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

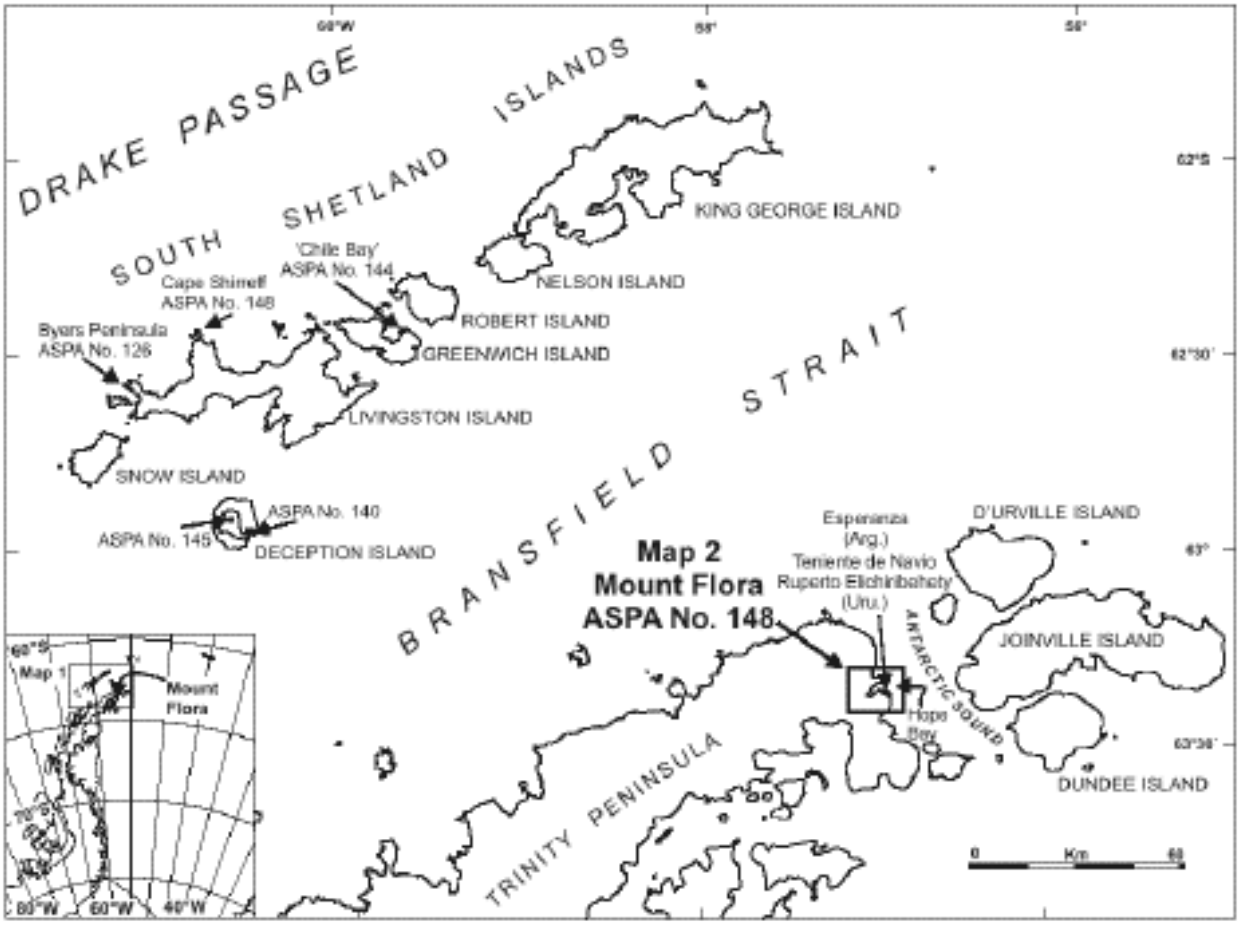
The following management activities shall be undertaken to protect the values of the Area:

- 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.

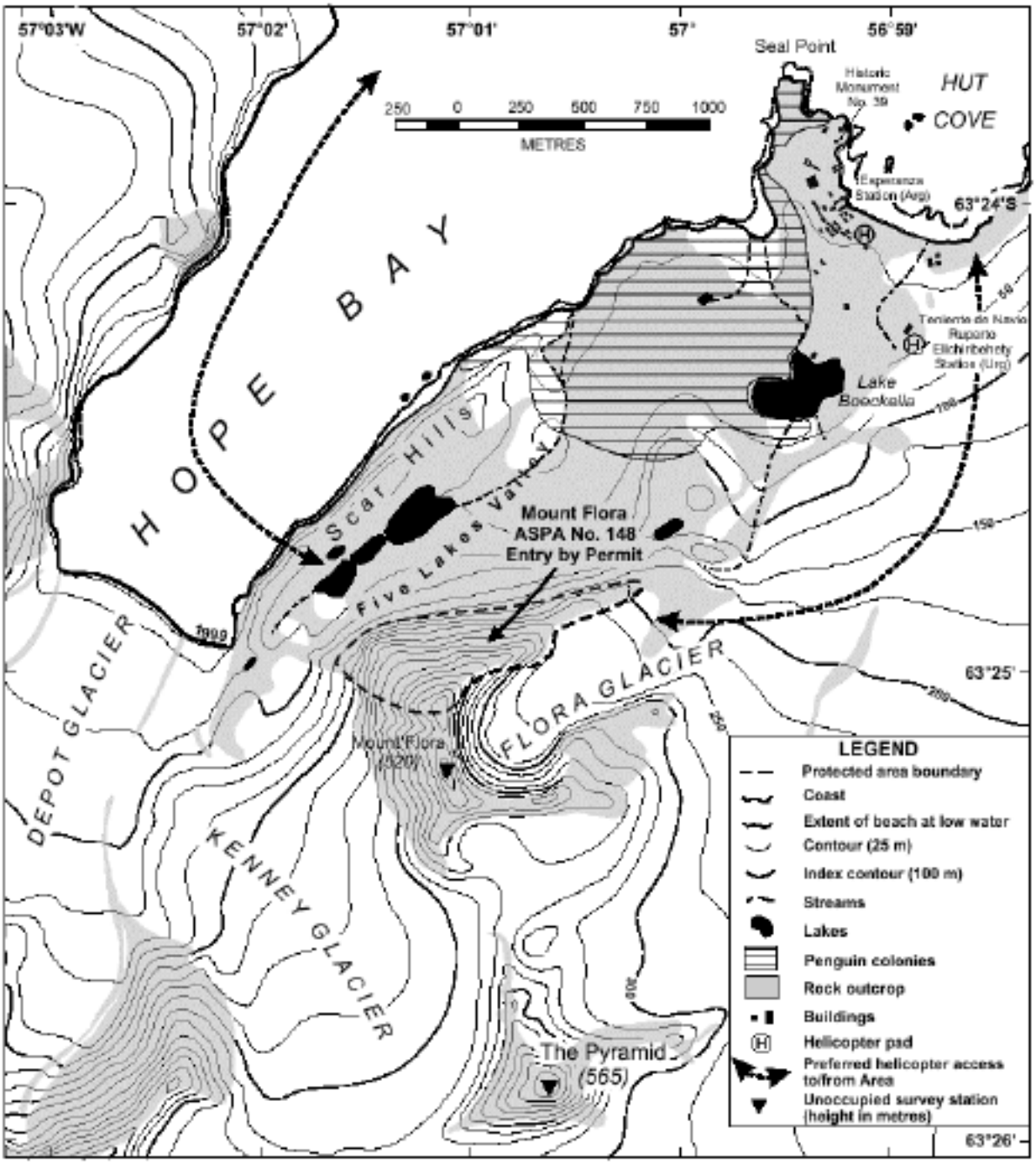
5. Maps and photographs



Map 1. Mount Flora (ASPA No. 148), Hope Bay, Antarctic Peninsula, location map. Inset: location of Mount Flora on the Antarctic Peninsula.

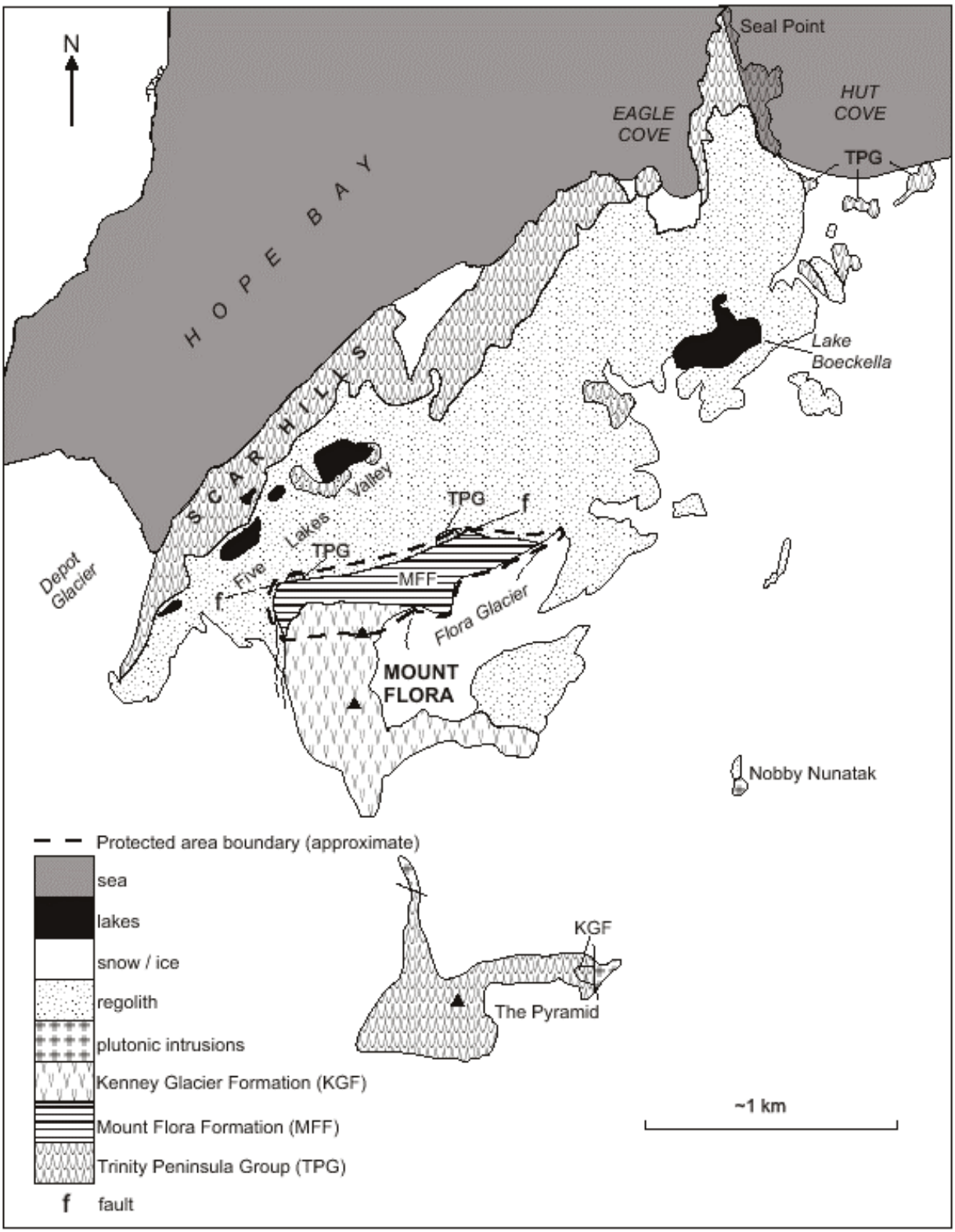
Map 1: Mount Flora ASPA No. 148 in relation to Hope Bay, Trinity Peninsula, and the South Shetland Islands, showing the location of the nearest protected areas. The location of Esperanza Station (Argentina) and Teniente de Navio Ruperto Elichiribehety Station (Uruguay) are also shown.

Inset: the location of Mount Flora on the Antarctic Peninsula.



Map 2. Mount Flora (ASPA No. 148), Hope Bay, topographic map.

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), Hope Bay, geological sketch map.

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:

1. 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.
2. 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.

Bibliography

Andersson, J.G. 1906. On the geology of Graham Land. *Bulletin of the Geological Institution of the University of Upsala* **7**:19-71.

Argentina 1997. Environmental Review of Argentine Activities at Esperanza (Hope) Bay, Antarctic Peninsula, *XXI ATCM, Information Paper 36.*

Bibby, J.S. 1966. The stratigraphy of part of north-east Graham Land and the James Ross Island group. *British Antarctic Survey Scientific Report* **53**.

Birkenmajer, K. 1992. Trinity Peninsula Group (Permo-Triassic?) at Hope Bay, Antarctic Peninsula. *Polish Polar Research* **13**(3-4):215-240.

Birkenmajer, K. 1993a. Jurassic terrestrial clastics (Mount Flora Formation) at Hope Bay, Trinity Peninsula (West Antarctica). *Bulletin of the Polish Academy of Sciences: Earth Sciences* **41**(1):23-38.

Birkenmajer, K. 1993b. Geology of late Mesozoic magmatic rocks at Hope Bay, Trinity Peninsula (West Antarctica). *Bulletin of the Polish Academy of Sciences: Earth Sciences* **41**(1):49-62.

Croft, W.N. 1946. Notes on the geology of the Hope Bay area. Unpublished report, British Antarctic Survey Archives Ref AD6/2D/1946/G1.

Farquharson, G.W. 1984. Late Mesozoic, non-marine conglomeratic sequences of Northern Antarctic Peninsula (Botany Bay Group). *British Antarctic Survey Bulletin* **65**: 1-32.

Francis, J.E. 1986. Growth rings in Cretaceous and Tertiary wood from Antarctica and their palaeoclimatic implications. *Palaeontology* **29**(4): 665-684.

Gee, C.T. 1989. Revision of the late Jurassic/early Cretaceous flora from Hope Bay, Antarctica. *Palaeontographica* **213**(4-6): 149-214.

Grikurov, G.E. and Dibner, A.F. 1968. Novye dannye o Serii Triniti (C1-2) v zapadnoy Antarktide. [New data on the Trinity Series (C1-2) in West Antarctica.] Doklady Akademi Nauk SSSR, 179, 410-412. (English translation: Proceedings of the Academy of Science SSSR (Geological Sciences) 179: 39-41).

Halle, T.G. 1913. The Mesozoic flora of Graham Land. *Wissenschaftliche ergebnisse der Schwedischen Südpolar-expedition 1901-1903* **3**(14).

Hathway, B. in press. Continental rift to back-arc basin: stratigraphical and structural evolution of the Larsen Basin, Antarctic Peninsula. *Journal of the Geological Society of London*.

Marshall, N.B. 1945. Annual report. Base D. Biology and Hydrography. Unpublished report, British Antarctic Survey Archives Ref AD6/1D/1945/N2.

Nathorst, A.G. 1906. On the upper Jurassic flora of Hope Bay, Graham Land. *Compte Rendus, 10th International Geological Congress, Mexico* **10**(2):1269-1270.

Pankhurst, R.J. 1983. Rb-Sr constraints on the ages of basement rocks of the Antarctic Peninsula. In Oliver, R.L., James, P.R. and Jago, J.B. eds. *Antarctic Earth Science*. Canberra, Australian Academy of Science: 367-371.

Pankhurst, R.J., Leat, P.T., Sruoga, P., Rapela, C.W., Marquez, M., Storey, B.C., and Riley, T.R., 1998. The Chon Aike province of Patagonia and related rocks in West Antarctica: a silicic large igneous province. Journal of Volcanology and Geothermal Research 81 113-136.

Rees, P. M. 1990. Palaeobotanical contributions to the Mesozoic geology of the northern Antarctic Peninsula region. Unpublished PhD thesis, Royal Holloway and Bedford New College, University of London.

Rees, P. M. 1993a. Dipterid ferns from the Mesozoic of Antarctica and New Zealand and their stratigraphical significance. *Palaeontology* **36**(3):637-656.

Rees, P. M. 1993b. Caytoniales in early Jurassic floras from Antarctica. *Geobios* **26**(1):33-42.

Rees, P.M., 1993c. Revised interpretations of Mesozoic palaeogeography and volcanic arc evolution in the northern Antarctic Peninsula region. *Antarctic Science* **5**: 77-85

Rees, P.M. and Cleal, C.J. 1993. Marked Polymorphism in *Archangelskya furcata*, a pteridospermous frond from the Jurassic of Antarctica. *Special papers in Palaeontology* **49**:85-100.

Rees, P.M. and Cleal, C.J. in press. Lower Jurassic floras from Hope Bay and Botany Bay, Antarctica. Submitted to *Special Papers in Palaeontology*.

Riley, T.R and Leat, P.T. 1999. Large volume silicic volcanism along the proto-Pacific margin of Gondwana: lithological and stratigraphical investigations from the Antarctic Peninsula. *Geological Magazine* **136** (1):1-16.

Smellie, J.L. and Millar, I.L. 1995. New K-Ar isotopic ages of schists from Nordenskjold Coast, Antarctic Peninsula: oldest part of the Trinity Peninsula Group? *Antarctic Science* **7**: 191-96.

Taylor, B.J. [no date]. Middle Jurassic plant material from Mount Flora, Hope Bay. Unpublished report, British Antarctic Survey Archives Ref ES3/GY30/6/1.

Thomson, M.R.A. 1977. An annotated bibliography of the paleontology of Lesser Antarctica and the Scotia Ridge. *New Zealand Journal of Geology and Geophysics* **20** (5): 865-904.

Truswell, E.M., 1991. Antarctica: a history of terrestrial vegetation. In Tingey, R.J., ed. *The geology of Antarctica.* Oxford: Clarendon Press, 499-537.

Woehler, E.J. (ed) 1993. *The distribution and abundance of Antarctic and sub-Antarctic penguins.* SCAR, Cambridge.

Zeuner, F.E. 1959. Jurassic beetles from Graham Land, Antarctica. *Palaeontology* **1**(4):407-409.