howell et al., 2006).

The most direct route through the Northwest Passage is via Viscount Melville Sound into the M'Clure Strait and around the coast of Banks Island. Unfortunately, this route is marred by difficult ice, particularly in the M'Clure Strait and in Viscount Melville Sound, as large quantities of multi-year ice enter this region from the Canadian Basin and through the Queen Elizabeth Islands. As Figure 5 illustrates, difficult ice became particularly evident, hence problematic, as sea-ice concentration within these regions increased from 1968 to 2005; as well, significant increases in multi-year ice are present off the western coast of Banks

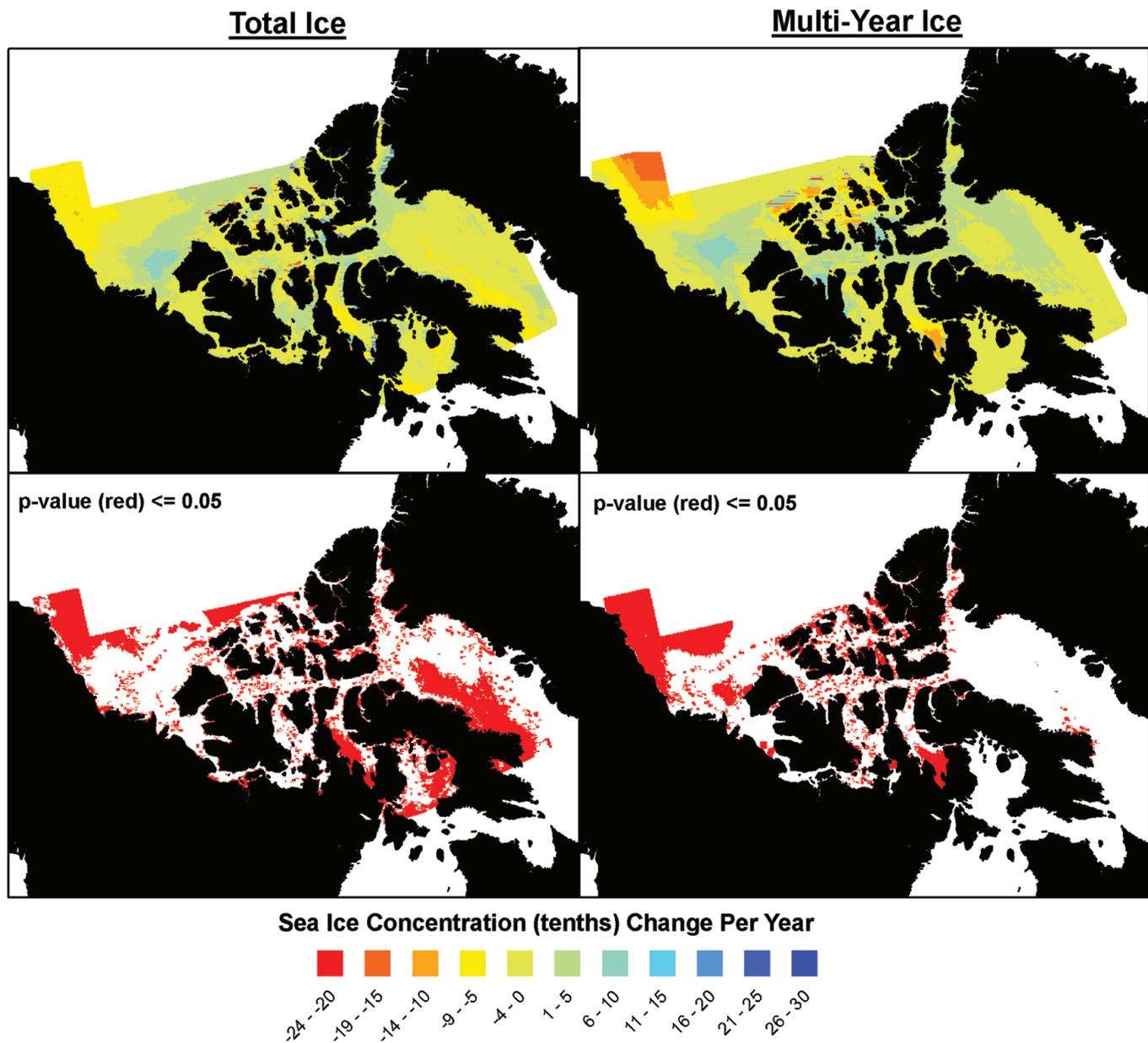


FIG. 5. Sea-ice concentration change (in tenths) per year in the Canadian Arctic from 1968 to 2005. The top left panel represents total ice and the top right panel, multi-year ice. The lower panels show significant regions ($p < 0.05$).

Island as well. Howell and Yackel (2004) illustrated that ice conditions within this region during the 1969–2002 navigation seasons exhibited greater severity from 1969 to 1979 than from 1991 to 2002. This variability likely is a reflection of the extreme light-ice season present in 1998 (Atkinson et al., 2006), from which the region has since recovered. Cruise ships could use the Prince of Wales Strait to avoid the choke points on the western coast of Banks Island, but entry is difficult; indeed, Howell and Yackel (2004) showed virtually no change in ease of navigation from 1969 to 2002.

An alternative, longer route through the Northwest Passage passes through either Peel Sound or the Bellot Strait. The latter route potentially could avoid hazardous multi-year ice in Peel Sound, but its narrow passageway

makes it unfeasible for use by larger vessels. Regardless of which route is selected, a choke point remains in the vicinity of the Victoria Strait (Fig. 5). This strait acts as a drain trap for multi-year ice that has entered the M'Clintock Channel region and gradually advances southward (Howell and Yackel, 2004; Howell et al., 2006). While Howell and Yackel (2004) showed slightly safer navigation conditions from 1991 to 2002 compared to 1969 to 1990, they attributed this improvement to the anomalous warm year of 1998 that removed most of the multi-year ice in the region. From 2000 to 2005, when conditions began to recover from the 1998 warming, atmospheric forcing was insufficient to break up the multi-year ice that entered the M'Clintock Channel. Instead the ice became mobile, flowing southward into the

Victoria Strait as the surrounding first-year ice broke up earlier (Howell et al., 2006).

IMPLICATIONS FOR CRUISE TOURISM

The 37-year observational record discussed in the previous section provides little to no evidence to support the claims that climate change is affecting sea-ice conditions in the Canadian Arctic sufficiently to enable increased ship traffic through the Northwest Passage. While some increases in open water have been recognized, the navigable areas through the Northwest Passage actually have exhibited increases in hazardous ice conditions; navigation choke points remain and are due primarily to the influx of multi-year ice into the channels of the Northwest Passage. Thus, cruise operators working in the Canadian Arctic face considerable uncertainty in the future: rather than widespread accessibility, as some have claimed, there is likely to be much more variability of ice conditions across this region.

A key concern in what seems to be the most likely scenario of increased cruise traffic, combined with increased interannual variability in sea-ice hazards, is the availability of short-term and long-range sea-ice forecasts to aid in safe vessel transits, route planning, and long-term planning. The National Ice Center in the United States and the Canadian Ice Service in Canada are the government departments responsible for relaying ice information to the public. Both agencies run short-term (12–24 h) ice forecasting models (Sayed and Carrieres, 1999; Van Woert et al., 2004). Unfortunately, both models were developed for the open ocean, and neither model incorporates sufficient sea-ice processes specific to the narrow channels of the Canadian Arctic Archipelago (such as ice bridges, fast ice, and the dynamics of ice flowing through narrow channels) to generate skillful forecasts. This is, however, an area of active research (Sayed et al., 2002).

Recent advances in seasonal forecasting have been incorporated into operations at both the National Ice Center and the Canadian Ice Service. Since the current state of the earth's climate is to some degree a function of past climate states, relatively simple statistical models that exploit this "interseasonal memory" in the climate system have successfully predicted summer ice conditions along the northern coast of Alaska (Drobot, 2003, 2005) and the start date of the shipping season in Hudson Bay (Tivy et al., in press). Further research would be required to adapt these models to meet the specific needs of the tourism industry. In general, the current state of short-term and long-range sea-ice forecasting is insufficiently advanced to deal with a major increase in ship traffic in Canada's ice-infested waters, particularly through the narrow channels of the Canadian Arctic Archipelago.

The consequences of climate change for prediction of tourist flows has been the subject of considerable debate in the tourism literature (see literature reviewed by Gössling

and Hall, 2006). Researchers have warned that destinations may experience simultaneous losses and gains in their attractiveness. Similarly in the Canadian Arctic the changing nature of sea ice is likely to have double-edged effects on the cruise tourism industry (Stewart and Draper, 2006b). On the one hand, an ice-free summer presents opportunities for improved ship access to some places in the Canadian Arctic. As stated previously, cruise operators may be forced to reduce their activities in the Northwest Passage and to focus more heavily on the Eastern Canadian Arctic, where ice conditions are likely to continue to be more favorable for safe navigation. This focus is starting to be seen around Baffin Island, where communities such as Pond Inlet are emerging as favored destinations for cruise operators. In contrast, we speculate that land-based tourism activities, such as sport hunting, eco/nature tourism, retreat tourism, conference tourism, and winter-based tourism activities, could play a more prominent role in Western Canadian Arctic communities in the future.

On the other hand, the absence of ice will significantly reduce the opportunities to view ice-dependent wildlife. Predicted changes to tundra across Arctic Canada could signal extinction of some key species and biomes and movement farther north of others (Scott and Suffling, 2000; Lemieux and Scott, 2005). Since tourism in the Canadian Arctic is built on the expectation of viewing ice-dependent species, some commentators have suggested that cruise ship itineraries may alter in the future to track the changing ranges of key wildlife species (ACIA, 2004). Anecdotal evidence from informal conversations with cruise tourists in Pond Inlet in August 2006 suggested that tourists were disappointed in the small number and variety of wildlife species viewed. Given that tourism in Arctic Canada relies on wildlife in particular but also on snow, ice, mountains, and glaciers to sell cruise experiences, a key question emerges: would people really continue to visit Arctic Canada if charismatic fauna such as bears and whales were to move elsewhere? Some tour operators might speculate that the variability of wildlife sightings from cruise vessels is part of the charm, and thrill, of Arctic cruising. But how long can tour agencies continue to sell Arctic cruises with images of polar bears, narwhal, and beluga whales without actually delivering on those promises?

Some commentators have suggested that, despite reduced opportunities to see wildlife and concerns about the safety of future navigation in the Canadian Arctic, cruise tourism inevitably will continue to increase, possibly to the extent witnessed elsewhere in the polar regions (Pagnan, 2003; Johnston, 2006). The arguments for this are convincing: visitors on more traditional cruises are becoming more adventurous, seeking out more challenging, more remote locations to add to their global cruise list (Marsh and Staple, 1995). Latent demand and the propensity for an increasing number of cruise visitors to become return patrons is important because even in the early days of

Arctic cruising, 30% of tourists indicated that they would return to the Arctic (Marsh and Staple, 1995). Research in Antarctica confirms that people who have visited “one polar region are also likely to want to experience the other” (Bauer, 2001:153), and with the number of tourists visiting Antarctica growing dramatically in recent years (IAATO, 2007), a potentially sizeable market exists for Arctic regions. Clearly, all of these trends suggest the prospect of continued growth in Arctic cruise tourism.

Cruise visits to the Canadian Arctic in 2007 reflected a stabilization of the growth trend in cruise tourism. Both the Northwest Passage and the Baffin Bay regions saw similar numbers of cruise ships as visited during the record year of 2006, with a variety of sailings between Baffin Island and Greenland and farther north into the High Arctic (Polar Cruises, 2006). The momentum of this growth in Arctic cruise tourism presents many challenges to Arctic Canada, particularly because to date there has been little coordinated, trans-regional planning for the sustained development of cruise tourism in Arctic Canada (Stewart and Draper, 2006b). As has been the experience elsewhere in the world, cruise operators are often responsible for planning their own itineraries, and the result is sporadic development of cruise activity (Liburd, 2001). Evidence suggests that communities and agencies in Arctic Canada need to take a long-term view toward adoption of holistic, integrated planning approaches for tourism. As Johnson (2002) suggests, operators need to continue to invest in good environmental practice (such as implementing bio-security measures), and both operators and communities need to raise current levels of environmental awareness and to practice environmentally responsible activities. Not only is political will required to safeguard Arctic destinations, but greater profit sharing must occur between shareholders and destination communities. There is a sense of urgency to address these issues because changes ushered in by climate change are likely to accelerate the development of cruise tourism in some regions of the Canadian Arctic, while decelerating development in others (Stewart and Draper, 2006b).

CONCLUSION

Arguably, global climate change is the most pressing environmental concern for tourism (Patterson et al., 2006). The changing global climate has significant implications for the key land, sea, and ice resources of Arctic tourism and for the people and wildlife that inhabit the region. The sensitivity of tourism to climate change is evident particularly in the polar cruise sector. We have examined the specific relationship between changing sea-ice conditions and cruise travel in the Canadian Arctic Archipelago and the Canadian Basin; it would be timely to examine similar themes in the Hudson Bay and the East Coast regions of Canada, where cruise tourism also is emerging as a significant enterprise.

During the past 20 years, cruises gradually have become an important element of Canadian Arctic tourism, and currently there seems to be consensus about the cruise industry’s inevitable growth, especially in the vicinity of Baffin Bay. However, we have stressed the likelihood that sea-ice hazards will continue to exist and will present ongoing navigational challenges to tour operators, particularly those operating in the western regions of the Canadian Arctic. To date, fortunately, cruise operators in Arctic Canada possess a good human safety record, although there is a “lengthy record and anecdotal history of groundings and other bumbles” (Jones, 1999:31). However, the Canadian Arctic remains a place of danger. Decision makers must be proactive to ensure that risk is minimized, as an accident or incident could completely alter the industry overnight (Stewart and Draper, 2006b).

We hope the observations made in this paper will help tour operators and governmental and community decision makers to ensure that development of cruise tourism in Arctic Canada continues to proceed with caution and that individual, cultural, and environmental safety issues are at the forefront of planning efforts.

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