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To cite this article: Suzanne de la Barre, Patrick Maher, Jackie Dawson, Kevin Hillmer-Pegram, Edward Huijbens, Machiel Lamers, Daniela Liggett, Dieter Müller, Albina Pashkevich & Emma Stewart (2016) Tourism and Arctic Observation Systems: exploring the relationships, *Polar Research*, 35:1, 24980, DOI: [10.3402/polar.v35.24980](https://doi.org/10.3402/polar.v35.24980)

To link to this article: <http://dx.doi.org/10.3402/polar.v35.24980>



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Published online: 01 Mar 2016.



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PERSPECTIVE

Tourism and Arctic Observation Systems: exploring the relationships

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Keywords

Arctic; Antarctic; citizen science; observation systems; tourism; IPTRN.

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Abstract

The Arctic is affected by global environmental change and also by diverse interests from many economic sectors and industries. Over the last decade, various actors have attempted to explore the options for setting up integrated and comprehensive trans-boundary systems for monitoring and observing these impacts. These Arctic Observation Systems (AOS) contribute to the planning, implementation, monitoring and evaluation of environmental change and responsible social and economic development in the Arctic. The aim of this article is to identify the two-way relationship between AOS and tourism. On the one hand, tourism activities account for diverse changes across a broad spectrum of impact fields. On the other hand, due to its multiple and diverse agents and far-reaching activities, tourism is also well-positioned to collect observational data and participate as an actor in monitoring activities. To accomplish our goals, we provide an inventory of tourism-embedded issues and concerns of interest to AOS from a range of destinations in the circumpolar Arctic region, including Alaska, Arctic Canada, Iceland, Svalbard, the mainland European Arctic and Russia. The article also draws comparisons with the situation in Antarctica. On the basis of a collective analysis provided by members of the International Polar Tourism Research Network from across the polar regions, we conclude that the potential role for tourism in the development and implementation of AOS is significant and has been overlooked.

The Arctic is affected by global environmental change and by diverse interests from many economic sectors and industries (Nuttall & Callaghan 2000). These sectors include oil and gas, mining, fisheries, tourism and marine transport. All of these sectors perceive both opportunities and challenges created by global environmental change and the impacts it has on the biophysical, social and regulatory environment (Lamers & Amelung 2010).

However, more knowledge is needed about the impacts of these sectors on the natural and social environment. Over the last decade, various actors have attempted to explore the options for establishing integrated and comprehensive trans-boundary systems for monitoring and observing impacts. AOS aim to enable the planning, implementation, monitoring and evaluation of responsible economic development in the Arctic (National Research

Abbreviations in this article

ACN: Arctic Co-operation Network
 AECO: Association of Arctic Expedition Cruise Operators
 AOS: Arctic Observation Systems
 IAATO: International Association of Antarctica Tour Operators
 IPTRN: International Polar Tourism Research Network
 NORDREG: Vessel Traffic Reporting Arctic Canada Traffic System
 NPI: Norwegian Polar Institute
 SAON: Sustaining Arctic Observing Networks
 SIOS: Svalbard Integrated Arctic Earth Observing System

Council 2006). Moreover, through these systems socio-cultural and environmental aspects can also be identified and addressed. One of the sectors rarely mentioned in AOS discussions is the tourism sector. This is remarkable given its growth and diversity across the Arctic, its economic significance, and the socio-cultural and environmental relationships involved (see Hall & Saarinen 2010). Given tourism's increasing growth and importance (in both value and impacts), the tourism sector and its extensive network of actors at multiple levels presents a significant opportunity to use the sector as part of existing and emerging observation and monitoring systems. Of particular relevance in this regard is the increasing attention paid to "citizen science."

It is significant that the tourism sector globally is already engaged in citizen science research; it is active also in similarly oriented activities through both "conservation tourism" and "participatory environmental research" (Scheepens 2014). Having an "experience" is at the heart of tourism and therefore visitors to the polar regions desire the inclusion of citizen science, an aspect desirable for both the destinations and other tourism stakeholders, which should be important for strategists reliant on observational monitoring. If a critical hurdle to engaging citizen science is the absence of alignment between community and research priorities (Pandya 2012), then tourism may offer a particular opportunity to engage given the potential that exists to align the environmental priorities of visitors, communities and researchers alike.

This article is authored by members of the IPTRN. The IPTRN was created in 2006 and provides a forum for researchers to investigate tourism and its intersection with environmental, cultural and economic issues in polar regions (see Grenier & Müller 2011; Lemelin et al. 2013; Müller et al. 2013). This article is inspired by claims made at the 2013 Arctic Observation Summit by Keskitalo et al. (2013). They proposed that tourism should be identified as a stakeholder sector that needs to be part of

an integrated observation and monitoring approach. The aim of this article is to identify and discuss the two-way relationship between AOS and tourism. On the one hand, tourism activities account for diverse changes across a broad spectrum of impact fields. On the other hand, due to its multiple and diverse actors and far-reaching activities, tourism is also well-positioned to collect observational data and participate as an actor in monitoring activities. The latter includes making contributions to monitoring and observation systems on changes that are not necessarily linked to tourism or its activities, but that occur where tourism activities takes place. On this point, we note the relative importance of tourism for AOS at the local level, as Arctic tourism often extends into remote areas that are rarely visited and, when they are visited, only for the purposes of tourism.

Since tourism has seldom been included in AOS discussions, the IPTRN posits that it is timely to identify and analyse the state of AOS in relation to tourism as a significant sector with a growing importance in Arctic and Antarctic regions. Furthermore, there are broad-based advantages related to the identification of the two-way relationship between AOS and tourism, and in the creation of a vision that encompasses collaborative approaches to the implementation of AOS in the future. To accomplish our goals, we provide an inventory of tourism-embedded issues and concerns of interest to AOS from a range of destinations in the Arctic circumpolar region, including Alaska, Arctic Canada, Iceland, Svalbard, the mainland European Arctic and Russia. The article also draws comparisons with the situation in Antarctica. Based on a collective IPTRN analysis across the polar regions, we conclude that the potential role for tourism in the development and implementation of AOS is significant and has been overlooked.

AOS and tourism

For the past decade, there has been consistent interest in creating an integrated Arctic observation network (see National Research Council 2006). In 2007–09, largely in line with the International Polar Year, the SAON process was created through a series of workshops and meetings of scientific bodies. The Arctic Council formally recognized the ongoing need for the SAON process at its 2011 meeting in Nuuk, Greenland.

Scholars have described the imperative for scientists to produce observations of the Arctic environment that meet the needs of various natural resource users, including tour operators (Lovecraft et al. 2012). Such research is important for linking tourism and AONs through: (1) identifying the need to improve the monitoring of Arctic

tourism and (2) describing the requirements of Arctic tour operators for pertinent environmental observations. However, scholarly research has yet to recognize the potential contributions that tourism itself can make to scientific observation in the Arctic.

Kruse et al. (2011) conceptualize an AON where geographical issues interact and interconnect with socio-cultural aspects through what they term the “Arctic social–ecological system.” Another observation model developed by Berman (2011) highlights the importance of societal dimensions by drawing a circle around a conceptualization of Arctic society, and placing the environment, government and world economy as outside forces impacting dimensions of wellbeing, control over one’s fate and the experience of nature. The Berman model is one way to conceptualize how tourism, as part of the global economy, may interact with the institutional and individual household decisions within AONs.

As part of the US Study of Environmental Arctic Change project, scholars identified Arctic tourism as an important area of human activity that should be monitored as a social component of AON (Fay & Karlsdottir 2011; Kruse et al. 2011). Under the AON rubrics, Fay & Karlsdottir (2011) provide tools that facilitate the observation of tourism trends; however, these represent an ad hoc, tentative exploration of factors, from a limited range of countries, and do not overcome the basic challenge of data source incompatibility.

Similarly, increasing attention has been placed on tourism impacts in the past two decades. Tourism impact research has a long history of identifying social, cultural, economic and environmental impacts. However, these considerations have largely been discussed in isolation from the broader disciplines that they are engaged in, and often placed within tourism industry specific contexts, notably for the impact these all have on economic development. Moreover, there is scant research that links impact discussions to observation and monitoring systems.

A number of issues and recommendations related to tourism observation-related challenges and opportunities were identified in a recent Canadian Polar Commission report (CPC 2014). The report draws on research by diverse Arctic scholars across multiple disciplines. Of relevance to this article is the work by Angell & Parkins (2011), who underline the objective to “better understand the needs of communities in order to facilitate the collection of community—and culturally-appropriate baseline data that can be used to help set environmental and socio-economic standards, predict and measure impacts, and inform legislation, policies, and programs” (p. 10). Also highlighted in the report is Stewart et al. (2005) list of research gaps, which includes the need to

undertake longitudinal studies of the cultural, economic, social and environmental impacts of tourism on communities and understand endogenous and exogenous influences on tourism development. Many scholars across the Arctic indicate that resolving the lack of baseline data is critical so as to better understand the impacts of tourism in order to inform appropriate adaptive responses (see Hall & Saarinen 2010; Fay & Karlsdottir 2011; CPC 2014).

A largely unexplored aspect of the relationship between tourism and AOS concerns the manner in which observations can be made for climate change related processes that may not be caused by or even (directly) related to tourism, but which are or can be (come) obvious in locations where tourism takes place. A case in point: the operational features of tourism activities can be embedded in emerging community-based and citizen-based observation approaches. The approaches have up to now been primarily discussed in the context of circumpolar residents, and almost exclusively in relation to Indigenous knowledge, Indigenous communities and Aboriginal self-government.

Tourism can assist SAON through community-based monitoring, defined as:

... a process which engages Arctic residents, governmental and non-governmental agencies, industry and academia in ongoing observing and monitoring of Arctic change as well as traditional knowledge ... in order to improve synergistic relationships within the Arctic observing community and fill gaps in the state of Arctic reporting. (SAON 2013: 6)

Along similar lines, Murray et al. (2013) advocate for citizen science as a way to provide:

... all interested individuals with the opportunity to participate in monitoring and observation-oriented research with the express purpose of collecting data to address a specific problem or set of problems. (unpaginated)

The authors add that monitoring and observation opportunities can be made available “regardless of the permanent physical location of the observer, the expertise of the observer, or the level of observer engagement in research problem formulation” (unpaginated). To that end, citizen scientists engaged in Arctic observing may be “residents of Arctic communities, but they may also be other individuals who have particular opportunities to collect information of relevance to Arctic observing needs and Arctic research” (unpaginated). While boundary demarcation issues still require attention, there is evidence that multi-disciplinary, community-based and citizen science approaches offer a

range of opportunities for the incorporation of the tourism sector in observational networks.

Polar regions overview

Though we acknowledge that definitions of the Arctic are plentiful, contested and in constant change (Müller 2013), we define tourism in the Arctic in relation to the geographic boundaries provided by the *Arctic human development report* (Stefansson Arctic Institute 2004), which includes Alaska, northern Canada, Greenland, the Faroe Islands, Iceland, northern Fennoscandia and northern Russia. The Arctic is defined as a socio-economically and culturally heterogeneous space, and similarly, Arctic tourism includes considerable shares of intraregional travel, business trips and urban tourism as well as the typical nature-based conceptions. Common characterizations of Arctic tourism include that it (1) is difficult to access tourism sites (geographically and financially); (2) faces human capital issues; (3) takes place in fragile environments; and (4) is a seasonal sector. Nonetheless, it is widely agreed that tourism activity in the Arctic has been increasing steadily over the past decades (see Hall & Saarinen 2010; Johnston 2011; Maher et al. 2014). A few examples help to illustrate the sector's value and growth.

In the summer of 2012, Alaska saw almost 1.6 million out-of-state visitors; that increased a further 263 100 in the fall/winter of that year (McDowell Group 2014). The economic value of this tourism includes an estimated 46 500 jobs, 179 million USD in taxes and revenues, 1.8 billion USD in visitor spending and an overall economic impact of 3.9 billion USD (McDowell Group 2014). Iceland has seen tourism more than double since 2000: 302 900 international visitors in 2000, 672 900 in 2012 (Óladóttir 2013). In 2012, the economic value of Iceland's tourism accounted for 23.5% of Iceland's export revenue (238 billion ISK). Similarly, in mainland Europe, visitor nights in Finnish Lapland grew from 1.7 million in 2001 to 2.4 million in 2013 (Lapland—Above Ordinary 2014). Moreover, while little research has been done on the growth of winter tourism, there is evidence that it is increasingly significant (Müller 2011). What is commonly agreed upon is that the economic value of tourism increases as tourist numbers increase, but the hard-to-measure environmental and socio-cultural ripple effects also increase.

The regional and country summaries that follow present an overview analysis of observation systems and aspects of tourism in the Arctic. It is not our intention to present a comprehensive survey of all actors, institutions or networks, but rather to provide a few useful examples

across a vast geo-political territory that will help to demonstrate the relationship between observation systems and tourism. In addition, a section on Antarctica is provided for comparison.

Alaska, USA

The state of Alaska constitutes the geographic presence of the USA in the Arctic. Within the US federal government, Arctic observing and monitoring is coordinated through multiple entities and programmes including the Inter-agency Arctic Research Policy Committee, the Arctic Research Consortium of the US and the Study of Environmental Arctic Change programme. The most recent articulation of the US vision for an integrated pan-Arctic observation network (IARPC 2007) makes reference to the Arctic monitoring priorities identified during the International Polar Year 2007–08 and the resultant international SAON programme. The US AON agenda appears to coordinate with the international effort. In addition, high-profile scientific initiatives—such as the Arctic Council's Arctic Monitoring and Assessment Program—include portions of the state located south of the Arctic Circle.

Two examples help to illustrate the potential contributions of Alaska tourism to AON. The Alaska Ocean Observing System, which is part of the US Integrated Ocean Observing System, reports on a series of community-based monitoring efforts in Alaska, including a ship-based tour called the Whales and Glacier Science Adventure. The tour is a joint effort between multiple public institutions (including the National Oceanic and Atmospheric Administration) and a private tour operator. It focuses on sampling phytoplankton, testing water quality and collecting data on humpback whales. While the tour is located in the south-east region of Alaska, such a model might also be viable in the far north of the state should cruise tourism increase.

The city of Barrow sits at the northernmost tip of Alaska. It is not uncommon for visitors to Barrow to hire guides for polar bear watching (Richard 2003). Bears can regularly be found at an area called “the boneyard,” which is a dumping ground for the carcasses of bowhead whales that have been harvested for subsistence. While data on bear sightings are not currently collected in a scientifically rigorous manner, such collection is possible and could potentially contribute to the scientific understanding of polar bears and how their population and range is altering with global environmental change.

These two examples, one presently occurring and the other hypothetical, only begin to illustrate the way that tourism can potentially contribute to the suite of observations needed to increase our understanding of the

US Arctic. Since Arctic Alaska is vast in size, but sparsely populated, tourists could play a key role in generating data about the remote places they visit, such as the Arctic National Wildlife Refuge in the north-east corner of the state. While such a project would take extensive centralized effort to coordinate data collection and processing, it may very well be worth the investment, as Alaska is undergoing unprecedented rates of environmental and social–economic change commensurate with the rest of the Arctic. The US National Park Service has published a climate change response strategy for Alaska (National Park Service 2011). The strategy prepares park employees for shifting visitor patterns as wildlife viewing becomes obscured by thickening flora and as glaciers continue to retreat. The National Park Service expects tourists to penetrate deeper into parks looking for such increasingly scarce attractions. This provides a direct opportunity for tourists, under the regulation and potential guidance of federal employees, to gather environmental data (e.g., location of animal sightings, types of plants encountered), and thus contribute to citizen sciences and AOS.

The likely mixed effects of climate change on Alaskan tourism are corroborated by a study that presents a quantitatively modelled tourism climate index for two tourism destinations in the state: King Salmon and Anchorage (Yu et al. 2009). The results show that climate change will likely extend the summer sightseeing season at King Salmon, but shorten the total time for skiing each winter in Anchorage. Through documenting the relationship between weather data (e.g., temperature, precipitation, sunniness) and visitor numbers, tourism operators can contribute to Arctic observing while simultaneously collecting valuable business data. Understanding how weather affects visitation will be important for future Arctic planning within and beyond the tourism sector.

Arctic Canada

Canada has established the SAON National Coordinating Committee to coordinate its activities related to monitoring environmental, social, economic and cultural issues (SAON Canada 2013). Members represent federal and territorial governments, academia, Indigenous groups and other relevant organizations. An early initiative was to comply with an inventory of current Arctic observing networks in 2009, which was updated in 2013 (www.arcticobservingcanada.ca). SAON Canada currently operates with full knowledge that Arctic observing programmes in Canada are currently scattered across the country and are often located in different organizations, and individual researchers or research groups sometimes carry out observation activities. In addition to these

challenges, there are gaps in the data that existing observing networks oversee. The 2013 inventory revealed five key clusters of networks: (1) atmospheric observations; (2) aquatic ecosystems; (3) terrestrial ecosystems; (4) cryospheric observations; and (5) human health. Moreover, it is surprising that shipping and yachting activity is currently not specifically part of Canada's integrated observing networks. Shipping has increased significantly, and yachting represents the fastest growing maritime sector in the region as it is elsewhere in the Antarctic (see Orams 2011). In fact, tourist vessels—which include cruise ships and private yachts—now make up a significant proportion of shipping activity in the Canadian Arctic (Pizzolato et al. 2014).

Since 2010, all vessels over 300 gross tonnes operating in Arctic Canada are required by legislation to report to NORDREG, an implementation process that is facilitated by the Canadian Coast Guard. Since 2009 Exact Earth and other smaller companies have been recording Automatic Information System data via satellite transponders for vessels travelling all over the world, including the Canadian Arctic. Access to the data is prohibitively expensive, but it is another important source of monitoring data.

The less expensive and more accessible NORDREG data were used in the Arctic Marine Shipping Assessment to determine ship volumes in the region (Arctic Council 2009). The Canadian NORDREG zone is divided into 16 subzones and is based on previously recorded ice conditions, which dictate when and where certain vessel types are permitted to travel safely. Vessels provide the Canadian Coast Guard with position data upon entry/exit of the NORDREG zone, daily position, vessel name, call sign, International Maritime Organization number and flag state (DFO 2014). A position report must also be provided if a vessel's master becomes aware of issues relating to vessels in difficulty, navigation obstructions, hazardous ice or weather conditions or observed pollutants. Clearly, these position reports provide important sources of environmental monitoring in places which may not be regularly visited by research or government vessels.

The Department of National Defense summarizes the NORDREG data each year through the Marine Safety Operations Centre. Additionally, the data have been refined, quality controlled and geo-located into a spatial data set through the Climate Change Adaptation Assessment for Transportation in Arctic Waters project at the University of Ottawa (Pizzolato et al. 2013; Pizzolato et al. 2014). Considering the availability of tourism data in Arctic Canada, it seems prudent to further refine the information for integration with SAON.

Furthermore, the AECO announced in 2013 that its jurisdiction would now extend into Arctic Canada

(AECO 2013). This move signals an additional opportunity for a more effective documentation of cruise tourism activities across the entire circumpolar region. In addition, there is evidence that visitors to the region are increasingly interested in contributing to citizen science projects such as those established through the Earthwatch's Climate Change at the Arctic's Edge programme and delivered by the Centre for Northern Studies based in Churchill, northern Manitoba (Earthwatch 2014). Scientific observation networks mostly ignore these types of tourism-based observation activities although they can potentially contribute to our understanding of change processes occurring in Arctic regions.

Iceland

Icelandic Arctic private sector stakeholders are primarily focused on resource extraction and how it can be serviced from Iceland, and identifying freight hubs servicing future Arctic shipping routes. Public sector stakeholders are more involved in search and rescue and research and development. In terms of the latter, the ACN was established at the University of Akureyri and the Arctic Policy Research group within the Institute of International Affairs at the University of Iceland. The former has more extensive ties with industry and regional stakeholders in the north of Iceland and can be considered a more comprehensive attempt at Arctic observation than the latter. Under the ACN umbrella are university-affiliated research bodies, such as the Stefansson Arctic Institute, the Arctic Council offices of the Protection of Arctic Marine Environment Working Group, the Conservation of Arctic Flora and Fauna, the Northern Research Forum and the Polar Law Institute and the Icelandic Tourism Research Centre. Affiliated to the ACN, and grouped under the Arctic Services collaboration, are the municipally funded Eyjafjörður regional business development agency, the privately owned information gateway Arctic Portal, and a cohort of other private sector stakeholders. In addition, through its regional governance body Eyþing, the town council of Akureyri funds and supports the network.

The ACN notwithstanding, no formal observation system exists in Iceland specifically focused on the Arctic. Several public sector institutes are responsible for monitoring Icelandic territory and waters from a variety of perspectives. These collaborate with institutes in neighbouring countries through the Office of the Foreign Secretary, which operates as Iceland's representative in joint intergovernmental Arctic-focused efforts. The seeds of an Arctic observation system can be seen in the activities of the ACN. The network was set up through the foreign secretary channelling funding dedicated to Arctic issues

into the regional government body of Eyþing. The foreign secretary was instrumental in moving the fund to the University of Akureyri, which in response set up the ACN. The funding covers the period ending in 2015.

The goals and objectives of the ACN remain elusive; moreover, capabilities are fragmented. Each of the co-operating bodies in the ACN has their own objectives and also their own governance structure. The ACN has therefore evolved into an information-sharing forum and a platform for facilitating project-oriented collaborations. Challenges remain in terms of defining the type of attention that Iceland should apply to the Arctic: Will Iceland focus on how to get on the resource extraction bandwagon, or will it focus on enhancing the means to sustain traditional livelihoods in tandem with nature? In terms of the latter, tourism could potentially play a significant role. Despite these issues and questions, stakeholder activities carried out by the ACN can broadly be placed into three categories: (1) monitoring and research of which the university-affiliated bodies belong to; (2) business development revolving primarily around servicing resource extraction and facilitating transport; and (3) providing information and facilitating governance collaboration. These activities are all centred in the north of Iceland, in Akureyri.

Currently, the only active tourism stakeholder in the ACN is the Icelandic Tourism Research Centre. Thus, while research and monitoring get profiled in terms of tourism and Arctic issues, neither business interests nor tourism governance are sufficiently involved—or attended to. Their involvement is imperative as tourism challenges in Iceland are shared throughout the Arctic. Getting a broader set of tourism stakeholders will help define the terms for an Arctic observation system that incorporates tourism, which does not currently exist. The Icelandic Tourism Research Centre has the objective to involve businesses and the public sector, as reflected in the board composition, which includes a member of the tourism industry association and a member also from the Icelandic Tourist Board. In essence, the Research Centre could be a platform for an Arctic observation system in relation to tourism.

Svalbard

Given the rapidity of environmental change and the science capacity present, it is not surprising that Svalbard is a member of the SAON network and has recently launched SIOS (SIOS 2013). The aim of SIOS is to establish a comprehensive observation system that covers all elements of the Arctic System, including geophysical, chemical and biological/ecosystem processes. The purpose

of the system is to illustrate and quantify the ongoing rapid changes in the Arctic and to contribute, in combination with model simulations, to their understanding and an improved prediction of future changes (Hansen 2011). However, given the importance of tourism for the Svalbard economy, it is surprising to note that the monitoring of tourism to the Svalbard archipelago and adjacent marine areas has been more or less absent in SIOS processes. In a recent report, it is only mentioned briefly in the context of pollution issues (Hansen 2011).

There are, however, numerous monitoring processes and projects that contribute to our understanding of the linkages between environmental change and tourism dynamics. The Governor of Svalbard, the NPI, Svalbard Tourism and the AECO are all involved in collecting and sharing statistics and data about tourist numbers, activities, locations and impacts. Cruise ship operators contribute to environmental monitoring, as all passenger vessels sailing in Svalbard waters are required, by law, to report all landings of passengers to the Governor. The NPI has established a comprehensive web-based environmental monitoring system called Environmental Monitoring of Svalbard and Jan Mayen, which contains over 200 environmental indicators, including tourism indicators (Viken 2011).

In collaboration with expedition cruise tour operators, the NPI administers the Svalbard Marine Mammal Sighting Database, whereby expedition guides and tourists can report observations of marine mammals. For this project, NPI monitoring activities benefit from the highly qualified staff present on cruise trips, the geographical spread of cruise trips and the desire of tourists to contribute to monitoring activities. Providing approximately 50% of the observations, tourists and tour guides deliver an invaluable contribution to monitoring and science of rare species, locations with no regular surveys and population dynamics (Andersen, pers. comm. 2013).

Furthermore, for issues of safety and environmental protection, the AECO is involved in multiple projects that contribute to operational and environmental monitoring of tourism activities in Svalbard, including the establishment of a cruise database, a satellite-based vessel tracking system and site guidelines. Many of these sector-based monitoring initiatives are replicated from the Antarctic cruise tourism sector and illustrate that learning opportunities exist across the polar regions. The Svalbard Environmental Protection Fund, a trust fund that collects a visitor fee from every tourist visiting Svalbard, funds many of the cruise tourism monitoring initiatives (Governor of Svalbard 2013).

On a final note, cruise operators in Svalbard make use of the PolarView satellite-based sea-ice observation charts

that are freely available, which enables them to make well-informed operational decisions. Similar information-sharing opportunities are also likely to apply to the increasingly sophisticated weather observation systems in the region.

It becomes clear that recent developments in both satellite-based and locally-based observation systems provide opportunities for the development of Svalbard cruise tourism, while at the same time the tourism sector contributes to the establishment of such systems. Industry-based efforts to manage and monitor the local effects of tourism on Svalbard should be incorporated into SIOS, and opportunities to further integrate tourism into the ongoing development of SIOS should be explored.

Mainland European Arctic: Sweden, Finland and Norway

Sweden has a long history of scientific monitoring of Arctic areas. In 1913, the Abisko Scientific Research Station was established, and a foundation was laid for one of the most comprehensive environmental records available. The Swedish Polar Research Secretariat, which mainly facilitates research in the high Arctic and Antarctica, is currently responsible for the management of the station. The Swedish Environmental Protection Agency is mainly responsible for monitoring programmes and the county councils are responsible for implementation and practical work. The agency is also in charge of the national parks, which are in majority located in the northern area, and also has responsibilities in outdoor recreation and research.

The situation in Finland largely mirrors the Sweden case. The Finnish Environment Institute is the main stakeholder regarding environmental monitoring. However, monitoring is achieved in cooperation with numerous other state agencies, including their regional branches. Altogether 19 different agencies were involved in a recent comprehensive monitoring exercise covering natural as well as human-made alterations to the Finnish landscape. Tourism is not mentioned in this context.

In Norway, the situation is similar and different at the same time from both Sweden and Finland. The Norwegian Environment Agency is responsible for monitoring the state of the Norwegian environment. This is accomplished through a decentralized structure similar to Sweden. Similar to the Norwegian Environment Agency, the NPI is another authority governed by the Ministry of Climate and Environment. However, its activities on mainland Norway are limited, and predominantly target Svalbard and other high Arctic areas, as well as Norwegian activities in Antarctica. Aside from state agencies, the Norwegian

Institute for Nature Research is a publically funded institute for applied ecological research and monitoring. The Norwegian Institute for Nature Research actually performs research and monitoring activities rather than just commissioning them. A special programme on Arctic ecology is run at the regional office in Tromsø.

The data produced by the Nordic monitoring exercises are accessible to the public (including online availability) in accordance with access to information traditions that typify the Nordic countries. In addition, governmental agencies for metrological survey and other areas provide additional information on the state of the environment. Legislation further requires environmental impact assessments for new activities that are considered to have the potential to harm the environment. Tourism is equally affected when it comes to the development of resorts and buildings. Otherwise, little is done to monitor tourism impacts; even rather crude measurements such as accommodation statistics and employment in tourism are difficult to obtain and often suffer from poor quality.

In summary, the Nordic mainland states have ambitious and often long-lasting environmental monitoring programmes. Nevertheless, the Arctic areas are treated in the same way as national areas outside the Arctic. With few exceptions, no special programmes are applied despite the sensitive nature of the polar environment. These assessments have to be considered against the background that Sweden and Finland, as well as Norway with regard to its mainland, only recently re-defined themselves as nations with Arctic territory. This re-definition has been done owing to geo-political reasons mainly. So far tourism does not play a major role in national monitoring programmes. It can be assumed this is the case because more pertinent challenges related to resource extraction are underway in all Nordic countries. In this context, tourism is often promoted as an environmentally friendlier use of northern environments.

Russia

The Russian Arctic has an extensive observation system and a long monitoring history. Soviet states have developed a network of points belonging to different scientific and public organizations to conduct and execute observations activities across its Arctic territory. Moreover, the original observation network established in the Russian Arctic included a whole range of thematically organized observations covering all Arctic system elements: hydrometeorology, cryosphere, environmental pollution control, geophysics, biology and socio-economic activities (AON 2010). Since the 1990s, and following public funding budget cuts, the system has experienced significant

setbacks. However, it is expected that Russia's ongoing and increasing interest in the Arctic will require that it continue to develop environmental monitoring and observation systems.

The establishment of Russia's integrated human-oriented observation systems is in its initial stages, and their development is due to the assistance provided by international actors such as the Norwegian Research Council. Since 2000, under the International Polar Year 2007–08 and with the International Arctic Science Committee as facilitator, the first attempt to create an integrated monitoring system incorporating a human dimension has been carried out within the PPS Arctic project (see PPS Arctic 2014). The socio-economic indicators connected to quality of life and sustainability issues were obtained from only three Russian Arctic regions (Komi Republic, Arkhangelsk and Murmansk). In their national report to the SAON network in April 2013, Russian representatives claimed that the human dimension-related data was updated and renewed even after the completion of the PPS project. Furthermore, the previously obtained data is only available "through collaboration with partner networks, projects, organizations" (AON 2010), which significantly complicates access to the data and its potential use. In fact, the Russian arm of the PPS project does not have a comprehensive web-based application connected to the results of the PPS Arctic. This stands in contrast to their Canadian counterpart, for instance, which provides easy access to results through the International Polar Year Metadata Repository. In fact, a web-based environmental monitoring system has still not been created in Russia, as this responsibility has not yet been assigned to any public organization or government body. This includes those currently responsible for monitoring of the environment in the Russian part of the Arctic, which is shared by the Federal Service for Hydrometeorology and Environmental Monitoring and the Russian Academy of Sciences.

The direct monitoring of human activities, including tourism, was never a part of any of the Russian observation initiatives. There are, however, a variety of state authorities responsible for data collection that is connected to the flow of foreign or domestic tourists in to the Russian Arctic territories. These data can contribute to understanding tourist visitation impacts. The data on foreign tourist numbers include the locations they visit in Russia and are collected by the Federal Migration Service through the visa application process for entry into the country. The Federal Security Service of Russia issues permissions to enter border zones to cruise ship passengers arriving in the Russian Arctic territories, for example, the archipelagoes of Franz Josef Land and Novaya Zemlya, as part of the Russian Arctic National Park expedition cruise

(Pashkevich & Stjernström 2014). So far, government authorities have not shared visitation data and the prospects of this information becoming available in the near future remains unlikely.

The development of observation systems in the Russian Arctic is currently focused on the scientific monitoring of natural processes with the aim of being able to predict changes to the natural environment. Thus far, tourism-related concerns and actors have not been involved. Russia is in the initial stages of establishing a comprehensive system, which integrates tourism, and will lead to better understanding linkages between human activities and environmental change. Cooperation between state and non-state actors, and especially with foreign actors, remains largely unexplored. Still, new linkages between renowned non-state actors such as AECO and other emerging Russian actors are increasing. For instance, in 2013 the AECO included a territory of the Russian Arctic National Park in their activities. The initiative involves cooperation for the development of environmentally sound tourism and establishing a positive dialogue between the Russian authorities responsible for nature protection and tourism development (Pashkevich et al. 2015). It also represents a first step towards creating knowledge transfer processes between the AECO and the park authorities, specifically when it comes to environmental protection standards and tourist safety issues.

Antarctica—a comparative polar view

Despite significant differences, parallels can be drawn between the Arctic and Antarctic regions. Similarities are primarily based on their biogeographic characteristics: their remoteness, extreme climate, the common perception of an environment inhospitable for humans, and high marine biodiversity and productivity. Arctic and Antarctic tourism also share a propensity for a cultural or nature-based educational focus and operational features (e.g., seasonality). Many tourism researchers conduct work at both poles, and virtually all the cruise vessels operating in the Arctic spend the austral summer season in the Antarctic. However, more so than in the Arctic, and mostly due to its lack of an Indigenous population, human engagement in the Antarctic is driven primarily by geopolitics and scientific research.

Only within the last decade did the Scientific Committee of Antarctic Research, along with its Arctic counterpart, the International Arctic Science Committee, acknowledge the weak and sporadic design of polar observing systems and the need for the development of long-term polar environmental monitoring networks (Rintoul et al. 2012). The Antarctic scientific community matched the approach

taken in the Arctic with SAON by establishing the Pan-Antarctic Observations System Action Group in 2007. Its objective is to evaluate and enhance the existing Antarctic observing systems structure (Rintoul et al. 2012). The work executed through the Pan-Antarctic Observations System remained low-key and little publicized and, as a result, other activities are taking its place. An integrated Southern Ocean Observing System is currently being developed (Rintoul et al. 2012) and is to be supplemented by a planned large-scale Antarctic Near-shore and Terrestrial Observing System (SCAR 2013).

Neither the Pan-Antarctic Observations System nor the Antarctic Near-shore and Terrestrial Observing System integrate social sciences research and methods into their approach; in fact, the social sciences and humanities generally operate on the margins of the much larger Antarctic natural science community. The Southern Ocean Observing System makes mention of Antarctic tourism and other shipping operators as potential users of Southern Ocean Observing System products and research results (Newman et al. 2012). Similarly, the Southern Ocean Observing System group considers gaining further leverage through the use of ships through opportunities presented by the Committee on the Conservation of Antarctic Marine Living Resources' member fishing and tourism vessels operated by members of IAATO (Newman et al. 2012). However, despite the large body of scholarly work on Antarctic tourism that has been published over the years (e.g., Enzenbacher 2007; Haase et al. 2009; Liggett et al. 2011), tourism researchers are rarely, if ever, consulted when integrated observing systems are being developed.

The Antarctic tourism industry could make a considerable contribution to a long-term integrated environmental monitoring network. IAATO already makes a contribution to Antarctic environmental monitoring by coordinating the majority of tourism itineraries and setting operational guidelines and codes of conduct for Antarctic tourism. In addition to IAATO and Antarctic Treaty System requirements to submit detailed post-visitation reports, the vigilance exhibited by tourism operators ensures that any unusual observations (e.g., high-mortality events of wildlife or violations of codes of conduct) are reported to the IAATO secretariat and the respective Antarctic Treaty Parties (IAATO 2008). Antarctic tourism operators have also contributed to the International Polar Year's Aliens in Antarctica project, which had the objective to identify the extent to which humans travelling to Antarctica carry with them propagules of non-native species (IAATO 2008, 2011). Through continuous support by Antarctic tourism operators, the non-profit science and educational organization Oceanites, Inc., undertook a longitudinal and

integrated environmental monitoring study which resulted in an in-depth and regularly updated Antarctic Peninsula Compendium detailing the status and health of Antarctic visitor sites (Naveen & Lynch 2011).

Tourism is the largest commercial activity on the Antarctic continent. Any properly integrated observing system needs to incorporate tourism data if it is to capture the scale and impact of diverse changes in the Antarctic across a range of interlinked ecological, cultural, political and economic systems. In addition, the potential for Antarctic tourism visitors, operators and researchers to contribute to Antarctic observing systems is far from exhausted.

A vision for the future

The polar regions overview section highlights the fact that many different observation systems and networks exist in the Arctic and Antarctic regions. It also underlines the lack of monitoring and observation infrastructure that incorporates tourism as a significant sector. On the one hand, there is a lack of data collected on tourism across jurisdictions; on the other hand, tourism is underutilized in terms of the contribution it can make as part of data collection initiatives and also as a monitoring agent at both polar regions. To address this exclusion, there are a number of critical challenges—and opportunities—that need to be considered at local, regional, national and international levels.

One immediate challenge for observing tourism, or for deploying it to assist with observation activities, is boundary demarcation. Observing tourism across boundaries is complicated by the variability in data collection across different sovereign territories; in some locations data are gathered differently even within a jurisdiction. Across boundaries, more detailed source market intelligence and more data on travel patterns and tourism behaviours in the Arctic represent emerging opportunities to source impacts of tourism information. For example, key indicators of tourism development are the number of visitors, how long they stay and how these figures change over the years. As a result, visitation-related numbers can be useful for investigating the impacts of tourism across boundaries. Within jurisdictions, forward-looking strategies should coordinate both the design and implementation of an AOS that is inclusive of tourism; for instance, by developing systems that have the ability to improve the sustained long-term observation of changes across the Arctic and where tourism activities also provide data collection opportunities. For example, opportunities exist to engage local tour operators and their partners to develop citizen science-oriented data collection programmes. Developing these

types of programmes in such a way that they can be reproduced across jurisdictional boundaries would ensure that data collected locally might have comparative value across a polar region. The comparative value will have significance only when it can be analysed with consideration for the Arctic as a heterogeneous place and context.

Infrastructure, at least its basic physical aspects that would permit using or adapting emerging community- and citizen-based approaches in a tourism context, already exists, or can be appropriately refined. For instance, by incorporating opportunities connected to the increasing Indigenous tourism market. Moreover, there already exist examples of tourism operations that offer additional monitoring and observation opportunities by non-Indigenous populations or operations that function in partnership with them. Four examples are briefly presented in the regional overviews: (1) the Whales and Glacier Science Adventure ship-based tour that forms part of a community-based monitoring effort in Alaska and focuses on sampling phytoplankton, testing water quality and collecting data on humpback whales; (2) the Churchill Centre for Northern Studies and Earthwatch's Climate Change at Arctic's Edge in Canada, which incorporates bird counts and plant species documentation; (3) the cruise tourism sector collaboration with the NPI which supplies data to the Svalbard Marine Mammal Sighting Database; and (4) the International Polar Year's Aliens in Antarctica programme, as well as the IAATO and Antarctic Treaty System post-visitation reports that provide data on unusual observations (e.g., high-mortality events of wildlife). Tourism research opportunities can also support observation mandates; the case in Iceland, for instance, provides a forward-looking model for institutionalized research-oriented observation initiatives.

A future vision for monitoring tourism and for using it to deploy observation activities would need to address how best to determine what the mechanisms are for the coordination of support, implementation, and operation of an SAON which involves tourism as a data collection actor. An emerging example is the ACN in Iceland, which has some support from its national government. However, other countries will need to be brought to the table. In a related way, would a tourism-integrated SAON be something that could fall under the Arctic Council's Protection of Arctic Marine Environment Working Group or Sustainable Development Working Group, particularly if these were designed to include community-based and citizen science approaches? There is a long-standing commitment to monitoring in the mainland European Arctic, but it too neglects tourism's potential contribution. If any design revisions are needed, they have to ensure they do not

cause disturbances to the processes and longitudinal data collected on a much wider country or regional scale (including non-Arctic areas in many cases). Therefore, a key question to be asked is: How do we integrate tourism into the extensive monitoring systems that already exist?

As stakeholder issues are expressed differently for tourism, assessing stakeholder issues in the realization of an AOS that incorporates this sector should assess how key tourism stakeholders are already involved in some polar locations: Could these activities be used as “models” to advance tourism stakeholders involvement and identification across other regions? IAATO is a key contributor in the Antarctic and presents one example of a model that may be useful. However, the situation is not nearly as clear in the Arctic. AECO is the only key stakeholder involved, and it operates on the basis of its focus on the cruise tourism sector in Svalbard, Jan Mayen, Greenland and, more recently, in Arctic Canada.

Tourism's sphere of influence is much larger in scope than what is currently considered by observation and monitoring bodies. Diverse stakeholder perspectives need to be identified and considered to adequately and effectively address the tourism dimensions involved. Related to stakeholder issues are other, equally significant questions: Are Arctic observations shared optimally today among diverse stakeholder communities (e.g., between scientists, governments, stakeholders)? Moreover, while citizen science is potentially empowering and inclusive, how do we heed cautionary deconstructions of science executed in the north (and post- and neo-colonial interpretations and narratives of phenomena, e.g., climate change) to ensure that colonial legacies are challenged (Bravo 2009; Stuhl 2013) and empowered Indigenous futures are supported?

Given that inter- and multi-disciplinary approaches to Arctic issues are required to cope with and address climate and other environmental concerns, the social sciences generally, and tourism studies more specifically, should be activated as valued contributors both in terms of monitoring and observing changes due to the impacts of tourism, and also for the role they can play as participants in AOS to report on observations that occur where tourism activities take place.

Acknowledgements

This article was a collaborative effort of the steering committee of the IPTRN (www.iptrn.rmfi.is/) and other select IPTRN members. SDLB and PM coordinated and synthesized author contributions, and developed the general and analytical sections of the article, with input from other authors. Other authors provided specific expertise in a given geographical area and are listed

alphabetically: JD (Arctic Canada); KHP (Alaska); EH (Iceland); ML (Svalbard); DL (Antarctica); DM (mainland European Arctic); AP (Russia); and ES (Arctic Canada and Svalbard). The authors wish to thank Keskitalo and co-authors for their White Paper presented at the 2013 AOS Summit (Vancouver, 30 April–2 May), which emerged from research funded by the Swedish Foundation for Strategic Environmental Research.

References

- AECO (Association of Arctic Expedition Cruise Operators) 2013. *AECO expands*. Accessed on the internet at <http://www.aeco.no/2013/11/aeco-expands/> on 12 November 2013.
- Angell A.C. & Parkins J.R. 2011. Resource development and aboriginal culture in the Canadian north. *Polar Record* 47, 67–79.
- Arctic Council 2009. *Arctic Marine Shipping Assessment 2009 report*. Tromsø, Norway: Arctic Council.
- AON (Arctic Observing Networks) 2010. *Country report, Russia*. Accessed on the internet at http://www.arcticobserving.org/images/pdf/Reports/National/Inventory_of_Arctic_Russia_En.pdf on 20 January 2016.
- Berman M. 2011. Arctic human dimension observing system. *Polar Geography* 34, 133.
- Bravo M. 2009. Voices from the sea ice: the reception of climate impact narratives. *Journal of Historical Geography* 35, 256–278.
- CPC (Canadian Polar Commission) 2014. *The state of Northern knowledge in Canada*. Ottawa: Canadian Polar Commission.
- DFO (Department of Fisheries and Oceans) 2014. *Vessel Traffic Reporting Arctic Canada Traffic Zone (NORDREG)*. Accessed on the internet at http://www.ccg-gcc.gc.ca/eng/MCTS/Vtr_Arctic_Canada_on_22_April_2014.
- Earthwatch 2014. *Climate change at the Arctic's edge*. Accessed on the internet at <http://au.earthwatch.org/expeditions/climate-change-at-the-arctics-edge> on 22 April 2014.
- Enzenbacher D.J. 2007. Antarctic tourism policy-making: current challenges and future prospects. In G. Triggs & A. Riddell (eds.): *Antarctica: legal and environmental challenges for the future*. Pp. 155–189. London: British Institute of International and Comparative Law.
- Fay G. & Karlsdottir A. 2011. Social indicators for Arctic tourism: observing trends and assessing data. *Polar Geography* 34, 63–86.
- Governor of Svalbard 2013. *Laws and regulations*. Accessed on the internet at <http://www.sysselmannen.no/en/Toppmeny/About-Svalbard/Laws-and-regulations/> on 2 December 2013.
- Grenier A.A. & Müller D.K. (eds.) 2011. *Polar tourism: a tool for regional development*. Montreal: Presses de l'Université du Québec.
- Haase D., Lamers M. & Amelung B. 2009. Heading into uncharted territory? Exploring the institutional robustness of self-regulation in the Antarctic tourism sector. *Journal of Sustainable Tourism* 17, 411–430.

- Hall C.M. & Saarinen J. 2010. Tourism and change in the polar regions: introduction—definitions, locations, places and dimensions. In C.M. Hall & J. Saarinen (eds.): *Tourism and change in polar regions: climate, environments and experiences*. Pp. 1–41. London: Routledge.
- Hansen G. (ed.) 2011. *Svalbard Integrated Arctic Earth Observing System (SIOS) gap analysis synthesis report*. Oslo: Research Council of Norway.
- IAATO 2008. *Report of the International Association of Antarctica Tour Operators 2007–2008 under Article III (2) of the Antarctic Treaty*. IP 86, XXXI ATCM in Kyiv. 2–13 June, Ukraine.
- IAATO 2011. *Report of the International Association of Antarctica Tour Operators 2010–11*. IP 108, XXXIV ATCM in Buenos Aires. 20 June–1 July, Argentina.
- IARPC (Interagency Arctic Research Policy Committee) 2007. *Arctic Observing Network: toward a U.S. contribution to pan-Arctic observing*. *Arctic Research of the United States* 21. Arlington, VA: Interagency Arctic Research Policy Committee, National Science Foundation.
- Johnston M.E. 2011. Arctic tourism introduction. In P.T. Maher et al. (eds.): *Polar tourism: human, environmental and governance dimensions*. Pp. 17–32. New York: Cognizant Communications Corporation.
- Keskitalo C., Müller D., Bergh K., Gerda K., Söderqvist T. & Sörlin S. 2013. *Stakeholder integration: a response to a suggested focus on Arctic residents and monitoring*. Arctic Observation Summit, Vancouver, 30 April to 2 May. Accessed on the internet at <http://www.arcticobservingsummit.org/aos-2013-white-papers> on 20 January 2016.
- Kruse J., Lowe M., Haley S., Fay G., Hamilton L. & Berman M. 2011. Arctic Observing Network Social Indicators Project: overview. *Polar Geography* 34, 1–8.
- Lamers M. & Amelung B. 2010. Climate change and its implications for cruise tourism in the polar regions. In M. Lück et al. (eds.): *Cruise tourism in the polar regions: promoting environmental and social sustainability*. Pp. 147–163. London: Earthscan.
- Lapland—Above Ordinary 2014. Statistics and publications. Accessed on the internet at <http://www.lappi.fi/lapinliitto/en/statistics> on 22 April 2014.
- Lemelin R.H., Maher P.T. & Liggett D. (eds.) 2013. *From talk to action: how tourism is changing the polar regions*. Thunder Bay, ON: Lakehead University Centre for Northern Studies Press.
- Liggett D., Storey B., McIntosh A., Carr A. & Gilbert N. 2011. From frozen continent to tourism hotspot? Five decades of Antarctic tourism development and management, and a glimpse into the future. *Tourism Management* 32, 357–366.
- Lovecraft A.L., Meek C.L. & Eicken H. 2012. Connecting scientific observations to stakeholder needs in sea ice social–environmental systems: the institutional geography of the northern Alaska. *Polar Geography* 36, 1–21.
- Maher P.T., Gelter H., Hillmer-Pegram K., Hovgaard G., Hull J., Jóhannesson G.T., Karlsdóttir A., Rantala O. & Pashkevich A. 2014. Arctic tourism: realities and possibilities. *Arctic Yearbook* 2014, 290–306.
- McDowell Group 2014. *Economic impact of Alaska's visitor industry. 2012–13 update*. Prepared for State of Alaska Department of Commerce, & Economic Development, Division of Economic Development. Accessed on the internet at https://www.commerce.alaska.gov/web/Portals/6/pub/TourismResearch/AVSP/Visitor%20Industry%20Impacts%202013%201_30.pdf
- Müller D.K. 2011. Tourism development in Europe's "last wilderness": an assessment of nature-based tourism in Swedish Lapland. In A.A. Grenier & D.K. Müller (eds.): *Polar tourism: a tool for regional development*. Pp. 129–153. Montreal: Presses de l'Université du Québec.
- Müller D.K. 2013. Tourism and the definition of the Arctic. In R.H. Lemelin et al. (eds.): *From talk to action: how tourism is changing the polar regions*. Pp. 9–20. Thunder Bay, ON: Lakehead University Centre for Northern Studies.
- Müller D.K., Lundmark L. & Lemelin R.H. (eds.) 2013. *New issues in polar tourism: communities, environments, politics*. Dordrecht: Springer.
- Murray M.S., Loring P.A., Ferren H. & Fedderer R. 2013. Citizen science and Arctic observing: using the internet and simple technologies to improve understanding of Arctic ecosystem change. Short Statement presented at the Arctic Observation Summit. Vancouver, BC. Accessed on the internet at <http://www.arcticobservingsummit.org/short-statements> on 20 January 2016.
- National Park Service 2011. *Alaska region climate change response strategy 2010–2014: summary*, Anchorage, Alaska. Accessed on the internet at <http://www.nps.gov/akso/docs/AKCCRS.pdf>
- National Research Council 2006. *Toward an integrated Arctic Observing Network*. Washington, DC: National Academies Press.
- Naveen R. & Lynch H. 2011. *Antarctic Peninsula compendium*. Chevy Chase, MD: Oceanites.
- Newman L., Meredith M. & Schofield O. 2012. The Southern Ocean Observing System. Accessed on the internet at http://aspect.antarctica.gov.au/_data/assets/pdf_file/0006/93381/SOOS-RossSeaMar2012.pdf on 20 January 2016.
- Nuttall M. & Callaghan T.V. 2000. *The Arctic: environment, people and policy*. Camberwell, Australia: Harwood Academic Publishers.
- Óladóttir O.P. 2013. *Tourism in Iceland in figures, April 2013*. Reykjavík: Icelandic Tourism Board.
- Orams M.B. 2011. Polar yacht cruising. In M. Lück et al. (eds.): *Cruise tourism in the polar regions: promoting environmental and social sustainability*. Pp. 13–24. London: Earthscan.
- Pandya R.E. 2012. A framework for engaging diverse communities in citizen science in the US. *Frontiers in Ecology and the Environment* 10, 314–317.
- Pashkevich A., Dawson J. & Stewart E. 2015. Governance of expedition cruise ship tourism in the Arctic: a comparison of the Canadian and Russian Arctic. *Tourism in Marine Environments* 10, 225–240.
- Pashkevich A. & Stjernström O. 2014. Making Russian Arctic accessible for tourists: analysis of the institutional barriers. *Polar Geography* 37, 137–156.
- Pizzolato L., Howell S.E.L., Dawson J., Copland L., Derksen C. & Johnston M.E. 2013. *Climate Change Adaptation Assessment*

- for *Transportation in Arctic Waters (CATAW) scoping study. Summary report*. Ottawa: Transport Canada.
- Pizzolato L., Howell S.E.L., Derksen C., Dawson J. & Copland L. 2014. Linkages between changing sea ice conditions and marine activity in Canadian Arctic waters between 1990 and 2012. *Climatic Change* 123, 161–173.
- PPS Arctic 2014. *Benefits*. Accessed on the internet at <http://ppsarctic.nina.no/content/projects-pps-arctic-benefits.html> on 17 May 2014.
- Richard T. 2003. Polar bears lure adventurous tourists to remote Barrow on Arctic Ocean. *Seattle Times*, 16 Feb., Accessed on the internet at <http://community.seattletimes.nwsources.com/archive/?date=20030216&slug=barrow16> on 20 January 2016.
- Rintoul S., Sparrow M., Meredith M.P., Wadley V., Speer K., Hofman E., Summerhayes C., Urban E. & Bellerby R. (eds.): 2012. *The Southern Ocean Observing System initial science and implementation strategy*. Accessed on the internet at http://www.scar.org/scar_media/documents/publications/SOOS_Strategy-lowres.pdf
- SAON Canada 2013. *Inventory of Arctic Observation Networks, Canada. 2013 update*. Accessed on the internet at <http://www.arcticobservingcanada.ca/Arctic-Observing-Network-Inventory-2013.pdf> on 20 January 2016.
- SCAR (Scientific Committee on Antarctic Research) 2013. SCAR Executive Committee (EXCOM) Meeting, Barcelona, Spain 22/23rd July 2013. *SCAR Bulletin* 187, 1–18.
- Scheepens S. 2014. *Exploring the potential participation in citizen science, conservation tourism, and participatory environmental research tourism to lead an environmental change in practices*. Master's thesis, Environmental Policy Group, Wageningen University.
- SIOS 2013. Website of the Svalbard Integrated Arctic Earth Observing System. Accessed on the internet at <http://www.sios-svalbard.org/>
- Stefansson Arctic Institute 2004. *Arctic human development report*. Akureyri: Stefansson Arctic Institute.
- Stewart E., Draper D. & Johnston M. 2005. A review of tourism research in the polar regions. *Arctic* 58, 383–394.
- Stuhl A. 2013. The politics of the “New North”: putting history and geography at stake in Arctic futures. *The Polar Journal* 3, 94–119.
- Viken A. 2011. Tourism, research, and governance on Svalbard: a symbiotic relationship. *Polar Record* 47, 335–347.
- Yu G., Schwartz Z. & Walsh J.E. 2009. Effects of climate change on the seasonality of weather for tourism in Alaska. *Arctic* 62, 443–457.