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# CLIMATE CHANGE, MARINE TOURISM, AND SUSTAINABILITY IN THE CANADIAN ARCTIC: CONTRIBUTIONS FROM SYSTEMS AND COMPLEXITY APPROACHES

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The climate-sensitive tourism industry, including Arctic marine tourism, is expected to be significantly impacted by climate change. The multifaceted impacts of climate change at multiple scales warrant a theoretical framework that is able to effectively examine complex and integrated relationships. The complex ties between culture, economy, and environment in the Arctic also mean a systems perspective on tourism-related change and sustainability seems highly appropriate. This article outlines some systems approaches to Arctic marine tourism. Key contributions of a systems framework include reconceptualizing Butler's Tourism Area Life Cycle, providing a framework for describing and understanding the tourism–climate change system, including identifying change influences and dynamics at varied spatial and temporal scales, and informing sustainability planning and assessment.

Key words: Systems; Complexity; Climate change; Arctic tourism

## Introduction

More often than not, the tourism industry is left off the list of globally significant resource use sectors such as mining, fisheries, agriculture, and forestry. This is a surprising omission considering the magnitude of tourism impacts on environmental systems and natural resources, through transportation as well as direct regional and local on-site impacts. Tourism often has been examined in a piecemeal fashion rather than as a process, or a system, which has helped researchers perpetuate the belief that the industry is more sustainable than other resource use sectors. More recently tourism researchers have outlined the usefulness of examining the tourism industry as a "system." discovering that it is

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much more consumptive than often portrayed (Becken & Patterson, 2006; Becken, Simmons, & Frampton, 2003; Gössling et al., 2005).

The potential positive and negative impacts of tourism growth may be significant, particularly in sensitive environments such as the Arctic and Antarctic. It has been estimated that tourism in the Canadian Arctic has been steadily increasing over the past few decades, although for a variety of reasons exact tourist numbers are difficult to deduce. Hall and Johnston (1995) suggest that the rapid expansion of tourist activity in the north can be attributed to tourists seeking to visit remote regions mainly for their natural history and cultural features. Historically, land-based nature tourism activities including hunting, wildlife viewing, and protected areas visitation have been most popular (M. E. Johnston & Haider, 1993). More recently, decreased ice cover and the increased availability of suitable ships such as icebreakers, have led to increased marine tourism, particularly via small and medium-sized cruise vessels.

Increased tourism numbers in the region have caused greater pressure on infrastructure, wildlife, and the natural ecosystem, and have generated significant waste disposal issues (M. E. Johnston & Madunic, 1995). Substantially increased marine tourism could also have significant effects, such as have been discussed for the industry elsewhere (Garrod & Wilson, 2003). Forecasting and planning for the future of Arctic tourism is complicated by numerous issues which will be discussed further. However, the prospect of climate change has even greater implications for effective Arctic tourism management and will be the main point of discussion throughout this article.

The Arctic Climate Impact Assessment (ACIA, 2004) described the Arctic as extremely vulnerable to observed and projected climate change impacts. Over the past few decades the average Arctic temperature has risen at almost twice the rate of the rest of the world which is cause for concern in the region (ACIA, 2004). Direct and indirect impacts likely will have significant effects on a range of Arctic tourism resources, including wildlife (polar bears, ice-dependent seals, migratory birds, and caribou/reindeer), local residents, and indigenous populations' cultural heritage and activities. Climate change may catalyze major physical, ecological, social, and economic changes, perhaps faster than humans are capable of adapting. Pagnan (2003) reported on discussions with Arctic tourism professionals, concluding that the tourism industry is not ready to respond to the dramatic impacts that climate change is expected to have in the Arctic.

This article draws on systems and sustainability ideas to explore the connections between tourism development and its effects, and climate change and its effects, in the Canadian Arctic, with an emphasis on marine tourism. The next two sections introduce tourism and climate change in the Canadian Arctic, and are followed by introduction of several key systems ideas and approaches and their applications to Arctic marine tourism planning and evaluation. A final section offers discussion and conclusions.

## Tourism in the Canadian Arctic

Although there are many ways to define "Arctic," we will use the common definition, which delineates the Arctic as north of the treeline or the similarly placed zone of continuous permafrost. In Canada that means we are looking at the northern portions of the three territories [the Yukon, Northwest Territories (NWT), and Nunavut], and several provinces (i.e., parts of Manitoba, Quebec and Labrador) (Fig. 1). This definition of Arctic reflects our emphasis specifically on marine tourism in the Canadian Arctic, but does present some data problems as tourism statistics are generally collected for entire political territories (e.g., all of the Yukon or Manitoba, not just the Arctic portions).

While Hall and Johnston (1995) state that in fact it may be impossible to truly estimate the number of Arctic or sub-Arctic visitors, in recent years tourist numbers in the Canadian Arctic have been estimated as follows:

- Labrador (entire portion of the province)—21,000/year (Hull, 2001)
- Churchill (the key tourism destination in Arctic Manitoba)—4,000–6,000/year (Lemelin, 2005)
- Arctic Yukon (specifically delineated as such)—8,000/year according to the WWF Arctic Programme (1998); or about 4,500 in 1994, 7,300 in 1999, and 6,200 in 2004 in the similarly defined North Yukon Tourism Region (Yukon Department of Tourism & Culture, 2005)

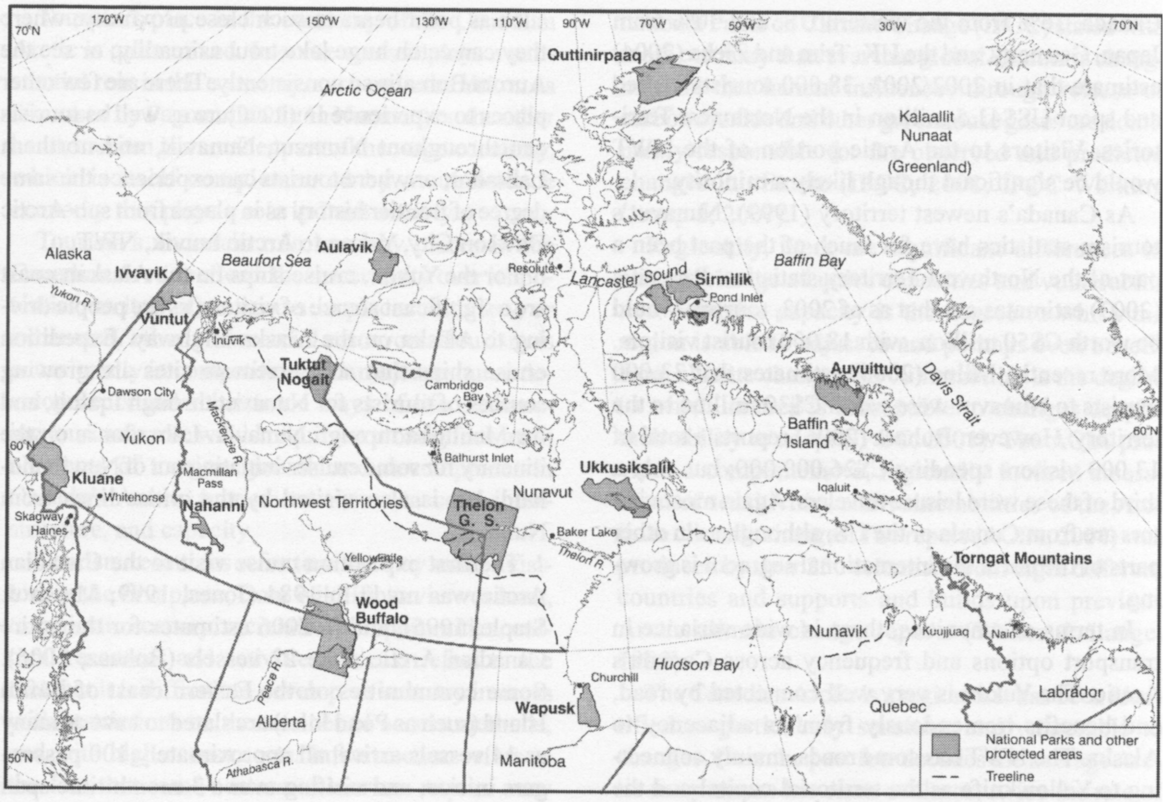


*Figure 1.* Northern Canada and the Arctic.

- NWT and Nunavut together (pre-1999)—48,000/year (WWF Arctic Programme (1998); in 2005 NWT visitors were estimated at about 37,000 and Nunavut at about 13,000 (Buhasz, 2006)

The scale and nature of tourism in the three Canadian territories is quite different. In 2005, the Yukon received approximately 325,000 tourists, up 3% from the previous year. Numbers have fluctuated somewhat since the early 1990s, when they were about 200,000. Most of these tourists were American (about 75%), while the remainder were from other parts of Canada (about 15%) or international destinations (about 10%). Tourism is estimated to contribute over C$170 million currently to the Yukon economy (Buhasz, 2006; Yukon Department of Tourism & Culture, 2005). Pagnan (2003) estimated that 890 businesses attributed some portion of their revenue from tourism, providing 11% of all direct jobs in the territory (1,900 in total). As the numbers above suggest, the Arctic share of Yukon tourism activity is small.

In 2004/2005 there were about 37,000 leisure visitors to the Northwest Territories (and another 24,000 business visitors), and tourism revenue was C$100,000,000 (Buhasz, 2006; Northwest Territories Industry, Tourism & Investment, 2007). This is up from about 35,000 visitors in 1998/1999 that spent about C$30,000,000 (NWT Resources, Wildlife & Economic Development, 2001). Comparably, Pagnan (2003) estimated visitors to the Northwest Territories in 1999/2000 as 33,120 leisure visitors (45% of all visitors). Of these visitors, 90% came for the outdoors (enjoying nature, specific outdoor recreation activities, and viewing the Aurora Borealis). A small portion of leisure visitors come to hunt or fish, but their expenditures are disproportionately high (in all the Territories). Unlike the Yukon, 50% of visitors to the NWT came from elsewhere in

Canada, 16% from the western US, and 30% from Japan, Germany, and the UK. Trim and Zieba (2004) estimate that in 2002/2003, 38,000 tourists visited and spent US$41.5 million in the Northwest Territories. Visitors to the Arctic portion of the NWT would be significant though likely a minority.

As Canada's newest territory (1999), Nunavut's tourism statistics have for much of the past been a part of the Northwest Territory statistics. Pagnan's (2003) estimates are that as of 2003, tourism would be worth C$50 million, with 18,000 tourist visitors. More recently, Milne (2006) estimates that 33,000 tourists to Nunavut were worth C$30 million to the territory. However, Buhasz (2006) reports a total of 13,000 visitors spending C$26,000,000; but only a third of these were leisure travelers. Again most visitors are from Canada or the US, although as in other parts of the north the international segment is growing.

In terms of amenities, there is wide variance in transport options and frequency across Canada's Arctic. The Yukon is very well connected by road, and benefits tremendously from its adjacency to Alaska. The NWT has some roads, mainly connecting to Yellowknife as the territorial capital and the second largest city in the Canadian North. According to Selwood and Heidenreich (2001), Nunavut is connected by air through two corridors, the east through Iqaluit on Baffin Island via centers such as Ottawa and Montreal, and the west through Baker Lake and the Hudson Bay/Manitoba corridor. Arguably there is also a third air route through Yellowknife, Cambridge Bay, and on to Resolute, which serves as an important entry/exit point for the High Arctic. Churchill, the major tourist destination in Arctic Manitoba is connected to Winnipeg via both rail and air, and is a major port for Hudson Bay. The Nunavik region of Quebec has no road access, virtually all access via air; and much smaller communities than the other areas previously described. The major amenity center for the region is Kuujjuaq (population 2,000), which in terms of regional tourism acts as the base for the Inuit-owned company, Cruise North. Similarly, Arctic Labrador has no road access, few air connections, and an amenity center in Nain (population 1,200).

Most tourism in Canada's Arctic is either nature or culture based. For example, there are few other places in the world where tourists can see animals such as polar bears in such close proximity; where they can catch huge lake trout as readily; or see the Aurora Borealis so consistently. There are few other places to experience Inuit culture as well as tourists can throughout Nunavut, Nunavik, and northern Labrador; or where tourists can experience the same degree of frontier history as in places from sub-Arctic Dawson City, Yukon to Arctic Inuvik, NWT.

For the Yukon, cruise ships on the Alaskan coast are a significant source of visitors, as are people driving to Alaska on the Alaska Highway. Expedition cruise ships that access remote sites are growing sources of tourists for Nunavut through Iqaluit, and for Manitoba through Nunavik. Labrador is on the itinerary for some cruises initiating out of Newfoundland, but is also visited by the cruise lines from Nunavik.

The first expedition cruise visit to the Canadian Arctic was made in 1984 (Jones, 1999; Marsh & Staple, 1995), and in 2006 estimates for the entire Canadian Arctic were 22 vessels (Buhasz, 2006). Some communities on the Eastern coast of Baffin Island (such as Pond Inlet) are slated to have as many as 14 vessels arrive, all approximately 100 passengers in size, and visiting over a 3-month time span (Stewart & Draper, 2006). This activity is far less than what the southeast coast of Alaska receives: perhaps 100,000–200,000 visitors to the town of Haines, AK, and many more to other major destinations, (e.g., well over 700,000 annually to Skagway in the last few years, up from about 500,000 in 1998) (Cerveny, 2004; Reeder, 2005). A few of these tourists then travel from Haines and Skagway, AK to the Yukon, and many of these on to Alaska again by road.

Small lodges for hunting and fishing have been popular tourist draws for many years in NWT and Nunavut. In Nunavut and elsewhere there is a growing number of purely wildlife viewing lodges in places such as Bathurst Inlet, Nunavut or Macmillan Pass, Yukon. Protected areas throughout the Arctic are major attractions for many (e.g., Glacier Bay National Park and Preserve in Alaska). Although a number of sub-Arctic protected areas draw thousands of tourists or more a year (e.g., Kluane National Park in the Yukon) due to their accessibility, many others in the Canadian Arctic attract far fewer (e.g., Auyuittuq and Quittinirpaaq National Parks in Nunavut) (Lachapelle, McCool, & Watson, 2005).

Tourism's place in the economy of the Canadian Arctic is quite mixed. In some areas it plays a substantial role in the economy, such as in the Yukon as discussed by Pagnan (2003). In Nunavut, on the other hand, tourism is a smaller part of the wage economy, which is itself complemented by a subsistence economy that plays a role in Inuit society.

Tourism's uncertain role in many places in the Canadian Arctic reflects the uncertainty over its potential, as it is often occurs in places with few, or exhausted, other commercial resources. Tourism is occasionally in competition with major resource developments and subsistence ways of life. Enhancing tourism's role would require exploring four main elements of tourism growth and development in Canada's Arctic: tourism resources, access, infrastructure, and capacity.

Tourism resources refer to what may attract visitors in the first place, from wildlife to view or hunt, to majestic scenery, recreational opportunities, cultural resources and activities. Access refers to the fact that it is difficult to develop an industry in areas with restrictions on the number of access methods, and with high access costs. Infrastructure refers to the fact that some sectors of tourism require very specific types of infrastructure (e.g., quality hotels, ground transport, and organized events) which can be difficult to find in remote settings. Capacity refers to the presence of skills, interest, and experience in working in and developing a service sector and industry. There also are issues of capacity in the simple absence of enough qualified, interested people living in these northern areas to fill all the necessary skilled jobs, tourism and otherwise.

Arctic tourism resources including scenery and wildlife will be directly affected by a changing climate. Tourism infrastructure, access to the region, and regional capacity will be indirectly affected by climate change which is expected to be significant in Arctic regions. The next section will outline climate change vulnerability in the Canadian Arctic discussing both biophysical and human system impacts and further examining climate related impacts on tourism resources, access, infrastructure, and capacity.

## Climate Change and Tourism in the Canadian Arctic

Release of the Third and now part of the Fourth Assessment Reports on climate change by the International Panel on Climate Change (IPCC) stated with more certainty than ever that global climate is changing and that human influences through release of carbon dioxide and other greenhouse gases are dominantly responsible for the observed and predicted changes in climate (IPCC, 2001; IPCC Working Group 1, 2007).

Regionally, there are significant differences in climate change adaptive capacities and vulnerabilities. Adaptive capacity is the degree to which the region is able to adjust to and perhaps even benefit from climate change and vulnerability is the degree to which an area is susceptible to changes despite their ability to adapt (IPCC, 2001). The ACIA provides a comprehensive, regionally focused assessment of sensitivities and vulnerabilities of the Arctic to climatic changes. The report (ACIA, 2004) was produced by over 250 scientists from eight different countries and supports and builds upon previous Arctic climate change reports (Weller & Lange, 1999).

The Canadian Arctic is a region that has been identified as particularly sensitive and vulnerable to changes. Over the past few decades the average Arctic temperature has risen at almost twice the rate of the rest of the world. There has been widespread melting of glaciers and sea ice, rising permafrost temperatures, shifting flora and fauna, and increased fire and insect outbreaks, which have all resulted in significant changes to the economic and cultural human systems in the region (ACIA, 2004). The IPCC's Third assessment suggests that significant regional vulnerability of Arctic climate will lead to major physical, ecological, sociological, and economic impacts. These impacts will be biophysical, economic and cultural, and likely will cumulatively affect tourism in the Arctic.

### *Impacts on the Biophysical System*

There is strong observational evidence of climate change in the Arctic. While variations do occur between regional landscapes, there are general warming trends across the Canadian Arctic. Warming is seen through recorded observations of warming temperatures, melting glaciers, reductions in thickness in sea ice, thawing permafrost, and rising sea levels. Over the past 40 years winter temperatures have increased by about 1.5°C in the western Canadian Arctic and 0.5°C in the central Canadian Arctic

(Government of Canada, 1997). Evidence of melting glaciers was observed as early as 1920 in low-lying areas (IPCC, 2001). There has been an 8% reduction of Arctic sea ice over the past 30 years (ACIA, 2004) and sea levels have risen by approximately 8 cm (3 in.) over the past 20 years. There has also been evidence of later freeze-up (5.8 days per 100 years) and earlier breakup (6.5 days per 100 years) of ice on lakes and rivers (ACIA, 2004).

Researchers currently rely on coupled Global Climate Models (GCMs) to predict future changes. GCMs are complex, mathematical computer models which use past (1961–1990 baseline) meteorological averages to simulate projected future climate data. The ACIA assessed five GCMs on their ability to replicate observed Arctic climate data from 1981 to 2000, finding that the distribution of annual mean temperature was reasonably well replicated. There was significant variability in the models' ability to replicate precipitation patterns during this time, making future precipitation predictions less reliable (Bonsal & Prowse, 2006). The models' ability to reasonably determine climate trends, which have already occurred, allows researchers to predict future trends including future temperature changes and related biophysical shifts in Arctic flora and fauna.

Using a moderate emission scenario Arctic summer temperature is expected to increase 3–5°C over land and up to 7°C over water by the end of this century. Arctic winter temperature projections are even more dramatic with predicted increases of 4–7°C over land and between 7–10°C over the oceans (ACIA, 2004). Warming temperatures are projected to increase the frequency and intensity of forest fires and insect infestations. Vegetation zones are projected to shift as warmer climates favor taller, denser vegetation. This will promote the expansion of forests northwards into the Arctic tundra and eventually force the Arctic tundra into a polar desert (ACIA, 2004).

Changing tundra vegetation also will affect caribou and reindeer herds, which are dependent on the region for feeding and breeding (ACIA, 2004). However, the degree to which they are affected by shifting vegetation zones is uncertain as these species are generalist feeders and tend to be highly resilient (IPCC, 2001). Many globally important seabird species, including some that are already endangered, are projected to lose more than 50% of their breeding area during this century (ACIA, 2004). Greater impacts will be seen among marine mammals due to the shifting sea ice, levels, and water quality. Ice-dependent seals such as ringed seals, ribbon seals, and bearded seals will be particularly vulnerable to declining sea ice where they give birth to and nurse their pups. This directly influences polar bears, which feed on the ice-bound seals (ACIA, 2004).

*Impacts on the Human System*

The changes that are expected in the biophysical system directly impact the human system. In the Arctic, as elsewhere, people have come to directly rely on the various services ecosystems provide, including provisioning services (fresh water and shelter construction), regulating services (climate and water), and cultural services (recreation and tourism) (Millennium Ecosystem Assessment [MEA], 2005). All of these services will be greatly affected by a changing climate. This section outlines some expected changes in the cultural services provided by the Canadian Arctic focusing on climate change and the tourism industry. Some of the major barriers to growth and development as well as opportunities in the region will be examined.

Changing Arctic temperatures, precipitation patterns, sea levels, sea ice coverage, and related shifts in vegetation zones and wildlife habitat and corridors mean that the tourism industry in the Canadian Arctic, which is largely nature and culture based, may be significantly impacted. For example, shifting vegetation zones and melting sea ice could cause ice-bound seals to migrate or decline. This in turn could affect polar bears that rely on seals as their primary food source and finally could significantly impact polar bear viewing tourism, including the economy and culture of communities such as Churchill, Manitoba.

We are currently observing a sensitive ecosystem with complex dynamics and anticipating change from the many small and large perturbations expected in the Canadian Arctic through climatic changes. However, not all of the impacts are expected to be negative. In fact there is support for the idea that there are ample opportunities for tourism growth alongside other traditional resource industry growth. What is surprising is the limited attention paid to the tourism industry in both the IPCC's Third Assessment and the ACIA despite the growing economic importance of tourism as a resource use industry in the Arctic. The absence of tourism-specific Arctic climate change information in these publications is concerning considering the fragility of the Arctic environment. There is, however, the start of a growing climate change and tourism literature (Agnew & Viner, 2001; Buerki, Elasser, & Abegg, 2003; Harrison, Winterbottom, & Sheppard, 1999; Scott & Jones, 2006; Scott, McBoyle, & Mills, 2003; Scott, McBoyle, & Minogue, 2006), including some Arctic-specific contributions (Johnson, 2006; Pagnan, 2003).

The main climate change related opportunity for tourism growth in the Canadian Arctic will likely be in cruise ship tourism. The permanent ice cover in the Arctic Ocean is predicted to diminish in the next few decades, potentially opening up more navigable waters in some regions (ACIA, 2004) while making it difficult in other areas dues to higher volumes of hull-penetrating multiyear ice (Howell, Tivy, Yackel, & Scharien, 2006; Howell & Yackel, 2004). A cruise industry in the region would cater to a growing market of affluent adventure travelers seeking to visit the most remote regions of the world. Macnab (2004) further suggests that the future may bring independent ocean sailing vessels and crews of enthusiastic tourists eager to push their personal limits. Pagnan (2003) admits that there could be significant economic opportunities for Arctic cruise tourism, as well as whale-watching tourism, but outlines some negative impacts, including changes in scenery (glaciers, tundra vistas) and wildlife, which are the foundation of Arctic tourism, and threats to low-lying coastal communities due to rising ocean levels.

A changing environment also may put pressure on the current mixed economy, and maintaining subsistence lifestyles could become an even greater challenge than it is currently. If, indeed, a mixed economy is to continue then significant attention needs to be paid to ensuring the sustainability and adaptability of the Canadian Arctic environment, culture, and economy. Despite predictions that tourism is likely to increase revenues and prosperity in the region there remain significant barriers to growth and development of the industry today and under climate change conditions. M. Johnston (2006) outlines some of the opportunities and barriers to tourism growth in the Arctic under changing conditions including effects on infrastructure, access, and attractions. We have modified M. Johnston's (2006) list to focus on marine tourism and added some indirect effects on capacity in order to capture the challenges of an untrained local labor force and shift in economy (Table 1).

Opportunities and challenges exist with regard to tourism development in the Canadian Arctic under a changing climate. From discussion with Arctic tourism professionals, Pagnan (2003) observed that we are currently not prepared for the impacts expected to occur within the biophysical and human systems. These impacts and associated challenges are complex, dynamic, and nonlinear. The resilience and adaptive capacity of the region and its societies also have yet to be determined. An inclusive, systems approach that considers a wide variety of complex and dynamically related factors is suggested in this article as a framework for guiding further research and enhancing future planning, management, and policy in the region with a specific focus on the tourism industry. Further research and planning are essential in the areas of Canadian Arctic marine tourism policy and management. The next section briefly outlines the origins, elements, and contributions of a systems-based theoretical framework.

## Systems, Arctic Marine Tourism, and Sustainability

Examining tourism-related problems from a systems or complexity perspective is not new. There is evidence of this line of thought back to early tourism literature, but it was not until more recently that we have seen traditional systems terms and language used in the tourism field. Examples include conceptualizations and studies of tourist attraction systems (Leiper, 1990), a chaos approach to tourism system functioning (McKercher, 1999), the dynamics of tourism development (Russell & Faulkner, 1999), spatial and temporal evolution of tourism resorts (Papatheodorou, 2004), regional tourism planning (Walker, Lee, Goddard, Kelly, & Pedersen, 2005), and individual travel and recreation choices (Woodside, Caldwell, & Spurr, 2006) (also see Farrell & Twining-Ward, 2004; Hall & Butler, 1995; Laws, Faulkner, & Moscardo, 1998). Indeed, there seems to be an emerging trend toward systems and complexity ideas in tourism research and planning,

Table 1

Direct and Indirect Effects of Climate Change on Barriers to Tourism Growth and Development in the Canadian Arctic

**Effects on Access**
- Decline in sea ice, extending shipping season
- Glacier melting leads to increased iceberg hazards
- Earlier melting of winter ice roads
- Increased frequency of flooding
- Northward movement of continuous permafrost line, leading to increased access through new road construction among other changes
- Sometimes limited and expensive transportation options (some road, some water, most air)
- Potential implementation of "carbon tax" in airline industry could increase transportation prices

**Effects on Attractions**
- Fewer cold weather days lead to seasonal challenges for winter activities
- Change in consistency of snow pack including more tundra ice versus snow leads to winter tourism challenges (dog sledding, etc.)
- More warm weather days lead to extended warm temperature (summer) activity seasons
- Warmer summer temperatures lead to increased insect challenges
- Ecosystem changes lead to changes in species diversity and abundance
- Ecosystem changes lead to appearance of new species in the north
- Scenic values diminished through environmental changes (species mobility and disease)

**Effects on Capacity**
- Warming climate causing increased tourist numbers that must be supported by local employment (not many residents are trained in hospitality or business management)
- Warming climate causing increased tourist numbers increases employment opportunities (often not enough people to fill the jobs required for a successful tourism endeavor)
- A climate enhanced shift from mixed economy to a market-based economy will have significant cultural implications which may be observed by tourists.

**Effects on Infrastructure**
- Sea level rise causing structural damage and mobility challenges
- Increased open water leads to increased storm surges and shoreline erosion
- Permafrost melting/land instability lead to construction and engineering problems and structural damage
- Increased cost of insurance on infrastructure

Sources: Baldacchino (2006); Hall and Johnston (1995); M. Johnston (2006); M. E. Johnston and Haider (1993); M. E. Johnston, Twynam, and Haider (1998); Sahlberg (2001); personal insight of the authors.

although certainly some are more enthusiastic than others. In this context, and given the complexities of planning for Arctic tourism and climate change, it seems appropriate to explore a complex systems approach here.

At its most basic level, systems thinking has origins in early studies of self-regulation and negative feedback ranging from steam engine controllers to the human circulatory system to developmental biology and the complex social dynamics observed by early ethnographers and anthropologists. As it was developed by biologist Ludwig von Bertalanffy and others, first in the 1930s and 1940s, and then by a wide range of researchers from social science, engineering, biology, since the 1950s, it has come to include holistic, multi- and transdisciplinary, multiscale, and relational dimensions as well. As such it has influenced many disciplines and been developed in many forms, more or less quantitatively (hard systems approaches), more or less participatory (soft systems approaches), more or less critical in orientation (Checkland, 1999; Jackson, 2003, for a survey).

In the last 20 years systems thinking has been greatly influenced by ideas from thermodynamics, physics, and hydrodynamics among others, that have lead to what are commonly called chaos, complexity, and self-organization theories. These add greater consideration of dynamics: chance, uncertainty, nonlinear interactions, and positive feedback and amplification processes to traditional systems approaches. Different approaches ascribe different significance to chance, uncertainty, and local versus global processes. Analyzing problems and management options from a nonreductionist, nonlinear, holistic perspective is now not new for disciplines such as business management (Jackson, 2003), physics (Badii & Politi; 1999), biology (von Bertalanffy, 1950), and resource and environmental management (Grzybowski & Slocombe, 1988). These applied approaches do not usually seek quantitative prediction, but rather seek to foster better understanding and more effective, sustainable, adaptive approaches to resolving complex problems.

For other disciplines, including tourism, systems thinking is relatively new in comparison, and could foster a greater awareness of system complexity, dynamics, and cross-scale connections. Butler's (1980) Tourism Area Life Cycle (TALC) is a perfect example of a dynamically simple, unidirectional model. Developed over 25 years ago, the s-curve model of "involvement–development–consolidation–decline" remains a foundation for large amounts of tourism research and literature (Cooper & Jackson, 1989; Getz, 1992; Hegarty & McDonagh, 2003; C. S. Johnston, 2001; Tooman, 1997; Weaver, 2000; Weaver, 2005). A simple modification from a modern systems perspective involves reconceptualizing it as a "lazy 8" cycle, after Holling's lazy-8 of ecosystem development (Gunderson & Holling 2002; Holling 1986; Walker & Salt, 2006). This complex, adaptive cycle models internal and multiscale process interactions that generate qualitative reorganizations in complex systems over time.

Butler's model laid out as a lazy-8 cycle can serve the same purpose as it did in its linear form, but as an eight it may encourage researchers to think more relationally and in terms of change and development (Fig. 2). It also is likely appropriate for an emerging industry such as Canadian Arctic marine tourism, whose future is highly uncertain, influenced by local factors such as capacity and resources as well as global forces such as climate change, economies, sovereignty, and security, and will likely see many

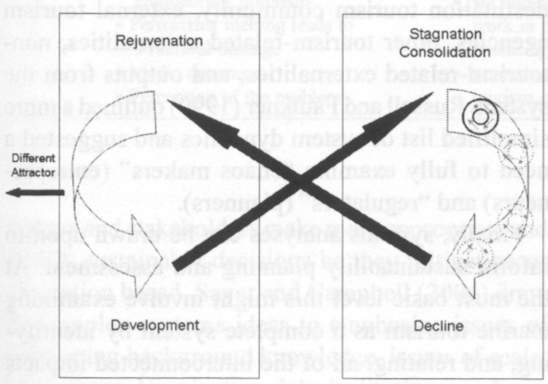


*Figure 2.* Tourism system moving through the figure eight of destination life cycle.

forms, false starts, and modifications before settling into some degree of stability.

The rotating circle passing through the life cycle stages of the lazy-8 represents a constantly fluctuating, changing, and evolving tourism system. When local or global factors influence the system (e.g., local social change, resource fluctuations, or climate change) with enough strength, then the system may move along the life cycle progression that Butler outlined in 1980.

Many tourism researchers who have embraced a systems approach have referred to the TALC model in their work but have failed to recognize that the simple addition of a feedback loop to the model itself can change its perspective from a Cartesian or Newtonian linear scientific paradigm to an adaptive systems model. For example, Russell and Faulkner (1999) in their discussion of systems theory and tourism suggest that the TALC model, "results in aspects of tourism development that are intrinsically chaotic, being overlooked" (p. 411). Here chaotic means small and/or distant changes having potentially significant, hard to predict effects on the tourism system of interest. Further, Casagrandi and Rinaldi (2002) state that, "Butler's diagrams are not appropriate for discussing sustainable tourism because they point out only the initial parts of the transition towards the attractors" (p. 19). The notable exception to this is Hovinen (2002), who suggested that systems theory provides a useful alternative and complementary perspective to Butler's TALC model.

Butler's model as a lazy-8 could be used in many tourism case studies to examine the potential impacts of a changing climate. For example, as outlined earlier, a warming climate in the Canadian Arctic might cause seals to decline or relocate. This could have a direct impact on polar bears, which feed on the seals, and in turn could have a significant impact on the economically vital Churchill tourism industry (Lemelin, 2005). This simplified example illustrates another key complex systems idea, sensitive dependence on initial conditions (SDIC); reflecting nonlinear amplification of a local perturbation, in which a small change has large and seemingly distant effects. Here, that means a small perturbation in seal populations or resource use could equate to a significant shift in tourism revenues and particularly the larger socioeconomic system.

A second systems contribution could come from a systems study of the implications of climate change for the marine tourism industry in the Canadian Arctic. As a first step this would more fully identify the potential change influences which could affect the functioning of the system. Both the supply and demand sides of a tourism marketplace should be considered (Fig. 3). A full application of this idea would involve participation by actors and stakeholders, and probably a workshop format. This approach could prove extremely useful for planning and management purposes. Several systems methodologies exist that include systems, complexity and postnormal or participatory science approaches and could be adapted for such purposes (Kay, Regier, Boyle, & Francis, 1999; Waltner-Toews, Kay, Murray, & Neudoerffer, 2004).

A third step, which builds on the basic systems study, or might be part of it, is to classify the change influences in terms of their spatial and temporal scale. This facilitates identifying cross-scale connections, priority issues at different spatial scales, and phenomena or processes in the system that may be amenable to influence and modification (Grzybowski & Slocombe, 1988). As a step for identifying cross-scale interactions this is a key part of analyzing the lazy-8 adaptive cycle (Gunderson & Holling, 2002; Walker & Salt, 2006). Table 2 presents an illustrative example of such an analysis. From it we can see that societal, economic, and environmental changes occur at predominantly differ-

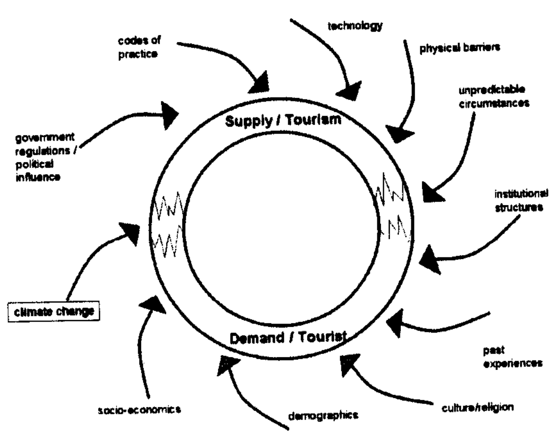


*Figure 3.* Change influences on arctic marine tourism supply and tourist demand.

ent scales and within different temporal period example, from a business perspective, climate arguably more appropriately, weather) affects ism in an approximate time horizon of 3–4 (Patterson, Bastianoni, & Simpson, 2006). Th similar time frame as for political office. Hov impacts through the slow release of greenhous emissions are felt over much longer time pe However, when change comes, it could com idly via nonlinear and threshold effects. For thi son, the implementation of a systems persp which explores the issues of scale (spatial an poral) is appropriate.

A fourth systems step involves more fully ining system dynamics. This means efforts to tify patterns in the behavior of the system, and cially whether there may be attractors (e.g., states, cycles, or more complex patterns) th system might tend to return to. Examining s dynamics requires long data time series to do ously. But at a minimum one can draw on s understanding, observed dynamics and p longer experience with other similar systems t tify patterns that seem likely, and which mi watched for. Berkes, Huebery, Fast, Manse Diduck (2005) provide much useful inforn from resilience and systems perspectives amo ers, on renewable resources and ocean mana in the Canadian north. McKercher (1999) dev a loosely defined "chaos approach" to touri outlines some of the tourism industry syst namics that need to be considered when impl ing a systems approach, including the travele munication vectors, communication b destination tourism community, external agencies, other tourism-related externaliti tourism-related externalities, and outputs f system. Russell and Faulkner (1999) outline simplified list of system dynamics and sug need to fully examine "chaos makers" (e neurs) and "regulators" (planners).

Finally, systems analyses can be drawn inform sustainability planning and assessn the most basic level this might involve ex marine tourism as a complete system by i ing, and relating, all of the interconnected (environmental, economic, social, positive, r etc), as well as the relative significance of and tourism effects in particular places, to he

Table 2
Interacting Processes in Tourism and Climate Change

| | Fast | Intermediate | Slow |
|---|---|---|---|
| Global | • Demographic change<br>• Winter recreation/tourism threatened<br>• Media coverage | • Increased frequency of floods<br>• Increased economic potential for some areas<br>• Decreased economic potential for other areas<br>• Loss of breeding habitat for globally significant sea birds<br>• Airline prices increasing | • Perception of the problem<br>• Awareness of the impacts<br>• Changes in international destination choice<br>• Agreement on appropriate mitigation and adaptation strategies<br>• UN Kyoto protocol<br>• Commitment to mitigation strategies<br>• Implementation of "carbon tax" effects many tourism related businesses<br>• Changing popularity of international tourism destinations |
| National | • Baby boomers ageing<br>• Generation X maturing<br>• Changing tourist demographic<br>• Vulnerability of conditions required for Nordic skiing and snowmobiling<br>• Seasonality issues<br>• Media coverage | • Warmer summer temperatures extend warm weather activities<br>• Increased national park visitation<br>• Sea ice melting creating more chartable water<br>• Election cycles | • Vulnerability of conditions required for downhill skiing |
| Regional | • Popularization of ecotourism<br>• Popularization of remote tourism<br>• Early break-up of ice roads<br>• Change in consistency of snow pack to ice<br>• Limited and expensive transportation options<br>• Extreme seasonality issues<br>• Shifting subsistence economy to market-based economy has visible cultural implications<br>• Media coverage | • Perception of the problem<br>• Awareness of the impacts<br>• Scenic value altered<br>• Decline in sea ice increasing cruise ship tourism<br>• Glacier melting causing iceberg hazards<br>• Warmer summer temperatures lead to increased insect challenges<br>• Increased open water leads to storm surges and shoreline erosion<br>• Increased warm weather tourism season lengths<br>• Decreased cold weather tourism season lengths<br>• Increased tourism numbers<br>• National support for regional impacts | • Arctic species habitat shifts<br>• Predicted decline in ice-bound seals<br>• Predicted decline in polar bears<br>• Northward movement of permafrost zone leads to increase in road construction<br>• Ecosystem changes lead to new species<br>• Implementation of "carbon tax" through air lines increases transportation costs |
| Local | • Seasonal variations in climate<br>• Permafrost melting/land instability leads to construction and engineering problems<br>• Permafrost melting leads to structural damage<br>• Media coverage<br>• Perception of the problem | • Perception of the problem<br>• Awareness of the impacts<br>• Subsistence living threatened<br>• Not enough trained local residents to work in the tourism industry<br>• Increasing awareness of climate change<br>• Increasing costs of insurance for tourism operators | • Increasing water levels<br>• Change in species diversity and abundance diversity<br>• Ecosystem changes lead to new species<br>• Increase in "novelty-seeking" tourists |

makers and stakeholders make more appropriate and ideally sustainable decisions be they mitigation or adaptation based. Sayer and Campbell (2004) draw on complex systems ideas to emphasize issues of developing background knowledge, issues of scale, governance, learning, models, institutions, and performance measurement. A systems approach also can help to move notions and criteria of sustainability beyond the traditional three pillars (environmental, economic, sociocultural) to more complex and systemic criteria of sustainability, (e.g., socioecological system integrity, livelihood sufficiency and opportunity, intra- and intergenerational equity, resource maintenance and efficiency, democratic governance and civility, precaution and adaptation, and integrated application) (Gibson, Hassan, Holtz, Tansey,

& Whitelaw, 2005). Systems approaches also could help consider what sustainability may mean in the context of potentially system-altering change.

Casagrandi and Rinaldi (2002) admit that, "it is difficult if not impossible, to formulate policies that guarantee that tourism can be maintained for a long time without severely impacting the environment" (p. 13). This is because unforeseen shocks in the tourism system can easily trigger a switch or change. As large as climate change effects may be, tourism industry effects also must be considered, especially at local scales. Implementation of a participatory systems perspective, including use of a precautionary approach (Fennell & Ebert, 2004), may be one of our best options for successful attempts at sustainable tourism management (Mason, Johnston, & Twynam, 2000).

For the nascent Canadian Arctic marine tourism industry this implies that both the supply and demand aspects of the tourism system be examined. For example, it is important to identify the potential impacts that climate change may have on tourism operations and infrastructure while at the same time identifying the resulting changes in tourist destination choice or behavior change. A systems perspective also would include the acknowledgement of other nonclimatic influences such as socioeconomic and demographic change, and tourism activity itself.

## Conclusion

Despite there being historic mention and discussion of the usefulness of a systems approach for tourism management, to date there remains a dearth of studies in the area and a complete absence of cases studies that actually apply the framework. This is likely because the implementation of a successful systems study is a large undertaking; one that requires a team approach including knowledge of various interrelated subjects. For example, in order to operationalize a comprehensive systems approach that analyzes the impacts of climate change on the Canadian Arctic tourism industry one would require expertise in climate science, resource and environmental management, Arctic environments, tourism management, Canadian Arctic culture, environmental economics, applied economics, tourist behavior, sociodemographics, and systems theory, among others.

Despite the challenges involved in developing an effective systems approach to tourism management it has the potential to be an effective tool for decision making and policy development in the tourism industry. McKercher (1999) displayed a strong belief in a systems-based approach to tourism development and planning when he suggested that the absence of systems-based critical thought has resulted in an "intellectual time warp that is up to 30 years old" (p. 425). He further outlines the drawbacks of previous frameworks in generating support for a systems perspective.

This article has outlined and supported the use of a systems approach to tourism management in the Canadian Arctic in a time of marine tourism growth and climate change. Climate change fosters environmental and economic change and uncertainty, making sustainability harder to plan and assess in the tourism sector. The interconnected and interacting impacts of both the biophysical and human systems make management of the problem diverse, difficult, and complex. The complexity of the problem in combination with the fact that the Arctic is being affected by climate change at twice the rate of the rest of the world makes the examination of this problem fortuitous if not urgent. Systems approaches can provide tools for analysis, and for thinking about how to foster resilience, adaptation, and sustainability (Folke, Colding, & Berkes, 2003)

There are various sources of uncertainty within the developing marine tourism sector. It is impossible to predict what future marine tourism operations entrepreneurs (chaos makers) will develop and promote and what consequences the interaction of those operations may incur. One thing that we can say with certainty is that the sector will go through many changes and iterations as the industry develops, stagnates, perhaps declines, and potentially rejuvenates. Therefore, it is reasonable to say that the extent of uncertainties is unknown yet there is certainty of change.

This article argues for the reconceptualization of Butler's TALC model to a lazy-8 adaptive cycle after Holling, to examine the dynamics of change within the Canadian Arctic marine tourism system. The new diagram should be as useful in examining destination development and management as Butler's linear model but may help researchers to begin examining the complexity of tourism systems more effectively and comprehensively. The second contribution of systems theory outlined in this article is fostering comprehensive identification of system influences. In a marine tourism context this includes outlining the potential pressures that the industry might experience and understanding that as a result the system is in constant motion. The third contribution is the acknowledgement of both temporal and spatial scales thus allowing researchers, managers and planners to apply time and space appropriate management tools and policies. The fourth contribution utilizes the knowledge generated from the previous three steps to identify important system dynamics, thus informing a more comprehensive perspective of sustainable tourism management.

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