

Management Plan for Antarctic Specially Protected Area No. 135

NORTH-EAST BAILEY PENINSULA, BUDD COAST, WILKES LAND

Introduction

North-east Bailey Peninsula was designated in 1985 as Site of Special Scientific Interest (SSSI) No 16 through Recommendation XIII-8, after a proposal by Australia. In accordance with Resolution 5 (1996) the site was redesignated and renumbered as Antarctic Specially Protected Area (ASPA) No. 135. The ASPA is designated primarily as a scientific reference site which, since the early 1980s, has supported a range of studies into the diverse assemblage of vegetation found in the area. The site is located in close proximity to Australia's Casey station, which allows ease of access for field research but also creates the potential for disturbance of study areas.

1. Description of Values to be Protected

Windmill Islands Region

Outside the Antarctic Peninsula, the Windmill Islands region supports some of the most extensive and best-developed plant communities on continental Antarctica. The region is floristically diverse with rich associations of macrolichens and bryophytes that occupy very specific ecological niches. The flora of the Windmill Islands region comprises at least 36 species of lichen, 6 bryophytes (5 mosses and 1 liverwort), 150 non-marine algae and at least 120 fungal taxa. An ascomycete mycorrhizal fungus has been shown in the liverwort *Cephaloziella varians*.

Lichens constitute the largest part of the Windmill Islands region flora, with bryophytes being dominant in moister areas. At least 11 cryptogamic community types have been identified. These vegetation groupings exist within a continuum of ecological variation along environmental gradients influenced by soil moisture, soil chemistry, and microclimate. On the peninsulas in the region, the major community types are distinguished by the dominance of three bipolar lichens, *Usnea sphacelata*, *Pseudephebe minuscula* and *Umbilicaria decussata*. Vegetation communities on the islands are dominated by algal species such as *Prasiola crispa*, with moss and lichen being considerably poorer developed than on the peninsulas. Mosses and lichens are all but absent in eutrophic sites near bird colonies with a prevalence of *Prasiola crispa*, *Prasiococcus calcareus* and *Desmococcus olivaceus* chlorophyte algae occurring.

North-east Bailey Peninsula Protected Area

The North-east Bailey Peninsula Antarctic Specially Protected Area (the Area) is representative of a diverse assemblage of the Windmill Islands region flora. As such, the Area has intrinsic ecological value and scientific importance, particularly to botanists, microbiologists, soil scientists and glacial geomorphologists.

The Area contains three extensive and contrasting moss fields that have been the subject of taxonomic, ecological and physiological studies since the summer of 1982/83. Additional studies have included population ecology of invertebrates associated with the vegetation, and soil/water chemistry. Permanent lichen growth monitoring sites are established, as are sites monitoring annual growth increments in mosses. Other floral studies have concentrated on the determination of biodiversity, physiological and biochemical attributes, component interactions, impact of anthropogenic pollutants, and potential effects of global climate change.

Global change studies have included a multi-season investigation into the impact of water and nutrients on various components of the vegetation, associated studies into the tolerance of mosses to both submergence and desiccation, and examination of the tolerance of three moss species to increased UV-B as a result of ozone depletion. Fine-scale analysis of genetic diversity of one cosmopolitan moss species *Ceratodon*

purpureus has been compared for this location and others in the region. Dating of long cores of mosses has been achieved using ^{14}C released during atmospheric atomic bomb testing in the 1950s and 1960s.

The Area is included within the geographic coverage of an Australian Antarctic program state of the environment indicator "Windmill Islands terrestrial vegetation dynamics", which involves quantitative analysis of a series of permanent transects across selected vegetation, with the aim of monitoring the effects of climate change on Antarctic cryptogamic communities.

Moss and lichen communities are used to monitor environmental impacts of Casey station. The Area provides baseline data with which to compare changes in similar plant communities in the immediate surroundings of Casey station. The Area also serves as a valuable comparative site for similar plant communities in ASPA 136 Clark Peninsula, which are subject to less environmental stress and disturbance.

2. Aims and Objectives

Management of the Area 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 a part of the natural ecosystem as a reference Area for the purpose of future comparative studies and to assess direct and indirect effects of Casey station;
- provide for compelling scientific research which cannot be served elsewhere;
- minimise the possibility of introduction of alien plants, animals and microbes to the Area; and
- allow for the continued maintenance of the Tandem Delta antenna communications installation and associated facilities without degradation of the Area's values.

3. Management Activities

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

- place signs illustrating the location and boundaries, with clear statements of entry restrictions at appropriate locations at the boundaries of the Area to help avoid inadvertent entry;
- display prominently information on the location of the Area (stating special restrictions that apply) and a copy of this Management Plan at Casey station and provide copies of this information to ships visiting the vicinity;
- secure and maintain in good condition markers, signs and structures erected within the Area for scientific or management purposes and remove them when no longer required;
- remove abandoned equipment or materials to the maximum extent possible provided this does not adversely impact on the values of the Area;
- detailed mapping of ongoing scientific experimental sites to ensure they are not disturbed;
- visit the Area 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 to ensure that management activities are adequate; and
- review the Management Plan at least every five years and update as required.

4. Period of Designation

Designated for an indefinite period.

5. Maps

Map A: Windmill Island, showing location of the North-east Bailey Peninsula ASPA No. 135 and other protected areas within the region.

Map specifications:

Projection: Lambert Conformal Conic

Horizontal Datum: WGS84

Map B: North-east Bailey Peninsula, Antarctic Specially Protected Areas No. 135: Topography, vegetation, birds, roads and structures.

Map specifications:

Projection: UTM Zone 49

Horizontal Datum: WGS84.

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Map C: North-east Bailey Peninsula, Antarctic Specially Protected Areas No. 135: Vegetation

Map specifications:

Projection: UTM Zone 49

Horizontal Datum: WGS84.

Map D: North-east Bailey Peninsula, Antarctic Specially Protected Areas No. 135. Geology.

Map specifications:

Projection: UTM Zone 49

Horizontal Datum: WGS84.

Map E: North-east Bailey Peninsula, Antarctic Specially Protected Areas No. 135: Showing buildings, structures and vegetation.

Map specifications:

Projection: UTM Zone 49

Horizontal Datum: WGS84.

6. Description of the Area

6(i) Geographical co-ordinates, boundary markers and natural features

General Description

The Area is located on Bailey Peninsula in the Windmill Islands region of Budd Coast, Wilkes Land, East Antarctica (Map A). Bailey Peninsula is an area of rock exposures and permanent snow and ice fields lying between Newcomb Bay and O'Brien Bay, two kilometres south of Clark Peninsula.

The Area is located in the north-east of Bailey Peninsula, approximately 200 m east of Casey station (66°16'59.9"S, 110°31'59.9"E), and covers an area of approximately 0.28 km². The boundary is irregular, extending in the north to within approximately 70 m south of Brown Bay. Boundary coordinates for the Area are shown in Appendix 1.

Topographically, Bailey Peninsula comprises low lying, rounded ice-free rocky outcrops (maximum altitude approximately 40 m), and, rising from the coast to the Løken Moraines (altitude approximately 130 m) approximately three kilometres to the east. Intervening valleys are filled with permanent snow or ice, or glacial moraine and exfoliated debris, and contain water catchment areas. The topography of Bailey Peninsula is shown at Map B.

Climate

The climate of the Windmill Islands region is frigid-Antarctic. Climate records from nearby Casey station (altitude 32 m) show mean temperatures for the warmest and coldest months of 2.2 and -11.4°C respectively, extreme temperatures ranging from 9.2 to -34°C, and mean annual maximum and minimum temperatures of -5.9°C and -12.5°C respectively. The climate is dry with a mean annual snowfall of 219 mm year (rainfall equivalent), precipitation as rain has been recorded in the summer.

There is an annual average wind speed of 25 km per hour. Gale winds are predominantly from the east, off the polar ice cap. Blizzards may occur very suddenly and are a frequent occurrence especially during winter. Snowfall is common during the winter, but the extremely strong winds scour the snow off exposed areas of the Peninsula. On most hill crests on Bailey Peninsula snow gathers in the lee of rock outcrops and in depressions in the substratum. Further down the slopes snow forms deeper drifts.

Geology and Soils

Windmill Islands Region

The Windmill Islands region represents one of the eastern-most outcrops of a Mesoproterozoic low-pressure granulite facies terrain that extends west to the Bunge Hills and further to the Archaean complexes in Princess Elizabeth Land, to minor exposures in the east in the Dumont d'Urville area and in Commonwealth Bay. The total outcrop areas do not exceed more than a few square kilometres. The Mesoproterozoic outcrop of the Windmill Islands and the Archaean complexes of Princess Elizabeth Land are two of the few major areas in East Antarctica that can be directly correlated with an Australian equivalent in a Gondwana reconstruction. The Mesoproterozoic facies terrain comprises a series of migmatitic metapelites and metapsammites interlayered with mafic to ultramafic and felsic sequences with rare calc-silicates, large partial melt bodies (Windmill Island supacrustals), undeformed granite, charnockite, gabbro, pegmatite, aplites and cut by easterly-trending late dolerite dykes.

Bailey Peninsula

Bailey Peninsula is part of the northern gradation of a metamorphic grade transition which separates the northern part of the Windmill Islands region from the southern part. The metamorphic grade ranges from amphibolite facies, sillimanite-biotite-orthoclase in the north at Clark Peninsula, through biotite-cordierite-almandine granulite, to hornblende-orthopyroxene granulite at Browning Peninsula in the south. The Ardery Charnockite of the south is prone to deep weathering and crumbles readily because of its mineral assemblage, whereas the metamorphic sequences of the northerly parts of the region have a much more stable mineral assemblage and crystalline structure. This difference has a significant influence on the distribution of vegetation in the Windmill Islands region with the northern rock types providing a more suitable substrate for slow growing lichens.

The leucocratic granite gneiss, which constitutes the main outcrop on Bailey Peninsula, may be subdivided into leucogneiss and two different types of garnet-bearing gneiss. The outcrop on Bailey Peninsula is characterised as a garnet-bearing gneiss type 1 which is white, medium grained and foliated. The foliation is defined by the alignment of an early biotite generation that is tight to openly folded, with a garnet and a later biotite generation that overgrows the fabric. Unmetamorphosed and undeformed dolerite dykes occur over Bailey Peninsula such as at "Penguin Pass" (66°17'18"S, 110°33'16"E), to the south of the Area. Small outcrops of metapelite, metapsammite and leuco- gneisses occur on the Peninsula. Recent geochronology of the rocks of the Windmill Islands region suggest two major phases of metamorphism, the first at c. 1400-1310 Ma, an upper amphibolite facies event, followed by a granulite facies overprint c. 1210-1180 Ma. The geology of Bailey Peninsula is shown at Map D.

Glaciation

The Windmill Islands region was glaciated during the Late Pleistocene. The southern region of the Windmill Islands was deglaciated by 8000 corr. yr B.P., and the northern region, including Bailey Peninsula deglaciated by 5500 corr. yr B.P. Isostatic uplift has occurred at a rate of between 0.5 and 0.6 m/100 yr, with the upper mean marine limit, featured as ice-pushed ridges, being observed on Bailey Peninsula at approximately 30 m where they extend in continuous rows from the present sea-level.

Soils

Soils on Bailey Peninsula are derived from weathered gneiss, moraine deposits and outwash gravels stemming from glacial episodes. Seabirds have a large impact on soil formation in the entire landscape. Soils are frozen much of the year during summer, the upper 30-60 cm thaws with the few top centimetres, refreezing at night. Soils are mainly formed by cryoturbation and cryoclastic weathering. In the vicinity of Casey station most soils are classified by Blume, Kuhn and Bølter (2002) as cryosols with lithic, leptic, skeletal, turbic and stagnic subunits. Other soils in the Area are gelic subunits of histosols, podzols, and regosols, boulder and rock outcrops with ecto- and endolithic flora are classified as Lithosols.

Lakes

Cold monomictic lakes and ponds occur throughout the Windmill Islands region in bedrock depressions and are usually ice-free during January and February. Nutrient rich lakes are found near the coast, in close proximity to penguin colonies or abandoned colonies, sterile lakes are located further inland and are fed by meltwater and local precipitation. A number of these lakes and ponds occur across Bailey Peninsula with two

large lakes located 500 m to the west of the Area. Two ponds occur within the protected Area, the largest being approximately 75 m by 50 m and the smaller approximately 25 m diameter. The distribution of lakes and ponds on Bailey Peninsula is shown at Map B.

Vegetation

The vegetation of Bailey Peninsula is exceptionally well developed and diverse and the Area represents one of the most important botanical sites on continental Antarctica. Within the relatively complex plant communities and contrasting habitats found on Bailey Peninsula, are found at least 23 lichens, three mosses, and a liverwort. There are expansive dense stands of macrolichens and in the more moist and sheltered areas bryophytes form closed stands of 25-50 m² with turf up to 30 cm in depth. Together with the lichens *Umbilicaria decussata*, *Pseudephebe minuscula* and *Usnea sphacelata*, mixed bryophytes dominate the vegetation cover of most of the ice-free areas. This is particularly so on the north-east and centre of the Peninsula where there are dense communities similar to those found on Clark Peninsula. The most complex bryophyte communities are restricted to small locally moist hollows adjacent to melt pools and streams in the central north-east and central parts of the Peninsula. Vegetation is absent or poorly developed on the ice-free areas of the Peninsula's southern coast. Appendix 2 provides a list of bryophytes and lichens identified in the Area. In many areas mosses appear to be becoming increasingly moribund and are being out-competed or overgrown by lichens.

Two principal cryptogamic subformations are recognised; a lichen-dominated association occupying a variety of windswept substrata ranging from bedrock to gravel, and, a short cushion and turf moss subformation comprising four moss dominated sociations. The vegetation of Bailey Peninsula is shown at Maps C and E.

At least 150 taxa of non-marine algae and cyanobacteria have been isolated; these include 50 cyanobacteria, 70 chlorophytes and 23 chromophytes. The taxa have been found in snow and ice, soil, rocks, ephemeral ponds, tarns and lakes; 24 cyanobacterial and algal species occur in the snow. Snow algae are abundant and widespread in the icy corridors between the rocky outcrops and in semi-permanent snow drifts. A list of cyanobacterial and algal species from the Area, Bailey Peninsula, and the Windmill Islands region is shown in Appendix 3.

The vegetated soils of Bailey Peninsula contain fungal hyphae, yeasts, fungal propagules, an assortment of algae, cyanobacteria, protozoa, and provide a significant habitat for soil microfauna such as nematodes, mites, rotifers and tardigrades. There is relatively low fungal diversity in the Windmill Islands region, with 35 taxa representing 22 genera of fungi being isolated from soils, mosses, algae and lichens. Thirty fungal taxa have been detected in soils in the vicinity of Casey station with 12 of these taxa restricted to anthropogenically influenced soils around the station, *Penicillium* species dominate in these sites. Within the Windmill Islands region, 21 fungal taxa have been isolated the mosses, with 12 taxa isolated from algae and 6 from lichens. A number of fungi have also been found associated with animals of the region. Appendix 4 provides detail of the taxa and their source.

Birds

Four species of birds are known to nest in the vicinity of Bailey Peninsula. These include Adélie Penguin *Pygoscelis adeliae*, the most abundant bird species in the Area. The nearest breeding colony is on Shirley Island about 1.5 km west of Casey station. Snow Petrels *Pagodroma nivea* are seen all year round and breed throughout the Windmill Islands region including Reeve Hill about 750 m west of the Area and Budnick Hill, 600 m to the northwest. Wilson's Storm Petrels *Oceanites oceanicus* breed throughout the Windmill Islands region and nest in the Area. The Antarctic Skua *Catharacta maccormicki* breeds throughout the Windmill Islands region at widely dispersed nests, mostly near Adélie Penguin colonies.

Other birds that breed in the Windmill Islands region but not in the immediate vicinity of Bailey Peninsula include Southern Giant Petrel *Macronectes giganteus*, Cape Petrel *Daption capense*, Southern Fulmar *Fulmarus glacialis* and Antarctic Petrel *Thalassoica antarctica*. The Emperor Penguin *Aptenodytes forsteri* is a common visitor to the Windmill Islands region and a breeding colony of approximately 2000 pairs is established in the area of Peterson Bank.

Terrestrial invertebrates and microbial communities

The Antarctic flea *Glaciopsyllus antarcticus* has been found in the nests of Southern Fulmars. The anopluran louse *Antarctophthirus ogmorhini* is found on the Weddell Seal *Leptonychotes weddellii*. A number of species of mallophagan lice have also been found on birds.

The mite *Nanorchestes antarcticus* has been found on Bailey Peninsula at sites characterised as having sandy or gravelly soils, free of extensive moss or lichen cover, and moist but not water-logged.

Five species of tardigrades have been collected on Bailey Peninsula: *Pseudechiniscus suillus*, *Macrobiotus* sp., *Hypsibius antarcticus*, *Ramajendas frigidus* and *Diphascoen chilense*. Significant positive associations between bryophytes and the most common species of tardigrades *P. suillus*, *H. antarcticus* and *D. chilense*, have been found, and strong negative associations between those species and algae and lichens have been established. No systematic or ecological accounts of nematodes have yet been published for the Windmill Islands region.

Protozoa have been studied at a number of sites on Bailey Peninsula and in the Area ciliates and testate amoebae are active. Twenty seven ciliate species and six testacean species have been found (see Appendix 5).

6(ii) Special Zones within the Area

There are no special zones within the Area.

6(iii) Location of Structures within and adjacent to the Area

Casey station (Australia) is located approximately 200 m west of the Area. Prior to the designation of the Area in 1986 an array of radio transmitters had been progressively established at the site since 1964. During the 2001/2002 and 2007/2008 summers redundant aerials and some other infrastructure were removed. A number of structures remain within the Area, including a small storage rack in the north-west, the transmitter building (which can also be used as an emergency refuge), a 45 m high tandem delta antenna mast and a non-directional beacon antenna located in the south-east (Map E). Another 35 m high mast is located approximately 100 m south of the Area.

6(iv) Location of other Protected Areas in the vicinity

- ASPA No. 136, Clark Peninsula, is located 2.5 km to the north-east, across Newcomb Bay.
- ASPA No. 103, Ardery and Odbert Islands, is located approximately 11 km to the south, west of Robinson Ridge.
- ASPA No. 160, Frazier Islands, is located in the eastern part of Vincennes Bay approximately 16 km to the west-north-west.

7. Permit Conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. A Permit to enter the Area may only be issued for compelling scientific research, maintenance of the Tandem Delta antenna communications installation and associated facilities, or for essential management purposes consistent with the Management Plan's objectives and provisions, and providing that the actions permitted will not jeopardise the ecological or scientific values of the Area or interfere with existing scientific studies. Conditions that must be included in the Permit are that the Permit or an authorised copy shall be carried within the Area, and that the Permit specify the period for specific activities. Additional conditions, consistent with the Management Plan's objectives and provisions, may be included by the issuing Authority.

7(i) Access to and Movement within or over the Area

Helicopters are prohibited from landing within the Area.

Vehicles are prohibited from entering the Area, except for the purpose of conducting ongoing maintenance of the transmitter building, associated buildings and antennas. Access to the transmitter building near the south-east end of the Area should be via the over-snow access route to Law Dome, several kilometres to the south. Within the Area, vehicles should follow the most direct practicable route between the Area boundary and the communications facilities, avoiding vegetation and cables. Vehicle use in the Area shall be kept to a minimum.

The Area is accessible on foot. Casey station is located approximately 200 m west of the north-west boundary of the Area. Visitors should avoid walking on visible vegetation. Care should be exercised when walking in areas of moist ground, where foot traffic can easily damage sensitive soils, plant or algae communities, and degrade water quality. Pedestrian traffic should be kept to the minimum necessary to undertake permitted activities and every reasonable effort should be made to walk around such areas, keeping to ice-covered areas or bare rock where it is practicable and safe to do so.

7(ii) Activities which are or may be conducted within the Area, including restrictions on time and place

- Compelling scientific research which cannot be undertaken elsewhere and which will not jeopardise the ecosystem of the Area.
- Essential management activities, including monitoring.
- Sampling, but this should be the minimum required for the approved research programs.
- Maintenance and activities associated with the antennas and transmitter facility.

7(iii) Installation, modification or removal of structures

Any structures erected or installed within the Area are to be specified in a Permit. Scientific markers and equipment must be secured and maintained in good condition, clearly identifying the permitting country, name of principal investigator and year of installation. All such items should be made of materials that pose minimum risk of contamination of the Area. Removal of equipment associated with scientific research, before the Permit for that research expires, shall be a condition of the Permit. Details of markers and equipment left in situ should be reported to the permitting Authority. Such details should include a description, expected "use by date", and accurate GPS location with longitude and latitude in decimal degrees to 6 decimal places (where practicable, details should also be given regarding the horizontal datum used, model of GPS, base station details, and horizontal and vertical accuracies).

7(iv) Location of field camps

Camping is prohibited within the Area.

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

- No living animals, plant material or microorganisms shall be deliberately introduced into the Area. To help maintain the ecological and scientific values of the plant communities found in the Area, persons entering the Area shall take special precautions against unintentional introductions. Of particular concern are microbial or vegetation introductions sourced from soils at other Antarctic sites, including stations, or from regions outside Antarctica. To minimise the risk of introductions footwear and any equipment – including carry cases, sampling equipment and markers – to be used in the Area shall be thoroughly cleaned before entering the Area.
- No herbicides or pesticides shall be brought into the Area. Other chemicals may be introduced for scientific or management purposes specified in a Permit and shall be removed from the Area at or before the conclusion of the permitted activity.
- Permanent fuel depots are prohibited. Fuel may be temporarily stored in the Area for essential purposes connected with an activity for which a Permit has been granted. Such fuel shall be stored in sealed and banded containers.
- Any materials introduced for a stated period shall be removed at or before the conclusion of the stated period, and shall be stored and handled so that the risk of dispersal into the environment is minimised.

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

Taking of or harmful interference with native flora and fauna is prohibited, except in accordance with a Permit. Where taking of or harmful interference with animals is involved this should, as a minimum standard, be in accordance with the *SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica*.

7(vii) Collection and removal of anything not brought into the Area by the Permit Holder

Material may only be collected or removed from the Area 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, and which was not brought into the Area by the Permit Holder or otherwise authorised, may be removed unless the impact of the removal is likely to be greater than leaving the material *in situ*. In such cases the appropriate national authority must be notified and approval obtained.

7(viii) Disposal of waste

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

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

Permits may be granted to enter the Area to carry out the following measures, provided they do not adversely impact on the values of the Area:

- biological monitoring and Area inspection and management activities, which may involve the collection of small samples for analysis or review;
- erect or maintain signposts;
- remove the storage rack, buildings, antenna masts and associated supplies located in the north-west of the Area; and
- other protective measures as required.

7(x) Requirements for reports

The principal Permit Holder for each Permit issued shall submit to the appropriate national authority a report describing the activities undertaken. Such reports should include, as appropriate, the information identified in the Visit Report form contained in Appendix 4 of the *Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas* appended to Resolution 2 (1998). 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.

8. Supporting documentation

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