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 Chile and the 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 an 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 artefacts, 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 petrel (*Oceanites oceanicus*), cape petrel (*Daption capense*), kelp gull (*Larus dominicanus*), southern giant petrel (*Macronectes giganteus*), black-bellied storm petrel (*Fregetta tropica*), blue-eyed cormorant (*Phalacrocorax atriceps*), brown skua (*Catharacta loennbergi*), and sheathbill (*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

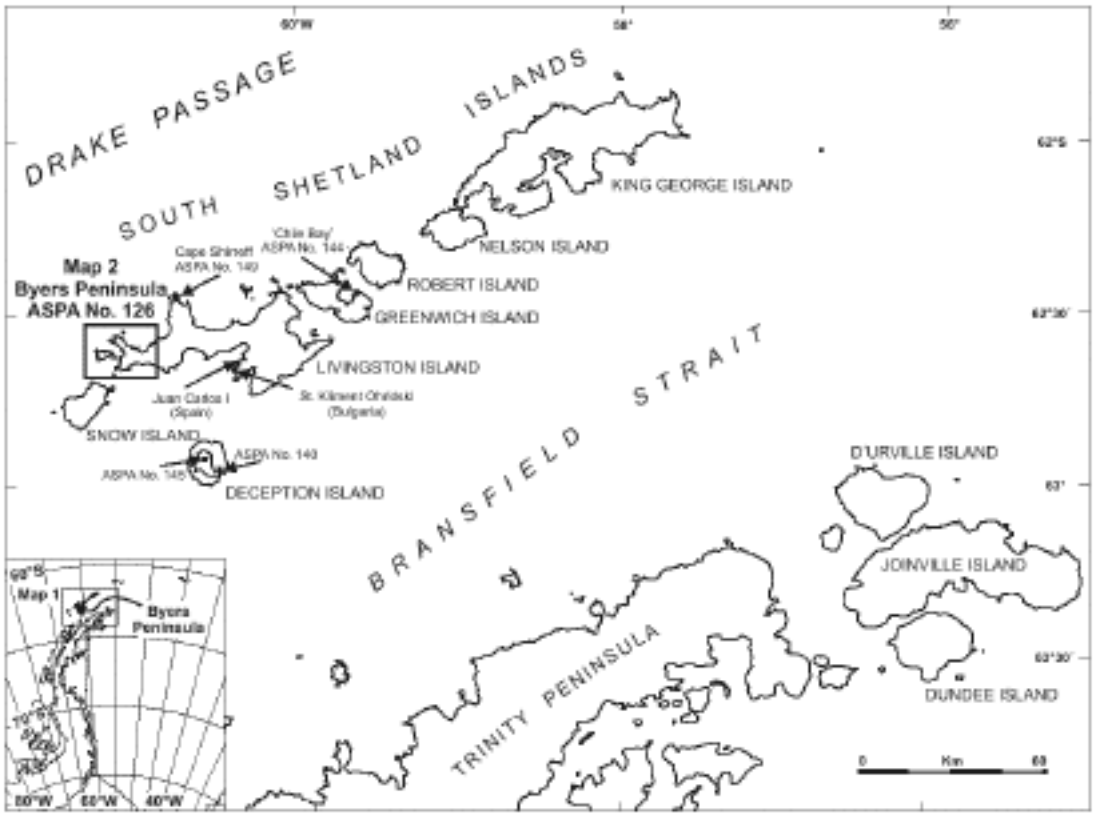
The following management activities shall be undertaken to protect the values of the Area:

- 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

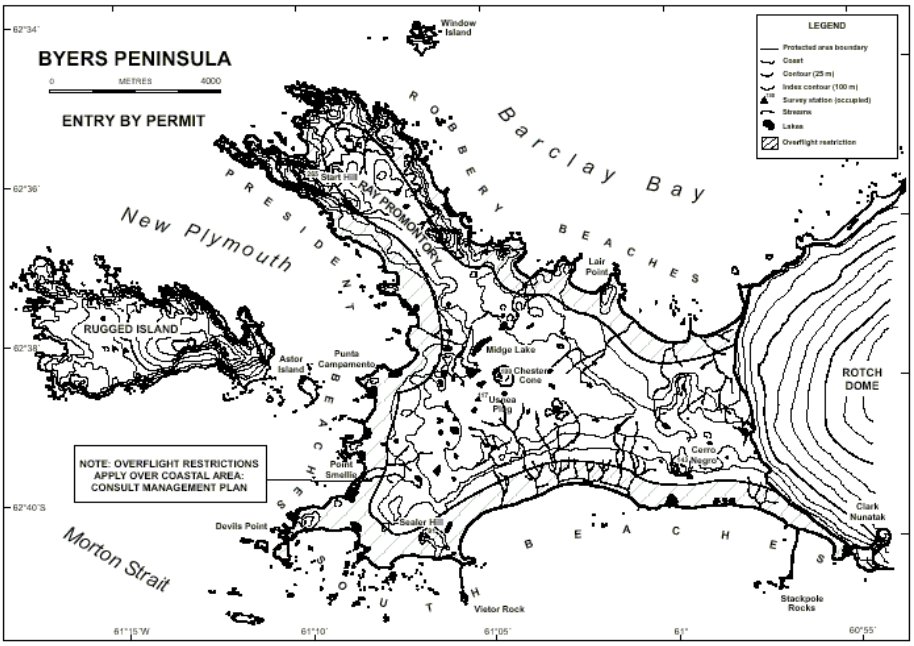
Designated for an indefinite period.

5. Maps and photographs



Map 1. Byers Peninsula, ASPA No. 126, Livingston Island, South Shetland Islands, location map. Inset: location of Byers Peninsula with respect to the Antarctic Peninsula

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.

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 the 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 the 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

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 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.
4. 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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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 artefacts (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).