XXV ATCM
Working Paper **WP-010**
Agenda Item: CEP 4g
UNITED KINGDOM
Original : English

To be translated soon

Review of draft Protected Area Management Plans
Report of the UK-led Intersessional Contact Group

Working Paper
Submitted by the United Kingdom

Introduction.

1. At CEP IV the UK submitted 6 draft management plans for protected areas for the Committee's consideration. These were:

   - Specially Protected Area No 8, Dion Islands
   - Specially Protected Area No 9, Green Island
   - Specially Protected Area No 21, Avian Island
   - Site of Special Scientific Interest No 6, Byers Peninsula (submitted jointly with Chile)
   - Site of Special Scientific Interest No 29, Ablation Valley – Ganymede Heights
   - Site of Special Scientific Interest No 31, Mount Flora

2. To review these draft management plans CEP IV decided to establish an open-ended intersessional contact group to be led by the UK, with the following terms of reference (paragraphs 65 and 66 of the Final Report of CEP IV refers):

   - Ensure that each of the draft Management Plans are consistent with the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas;
   - Ensure consistency of approach of management measures, as appropriate, across the Management Plans being reviewed;
   - Report back to CEP V on the results of the contact group's assessment and provide recommendations on how the CEP should proceed with respect to these Management Plans.

Intersessional Review Process.

3. The UK initiated the contact group by means of a circular email to all CEP contact points on 27 February 2002. Australia, Italy, New Zealand, Norway, The United, ASOC, IAATO, and IUCN responded to say that they wished to participate in the work of the group.

4. By the agreed deadline, Norway, the United States, and SCAR had submitted comments on the draft plans in accordance with the terms of reference. The plans were revised on the basis of the comments received. Comments supplied previously by Australia, Spain and Uruguay were also incorporated into the revised draft plans.

Key issues.

5. The following key issues arose during the intersessional review process:

   - Following the entry into force of Annex V to the Environmental Protocol on 24 May 2002, all SPAs and SSSIs automatically became ASPAs. The draft plans under review by this group have therefore been renamed and renumbered on the basis of Resolution V (1996);
   - Revised and updated maps have been prepared for the majority of the draft plans both to take account of the renaming and renumbering of sites as ASPAs, as well as the comments received from SCAR;
   - SCAR also suggested that geological maps should be prepared for Ablation Valley (ASPA 147) and Byers Peninsula (ASPA 126) as both sites are protected (in part) for their geological values. For Ablation Valley it should be noted that insufficient data are currently available to allow such a map to be prepared. However, a geological map for Byers Peninsula will be prepared in due course. However, it is suggested that the lack of this map should not prevent adoption of the Management Plan;
   - On the matter of consistency between plans two particular issues are worthy of note; i.e. overflight restrictions, and controls over poultry products.
     - In relation to the first of these, where overflight restrictions have been incorporated into the plans identical height / distance limits have been applied.
     - In relation to the latter, the UK recognises that at present there is no scientific evidence that Newcastle's disease has been or can be transferred from poultry products to Antarctic avifauna. Nevertheless, as a precautionary measure controls over the use of poultry products within sites protected in part for their avifauna have been included. However, for Avian Island (ASPA 117), a site protected solely for its large breeding bird colonies, poultry products have been prohibited entirely. However, such an approach may not be consistent with draft management plans for sites elsewhere in Antarctica. The CEP may therefore wish to take a common view on the appropriate standards to apply on his matter.

Summary.

6. The revised draft Protected Area Management Plans are attached to this Working Paper for the Committee's further consideration.
7. The intersessional contact group is satisfied that the plans have been appropriately revised and that they are consistent with the Guide to the Preparation of Management Plans. The contact group therefore recommends that the CEP forward these draft plans to the ATCM for adoption by means of the attached draft Measure (Appendix 1).

Appendix 1.

Draft Measure nn (2002)

Antarctic Protected Area System: Management Plans for Antarctic Specially Protected Areas

The Representatives,

Recalling Resolution 1 (1998) allocating responsibility among Consultative Parties for the revision of Management Plans for protected areas;

Noting that the draft Management Plans appended to this Measure have been endorsed by the Committee for Environmental Protection and the Scientific Committee on Antarctic Research (SCAR);

Recognising that these Areas support outstanding natural features and biota of scientific interest;

Recommend to their Governments the following Measure for approval in accordance with paragraph 1 of Article 6 of Annex V to the Protocol on Environmental Protection to the Antarctic Treaty:

That the Management Plans for the following sites:

- Antarctic Specially Protected Area No 107, Emperor Island, Dion Islands;
- Antarctic Specially Protected Area No 108, Green Island, Bertholot Islands;
- Antarctic Specially Protected Area No 117, Avian Island, Marguerite Bay;
- Antarctic Specially Protected Area No 126, Byers Peninsula, Livingston Island;
- Antarctic Specially Protected Area No 147, Ablation Valley – Ganymede Heights;
- Antarctic Specially Protected Area No 148, Mount Flora, Hope Bay;

and which are annexed to this Measure, be adopted.

Management Plan for
Antarctic Specially Protected Area No. 147
ABLATION VALLEY AND GANYMEDE HEIGHTS, ALEXANDER ISLAND

1. Description of values to be protected

Ablation Point – Ganymede Heights (latitude 70°48' S, longitude 68°30' W, approximately 180 km^2, Alexander Island, was originally designated in 1989 as Site of Special Scientific Interest (SSSI) No. 29 through Recommendation XV-6, after a proposal by the United Kingdom. Included was a largely ice-free region between latitudes 70°45' S and 70°55' S and from longitude 68°40' W to George VI Sound coastline. The Area comprised several valley systems separated by ridges and plateau of about 650-760 m high.

The original management plan (Recommendation XV-6) described the Area as "one of the largest ablation areas in West Antarctica…[with]…a complex geology, the main rock types being conglomerates, arkosic sandstones and shales with subordinate pebbly mudstones and sedimentary breccias. The base of the succession is formed of a spectacular mélange, including large blocks of lava and agglomerate. This outcrops on the valley floors and at the base of several cliffs. [The Area] possesses a wide range of geomorphological features including raised beaches, moraine systems and patterned ground. There are several permanently frozen freshwater lakes and many ice-free ponds supporting a diverse flora (including aquatic bryophytes) and fauna. The vegetation is generally sparse, with the unique moss and liverwort-dominated community type being restricted to 'oases' where water issues from otherwise dry barren hillsides. The terrestrial and freshwater ecosystems are vulnerable to human impact and therefore merit protection from uncontrolled human presence". In summary, the principal values of the Area were considered to be the geological, geomorphological, glaciological, limnological, and ecological features, and the associated outstanding scientific interest of one of the largest ice-free ablation area in West Antarctica.

The values noted in the original designation are reaffirmed and expanded in the present management plan. Further values evident from scientific descriptions of Ablation Valley – Ganymede Heights, are also considered important as reasons for special protection of the Area. These values are:

- The presence of exposures of the Fossil Bluff Formation, which is of prime geological importance because it is the only known area of unbroken exposure of rocks spanning the Jurassic – Cretaceous boundary in the Antarctic, which makes this a critical locality for understanding the change in floras and faunas at this temporal boundary;
- The presence of an exceptional and unique contiguous geomorphological record of glacier and ice-shelf fluctuations extending over several thousand years, together with an outstanding assemblage of other geomorphological features derived from glacial, periglacial, lacustrine, aeolian, alluvial and slope processes;
- Two perennially frozen freshwater lakes (Ablation and Moutonnée lakes) which have the unusual property of contact with the saline waters of George VI Sound;
- The presence of marine biota, including the fish *Trematomus bernacchii*, in Ablation Lake, where several seals have also been observed, despite the fact that it is almost 100 km from open sea;
- The Area has the greatest bryophyte diversity of any site at this latitude in Antarctica (at least 21 species); it also has a diverse lichen (>35 taxa), alga and cyanobacteria biota. Many of the bryophytes and lichens are at the southern limit of their know distributions. There are several species which are very rare in the Antarctic;
- Several mosses occur in lakes and ponds to depths of 9 m. Although these are all terrestrial species, they tolerate inundation for several months each year when their habitat floods. One species, *Campyliadelphus polygamus*, has adapted to an aquatic existence, and some permanently submerged colonies reach large dimensions, with shoots in excess of 30 cm length. These are the best examples of aquatic vegetation in the Antarctic Peninsula region;

- Several bryophyte species within the Area are fertile (producing sporophytes), and some of these are not known or very rare in this condition elsewhere in the Antarctic (e.g. the liverwort *Cephaloziella varians*, and mosses *Bryoerythrophyllum recurvirostrum*, *Distichium capillaceum*, *Schistidium* spp.);
- With the exception of one site on the northwestern coast, the Area has the most extensive stands of vegetation on Alexander Island. Many of these occur on seepage areas where the bryophyte and lichen communities cover up to 100 m^2 or more. In the sheltered seepage area assemblages of terricolous species develop communities not known elsewhere in Antarctica, while exposed rock ridges and stable boulder fields support a community of locally abundant lichens, usually dominated by *Usnea sphacelata*;
- Ablation Valley is comparatively rich in the number and abundance of microarthropod species for its locality this far south, with representation of the springtail *Friesia topo* which is thought to be endemic to Alexander Island. Ablation Valley is also the only site on Alexander Island where the predatory mite *Rhagidia gerlachei* has been described, making the food web more complex than other sites at this latitude.

The boundaries of the Area designated under Recommendation XV-6 have been changed, replacing the former rectangular-shaped boundary with one that is defined on the basis of prominent geographical features and the regional hydrological catchments.

2. Aims and objectives

Management at Ablation Valley – Ganymede Heights aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance and sampling in the Area;
- preserve the Area for its potential as a largely undisturbed reference site;
- allow scientific research in the Area consistent with the objectives of the management plan;
- minimise the possibility of introduction of alien plants, animals and microbes to the Area;
- allow visits for management purposes in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at General San Martín (Argentina) and at Rothera (UK) scientific stations in Marguerite Bay, where copies of this Management Plan shall be made freely available.
- Abandoned equipment or materials shall be removed to the maximum extent practcable.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Visits shall be made as necessary (preferably at least once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Ablation Valley – Ganymede Heights ASPA No. 147 location map. Inset: Location of Ablation Valley on the Antarctic Peninsula

Map 2: Ablation Valley – Ganymede Heights ASPA No. 147 topographic sketch map.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

Ablation Valley – Ganymede Heights (between latitudes 70°45' S and 70°55' S and longitudes 68°21' and 68°40' W, approximately 180 km^2, is situated on the east side of Alexander Island, the largest island off the western coast of Palmer Land, Antarctic Peninsula (Map 1). The Area has a central west–east extent of about 10 km and a north–south extent of about 18 km, flanked to the west by the upper part of Jupiter Glacier, to the east by the permanent ice shelf in George VI Sound, to the north by Grotto Glacier and to the south by the lower reaches of Jupiter Glacier. Ablation Valley – Ganymede Heights contains the largest contiguous ice-free area in the Antarctic Peninsula sector of Antarctica, with the smaller permanent ice fields and valley glaciers within the massif representing only about 17% of the Area. The topography of the region is mountainous, comprising steep-sided valleys separated by gently undulating plateau-like ridge crests lying generally between 650-750 m, rising to a maximum altitude of 1070 m (Clapperton and Sugden 1983). The region has been heavily glaciated, although the relatively flat-lying attitude of the sedimentary rocks and rapid weathering have contributed to a generally rounded form of topography, coupled with sheer cliff 'steps' of thickly-bedded sandstones and conglomerates (Taylor et al 1979).

The Area includes four principal ice-free valleys (Ablation, Moutonnée, Flatiron and Striation), the first three of which contain large ice-covered freshwater lakes (Heywood 1977, Convey and Smith 1997). The largest of these is the proglacial Ablation Lake (approximately 7 km^2), which has been impounded by shelf ice penetrating up-valley under pressure from the westward movement of the 100-500 m thick George VI Ice Shelf, the surface of which lies 30 m above sea level (Heywood 1977, Clapperton and Sugden 1982). Biologically, the terrestrial ecosystem is intermediate between the relatively mild maritime Antarctic farther north and the colder, drier continental Antarctic to the south. As a "dry valley" area it is extremely rich in biota and serves as a valuable contrast to the more extreme and biologically impoverished ablation areas on the Antarctic continent (Smith 1988). For a detailed description of the geology and biology of the Area see Annex 1.

BOUNDARIES

The designated Area comprises the entire Ablation Valley – Ganymede Heights massif, bounded in the west by the principal ridge dividing Jupiter Glacier from the main Ablation – Moutonnée – Flatiron valleys (Map 2). In the east, the boundary is defined by the western margin of George VI Ice Shelf. The northern boundary of the Area is defined as the principal ridge dividing Grotto Glacier from Erratic Valley and other tributary valleys feeding into Ablation Valley, immediately to the south. In the northwest of the Area, the boundary extends across the mostly-glaciated col separating upper Jupiter Glacier from Ablation Valley. The southern boundary of the Area, from east of the principal ridge on the west side of Flatiron Valley to where Jupiter Glacier joins George VI Ice Shelf, is defined as the northern lateral margin of Jupiter Glacier.

As the margin between Ablation Lake and George VI Ice Shelf is in places indistinct, the eastern boundary of the Area at Ablation Valley is defined as a straight line extending due south from the eastern extremity of Ablation Point to where the ice shelf abuts land, and from where the eastern boundary follows the land / ice shelf margin. The physiography is similar further south at Moutonnée Lake, and the eastern boundary in this locality is defined as a straight line extending from the eastern extremity of the point on the northern side of (and partially enclosing) Moutonnée Lake to the locality of a prominent meltwater pool where the ice shelf abuts land, and from where the boundary follows the land / ice shelf margin south to where Jupiter Glacier and George VI Ice Shelf adjoin. The Area thus includes the entirety of Ablation and Moutonnée lakes and those parts of the ice shelf behind which they are impounded.

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

There are no structures known to be present in the Area. A number of cairns have been installed as survey markers in throughout the Area (Perkins 1995, Harris 2001). Nine plastic bright red reflector markers (30 cm high, held down by rocks) have been placed to mark the airstrip in Moutonnée Valley. The nearest structure to the Area appears to be an abandoned caboose at Spartan Cwm, approximately 20 km south of the Area, although in 2001 the structure was reported to be buried by snow. A summer-only scientific camp facility exists at Fossil Bluff (UK), approximately 60 km to the south on the eastern coast of Alexander Island. The nearest permanently occupied scientific research stations are in Marguerite Bay (General San Martín (Argentina) and Rothera Research Station (UK)), approximately 350 km to the north (Map 1).

6(iv) Location of other protected areas within close proximity of the Area

There are no other protected areas within 300 km of the Area. The nearest protected area to Ablation Valley – Ganymede Heights is Lagotellerie Island, SPA No. 19, approximately 350 km north in Marguerite Bay (Map 1).

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued only for compelling scientific reasons that cannot be served elsewhere, or for essential management purposes consistent with plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the natural or scientific values of the Area;
- any proposed sampling will not take, displace, remove or damage such quantities of rock, soil, water, or native flora or fauna so that their distribution or abundance at Ablation Valley – Ganymede Heights is significantly affected;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with the Management Plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(i) Access to and movement within the Area

- Access to the Area shall be by aircraft, vehicle or on foot.
- Movement over land within the Area shall be on foot.
- Movement by vehicle within the Area shall be restricted to snow or ice surfaces.
- Movement by aircraft within the Area is subject to the restrictions described below.

There are no special restrictions on the points of access to the Area, nor on the overland or air routes used to move to and from the Area. However, access from George VI Ice Shelf may be difficult because of pressure ice, and some routes into the Area from the glaciers to the west are steep, crevassed and arduous.

- Landing of fixed-wing aircraft within the Area is restricted to the ice-covered lakes or to a single terrestrial site immediately west of Moutonnée Lake, provided landings are feasible.

Pressure deformation of the ice surface of lakes, meltwater and thinning ice-cover may make landing on lake ice impractical later in the summer. Landings at Ablation Lake and the terrestrial site were carried out in November 2000. The terrestrial landing site near Moutonnée Lake (Map 2) is oriented E–W and consists of approximately 350 m of gently sloping coarse gravel on a bench raised approximately 2 m above the surrounding valley. The gravel bench was mostly frozen in November 2000, and generally dry and well drained in February 2001 (some 50 m was moist and soft at the western end of the strip at that time). Red reflective markers at both ends mark the landing site and mid-way on the side, with some red-painted stones also marking the western (upper) end in the form of an arrow. Tyre-impressions are evident in the gravel. Should helicopter access prove feasible, specific landing sites have not been designated but landings are prohibited from within 200 m of lake shores, or within 100 m of any vegetated or moist ground, or in stream beds. Access is also possible by aircraft to upper Jupiter Glacier (550 m), immediately west of Ablation Valley and outside of the Area, from where access may be made into the Area overland on foot.

- Pilots, air crew, or other people on aircraft, are prohibited from moving on foot beyond the immediate vicinity of their landing site unless specifically authorised by Permit.
- Any visitors should move carefully so as to minimise disturbance to soil and vegetated surfaces. Avoid walking in stream or dry lake beds, or on moist ground, if practical, to avoid disturbance to the hydrology and / or damage to sensitive plant communities. Care should be taken even when moisture is not obviously present, as inconspicuous plants may still colonise the ground. Visitors should by preference and where practical walk on rocky or ice-covered terrain, and avoid sensitive geomorphological features such as dunes. Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise trampling effects.
- Diving in lakes within the Area is normally prohibited unless it is necessary for compelling scientific purposes. If diving is undertaken, great care should be taken to avoid disturbance of the water column and of sensitive sediments and biological communities. The sensitivity of the water column, sediments and biological communities to disruption by diving activities shall be taken into account before Permits are granted for these purposes.

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the ecosystem or scientific values of the Area, and which cannot be served elsewhere;
- Essential management activities, including monitoring.

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit and permanent structures or installations, other than the airstrip markers, are prohibited. All scientific equipment installed in the Area shall be approved by Permit and clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of contamination of the Area. Removal of specific equipment for which the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

When necessary for purposes specified in the Permit, temporary camping is allowed within the Area. One camp site has been designated within the Area: it is located on the north-western (upper) end of the airstrip in Moutonnée Valley (latitude 70°51'48" S, longitude 68°21'39" W) (Map 2). The site is not marked, although tents should be erected as close as practicable to the marker on the north-western end of the airstrip. This site should be used by preference when working in this vicinity. Other specific camp site locations have not, as yet, been designated, although camping is prohibited on sites where significant vegetation is present. Camps should be located as far as practicable (preferably at least 200 m) from lakeshores, and avoid dry lake or stream beds (which may host an inconspicuous biota). By preference and where practical, camps should be located on snow or ice surfaces. Previously existing campsites should be re-used where possible, except where the above guidelines suggest these were inappropriately located.

7(v) Restrictions on materials and organisms which can be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area and the precautions listed in 7(ix) below shall be taken against accidental introductions. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel is not to be stored in the Area, unless authorised by Permit for specific scientific or management purposes. All materials introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of any materials released and not removed that were not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

Killing of any seal within the Area is prohibited. Any other taking or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica* should be used as a minimum standard.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Material may be collected or removed from the Area only in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs. Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder or otherwise authorised, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, except human and domestic liquid wastes, shall be removed from the Area. Human and domestic liquid wastes may be disposed of within the Area down ice cracks along the margin of George VI Ice Shelf or Jupiter Glacier, or by burying in moraine along the ice margin in these localities as close as practical to the ice. Disposal of human and domestic liquid wastes in this manner shall be more than 200 m from, and avoiding the catchments of, the main lakes in Ablation, Moutonnée or Flatiron valleys, or shall otherwise be removed from the Area.

7(ix) Measures that are necessary to ensure that the aims and objectives of the Management Plan can continue to be met

1. Permits may be granted to enter the Area to carry out monitoring and site inspection activities, which may involve the small-scale collection of samples for analysis or review, or for protective measures.
2. Any specific long-term monitoring sites shall be appropriately marked.
3. To help maintain the ecological and scientific values derived from the relatively low level of recent human impact at Ablation Valley – Ganymede Heights, visitors shall take special precautions against introductions. Of concern are microbial, invertebrate or plant introductions derived from soils at other Antarctic sites, including stations, or from regions outside Antarctica. Visitors shall ensure that sampling equipment or markers brought into the Area are thoroughly cleaned or sterilised. To the maximum extent practicable, footwear and other equipment to be used in the Area shall be thoroughly cleaned beforehand.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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6(i) Additional information on the natural features of the Area.

CLIMATE

No extended meteorological records are available for the Ablation Valley – Ganymede Heights area, but the climate has been described as dominated by the dual influences of easterly-moving cyclonic depressions of the Southern Ocean, against the more continental, north to northwesterly, flow of cold anticyclonic air from the West Antarctic Ice Sheet (Clapperton and Sugden 1983). The former bring relatively mild weather, strong northerly winds and a heavy cloud cover to the region, whereas the latter induces clear, cold and stable conditions with temperatures below 0º C, and relatively light winds from the south. Based on data recorded nearby (25 km) in the early 1970s, the mean summer temperature was estimated as just below freezing point, with mean annual temperature estimated at about -9º C (Heywood 1977); precipitation was estimated at <200 mm of water equivalent per year, with little snow falling in summer. A thin snow cover is common after winter, but the region is generally snow-free by the end of the summer, apart from isolated snow patches that may persist in places.

GEOLOGY

The geology of Ablation Valley – Ganymede Heights is complex, but is dominated by well-stratified sedimentary rocks. The most prominent structural feature of the massif is a large asymmetrical anticline with a northwest–southeast orientation, extending from Grotto Glacier to Jupiter Glacier (Bell 1975, Crame and Howlett 1988). Thrust faults in the central part of the massif suggest vertical displacements of strata of up to 800 m (Crame and Howlett 1988).

The main lithologies are conglomerates, arkosic sandstones and fossiliferous shales, with subordinate pebbly mudstones and sedimentary breccias (Elliot 1974, Taylor *et al* 1979, Thomson 1979). A range of fossils have been found in the strata, which are of Upper Jurassic–Lower Cretaceous age, including bivalves, brachiopods, belemnites, ammonites, shark teeth and plants (Taylor *et al* 1979, Thomson 1979, Crame and Howlett 1988, Howlett 1989). Several interstratified lavas have been observed in the lowest exposures at Ablation Point (Bell 1975). The base of the succession is formed of a spectacular mélange, including large blocks of lava and agglomerate which crop out on the valley floors and at the base of several cliffs (see Bell 1975; Taylor *et al* 1979). The presence of exposures of the Fossil Bluff Formation is of prime geological importance because it is the only known area of unbroken exposure of rocks spanning the Jurassic – Cretaceous boundary in the Antarctic, which makes this a critical locality for understanding the change in floras and faunas at this temporal boundary.

GEOMORPHOLOGY AND SOILS

The entire area was at one time over-run by glacier ice from the interior of Alexander Island. Thus, landforms of both glacial erosion and deposition are widespread throughout the Area, providing evidence of a former general eastward flow of ice into George VI Sound (Clapperton and Sugden 1983). Misfit glaciers, striated bedrock, and erratics indicate considerable deglaciation since the Pleistocene glacial maximum (Taylor *et al* 1979). Numerous terminal moraines fronting present remnant glaciers, several unexpectedly talus-free sites, and polished and striated roches moutonnées indicate that glacial retreat may have been rapid (Taylor *et al* 1979). There is evidence that George VI Ice Shelf did not exist around 6500 yr B.P., which suggests that the Ablation Valley – Ganymede Heights massif is likely to have been largely free of permanent ice around that time, although there have been a number of subsequent glacier fluctuations in the region (Clapperton and Sugden 1982).

The landforms have been modified by periglacial, gravitational and fluvial processes. Bedrock on the upper plateau surfaces (where it has been largely scraped free of a till overburden) has been shattered by frost action into platy or blocky fragments (Clapperton and Sugden 1983). On valley slopes gelifluction

lobes and stone stripes and circles are common, while on valley floors stone circles and polygonal patterned ground are frequently found in glacial till and in fluvioglacial sediments subjected to frost action. Valley walls are also dominated by landforms derived from frost action, rock/ice-fall activity, and seasonal meltwater flows, which have led to ubiquitous talus slopes and, commonly, boulder fans below incised gullies. Mass wasting of fissile sedimentary rocks has also led to the development of steep (about 50º) horizontally rectilinear bedrock slopes thinly veneered with debris. Occasional aeolian landforms have been observed, with dunes of up to 1 m in height and 8 m in length as, for example, in Erratic Valley (Clapperton and Sugden 1983). 'Raised beaches' mentioned in the original management plan are not described in other literature (Clapperton and Sugden 1983): it is likely the reference is either to elevated moraines derived from a formerly more extensive George VI Ice Shelf, or perhaps to raised alluvial or lacustrine beaches. Thin layers of peat of up to 10-15 cm in depth are occasionally associated with vegetated areas, and these are the most substantial developments of soil within the Area.

FRESHWATER ECOLOGY

Ablation Valley – Ganymede Heights is an exceptional limnological site that contains a number of lakes, ponds and streams and a generally rich benthic flora. From late December until February running water develops from three main sources: precipitation, glaciers and from melting on George VI Ice Shelf, with run-off generally converging toward the coast (Clapperton and Sugden 1983). Most of the streams, which are up to several kilometres in length, drain glaciers or permanent snowfields. The principal streams drain into Ablation Lake and Moutonnée Lake, both dammed by the ice shelf. Surveys in the early 1970s recorded these lakes as frozen to 2.0–4.5 m depth year-round, with maximum water depths of around 117 m and 50 m respectively (Heywood 1977). A stable upper layer of fresh water, down to approximately 60 m and 30 m respectively, overlies increasingly saline waters influenced by interconnection with the ocean beneath the ice shelf and which subjects the lakes to tidal influence (Heywood 1977). Surface meltwater pools – which in summer form particularly in hollows between lake-ice pressure ridges – flood to higher levels daily and encroach up alluvial fans in the lower valleys (Clapperton and Sugden 1983). Some recent observations suggested a decrease in the permanent ice cover of the lakes, for example with about 25% of Moutonnée Lake being free of ice cover in the 1994–95 and 1997–98 summers (Convey and Smith 1997, Convey pers comm 1999). However, all three of the main lakes in the Area showed almost complete ice cover in early February 2001 (Harris 2001).

Numerous ephemeral, commonly elongated, pools and ponds form laterally along the land / ice shelf margin, varying in length from 10 to 1500 m and up to 200 m wide, with depths ranging from 1 to 6 m (Heywood 1977, Clapperton and Sugden 1983). These pools / ponds often rise in level over the melt period, yet on occasion may drain suddenly via sub-ice fissures opening into the ice shelf, leaving former lake shorelines evident in surrounding moraines. The pools / ponds vary widely in their turbidity depending on the presence of suspended glacial sediment. The pools are typically ice-free in summer, while the larger ponds often retain a partial ice cover, and all but the deeper ponds probably freeze solid in winter (Heywood 1977).

Numerous ponds of up to 1 ha and 15 m in depth are present within the valleys, some with moss growth covering extensive areas down to 9 m in depth (Light and Heywood 1975). The dominant species described were *Campylidelphus polygamus* (=*Campylium polygamum*) and *Dicranella*, stems of which reached 30 cm in length. *Bryum pseudotriquetrum* (and possibly a second *Bryum* species), *Distichium capillaceum*, and an unidentified species of *Dicranella* all grew on the benthic substratum at or below 1 m in depth (Smith 1988). Moss cover was 40-80% in the 0.5-5.0 m depth zone (Light and Heywood 1975). Much of the remaining area was covered by dense cyanobacterial felts (11 taxa) up to 10 cm thick, dominated by species of *Calothrix*, *Nostoc* and *Phormidium* together with 36 taxa of associated microalgae (Smith 1988). The extensive growths of moss suggest that these ponds are probably relatively permanent, although their levels may fluctuate from year to year. The water temperature reaches 7ºC in the deeper ponds and 15ºC in the shallower pools in summer, offering a relatively favourable and stable environment for bryophytes. The shallower pools, in which several mosses have been found, may normally be occupied by terrestrial vegetation and flooded for short periods during summer (Smith 1988).

Algae are abundant in slow-moving streams and ephemeral melt runnels, although they do not colonise the unstable beds of fast-flowing streams. For example, large wet areas of level ground in Moutonnée Valley have particularly rich floras, in places forming over 90% cover, with five species of desmid (which are rare in Antarctica) and the filamentous green *Zygnema* being abundant, and *Nostoc* sp. and *Phormidium* spp. colonising drier, less stable and silted areas (Heywood 1977).

Protozoa, Rotifera, Tardigrada and Nematoda form a benthic fauna in the pools, ponds and streams, and probably occur in the lakes although none has thus far been caught (Heywood 1977). Densities are generally highest in the slow-moving streams. The copepod *Boeckella poppei* was abundant in lakes, ponds and pools, but absent from streams. The marine fish *Trematomus bernacchii* was captured in traps laid in Ablation Lake at a depth of 70 m, within the saline water layer (Heywood and Light 1975, Heywood 1977). A seal (species unidentified, but probably crabeater (*Lobodon carcinophagus*) or Weddell (*Leptonychotes weddellii*)) was reported at the edge of Ablation Lake in mid-December 1996 (Rossaak 1997), and isolated sightings of solitary seals have also been reported in earlier seasons. The fish and seals may be part of a marine ecosystem present beneath the adjacent ice shelf that is capable of travel to the open sea, or may represent isolated vestigial populations confined to the Ablation Point region following the relatively recent re-formation of George VI Ice Shelf (Clapperton and Sugden 1982). If the latter, then the populations may have special genetic significance because of their extended isolation. However, the seals may be capable of travel to the sea overland on George VI Ice Shelf. Further research is required to explain these observations.

VEGETATION

Much of the Ablation Valley – Ganymede Heights area is arid, and overall vegetation abundance is low with a discontinuous distribution. However, complex plant communities exist in seepage areas and along stream margins, which are of particular interest because:

a) they occur in an otherwise almost barren landscape;

b) the mixed bryophyte and lichen communities are the best-developed and most diverse of any south of 70ºS (Smith 1988);

c) some bryophyte taxa are profusely fertile and fruiting at their southern limit – an unusual phenomenon in most Antarctic bryophytes, especially so far south;

d) the region represents the southernmost known locality for many taxa; and

e) although some of these communities also occur at other sites on southeastern Alexander Island, the Area contains the best and most extensive examples known at this latitude.

The diversity of mosses is particularly high for this latitude, with at least 21 species recorded within the Area, which represents 73% of those known to occur on Alexander Island, and half of all those occurring on the Antarctic Peninsula (Smith 1997). The lichen flora is also diverse with more than 35 taxa known. Of the macrolichen flora, 12 of the 15 species known to occur on Alexander Island are represented within the Area, which is about one third of the 35 species described on the Antarctic Peninsula as a whole (Smith 1997). Moutonnée and Striation valleys, and the SE coastal area, contain the most extensive stands of both terrestrial and freshwater vegetation (Smith 1998, Harris 2001).

Smith (1988, 1997) reported the bryophyte vegetation is generally found in patches of about 10 to 50 m^2, with some stands up to 625 m^2, occurring from around 5 m to 40 m altitude on the north- and east-facing gentle slopes of the main valleys. More recently, Harris (2001) recorded large stands of near-continuous bryophyte vegetation of up to approximately 8000 m^2 on gentle SE-facing slopes on the south-eastern coast of the Area, at an elevation of approximately 10 m, close to where the Jupiter Glacier joins George VI Ice Shelf. A continuous stand of approximately 1600 m^2 was recorded on moist slopes in lower Striation Valley. Several large patches of continuous moss (of up to 1000 m^2) were observed on SW/NW-facing eastern slopes of Flatiron Valley, at elevations of 300-400 m. Small discontinuous patches of moss were recorded in this vicinity up to an elevation of 540 m. Mosses were observed on peaks above Ablation Valley at elevations of up to approximately 700 m. Samples are being analysed to identify species.

The dominant bryophyte in the wettest areas is frequently the liverwort *Cephaloziella varians* (= *C. exiliflora*), which forms a blackish mat of densely interwoven shoots. Although the most southerly record of *C. varians* has been reported at 77ºS from Botany Bay (SSSI No. 37) in Victoria Land, the extensive mats it forms in the Ablation Valley – Ganymede Heights massif represent the most substantial stands of this species this far south. Cyanobacteria, notably *Nostoc sp.*, are usually associated either on the surface of the liverwort or soil, or with moss shoots. Beyond the wettest areas, undulating carpets of pleurocarpous mosses dominated by *Campyliadelphus polygamus* forms the greenest stands of vegetation, with associated *Hypnum revolutum.* These carpets overlie up to 10-15 cm of peat composed of largely undecomposed moribund moss shoots. Intermixed with these mosses, but often predominating on the drier margins, *Bryum pseudotriquetrum* grows as isolated cushions that may coalesce to develop a convoluted turf. In these drier, peripheral areas, several other turf-forming bryophytes are often associated with *Bryum.* Besides the more hydric species already cited, these include the calcicolous taxa *Bryoerythrophyllum recurvirostrum, Didymodon gelidus, Distichium capillaceum, Encalypta rhaptocarpa* (=*E. patagonica*), *E. procera, Pohlia cruda, Schistidium antarcticum, S. fragilis, Syntrichia princeps* (=*Tortula princeps*), *Tortella alpicola,* and several unidentified species of *Bryum* and *Schistidium*.

A significant characteristic of the vegetation in the Ablation Valley – Ganymede Heights massif is the unusual occurrence of a number of fertile bryophytes. Antarctic bryophytes seldom produce sporophytes, yet *Bryum pseudotriquetrum, Distichium capillaceum, Encalypta rhaptocarpa, E. procera* and *Schistidium* spp. have all been recorded in the Area as frequently fertile. Most unusually, small quantities of the moss *Bryoerythrophyllum recurvirostre* and the liverwort *Cephaloziella varians* have been observed fruiting in Ablation Valley, which was the first time this had been recorded anywhere in Antarctica (Smith pers comm., cited in Convey 1995; Smith 1997); in addition, *D. capillaceum* has never before been recorded with sporophytes throughout the maritime Antarctic (Smith 1988). *E. procera* has only been reported as fertile in one other Antarctic location (on Signy Island, South Orkney Islands: Smith 1988).

Beyond the permanent seepage areas, bryophyte vegetation is extremely sparse and restricted to habitats where there is free water for at least a few weeks during the summer. Such sites occur sporadically on the valley floors, stone stripes on slopes, and also in crevices in north-facing rock faces. Most of the species occurring in the bryophyte patches have also been observed in these habitats, including lichens, most frequently in the shelter of, or even in crevices beneath, larger stones – especially at the margins of patterned ground features. At elevations of over 100 m aridity increases, and at higher altitudes only *Schistidium antarctici* (at 500 m in MoutonnéeValley) and *Tortella fragilis* (near the summit of the highest peak south-west of Ablation Valley (775 m) have been recorded.

In these drier habitats lichens tend to become more frequent, especially where the substratum is stable. Lichens are widespread and locally abundant on the more stable screes, ridges, and plateaux above the valleys, the most predominant species being *Usnea sphacelata (=U. sulphurea*), giving rock surfaces a black hue. This species is often associated with *Pseudephebe minuscula*, several crustose lichen species and, rarely, *Umbilicaria decussata* reaching the highest part of the massif; all but the latter species are also common in Moutonnée Valley. Epiphytic and terricolous lichens, predominantly the white encrusting species *Leproloma cacominum*, are often frequent where the marginal bryophyte surface is driest. Other genera such as *Cladonia galindezii, C. pocillum* and several crustose lichens are also sometimes present. Various lichens colonise the dry soil and pebbles in these localities, occasionally spreading onto cushions of moss. These include *Candelariella vitellina, Physcia caesia, Physconia muscigena*, occasional *Rhizoplaca melanophthalma, Usnea antarctica, Xanthoria elegans*, and several unidentified crustose taxa (especially species of *Buellia* and *Lecidea*). An abundance of *Physcia* and *Xanthoria* in isolated places suggests nitrogen enrichment deriving from south polar skuas (*Catharacta maccormicki*). A few ornithocoprophilous lichens occur on occasional boulders used as bird perches.

Many of the bryophytes and lichens are at the southern limit of their know distributions and several species are very rare in the Antarctic. Rare moss species within the Area include *Bryoerythrophyllum recurvirostrum, Campylium polygamum, Encalypta rhaptocarpa, Tortella alpicola*, and *Tortella fragilis*. Several *Bryum* species, *Encalypta* rhaptocarpa, Schistidium *occultum* and *Schistidium chrysoneurum* are all at the southern limit recorded for these species. Of the lichen flora, Ablation Valley is the only known site where *Eiglera flavida* has been observed in the S. Hemisphere, and *Mycobilimbia lobulata* and *Stereocaulon antarcticum* are also rare. Lichen species with furthest-south records are *Cladonia galindezii*,

Cladonia pocillum, *Ochrolechia frigida*, *Phaeorrhiza nimbosa*, *Physconia muscigena*, and *Stereocaulon antarcticum*.

INVERTEBRATES, FUNGI, BACTERIA

The microinvertebrate fauna thus far described is based on ten samples from Ablation Valley, and comprises seven confirmed taxa (Convey and Smith 1997): two Collembola (*Cryptopygus badasa*, *Friesea topo*); one cryptostigmatid mite (*Magellozetes antarcticus*); and four prostigmatid mites (*Eupodes parvus*, *Nanorchestes nivalis* (= *N. gressitti*), *Rhagidia gerlachei* and *Stereotydeus villosus*). A number of specimens collected were earlier reported as *Friesea grisea*, a widespread maritime Antarctic species. However, specimens of *Friesia* collected subsequently from Alexander Island (i.e. from 1994 onwards) have been described as a distinct new species, *F. topo* (Greenslade 1995), which is itself currently thought to be endemic to Alexander Island. The earlier specimens from Ablation Valley have been re-examined, with all those that remain identifiable being reassigned as *F. topo*.

While the same number of species has been described at one other site on Alexander Island, the samples from Ablation Valley exhibited a mean total microarthropod population density about seven times greater than other sites in the region. Diversity at Ablation Valley was also greater than at several other documented sites on Alexander Island. Both diversity and abundance are considerably less than has been described at sites in Marguerite Bay and further north (Starý and Block 1998, Convey et al 1996, Convey and Smith 1997, Smith 1996). The most populous species recorded in Ablation Valley was *Cryptopygus badasa* (96.6% of all arthropods extracted), which was particularly common in moss habitats. *Friesea topo* was found on stones at low population densities and was virtually absent from the moss habitat, showing these species to have distinct habitat preferences. Ablation Valley is the only site on Alexander Island where the predatory mite *R. gerlachei* has been described. Very little research has been conducted on fungi in the Area, and the only publication available reported an unidentified nematode-trapping fungus present in a pond in Ablation Valley (Maslen 1982). While further sampling is required to describe the terrestrial microfauna more fully, available data support the biological importance of the Area.

BREEDING BIRDS

The avifauna of Ablation Valley – Ganymede Heights has not been described in detail. A few pairs of south polar skuas (*Catharacta maccormicki*) have been reported as nesting close to some of the moist vegetated sites (Smith 1988). Snow petrels have been noted as “probably breeding” in the vicinity of Ablation Point (Croxall *et al* 1995, referring to Fuchs and Adie 1949). No other bird species has been recorded in the Ablation Valley – Ganymede Heights massif.

HUMAN ACTIVITIES / IMPACTS

Human activity at Ablation Valley – Ganymede Heights has been exclusively related to science. The first visit to the Ablation Valley area was by members of the British Graham Land Expedition in 1936, who collected about 100 fossil specimens from near Ablation Point (Howlett 1988). The next visits were about a decade later, when basic geological descriptions and further fossil collections were undertaken. More intensive palaeontological investigations were made by British geologists in the 1960s through to the 1980s, with detailed studies of the geomorphology (Clapperton and Sugden 1983). Limnological investigations were undertaken in the 1970s, with a number of expeditions examining the terrestrial biology being initiated in the 1980s and 1990s. All known expeditions into the Area have been by British scientists. The impacts of these activities have not been fully described, but are believed to be minor and limited to footprints, aircraft tracks at the Moutonnée Valley terrestrial airstrip (see Section 7.1), removal of small quantities of geological and biological samples, markers, abandoned items such as supplies and scientific equipment, and the remains of human wastes.

In February 2001 an abandoned depot remained on the moraine bench adjacent to George VI Ice Shelf, approximately 500 m north of Moutonnée Lake. The depot consists of a number of fuel and oil

containers, an old food box, poles, disintegrating cardboard and string. Various expeditions in the 1970s-80s placed empty fuel drums as route markers through pressure ice from George VI Sound into Ablation Valley, and a large onshore rock is painted yellow SE of Ablation Lake (McAra 1984, Hodgson 2001). Nearby is a large cross made from red painted rocks and cairns, with a wooden marker board in the centre.

Evidence of campsites close to the shore of Ablation Lake remained in 2000-01 (Harris 2001, Hodgson 2001). One site is on the SW shore near a rich area of vegetation, and another is approximately four kilometres east on the SE shore. At both sites circles of stones mark old tent sites, and circular structures have been built with low (0.8 m) stone walls. At the former site a number pieces of wood (including old markers), an old food box, string and human wastes were observed (Harris 2001, Hodgson 2001). Several red-painted rocks were found around the southern and western shores of Ablation Lake in February 2001, and paint fragments were sometimes observed in sediments. In 2000-01 some of the abandoned materials in Ablation Valley were removed: three fuel drums on lake ice, the old food box and some wood and string on the SW shore, and numerous fragments from broken perspex acryllic cloches on the SW shore (nine were deployed in January 1993 – Wynn-Williams 1993, Rossaak 1997 – all were destroyed by wind) (Harris 2001, Hodgson 2001). The painted rocks and other materials remain.

Snowmobiles have been used on lake and glacier ice, and modified snowmobiles with front wheels were used over gravel terrain in a limited vicinity of the SW shore of Ablation Lake in 1983–84 (McAra 1984). Some evidence of erosional paths forming on steep scree slopes, presumably a result of field work, was recorded in Moutonnée Valley (Howlett 1988). Cairns have been built on a number of mountain summits and to mark a number of survey sites throughout the Area.

Management Plan for
Antarctic Specially Protected Area No. 117
AVIAN ISLAND, MARGUERITE BAY, ANTARCTIC PENINSULA

1. Description of values to be protected

Avian Island (Latitude 67°46' S, Longitude 68°54' W, 0.49 km^2), is situated in northwestern Marguerite Bay, 400 m south of Adelaide Island on the western side of the central Antarctic Peninsula. It was originally designated as Site of Special Scientific Interest (SSSI) No. 30 under Recommendation XV-6 in 1989 after a proposal by the United Kingdom. Included was the island together with its littoral zone, but excluded was a small area near a refuge on the northwestern coast of the island. Values protected under the original designation were described as the abundance and diversity of breeding seabirds present on the island, that the southern giant petrel (*Macronectes giganteus*) colony is one of the most southerly known breeding population of this species, and that the blue-eyed cormorants (*Phalacrocorax atriceps*) are breeding close to the southern limit of their range. The Area was therefore considered of outstanding ornithological importance, meriting protection from unnecessary human disturbance.

Designation as an SSSI was terminated with redesignation of Avian Island as a Specially Protected Area (SPA) through Recommendation XVI-4 (1990, SPA No. 21) after a proposal by the United Kingdom. The boundaries were similar to the original SSSI, but included the entire island and the littoral zone without the exclusion zone near the refuge on the northwestern coast. The values protected were the same as for the SSSI, but with attention drawn to the additional important values of:

- "35,600 pairs of Adélie penguins (*Pygoscelis adeliae*), which is the largest Adélie colony on the Antarctic Peninsula, containing a third of the total breeding population of the region";
- "670 pairs of blue-eyed cormorants, which are close to the southern limit of their breeding range, and one of the largest known breeding colonies in the Antarctic, representing approximately 85% of the total population breeding south of the Antarctic Circle".

While the size of the Avian Island Adélie penguin colony on the Antarctic Peninsula is not substantiated by recent data, this colony and those of several other resident species are nonetheless some of the largest in the region, and the values noted in the original SSSI and subsequent SPA designations are generally reaffirmed in the present management plan. Further values evident from scientific descriptions of Avian Island are also considered important as reasons for special protection of the Area. These values are:

- the outstanding and unique attribute of being the only known site on the Antarctic Peninsula where seven seabird species are breeding in such close proximity to each other within the confined space of a single, small island, with unusually high population densities and virtually the whole island occupied by breeding birds throughout the summer;
- Representation of seven of the seabird species breeding along the Antarctic Peninsula;
- the southern giant petrel colony is one of the two largest on the Antarctic Peninsula, comprising about one-fifth of the population south of the South Shetland Islands, and these birds are extremely vulnerable to disturbance;
- the kelp gull (*Larus dominicanus*) colony is also large and is breeding near the southern extent of its range;

- the southernmost record of breeding brown skuas (*Catharacta loennbergi*) in the Antarctic Peninsula region was noted on Avian Island in 1978-79;
- the moss *Warnstorfia laculosa* (=*Calliergidium austro-stramineum*) on Avian Island is at the southern limit of its known range.

The boundaries of the Area designated under Recommendation XVI-4 have been changed in this management plan to include offshore islets and rocks previously excluded.

2. Aims and objectives

Management at Avian Island aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- allow scientific research on the ecosystem and physical environment, particularly on the avifauna, provided it is for compelling reasons which cannot be served elsewhere;
- minimise the risk of introduction of pathogens which may cause disease in bird or mammal populations within the Area;
- minimise the possibility of introduction of alien plants, animals and microbes to the Area;
- gather data on the population status of the seabirds on the island on a regular basis, preferably for all resident breeding species at least once every five years;
- allow visits for management purposes in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at the stations Teniente Luis Carvajal (Chile), Rothera (UK) and General San Martín (Argentina), where copies of this management plan shall also be made available.
- Signs showing the location and boundaries of the Area with clear statements of entry restrictions shall be placed in prominent positions on the northwestern and eastern coasts of the island (Map 2), to help avoid inadvertent entry.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition or removed.
- Visits shall be made as necessary (no less than once every five years) to assess whether the Area continues to serve the purposes for which it was designated, and in particular to conduct bird censuses, and to ensure management and maintenance measures are adequate.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Avian Island, ASPA No. 117, in relation to Marguerite Bay, showing the locations of the stations Teniente Luis Carvajal (Chile), Rothera (UK) and General San Martín (Argentina). The location of other protected areas within Marguerite Bay (ASPA No. 107 at Emperor Island (Dion Islands), ASPA No. 115 at Lagotellerie Island, and ASPA No. 129 at Rothera Point) are also shown. Inset: the location of Avian Island on the Antarctic Peninsula.

Map 2: Avian Island, ASPA No. 117, topographic map. Map specifications – Projection: Lambert Conformal Conic; Standard parallels: 1st 67° 30' 00" S; 2nd 68° 00' 00"S; Central Meridian: 68° 55' 00" W; Latitude of Origin: 68° 00' 00" S; Spheroid: WGS84; Datum: Mean sea level; Vertical contour interval 5 m; Horizontal accuracy: ± 5 m; vertical accuracy ±1.5 m.

Map 3: Avian Island, ASPA No. 117, distribution of breeding wildlife. Map derived from ground survey and digital orthophotography (ground pixel resolution 25 cm; source aerial photography taken 15 December 1998 by the British Antarctic Survey). Adélie penguin (*Pygoscelis adeliae*) and elephant seal (*Mirounga leonina*) distributions are digitised from the orthophotograph. Nests of other species are derived from a sketch map and ground survey conducted in 1978 (Poncet 1982), with positions approximate. Note: data on distributions for other breeding species are unavailable. Map specifications are the same as for Map 2.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

Avian Island (Latitude 67°46' S, Longitude 68°54' W, 0.49 km^2), is situated in the northwest of Marguerite Bay, 400 m south of the southwestern extremity of Adelaide Island (Map 1). The island is 1.45 km long by 0.8 km at its widest, and is of roughly triangular shape. It is rocky with a low relief of generally less than 10 m in the north, rising to about 30 m at the centre, and 40 m in the south where several rock and ice slopes of up to 30 m drop steeply to the sea. The coastline is irregular and rocky with numerous offshore islets, although there are several accessible beaches on the northern and eastern coasts. The island is usually ice-free in summer. It contains habitat particularly suitable for a variety of breeding birds: well-drained north-facing slopes suitable for blue-eyed cormorants (*Phalacrocorax atriceps*); broken rock and boulders with crevices suitable for small nesting birds such as Wilson's storm petrels (*Oceanites oceanicus*); elevated rocky heights suitable for southern giant petrels (*Macronectes giganteus*); extensive expanses of snow-free ground for Adélie penguins (*Pygoscelis adeliae*). The presence of the latter attracts skuas (*Catharacta maccormicki* and *C. loennbergi*) and kelp gulls (*Larus dominicanus*). For a detailed description of the geology and biology of the Area see Annex 1.

BOUNDARIES

The designated Area comprises the whole of Avian Island and the littoral zone, offshore islets and rocks, and a buffer zone of the surrounding marine environment (including sea ice when present) within 100 m of the shoreline of the main island (Map 2). Boundary markers have not been installed because the coast forms a visually obvious reference for the marine boundary.

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

Two small abandoned refuges and two beacon structures are present within the Area. A refuge erected by Chile in 1962 is located on the northwestern coast of the island at latitude 67°46'16" S, longitude 68°54'00" W. A refuge constructed by Argentina in 1957 is 650 m SE of this position, on the eastern coast at latitude 67°46'39" S, longitude 68°53'35" W. Both refuges were in a poor state of repair in February 2001. Further deterioration of the huts has potential to impact on nesting birds.

An old iron frame structure, believed to have been erected by the UK during the operation of Adelaide Base and used as a navigational aid, is located at approximately 38 m near the highest point of the island. The structure remains standing, although is rusting.

A new beacon was constructed by Chile in February 1998 on an adjacent site at a similar elevation. This structure is a solid cylindrical painted iron tower of approximately 2 m diameter and 2.5 m in height, set in a concrete pad of approximately 2.5 x 2.5 m. A lit beacon, protective rails and solar panels are affixed to the top of the structure. No other structures are known to exist on the island.

Four survey control markers were installed on the island on 31 January 1999 (Map 2). The southernmost marker is located adjacent to the navigation beacon and consists of a survey nail in bedrock covered by a cairn. A similar marker is installed on the high point of the low ridge on the northeastern coast of the island, also covered by a cairn. The remaining two markers are survey nails affixed to the roof of each of the refuges. Two signs marking the Area shall be installed in prominent positions on the northwestern and eastern coasts of the island.

The nearest scientific research station is 1.2 km northwest at Teniente Luis Carvajal (Chile), on southern Adelaide Island (latitude 67°46' S, longitude 68°55' W). Since 1982 this has been operated as a summer-only facility, open from October until March. Over this period the station has generally accommodated up to 10 personnel. Formerly, this facility was established and operated continuously by the UK from 1961 until 1977.

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Avian Island are the Dion Islands (ASPA No. 107) about 12.5 km SSE, Rothera Point (ASPA No. 129) 40 km to the NE, and Lagotellerie Island (ASPA No. 115) 65 km east (Map 1).

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued only for compelling scientific reasons that cannot be served elsewhere, in particular for scientific study of the avifauna and ecosystem of the Area, or for essential management purposes consistent with plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the values of the Area;
- any management activities are in support of the objectives of the management plan;
- the actions permitted are in accordance with the management plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(i) Access to and movement within the Area

- Vehicles are prohibited on land within the Area. All movement on land within the Area shall be on foot. Movement within the Area on foot shall be by routes that minimise any disturbance to breeding birds, and to achieve this it may be necessary to take a longer route to the destination than would otherwise be the case. A preferred walking route, which avoids the most sensitive bird breeding sites, should be used when traversing across the central part of the island where movement in this area is necessary (Map 2). The designated route extends from the central eastern coast up the eastern slopes of the hill (Map 2). Visitors should bear in mind that specific nest sites may vary from year to year, and some variations on the recommended route may be preferable: the route is intended as a guide, and visitors are expected to exercise good judgement to minimise the effects of their presence. In other areas, and where practical and safe, it is usually preferable to adopt a route that follows the coastline of the Area.
- Access into areas where southern giant petrels are nesting (Map 3) shall only be undertaken for purposes specified in the Permit. When access to the beacon is necessary (eg. for maintenance), visitors shall follow the designated access route as closely as possible, trying to avoid nesting birds. Much of the area leading up to and surrounding the beacon is occupied by breeding petrels, so great care must be exercised.
- Movements should be slow, noise kept to a minimum, and the maximum distance practicable should be maintained from nesting birds.
- Visitors shall watch carefully for signs of agitation and preferably retreat from approach if significant disturbance is observed.
- Small boat landings should be made at the designated locations on the central northwestern coast or on the central eastern coast of the island (Map 2). If sea or ice conditions render this impractical, small boat landings may be made elsewhere along the coast as conditions allow.
- Access by vehicle to the coast when sea ice is present should also use these access points, and vehicles shall be parked at the shore.
- Travel by small boat or vehicle within the marine part of the Area is not confined to specific routes, but shall be by the shortest route consistent with the objectives and requirements of the permitted activities. Vehicle or boat crew, or other people on vehicles or boats, are prohibited

from moving on foot beyond the immediate vicinity of the landing site unless specifically authorised by Permit.

- Aircraft should avoid landing within the Area throughout the year. Restrictions on overflight also apply (see Table 2 below). A Permit may be granted for helicopter use when this is considered necessary for essential purposes and where there is no practical alternative, such as for the installation, maintenance or removal of structures. In such instances the need for helicopter access, including alternatives, and the potential disturbance to breeding birds shall be adequately assessed before a Permit may be granted. Such a Permit shall clearly define the conditions for helicopter access based on the findings of the assessment.

Table 2: Aircraft overflight restrictions applying year-round at Avian Island.

Aircraft type	Number of engines	Minimum approach distance (m)			
		Vertical (above ground)		Horizontal	
		Feet	**Metres**	***Feet***	**Metres**
Helicopter	1	*2460*	750	*2460*	750
Helicopter	2	*3300*	1000	*3300*	1000
Fixed-wing	1 or 2	*1480*	450	*1480*	450
Fixed-wing	4	*3300*	1000	*3300*	1000

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the avifauna or ecosystem of the Area, and which is for compelling reasons that cannot be served elsewhere;
- Essential management activities, including monitoring;

Restrictions on times at which activities may be conducted apply within the Area, and are specified in the relevant sections of this management plan.

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit. Any new or additional permanent structures are prohibited. Existing abandoned or dilapidated structures should be removed or renovated. Small temporary hides, blinds or screens may be constructed for the purpose of scientific study of the avifauna. Before a Permit may be granted for the installation, modification or removal of structures, an adequate environmental impact assessment shall be undertaken. Installation, modification, maintenance or removal of structures shall be undertaken in a manner that minimises disturbance to breeding birds. Such activities shall be undertaken between 1 February and 30 September inclusive to avoid the main breeding season. All structures, scientific equipment, hides or markers installed within the Area must be approved by Permit for a specified period, clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of harm to bird populations or of contamination of the Area. Removal of specific equipment, hides or markers for which the period specified in the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

Camping should be avoided within the Area. However, when necessary for purposes specified in the Permit, temporary camping is allowed at two designated campsites: one on the central eastern coast of the island, the other on the central northwestern coast of the Area (Map 2).

7(v) Restrictions on materials and organisms that can be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area and the precautions listed in 7(ix) below shall be taken to prevent accidental introductions. In view of the presence of significant breeding bird colonies on the island, poultry products, including products containing uncooked dried eggs, are prohibited within the Area. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel is not to be stored in the Area, unless specifically authorised by Permit for specific scientific or management purposes. Refuelling of aircraft or vehicles is prohibited on land within the Area. Anything introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of any introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of anything released and not removed that was not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

Taking or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica* should be used as a minimum standard.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Material may be collected or removed from the Area only in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs. Permits shall not be granted if there is a reasonable concern that the sampling proposed would take, remove or damage such quantities of soil, native flora or fauna that their distribution or abundance on Avian Island would be significantly affected. Samples of flora or fauna found dead within the Area may be removed for analysis or audit without prior authorisation by Permit. Material of recent human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder, or is not otherwise authorised, shall be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, except human wastes, shall be removed from the Area. Human wastes shall be removed from the Area or disposed of into the sea.

7(ix) Measures that are necessary to ensure that the aims and objectives of the Management Plan can continue to be met

4. Permits may be granted to enter the Area to carry out monitoring and site inspection activities, which may involve the small-scale collection of samples for analysis or review, or for protective measures.
5. Any specific long-term monitoring sites shall be appropriately marked.
6. To help maintain the ecological and scientific values found at Avian Island visitors shall take special precautions against introductions. Of concern are pathogenic, microbial or plant introductions sourced from other Antarctic sites, including stations, or from regions outside Antarctica. Visitors shall ensure that sampling equipment or markers brought into the Area are cleaned or sterilised. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including backpacks, carry-bags and tents) shall be thoroughly cleaned before entering the Area.
7. Poultry products and other introduced avian products, which may be a vector of avian diseases, are prohibited within the Area.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the management plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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6(i) Additional information on the natural features of the Area.

CLIMATE AND SEA ICE

No extended meteorological records are available for Avian Island, but records from 1962-74 for Adelaide Base (formerly UK; now Teniente Luis Carvajal, Chile), 1.2 km distant, show a mean daily maximum temperature of 3ºC in February (extreme maximum 9ºC) and a mean daily minimum of -8ºC in August (extreme minimum -44ºC). The same general pattern was observed in year-round observations made on the island in 1978-79 (Poncet and Poncet 1979). Precipitation on the island in this year was usually as snow, most of which fell between August and October, but with occasional snowfalls and some rain in the summer.

Marguerite Bay usually freezes in winter, although the extent and character of sea ice shows considerable inter-seasonal variation. Occasionally Marguerite Bay may not clear of ice completely until February or March, at which time the sea may again begin to freeze. Despite the extent and frequent persistence of regional sea ice, a recurrent polynya has been observed near Avian Island, which can provide locally ice-free conditions from October onward. In addition, strong tidal currents around Avian Island help to keep surrounding waters ice-free for much of the year, which facilitates easy access to feeding grounds for several species. The island is not particularly windy, with an annual average of 10 knots in 1978-79. However, the strong katabatic winds that descend from Adelaide Island, perhaps for 1-3 days a few times every month, reduce snow accumulation on the island and push sea ice away from the coast, helping to form the polynya. The relatively snow-free conditions are important for bird colonisation.

GEOLOGY, GEOMORPHOLOGY AND SOILS

The bedrock of Avian Island forms the eastern limb of a NNE – SSW trending synclinal structure at the southwestern end of Adelaide Island and is composed of interbedded lithic-rich and feldspar-rich volcaniclastic sandstones. Bedded tuffaceaous sandstones, pebbly sandstones rich in volcanic lithics, and a volcanic granule breccia also occur. The latter is probably a primary volcanic deposit, while the rest of the sequence is largely composed of reworked volcanic material. The sequence forms part of the Antarctic Peninsula Volcanic Group and is of Jurassic to early Tertiary age (Griffiths 1992, Moyes *et al* 1994). Apart from rock outcrop, the surface consists mainly of frost-shattered rock with permafrost. Ornithogenic soils are widespread, particularly in the north; organic peat soil is virtually absent, but where present is not well-developed and is associated with moss growth. Several raised beaches have been noted on Avian Island, but the geomorphology has not otherwise been described.

STREAMS AND LAKES

Avian Island has several ephemeral freshwater ponds of up to 10,000 m^2 and of about 40 cm in depth, the largest being on the eastern coast, at about 5 m altitude, and on the north-western coast near sea level. Numerous small pools and meltwater channels develop from seasonal snow melt, and small streams drain valleys in the vicinity of the ponds. Both the ponds and melt-pools freeze solid in winter. Freshwater bodies on the island are organically enriched by guano, a source

of nutrients, and in summer a number of the ponds show a rich benthic flora and fauna of algae, phyllopods, copepods, Nematoda, Protozoa, Rotifera, and Tardigrada. Large numbers of the crustacean *Branchinecta* sp. have also been observed (Poncet and Poncet 1979). The freshwater ecology of the island has not been studied in detail.

BREEDING BIRDS

Seven species of birds breed on Avian Island, which is a relatively high number compared to other sites on the Antarctic Peninsula. Several species have unusually high populations, being some of the largest for their species in the Antarctic Peninsula region (Map 3). Detailed year-round data for all species were collected in 1978-79 (Poncet and Poncet 1979), while data are otherwise sporadic. Descriptions below are thus often based on a single season's observations and it should be emphasised that these data are therefore not necessarily representative of longer term population trends. However, this is the best information that is presently available.

The most recent data available for Adélie penguins (*Pygoscelis adeliae*) on Avian Island indicated a population of 35,600 breeding pairs (11/11/78) (Poncet and Poncet 1979, Woehler 1993). The colony occupies the northern half and central eastern coast of the island (Map 3). The former management plan referred to the Avian Island colony as "the largest on the Antarctic Peninsula [containing] a third of the total population breeding in the region". While this is not substantiated by recent data (e.g. one Antarctic Peninsula colony has over 120,000 pairs and several others have over 30,000 (Woehler 1993)), the Avian Island colony represents one of the largest breeding populations in this region. It contains perhaps as much as 9% of the total Adélie breeding population along the Antarctic Peninsula, excluding the South Shetland Islands.

In 1978-79 Adélie penguins were recorded on the island from October until the end of April, with egg laying occurring through October and November, and the first chicks hatching around mid-December. Chick créches were observed around mid-January, with the first chicks becoming independent near the end of January. Most of the moulting adults and independent chicks had departed the island by the third week of February, although groups returned periodically throughout March and April.

A large colony of blue-eyed cormorants (*Phalacrocorax atriceps*) has been recorded in three groups located on the south-western coastal extremity of the island (Map 3). Stonehouse (1949) reported about 300 birds present in October 1948; a similar number were recorded in mid-November 1968, most of which were breeding (Willey 1969). Poncet and Poncet (1979) observed 320 pairs in 1978, and approximately 670 pairs on 17 January 1989 (Poncet 1990). A count on 23 February 2001 recorded 185 chicks, although it is probable some had departed by the time of the count; approximately 250 nest sites were counted. In 1968 blue-eyed cormorants were observed present on the island from 12 August, with egg laying occurring from November, and chicks hatching in December (Willey 1969). In 1978-79 they were observed from September until June, with egg laying occurring from November through to January, when the first chicks hatched, and chicks started to become independent in the third week of February (Poncet and Poncet 1979) .

Of the thirteen southern giant petrel (*Macronectes giganteus*) colonies known south of the South Shetland Islands, Avian Island is one of the two largest, and comprises about one fifth of the breeding population in the southern Antarctic Peninsula region (Patterson *et al* in press). In 1979 the southern giant petrels occupied principally the elevated rocky outcrops of the central and

southern half of the island in four main groups (Map 3). Data on the numbers of birds present on the island are shown in Table 1.

Table 1: Southern giant petrel (*Macronectes giganteus)* numbers at Avian Island.

Year	Number of birds	Number of pairs	Number of chicks	Source
1948	~100	n/a	n/a	Stonehouse 1949
1965	n/a	160	n/a	Patterson *et al* 2000 (?)
1968	400	163	n/a	Willey 1969
1979	n/a	197	n/a	Poncet and Poncet 1979
1989	n/a	250	n/a	Poncet 1990
2001	n/a	n/a	237	Harris 2001

n/a - not available.

In 1978-79 the birds were present on Avian Island from mid-September through to as late as June. In this season, egg laying occurred from late October through to the end of November, with hatching occurring throughout January and chicks generally achieving independence by April. In the 1978-79 austral summer up to 100 non-breeders were observed on the island during the courtship period in October, with these numbers decreasing to a few non-breeders as the season progressed.

Approximately 200 adult Kelp gulls (*Larus dominicanus*), of which over 60 pairs were breeding, were recorded on Avian Island in 1978-79. These birds were distributed widely, but principally in the elevated central and southern parts of the island (Poncet and Poncet 1979) (Map 3). In the 1978-79 austral summer the majority of breeders arrived in early October, followed by egg laying around mid-November and hatching a month later. Detailed data are not available because of concern that human disturbance by data collection would seriously impair the breeding performance of this species. However, no more than 12 chicks were observed on the island near the end of January 1979, which would suggest breeding performance in this season was low: the exact cause – whether human disturbance or natural factors – could not be determined. In 1967, 19 pairs and 80-120 birds were recorded (Barlow 1968).

An estimate of at least several hundred pairs of breeding Wilson's storm petrels (*Oceanites oceanicus*) on the island was made in 1978-79 (Poncet and Poncet 1979). Wilson's storm petrels were observed on the island from the second week of November, with laying and incubation probably occurring through to mid-December. Departure of adults and independent chicks was largely complete by the end of March. Most of the rocky outcrops on the northern half of the island and all of the stable rocky slopes in the south are ideal habitat for this species.

In 1978-79 about 25-30 pairs of south polar skuas (*Catharacta maccormicki*) were breeding on Avian Island. The skua nests were distributed widely over the island, although the majority were on the central and eastern part of the island, especially on slopes overlooking the Adélie penguin colony (Map 3). Large groups of non-breeders (around 150 birds; Poncet and Poncet 1979) were observed to congregate around the shallow lake on the eastern side of the island. Barlow (1968) reported approximately 200 non-breeding birds in 1968. In the 1978-79 austral

summer the south polar skuas took up residence around the end of October, with egg laying in early December and hatching complete by the end of January. Independent chicks and adults generally departed by the end of March, with some late-breeders remaining until mid-April. A breeding success of one chick per nest was reported in the 1978-79 austral summer. Barlow (1968) reported 12 breeding pairs of brown (=subantarctic) skuas (*Catharacta loennbergi*), although this number could include south polar skuas. One breeding pair of brown skuas was recorded on the southwest of the island in the 1978-79 austral summer. This is the southernmost record of this species breeding along the Antarctic Peninsula. Several non-breeding brown skuas were also recorded in the same season.

Several other bird species, known to breed elsewhere in Marguerite Bay, are frequent visitors to Avian Island, notably Antarctic terns (*Sterna vittata*), snow petrels (*Pagodroma nivea*), and southern fulmars (*Fulmarus glacialoides*). These species have not been observed to nest on Avian Island. Small numbers of Antarctic petrels (*Thalassoica antarctica*) have been seen on a few occasions. The cape petrel (*Daption capense*) was observed on Avian Island in October 1948 (Stonehouse 1949). Solitary individuals of king (*Aptenodytes patagonicus*) and chinstrap (*Pygoscelis antarctica*) penguins were observed in 1975 and 1989, respectively.

TERRESTRIAL BIOLOGY

Vegetation on Avian Island is generally sparse, and the flora has not been described in detail. Phanerogams are absent from the island and there is a limited range of cryptogams, although there is a rich lichen flora. To date, nine moss and 11 lichen species have been identified within the Area.

Mosses described are *Andreaea depressinervis*, *Brachythecium austro-salebrosum*, *Bryum argenteum*, *B. pseudotriquetrum*, *Pohlia cruda*, *P. nutans*, *Sanionia uncinata* (=*Drepanocladus uncinatus*), *Syntrichia princeps* (=*Tortula princeps*) and *Warnstorfia laculosa* (=*Calliergidium austro-stramineum*). The latter species is at the southern limit of its known range on Avian Island (Smith 1996). Moss development is confined to those parts of the island that are unoccupied by breeding Adélie penguins or blue-eyed cormorants, and occurs in moist depressions or by melt pools. Patches of moss of up to 100 m^2 surround the shore of a small pond on the hill in the south of the Area, at ca. 30 m elevation. The green foliose alga *Prasiola crispa* is widespread in wet areas of the island.

Lichens identified on Avian Island are *Acarospora macrocyclos*, *Cladonia fimbriata*, *C. gracilis*, *Dermatocarpon antarcticum*, *Lecanora dancoensis*, *Lecidea brabantica*, *Physcia caesia*, *Rinodina egentissima*, *Siphulina orphnina*, *Thamnolecania brialmontii*, and *Usnea antarctica*. The most extensive communities are on the rocky outcrops in the south of the island.

The microinvertebrate fauna, fungi and bacteria on Avian Island have yet to be investigated in detail. Thus far only one mesostigmatid mite (*Gamasellus racovitzai*) (BAS Invertebrate Database 1999) has been described, although a Collembollan (springtail) and several species of Acari (mites) have been observed but not identified (Poncet 1990). A number of nematode species (dominated by *Plectus* sp.) (Spaull 1973) and one fungus (*Thyronectria hyperantarctica*) (BAS Invertebrate Database 1999) have been recorded on the island.

BREEDING MAMMALS AND MARINE ENVIRONMENT

Weddell seals (*Leptonychotes weddellii*) were common on and around Avian Island in 1978-79. During the winter more than a dozen remained, hauled out on coastal ice (Poncet 1990). Several pups were born on the shores of the island in the last week of September 1978. An elephant seal (*Mirounga leonina*) was reported pupping on the northeastern coast of Avian Island on 10 October 1969 (Bramwell 1969). Aerial photography taken on 15 December 1998 revealed 182 elephant seals hauled out in groups, mostly close to the ponds. Leopard seals (*Hydrurga leptonyx*) have been observed around the shoreline, and one was observed ashore in winter 1978. A number of non-breeding Antarctic fur seals (*Arctocephalus gazella*) were reported on the island in March 1997 (Gray and Fox 1997), and again at the end of January 1999 (Fox pers comm 1999). At least several hundred were present on 23 February 2001 (Harris 2001), particularly on beaches and low-lying ground in the central and northern parts of the island. Crabeater seals (*Lobodon carcinophagus*) are regularly seen in Marguerite Bay, but have not been reported on Avian Island. The marine environment surrounding Avian Island has not been investigated.

HUMAN ACTIVITIES / IMPACTS

Human activity at Avian Island has been sporadic. The first record of a visit was made in October 1948, when members of the UK Stonington Island expedition discovered the large Adélie penguin colony on Avian Island (then referred to as one of the Henkes Islands). Subsequent visits have comprised a mixture of science, base personnel recreation, tourism and logistic activity (survey etc.). Refuges were constructed on the island in 1957 and 1962 by Argentina and Chile respectively (see Section 6(iii)).

A geological field party of two camped for about 10 days on the southeast of the island in November 1968 (Elliott 1969). In the same year, a UK Naval hydrographic survey team camped on the eastern coast of Avian Island over the summer. Permanent chains and rings for mooring lines to the survey vessel were installed in a small bay on the northwestern coast, and were still present in 1989 (Poncet 1990).

In 1969, a field party camped on the island for a month conducting research on the common cold virus: accompanying dogs were inoculated with a virus and then returned to base (Bramwell 1969). Dogs often accompanied personnel on the regular visits to Avian Island during the period of operation of the UK base on Adelaide Island, but impacts are unknown.

A two-person party spent a year on the island in 1978-79, based on the yacht *Damien II*, making detailed observations of the avifauna and other aspects of the biology and natural environment of the island (Poncet and Poncet 1979, Poncet 1982, Poncet 1990). The yacht was moored in a small cove on the NW coast. This yacht party regularly visited the island over the next decade before SPA designation.

Map survey work and aerial photography was conducted on and over the island in 1996-98 (Fox and Gray 1997, Gray and Fox 1997), and 1998-99 (Fox pers. comm.1999).

The impacts of these activities have not been described and are not known, but are believed to have been relatively minor and limited to transient disturbance to breeding birds, campsites, footprints, occasional litter, human wastes, scientific sampling and markers. Despite the likely transient nature of most disturbance, it has been reported that human visits have caused loss of

eggs and chicks, either through nest abandonment or by opportunistic predation. Several species, such as southern giant petrels and kelp gulls are particularly vulnerable to disturbance, and have been observed to abandon nests at particular periods of the nesting cycle, perhaps at the sight of people as much as 100 m distant (Poncet 1990). Approximately 140 people, including a tour vessel of 100, were reported to have visited Avian Island in the 1989-90 summer. Growing concern over the number and unregulated nature of visits prompted SPA designation.

The most lasting and visually obvious impacts are associated with the two refuges and beacon structures described in Section 6(iii), which are situated close to breeding birds. Both refuges were in poor repair in February 2001, with rubbish such as rusting cans, glass, wood, roofing iron and empty fuel drums nearby. Birds and seals were observed among this rubbish in February 2001. The older of the two beacon structures is disused and its iron structure, while standing, is rusting and deteriorating. The new beacon, erected in February 1998, was in good repair in February 2001.

Management Plan for
Antarctic Specially Protected Area No. 126
BYERS PENINSULA, LIVINGSTON ISLAND, SOUTH SHETLAND ISLANDS

1. Description of values to be protected

Byers Peninsula (latitude 62°34'35" S, longitude 61°13'07" W, 60.6 km^2), Livingston Island, South Shetland Islands, was originally designated as Specially Protected Area (SPA) No. 10 through Recommendation IV-10 in 1966. This area included the ice-free ground west of the western margin of the permanent ice sheet on Livingston Island, below Rotch Dome, as well as Window Island about 500 m off the northwest coast and five small ice-free areas on the south coast immediately to the east of Byers Peninsula. Values protected under the original designation included the diversity of plant and animal life, many invertebrates, a substantial population of southern elephant seals (*Mirounga leonina*), small colonies of Antarctic fur seals (*Arctocephalus gazella*), and the outstanding scientific interest associated with such a large variety of plants and animals within a relatively small area.

Designation as an SPA was terminated through Recommendation VIII-2 and redesignation as a Site of Special Scientific Interest (SSSI) was made through Recommendation VIII-4 (1975, SSSI No. 6). The new designation as an SSSI more specifically sought to protect three smaller ice-free sites on the peninsula of Jurassic and Cretaceous sedimentary and fossiliferous strata, considered of outstanding scientific value for study of the former link between Antarctica and other southern continents. Following a proposal by the Chile and United Kingdom, the SSSI was subsequently extended through Recommendation XVI-5 (1991) to include boundaries similar to those of the original SPA: i.e. the entire ice-free ground of Byers Peninsula west of the margin of the permanent Livingston Island ice sheet, including the littoral zone, but excluding Window Island and the five southern coastal sites originally included, as well as excluding all offshore islets and rocks. Recommendation XVI-5 noted that in addition to the special geological value, the Area was also of considerable biological and archaeological importance. Biological values noted were:

- Sparse but diverse flora of calcicolous and calcifuge plants and cyanobacteria associated with the lavas and basalts respectively;
- Particularly well-developed vegetation on basaltic plugs;
- Several rare cryptogams and two native vascular plants (*Deschampsia antarctica* and *Colobanthus quitensis*) occur at several sites;
- Coastal and inland lakes, the latter with a particularly important biota, including aquatic mosses, and serving as breeding sites for the midge *Parochlus steinenii*, the only native winged insect in the Antarctic and which has exceptionally restricted distribution;
- The only other Antarctic dipteran, the wingless midge *Belgica antarctica*, occurs with restricted distribution in stands of moist moss near Cerro Negro.

In addition, the archaeological values were described as unique in possessing the greatest concentration of historical sites in Antarctica, namely the remains of refuges, together with contemporary artifacts, and shipwrecks of early nineteenth century sealing expeditions.

The values recorded in the original management plans, are reaffirmed in the present management plan. Further values not referred to originally, but evident from scientific descriptions of Byers Peninsula, are also considered important as reasons for special protection of the Area. These values are:

- well-preserved sub-fossil whale bones are present in raised beaches, which are important for radiocarbon dating of beach deposits;
- the described terrestrial flora and fauna is of exceptional diversity, with one of the broadest representations of species known in the maritime Antarctic;
- with over 60 lakes, numerous freshwater pools and a great variety of often extensive streams, it is the most significant limnological site in the South Shetland Islands – and perhaps the Antarctica Peninsula region – and also one which has not been subjected to significant levels of human disturbance;
- the lakes and their sediments constitute one of the most important archives for study of the Holocene palaeoenvironment in the Antarctic Peninsula region, as well as for establishing a regional Holocene tephrachronology;
- *Parochlus steinenii* is of limited distribution in the South Shetland Islands, and *Belgica antarctica* has a very restricted distribution on the Antarctic Peninsula, but both species are abundant at several of the lakes and pools on Byers Peninsula;
- unusually thick (3-10 cm) and extensive cyanobacterial mats of *Phormidium* sp., particularly on the upper levels of the central Byers Peninsula plateau, are the best examples so far described in the maritime Antarctic;
- the breeding avifauna within the Area is diverse, including two species of penguin (chinstrap *Pygoscelis antarctica* and gentoo *P. papua*), Antarctic tern (*Sterna vittata*), Wilson's storm petrels (*Oceanites oceanicus*), cape petrels (*Daption capense*), kelp gulls (*Larus dominicanus*), southern giant petrels (*Macronectes giganteus*), black-bellied storm petrels (*Fregetta tropica*), blue-eyed cormorants (*Phalacrocorax atriceps*), brown skuas (*Catharacta loennbergi*), and sheathbills (*Chionis alba*).

While the particular status of designation and boundaries have changed from time to time, Byers Peninsula has in effect been under special protection for most of the modern era of scientific activity in the region. Recent activities within the Area have been almost exclusively for scientific research. Most visits and sampling within the Area, since original designation in 1966, have been subject to Permit conditions.

2. Aims and objectives

Management at Byers Peninsula aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance;
- allow scientific research on the ecosystem and geology;
- allow other scientific research within the Area provided it is for compelling reasons which cannot be served elsewhere;
- allow archaeological research and measures for artefact protection, while protecting historic artefacts present within the Area from unnecessary destruction, disturbance, or removal;

- minimise the possibility of introduction of alien plants, animals and microbes to the Area;
- allow visits for management purposes in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at Base Juan Carlos I (Spain) and St. Kliment Ochridski Station (Bulgaria) on Hurd Peninsula, where copies of this management plan shall be made available;
- Markers, signs, fences or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition;
- Visits shall be made as necessary (preferably no less than once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Byers Peninsula ASPA No. 126 in relation to the South Shetland Islands, showing the location of Base Juan Carlos I (Spain) and St. Kliment Ochridski Station (Bulgaria), and showing the location of protected areas within 75 km of the Area. Inset: the location of Livingston Island along the Antarctica Peninsula.

Map 2: Byers Peninsula ASPA No. 126 topographic map. Topographic information simplified after SGE *et al* (1993). Map specifications: Projection UTM Zone 20; Spheroid: WGS84; Datum: Mean Sea Level. Horizontal accuracy of control: ±0.05 m. Vertical contour interval 25 m, vertical accuracy unknown but expected to be better than ±12.5 m.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

Byers Peninsula (between latitudes 62°34'35" and 62°40'35" S and longitudes 60°54'14" and 61°13'07" W, 60.6 km^2) is situated at the west end of Livingston Island, the second-largest of the South Shetland Islands (Map 1). The peninsula has a central west-east extent of about 9 km and a NW-SE extent of 18.2 km, and is the largest ice-free area in the South Shetland Islands. The peninsula is generally of low, gently rolling relief, although there are a number of prominent hills ranging in altitude between 80 – 265 m (Map 2). The interior is dominated by a series of extensive platforms at altitudes of up to 105 m, interrupted by isolated volcanic plugs such as Chester Cone (188 m) and Cerro Negro (143 m) (Thomson and López-Martínez 1996). There is an abundance of rounded, flat landforms resulting from marine, glacial and periglacial erosional processes. The most rugged terrain occurs on Ray Promontory, a ridge forming the northwest-trending axis of the

roughly 'Y'-shaped peninsula. Precipitous cliffs surround the coastline at the northern end of Ray Promontory with Start Hill (265 m) at the NW extremity being the highest point on the peninsula.

The coast of Byers Peninsula has a total length of 71 km (Map 2). Although of generally low relief, the coast is irregular and often rugged, with numerous headlands, cliffs, offshore islets, rocks and shoals. Byers Peninsula is also notable for its broad beaches, prominent features on all three coasts (Robbery Beaches in the north, President Beaches in the west, and South Beaches). The South Beaches are the most extensive; extending 12 km along the coast and up to almost 0.9 km in width, these are the largest in the South Shetland Islands (Thomson and López-Martínez 1996). For a detailed description of the geology and biology of the Area see Annex 1.

BOUNDARIES

The boundaries of the Area designated under Recommendation XVI-5 have been changed in this management plan. The Area now includes two islets several hundred metres SW of Devils Point and a small area of ice-free ground at Clark Nunatak in the SE corner as these sites also support values consistent with the remainder of the Peninsula. The Area is now defined to include the whole of Byers Peninsula west of the permanent ice sheet of Rotch Dome, Livingston Island, above the low tide water level, including the two islets adjacent to Devils Point noted above, but excluding all other offshore islets and rocks (Map 2).

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

Besides the sealers refuges, there are no structures known to be present in the Area. Several cairns marking sites used for topographical survey are present within the Area. The nearest scientific research stations are 30 km east at Hurd Peninsula, Livingston Island (Base Juan Carlos I (Spain) and St Kliment Ochridski (Bulgaria)).

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Byers Peninsula are: Cape Shirreff, ASPA No. 149, which lies about 20 km to the northeast; Port Foster and other parts of Deception Island, ASPAs No. 140 and No. 145 respectively, which are approximately 40 km SSE; and 'Chile Bay' (Discovery Bay), ASPA No. 144, which is about 70 km to the east at Greenwich Island (Map 1).

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued only for scientific study of the ecosystem, geology or archaeology of the Area, or for compelling scientific reasons that cannot be served elsewhere; or
- it is issued for essential management purposes consistent with plan objectives such as inspection, maintenance or review;

- the actions permitted will not jeopardise the ecological, geological, historical or scientific values of the Area;
- the sampling proposed will not take, remove or damage such quantities of soil, rock, native flora or fauna that their distribution or abundance on Byers Peninsula would be significantly affected;
- any management activities are in support of the objectives of the management plan;
- the actions permitted are in accordance with the management plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(i) Access to and movement within the Area

- Vehicles are prohibited within the Area and access shall be by small boat or by helicopter.
- There are no special restrictions on landings from the sea, or that apply to the sea routes used to move to and from the Area.
- During the period 1 October – 30 April inclusive, aircraft should avoid landing within 500 m of the coast (Map 2). Within this zone the overflight guidelines, specified in Table 1 (below), should be followed to the maximum extent practicable in order to protect the numerous birds and seals concentrated along the coast.
- Helicopters may land elsewhere within the Area when necessary for purposes consistent with the objectives of the Plan, although landings should, where practicable, be made on ridge and raised beach crests.
- Helicopters should avoid sites where there are concentrations of birds or well-developed vegetation. When conditions require aircraft to fly at lower elevations than recommended in the guidelines, aircraft should maintain the maximum elevation possible and minimise the time taken to transit the coastal zone.
- Use of helicopter smoke grenades is prohibited within the Area unless absolutely necessary for safety. If used all smoke grenades should be retrieved.
- Subject to the guidelines in Table 1, movement within the Area shall be on foot or by helicopter.
- Pilots, air or boat crew, or other people on aircraft or boats, are prohibited from moving on foot beyond the immediate vicinity of their landing site unless specifically authorised by Permit.
- All movement should be undertaken carefully so as to minimise disturbance to animals, soils, geomorphological features and vegetated surfaces, walking on rocky terrain or ridges if practical to avoid damage to sensitive plants, patterned ground and the often waterlogged soils.
- Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise trampling effects.

Table 1: Aircraft overflight guidelines applying 1 October – 30 April inclusive within a 500 m coastal zone at Byers Peninsula.

Aircraft type	Number of engines	Minimum approach distance (m) Vertical (above ground) *Feet*	Metres
Helicopter	1	*2460*	750
Helicopter	2	*3300*	1000
Fixed-wing	1 or 2	*1480*	450
Fixed-wing	4	*3300*	1000

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the ecosystem of the Area;
- Essential management activities, including monitoring;
- Specific guidelines on times and locations at which aircraft may operate within the Area apply, specified in Section 7 (i) of this Management Plan.

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit. Permanent structures are prohibited. All structures or scientific equipment installed in the Area shall be approved by Permit for a specified period and clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of contamination to the Area. Removal of specific equipment for which the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

When necessary for purposes specified in the Permit, temporary camping is allowed within the Area. Specific camp site locations have not been designated, although camps should be located on non-vegetated sites, such as on the drier parts of the raised beaches, or on thick (>0.5 m) snow-cover when practicable, and should avoid concentrations of breeding birds or mammals. It is prohibited to camp within 50 m of any historic sealer's refuge or shelter.

7(v) Restrictions on materials and organisms which can be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area and the precautions listed in 7(ix)(3) below shall be taken against accidental introductions. In view of the presence of breeding bird colonies on Byers Peninsula, no poultry products, including products containing uncooked dried eggs, including wastes from such products, shall be released into the Area or into the adjacent sea. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was

granted. Fuel is not to be stored in the Area, unless specifically authorised by Permit for specific scientific or management purposes. Anything introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of any introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of anything released and not removed that was not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

Taking or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica* should be used as a minimum standard.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Collection or removal of anything not brought into the Area by the Permit holder shall only be in accordance with a Permit and should be limited to the minimum necessary to meet scientific, archaeological or management needs. Anything of recent human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit holder, or is not an historic artefact or otherwise authorised, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area. Human wastes may be disposed of into the sea.

7(ix) Measures that are necessary to ensure that the aims and objectives of the management plan can continue to be met

8. Permits may be granted to enter the Area to carry out monitoring and site inspection activities, which may involve the small-scale collection of samples for analysis or review, or for protective measures.
9. Any specific long-term monitoring sites shall be appropriately marked.
10. To help maintain the ecological and scientific values derived from the relatively low level of recent human impact at Byers Peninsula special precautions shall be taken against introductions. Of concern are microbial or plant introductions sourced from other Antarctic sites, including stations, or from regions outside Antarctica. All sampling equipment or markers brought into the Area shall be cleaned or sterilised. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including backpacks, carry-bags and tents) shall be thoroughly cleaned before entering the Area.

11. Poultry products and other introduced avian products, which may be a vector of avian diseases, shall not be released into the Area.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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6(i) Geographical coordinates, boundary markers and natural features

CLIMATE

No extended meteorological records are available for Byers Peninsula, but the climate is expected to be similar to that at Base Juan Carlos I, Hurd Peninsula. Conditions there indicate a mean annual temperature of below 0º C, with temperatures >0º C for at least several months each summer, and a relatively high precipitation rate estimated at about 800 mm/yr, much of which falls as rain in summer (Ellis-Evans 1996). The peninsula is snow-covered for much of the year, but is usually completely snow-free by the end of the summer. The peninsula is exposed to weather from the Drake Passage in the north and northwest, the directions from which winds prevail, and Bransfield Strait to the south.

GEOLOGY

The bedrock of Byers Peninsula is composed of Upper Jurassic to Lower Cretaceous marine sedimentary, volcanic and volcaniclastic rocks, intruded by igneous bodies (see Smellie *et al* 1980; Crame *et al* 1993, Hathway and Lomas 1998) (Map 3 – IN PREP). The rocks represent part of a Mesozoic-Cenozoic magmatic arc complex, which is exposed throughout the whole of the Antarctic Peninsula region, although most extensively on the Byers Peninsula (Hathway and Lomas 1998). The interior, elevated, region of the eastern half of the peninsula – surrounded to the north and south by Holocene beach deposits – is dominated by Lower Cretaceous non-marine tuffs, volcanic breccias, conglomerates, sandstones and minor mudstones, with intrusions in several places by volcanic plugs and sills. The western half of the peninsula, and extending NW half-way along Ray Promontory, is predominantly Upper Jurassic-Lower Cretaceous marine mudstones, with sandstones and conglomerates, with frequent intrusions of volcanic sills, plugs and other igneous bodies. The NW half of Ray Promontory comprises mainly volcanic breccias of the same age. Mudstones, sandstones, conglomerates and pyroclastic rocks are the most common lithologies found on the peninsula. Expanses of Holocene beach gravels and alluvium are found in coastal areas, particularly on South Beaches and the eastern half of Robbery Beaches, with less-extensive deposits on President Beaches.

The Area is of high geological value because "the sedimentary and igneous rocks exposed at Byers Peninsula constitute the most complete record of the Jurassic-Early Cretaceous period in the northern part of the Pacific flank of the magmatic arc complex, and they have proved a key succession for the study of marine molluscan faunas (e.g. Crame 1984, 1995, Crame and Kelly 1995) and non-marine floras (e.g. Hernandez and Azcárte 1971, Philippe *et al* 1995)." (Hathway and Lomas 1998).

GEOMORPHOLOGY AND SOILS

Much of the terrain consists of lithosols, essentially a layer of shattered rock, with permafrost widespread below an active layer of 30-70 cm depth (Thom 1978, Ellis-Evans 1996, Serrano *et al* 1996). Stone fields (consisting of silty fines with dispersed boulders and surficial clasts), gelifluction lobes, polygonal ground (both in flooded and dry areas), stone stripes and circles, and other periglacial landforms dominate the surface morphology of the upper platforms where bedrock outcrop is absent (Serrano at al 1996). Debris- and mud-flows are observed in several localities. Beneath some of the moss and grass communities there is a 10-20 cm deep

layer of organic matter although, because vegetation is sparse over most of Byers Peninsula, there are no deep accumulations of peat (Bonner and Smith 1985). Ornithogenic soils are present especially in the Devils Point vicinity and on a number of knolls along President Beaches (Ellis-Evans 1996).

Parts of the interior of the peninsula have been shaped by coastal processes, with a series of raised beaches ranging from 3 to 54 m in altitude, some of which are over 1 km wide. A radiocarbon date for the highest beach deposits suggests that Byers Peninsula was largely free of permanent ice by 9700 yr B.P., while the lowest beach deposits are dated at 300 yr B.P (John and Sugden 1971, Sugden and John 1973). Lake sediment analyses, however, suggest a more recent general deglaciation of central Byers Peninsula of around 4000-5000 yr B.P., and radiocarbon dates in the locality need to be interpreted cautiously (Björck *et al* 1991a, b). In several places sub-fossil whalebones are embedded in the raised beaches, occasionally as almost entire skeletons. Radiocarbon dates of skeletal material from about 10 m a.s.l. on South Beaches suggest an age of between 2000 and 2400 yr B.P. (Hansom 1979). Pre-Holocene surfaces of Byers Peninsula exhibit clear evidence of a glacial landscape, despite the gentle landforms. Today only three small residual glaciers (comprising less then 0.5 km^2) remain on Ray Promontory. The pre-existing, glacially modified, landforms have been subsequently overprinted by fluvial and periglacial processes, and moraines and other glacial deposits are scarce (Martinez de Pison *et al* 1996).

STREAMS AND LAKES

Byers Peninsula is perhaps the most significant limnological site in the South Shetland Islands / Antarctica Peninsula region, with over 60 lakes, numerous freshwater pools (differentiated from lakes in that they freeze to the bottom in winter), and a dense and varied stream network probably has the most stream types in the Maritime Antarctic. The gentle terrain favours water retention and waterlogged soils are common in the summer. However, the water capacity of the thin soils is limited, and many of the channels are frequently dry, with flow often intermittent except during periods of substantial snow melt or where they drain glaciers (Lopez-Martinez *et al* 1996). Most of the streams drain seasonal snowfields and are often no more than 5-10 cm in depth (Ellis-Evans 1996). The larger streams are up to 4.5 km in length, up to 20 m in width, and 30-50 cm in depth in the lower reaches during periods of flow. Streams that drain to the west often have sizeable gorges (Lopez-Martinez *et al* 1996), and gullies up to 30 m in depth have been cut into the uppermost, and largest, of the raised marine platforms (Ellis-Evans 1996). Above the Holocene raised beaches the valleys are gentle, with widths of up to several hundred metres.

Lakes are especially abundant on the higher platforms (i.e. at the heads of basins) and on the Holocene raised beaches near the coast. Midge Lake is the largest at 587x112 m, and deepest with a maximum depth of 9.0 m (Map 2). The inland lakes are all nutrient-poor and highly transparent, with extensive sediments in deeper water overlain by cyanobacterial mats. In some lakes, notably Chester Cone Lake about 500 m to the south of Midge Lake (Map 2), stands of aquatic moss *Drepanocladus longifolius*(= *D. aduncus*) are found growing at one to several metres in depth. Large masses of this moss are sometimes washed up along parts of the shoreline and may serve as an opportunistic habitat for *Parochlus* larvae (Bonner and Smith 1985).

The lakes are generally frozen to a depth of 1.0-1.5 m for 9-11 months of the year, overlain by snow, although surfaces of some of the higher lakes remain frozen year-round (Ellis-Evans 1996, Lopez-Martinez *et al* 1996). On the upper levels of the central plateau, many small, shallow, slow-flowing streams flow between lakes and drain onto large flat areas of saturated lithosol covered with thick (3-10 cm) cyanobacterial mats of *Phormidium* sp.. These mats are

more extensive than in any other Maritime Antarctic site thus far described, and reflect the unique geomorphology and relatively high annual precipitation of the Area. With spring melt there is considerable flush through most lakes, but outflow from many lakes may cease late in the season as seasonal snowmelt decreases. Some of the streams also contain substantial growths of cyanobacterial and green filamentous algae, along with diatoms and copepods. A number of relatively saline lakes of lagoonal origin occur close to the shore, particularly on President Beaches, and where these are used as southern elephant seal (*Mirounga leonina*) wallows these have been highly organically enriched. Those coastal shallow lakes and pools located behind the first raised beach often have abundant algal mats and crustaceans, including the copepods *Boeckella poppei* and *Parabroteas sorsi*, and occasionally the fairy shrimp *Branchinecta gainii*.

VEGETATION

Although much of Byers Peninsula lacks abundant vegetation, especially inland (see Lindsay 1971), the sparse communities contain a diverse flora, with at least 56 lichen species, 29 mosses, 5 hepatics and 2 phanerogams having been identified as present within the Area. Numerous unidentified lichens and mosses have also been collected. This suggests the Area contains one of the most diverse representations of terrestrial flora known in the maritime Antarctic. A number of the species are rare in this part of the maritime Antarctic. For example, of the bryophytes, *Anthelia juratzkana*, *Brachythecium austroglareosum*, *Chorisodontium aciphyllum*, *Ditrichum hyalinum*, *Herzogobryum teres*, *Hypnum revolutum*, *Notoligotrichum trichodon*, *Pachyglossa dissitifolia*, *Platydictya jungermannioides*, *Sanionia* cf. *plicata*, *Schistidium occultum*, *Syntrichia filaris* and *Syntrichia saxicola* are considered rare. For *A. juratzkana*, *D. hyalinum*, *N. trichodon* and *S. plicata*, their furthest-south record is on Byers Peninsula. Of the lichen flora, *Himantormia lugubris*, *Ochrolechia parella*, *Peltigera didactyla* and *Pleopsidium chlorophanum* are considered rare.

Vegetation development is much greater on the south coast than on the north. Commonly found on the higher, drier raised beaches in the south is an open community dominated by abundant *Polytrichastrum alpinum* (=*Polytrichum alpinum*), *Polytrichum piliferum* (=*Polytrichum antarcticum*), *P. juniperinum*, *Ceratodon purpureus*, and the moss *Pohlia nutans* and several crustose lichens are frequent. Some large stands of mosses occur near President and South Beaches, where extensive snowdrifts often accumulate at the base of slopes rising behind the raised beaches, providing an ample source of meltwater in the summer. These moss stands are dominated mainly by *Sanionia uncinata* (=*Drepanocladus uncinatus*), which locally forms continuous carpets of several hectares. The vegetation composition is more diverse than on the higher, drier areas. Inland, wet valley floors have stands of *Brachythecium austro-salebrosum*, *Campylium polygamum*, *Sanionia uncinata*, *Warnstorfia laculosa* (=*Calliergidium austro-stramineum*), and *W. sarmentosa* (=*Calliergon sarmentosum*). In contrast, moss carpets are almost non-existent within 250 m of the northern coast, replaced by scant growth of *Sanionia* in hollows between raised beaches of up to 12 m in altitude, and of lichens principally of the genera *Acarospora*, *Buellia*, *Caloplaca*, *Verrucaria* and *Xanthoria* on the lower (2-5 m) raised beach crests, with *Sphaerophorus*, *Stereocaulon* and *Usnea* becoming the more dominant lichens with increasing altitude (Lindsay 1971).

On better drained ash slopes *Bryum* spp., *Dicranoweisia* spp., *Ditrichum* spp., *Pohlia* spp., *Schistidium* spp., and *Tortula* spp. are common as isolated cushions and turves with various liverworts, lichens (notably the pink *Placopsis contortuplicata* and black foliose *Leptogium puberulum*), and the cyanobacterium *Nostoc commune*. *P. contortuplicata* occurs in inland and upland habitats lacking in nitrogen, and is typical of substrata with some degree of disturbance such as solifluction; it is often the only plant to colonise the small rock fragments of stone stripes

and frost-heave polygons (Lindsay 1971). It is usually found growing alone, though rarely with species of *Andreaea* and *Usnea*. *N. commune* covers extensive saturated areas on level or gently sloping, gravelly boulder clay from altitudes of between 60-150 m, forming discrete rosettes of about 5 cm in diameter 10-20 cm apart (Lindsay 1971). Scattered, almost spherical, cushions of *Andreaea, Dicranoweisia,* and *Ditrichum* are found on the driest soils. In wet, bird- and seal-influenced areas the green foliose alga *Prasiola crispa* is sometimes abundant.

Rock surfaces on Byers Peninsula are mostly friable, but locally colonised by lichens, especially near the coast. Volcanic plugs are composed of harder, more stable rock and are densely covered by lichens and occasional mosses. Usnea Plug is remarkable for its luxuriant growth of *Himantormia lugubris* and *Usnea aurantiaco-atra* (=*U. fasciata*). More generally, *H. lugubris* and *U. aurantiaco-atra* are the dominant lichen species on inland exposed montane surfaces, growing with the moss *Andreaea gainii* over much of the exposed rock with up to 80% cover of the substratum (Lindsay 1971). In sheltered pockets harbouring small accumulations of mineral soil, the liverworts *Barbilophozia hatcheri* and *Cephaloziella varians* (=*exiliflora*) are often found, but more frequently intermixed with cushions of *Bryum, Ceratodon, Dicranoweisia, Pohlia, Sanionia, Schistidium,* and *Tortula*. *Sanionia* and *Warnstorfia* form small stands, possibly correlated with the absence of large snow patches and associated melt streams. *Polytrichastrum alpinum* forms small inconspicuous cushions in hollows, but it may merge with *Andreaea gainii* cushions in favourable situations (Lindsay 1971).

Crustose lichens are mainly species of *Buellia, Lecanora, Lecedella, Lecidea, Placopsis* and *Rhizocarpon* growing on rock, with species of *Cladonia* and *Stereocaulon* growing on mosses, particularly *Andreaea* (Lindsay 1971). On the south coast moss carpets are commonly colonised by epiphytic lichens, such as *Leptogium puberulum, Peltigera rufescens, Psoroma* spp., together with *Coclocaulon aculeata* and *C. epiphorella*. On sea cliffs *Caloplaca* and *Verrucaria* spp. dominate on lower surfaces exposed to salt spray up to about 5 m, with nitrophilous species, such as *Caloplaca regalis, Haematomma erythromma,*and *Xanthoria elegans* often dominant at higher altitudes where seabirds are frequently nesting. Elsewhere on dry cliff surfaces a *Ramalina terebrata* - crustose lichen community is common. A variety of ornithocoprophilous lichens, such as *Catillaria corymbosa, Lecania brialmontii,* and species of *Buellia, Haematomma, Lecanora,* and *Physcia* occur on rocks near concentrations of breeding birds, along with the foliose lichens *Mastodia tessellata, Xanthoria elegans* and *X. candelaria* which are usually dominant on dry boulders.

Antarctic hairgrass (*Deschampsia antarctica*) is common in several localities, mainly on the south coast, and occasionally forms closed swards (e.g. at Sealer Hill); Antarctic pearlwort (*Colobanthus quitensis*) is sometimes associated. Both plants are quite abundant in southern gullies with a steep north-facing slope, forming large, occasionally pure stands with thick carpets of *Brachythecium* and *Sanionia*, although they are rarely found above 50 m in altitude (Lindsay 1971). An open community of predominantly *Deschampsia* and *Polytrichum piliferum* extends for several kilometres on the sandy, dry, flat raised beaches on South Beaches. A unique growth-form of the grass, forming isolated mounds 25 cm high and up to 2 m across, occurs on the beach near Sealer Hill. *Deschampsia* has been reported at only one locality on the north coast (Lair Point), where it forms small stunted tufts (Lindsay 1971).

INVERTEBRATES, FUNGI AND BACTERIA

The microinvertebrate fauna on Byers Peninsula thus far described comprises 23 taxa (Usher and Edwards 1986, Richard *et al* 1994, Block and Stary 1996, Convey *et al* 1996): six Collembola (*Cryptopygus antarcticus, Cryptopygus badasa, Friesea grisea, Friesea woyciechowskii, Isotoma*

(*Folsomotoma*) *octooculata* (=*Parisotoma octooculata*) and *Tullbergia mixta*; one mesostigmatid mite (*Gamasellus racovitzai*), five cryptostigmatid mites (*Alaskozetes antarcticus, Edwardzetes dentifer, Globoppia loxolineata* (=*Oppia loxolineata*), *Halozetes belgicae* and *Magellozetes antarcticus*); nine prostigmatid mites (*Bakerdania antarcticus, Ereynetes macquariensis, Eupodes minutus, Eupodes parvus grahamensis, Nanorchestes berryi, Nanorchestes nivalis, Pretriophtydeus tilbrooki, Rhagidia gerlachei, Rhagidia leechi,* and *Stereotydeus villosus*); and two Dipterans (*Belgica antarctica* and *Parochlus steinenii*).

Larvae of the wingless midge *Belgica antarctica* occur in limited numbers in moist moss, especially carpets of *Sanionia*, although it is of very restricted distribution on Byers Peninsula (found especially near Cerro Negro) and may be near its northern geographical limit. The winged midge *Parochlus steinenii* and its larvae inhabit the margins of inland lakes and pools, notably Midge Lake and another near Usnea Plug, and are also found amongst the stones of many stream beds (Bonner and Smith 1985, Richard *et al* 1994, Ellis-Evans pers comm 1999). During warm calm weather, swarms of adults may be seen above lake margins.

The diversity of the arthropod community described at Byers Peninsula is greater than at any other documented Antarctic site (Convey *et al* 1996). Various studies (Usher and Edwards 1986, Richard *et al* 1994, Convey *et al* 1996) have demonstrated that the arthropod population composition on Byers Peninsula varies significantly with habitat over a small area. *Tullbergia mixta* has been observed in relatively large numbers; it appears to be limited in Antarctic distribution to the South Shetland Islands (Usher and Edwards 1986). Locally, the greatest diversity is likely to be observed in communities dominated by moss cushions such as *Andreaea* spp. (Usher and Edwards 1986). Further sampling is required to establish populations and diversities with greater reliability. While further sampling at other sites may yet reveal the communities described at Byers Peninsula to be typical of similar habitats in the region, available data on the microfauna confirm the biological importance of the Area.

An analysis of soil samples collected from Byers Peninsula yielded several nematophagous fungi: in *Deschampsia* soil *Acrostalagmus goniodes*, *A. obovatus*, *Cephalosporium balanoides* and *Dactylaria gracilis*; in *Colobanthus* soil, *Cephalosporium balanoides* and *Dactylella gephyropaga* were found (Gray and Smith 1984). The basidiomycete *Omphalina antarctica* is often abundant on moist stands of the moss *Sanionia uncinata* (Bonner and Smith 1985).

BREEDING BIRDS

The avifauna of Byers Peninsula is diverse, although breeding colonies are generally not large. Two species of penguin, the chinstrap (*Pygoscelis antarctica*) and the gentoo (*P. papua*), breed in the Area; although widely distributed in the region, Adélie Penguins (*P. adeliae*) have not been observed to breed on Byers Peninsula or its offshore islets. The principal chinstrap penguin colony is at Devils Point in the SW, where a rough estimate of about 3000 pairs was made in 1987; a more accurate count made in 1965 indicated about 5300 pairs in four discrete colonies, of which almost 95% were nesting on an islet 100 m to the south of Devils Point (Croxall and Kirkwood 1979, Woehler 1993). Small chinstrap penguin colonies have been reported on the northern coast, but no breeding pairs were reported in a 1987 survey. Gentoo penguins breed at several colonies on Devils Point, with approximately 750 pairs recorded in 1965. Two smaller gentoo colonies totalling about 400 pairs were reported on the northern coast in 1965 (Croxall and Kirkwood 1979, Woehler 1993). More recent data are not available.

The most recent data available for other breeding species are from a detailed survey conducted in 1965 (White 1965, in Croxall – BAS internal bird data reports). The most populous breeding species recorded then, with approximately 1760 pairs, was the Antarctic tern (*Sterna*

vittata), followed by 1315 pairs of Wilson's storm petrels (*Oceanites oceanicus*), approximately 570 pairs of cape petrels (*Daption capense*), 449 pairs of kelp gulls (*Larus dominicanus*), 216 pairs of southern giant petrels (*Macronectes giganteus*), 95 pairs of black-bellied storm petrels (*Fregetta tropica*), 47 pairs of blue-eyed cormorants (*Phalacrocorax atriceps*) (including those on nearshore islets), 39 pairs of brown skuas (*Catharacta loennbergi*), and 3 pairs of sheathbills (*Chionis alba*). In addition, prions (*Pachytilla* sp.) and snow petrels (*Pagodroma nivea*) have been seen on the peninsula but their breeding presence has not been confirmed. The census of burrowing and scree-nesting birds is considered an underestimate (White pers. comm. 1999). The majority of the birds nest in close proximity to the coast, principally in the west and south.

BREEDING MAMMALS

Large groups of southern elephant seals (*Mirounga leonina*) breed on the Byers Peninsula coast, with a total of over 2500 individuals reported on South Beaches (Torres *et al*. 1981) – which is one of the largest populations of this species recorded in the South Shetland Islands. Large numbers haul out in wallows and along beaches in summer. Weddell (*Leptonychotes weddellii*), crabeater (*Lobodon carcinophagous*) and leopard (*Hydrurga leptonyx*) seals may be seen around the shorelines. Antarctic fur seals (*Arctocephalus gazella*) were once very abundant on Byers Peninsula (see below), but have not substantially recolonised the Area in spite of the recent rapid population expansion in other parts of the maritime Antarctic.

HISTORICAL FEATURES

Following discovery of the South Shetland Islands in 1819, intensive sealing at Byers Peninsula between 1820 and 1824 exterminated almost all local Antarctic fur seals and southern elephant seals (Smith and Simpson 1987). During this period there was a summer population of up to 200 American and British sealers living ashore in dry-stone refuges and caves around Byers Peninsula (Smith and Simpson 1987). Evidence of their occupation remains in their many refuges, many of which still contain artifacts (clothing, implements, structural materials, etc.). Several sealing vessels were wrecked near Byers Peninsula and timbers from these ships may be found along the shores. Byers Peninsula has the greatest concentration of early 19th Century sealers' refuges and associated relics in the Antarctic, and these are vulnerable to disturbance and/or removal.

Elephant seal numbers, and to some extent fur seal numbers, recovered after 1860, but were again decimated by a second sealing cycle extending to the first decade of the twentieth century.

HUMAN ACTIVITIES / IMPACTS

The modern era of human activity at Byers Peninsula has been largely confined to science. The impacts of these activities have not been described, but are believed to be minor and limited to items such as campsites, footprints, markers of various kinds, sea-borne litter washed onto beaches (e.g. from fishing vessels), and from human wastes and scientific sampling. Several wooden stake markers and a plastic fishing float were observed in the SW of the Area in a brief visit made in February 2001 (Harris 2001).

Management Plan for
Antarctic Specially Protected Area No. 107
EMPEROR ISLAND, DION ISLANDS, MARGUERITE BAY, ANTARCTIC PENINSULA

1. Description of values to be protected

The Dion Islands (Latitude 67°52' S, Longitude 68°42' W), on the western side of the central Antarctic Peninsula in north-western Marguerite Bay, were originally designated as Specially Protected Area (SPA) No. 8 through Recommendation IV-8 in 1966 after a proposal by the United Kingdom. All of the islands in the Dion Islands archipelago were included. Values protected under the original designation were described as the presence of the only colony of emperor penguins (*Aptenodytes forsteri*) known to exist on the west side of the Antarctic Peninsula and that the isolation of this colony from others of the same species makes it of outstanding scientific interest. A management plan for the Area was adopted through Recommendation XVI-6 (1990), which reaffirmed the values of the Area. The boundaries were extended to include the intervening sea between the islands to ensure protection of the emperors at sea or on sea-ice in the immediate vicinity. Attention was drawn to the additional important value of the colony being one of only two known in which breeding occurs on land. It was also noted as the most northerly and probably the smallest of Emperor colonies, with annual numbers fluctuating around 150 pairs.

The values of the emperor penguin colony are reaffirmed in this revised management plan. The boundaries of the Area are now defined more precisely.

2. Aims and objectives

Management at Emperor Island aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- allow scientific research on the ecosystem and physical environment, particularly on the avifauna, provided it is for compelling reasons which cannot be served elsewhere;
- minimise the possibility of introduction of pathogens which may cause disease in bird populations within the Area;
- minimise the possibility of introduction of alien plants, animals and microbes to the Area;
- gather data on the population status of the emperor penguin colony on a regular basis, preferably at least once every five years;
- allow visits for management purposes in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- Maps showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at any operational research station located within 50 km of the Area, where copies of this management plan shall also be made available.

- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Visits shall be made as necessary (preferably no less than once every five years) to assess whether the Area continues to serve the purposes for which it was designated, and in particular to conduct bird censuses, and to ensure management and maintenance measures are adequate.

4. Period of designation

Designated for an indefinite period, provided the Emperor penguins continue to breed in the Area.

5. Maps and photographs

Map 1: Emperor Island, Dion Islands, ASPA No. 107, in relation to Marguerite Bay, showing the locations of the stations Teniente Luis Carvajal (Chile), Rothera (UK) and General San Martín (Argentina). The location of other protected areas within Marguerite Bay (ASPA No. 117 at Avian Island, ASPA No. 115 at Lagotellerie Island, and ASPA No. 129 at Rothera Point) are also shown. Inset: the location of Dion Islands on the Antarctic Peninsula.

Map 2: Emperor Island, Dion Islands, ASPA No. 107: topographic map. Map specifications:

Projection: Lambert Conformal Conic; Standard parallels: 1st 67° 0' 00" W; 2nd 68° 00' 00"S; Central Meridian: 68° 42' 30" W; Latitude of Origin: 68° 00' 00" S; Spheroid: WGS84; Datum: Mean sea level. Horizontal accuracy: ± 1.5 m; Vertical accuracy ±1 m (best accuracy of the control points); Vertical contour interval 5 m (index contour interval 15m).

Map 3: Emperor Island, ASPA No. 107: topographic map. Map specifications as for Map 2.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

The Dion Islands (Latitude 67°53' S, Longitude 68°42' W, within a region of approximately 12 km^2), situated 13.5 km south of the south-western extremity of Adelaide Island in north-western Marguerite Bay (Map 1), is a small archipelago comprising the following islands, rocks and reefs: Envoy Rock, Regent Reef, Consort Islands (approximately 3 ha), Emperor Island (approximately 5 ha), Jester Rock, Noble Rocks, Courtier Islands (approximately 8 ha), Embassy Islands and Consul Reef. The islands are generally small, rocky and precipitous, especially Emperor Island, which at a maximum elevation of 46 m is also the highest. The island group contains numerous offshore islets, rocks and reefs, which are potentially hazardous to shipping. The Dion Islands have only been visited occasionally and detailed descriptions of the Area have yet to be made. The islands are generally ice-free in summer, although there are a few small patches of permanent ice and persistent snow. A meltwater pond is located on the northern side of Emperor Island. Terrain suitable for breeding birds is limited, and the colonies present are relatively small, mostly found on Emperor Island. For a detailed description of the geology and biology of the Area see Annex 1.

BOUNDARIES

The designated Area of just over 3 km^2 comprises Emperor Island and the marine environment (including sea ice when present) within 1000 m of the coastline of Emperor Island (Maps 2 and 3). The 1000 m boundary is set as a precautionary limit to avoid disturbance to breeding Emperor penguins. Within this zone landing and overflight restrictions apply to aircraft during the period 1 April to 15 December (see Section 7(i) below). However, the area does not include the terrestrial areas of the Consort Islands in the north, Jester Rock in the east, or the Courtier Islands in the southwest.

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

No structures are known to be present within the Area. A GPS survey station, consisting of a nail driven into a rock marked by a small cairn, was installed on the northeastern side of the largest of the Courtier Islands in March 1997 (Gray and Fox 1997).

The nearest scientific research station is 14 km north-west at Teniente Luis Carvajal (Chile), on southern Adelaide Island (Latitude 67°46' S, Longitude 68°55' W), a summer-only facility operated from October until March since 1982. Over this period the station has generally accommodated up to 10 personnel. Formerly, this facility was established and operated by the UK year-round from 1961 until 1977. The nearest year-round scientific station is Rothera Research Station (UK), 41 km to the north-east on Rothera Point, also on Adelaide Island.

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Emperor Island are Avian Island (ASPA No. 117) about 12.75 km NNW, Lagotellerie Island (ASPA No. 115) 58 km east, and Rothera Point (ASPA No. 129) 41 km to the NE (Map 1).

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued only for compelling scientific reasons that cannot be served elsewhere, in particular for scientific study of the avifauna and ecosystem of the Area, or for essential management purposes consistent with plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the values of the Area;
- any management activities are in support of the objectives of the management plan;
- the actions permitted are in accordance with the management plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(i) Access to and movement within the Area

- Subject to the following restrictions, access to the Area shall be by boat, aircraft or over sea ice by vehicle or foot.
- Vehicles are prohibited on land within the Area and all movement on land within the Area shall be on foot.
- Access shall be conducted so as to minimise disturbance to any fauna that may be present, and vehicles or boats should not approach closer than 200 m to any breeding colony.
- There are otherwise no special restrictions on the locations where vehicle or small boat travel or landings may be made, but this shall be by the shortest route consistent with the restrictions in this plan and the objectives and requirements of the permitted activities.
- Aircraft are prohibited from landing within the Area or overflying the Area below 1000 m in the period 1 April to 15 December inclusive.
- Vehicle, aircraft or boat crew, or other people on vehicles, aircraft or boats, are prohibited from moving on foot beyond the immediate vicinity of their landing site unless specifically authorised by Permit.
- All movement should be undertaken carefully so as to minimise disturbance to breeding birds, the soil and vegetated surfaces.
- Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise effects.

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the avifauna or ecosystem of the Area, and which is for compelling reasons that cannot be served elsewhere;
- Essential management activities, including monitoring;

Restrictions on times and locations at which aircraft may operate within the Area apply, specified in Section 7 (i) of this Management Plan.

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit and permanent structures or installations are prohibited. Small temporary refuges, hides, blinds or screens may be constructed for the purpose of scientific study of the avifauna. Installation (including site selection), removal, modification or maintenance of structures shall be undertaken in a manner that minimises disturbance to breeding birds. All scientific equipment or markers installed within the Area must be clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of harm to bird populations or of contamination of the Area. Removal of specific structures, equipment or markers for which the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

Temporary camping within the Area is allowed when necessary for purposes specified in the Permit. Specific campsite locations have not been designated, but camping within 200 m of the emperor penguin colony should be avoided.

7(v) Restrictions on materials and organisms that can be brought into the Area

No living animals, plant material, pathogens or microorganisms shall be deliberately introduced into the Area and the precautions listed in 7(ix) below shall be taken against accidental introductions. In view of the presence of breeding bird colonies on Emperor Island, no poultry products, including products containing uncooked dried eggs, including wastes from such products, shall be released into the Area, including into the sea. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel is not to be stored in the Area, unless specifically authorised by Permit for specific scientific or management purposes. All materials introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of any materials released and not removed that were not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

Taking or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica* should be used as a minimum standard.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Collection or removal of anything not brought into the Area by the Permit holder shall only be in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs. Permits shall not be granted in instances where it is proposed to take, remove or damage such quantities of soil, native flora or fauna that their distribution or abundance within the Area would be significantly affected. Samples of flora or fauna found dead within the Area may be removed for analysis or audit without prior authorisation by Permit. Anything of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder or otherwise authorised, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, except human wastes, shall be removed from the Area. Human wastes shall be removed from the Area or disposed of into the sea.

7(ix) Measures that are necessary to ensure that the aims and objectives of the management plan can continue to be met

12. Permits may be granted to enter the Area to carry out monitoring and site inspection activities, which may involve the small-scale collection of samples for analysis or review, or for protective measures.
13. Any specific long-term monitoring sites shall be appropriately marked.
14. To help maintain the ecological and scientific values found at Emperor Island visitors shall take special precautions against introductions. Of concern are pathogenic, microbial or plant introductions sourced from other Antarctic sites, including stations, or from regions outside Antarctica. Visitors shall ensure that sampling equipment or markers brought into the Area are cleaned or sterilised. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including backpacks, carry-bags and tents) shall be thoroughly cleaned before entering the Area.
15. Poultry products and other introduced avian products, which may be a vector of avian diseases, shall not be released into the Area.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the management plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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6(i) Additional information on the natural features of the Area.

CLIMATE AND SEA ICE

Extended meteorological records are not available for Dion Islands, but records from 1962-74 for Adelaide Base (formerly UK; now Teniente Luis Carvajal, Chile), show a mean daily maximum temperature of 3ºC in February (extreme maximum 9ºC) and a mean daily minimum of -8ºC in August (extreme minimum -44ºC). This general pattern is consistent with observations at the Dion Islands recorded by Stonehouse (1953) during the winter of 1949, who also noted that the dominant winds occurred from a northerly direction. The islands are surrounded by fast ice up to 2 m thick for about seven months of the year, with a variable presence of open water and pack ice during the summer.

GEOLOGY, GEOMORPHOLOGY AND SOILS

The geology of the Dion Islands consists of dark fine-grained lavas and tuffs of Jurassic to Early Tertiary age belonging to the Antarctic Peninsula Volcanic Group (Dewar 1970, Moyes *et al* 1994). Andesitic and basaltic lavas and pyroclastic rocks dominate toward the south, while in the north are found well-bedded sedimentary and volcaniclastic rocks. Shales, sandstones, grits and conglomerates are also present, usually as thin units of up to about 1 m thick (Skinner 1969). Poorly preserved plant fossils have been observed on Consort Islands and Noble Rocks, where indeterminate carbonaceous compressions, presumably representing tree trunks, of up to 1 m across occur (Thomson 1972). Flattened, carbonised and mineralised logs, up to 4 m long and 50 cm across, are common in siltstones on these islands (Thomson and Griffiths 1994). Small veins of copper are prominent as green streaks on the rocks.

There is virtually no soil development in the island group, except for small pockets of ornithogenic mud composed largely of guano, decayed moss and *Prasiola crispa*, notably on Emperor Island. Deposits of pure guano 10-30 cm thick have been observed on the edge of the Emperor Island cormorant colony. On the raised pebble beach on the largest of the Courtier Islands, periglacial circles of a yellowish-brown clay suggest an ornithogenic origin, although bird colonies do not presently occupy the site. In moist depressions this soil type is colonised by the moss *Sanionia uncinata* (=*Drepanocladus uncinatus*). The soils have exceptionally high concentrations of Ca, P and Mg, and also of Na in soils associated with the seabird colonies, as, for example, near the cormorant colony on Emperor Island (Smith 1996).

Several small low-lying areas on the Courtier and Emperor islands consist of large pebbles, suggesting raised beach deposits. The deposits occur on the south-eastern side of Emperor Island and on the largest of the Courtier Islands. Small sorted soil circles are evident in the deposits at about 6 m above mean sea level on this island. The geomorphology of the Dion Islands has otherwise not been described.

BREEDING BIRDS

Six species of birds have been recorded as breeding on Dion Islands. Owing to the difficulties of access, however, data are few and dated. Descriptions below are thus often based

on limited and/or old observations and it should be emphasised that these data are therefore not necessarily representative of present numbers or trends.

The outstanding feature of the avifauna is the presence of a small colony of emperor penguins which typically breeds on a low-lying shingle beach and rocky headland on the northern coast of south-eastern Emperor Island. The colony was discovered in October 1948 by Stonehouse (1953), who studied the breeding behaviour and performance, while Glenister (1954) investigated emperor penguin embryology from specimens taken by Stonehouse. It is the only emperor penguin colony in this region of Antarctica; it is also the most northerly colony and possibly the smallest, and one of only two in which breeding occurs on land (the other is at Taylor Rookery, SPA No. 1). It is also the most isolated, being about 2500 km (by sea) from the nearest known breeding colony. Stonehouse (1953) reported that the birds spent most of their time on the low-lying beach, occupying an area of about 650 m^2.

Stonehouse (1953) reported numbers of adult birds varying between 100 and 183 during the 1949 winter (observations between 5 June – 15 August), and from egg counts it was estimated that about 150 breeding pairs were present. In the previous year 100 adults and 70 chicks were counted. Egg-laying occurred from around 1 June until 29 June, 1949, with most eggs laid in the first week. Birds laid one egg per pair, and replacement eggs were not laid if originals were lost. Initially, eggs were passed a number of times between pair partners, eventually being held by the male for incubation over several months while their partners were at sea, most of which returned around the end of July / early August when hatching occurred. The numbers of adult birds present increased after hatching, with frequent arrivals and departures. Observations made on chicks the previous year showed they had formed *crêches* by October, and some evidence in the 1949 season suggested *crêches* were formed around a month earlier. A chick mortality rate of less than 10% was estimated by Stonehouse for this season.

Fluctuations in numbers have been discussed by Conroy (1975), Croxall and Kirkwood (1979) and Woehler (1993). Approximately 150 breeding pairs were observed until about 1968, with some evidence (based on aerial photographs) of an increase (possibly to about 500 pairs) in 1977. However, it is probable this latter count included Adélie penguins which breed nearby, as only 70-80 adults and about 20 chicks were reported from a ground count in late July 1978 (Poncet 1982). The most recent count was made in July 1999, when only 14 males with eggs were counted in the same location on Emperor Island. It is not known whether this number is typical of recent seasons. If so, continued presence of the colony may be marginal.

A small colony of Adélie penguins (*Pygoscelis adeliae*) in several groups occupies the south-eastern part of Emperor Island. A rough count in 1948 indicated about 500 pairs, while a 1969 estimate indicated about 175 pairs. The most recent data available (a rough estimate made in 1986) indicated a population of 700 breeding pairs (Poncet and Poncet 1987, Woehler 1993).

A small colony of blue-eyed cormorants (*Phalacrocorax atriceps*) was present in the Dion Islands in October 1948, although numbers were not recorded (Stonehouse 1949). About 50 pairs were recorded on Emperor Island on 30 August 1968 (Willey 1969), while a more precise nest count at the same location in February 1969 recorded 107 pairs and 33 pairs in two adjacent groups. About 200 empty nests were counted on broad ledges on the steep north-western side of Emperor Island in July 1978, and there was evidence of the smaller breeding group closer to the location of the emperor penguin colony (BAS internal records, Bonner and Smith 1984). In February 1986, 388 pairs were recorded in two main colonies on Emperor Island, one in the north and one in the southeast. Eight pairs were recorded nesting within the Adélie penguin colony (Poncet pers comm., 1999).

Kelp gulls (*Larus dominicanus*) and brown skuas (*Catharacta loennbergi*) are numerous, with several pairs nesting on the larger islands (Bonner and Smith 1984). A breeding pair of kelp gulls with a chick was observed on Consort Islands on 24 February 1969 (BAS internal records). Southern giant petrels (*Macronectes giganteus*), cape petrels (*Daption capensis*) and snow petrels (*Pagodroma nivea*) are frequently seen around the islands, but breeding of these or other seabirds that have been observed in the area is unconfirmed, the nearest major breeding site being Avian Island, 12.75 km to the north-west. A few Wilson's storm petrel (*Oceanites oceanicus*) nests were noted on Emperor Island in February 1969 (BAS internal records).

VEGETATION

Vegetation on Dion Islands is generally sparse, and the flora has not been described in detail. Collections have been made principally on Emperor and Consort islands. Phanerogams are absent from the island and there is a limited range of cryptogams, although there is a rich lichen flora. The few taxa recorded on the islands are typical of maritime Antarctic sites exposed to strong winds, sea spray and nitrogenous enrichment from seabirds. The flora of the Area is not regarded as possessing properties that in itself merits special protection. To date, six mosses and at least 19 lichen species have been identified as present within the Area (BAS Plant Database 1999).

Bryophytes are restricted to small patches dominated by *Sanionia uncinata* (=*Drepanocladus uncinatus*) in moist hollows where there is some soil accumulation. The most substantial stands, covering several square metres, occur on the largest of the Courtier Islands. *Bryum pseudotriquetrum* (=*Bryum algens*), *Ceratodon purpureus* and *Pohlia nutans* are usually associated. The moss *Syntrichia princeps* (=*Tortula princeps*) has been recorded on Courtier Islands and *Polytrichastrum alpinum* (=*Polytrichum alpinum*) has been recorded on Emperor Island.

The epipetric communities are composed entirely of lichens. Macrolichens, such as *Usnea* and *Umbilicaria*, are rare although are common in the general region. The most prominent lichens include *Acarospora macrocyclos*, *Amandinea petermannii*, *Buellia anisomera*, *B.* cf. *latemarginata*, *B. russa*, *Caloplaca cirrochrooides*, *C.* spp., *Lecania brialmontii*, *Lecanora* spp., *Lecidea atrobrunnea*, *L.* spp., *Mastodia tessellata*, *Physcia caesia*, *Usnea antarctica*, *Verrucaria elaeoplaca*, *V. psychrophilia*, *Xanthoria candelaria* and *X. elegans*. *Haematomma erythromma* is frequent on the largest of the Courtier Islands. The only soil encrusting lichen noted is *Candelariella vitellina*. Moist rock depressions and faces associated with sea bird colonies support small patches of the alga *Prasiola crispa* and cyanobactarium *Phormidium*.

INVERTEBRATES, FUNGI, BACTERIA

The microinvertebrate fauna, fungi and bacteria on Dion Islands have yet to be investigated in detail. Nine species of microinvertebrate fauna have been recorded from the island group (BAS Invertebrate Database 1999): two Collembola (*Cryptopygus antarcticus*, *Friesea grisea*); one mesostigmatid mite (*Gamasellus racovitzai*), four cryptostigmatid mites (*Alaskozetes antarcticus*, *Halozetes belgicae*, *Magellozetes antarcticus* and *Globoppia loxolineata* (=*Oppia loxolineata*)); and two prostigmatid mites (*Eupodes minutus* and *Pretriophtydeus tilbrooki*). The dominant species are *Cryptopygus antarcticus* and *Alaskozetes antarcticus*.

Nematodes have been recorded as abundant in *Sanionia uncinata* on the largest of the Courtier Islands, but were rare in *Prasiola* growing on Emperor Island (Bonner and Smith 1985). A sample of *Sanionia uncinata* intermixed with *Bryum pseudotriquetrum* from Emperor Island yielded several nematode taxa: mostly of the genus *Mesodorylaimus*, with *Plectus* and

Eudorylaimus also present (Spaull 1973). Of the tardigrades in the sample, most were *Macrobiotus furciger* and *Hypsibius dujardini*, with a small proportion of *H. alpinum* and *H. pinguis* also present. Of nine specimens recovered from a soil sample from Consort Islands all were *H. renaudi* (Jennings 1976). Rotifers have been recorded on Emperor Island, although no protozoans. Three predacious fungi have been isolated from the Dion Islands: an unidentified endoparasite from *Sanionia uncinata* on Courtier Islands; and *Arthrobotrys robusta* and *Cephalosporium balanoides* from *Prasiola* on Emperor Island (Gray and Smith 1984).

BREEDING MAMMALS AND MARINE ENVIRONMENT

Crabeater seals (*Lobodon carcinophagus*) are common on ice floes near the islands, with Weddell seals (*Leptonychotes weddellii*) and Leopard seals (*Hydrurga leptonyx*) being less frequent visitors (Bonner ad Smith 1985). A single immature bull Elephant seal (*Mirounga leonina*) was seen on the largest of the Courtier Islands on 14 March 1981. The marine environment within the Area has not been investigated.

HUMAN ACTIVITIES AND IMPACTS

There has been little human activity at the Dion Islands. Visits have comprised a mixture of science and topographical survey. The impacts of activities such as these have not been described and are not known, but are believed to have been minor and limited to items such as transient disturbance to breeding birds, campsites, footprints, occasional litter, human wastes, scientific sampling and markers. A fuel drum, a box (possibly a food cache, as mentioned in 1969 field reports), and several poles were apparent in aerial photographs of Emperor Island taken in December 1998, although their status has not been assessed in the field.

Management Plan for
Antarctic Specially Protected Area No. 108
GREEN ISLAND, BERTHELOT ISLANDS, ANTARCTIC PENINSULA

1. Description of values to be protected

Green Island (Latitude 65°19' S, Longitude 64°09' W, approximately 0.2 km^2), Berthelot Islands, Grandidier Channel, Antarctic Peninsula, was originally designated as a Specially Protected Area through Recommendation IV-9 (1966, SPA No. 9) after a proposal by the United Kingdom. It was designated on the grounds that the vegetation "is exceptionally rich, [and] is probably the most luxuriant anywhere on the west side of the Antarctic Peninsula". The Recommendation noted: "in some places the humus is 2 metres thick and that this area, being of outstanding scientific interest, should be protected because it is probably one of the most diverse Antarctic ecosystems". A Management Plan for the site was prepared by the United Kingdom and adopted through Recommendation XVI-6 (1991). The original reasons for designation were extended and elaborated, although following comparisons to other sites in the vicinity, Green Island was no longer considered to be particularly diverse. The vegetation on the island was described as extensive on the north-facing slopes, with well-developed continuous banks of moss turf formed by *Chorisodontium aciphyllum* and *Polytrichum strictum* that, over much of their extent, overlie peat of more than one metre in depth. Antarctic hair grass (*Deschampsia antarctica*), one of only two native vascular plants that grow south of 56°S, was noted as frequent in small patches near a blue-eyed cormorant (*Phalacrocorax atriceps*) colony. The colony of blue-eyed cormorants, located on the steep, rocky northwestern corner of the island, was noted as being possibly one of the largest along the Antarctic Peninsula.

The present management plan reaffirms the values of the rich *Chorisodontium-Polytrichum* moss turf as being the primary reason for special protection of Green Island. The *Polytrichum strictum* moss banks, with associated *Chorisodontium aciphyllum*, are considered to be the most extensive examples of this vegetation feature in the west Antarctic Peninsula region, occupying an area of over 0.5 ha. Moreover, in recent years many comparable moss banks on more northerly islands have suffered damage as a result of an increase in Antarctic fur seals (*Arctocephalus gazella*). The vegetation at Green Island has thus far escaped any significant damage. In addition, *Chorisodontium aciphyllum* is close to the southern-most limit of its range at the Berthelot Islands. The blue-eyed cormorant colony was one of the largest along the Antarctic Peninsula in 1981, when 500-600 individuals were present, and, until more recent data confirm otherwise, the value of this colony as one of the largest known, is included as an additional value and thus a further reason for special protection of Green Island.

Green Island has been afforded protection throughout most of the period of scientific activity in the region, with entry permits having been issued for only the most compelling scientific reasons. The island has not been subjected to intensive visitation, research or sampling and is potentially valuable as a baseline site for future studies. Due to the lack of visits and scientific studies, detailed information on the island's geography and ecology is lacking.

The coastline boundary of the original Area has not been changed, but the boundary is defined more precisely to include the whole island above the low tide water level, excluding offshore islets and rocks.

2. Aims and objectives

Management at Green Island aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance and sampling in the Area;
- preserve the ecosystem of the Area for its potential as a largely undisturbed reference area;
- allow scientific research on the ecosystem in the Area provided it is for compelling reasons which cannot be served elsewhere, in particular research which is expected to improve knowledge of the features and communities identified of special value, and which gathers baseline data on the island's features for which information is poor or not available;
- minimise the possibility of introduction of alien plants, animals and microbes to the Area;
- allow visits for management purposes only in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at Akademik Vernadsky Station (Ukraine), where copies of this Management Plan shall be made available.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Visits should be made as necessary (preferably at least once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

5. Maps and photographs

Map 1: Green Island, ASPA No. 108, in relation to the Graham Coast, showing the location of Akademik Vernadsky Station (Ukraine). Inset: location of the Berthelot Islands on the Antarctic Peninsula.

Map 2: Green Island, ASPA No. 108, topographic map. Map derived from ground survey 24 February 2001 and digital orthophotography (ground pixel resolution 12 cm; source aerial photography taken 14 February 2001 by the British Antarctic Survey). Ground features (vegetation, permanent snow, colony, coastline and ponds) are digitised from the orthophotograph. Vegetation distribution indicates the principal moss banks, dominated by *Polytrichum strictum*. Map specifications – Projection: UTM Zone 20S; Spheroid: WGS84; Datum: mean sea level (EGM96). Vertical contour interval 5 m. Horizontal and vertical accuracy: ±2.0 m.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

Green Island (65°19' S, 64°09' W, approximately 0.2 km^2) is a small island situated 150 m north of the largest of the Berthelot Islands group, Grandidier Channel, approximately 3 km off the Graham Coast of the Antarctic Peninsula (Map 1). Green Island is 520 m from north to south and 500 m from east to west, rising to a rounded peak at a height of 83 m. The island rises steeply on all sides, with high precipitous cliffs on the south and east side. The largest extent of low ground occurs above the northern coast, which comprises a gently sloping rock platform. There are several permanent snow patches with the largest occurring around the summit and to the south and east of the summit.

BOUNDARIES

The designated area comprises the entire island, with the boundary defined as the low tide level. Offshore islets and rocks are not included within the Area. Boundary markers have not been installed. The coast itself is a clearly defined and visually obvious boundary feature.

CLIMATE

No climate data are available for Green Island but conditions are expected to be similar to those at Akademik Vernadsky Station (Ukraine) on Galindez Island, Argentine Islands 8 km to the north. The mean summer temperature at Vernadsky is 0°C while the extreme maximum summer temperature is 11.7°C. In winter, the mean temperature is -10°C and the extreme minimum temperature is -43.3°C. The mean wind speed is 7.5 knots.

GEOLOGY AND SOILS

Green Island, together with the rest of the Berthelot Islands, is composed of gabbro of Lower Jurassic to Lower Tertiary age (British Antarctic Survey 1981). No further information is available on the geology of Green Island. Excluding the large peat deposits, soil is sparse and seldom exceeds 20 cm in depth, except occasionally in rock depressions and gullies. This is predominantly an ahumic coarse mineral soil derived from weathering of the parent rock. Ledges and gullies close to the Blue-eyed Cormorant colony contain an organically richer soil derived in part from decayed moss and guano. Over much of the steep northern slopes the mosses *Chorisodontium aciphyllum* and *Polytrichum strictum* have developed a deep turf of living moss overlying at least 1 m of barely altered or decomposed moss peat (Smith 1979, Fenton and Smith 1982). The permafrost layer is found 20-30 cm below ground level. Elsewhere on the island, notably the northeastern side, there are small areas of scree. There are no well-developed periglacial features, although a few small stone circles are occasionally evident.

VEGETATION

The most significant feature of the vegetation is the extensive continuous stand of *Polytrichum strictum* (= *Polytrichum alpestre*) on the northern slopes of the island (Map 2). The stand is approximately 140 m wide, extends from an elevation of approximately 25 m up to 70 m, and covers over 0.5 ha (Bonner and Smith 1985). Growth is lush and the permanently frozen peat in places reaches two metres deep. The surface of the hard compact moss is stepped, which is thought to be a result of slumping of the active layer on the steep slope. *Chorisodontium aciphyllum* (=*Dicranum aciphyllum*) is abundant at the edges of the bank and around the periphery of small gullies in the bank, where there is some shelter and moisture available from drifted snow. Both these tall turf-forming mosses are usually intimately intermixed in such communities further north in the maritime Antarctic; however, in the Grandidier Channel region the more xeric *P. strictum* often occurs alone. *C. aciphyllum* is close to its southernmost limit on Green Island (Smith 1996). Amongst the *C. aciphyllum*, *Pohlia nutans* is frequent, together with the liverworts

Barbilophozia hatcheri and *Cephaloziella varians*. Epiphytic lichens are not abundant on the live *Polytrichum* and *Chorisodontium*, but *Sphaerophorus globosus* is frequent in the more exposed north-western area. Several species of *Cladonia* are widespread on the moss banks. The white encrusting epiphyte *Ochrolechia frigida* is present but not abundant here; black crustose species occur on moribund moss.

Wet hollows among rocks and melt runnels support small stands of the mosses *Warnstorfia laculosa* (= *Calliergidium austro-stramineum*), *Brachythecium austro-salebrosum* and *Drepanocladus uncinatus*. Elsewhere lichens dominate the vegetation. On rocks and boulders away from the shore and the influence of seabirds, a community dominated by *Usnea antarctica* and species of *Umbilicaria* (*U. antarctica, U. decussata* and *U. propagulifera*) prevail, with the mosses *Andreaea depressinervis* and *A. regularis* and various crustose lichens associated. Cliffs above the shore possess the most diverse and heterogenous communities, composed predominantly of lichens. These are a modification of the *Usnea-Umbilicaria* community with various nitrophilous taxa, especially close to seabird nests, including species of *Acarospora, Buellia, Caloplaca, Lecanora, Mastodia, Omphalodina, Physcia* and *Xanthoria*.

The only flowering plant thus far recorded on Green Island is Antarctic hair grass (*Deschampsia antarctica*), which is frequent in small patches above the cormorant colony and on rock ledges on the western side of the island.

BREEDING BIRDS

A sizeable colony of blue-eyed cormorants (*Phalacrocorax atriceps*) is present on the steep, rocky northwestern flank of the island (Map 2). This is one of the largest known blue-eyed cormorant colonies along the Antarctic Peninsula (Bonner and Smith 1985), although numbers may vary substantially from year to year. Approximately 50 pairs were estimated as present in 1971 (Kinnear 1971), while 112 birds were recorded in 1973 (Schlatter and Moreno 1976). 500-600 individuals (of which 300-400 were immatures) were present when visited in March 1981. Harris (2001) recorded 71 chicks on 24 February 2001.

Brown skuas (*Catharacta loennbergi*) are numerous over much of the island, particularly on the extensive moss banks. South polar skuas (*C. maccormicki*) are also present, along with a few possible hybrids. Over 80 birds were noted in March 1981, but only ten breeding pairs were confirmed, most of which were rearing two chicks. No other breeding birds were noted.

INVERTEBRATES, FUNGI AND BACTERIA

There is little information on the invertebrate fauna at Green Island, although 15 species were recorded in a study that suggested the invertebrate fauna on Green Island was comparatively diverse for the region (Usher and Edwards 1986). The most abundant species were *Cryptopygus antarcticus*, *Belgica antarctica* and *Nanorchestes gressitti*. Larval *B. antarctica* were particularly abundant on Green Island compared to neighbouring Darboux Island. Other species recorded in the Area are: *Alaskozetes antarcticus; Ereynetes macquariensis; Eupodes minutus; Eupodes parvus grahamensis; Friesea grisea; Gamasellus racovitzai; Halozetes belgicae; N. berryi; Oppia loxolineata; Parisotoma octo-oculata; Rhagidia gerlachei;* and *Stereotydeus villosus*. A definitive characterisation of the arthropod fauna on Green Island cannot be given until more site-specific research has been conducted. Information on fungal and bacterial communities is not available. There are no permanent freshwater bodies on the island, and there is no information available on seasonal freshwater communities.

HUMAN ACTIVITIES AND IMPACTS

There have been few reported visits to Green Island. The first recorded landing on the island was by the Première Expédition Antarctiques Française in 1903-05. The Deuxième Expédition

Antarctiques Française visited Green Island several times during the winter in 1909. The British Graham Land Expedition landed on the island on 18 March 1935. Vegetation studies were undertaken on Green Island by Lewis-Smith in 1981 (Bonner and Smith 1985) and Komárková in 1982-83 (Komárková 1983). Numerous 30 cm lengths of 2.5 mm diameter iron wire, marking the corners of 50 m square quadrats of the *Polytrichum strictum* moss turf overlying the peat banks, were recorded (and left *in situ*) by an inspection team in January 1989 (Heap 1994). It is not known precisely when these markers were installed. The number of markers, their distribution and the nature of any possible contamination these may have had on the moss is unknown.

In recent years a number of important vegetation sites in the Antarctic Peninsula region have been subjected to damage from trampling and nutrient enrichment by increasing numbers of Antarctic fur seals (*Arctocephalus gazella*). While no Antarctic fur seals were observed on Green Island during a site visit made on 24 February 2001, there was some evidence of recent trampling and nutrient enrichment on parts of the lower moss banks. However, damage appeared limited and most of the extensive moss banks remained in tact.

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

There are no structures present in the Area. The nearest scientific research station is Akademik Vernadsky (Ukraine) (65°15'S, 64°16'W), approximately 9 km north of the Area on Galindez Island.

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Green Island are Biscoe Point (ASPA No. 139), 62 km north, and Litchfield Island (ASPA No. 113), 63 km north, both near the southern coast of Anvers Island.

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued only for compelling scientific reasons that cannot be served elsewhere, or for essential management purposes consistent with plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the ecological or scientific values of the Area;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with the Management Plan;
- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;

- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit

7(i) Access to and movement within the Area

- Subject to the following restrictions, access to the Area shall be by boat, or over sea ice by vehicle or foot.
- Vehicles are prohibited within the Area and all movement within the Area shall be on foot.
- Access to the island should be made on the rocky northern coast (Map 2). No special restrictions apply to the routes used to move to and from the Area.
- Aircraft are prohibited from landing within the Area year-round, and restrictions apply to overflight (see Table 1 below).
- Vehicle or boat crew, or other people on vehicles or boats, are prohibited from moving on foot beyond the immediate vicinity of their landing site unless specifically authorised by Permit.
- All movement should be undertaken carefully so as to minimise disturbance to the soil and vegetated surfaces and birds present, walking on snow or rocky terrain if practical.
- Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise trampling effects.

Table 1: Aircraft overflight restrictions applying year-round at Green Island.

Aircraft type	Number of engines	Minimum approach distance (m) Vertical (above ground)	
		Feet	**Metres**
Helicopter	1	*2461*	750
Helicopter	2	*3281*	1000
Fixed-wing	1 or 2	*1476*	450
Fixed-wing	4	*3281*	1000

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the ecosystem or scientific values of the Area, and which cannot be served elsewhere;
- Essential management activities, including monitoring;

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit and permanent structures or installations are prohibited. All scientific equipment installed in the Area must be approved by Permit and clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of contamination of the Area. Removal of specific equipment for which the Permit has expired shall be a condition of the Permit..

7(iv) Location of field camps

When necessary for purposes specified in the Permit, temporary camping is allowed within the Area on the low platform on the northern coast (Map 2). Camps should preferably be located on snow surfaces, which typically persist in this locality, or on gravel / rock when snow cover is absent. Camping on continuously covered vegetated surfaces is prohibited.

7(v) Restrictions on materials and organisms which can be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area and the precautions listed in 7(ix) below shall be taken to prevent accidental introductions. In view of the presence of breeding bird colonies on the island, no poultry products, including products containing uncooked dried eggs, including wastes from such products, shall be released into the Area or into the adjacent sea. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel is not to be stored in the Area, unless specifically authorised by Permit for specific scientific or management purposes. Anything introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of any introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of anything released and not removed that was not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

Taking or harmful interference with native flora or fauna is prohibited, except by Permit issued in accordance with Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica* should be used as a minimum standard.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Collection or removal of anything not brought into the Area by the Permit holder shall only be in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs. Permits shall not be granted in instances where it is proposed to take, remove or damage such quantities of soil, native flora or fauna that their distribution or abundance on Green Island would be significantly affected. Anything of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder or otherwise authorised, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area. Human wastes may be disposed of into the sea.

7(ix) Measures that are necessary to ensure that the aims and objectives of the Management Plan can continue to be met

16. Permits may be granted to enter the Area to carry out monitoring and site inspection activities, which may involve the small-scale collection of samples for analysis or review, or for protective measures.
17. Any specific long-term monitoring sites shall be appropriately marked.
18. To help maintain the ecological and scientific values of Green Island special precautions shall be taken against introductions. Of concern are microbial, invertebrate or plant introductions from other Antarctic sites, including stations, or from regions outside Antarctica. All sampling equipment or markers brought into the Area shall be cleaned or sterilised. To the maximum extent practicable, footwear and other equipment used or brought into the Area (including backpacks, carry-bags and tents) shall be thoroughly cleaned before entering the Area.
19. Poultry products and other introduced avian products, which may be a vector of avian diseases, shall not be released into the Area.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the Management Plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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Management Plan for
Antarctic Specially Protected Area No. 148

MOUNT FLORA, HOPE BAY, ANTARCTIC PENINSULA

1. Description of values to be protected

Mount Flora (Latitude 63°25' S, Longitude 57°01' W, 0.3 km^2), Hope Bay, Antarctic Peninsula was originally designated as a Site of Special Scientific Interest through Recommendation XV-6 (1989, SSSI No. 31) after a proposal by the United Kingdom. It was designated on the grounds that "the site is of exceptional scientific importance for its rich fossil flora. It was one of the first fossil floras discovered in Antarctica and has played a significant role in deducing the geological history of the Antarctic Peninsula. Its long history as an easily accessible site and the large amount of fossiliferous debris occurring in scree has made it vulnerable to souvenir collectors, and the amount of material available for serious research has been considerably depleted."

Geologist Johann Gunnar Andersson discovered Mount Flora during the Swedish South Polar Expedition (1901-04), whose original stone hut (Historic Monument No. 39) remains nearby at Seal Point, Hope Bay. Otto Nordenskjöld, the leader of the expedition, named Mount Flora (as 'Flora-Berg') following the geological observations of Andersson, recognising it as the first significant fossil locality discovered in Antarctica. The Area subsequently became of great scientific importance for interpreting key geological relationships in the region. Mount Flora has important values associated with this significant heritage of geological discovery in Antarctica.

The scientific values of the rich fossil flora are reaffirmed in this revised management plan. Mount Flora is characterised by three distinct geological formations: the Hope Bay Formation (Trinity Peninsula Group), which is separated by an unconformity from the overlying gently tilted plant beds of the Mount Flora Formation (Botany Bay Group), which in turn are overlaid by ignimbrites and welded tuffs of the Kenney Glacier Formation (Antarctic Peninsula Volcanic Group). The relationships between these formations have been fundamental for determining the age of the plant beds, which has been vital to the interpretation of the geology of the Antarctic Peninsula. Historically, the site has also played an important role in comparisons with other Southern Hemisphere floras. The fossil flora has also been important for providing Mesozoic palaeoclimate data from a region where such information is otherwise sparse. Moreover, Mount Flora holds one of the few Jurassic floras known from Antarctica and it is the only site that has been relatively well studied and documented. The Mesozoic plant assemblages from Mount Flora include members of the sphenophytes, ferns, cycadophytes (cycads and bennetites), pteridosperms and conifers. Samples of the fossils have served as a major reference source for many studies of Jurassic and Cretaceous palaeobotany.

The Area is approximately three kilometres southeast of Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay). The Area is easily accessible on foot from both the stations and Hope Bay. The boundaries designated in the original management plan were inaccurate and excluded some of the fossiliferous strata. The boundaries have therefore been revised in the current management plan to include all of the exposed fossiliferous strata, which are found on the northern slopes of Mount Flora.

2. Aims and objectives

Management at Mount Flora aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance and sampling in the Area;
- allow scientific geological and palaeontological research, while ensuring protection from over-sampling;
- allow other scientific research within the Area provided it will not compromise the values for which the Area is protected;
- allow visits for management purposes only in support of the aims of the management plan.

3. Management activities

The following management activities shall be undertaken to protect the values of the Area:

- A map showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently at Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay), where copies of this management plan shall be made available.
- A sign showing the location and boundaries of the Area with clear statements of entry restrictions shall be placed in a prominent location on the lower NE ridge at the northeastern boundary (approximate elevation 200 m) to help avoid inadvertent entry.
- Persons wishing to make the ascent of Mount Flora shall be instructed not to enter the Area without a Permit issued by the appropriate authority.
- Markers, signs or other structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition.
- Visits shall be made as necessary (at least once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.
- Increasing exposure of fossiliferous rocks on Mount Flora is expected if glacial ice in the vicinity continues to retreat, as has occurred in recent years. Periodic updating of the boundaries should be undertaken to ensure any newly-exposed fossiliferous rocks are included within the Area, which should be considered at the time of review of the management plan.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1: Mount Flora ASPA No. 148 in relation to Hope Bay, Trinity Peninsula, and the South Shetland Islands, showing the location of the nearest protected areas. The location of Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay) are also shown.

<u>Inset:</u> the location of Mount Flora on the Antarctic Peninsula.

Map 2: Mount Flora ASPA No. 148, Hope Bay, topographic map. Map specifications: Projection: Lambert Conformal Conic: Standard parallels: 1st 76° 40' S; 2nd 63° 20' S Central Meridian: 57° 02' W; Latitude of Origin: 70° 00' S; Spheroid: WGS84. Vertical

datum: mean sea level. Vertical contour interval 25 m. Horizontal and vertical accuracy unknown. Note: topography and positions are based on original 1950s survey data, and true positions are known to be in error by up to 500 m (a new map correcting the positional errors is in preparation). Ice margins are updated to approximate present positions using 1999 aerial photography.

Map 3: Mount Flora ASPA No. 148 geological sketch map, based on data from Birkenmajer 1993a&b, aerial photography, and field observations by Smellie (unpublished, pers. comm. 2000).

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

GENERAL DESCRIPTION

Mount Flora (latitude 63°25' S, longitude 57°01' W, 0.3 km^2) is situated on the southeastern flank of Hope Bay, at the northern end of Trinity Peninsula, Antarctic Peninsula (Map 1). The summit of Mount Flora (520 m) is approximately 1 km from the southern shore of Hope Bay. Four glaciers surround Mount Flora. The Flora Glacier extends from the cirque below the summit of Mount Flora in a northeasterly direction for one kilometre before it flows into a larger glacier that flanks the eastern and southern slopes of Mount Flora, extending northeast from The Pyramid (565 m) (Map 2). The western slopes of Mount Flora are bounded by the Kenney Glacier, which joins Depot Glacier before flowing into the head of Hope Bay. The Pyramid is a distinctive peak 1.5 km to the SSE of Mount Flora. To the north of the Area is the ice-free Five Lakes Valley and Scar Hills, and to the northeast is Lake Boeckella.

BOUNDARIES

The boundaries designated in the original management plan have been revised in the current management plan to include all of the known exposed fossiliferous strata on the northern slopes of Mount Flora. The summit ridge and highest peak of Mount Flora (520 m), which were formerly within the boundary, are comprised of non-fossiliferous volcanic rocks and have now been excluded from the Area. The boundary runs from the north summit of Mount Flora (516 m) – the highest point of the boundary – westward down the ridge to the Kenney Glacier, the eastern margin of Kenney Glacier northward to the 150m contour, eastward along the 150m contour to the northwestern margin of the Flora Glacier, the northwestern margin of the Flora Glacier south-westward to the ridge leading westward to the north summit of Mount Flora. Where present, the glacier margins, lower outcrops, western ridge and northern summit of Mount Flora form visually obvious features that indicate the boundaries: the Area remains otherwise unmarked.

CLIMATE

No climate data are available for Mount Flora but local conditions are indicated by those at Esperanza Station. Average summer temperatures (October – March) at Esperanza Station over the 1990s were -0.7°C, while the average in winter was -8.6°C. Over the 1990s, the warmest month was January with an average of +1.5°C, while the coldest was August with an average of -11.2°C. Temperatures at Mount Flora are likely to be lower owing to its greater elevation.

GEOLOGY, SOILS AND PALAEONTOLOGY

The geology of the Area comprises three main formations: the Hope Bay Formation, the Mount Flora Formation and the Kenney Glacier Formation. At the base, the Hope Bay Formation (Trinity Peninsula Group) is more than 1200 m thick and is characterised by marine siliciclastic turbidite and sandstone. It has an inferred Permo-Carboniferous age based on supposed

Carboniferous spores (Grikurov and Dibner 1968) and Rb-Sr isotopic dating of 'grits' and mudstones (281 ±16 Ma; Pankhurst 1983) but the age evidence is sparse and open to ambiguous interpretation (Smellie and Millar 1995). The Hope Bay Formation is separated by an angular unconformity and a long stratigraphic gap from the overlying Mount Flora Formation. The Mount Flora Formation (Botany Bay Group) is composed mainly of sandstones, conglomerates and shale, and contains the most significant fossil strata. The overlying Kenney Glacier Formation (Antarctic Peninsula Volcanic Group), which is also separated from the Mount Flora Formation by an angular unconformity, is composed of ignimbrites and welded tuffs. There has been debate over the age of the Mount Flora Formation (Andersson 1906, Halle 1913, Bibby 1966, Thomson 1977, Farquharson 1984, Francis 1986, Gee 1989, Rees 1990); the most recent palaeobotanical and radiometric data available support an age of Early to Middle Jurassic (Rees 1993a&b, Rees and Cleal 1993, Riley and Leat 1999). Faults have been observed in the northern face of Mount Flora (Birkenmajer 1993a: 30-31) and mapped separating the Trinity Peninsula Group and Mount Flora Formation (Smellie pers. comm. 2000).

The Mount Flora Formation is about 230-270 m thick and may be subdivided into an older Five Lakes Member and an upper Flora Glacier Member, which contains the most important fossil deposits. The Five Lakes Member is about 170 m thick and consists of plant-bearing coarse sedimentary breccias, conglomerates and sandstones. The dominant lithology, particularly in the lower part of the succession, is clast-supported cobble to boulder conglomerate (Farquharson 1984). It is well-exposed on the northern and northeastern slopes of Mount Flora between the Flora Glacier and Five Lakes Valley. The lower boundary of this member is an angular unconformity against the Hope Bay Formation. The contact between the Mount Flora Formation and the Hope Bay Formation is covered by scree: this is mapped as a fault on Map 3 (Smellie, unpublished data, pers. comm. 2000). Some 50 m of basal beds of the Five Lakes Member are presumed unexposed. A higher section of the Five Lakes Member is well-exposed at a buttress which separates Flora Glacier from Five Lakes Valley.

The Flora Glacier Member comprises a sandstone-conglomerate complex 60-100 m thick, locally overlain by a shale complex up to 10 m thick, which is the main fossiliferous zone. It is best exposed at a buttress that divides the Flora Glacier cirque from Five Lakes Valley at approximately 350 m. A one metre-thick sill occurs in the upper section of the shale, close to the contact with the Kenney Glacier Formation. The sandstone association is dominated by fining-upward cycles (characterised by decreasing grain size) that range in thickness from 2.5 – 11.5 m (Farquharson 1984). Although mostly inaccessible, good exposures of the Flora Glacier Member continue in the steep slopes of Mount Flora above Five Lakes Valley, extending westward to the margin of the Kenney Glacier. The thickness of the unit increases from 50-60 m at the buttress to about 100 m at the glacier margin. Volcanogenic deposits form a small but significant part of the Mount Flora Formation. A single ignimbrite 26 m thick forms a pale band across the north face of Mount Flora, approximately halfway up the sedimentary sequence (Farquharson 1984).

The Kenney Glacier Formation volcanic rocks overlie the Mount Flora Formation, exposed in the highest part of Mount Flora. It also unconformably overlies the Hope Bay Formation on the eastern spur of the Pyramid (Smellie, pers. comm. 2000). The incomplete formation is a complex of predominantly evolved, rhyolite-dacite lavas, ignimbrites, agglomerates and tuffs (Birkenmajer 1993a & b). Farquharson (1984) identified the presence of tuffs, fine-grained agglomerates and welded tuffs.

The most significant fossil exposures are found on the northern and northwestern faces of Mount Flora. Most research has been conducted on samples from the relatively accessible northern face. The fossil flora was first comprehensively described by Halle (1913) and since then has been considered a standard for Mesozoic gondwanan floristic and biostratigraphic studies

(Rees and Cleal 1993). Halle (1913) originally described 61 species from the fossils: more recently this was revised to 43 species (Gee 1989), and later to 38 species (Rees 1990, Rees and Cleal in press). The flora is represented typically by stems of sphenophytes (*Equisetum*), as well as foliage of ferns and gymnosperms (cycadophytes, pteridosperms and conifers). Cycadophyte and conifer cone scales, seeds and other unidentifiable stems, leaves and foliage branches are also preserved (Taylor, no date; Rees pers. comm. 1999). Four beetle elytra (exoskeletons) have been identified from a small sample of shale from Mount Flora (Zeuner 1959). These were identified as *Grahamelytron crofti* and *Ademosynoides antarctica*. No other examples of fossil fauna have been recorded. There are no known marine fossil floral or faunal deposits in the Area.

TERRESTRIAL AND FRESHWATER BIOLOGY

The living flora within the Area is sparse and patchily distributed. Although a full floristic survey has not been made, a number of moss and lichen species have been identified as present. Moss species identified are: *Andreaea gainii, Bryum argenteum, Ceratodon purpureus, Hennediella heimii, Pohlia nutans, Sanionia uncinata, Schistidium antarctici* and *Syntrichia princeps*. Lichen species identified are: *Acarospora macrocyclos, Buellia anisomera, Buellia* spp., *Caloplaca* spp., *Candelariella vitellina, Cladonia pocillum, Haematomma erythromma, Physcia caesia, Pleopsidium chlorophanum, Pseudephebe minuscula, Rhizocarpon geographicum, Rhizoplaca aspidophora, Stereocaulon antarcticum, Tremolecia atrata, Umbilicaria antarctica, Umbilicaria decussata, Umbilicaria kappenii, Usnea antarctica, Xanthoria candelaria* and *Xanthoria elegans*.

There are no permanent streams or lakes within the Area. No information is available on the invertebrate fauna or microbial communities present at Mount Flora.

BREEDING BIRDS

Little information is available on bird communities present at Mount Flora, although a report on the exact nesting sites of some species suggested that birds are unlikely to breed within the Area (Marshall 1945). However, the breeding birds of Hope Bay generally have been well-studied, and part of a large Adélie penguin (*Pygoscelis adeliae*) colony, numbering around 125 000 pairs, is situated about 500 m northeast of the Area (Woehler 1993) (Map 2). Other birds breeding at Hope Bay include gentoo penguins (*Pygoscelis papua*), brown skua (*Catharacta loennbergi*), Antarctic tern (*Sterna vittata*), Wilson's storm petrel (*Oceanites oceanicus*), kelp gull (*Larus dominicanus*), and sheathbill (*Chionis alba*). Further information on the number of breeding birds in the vicinity of Mount Flora can be found in Argentina (1997).

HUMAN ACTIVITIES AND IMPACTS

Mount Flora was discovered in 1903 by Johann Gunnar Andersson, a member of the Swedish South Polar Expedition of 1901-04, which explored and mapped much of the northern Antarctic Peninsula. Andersson collected fossil and mineralogical specimens from Mount Flora while stranded and awaiting rescue at Hope Bay over the winter of 1903. Andersson and his companions over-wintered in a stone hut (Historic Monument No. 39). The leader of the expedition was Otto Nordenskjöld, who named Mount Flora because of the geological findings of Andersson.

The United Kingdom established Base 'D' at Hope Bay in 1945 as part of 'Operation Tabarin'. The station was operational until February 1964 with a winter complement of 7-19 personnel. Base 'D' was transferred from the United Kingdom to Uruguay in 1997 and renamed as Teniente de Navio Ruperto Elichiribehety Station. Argentina established Esperanza Station on 31 December 1951 and has operated the station continuously since, with approximately 50 winter and up to 70 summer personnel.

Mount Flora was designated as a Site of Special Scientific Interest in 1989 as a result of concern that the best examples of fossils were being collected by casual visitors and might therefore be lost to science.

6(ii) Restricted and managed zones within the Area

None.

6(iii) Structures within and near the Area

There are no structures present within the Area. The nearest scientific research stations are Esperanza Station (Argentina) (latitude 63°24'S, longitude 56°59'W) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay) (latitude 63°24'S, longitude 56°59'W), both approximately 1.5 kilometres northeast of the Area.

The remains of a British Base, which burnt down in 1948, are situated 300 metres to the Northeast of the Uruguayan base. The graves of two British men who died in the above fire are located on a small promontory some 300 metres to the north of the Uruguayan base.

An Argentine hut is located close to the Area at 63°25'S, 56°58'W. It was established in 1956 and re-built in 1971.

6(iv) Location of other protected areas within close proximity of the Area

The nearest protected areas to Mount Flora are Potter Peninsula (ASPA No. 132) and the western shore of Admiralty Bay (ASPA No. 128), both located on King George Island, South Shetland Islands, lying approximately 150 km to the west (Map 1). A stone hut (Historic Monument No. 39) built by members of the Swedish South Polar Expedition is present within the vicinity of Esperanza Station (Map 2).

7. Permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- it is issued for scientific study of the geology or palaeontology of the Area, or for other scientific study which will not compromise the values for which the Area is protected;
- should the applicant for a Permit propose to make rock collections, the applicant shall demonstrate to an appropriate national authority that the research proposed cannot be adequately served by samples already collected and held in the various collections world-wide, before a Permit is granted;
- it is issued for essential management purposes consistent with plan objectives such as inspection, maintenance or review;
- the actions permitted will not jeopardise the geological or scientific values of the Area;
- any management activities are in support of the objectives of the management plan;
- the actions permitted are in accordance with the management plan;

- the Permit, or an authorised copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- permits shall be issued for a stated period;
- the appropriate authority should be notified of any activities/measures undertaken that were not included in the authorised Permit.

7(i) Access to and movement within the Area

- Access to and movement within the Area shall be on foot or by helicopter.
- Vehicles are prohibited from the Area.
- Access to the area by helicopter should avoid the penguin colony, either by a route following central Hope Bay and over Scar Hills to Five Lakes Valley, or over the ice cap about one kilometre east of Esperanza Station and Lake Boeckella (Map 2).
- No special restrictions apply to where helicopters may land within the Area.
- Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise trampling effects such as breakage of rocks, especially of rocks *in situ*.

7(ii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardise the scientific values of the Area;
- Essential management activities, including monitoring.

7(iii) Installation, modification or removal of structures

Structures shall not be erected within the Area except as specified in a Permit and permanent structures are prohibited. All scientific equipment installed in the Area must be approved by Permit and clearly identified by country, name of the principal investigator and year of installation. All such items should be made of materials that pose minimal risk of contamination of the Area. Removal of specific equipment for which the Permit has expired shall be a condition of the Permit.

7(iv) Location of field camps

Camping is prohibited within the Area.

7(v) Restrictions on materials and organisms which can be brought into the Area

No living animals, plant material or microorganisms shall be deliberately introduced into the Area. No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted. Fuel is not to be stored in the Area, unless specifically authorised by Permit for specific scientific or management purposes. All materials introduced

shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised. If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*. The appropriate authority should be notified of any materials released and not removed that were not included in the authorised Permit.

7(vi) Taking or harmful interference with native flora or fauna

There are no described fauna or flora within the Area.

7(vii) Collection or removal of anything not brought into the Area by the Permit holder

Material may be collected or removed from the Area only in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs. Permits shall not be granted if there is a reasonable concern that the sampling proposed would take, remove or damage such quantities of fossiliferous rocks that their abundance on Mount Flora would be significantly affected. Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit Holder or otherwise authorised, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified.

7(viii) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area.

7(ix) Measures that are necessary to ensure that the aims and objectives of the management plan can continue to be met

In view of the fact that geological sampling is both permanent and of cumulative impact the following measures shall be taken to safeguard the scientific values of the Area:

20. Visitors removing geological samples from the Area shall complete a record describing the geological type, quantity and location of samples taken, which should, at a minimum, be deposited with their National Antarctic Data Centre or with the Antarctic Master Directory.
21. Visitors planning to sample within the Area shall demonstrate that they have familiarised themselves with earlier collections to minimise duplication. Sample collections exist in repositories around the world, namely in: Museum of Natural Sciences B. Rivadavia, Buenos Aires; Museum of Natural Sciences, La Plata, Argentina; Natural History Museum, London; Swedish Natural History Museum, Stockholm; the Byrd Polar Research Centre, Ohio; Institute of Geological Sciences, Polish Academy of Sciences, Krakow, Poland; Department of Geology, Institute of Geosciences, Federal University of Rio de Janeiro, Brazil, British Antarctic Survey, Cambridge.

7(x) Requirements for reports

Parties should ensure that the principal holder for each Permit issued submits to the appropriate authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form suggested by SCAR. Parties

should maintain a record of such activities and, in the Annual Exchange of Information, should provide summary descriptions of activities conducted by persons subject to their jurisdiction, which should be in sufficient detail to allow evaluation of the effectiveness of the management plan. Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, to be used both in any review of the management plan and in organising the scientific use of the Area.

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