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Area protection in Antarctica: How can conservation and scientific research goals be managed compatibly?

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ABSTRACT

The footprint of human activities within Antarctica is increasing, making it essential to consider whether current conservation/protection of environmental and scientific values is adequate. The Antarctic protected area network has developed largely without any clear strategy, despite scientific attempts to promote protection of representative habitats. Many Antarctic Specially Protected Area (ASPA) Management Plans do not state clearly if conservation or science is the priority objective. This is problematic as science and conservation may have conflicting management requirements, i.e. visitation may benefit science, but harm conservation values. We examined recent estimated mean annual levels of visitation to ASPAs. On average, ASPAs protecting scientific research interests were visited twice as often as ASPAs conserving Antarctic habitat and biological communities. However, ASPAs protecting both science and conserving habitat were visited three times as often as ASPAs conserving habitat alone. Examination of visitation data showed that the proportion of visitors entering ASPAs for science, environmental management and/or education and tourism purposes, did not reflect the primary reason for designation, i.e. for science and/or conservation. One third of APSAs designated since the Environmental Protocol entered into force (1998) did not describe clearly the main reason for designation. Policy makers should consider (i) for all Management Plans stating unambiguously the reason an area has ASPA designation, e.g. either to protect habitat/environmental values or scientific research, in accordance with adopted guidance, (ii) designating new protected areas where visitation is kept to an absolute minimum to ensure the long-term conservation of Antarctic species and habitats without local human impacts (possibly located far from areas of human activity), and (iii) encouraging the use of zoning in ASPAs to help facilitate the current and future requirements of different scientific disciplines.

1. Introduction

It is over one hundred years since the parties of Amundsen and Scott reached the South Pole. At that time Antarctica was largely unknown, unmapped and visited by very few people (Headland, 2009). Today, Antarctica hosts over 100 research facilities, c. 4000 national operator staff and up to 33,000 tourist landings each year (COMNAP, 2012; IAATO, 2012) with some areas, particularly within the northern Antarctic

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Peninsula and Ross Sea Region, experiencing high levels of concentrated long-term activity (Braun et al., 2012). Antarctica is a continent dominated by ice with only 0.34% ice-free (c. 45,000 km^2), and only c. 6,000 km^2 both ice-free and within 5 km of the coast. Due to the less severe climatic conditions found at coastal locations, compared with the interior of the continent, the majority of Antarctic macrobiota are found within this small area, although communities dominated by microorganisms are found at inland locations. Biological communities in ice-free coastal areas, particularly in the Antarctic Peninsula region, are likely to be most exposed to climate change impacts, but their level of resilience is largely unclear (Turner et al., 2009). It is in the coastal ice-free areas that the great majority of research stations (c.80%) and other infrastructure are found as here access is comparatively easy and research opportunities most diverse. Coastal stations continue to be built, with three having been constructed on ice-free ground in the past nine years (COMNAP, 2012). Consequently, Antarctica's special values, features and habitats are more exposed to potential impacts created by the expanding human footprint (Tin et al., 2009; Hughes et al., 2011; Chown et al., 2012; Convey et al., 2012). Therefore, a comprehensive and robust protected area system is required to provide an effective framework for the conservation of Antarctica's environmental and scientific values (Morgan et al., 2007; Hughes and Convey, 2010; Terauds et al., 2012).

1.1. *Specially Protected Areas (SPAs)*

The Antarctic Treaty (signed in 1959, came into force 1961) says little about the conservation of Antarctica with only one reference relating to the preservation and conservation of living resources in Antarctica (Article IX, 1(f)). However, at the third Antarctic Treaty Consultative Meeting (ATCM) in Brussels in 1964, following substantial encouragement and support from the Scientific Committee on Antarctic Research (SCAR), the Agreed Measures for the Conservation of Antarctic Fauna and Flora were drawn up. In the Preamble it was stated that the Parties consider the Antarctic Treaty area as a Special Conservation Area, although it is not clear how this designation has been defined. More specifically, Article VIII sets out the measures for the designation of Specially Protected Areas (SPAs) to preserve the area's '*unique natural ecological system*'. Within an SPA, driving any vehicle was prohibited, as was the collection of any native plant, except in accordance with a permit. The allocation of a permit was only considered appropriate if it was issued for a compelling scientific purpose which could not be served elsewhere, and the actions permitted would not jeopardise the natural ecological system existing in the SPA. To strengthen the existing measures further, at ATCM VI (Tokyo, 1970), a recommendation was made that Parties prohibit entry by their nationals into SPAs, except in accordance with a permit (Recommendation ATCM VI-8). Furthermore, at ATCM VII (Wellington, 1972), Recommendation ATCM VII-2 suggested that the existing SPAs be reviewed and should include:

(a) representative examples of the major Antarctic land and freshwater ecological systems;
(b) areas with unique complexes of species;
(c) areas which are the type locality or only known habitat of any plant or invertebrate species;
(d) areas which contain specially interesting breeding colonies of birds or mammals;
(e) areas which should be kept inviolate so that in the future they may be used for purposes of comparison with localities that have been disturbed by man.

However, a recommendation for SPAs to have Management Plans, to control and regulate activities within the SPA, did not occur until 1989 (Recommendation ATCM XV-8).

1.2. *Sites of Special Scientific Interest (SSSIs)*

In the Preamble to Recommendation ATCM VII-3 (1972) it was made clear that areas of non-biological interest could not be made SPAs, which left a large gap in the protected area system. In addition, soon after the initiation of the SPA system, it became clear that measures designed to protect biodiversity and habitats within SPAs were also being used by Parties to protect scientific activities from external interference (Smith, 1994). This is an important distinction, as management action may vary markedly depending upon whether scientific activities or conservation have priority at a location. This issue was resolved, following a proposal from the Scientific Committee on Antarctic Research (SCAR), with the designation of a new class of protected area called a Site of Special Scientific Interest (SSSI) at ATCM VIII (Oslo, 1975; Recommendation ATCM VIII-3). SSSIs were designated to protect areas where scientific investigations were undertaken (or planned to be undertaken in the future) from wilful or accidental damage or interference. It was agreed that the SSSI systems should be used only to protect sites where harmful interference was generally recognised to be likely. SCAR recommended that individual Management Plans should be drawn up and applied to regulate access to and activities within the site. This stimulated a change in designation of several SPAs to SSSIs to allow scientific uses (see http://www.ats.aq/documents/ATCM34/WW/atcm34_ww003_e.pdf).

1.3. *Special Reserved Areas (SRAs) and Multiple-use Planning Area (MPA)*

In 1989 an additional category of protected area known as a Special Reserved Area (SRA) was proposed to protect areas of outstanding geological, glaciological, geomorphological, aesthetic, scenic, or wilderness value (Recommendation ATCM XV-10, Paris, 1989). However, the North Side of Dufek Massif was the only area ever proposed as an SRA (ATCM XVI, Bonn, 1991). Another category of protected area proposed at the same meeting was the Multiple-use Planning Area (MPA) (Recommendation ATCM XV-11) which was to assist in planning and co-ordinating activities to avoid mutual interference and minimise cumulative environmental impacts in high-use areas. However, like SRAs, MPAs were never formally adopted.

1.4. *The Protocol on Environmental Protection to the Antarctic Treaty*

A major revision of the Antarctic protected area system came about with the entry into force of the Protocol on

Environmental Protection to the Antarctic Treaty (also known as the Madrid Protocol or Environmental Protocol) in 1998 (ATCP, 1991; Bastmeijer, 2003). Most of the Recommendations produced before 1998 are no longer in force today and have been replaced with other tools including the Environmental Protocol. In Article 2 of the Protocol, Parties committed themselves to the comprehensive protection of the Antarctic environment, designating Antarctica as a '*natural reserve, devoted to peace and science*'. On 4 October 1991 the Environmental Protocol was signed in Madrid along with four Annexes concerning various aspects of marine and terrestrial environmental protection. However, it was not until the ATCM in Bonn later that month that Annex V 'Area Protection and Management' was agreed (Recommendation ATCM XVI-10), which set out a new system for area protection in Antarctica with the creation of the classifications: Antarctic Specially Managed Area (ASMA) and Antarctic Specially Protected Area (ASPA). ASPAs were meant to simplify the perception of protected areas by rolling all SPAs, SSSIs and SRAs into a single format, regardless of their previous use. ASMAs, a revised form of Multiple-use Planning Area, were to be used to '*assist in the planning and co-ordination of activities, avoid possible conflicts, improve co-ordination between Parties or minimise environmental impacts*' (Annex V; Article 4). Currently there are seven ASMAs, with a combined area of c. 42,300 km^2. ASMAs may include ASPAs within their area (Hughes and Convey, 2010). ASMAs are required to have a Management Plan (Annex V, Article 5), but do not have conservation of environmental and/or scientific values as their primary purpose. As permits are not required for entry, and their regulations are hortatory rather than mandatory, they are not considered further in this study.

1.5. *Antarctic Specially Protected Areas (ASPAs)*

At present the highest level of environmental protection for a site within the Antarctic Treaty area is through designation as an ASPA. According to Annex V, ASPAs are to protect '*outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or on-going or planned scientific research*'. No ASPAs have been designated with aesthetic or wilderness values as the main reason for designation, but historical, environmental and scientific values (including biological, geological, and physical values) are all represented (New Zealand, 2005a,b). The drafting of a Management Plan is a requirement for an area to be designated as an ASPA (Annex V, Article 5), as was the case for SSSIs and latterly SPAs. Likewise, as with SPAs and SSSIs, entry is only allowed in accordance with a permit issued by an appropriate national authority.

1.6. *Reclassification of SPAs and SSSIs as ASPAs*

Following implementation of the Environmental Protocol on 14 January 1998, existing SPAs and SSSIs were re-designated as ASPAs, and renumbered accordingly, with the intention of simplifying the protected area classification system. Crucially, in doing so, the intended main reason for protection of the area became obscured, i.e. either to conserve Antarctic habitat (as performed by the SPAs) or to protect scientific interests (as performed by the SSSIs). The Management Plan for each ASPA should set out clearly the reason for protection (see the 'Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas', adopted under ATCM XXII Resolution 2 (1998) and updated under ATCM XXXIV Resolution 2 (2011)), but due to revisions and frequent 'borrowing' of text from earlier ASPA Management Plans, the original distinction is now often unclear.

It was originally envisaged that SPAs would be expected to be long term with the potential for regular review to ensure the original conservation objectives were still sound. On the other hand, the designation of a SSSI was expected to last only as long as the scientific research programme, although it was possible that longer-term research could be performed within a SSSI. Thus the original concept was for a core of conservation sites representing the complete range of habitats and species, with a continually changing set of SSSIs driven by changing science needs. However, this is not what has occurred. All current ASPA Management Plans state that the area should be designated as an ASPA for an indefinite period with no reference to the idea of a 'time constrained' designation, i.e. to protect current/planned scientific work as long as such activity is active and/or relevant. Furthermore, it is unclear whether all ASPAs that were originally SSSIs still serve the same protection purpose as when they were established.

Originally, protected areas were mainly proposed and reviewed by the SCAR Working Group on Biology and its Sub-Committee on Conservation. Proposals for protected areas were presented to the ATCM through the UK delegation as the SCAR Office was in the UK and SCAR had no direct access to the Treaty until 1987.

From 1988 to 2004 the SCAR Group of Specialists on Environmental Affairs and Conservation (SCAR-GOSEAC) took on this role, and when the SPAs and SSSIs were re-classified as ASPAs, SCAR-GOSEAC provided the Treaty with a list of probable proponents for each protected area derived from Treaty and SCAR records (SCAR-GOSEAC, 1996). Although SCAR-GOSEAC identified a number of possible candidate areas for protection during this period, SCAR decided that it would not propose them itself but leave the responsibility with Parties. From 2004 onward, the Committee for Environmental Protection (CEP) took a more direct and active role in protected area discussions. The CEP Subsidiary Group on Management Plans (SGMP; founded in 2007) was tasked with assisting Parties with the revision of Management Plans for which they are proponents (Australia, 2007). The mandate of the SGMP is to examine any draft Management Plan and consider (i) whether it is consistent with the provisions of Annex V to the Protocol, (ii) its content, clarity, consistency and likely effectiveness, (iii) whether it clearly states the primary reason for designation, and (iv) whether it clearly states how the proposed Area complements the Antarctic protected areas system as a whole. In general, the work of the SGMP has improved the quality of Management Plans; nevertheless, the distinction between a designation for environmental or habitat conservation and protection of scientific activities is not always made clear in many of the ASPAs that have been designated to date.

A further complication has now arisen over areas designated with a marine component (such as ASPA 145 Port Foster,

Deception Island and ASPA 152 Western Bransfield Strait). Article 6(2) of Annex V to the Environmental Protocol provides for the Commission for the Conservation of Marine Living Resources' (CCAMLR') 'prior approval' of any proposed protected or managed areas with a marine component, which has necessitated joint consultations between the CEP and CCAMLR over any protected area, new or old, that contains any marine component.

Some progress has been made in developing a more strategic approach to area protection within Antarctica. Recent initiatives, developed and agreed within the Antarctic Treaty system, have begun to be used as underlying systematic frameworks for the area protection system, including the Environmental Domains Analysis (ATCM XXXI Resolution 3 (2008) and ATCM XXXIV Resolution 5 (2011)) and the Antarctic Conservation Biogeographic Regions (ATCM XXXV Resolution 6 (2012)).

1.7. *Human impacts within ASPAs*

ASPAs are generally small, with around 55% having an area of less than 5 km^2, and therefore may be exposed to potential impacts by even moderate levels of human visitation (Hughes and Convey, 2010). Cumulative impact with ASPAs can result from the activities of (i) permitted visitors who conform with the Management Plan, (ii) permitted visitors who do not conform fully with the Management Plan and (iii) those who enter the ASPA without a permit. Monitoring of human impacts is not undertaken routinely within many protected areas and consequently it is difficult to identify evidence showing if existing levels of visitation are having a negative impacting upon the values being protected. However, some evidence of impacts does exist. Within ASPA 126 Byers Peninsula, Livingston Island, South Shetland Islands, the location of past field camps supporting scientists from several nations can be identified by the presence of litter/waste and disturbed ground. Meteorological stations, sensors, plots and markers, some of which are not maintained regularly, and might, in effect, be abandoned, are also found within the ASPA (Pertierra et al., 2013). Within ASPA 140 Parts of Deception Island, South Shetland Islands, rare plants communities have been trampled inadvertently by scientist undertaking geological research (Site C, Caliente Hill; United Kingdom, 2011). ASPA 117, Avian Island, Marguerite Bay, contains two abandoned refuges, 650 m apart, which were erected originally by two different Parties to support ornithological research. Both refuges are now in a poor state of repair and may have the potential to impact on nesting birds (United Kingdom, 2002; M. von Tersch, pers. comm., 2011). Substantial levels of human impact and breaches of the Management Plan have been reported within ASPA 125 Fildes Peninsula, King George Island and ASPA 150 Ardley Island, Maxwell Bay, King George Island (Braun et al., 2012; Peter et al., 2013). Human activities within one or both of these ASPAs, causing impacts to both scientific and environmental values, included (i) release of waste originating from the local research stations, (ii) the collection of fossils for personal souvenirs, (iii) overflight of bird colonies contrary to the stipulated minimum flight heights and distances, (iv) scientific and unpermitted recreational visits that exceed the number of people permitted by the Management Plan to enter the area at any one time, (v) use of vehicles, (vi) trampling of vulnerable areas of vegetation and (vii) handling and interfering with wildlife (Braun et al., 2012; Peter et al., 2013). These activities are contrary, not only to the ASPA Management Plans, but in some cases the minimum standards set out in the Environmental Protocol. It is not known to what extent impacts similar to those described here occur at other ASPAs, and, in particular, those ASPAs which are close to research stations.

We hypothesise that environmental management practices within ASPAs may not be fully effective in communicating the primary reason an area is protected, i.e. if conservation or science is the priority objective. Evidence to support or reject our hypothesis was generated by (i) estimating the relative numbers of visits to ASPAs protecting environmental and scientific values, (ii) calculating the proximity of ASPAs relative to their nearest research stations, (iii) examining the reason visitors enter ASPAs (i.e. for science, environmental management or education/tourism reasons) and comparing this with the reason for designation and (iv) examining the clarity of Management Plans of ASPAs designated after the Environmental Protocol entered into force in 1998, in detailing the main values protected (i.e. science, conservation of habitat or a combination of both).

2. Materials and methods

Data for our research was obtained from the Antarctic Treaty Secretariat (ATS) website (www.ats.aq). ASPA Management Plans were obtained from the Protected Areas webpage (http://www.ats.aq/e/ep_protected.htm), which includes information on the Party that first recommended that the area be protected and is responsible for the revision of the area's Management Plan (i.e. the proponent Party). The Information Exchange web pages (http://www.ats.aq/e/i.e.html), and in particular the Electronic Information Exchange System (EIES), were used to gather information on allocation of permits by Consultative Parties for entry to ASPAs. Relevant ATCM and CEP Working and Information Papers were also accessed through the ATS website (http://www.ats.aq/devAS/ats_meetings.aspx?lang=e). Data available on the EIES as of December 2011 was used in this study. Information added subsequently was not incorporated into the analysis.

2.1. *Permit applications and ASPA visitation*

We examined the allocation of permits by Parties for entry to ASPAs using the EIES database of the ATS. As the EIES was only formally recognised as the repository for this information in 2008/09, we focused on data submitted by Consultative Parties pertaining to the three years 2008–09, 2009–2010 and 2010–11. Within the EIES, Pre-season Information contained information relating to the intended activities of Parties over the forthcoming Antarctic season. Annual Reports contained information relating to the Antarctic season that just passed and should have represented an accurate record of activities performed and permits allocated.

Permit applications and ASPA visitation were examined with a regional perspective, i.e. (i) the Antarctic Peninsula region, (ii) the Ross Sea region and (iii) the remainder of East Antarctica. No ASPAs have been designated within West Antarctica, outside of the Peninsula region. For each ASPA, the number of permit applications was obtained from Pre-season Information and levels of visitation by Parties were recorded from Annual Report information. The visitation levels contained in Annual Reports were not available for all Parties or all years in contravention of the Environmental Protocol, Annex V, Article 10, which sets out the information exchange obligations of Parties within ASPAs. Therefore, an attempt was made to estimate likely levels of visitation to each ASPA by making use of available data in the equivalent year's Pre-season Information or other Annual Report years. The following rules were used to make this estimation, in order of priority:

1. For Parties with one or two missing Annual Reports, but available Pre-season Information for (i) the missing year(s) and (ii) the other years where Annual Reports are available, a ratio (or a mean of two ratios) of Annual Report/Pre-seasonal Information was applied to the available Pre-season Information figures to give an estimation of likely levels of ASPA visitation (applied to data from New Zealand, Spain, Germany and China).
2. For Parties where no Pre-season Information or Annual Report data are available for a given year or years, the mean of the available Annual Report information was used (applied to data from Australia, Brazil, Chile, Japan and USA).

Where Parties exchanged information on topics other than protected area visitation via the EIES, but did not submit information on ASPA visitation, we assumed that no ASPAs were visited during the reporting period. Once estimated visit numbers for the three year period were made, the mean estimated visitation levels per year were calculated by dividing the initial figure by three. This value was used as a proxy for visitation levels in further analyses.

2.2. *Distance of ASPAs from stations*

The distance of each ASPA from its nearest research station (excluding summer field camps and huts) was obtained from the ASPA Management Plans obtained from the Antarctic Treaty Systems document entitled 'Status of Antarctic Specially Protected Area and Antarctic Specially Managed Area Management Plans' found at http://www.ats.aq/documents/ATCM34/WW/atcm34_ww003_e.pdf.

2.3. *Activities undertaken within ASPAs*

An EIES function that summarises information on ASPA permitting, visitation and activities, available at: http://www.ats.aq/devAS/ie_reports.aspx?lang=e, was used to examine the stated reason for visitor entry to the ASPAs, and how this varied depending upon each ASPA's intended purpose. This analysis used actual submitted data, rather than estimated data. Annual Report submissions for 2008/09, 2009/10 and 2010/11 were examined and for each permit the reason for the ASPA visit was ascertained and the number of visitors permitted to enter the ASPA allocated to one of four headings: (i) science/research support, (ii) environmental management/site inspection, (iii) education, familiarisation or tourism and (iv) non-scientific technical or logistical activities. Where the permit described activities that fell into two or more categories, the visitor number was divided and allocated evenly to each of the categories. Analysis was then undertaken to see how the activities undertaken differed within ASPAs designated previously as SPAs, SSSI, those with joint SPA/SSSI status and those designated after 1998 as ASPAs.

3. Results

3.1. *ASPA designation*

Five of the 28 Consultative Parties are proponents for 78.9% of all ASPAs (UK, New Zealand, USA, Australia and Chile) with the UK the proponent for almost 20% (Fig. 1). Most of these five nations have proposed ASPAs (or their earlier equivalent, Specially Protected Areas (SPAs), Sites of Special Scientific Interest (SSSIs), etc.) since 1966, while other Parties have only become active proponents of ASPAs in more recent years (e.g. Republic of Korea, China and India). The level of protected area designation over the years has not been constant. Years during which high numbers of protected areas were designated include (i) 1966, when SPAs were first introduced, (ii) 1975, when SSSIs were adopted, and (iii) 1985 when 16 protected areas were designated as a result of an initiative within SCAR to expand the network of protected areas (Bonner and Smith, 1985). After this, protected area designation was more regular with an average of 1.27 designated per year from 1985 to 2011 (compared with 2.00 per year from 1966 to 1985 and 1.57 per year from 1966 to 2011). Since the Environmental Protocol came into force in 1998, the ASPA designation rate has fallen to less than one new ASPA per year.

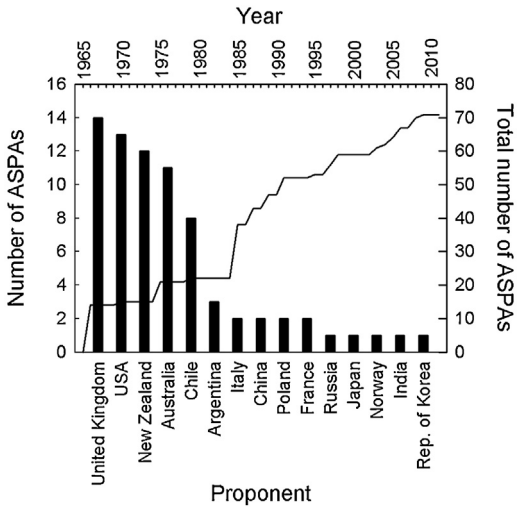

Fig. 1 – Designation of ASPAs (or the earlier equivalents) between 1966 and 2011 and number of ASPAs proposed by each proponent Consultative Party.

Table 1 – Earlier designation of ASPAs as Specially Protected Areas (SPAs)[a] or Sites of Special Scientific Interest (SSSIs) prior to the adoption of Annex V of the Environmental Protocol.

	ASPAs previously designated as SPAs (% within region)	ASPAs previously designated as SSSIs (% within region)	ASPAs previously designated as both SPAs and SSSIs (% within region)	ASPAs designated after 1998 (% within region)	Total (% within region)
Peninsula region[b]	9 (29.0%)	16 (51.6%)	4 (12.9%)	2 (6.5%)	31 (100%)
Ross Sea region[c]	8 (39.1%)	8 (39.1%)	3 (14.3%)	2 (9.5%)	21 (100%)
East Antarctica[d]	5 (26.3%)	6 (31.6%)	0 (0%)	8 (42%)	19 (100%)
All Antarctica	22 (31%)	30 (42.3%)	7 (9.9%)	12 (16.9%)	71 (100%)

[a] SPAs were aimed primarily at protection of biological habitats, while SSSIs were for the protection of scientific research activities.
[b] Proponent Parties (no. of ASPAs): UK (14), Chile (8), United States (5), Argentina (3), Poland (2), Republic of Korea (1).
[c] Proponent Parties (no. of ASPAs): New Zealand (12), United States (7), Italy (2).
[d] Proponent Parties (no. of ASPAs): Australia (11), China (2), France (2), Japan (1), Russian Federation (1), United States (1), India (1), Norway (1).

3.2. *Earlier categorisation of current ASPAs and visitation levels*

Table 1 shows the earlier categorisation of existing protected areas (as SPAs, SSSIs, ASPAs, etc.) within the Antarctic Peninsula region, Ross Sea region and remainder of East Antarctica (Fig. 2). Roughly similar proportions of SPAs and SSSIs were designated within the Ross Sea region and East Antarctica prior to 1998, but considerably more SSSIs have been designated in the Antarctica Peninsula compared with SPAs (c. 40% more).

In light of a lack of full ASPA visitation data (see Pertierra and Hughes, 2013), we used the information available to make estimates of likely visitation, but acknowledge that results would be more reliable if Parties fulfilled their obligations under the Environmental Protocol and provided full information on visitation of all ASPAs. Consequently, the following results should be considered as an indicator of likely trends rather than completely accurate values. Overall, on average each protected area received c. 47 visitors per year. ASPAs that were previously designated as SPAs had the highest mean estimated number of visits (90 per year); however, this category included four highly visited historic sites and once these were excluded the number fell to 12 visits per year (Fig. 3). Fig. 3 shows the estimated levels of visitation of terrestrial ASPAs according to their earlier classification as

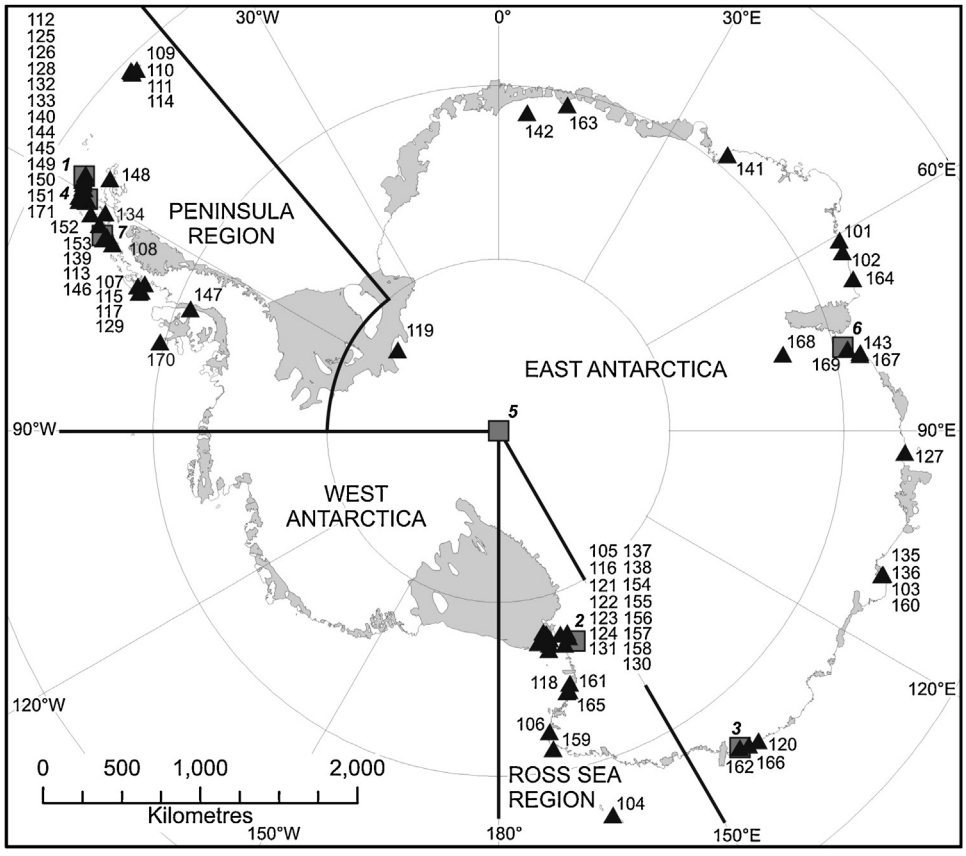

Fig. 2 – Map of Antarctica showing the locations of 71 Antarctic Specially Protected Areas (ASPAs) examined in this study and 7 Antarctic Specially Managed Areas (ASMAs). The four regions used in this research are shown.

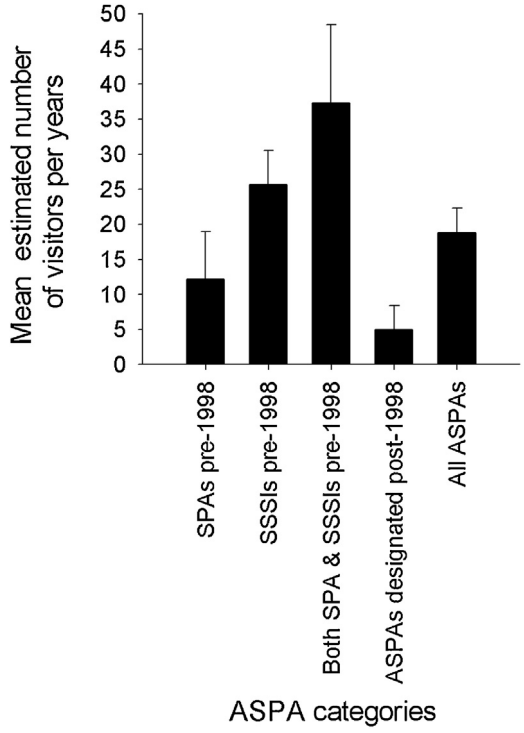

Fig. 3 – Mean estimated number of visits per year (±SE) to terrestrial ASPAs designated previously as SPAs, SSSIs, joint SPA and SSSIs and areas designated as ASPAs following the implementation of the Environmental Protocol in 1998.

SPAs, SSSIs, joint SPA and SSSIs or as ASPAs if designated for the first time after 1998. ASPAs designated previously as SSSIs on average received almost 26 visits per year, roughly twice as many as former SPAs designated to conserve habitat. On average, ASPAs previously designated with dual SPA and SSSI

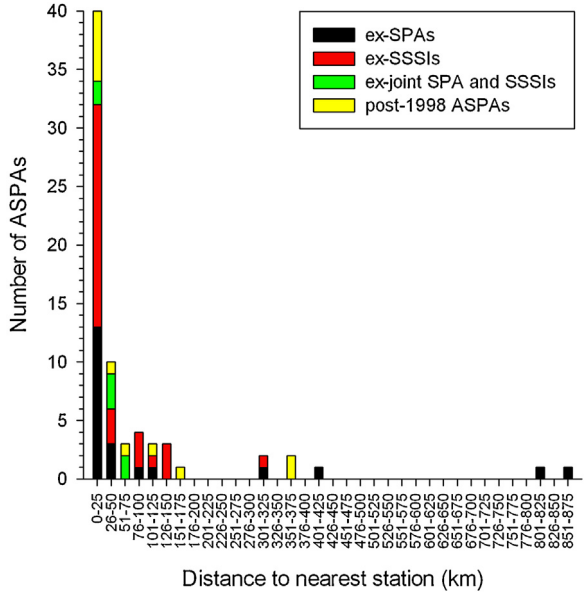

Fig. 4 – Number of ASPAs found at different distances from the nearest research station (25 km bins).

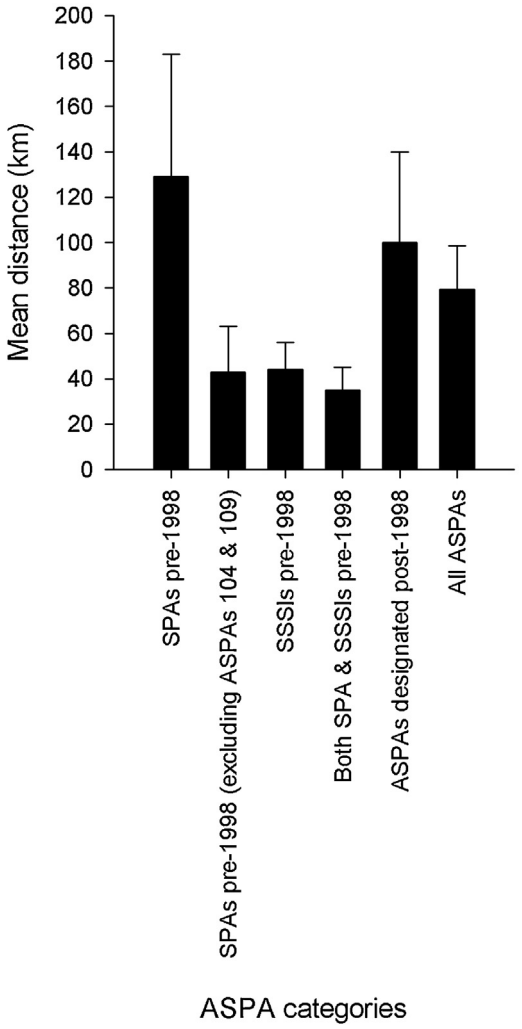

Fig. 5 – Mean distance (±SE) to the nearest research station of ASPAs previously designated as SPAs, SSSIs, both SPA and SSSIs and areas designated as ASPAs following the implementation of the Environmental Protocol in 1998.

status were visited almost three times as often as ASPAs that were formally SPAs. Excluding the historic huts (specifically ASPA 162 Mawson's Hut, Cape Denison, East Antarctica) and areas protecting predominantly benthic marine communities, ASPAs designated after the implementation of Annex V in 1998 received comparatively few visitors (estimated mean of five visits per year) (Fig. 3). Although these numbers may seem low, we have no information on the duration of each visit and, with a few exceptions, ASPAs tend to be small with small areas of ice-free ground where human activities may be concentrated (Pertierra and Hughes, 2013).

3.3. *Distance of ASPAs from stations*

Fig. 4 shows the number of ASPAs at different distances from the nearest research station. Over 56% of ASPAs were within 25 km of their nearest research station, with 28% within 3 km of the station. The mean estimated number of visits per year for ASPAs within 3 km of stations was 68 compared with 39 for

ASPAs beyond this distance. The ASPAs most distant from stations were ASPA 104 Sabrina Island, Northern Ross Sea and ASPA 119 Davis Valley and Forlidas Pond, Dufek Massif, Pensacola Mountains, both of which were >800 km from the nearest station and were classified previously as SPAs (Nos. 4 and 23, respectively). Fig. 5 shows the mean distance of ASPAs from the nearest research station according to their earlier classification as SPAs, SSSIs, joint SPA and SSSIs or as ASPAs if designated after 1998. When the two very remote ASPAs 104 and 119 are excluded from the analysis there is little difference in mean distance between ASPAs that were previous classified as SPAs, SSSIs or those with both SPA and SSSI status (see the 2nd, 3rd and 4th vertical bar in Fig. 5). ASPAs designated after 1998 were generally situated more remotely from their nearest research station.

3.4. *Activities undertaken within ASPAs*

For the three-year period examined, on average 736 visitors went to each ASPA protecting historical values or commemorative areas (ASPAs 155, 156, 157, 158, 159 and 162), with 96.3% visiting for education or tourism reasons, 3.0% for science and 0.6% for environmental management reasons. No visits were made for technical or logistical reasons. While these visitor numbers may appear high compared to ASPAs protecting other values, the Management Plans of some ASPAs protecting historic values (and in particular historic huts) allow higher numbers of visitors than currently enter the area each year (e.g. the Management Plan for ASPA 158 Hut Point, Ross Island allows an annual maximum number of visitors of 2000 people). Therefore, high visitor numbers may not be seen necessarily as compromising the value to be protected.

On average 81 visitors went to ASPAs protecting predominantly marine values (ASPAs 144, 145, 146, 152, 153 and 161) with 2.1% visiting for education or tourism reasons, 23.0% for science and 75.0% for environmental management and site inspections. The high level of visits for environmental management and site inspections was due to some Parties allocating permits for ASPA entry to the total number of people on the vessel entering the Area, even if they were not involved in the management or inspection activity. No visits were made for technical or logistical reasons. Table 2 shows the mean number of permitted visitors to terrestrial areas protected for their biological, geological or physical values for the purpose of science, environmental management and tourism/education for the three year reporting period. For ASPAs designated previously as both SPA and SSSIs, on average 2.5% of visits were for non-scientific technical or logistical activities, for example, for maintenance of communication equipment within ASPA 118 Mt Melbourne, Victoria Land.

3.5. *ASPAs designated after 1998*

Table 3 shows the features and values protected by ASPAs designated since the implementation of Annex V to the Environmental Protocol in 1998. Based on the information provided in the ASPA Management Plans, an attempt was made to discern whether the dominant reason for designation was for conservation of historical or environmental values (as indicated in earlier years by the SPA classification) or to protect scientific research (as indicated previously by the SSSI classification). It was clear that three ASPAs were designated for the conservation of habitat or historic values, two were for protection of scientific research and three were both to conserve habitat and protect scientific interests. In four cases the Management Plan did not state unambiguously the primary aim of the protected area (ASPAs 161, 164, 167 and 171).

Table 2 – Mean number of permitted visits to terrestrial areas protected for their biological, geological or physical values for the purpose of science, environmental management and tourism/education for the three-year reporting period 2008/09 to 2010/11.

			Purpose of visit			
			Science	Environmental management	Education, familiarisation or tourism	All visits
Protected area category	ASPAs designated previously as SPAs	No. of visits (±SE)	17.8 (±4.1)	3.8 (±1.3)	9.1 (±8.2)	30.7 (±10.8)
		% of total visits (±SE)	58.0 (±13.4)	12.4 (±4.2)	29.6 (±26.7)	(100%)[a]
	ASPAs designated previously as SSSIs	No. of visits (±SE)	43.8 (±8.8)	4.8 (±1.4)	2.7 (±1.5)	51.3 (±9.7)
		% of total visits (±SE)	85.3 (±17.2)	9.4 (±2.7)	5.3 (±2.9)	(100%)
	ASPAs designated previously as both SPAs and SSSIs	No. of visits (±SE)	70.1 (±20.3)	9.8 (±4.8)	1.6 (±1.6)	83.6 (±24.8)[b]
		% of total visits (±SE)	83.9 (±24.3)	11.7 (±5.7)	1.9 (±1.9)	(100%)
	ASPAs designated after 1998	No. of visits (±SE)	10.4 (±7.1)	0.4 (±0.2)	0.0 (±0.0)	10.7 (±6.5)
		% of total visits (±SE)	96.3 (±65.7)	3.7 (±1.9)	0.0 (±0.0)	(100%)

[a] ASPA 106 Cape Hallett received a high number of visits for education and tourism reasons during the period examined. When the data for this ASPA was excluded from the analysis, ASPAs that were designated previously as SPAs received on average 21.3 visits, with 82.2% (±20.7), 13.6% (±4.2) and 4.2% (±4.2) of visitors entering the area for science, environmental management and education/tourism purposes, respectively.

[b] A small number of visits to ASPA that were previously designated as both SPAs and SSSIs had visits permitted for technical purposes, such as maintenance of communications equipment for logistical purposes. These were not allocated to the existing categories describing the purpose of the visit, but were added to the total.

Table 3 – Main reason for protection of ASPAs designated following the entry into force of the Protocol on Environmental Protection to the Antarctic Treaty, based on information in the associated Management Plan.

ASPA No.	Name	Proponent	Reason for protection	Main value protected as described in management plan	Proposed designation under earlier classification based on information in Management Plan	
					Conservation of historical values or habitat (SPA pre-1998)	Protection of scientific research interests (SSSI pre-1998)
160	Frazier Islands, Windmill Islands, Wilkes Land, East Antarctica	Australia	Southern giant petrels	?	Yes	No
161	Terra Nova Bay, Ross Sea	Italy	Littoral area	Ecological and scientific values	No?	Yes
162	Mawson's Huts, Cape Denison, Commonwealth Bay, George V Land, East Antarctica	Australia	Historic site	Historic, archaeological, technical, social and aesthetic values	Yes	No
163	Dakshin Gangotri Glacier, Dronning Maud Land	India	Glacier	Historic, scientific and environmental values	No	Yes (clearly stated Section 2ii)
164	Scullin and Murray Monoliths, Mac Robertson Land	Australia	Breeding colonies of seabirds	Ecological and scientific values aesthetic and wilderness values	Yes	Minor?
165	Edmonson Point, Wood Bay, Ross Sea	Italy	Terrestrial and freshwater ecosystem	Biological/ecological and scientific values	Yes (Colline Ippolito site)	Yes
166	Port-Martin, Terre Adélie	France	Historic site	Historical values	Yes	No
167	Hawker Island, Vestfold Hills, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica	Australia	Southernmost breeding colony of southern giant petrels	? Section 7(x) mentions ecological and scientific values	Yes	Minor?
168	Mount Harding, Grove Mountains, East Antarctica	China	Unique geomorphological features	Scientific, aesthetic and wilderness values	No	Yes
169	Amanda Bay, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica	Australia and China	Emperor penguin colony	Intrinsic and scientific values	Yes (representative example of species)	Yes
170	Marion Nunataks, Charcot Island, Antarctic Peninsula	United Kingdom	Unique species assemblage	Environmental values, scientific research	Yes	Yes
171	Narębski Point, Barton Peninsula, King George Island	Republic of Korea	Terrestrial communities, penguin colonies	Ecological, scientific, and aesthetic values	Yes?	Yes

4. Discussion

4.1. *Numbers of visitors and reasons for ASPA visitation*

Our analysis showed that on average ASPAs conserving habitat (previously SPAs) received about half as many visitors as ASPAs protecting scientific research (previously SSSIs), but these numbers may still be considered high given the reason the area was designated, i.e. to protect the habitat from human impact and disturbance. That we found on average three times as many visitors to ASPAs designated for both conservation of habitat and protection of scientific research compared with ASPAs designated predominantly for habitat conservation, suggests that scientific research and conservation are not compatible within a single area and the range of values being protected are not always considered fully during the permit allocation process.

It might be expected that ASPAs protected for conservation of habitat would be visited predominantly for environmental management purposes, with science visits made predominantly at ASPAs designated for research. However, when we investigated the reasons visits were made to terrestrial areas protecting predominantly biological, geological and physical values, on average only 12% of visits to ASPAs designated primarily for conservation reasons were for environmental management purposes, which is similar to levels seen in ASPAs overall. Furthermore, little difference was seen in the level of visitation to ASPAs designated for both conservation of habitat and protection of scientific research compared with ASPAs designated predominantly for science, despite their different roles (i.e. 84 and 85% of visits were for science, 12 and 9% for environmental management and 2 and 5% for education/tourism, respectively). Clearly, substantial amounts of scientific research are undertaken in areas designated for conservation, which may not be in the best interest of the environmental values under protection.

For ASPAs designated after 1998 that protect predominantly biological, geological and physical values, visits for scientific reasons dominated with only 3.7% of visits for environmental management purposes. These figures may be explained in part by the fact that the main value being protected was not indicated clearly in a third of Management Plans (Table 3). With this in mind it may be useful to (i) give more emphasis to the main reason why an area has been protected and (ii) make it more clear what the environmental management expectations are for areas protected to conserve habitats (i.e. ASPAs that were formally SPAs), as compared to those where scientific values are a greater priority for protection (i.e. ASPAs that were formally SSSIs). Furthermore, many ASPAs originally designated as SSSIs may have little science or monitoring occurring within them: our analysis suggested that 20% of ASPAs with an earlier designation as a SSSIs (i.e. protecting scientific values) received fewer than two visitors per year during the study period and almost 50% had fewer than 10 visitors, although this may be an underestimate. In the original dynamic concept for conservation, those sites which were no longer needed for science would have the protection removed when the experiments or monitoring came to an end. The removal of a site from the Protected Areas list has so far not happened, suggesting a widespread misunderstanding of how the system should operate.

4.2. *Spatial distribution – the case for more remote ASPAs*

Inadequacies in the spatial distribution of ASPAs around the Antarctic Treaty area have been noted repeatedly over many years (Bonner and Smith, 1985; Smith, 1994; Valencia, 2000; New Zealand, 2009; SCAR, 2010; Terauds et al., 2012). The great majority of ASPAs are found close to research stations or areas of substantial national operator activity (particularly around the Antarctic Peninsula and Ross Sea regions; Fig. 5) and the system largely does not protect values in other more remote areas of the continent.

The restricted spatial distribution may be justified to some degree, as ASPAs are generally created to protect areas from some threat of human interference or impact; if no science is undertaken or visits made to a remote location there may be little reason for its designation as a protected area. However, this view does not take into consideration future science or tourism activities which are occurring increasingly at more remote locations (Convey et al., 2012). Nor does the current system provide adequate protection of the diversity of habitats, biological communities (including microbial communities) and endemic species that exist within the Treaty area (Cowan et al., 2011; Terauds et al., 2012; Hughes et al., 2013). Nevertheless, recent initiatives to develop underlying systematic frameworks for the area protection system have been agreed within the Antarctic Treaty system, including the Environmental Domains Analysis and the Antarctic Conservation Biogeographic Regions, which may go some way to enhance the protected area network as it develops further.

Given the slow pace at which ASPAs are designated (Harris, 2000), it may be useful to adopt a precautionary approach and protect areas not yet perceived as threatened, which are found in regions unrepresented in the Antarctic protected area system (e.g. West Antarctica; New Zealand, 2009; Australia, 2012). ASPAs may be visited more often when close to stations (Fig. 4) and the remoteness of ASPAs seem unrelated to the values being protected (Fig. 5). Therefore, where appropriate and where options exist, it may be useful to select areas for the conservation of habitat (or for designation as an inviolate area) at locations far from areas of human activity (Valencia, 2000). Supporting this suggestion, both ASPA 104 Sabrina Island and ASPA 119 Davis Valley and Forlidas Pond remained unvisited during the period studied, probably due in large part to their locations more than 800 km from the nearest research stations.

4.3. *Conflict of interests within ASPAs*

Conflict of interests within ASPAs may arise due to the different values being protected and the different interests of those entering the area. Firstly, there may be those wishing to prioritise the conservation of an area's environmental values or habitat and those who want to undertake scientific research. For example, the sub-sites of ASPA 140 Parts of Deception Island, South Shetland Islands were designated to conserve unique plant communities that have developed on

heated ground adjacent to fumaroles, yet these areas have also been studied intensively by geologists who have inadvertently caused trampling impacts even with the Management Plan measures in place (Hughes pers. observ. 2010; United Kingdom, 2011). Secondly, within an ASPA the requirements of scientists of one discipline may not be compatible with those of a different discipline. Furthermore, the inadvertent impacts of one type of science may permanently reduce the future scientific value of the site for another science discipline. For example, microbiological research that uses sophisticated molecular techniques may require the permanent imposition of the highest standards of sterility and biosecurity, but these requirements may not be compatible with scientists of other disciplines requiring general access to an area (e.g. for botanical or geological surveys) (Hughes and Convey, 2010; Cowan et al., 2011; Hughes et al., 2011). Some steps have been taken to solve potential scientific conflicts by the introduction of zoning within ASPAs to protected subareas for different types of scientific research (e.g. the Management Plans for ASPA 126 Byers Peninsula, Livingston Island and ASPA 118, Cryptogam Ridge, Mt Melbourne). However, depending upon interpretation, only c. 15 ASPA Management Plans describe permanent or seasonally restricted zones. More widespread use of this conservation mechanism may be appropriate, particularly where scientific disciplines may have conflicting requirements within the area, or where an area is designated for both conservation of habitat and protection of scientific research interests (Harris, 1994; United States, 2010; ASOC, 2012). Furthermore, in the case where scientific value is the primary purpose, it may be helpful to specify the scientific discipline for which the area is designated, for example, microbiology, where higher standards of biosecurity may be required to minimise microbial contamination within the area (Cowan et al., 2011; Hughes et al., 2013). Finally, despite the original requirement that those permitted to visit ASPAs would file reports on their visits to allow continuing oversight on the condition of each ASPA, this has been largely ignored by the scientists themselves and/or the authorities granting their permits, making informed management decisions even harder to achieve (Pertierra and Hughes, 2013).

5. Conclusions and recommendations

It could be argued that, due to the different management requirements of areas protected for conservation and scientific research, the removal of the SPA/SSSI categories and their replacement with the overarching ASPA title has caused confusion regarding the primary purpose of the protected area designation in many cases. We suggest that the protection of Antarctica's most valuable areas could be enhanced if environmental managers and scientists:

(i) state unambiguously the main reason that an area is designated as an ASPA, e.g. to protect habitat/environmental values or scientific research,
(ii) state clearly the primary scientific purpose of the ASPA (e.g. microbiology, or geology, or paleoclimatology, etc.) in areas protected specifically for scientific research,
(iii) designate new ASPAs where visitation is kept to an absolute minimum to ensure the long-term conservation of Antarctic species and habitats with minimal levels of local human impact (possibly located far from areas of human activity),
(iv) encourage better co-ordination of activities between scientists of different disciplines, possibly through greater use of restricted zones within ASPAs, and
(v) encourage submission of ASPA visit report forms after permitted visits (see Appendix 2 'Antarctic Specially Protected Areas (ASPA) visit report form' in the CEP 'Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas').

The ASPA system is still immature and someway off a comprehensive protection of values across the whole of Antarctica (Terauds et al., 2012). The CEP and the ATCM are only slowly catching up with the modern aspects of dynamic conservation well-recognised in the rest of the world, and so in some respects Antarctic conservation lags behind the initiatives developed elsewhere. It can only be hoped that the Antarctic community can enhance the protected area system at a faster rate than the region's values are being impacted, and in some cases compromised, by on-going and ever more widely distributed human activity (Tin et al., 2009; Braun et al., 2012; Peter et al., 2013).

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REFERENCES

Antarctic Southern Ocean Coalition (ASOC), 2012. Annex V inviolate and reference areas: current management practices. Information Paper 49, Antarctic Treaty Consultative Meeting XXXV, Committee for Environmental Protection XV, Hobart, Australia, 11–20 June 2012.

Antarctic Treaty Consultative Parties (ATCP), 1991. Protocol on Environmental Protection to the Antarctic Treaty. CM 1960. Her Majesty's Stationery Office, London.

Australia, 2007. Intersessional CEP consideration of draft management plans. Working Paper 10, Antarctic Treaty Consultative Meeting XXX, Committee for Environmental Protection X, New Delhi, India, 30 April–11 May 2007.

Australia, 2012. Analyses of the Antarctic protected areas system using spatial information. Information Paper 26, Antarctic Treaty Consultative Meeting XXXV, Committee for Environmental Protection XV, Hobart, Australia, 11–20 June 2012.

Bastmeijer, K., 2003. The Antarctic Environmental Protocol and its domestic legal implementation. International Environmental Law and Policy Series Volume 65. Kluwer Law International, Alphen aan den Rijn, The Netherlands.

Bonner, W.N., Smith, R.I.L., 1985. Conservation areas in Antarctica: A Review prepared by the Sub-committee of Conservation Working Group on Biology. Scientific Committee on Antarctic Research/International Council of Scientific Unions, Cambridge.

Braun, C., Mustafa, O., Nordt, A., Pfeiffer, S., Peter, H.-U., 2012. Environmental monitoring and management proposals for the Fildes Region (King George Island, Antarctica). Polar Research 31 (Art. 18206).

Chown, S.L., Lee, J.E., Hughes, K.A., Barnes, J., Barrett, P.J., Bergstrom, D.M., Convey, P., Cowan, D.A., Crosbie, K., Dyer, G., Frenot, Y., Grant, S.M., Herr, D., Kennicutt, I.I., Lamers, M.C., Murray, M., Possingham, A., Reid, H.P., Riddle, K., Ryan, M.J., Sanson, P.G., Shaw, L., Sparrow, J.D., Summerhayes, M.D., Terauds, C., Wall, A.D.H., 2012. Challenges to the future conservation of the Antarctic. Science 337, 158–159.

Convey, P., Hughes, K.A., Tina, T., 2012. Continental governance and environmental management mechanisms under the Antarctic Treaty System: sufficient for the biodiversity challenges of this century? Biodiversity 13, 1–15.

Council of Managers of National Antarctic Programs (COMNAP) 2012. Antarctic information. Available at: https://www.comnap.aq/Information/SitePages/Home.aspx.

Cowan, D.A., Chown, S.L., Convey, P., Tuffin, M., Hughes, K.A., Pointing, S., Vincent, W.F., 2011. Non-indigenous microorganisms in the Antarctic-assessing the risks. Trends in Microbiology 19, 540–548.

Harris, C.M., 1994. Standardisation of zones with specially protected and managed areas under the Antarctic Environmental Protocol. Polar Record 30, 283–286.

Harris, C., 2000. Issues in the development and management of Antarctic Protected Areas. In: Valencia, J. (Ed.), Second Antarctic Protected Areas Workshop. Ministerio de Relaciones Exteriores, Instituto Antartico Chileno, Santiago, pp. 57–58.

Headland, R., 2009. A Chronology of Antarctic Exploration. Quaritch, London.

Hughes, K.A., Convey, P., 2010. The protection of Antarctic terrestrial ecosystems from inter- and intra-continental transfer of non-indigenous species by human activities: a review of current systems and practices. Global Environmental Change 20, 96–112.

Hughes, K.A., Fretwell, P., Rae, J., Holmes, K., Fleming, A., 2011. Untouched Antarctica: mapping a finite and diminishing environmental resource. Antarctic Science 23, 537–548.

Hughes, K.A., Cary, S.C., Cowan, D.A., Lovejoy, C., Vincent, W.F., Wilmotte, A., 2013. Guest Editorial: Pristine Antarctica: threats and protection. Antarctic Science 25, 1.

International Association of Antarctica Tour Operators (IAATO), 2012. Tourism statistics. Available at: http://iaato.org/tourism-statistics.

Morgan, F., Barker, G., Briggs, C., Price, R., Keys, H., 2007. Environmental Domains of Antarctica Version 2. 0 Final Report. Manaaki Whenua Landcare Research New Zealand Ltd..

New Zealand, 2005a. A review of the protected areas system. Working Paper 11, Antarctic Treaty Consultative Meeting XXVIII, Committee for Environmental Protection VIII, Stockholm, Sweden, 6–17 June 2005.

New Zealand, 2005b. A review of the protected areas system. Information Paper 29, Antarctic Treaty Consultative Meeting XXVIII, Committee for Environmental Protection VIII, Stockholm, Sweden, 6–17 June 2005.

New Zealand, 2009. Updated analysis of representation of Annex V categories and Environmental Domains in the system of Antarctic Specially Protected and Managed Areas. Working Paper 31, Antarctic Treaty Consultative Meeting XXXII, Committee for Environmental Protection XII, Baltimore, United States, 6–17 April 2009.

Pertierra, L.R., Hughes, K.A., 2013. Management of Antarctic Specially Protected Areas: permitting, visitation and information exchange practices. Antarctic Science, http://dx.doi.org/10.1017/S0954102012001204.

Pertierra, L.R., Hughes, K.A., Benayas, J., Justel, A., Quesada, A., 2013. Environmental management of a scientific field camp in Maritime Antarctica: Reconciling research impacts with conservation goals in remote ice-free areas. Antarctic Science, http://dx.doi.org/10.1017/S0954102012001083.

Peter, H.-U., Braun, C., Janowski, S., Nordt, A., Nordt, A., Stelter, M., 2013. The current environmental situation and proposals for the management of the Fildes Peninsula Region. Federal Environment Agency (Umweltbundesamt), Dessau-Roßlau, Germany. Available at: http://www.umweltdaten.de/publikationen/fpdf-l/4424.pdf.

Scientific Committee on Antarctic Research—Group of Specialists on Environmental Affairs and Conservation (SCAR-GOSEAC), 1996. Report of the GOSEAC V Meeting, 1994. SCAR Report no. 12, 1–13.

Scientific Committee on Antarctic Research (SCAR), 2010. Biodiversity-based evaluation of the Environmental Domains Analysis. Working Paper 3, Antarctic Treaty Consultative Meeting XXXIII, Committee for Environmental Protection XIII, Punta de Este, Uruguay, 3–14 May 2010.

Smith, R.I.L., 1994. The Antarctic Protected Area System. In: Smith, R.I.L., Walton, D.W.H., Dingwall, P.R. (Eds.), Developing the Antarctic Protected Area System. IUCN, Gland, Cambridge, pp. 15–26.

Terauds, A., Chown, S.L., Morgan, F., Peat, H.J., Watts, D.J., Keys, H., Convey, P., Bergstrom, D.M., 2012. Conservation biogeography of the Antarctic. Diversity and Distributions 18, 726–741.

Tin, T., Fleming, Z., Hughes, K.A., Ainley, D., Convey, P., Moreno, C., Pfeiffer, S., Scott, J., Snape, I., 2009. Impacts of local human activities on the Antarctic environment: a review. Antarctic Science 21, 3–33.

Turner, J., Bindschadler, R., Convey, P., di Prisco, G., Fahrbach, E., Gutt, J., Hodgson, D., Mayewski, P., Summerhayes, C. (Eds.), 2009. Antarctic Climate Change and the Environment. Scientific Committee on Antarctic Research (SCAR), Cambridge.

United Kingdom, 2002. Review of draft protected area Management Plans. Report of the UK-led Intersessional Contact Group. Working Paper 10, Antarctic Treaty Consultative Meeting XXXV, Committee for Environmental Protection XV, Warsaw, Poland, 10–20 September 2002.

United Kingdom, 2011. Revision of the Management Plan for Antarctic Specially Protected Area (ASPA) No. 140 Parts of Deception Island, South Shetland Islands. Attachment. Working Paper 23, Antarctic Treaty Consultative Meeting XXXIV, Committee for Environmental Protection XIV, Buenos Aires, Argentina, 20 June–1 July 2011.

United States, 2010. Guidelines for the application of management zones within Antarctic Specially Managed Areas and Antarctic Specially Protected Areas. Working Paper 10, Antarctic Treaty Consultative Meeting XXXIII, Committee for Environmental Protection XIII, Punta del Este, Uruguay, 3–14 May 2010.

Valencia, J. (Ed.), 2000. Second Antarctic Protected Area Workshop. Ministerio de Relaciones Exteriores. Instituto Antartico Chileno, Santiago.

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