

Antarctic tourism

Tourism on ice: environmental impact assessment of Antarctic tourism

Lorne K Kriwoken and David Rootes

The evolving institutional arrangements for the environmental impact assessment (EIA) of Antarctic tourism are evaluated and suggestions made on its future. The EIA provisions of the 1991 Madrid Protocol are legally required by companies, registered in Treaty signatory states, in planning and managing all tourist activities. An assessment of the three tiers of EIA established under the Protocol is presented. Potential solutions for assessing impacts of Antarctic tourism include adoption of strategic environmental assessment, regional assessments and environmental auditing. International best practice methods should be adopted in the initial environmental evaluation along with greater consistency of EIA application through indicative lists and guidelines, a dedicated database of Antarctic EIAs and increased cooperation in the EIA process between the tourism industry and Antarctic Treaty Consultative Parties that support Antarctic logistics and science.

Keywords: tourism; environmental impact assessment; Antarctica

Dr Lorne K Kriwoken (the contact author) is at the Centre for Environmental Studies, University of Tasmania, GPO Box 252-78, Hobart, Tasmania 7001 Australia; Tel: +61 3 6226 2458; Fax: +61 3 6226 2989; E-mail: L.K.Kriwoken@utas.edu.au. David Rootes is at Poles Apart, PO Box 89, Bourn, Cambridge CB3 7TF, UK.

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THE ANTARCTIC CONTINENT and the Southern Ocean cover 50 million square km, or about 10% of the Earth's surface (Figure 1). Continental Antarctica is almost entirely covered by ice with an average thickness of over 2,000 meters. The ice sheet holds 90% of the earth's fresh water and its thermal mass is significant for global climate. Less than 2% of the continent is ice-free (Kriwoken and Keage, 1989).

As a result, plant life is impoverished and consists of a patchy distribution of mosses, lichen and grasses. Except for a few insects, animal life is sea or airborne and migratory. There are six species of seal and 14 species of bird. Compared with ecosystems in more temperate parts of the world, the Antarctic marine ecosystem has relatively few species but they are abundant (Walton, 1987).

Forty-three countries now adhere to the Antarctic Treaty which applies to the area south of 60° South latitude (Headland, 1999). The Antarctic Treaty System consists of a number of separate international instruments and their associated measures: 1959 Antarctic Treaty; 1964 Agreed Measures for the Conservation of Antarctic Fauna and Flora; 1972 Convention on the Conservation of Antarctic Seals; 1980 Convention for the Conservation of Antarctic Marine Living Resources; 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol); and recommendations of Antarctic Treaty Consultative Meetings and several Special Meetings in the form of decisions, measures and resolutions (Kriwoken and Keage, 1989).

The most significant environmental instrument, with origins in the 1988 Convention for the Regulation of Antarctic Mineral Resource Activities (CRAMRA) (Joyner, 1987), has been the Madrid

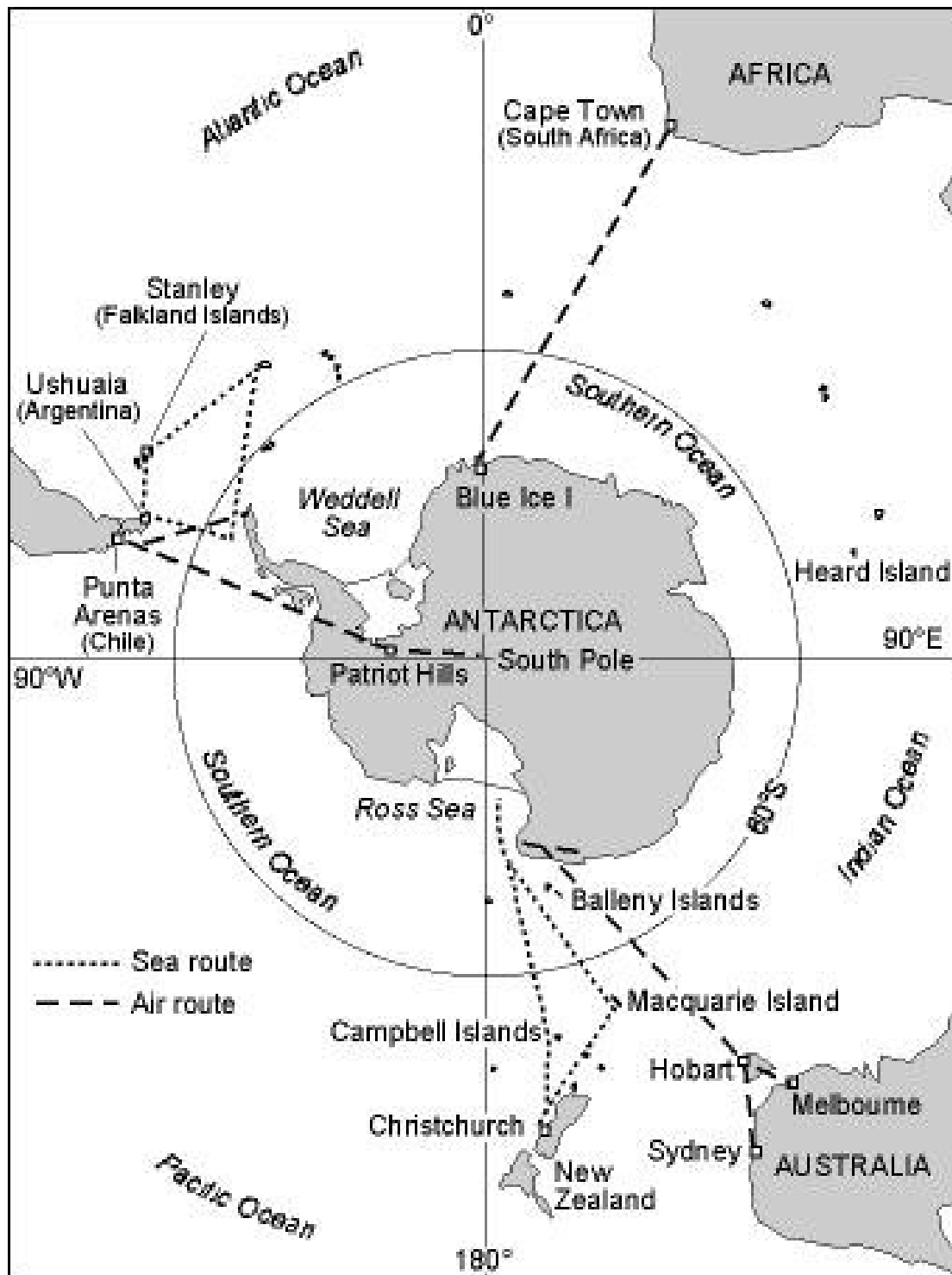


Figure 1. Major seaborne and airborne tourist routes to Antarctica

Protocol which codified and made legally binding a number of environmental protection measures. The Protocol and its five annexes (Annex I: Environmental Impact Assessment; Annex II: Conservation of Antarctic Fauna and Flora; Annex III: Waste Disposal and Waste Management; Annex IV: Prevention of Marine Pollution; Annex V: Area Protection and Management) provide a comprehensive multilateral agreement on the management of the Antarctic environment (Blay, 1992).

The Protocol bans mining in Antarctica for a minimum of 50 years and designates the whole of the continent and its dependent marine ecosystems a “natural

reserve devoted to peace and science”. All 27 Antarctic Treaty Consultative Parties (ATCPs) had ratified the Protocol and it formally entered into force on 14 January 1998. However, not all Parties have detailed regulations in place to guide human activities.

Antarctica can be cold, windy and dangerous. Yet, in the 1996/97 austral summer, 7,322 tourists ventured south to Antarctica by ship, 155 by aircraft, and a further 2,958 passengers visited by overflying the continent (IAATO, 1996a). As tourist numbers increase so does the potential for environmental impact during the short Antarctic summer. The use of environmental impact assessment (EIA) has been widely

acknowledged as an appropriate tool to assess and mitigate the impacts of Antarctic tourism.

The Madrid Protocol, particularly Annex I (Environmental Impact Assessment), introduced a three-tiered process which applies to all activities, whether government, private or commercial. This requirement has meant that tour companies, registered in Treaty signatory states, are now legally required to conduct EIAs for their Antarctic shipborne, landborne or airborne/overflight operations.

The overall objective of the paper is to evaluate the evolving institutional arrangements for EIA in Antarctic tourism. It begins by describing the scale of Antarctic tourism and the types of impact associated with the industry. The conduct of EIA, outlined in the Madrid Protocol, is presented with problems related to implementation and arrangements for its application.

This is followed by an examination of the three tiers of EIA outlined in the Protocol, along with specific examples. The paper goes on to outline additional means of supporting environmentally responsible Antarctic tourism and specific institutional suggestions are made with respect to increased integration between the three tiers of EIA and co-operation between industry, science and government. Discussion is limited to the Antarctic Treaty area and therefore does not include peri-Antarctic islands.

Antarctic tourism and environmental impacts

Antarctica is a growing international tourist destination and marketed as a unique nature-based experience. The tourist industry consists of three types of activity: shipborne; landborne; and airborne or overflights (Hall and Johnston, 1995a). In 1996/97, 48% of tourists were from the USA, followed by Germany (11 %), Australia (9%); Japan (7%); and others (25%). Typically, Antarctic tourists are tertiary educated, well traveled and have high disposable incomes. The numbers of tourists visiting each year fluctuates with 6,585 in 1992/93 compared with 10,013 in 1997/98 (IAATO, 1999). Each tourist activity has associated environmental impacts (Enzenbacher, 1992; 1993; Hall, 1992; Hall and Wouters, 1995) which are outlined below.

Shipborne tourism began to Antarctica in 1958 with tours to the South Shetland Islands and the west coast of the Antarctic Peninsula (Reich, 1980) (Figure 1). Lindblad Travel, the first US company to offer trips to Antarctica, began in 1966 and strengthened its Antarctic shipborne tourism operations during the 1970s. The *Lindblad Explorer*, which was purpose-built for polar tourism, made its maiden voyage in 1970 (Headland, 1989). This is considered the beginning of modern Antarctic tourism.

Thirty years later the focus remains on the Peninsula with the majority of ships departing from Ushuaia, Tierra del Fuego, Argentina. In the 1996/97 austral summer 7,322 shipborne passengers visited



Figure 2. Russian-registered, *Kapitan Khlebnikov*, chartered to US-based Quark Expeditions

Antarctica on 13 different vessels, exceeding the number of national scientific and logistic personnel, which is estimated at 4,000. Ushuaia was home port to 114 departures, averaging 70 passengers per voyage, yet ranging from 23 to 162. During this summer period, 1,007 landings were made (IAATO, 1996a). Additionally, 17 yachts made 22 expeditions during the 1995/96 season for a total of 150 passengers (IAATO, 1997b).

A typical shipborne tourist itinerary would involve: flying from the eastern USA to Ushuaia; sailing two days across the Drake Passage onboard an ice strengthened ship; five days exploring the Peninsula with two or three landings and one or two Zodiac cruises per day; and two days return sailing to Ushuaia (Figures 1 and 2). For this, and other related polar tourist experiences, passengers pay from US\$4,000 to US\$20,000 for a trip ranging from 6 to 21 days.

Hall (1992) and Hall and Johnston (1995a) have assessed the nature of environmental impacts associated with infrastructure characteristics. Shipborne tourism does not usually require a permanent land-based facility as passengers are accommodated onboard for the duration of the expedition. Environmental impacts are generally transient (Hall and Johnston, 1995a) with pressure placed on repeat visited shore-based attractions such as colonial seabird rookeries (penguins). Impacts can involve: water pollution from oils spills, Zodiac operations and sewage disposal; introduction of bird and plant diseases; littering; collection of souvenirs; introduction of exotic flora; incineration from the ships; and disturbance as a result of a shipwreck.

Landborne tourism is the second significant type of tourist operation in Antarctica. One company, Adventure Network International (ANI), operates a tented summer camp at Patriot Hills, Ellsworth Mountains, accommodating 50 people and taking advantage of a natural runway on blue ice (glacial ice) (Figures 1 and 3). Over the 1997/98 season, ANI carried 131 passengers to Antarctica (Swithinbank, 1998), chartering a Lockheed L-382G Hercules, two DHC-6 Twin Otters and a Cessna 185. Eight Hercules flights were made between Punta Arenas, Chile and the Patriot Hills in the 1997/98 season (Swithinbank, 1998).

ANI is the only company that provides regular intercontinental flights between South America and



Figure 3. Hercules C-130 landing on blue ice at Patriot Hills

Antarctica. The most popular activity is the climbing program to Vinson Massif (the highest mountain in Antarctica), followed by flights to the South Pole and visits to an Emperor penguin rookery. ANI also provides logistical support for other activities such as skiing, trekking, parachuting and photography. Polar Logistics, the logistical arm of ANI, also operates flights between Cape Town, South Africa and Dronning Maud Land (Blue Ice I), Antarctica (Figure 1).

Other landborne activities involve expeditions for climbing, skiing, photography and ocean kayaking, often in association with seaborne tourist operators. Adventure travel companies specialize in small group travel and can spend from one day to one week camping on the continent. For instance, Aurora Expeditions and World Expeditions offer skiing and climbing trips with opportunities to camp overnight and are supported by tourism ships operating in the Antarctic Peninsula.

Impacts associated with landborne activities are potentially the most severe. Infrastructure support can be extensive including: airstrips; accommodation facilities; tracks and trails; and waste disposal facilities (Hall and Johnston, 1995a). The nature of the impacts can include: human competition with flora and fauna for ice-free land; site-specific degradation of high-use areas, such as trampling; water pollution; disposal of sewage and waste; introduction of exotic flora and fauna; collection of souvenirs; cruising of small boats close to animals; disturbance to bird colonies; and damage to heritage sites (Hall and Johnston, 1995a).

Airborne tourism began in 1956 when a Chilean airline overflew the South Shetland Islands (Stonehouse and Crosbie, 1995). In 1957, the first commercial flight landed at McMurdo Sound in a Pan American Stratocruiser which departed from New Zealand. Qantas and Air New Zealand made 44 flights from 1977 to 1980 carrying over 11,000 passengers. The crash of an Air New Zealand aircraft on Mt Erebus in late 1979 saw the cessation of this period of airborne tourism. In 1983/84, the Chileans had commenced flights from Punta Arenas, Chile to Teniente Rodolfo Marsh Station, King George Island, South Shetland Islands (Kriwoken, 1995).

A resurgence of airborne tourism to Antarctica took place in 1994/95 with Croydon Travel, based in

The nature of the impacts of landborne activities includes: human competition with flora and fauna for ice-free land; trampling of high-use areas; water pollution; disposal of sewage and waste; and introduction of exotic flora and fauna

Victoria, Australia, using Qantas Airlines Boeing 747s. The Antarctic Day Sightseeing consists of a 13-hour flight departing Melbourne, Victoria or Sydney, New South Wales, overflying Hobart, Tasmania, the Antarctic continent and returning to Australia (Figure 1). In the five seasons since 1994/95, over 13,000 passengers and 900 crew have taken part in 52 flights (Betts, 1999). In recognition of its environmentally sound Antarctic overflight program, Croydon Travel was awarded the Victoria Tourism Environmental Award in 1995 and was a finalist in 1998 (Keage, 1999).

The growth in Antarctic tourism resulted in an industry association being formed in 1991. Seven Antarctic tour operators formed the International Association of Antarctica Tour Operators (IAATO) to represent industry interests (Enzenbacher, 1993). Concern for environmental principles has been demonstrated by the Association through support for Antarctic Treaty Consultative Meeting Recommendation XVIII-1 on guidance for visitors to the Antarctic. In addition, IAATO members are bound by the organization's "Guidelines of conduct for Antarctic tour operators".

There are now 23 members and associate members in Australia, Canada, Chile, Germany, Japan, Netherlands, New Zealand, United Kingdom and the United States. IAATO policy is to "operate within the parameters of the Antarctic Treaty, Environmental Protocol, relevant national legislation and other international agreements ..." (IAATO, 1996b). The Association has argued that rules and regulations that apply to tourism should apply to all other human activities. IAATO encourages the preparation of environmental impact assessments by its members and may endorse appropriate research studies.

The Madrid Protocol and EIA

The tourist impacts must be considered in the context of environmental regulations outlined in the Madrid Protocol. With respect to EIA of tourist operations, the most significant requirements are detailed in three Articles and Annex I to the Protocol.

Article 3 (Environmental Principles) is a cornerstone of the Protocol and states, *inter alia*, that in the Antarctic Treaty area:

“activities ... shall be planned and conducted so as to limit adverse impacts on the environment and dependent and associated ecosystems; activities ... shall be planned and conducted to avoid:

- significant adverse effects on air or water quality;
- significant changes in the atmospheric, terrestrial (including aquatic), glacial or marine environments;
- detrimental changes in the distribution, abundance or productivity of species or populations of species of fauna and flora;
- degradation of, or substantial risk to, areas of biological, scientific, historic, aesthetic or wilderness significance.”

Moreover, the Article requires that “activities ... be planned and conducted on the basis of information sufficient to allow prior assessments of, and informed judgments about, their possible impacts” (Article 3(c)). This Article provides general guidance on the activities allowed and makes predictive EIA a requirement.

Article 6 (Cooperation) states that “Consultative Parties should co-operate in the planning and conduct of activities in the Antarctic Treaty area and provide appropriate assistance to other Parties in the preparation of environmental impact assessments”. Article 8 (Environmental Impact Assessment) states that proposed activities shall be subject to the EIA process as outlined in Annex I (EIA), which details a three-tiered process. It also includes the requirement that activities “shall be subject to the procedures set out in Annex I for prior assessment of the impacts of those activities on the Antarctic environment ...”

All Antarctic tourist operators are therefore required to conduct an EIA of their activities. The co-operation referred to in Article 6 is between Treaty parties, not with tourism operators, as the operators are not party to the Madrid Protocol. Examples of tourist activities, at each level of assessment, will be provided in the next section.

Article 4 of the 1959 Antarctic Treaty puts sovereign claims on hold, yet the reality for Antarctic tour operators is that sovereignty plays a large part in managing tourist activities. In order for the Madrid Protocol to apply at a national level it must be given effect through domestic legislation. In Australia, for instance, the Madrid Protocol is implemented through the 1980 Antarctic Treaty (Environment Protection) Act [AT(EP) Act] and associated environmental impact assessment regulations (the EIA Regulations). Australian nationals operating tourist activities in the Antarctic Treaty area must comply with the Act, which is administered by the Australian Antarctic Division of the Department of Environment and Heritage.

Whilst the Madrid Protocol came into force on 14 January 1998, many of the Consultative Parties that ratified the Protocol have not completed their national implementing legislation. The Protocol provides the framework for protecting the Antarctic environment,

however the implementing legislation gives effect to the policies and permitted activities of the Protocol. Even after national legislation has been enacted it may take some time before the regulatory framework for each country is in place.

These differing national legal systems have, by necessity, resulted in a variety of interpretations of the Protocol. Lyons (1993) has argued that there are difficulties in determining the appropriate level of assessment and that the language of the EIA provisions is open to interpretation. Phrases such as “a minor or transitory impact on the environment”, “significant changes” and “detrimental changes” are indicative of the problems of interpretation. There are no quantitative standards to assist tourist operators, or the countries that assess those activities, to determine precise measures of impact.

Three tiers of environmental assessment

Preliminary assessment

Each of the three levels of environmental assessment varies according to form, circulation and evaluation. The first is the preliminary assessment, following which, “if an activity is determined as having less than a minor or transitory impact, the activity may proceed” (Annex I, Article 1). It is implied, although no guidance is given, that the preliminary assessment is an ‘in-house’ activity.

The decision as to whether to progress to the next stage of the assessment process is usually made by the national authority responsible for Antarctic environmental affairs. There is no triggering mechanism that automatically pushes the tourist activity up to an initial environmental evaluation (IEE). Indicative lists and schedules of activities that require a second level of assessment, often found in domestic environmental legislation, do not exist in the Madrid Protocol. Most countries do not maintain such lists and the judgment about the level of assessment usually rests with the policy and/or environment representatives in the responsible national authority.

Table 1. Requirements for a Preliminary Assessment of Environmental Impacts under the Australian 1980 Antarctic Treaty

A description of the activity
Impacts (on flora, fauna, ecological processes, ice, water, air, surface quality)
Heritage, wilderness and/or aesthetic values
Waste management
Cumulative impacts
Most significant negative impact
Mitigation measures
Alternatives
Conformity with management plans
Possible public concerns

Table 2. Selected preliminary assessments for Antarctic tourism activities

Tourist operator (country registered)	Tourist activity (country of assessment)	Date prepared
Adventure Network International (Canada, UK)	Fuel cache, Marble Point (UK)	1994
Qantas/Croydon Travel (Australia)	Qantas overflights (Australia)	1994
GMMS Pty Ltd (Australia) (now Aurora Expeditions)	Climbing and photography expedition (Australia)	1995
Adventure Network International/ Polar Logistics (Canada, UK)	Dronning Maud Land Air Link (UK)	1996
Quark Expeditions (USA)	Visits to Macquarie Island Base, Cape Denison Historic Sites, Mawson, Davis and Casey Bases (Australia)	1996/97; 1997/98
One Step Beyond (UK)	Camping permit application (UK)	1997
Aurora Expeditions (Australia)	Voyages to the Antarctic Peninsula, expedition for climbers and photographers (Australia)	1997

In Australia for instance, a Preliminary Assessment of Environmental Impacts (PA) is required for non-science (tourist) activities in accordance with section 12D of the Antarctic Treaty (Environment Protection) Act. The assessment consists of check-list-type questions to be submitted by the proponent (Table 1). The assessment is then reviewed by the Environment Management Section in the Australian Antarctic Division. A decision on whether the activity can proceed, or should be subject to an IEE, is made by the Minister (although this power is delegated to an official within the Division).

When the tourist operator would be visiting bases of other nationalities, the Antarctic Division may seek external comment. For instance, if a tourist operator intended to visit the historic huts in the Ross Sea or McMurdo Station, comments could be solicited from Antarctica New Zealand or the United States Antarctic Program. The PA is not required to be publicly

The critical consideration for tour operators is that the assessment of their planned activities should not exceed minor or transitory impacts: if they do exceed these levels they would not be allowed to continue without mitigation measures

circulated or advertised. Examples of tourist activities that have required a preliminary assessment are shown in Table 2.

Initial environmental evaluation

The second level of assessment is the initial environmental evaluation (IEE) which is required for proposed activities that may have a minor or transitory impact on the Antarctic environment (Annex I, Article 2). The IEE should include sufficient detail to assess whether the proposed activity may have more than a minor or transitory impact (Annex I, Article 1(1)(a)(b)) and must include the following information:

a description of the proposed activity, including its purpose, location, duration and intensity (Annex I, Article 2(1)(a)); and
consideration of alternatives to the proposed activity and any impacts that the proposed activity may have on the Antarctic environment, including cumulative impacts in light of existing and known planned activities and existing information on such activities (Annex I, Article 2(1)(b)).

Whilst the general detail of the IEEs is found in Annex I, the format has been largely drawn from "The environmental impact assessment process: practical guidelines" developed by the Committee of Managers of National Antarctic Programs (COMNAP, 1992) (Table 3). The 1992 guidelines have been subsequently updated (COMNAP, 1999) and act as an aid for both national programs and tourist operators proposing activities in Antarctica. These guidelines "are meant to encourage flexibility and creativity in preparation of ... IEEs and CEEs as defined in Annex I of the Protocol" (COMNAP, 1992).

The guidelines provide an element of comparability in the environmental assessment process used by all national Antarctic programs and nongovernment organizations, including tour operators. The critical consideration for tour operators is that the assessment of their planned activities should not exceed minor or

Table 3. Initial environmental evaluation format

Nontechnical summary
Description of the proposed activity
Description of the existing environment
Methods and data used to predict impacts
Analysis of expected impacts
Alternatives
Mitigation measures
Monitoring of impacts
Unavoidable impacts
Potential impacts on research and other uses
Gaps and uncertainties
Contact name and address

Source: COMNAP (1992)

transitory impacts. If their planned activities do exceed these levels they would not be allowed to continue without mitigation measures to ensure that these levels are met.

The IEE is the first point in the process at which there is a formal requirement to notify other agencies or interested parties of the assessment (Annex I, Article 6, Circulation of Information). This notification occurs generally post-event in association with the Antarctic Treaty Consultative Meeting. IEEs conducted for tourist operators are submitted to the appropriate national Antarctic authority and are often tabled at annual Antarctic Treaty Consultative Meetings by the IAATO representative (IAATO, 1997a). Feedback on the content of the IEEs can come from the national authority, other Consultative Parties, nongovernmental organizations or private citizens. Preparation of IEEs is the responsibility of the proponent, although in some instances the tour operator may engage another person to prepare the documentation on their behalf.

The first IEE undertaken for an Antarctic tour operator was in 1993 for Adventure Network International, which operates the intercontinental flights from Chile to Antarctica. The concerns of ANI were quite different from the rest of Antarctic tourist operators which were largely ship-based. Because ANI used one main summer camp it was possible to focus the IEE on their Patriot Hills operations (Poles Apart, 1993).

ANI has also undertaken preliminary assessments for its fuel caches and one for the environmental impact of proposed intercontinental flights to Dronning Maud Land from South Africa (Poles Apart, 1996). This assessment was presented to the 8th Council of Managers of National Antarctic Programs meeting in August 1996. Although the latter assessment was presented to COMNAP the ultimate decision-making responsibility on all EIA rests with the national authority, in this case, the UK.

The number of IEEs prepared for ship-based operators has been growing. Marine Expeditions Inc, based in Toronto, Canada, commissioned an IEE for its Antarctic and Southern Ocean tourism operations in the 1994/95 season (Poles Apart, 1995). Orient Lines (1995) has produced an IEE for the *Marco Polo* which has a capacity of 800 passengers, but is limited to 400 for its Antarctic operations. The New Zealand based Southern Heritage Expeditions conducted an IEE in 1995 for *Academik Shokalski* that operated three expeditions to Antarctica sailing from the Ross Sea Sector (Southern Heritage Expeditions, 1995). The German-based Hanseatic Cruises completed an IEE for the *MS/Bremen* (*Fragebogen zur Prufung der Umweltvertraglichkeit für Antarktisreisen*) in 1996.

Affiliated with these ship-based operators are mountaineering, skiing and photography expeditions. For instance, in 1995 Adventure Consultants completed an IEE for its fifth mountaineering expedition to the Ellsworth Mountains to climb Vinson Massif and Mount Tyree.

An increasingly significant player in Antarctic tourism, in terms of passenger numbers, has been Croydon Travel of Victoria, Australia. They have operated the Antarctic Day Sightseeing flights (Figure 1) since 1994 and undertook environmental impact assessments at a Preliminary Assessment level but with IEE-level documentation (Qantas, 1994). Overflights, with no requirement for permanent land-based facilities in Antarctica, have the least impact of the three types of tourist activity.

The Qantas environmental assessment (Qantas, 1994) recognizes two types of discernible impacts: noise and exhaust emissions. Overflying at 3,048 meters (10,000 feet), a B747 aircraft would produce approximately 70dB on the ground. Jet engine exhaust emissions consist of smoke (soot), unburned hydrocarbons, carbon monoxide, oxides of nitrogen (NO_x), and carbon dioxide (CO_2). NO_x and CO_2 can contribute to global warming. Overflights can also cause terrestrial impacts because of aircraft crashes, as witnessed in the 1979 Mt Erebus Air New Zealand disaster.

Given the number of countries and the range of tourist operators, it is not surprising that different interpretations have led to different requirements for, or levels of, environmental impact assessment. For example, Norwegian law requires advance notice of any activity that falls under its authority including "... information on who is responsible for the activity, and on the scope of the activity, including an initial environmental evaluation ..." (Norway, 1995). This means that the first step of the environmental impact assessment procedure under Norwegian law is the IEE; there is no preliminary assessment. Furthermore the Act requires a full year's advance notice for activities. The content required by the IEE has also been modified and differs slightly from that prescribed by the Protocol under Annex I, Article 2.

Under the New Zealand 1994 Antarctica (Environmental Protection) Act there is no requirement to provide an 'initial environmental reference state', which corresponds to Annex I, Article 2 of the Protocol. However, the provision of an 'initial environmental reference state' is a requirement under the Australian 1993 Antarctic Treaty (Environmental Protection) (Environmental Impact Assessment) Regulations (s6).

The provision of an 'initial environmental reference state' raises some important questions with respect to the application of IEEs. The IEE in the context of the Madrid Protocol uses the traditional project-type assessment procedure whereby impacts are predicted before the development takes place. The project is monitored and an assessment of the impacts is undertaken to see whether the original prediction was successful. Mitigation of impacts plays a critical role in the process.

However, in most cases, Antarctic tour operations are existing and continuing. The predictive element required by the Protocol then becomes one of measurement from an impacted state. This makes the

Table 4. Contents of a comprehensive environmental evaluation

A description of the proposed activity including its purpose, location, duration and intensity, and possible alternatives to the activity, including the alternative of not proceeding, and the consequences of those alternatives
A description of the initial environmental reference state with which predicted changes are to be compared and a prediction of the future environmental reference state in the absence of the proposed activity
A description of the methods and data used to forecast the impacts of the proposed activity
Estimation of the nature, extent, duration, and intensity of the likely direct impacts of the proposed activity
Consideration of possible indirect or second order impacts of the proposed activity
Consideration of cumulative impacts of the proposed activity in the light of existing activities and other known planned activities
Identification of measures, including monitoring programs, that could be taken to minimize or mitigate impacts of the proposed activity and to detect unforeseen impacts and that could provide early warning of any adverse effects of the activity as well as to deal promptly and effectively with accidents
Identification of unavoidable impacts of the proposed activity
Consideration of the effects of the proposed activity on the conduct of scientific research and on other existing uses and values
An identification of gaps in knowledge and uncertainties encountered in compiling the information required under this paragraph
A non-technical summary of the information provided under this paragraph
The name and address of person or organization which prepared the CEE and the address to which comments thereon should be directed

Source: Article 3 (2)(a) - (I) Annex I, Madrid Protocol

establishment of the initial reference state more difficult. In most cases, tourist operators do not have the capability to document the 'initial environmental reference state' of a number of sites used throughout a season. Some operators may use from 20 to 60 different sites in a season and in some locations only land once. If the same level of information is required for each site it then seems disproportionate for a transient visit which may not be repeated.

To address some of these issues, the New Zealand Government developed a model IEE for shipborne Antarctic tour operations (Hemmings, 1997). The model IEE was tabled as an information paper in 1997 at the XXI Antarctic Treaty Consultative Meeting (ATCM). Hemmings (1998) has argued that three issues have not been evident in Antarctic tourist IEEs to date: identification of precisely where the expedition proposes to go; the proposed activities en route and at each particular site; and consideration of the potential direct, secondary and cumulative impacts of the proposed activity. The model makes suggestions for: site-specific landing details; direct/indirect impacts from ship and helicopter operations and passenger activities; and cumulative impacts.

Coincidentally, the Australian Antarctic Division developed a model similar to Hemmings' (1997) whereby information from tourist operators should be provided on a site-specific basis (Betts, 1999). Under

this model, the government agency takes on the responsibility of developing comprehensive site information, and the operators, in their EIAs, concentrate on the proposed activities at each site. In this way, the repetitive description of the environment was avoided and the EIA could focus on process and mitigation measures.

Comprehensive environmental evaluation

The third level of assessment is the comprehensive environmental evaluation (CEE) which must be prepared for any activity likely to have more than a minor or transitory impact. The Protocol states "[i]f an IEE indicates or if it is otherwise determined that a proposed activity is likely to have more than a minor or transitory impact, a CEE shall be prepared" (Annex I, Article 3). The CEE must be publicly available and circulated to interested Consultative Parties, allowing 90 days for comments. Once comments have been incorporated the draft CEE is forwarded to the Committee for Environmental Protection (CEP) and the Consultative Parties at least 120 days before the next Consultative Meeting. Table 4 outlines the contents of a CEE as detailed in the Protocol.

CEEs have not been undertaken for Antarctic tourism, although they have been used by national operators to assess major projects such as scientific rock drilling (New Zealand) (Keys, 1994), the construction of a research station (South Africa) (Claassen and Sharp, 1993) and the construction of an airstrip (United Kingdom) (Bonner, Lewis Smith and Walton, 1989). The scale of these projects has meant a significant commitment of resources to complete the CEE.

The relevance of CEEs has been canvassed as an appropriate level of assessment for Antarctic tourism although specific details regarding its introduction have not been forthcoming. Two workshops in 1996 have provided a first look at how cumulative impacts could be assessed. The World Conservation Union held a Workshop on Cumulative Environmental Impacts in Antarctic" (18–21 September 1996, Washington, DC) (IUCN, 1996) and was attended by 25 Consultative Parties and tourist representatives. Twenty-two recommendations were made under the following headings: site protection; protected species; EIA; information exchange; tools for assessing compliance; education and training; information management; international cooperation; monitoring; and further research.

A second workshop followed closely behind entitled "IAATO Workshop on Environmental Assessment: Building the Frame" (27–29 September 1996, Warrenton, VA). Representatives from the US National Science Foundation, US Environmental Protection Agency (EPA), IAATO members and independent consultants attended. The workshop concluded that the

"most effective way of addressing potential environmental impacts, particularly cumulative

impacts, would be to conduct an EIA on overall activities in the Peninsula by IAATO-member companies with substantially similar operations.” (IAATO, 1997b)

Although a cumulative-type assessment has not been undertaken for IAATO, five of its members developed a ‘programmatic’ environmental assessment for shipborne activities in the Antarctic Peninsula and South Shetland Islands for the 1997/98 season (Anonymous, 1997). Submitted as an IEE, it covered five US tour operators undertaking similar tourist activities and was submitted to the US EPA, which accepted it as sufficient to meet the requirements of Article 8 and Annex I of the Protocol: the expeditions proceeded (Jatko, 1999). The assessment also complied with the US EPA “Interim Final Rule for Environmental Assessment of Nongovernmental Activities in Antarctica” issued 30 April 1997.

It is evident that the assessment of cumulative impacts of Antarctic tourism is very much in its infancy. Baseline data on site assessment and landing criteria are beginning to be compiled. Some of this information is now being gathered through the US-based Oceanites Antarctic Peninsula site inventory project (Oceanites, 1997). Tourism in Antarctica has been studied by Project Antarctic Conservation, Scott Polar Research Institute, University of Cambridge. The project aimed, *inter alia*, to study the development, evolution and environmental impact of tourism and made recommendations on the management of the industry (Stonehouse and Crosbie, 1995). The International Centre for Antarctic Information and Research, Christchurch, New Zealand has been active in documenting the growth and development of Antarctic tourism.

Internet-based sites are now developing, such as the Australian Antarctic Division’s “Antarctic Tourism and Nongovernmental Expeditions: Policy and Management” (Australia, 1999). The site provides details on, *inter alia*, the history and status of tourism, planning and management provisions and operations. Specific details on landing requirements, protected areas or sensitive ecosystems and contact protocol with the stations are provided. The advantage of this internet site is that it can be accessed by tour operators, passengers and the interested public and updated when new information becomes available.

SEA is used to ensure that environmental considerations are integrated into government policy-making, yet its use and application could be used by the Antarctic tourism industry and national operators supporting science and logistics

Potential solutions for assessing impacts

The discussion so far has revealed limitations of the existing administrative framework for EIA of Antarctic tourism. This section provides potential solutions by supporting more integrated and forward-looking alternatives to the project-specific EIA process which are now gaining prominence (Vanclay and Bronstein, 1995; Porter and Fittipaldi, 1998).

Strategic environmental assessment

One technique that has been gaining wide international attention is the application of strategic environmental assessment (SEA) whereby the consequences of policies, plans and programs are considered at the earlier stages of decision-making (Therivel *et al*, 1992). SEA is an approach used to ensure that environmental considerations are integrated into government policy-making (Court *et al*, 1996), yet the use and application of SEA could extend beyond this and be used by the Antarctic tourism industry and national operators supporting science and logistics.

SEA is a proactive process of assessing the environmental effects of any proposed decision by adopting, as the basis for making the assessment, the concepts of land-use capability, environmental carrying capacity or limits of acceptable change. Properly developed, SEA can instill and integrate environmental goals into the highest levels of policy making (Court *et al*, 1996).

Although the Madrid Protocol makes no mention of SEA, at a national level some of the Antarctic Treaty Consultative Parties have in place directives to consider SEA. In the United States, the National Environmental Policy Act 1969 requires programmatic environmental impact statements. The US Department of Housing and Urban Development has developed a methodology for area-wide EIAs and has produced a guidebook for undertaking SEA. The State of California has a legislative requirement to prepare SEAs and is considered the most developed and operational system in the world (Therivel *et al*, 1992). The United Kingdom’s Department of Environment has recommended procedures resembling SEA and the Netherlands set up a statutory SEA system in 1987 (Therivel *et al*, 1992).

Whilst limited institutional arrangements for SEA have been set up at a national level this has not extended to all countries involved in Antarctic science or the tourism industry. Most Consultative Parties do not have requirements for SEA in their own domestic legislation and therefore lack the requisite expertise in the area. Similarly, the tourism industry has not embraced the concept inherent in SEA.

Nevertheless, SEA is widely seen as one of the principal mechanisms to implement ecologically sustainable development principles (Goodland and Sadler, 1993). Consultative Parties should be encouraged to undertake SEAs of the Antarctic tourism, science and logistic sectors to ensure that the

environmental effects of decisions are considered in the earliest stages of planning. The programmatic EIA for the Antarctic Peninsula carried out by Antarctic tourism operators could be considered as a form of SEA and should be more widely supported by the tourism industry.

Regional assessments and cumulative impacts

An additional planning tool to assess Antarctic tourism is the use of regional assessments and cumulative impact assessment. This is particularly the case because Antarctic tourist activity is concentrated in three Antarctic regions (Antarctic Peninsula, Ross Sea, Ellsworth Mountains) and there is a tendency for seaborne tourist operators to concentrate their activities in a localized and repetitive manner. Court *et al* (1994) have argued that there is a “general agreement on the need to have regard for cumulative, regional and long-term impacts and to evaluate development proposals within the carrying capacity of regional environments”.

This has direct application to Antarctic tourism where more emphasis should be given to environmental management on a regional basis (Kriwoken, 1991). Regional planning activities are supported in Annex V of the Madrid Protocol that provides for Antarctic Specially Managed Areas (ASMAs). The ASMA is an area

“where activities are being conducted or may in the future be conducted ... to assist in the planning and coordination of activities, avoid possible conflicts, improve cooperation between Parties or minimize environmental impacts.”

ASMAs may include:

areas where activities pose risks of mutual interference or cumulative impacts; and
sites or monuments of recognized historic value (Article 4(2)(a)(b)).

The application of regional assessments, incorporating zoning at a coastal zone level, could prove beneficial for seaborne tourist management, especially in reducing cumulative impacts. A major component of the regional assessment process would be the identification of different types of landing sites and ecologically sensitive areas plus the development of prescribed management plans with detailed provisions for zoning.

The monitoring of tourism numbers, nationalities of tourists and areas visited at this regional level would provide valuable baseline data on cumulative impacts. An additional area, which is often neglected, is the associated environmental impact of ship traffic from both tourist operators and Consultative Parties. Ship movements, emissions, noise and waste management should also be considered in these regional assessments.

If CEEs of Antarctic tourism are required in the future, regional assessments will assist in identifying and quantifying cumulative impacts. Increased co-operation between stakeholders will be critical to ensure success. Greater cooperation between IAATO, COMNAP and the Scientific Committee on Antarctic Research (SCAR) would be instrumental in such an undertaking. The joint COMNAP–IAATO meeting which was held on 21 March 1997 in New York discussed issues of common interest and concern (IAATO, 1997b) between the logistics and operations sections of the national operators and the tourism industry. National operators have expertise in assembling long-term biological and physical data sets, mapping and geographical information systems and established monitoring protocols. This expertise will need to be shared with the Antarctic tourism industry and mechanisms for cooperation will need to be formalized.

Environmental auditing

The third of the possible solutions for assessing impacts is the introduction of environmental auditing at the level of the tourist operator. Most operators have nominated environmental officers for overseeing the environmental responsibilities of the tourism company, and environmental policies and regulations have been developed. These are important first steps in the process of greater environmental awareness and accountability.

It is here that the role of environmental auditing could further support Antarctic tour operators. Goodall (1995) argues that:

“environmental auditing provides tourism firms with a tool to assess their environmental performance, identifying any negative environmental impacts and evaluating the opportunities to change current practices in order to improve that performance.”

Although environmental audits are not widely used in Antarctica there are two examples from the private and public sectors. Quark Expeditions (USA) produced an environmental audit of its Antarctic and Southern Ocean expedition cruises in 1994 (Poles Apart, 1994). The national operator, Antarctica New Zealand, undertook an independent environmental audit of its operations in 1993/94 (Royds Consulting, 1994).

Whilst the Madrid Protocol does not specifically require environmental auditing procedures, tour operators should consider its application. The ISO 14000 environmental management standards provide guidance on the management of five areas: environmental management systems; environmental performance evaluations; environmental labeling; life-cycle assessment; and environmental auditing (AS/NZS ISO 140001, 1995). This could have direct application to Antarctic tourism whereby audits could be

undertaken internally and used to identify areas of environmental improvement and compliance.

Conclusions

The objective of this paper was to evaluate the evolving institutional arrangements for EIA of Antarctic tourism and to make suggestions on its future. The following four points are meant as positive suggestions in which to improve the integration of EIA principles in Antarctic tourism operations and to generate discussion about their application.

International best practice in EIA

The EIA provisions of the Madrid Protocol are legally required by companies, registered in Antarctic Treaty signatory states, in the planning and management of all shipborne, landborne or airborne/overflight tourist activities in Antarctica. Thus tourist operators have an obligation to conduct EIAs whether at a preliminary assessment, initial environmental evaluation or comprehensive environmental evaluation level. However, there are other internationally accepted best-practice methods that can offer additional improvement to the existing case-by-case reactive system of project EIA currently supported by the adoption of IEEs. For instance, internationally industry and governments have adopted a range of techniques including strategic environmental assessment, regional assessments and environmental auditing.

Operators are not solely responsible for producing individual assessments (PAs, IEEs) for their operations. They increasingly have to address cumulative, indirect or secondary impacts of their diverse and multiple activities. This requires greater sophistication in the EIA process and those methods outlined under "Potential solutions" should be assessed in the wider application of EIA for Antarctic tourism. In some cases the tourism industry has adopted SEA-like assessments such as programmatic EIAs for the Antarctic Peninsula. These developments should be encouraged by the tourism operators and supported by the relevant national authorities.

Determining the proper level of the EIA document

The wording of the Protocol allows for wide interpretation of the EIA requirements. However, this is not unique to the Madrid Protocol. Different Consultative Parties interpret the Protocol in different ways through their own domestic implementing legislation. Discrepancies between ATCPs, in the implementation of domestic legislation, will continue and this will complicate the application of EIA for tourist activities. However, as the number of completed tourism EIAs increases there will be a larger pool of indicative activities with which to make comparisons between countries and operators.

To ensure greater consistency there is a greater role

for the CEP and the SCAR Group of Specialists on Environmental Affairs and Conservation (GOSEAC) to assemble and disseminate indicative lists for the range of EIAs currently adopted under the Madrid Protocol. These lists would assist in facilitating comparison of EIAs for similar activities and/or environmental conditions. Explanatory guidelines on EIA, such as those produced by COMNAP, are extremely useful in interpreting the EIA provisions under the Madrid Protocol and should be more widely encouraged.

Database of Antarctic EIAs

EIAs undertaken for tourism operators and ATCPs represent a wealth of information that has not been fully documented or assessed. Since 1995, ATCPs agreed as Resolution 6 that the host country of the Antarctic Treaty Meeting should compile an updated list summarizing EIAs and environmental audits. The host government updates the list, presents the paper at the ATCM, and then it becomes the job of the next host. This type of institutional arrangement is clearly inadequate and more formal arrangements need to be introduced.

Again, there is a clear role for the CEP to take a lead in hosting an updated Antarctic EIA database. There are other institutions that could assist in this process such as GOSEAC, the Antarctic Environment Officers Network and the SCAR-COMNAP Joint Committee on Antarctic Data Management (JCADM). JCADM comprises the manager of each National Antarctic Data Centre and its role is to promote the establishment, coordinate and support the Antarctic Data Directory System, promote data management within the Antarctic scientific community, assist in establishing Antarctic data management policies and priorities and to report to SCAR and COMNAP on Antarctic data management issues. A centralized and searchable database of Antarctic EIAs would greatly assist in the analysis of cumulative impacts for specific sites and encourage a process of continuous improvement for EIAs.

Cooperation between Antarctic stakeholders

As requirements for EIA increase so will the need for greater cooperation, information sharing and resourcing between the tourism industry and the Antarctic Treaty Consultative Parties that support Antarctic logistics and science. This means that linkages between IAATO, CEP, COMNAP and SCAR must be forged and strengthened. The tourist industry will need assistance in developing appropriate science and technical tools needed for EIAs. Operators will need to employ the skills required to undertake scientific baseline monitoring at the landing sites most frequently visited.

The Consultative Parties have not widely supported directed research into tourism impact, besides those notable exceptions mentioned under

"Comprehensive environmental evaluation". There has been some promising progress made in this regard, but the true test lies ahead. The necessity for co-operation between Consultative Parties in the EIA process is clearly outlined in the Protocol, yet this needs to be extended more widely to the tourism industry. Finally, cooperative funding and resourcing at this highest level will need to be addressed if the EIA charter of the Madrid Protocol is to be fulfilled.

References

- AS/NZS ISO 140001 (Int) (1995), "Interim Australian/New Zealand Standard Environmental Management Systems — specification with guidance for use" (Standards Australia/Standards New Zealand, Homebush, Wellington).
- Anonymous (1997), "Initial environmental evaluation, ship based tourism by five US organizers for the Antarctic Peninsula, South Shetland Islands and South Orkney Islands", November 1997–March 1998, USA.
- Australia (1999), Australian Antarctic Division, Kingston, Tasmania, "Antarctic tourism and nongovernmental expeditions: policy and management", <<http://www.antdiv.gov.au/tourism/HomePage.html>>.
- M Betts (1999), personal communication, Senior Policy Officer (Tourism and Non-Governmental Expeditions), Policy Section, Australian Antarctic Division, Kingston, Tasmania, Australia.
- S K N Blay (1992), "New trends in the protection of the Antarctic environment: the 1991 Madrid Protocol", *American Journal of International Law*, 86, pages 377–399.
- W N Bonner, R I Lewis Smith and D W H Walton (1989), "Proposed construction of airstrip at Rothera Point, Antarctica: final comprehensive environmental evaluation" (British Antarctic Survey, Natural Environment Research Council, Cambridge, UK).
- P Claassen and PA Sharp (editors) (1993), "Draft comprehensive environmental evaluation of the proposed new SANAE IV facility at Vesleskarvet, Queen Maud Land, Antarctica" (Department of Environment Affairs, Pretoria, Republic of South Africa).
- COMNAP, Committee of Managers of National Antarctic Programs (1992), "The environmental impact assessment process: practical guidelines" (COMNAP, Washington, DC, USA).
- COMNAP, Committee of Managers of National Antarctic Programs (1999), "Guidelines for Environmental Impact Assessment" (COMNAP, Hobart, Tasmania, Australia).
- J D Court, C J Wright and A C Guthrie (1994), "Assessment of cumulative impacts and strategic assessment in environmental impact assessment" (Commonwealth Environment Protection Agency, Canberra, Australia).
- J D Court, C J Wright and A C Guthrie (1996), "Environmental assessment and sustainability: are we ready for the challenge?", *Australian Journal of Environmental Management* 3, pages 42–57.
- D J Enzenbacher (1992), "Antarctic tourism and environmental concerns", *Marine Pollution Bulletin*, 25(9–12), pages 258–265.
- D J Enzenbacher (1993), "Antarctic tourism: 1991/92 season activity", *Polar Record*, 29(170), pages 240–242.
- B Goodall (1995), "Environmental auditing: a tool for assessing the environmental performance of tourism firms", *The Geographical Journal*, 161(1), March, pages 29–37.
- R Goodland and B Sadler (1993), "The use of environmental assessment in economic policy making", Proceedings of Annual Meeting of International Association of Impact Assessment" (Shanghai, China).
- CM Hall (1992), "Tourism in Antarctica: activities, impacts, and management", *Journal of Travel Research*, 30(4), pages 2–9.
- C M Hall and M E Johnston (1995a), "Introduction: pole to pole: tourism issues, impacts and the search for a management regime in polar regions", in Hall and Johnston (1995b), pages 1–26.
- C M Hall and M E Johnston (editors) (1995b), *Polar Tourism: Tourism in the Arctic and Antarctic Regions* (John Wiley and Sons, Brisbane).
- C M Hall and M Wouters (1995), "Issues in Antarctic tourism", in Hall and ME Johnston (1995b), pages 147–166.
- R K Headland (1989), *Chronological List of Antarctic Expeditions and Related Historical Events*, Studies in Polar Research (Cambridge University Press, Cambridge, UK).
- R K Headland (1999), "Circulated note, Archivist and Curator" (Scott Polar Research Institute, University of Cambridge, Cambridge, UK).
- A D Hemmings (1997), "A model initial environmental evaluation (IEE): Antarctic tourism cruise 1996/97 *MV Hypotheticus*" (Antarctic Policy Unit, Ministry of Foreign Affairs and Trade, Wellington, New Zealand).
- AD Hemmings (1998), personal communication (Antarctic Policy Unit, Ministry of Foreign Affairs and Trade, Wellington, New Zealand).
- IAATO, International Association of Antarctica Tour Operators (1996a), *IAATO News* (Office of the Secretariat, New York, USA).
- IAATO, International Association of Antarctica Tour Operators (1996b), "Preliminary overview of Antarctic tourism, 1995–97", XX ATCM/INF 96, Utrecht, Netherlands.
- IAATO, International Association of Antarctica Tour Operators (1997a), "Environmental impact assessments for Antarctic tourist activities", Agenda Item 6b, XXI ATCM, Information Paper 74.
- IAATO, International Association of Antarctica Tour Operators (1997b), "Overview of Antarctic tourism activities: a summary of 1996/98 and five year projection 1997/2002", Agenda Item 9, XXI ATCM, Information Paper 75.
- IAATO, International Association of Antarctica Tour Operators (1999), IAATO Home Page, <www.iaato.org/>.
- IUCN, International Union for the Conservation of Nature (1996), "IUCN International Workshop on Cumulative Environmental Impacts in Antarctica: Minimisation and Management", XX ATCM/INF 85, Utrecht, Netherlands).
- J Jatko (1999), personal communication, Environment Officer, National Science Foundation, Virginia, USA.
- C C Joyner (1987), "The Antarctic minerals negotiating process", *American Journal of International Law*, 27(4), October–November, pages 441–482.
- P L Keage (1999), personal communication, Senior Policy Officer (Victoria Tourism, Melbourne, Victoria, Australia).
- J R Keys (1994), "Final comprehensive environmental evaluation: Antarctic stratigraphic drilling east of Cape Roberts in Southwest Ross Sea, Antarctica", Department of Conservation, Turangi, New Zealand.
- L K Kriwoken (1995), "Antarctic tourism and environmental impact assessment", *Issues March*, pages 28–33.
- L K Kriwoken (1991), "Antarctic environmental planning and management: conclusions from Casey Station, Australian Antarctic Territory", *Polar Record*, 27(160), pages 1–8.
- L K Kriwoken and P L Keage (1989), "Introduction: the Antarctic Treaty System", in J Handmer (editor), *Antarctica: Policies and Policy Development* (Centre for Resource and Environmental Studies, Australian National University, Canberra, Australia) pages 1–6.
- D Lyons (1993), "Environmental impact assessment in Antarctica under the Madrid Protocol", *Polar Record*, 29(169), pages 111–120.
- Norway (1995), "Forskrift om vern av miljøet i Antarktis", ("Regulations relating to protection of the environment in Antarctica"), Miljøvern departementet, Oslo.
- Oceanites (1997), "Compendium of Antarctic Peninsula visitor sites — a report to the governments of the United States and the United Kingdom".
- Orient Lines (1995), "M/V Marco Polo, Initial Environmental Evaluation Antarctic Cruises 1995/96" (Fort Lauderdale, Florida, USA).
- Poles Apart (1993), "IEE Adventure Network International: Antarctic air operations" (Adventure Network International, Darien, USA).
- Poles Apart (1994), "Environmental audit: Antarctic and Southern Ocean cruises of Quark Expeditions Inc" (Darien, USA, Quark Expeditions Inc).
- Poles Apart (1995), "Initial environmental evaluation: Antarctic and Southern Ocean seaborne tourism of Marine Expeditions Inc" (MEI, Toronto, Canada).
- Poles Apart (1996), "Preliminary assessment of environmental impact: Dronning Maud Land Fuel cache" (Adventure Network International, Bucks, UK).
- A J Porter and J Fittipaldi (1998), *Environmental Methods Review: Retooling Impact Assessment for A New Century* (The Press Club, Fargo, North Dakota, USA).
- Qantas (1994), "Initial environmental evaluation of overflights" (Qantas, Australia).
- R J Reich (1980), "The development of Antarctic tourism", *Polar Record*, 20(126), pages 303–314.
- Royds Consulting (1994), "New Zealand Antarctic Programme

- environmental audit under the 1991 Madrid Protocol" (Christchurch, New Zealand).
- Southern Heritage Expeditions (1995), "Initial environmental evaluation prepared for Southern Heritage Expeditions 1995/96 Antarctic Cruise Programme, Polar Research Vessel *Akademik Shokalski*" (Christchurch, New Zealand).
- B Stonehouse and K Crosbie (1995), "Tourist impacts and management in the Antarctic Peninsula Area" in CM Hall and ME Johnston (1995b), pages 218-233.
- C Swithinbank (1998) "Non-government aviation in Antarctica 1997/98", *Polar Record*, 34(190), page 249.
- R Therivel, E Wilson, S Thompson, D Heaney and D Pritchard (1992), *Strategic Environmental Assessment* (Earthscan Publications Ltd, London.)
- F Vanclay and D Bronstein (editors) (1995), *Environmental and Social Impact Assessment* (Wiley, Chichester, UK).
- D W H Walton (editor) (1987), *Antarctic Science* (Cambridge University Press, Cambridge, UK).