Management Plan for

Antarctic Specially Protected Area (ASPA), No 169

AMANDA BAY, INGRID CHRISTENSEN COAST, PRINCESS ELIZABETH LAND, EAST ANTARCTICA

1. Introduction

Amanda Bay is located on the Ingrid Christensen Coast of Princess Elizabeth Land, East Antarctica at 69°15' S, 76°49'59.9" E. (Map A). The Antarctic Specially Protected Area (ASPA) is designated to protect the breeding colony of several thousand pairs of emperor penguins annually resident in the south-west corner of Amanda Bay, while providing for continued collection of valuable long-term research and monitoring data and comparative studies with colonies elsewhere in East Antarctica.

Only two other emperor penguin colonies along the extensive East Antarctic coastline are protected within ASPAs (ASPA 120, Point Géologie Archipelago and ASPA 167 Haswell Island). Amanda Bay is more easily accessed, from vessels or by vehicle from research stations in the Larsemann Hills and Vestfold Hills, than many other emperor penguin colonies in East Antarctica. This accessibility is advantageous for research purposes, but also creates the potential for human disturbance of the birds.

The Antarctic coastline in the vicinity of Amanda Bay was first sighted and named the Ingrid Christensen Coast by Captain Mikkelsen in command of the Norwegian ship Thorshavn on 20 February 1935. Oblique aerial photographs of the coastline were taken by the Lars Christensen expedition in 1937 and by the US Operation Highjump in 1947 for reconnaissance purposes. In the 1954/55 summer, the Australian National Antarctic Research Expedition (ANARE) on the Kista Dan explored the waters of Prydz Bay, and the first recorded landing in the area was made by a sledging party led by Dr. Phillip Law on 5 February 1955 on Lichen Island (69°19'59.9"S, 75°31'59.9 E). Extensive aerial photography was flown by ANARE from 1957 to 1960.

The first recorded visit to Amanda Bay itself took place in August 1957, when a surveying party observed an astro fix at the Larsemann Hills. During the return flight to Davis, the area was photographed and named Amanda Bay after the newly-born daughter of the pilot, RAAF Squadron Leader Peter Clemence. Between 1957 and 1997 the colony is known to have been visited approximately once every for years (see Appendix 1), however in recent years there has been increased visitation from research scientists, station personnel on overland traverses, and commercial tourism operators.

2. Description of values to be protected

The Area is primarily designated to protect the breeding colony of emperor penguins located at Amanda Bay for their intrinsic and scientific values. The colony lies adjacent to the highly productive area of Prydz Bay and provides an ideal opportunity for comparative studies with emperor penguin colonies of the Mawson Coast further to the west.

The emperor penguin colony consists of several thousand pairs located on the fast ice in the southwest corner of the bay. The current range of the number of breeding pairs at the colony is unknown as no systematic census has been carried out since 1983 when Cracknell (1986) counted 2339 chicks and 2448 adults in the colony on 29/30 September (see Appendix 1). Since that count was conducted half way through the breeding season, it is not possible to accurately estimate the size of the breeding population, however it gives an indication of a minimal number of breeders present in that year

Emperor penguins *Aptenodytes forsteri* live all year in Antarctic waters and have a circumpolar breeding distribution. Colonies occur chiefly in three main areas: (1) the Weddell Sea and Dronning Maud Land; (2) Enderby and Princess Elizabeth Lands; and (3) the Ross Sea. There may be as many as 40 known breeding colonies; the majority of these have not been visited or systematically counted for decades, so the total breeding population is not accurately known. Most colonies are located between 20°W and 110°E along the coast of East Antarctica, and there is a concentration of breeding pairs at six colonies in the Ross Sea East (160°E to 170°E). The latitudes of colonies range from 66°S to 78°S. Emperor penguin colonies are typically located on the winter fast ice in areas where the ice forms early in the year and remains stable until early summer. Only three colonies are known to be located on land: one on Dion Island in Marguerite Bay, on the western Antarctic Peninsula (ASPA 107, 67°52'S, 68°43'W); one near Taylor Glacier, Mac. Robertson Land (ASPA 101, 67°28'S, 60°53'E); and one in the area of Richardson Lakes near Amundsen Bay in Enderby Land (66° 45'S, 50° 38'E).

3. Aims and Objectives

Management at Amanda Bay aims to:

- avoid degradation of, or substantial risk to, the emperor penguin colony by preventing / minimising unnecessary human disturbance;
- provide for ongoing research and monitoring of the emperor penguin colony, and other compelling scientific activity which cannot be undertaken elsewhere; and
- gather survey data on the population status of the emperor penguin colony on a regular basis.

4. Management Activities

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

- signs illustrating the location and boundaries, with clear statements of entry restrictions, shall be placed at appropriate locations on the boundary of the Area to help avoid inadvertent entry;
- information about the Area (describing the boundary and all special restrictions that apply) and copies of this Management Plan shall be made available at research/field stations in the Vestfold Hills and Larsemann Hills, and shall be provided to all ships visiting the vicinity;
- visits shall be made to the Area as necessary (where practicable, not 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
- the Management Plan shall be reviewed at least every five years and updated as required.

5. Period of Designation

Designated for an indefinite period.

6. Maps

The following maps are provided:

Map A: Amanda Bay Antarctic Specially Protected Area, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica. Location Amanda Bay on Ingrid Christensen Coast.

Map Specifications: Projection: Lambert Conical Conformal; Horizontal Datum: WGS84; Vertical Datum: Mean Sea Level.

Map B: Amanda Bay Antarctic Specially Protected Area, Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica. Location of Emperor Penguin Colony and Physical Features.

Map Specifications: Horizontal Datum: WGS84; Vertical Datum: Mean Sea Level.

7. Description of the Area

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

Amanda Bay (69°15'S, 76°49'59.9"E) lies south-west of the Brattstrand Cliffs, between the Vestfold Hills to the north-east and the Larsemann Hills to the south-west on the Ingrid Christensen Coast, Princess Elizabeth Land, East Antarctica (Map A). Amanda Bay is approximately 3 km wide and 6 km long, and opens north-west into Prydz Bay. The south-west side of the bay is flanked by the Flatnes Ice Tongue secured by Cowell Island at its western corner. The southern and eastern sides are bounded by continental ice cliffs. There are small islets towards the centre of the bay and several un-named islands a few kilometres offshore.

The Amanda Bay Antarctic Specially Protected Area comprises the rocks, islands and water, including fast ice, lying within an irregular area, covering the general area of Amanda Bay, commencing at a point to the north-east of Hovde Island at the terminus of the Hovde Glacier, 76°53'54.48"E, 69°13'25.77"S; then south along the coastline at the base of the Hovde Glacier ice cliffs, to a point at 76°53'44.17"E, 69°16'22.72"S; then west along the coastline at the base of a series of ice-free bluffs to a point 76°49'37.47"E, 69°16'58'48"S; then north along the base of the Flatnes Ice Tongue ice cliffs, to a point at the terminus of the Flatnes Ice Tongue, 76°46'41.07'E, 69°14'44.37"S; then a straight line in a north-easterly direction connecting with the originating point at 76°53'54.48"E, 69°13'25.77"S (Map B)

Emperor Penguins

The Amanda Bay emperor penguin colony occupies fast ice in the south-west corner of Amanda Bay, between two small islands to the east and the glacier tongue to the west. The colony has occupied a number of sites within Amanda Bay location since its discovery in 1957.

In September – October 1986, the colony occupied an area of some 100 m by 500 m during winter. This was in an area about 3.3 km south of that reported in 1961, but probably similar to the position reported in May 1960. In September – October 1986, the colony was divided into two major groups, the first occupying a dark–stained slope of consolidated snow, ice and excreta based on a strip of moraine landward of the tide cracks at the foot of the ice-cliffs. The second group was on the flat sea ice just seaward of the main tide crack zone. In October that year, open water was approximately 38 km from the colony and there was a continuous movement of adults and chicks between the two groups. In winter 1997, the colony consisted of six groups of ranging in size and covering a site some 2.5 km by 5 km on the fast ice, approximately 10 km from open water. The strong circular currents in Prydz Bay render the sea ice unstable for most of the year, and in so doing provide the penguins with good access northwards to open water for feeding.

The Amanda Bay colony was viewed from the air on three occasions in 1956/57, once in 1960 and again in December 1981. The only recorded ground count before 1970 was made on a one day visit on 21 May 1960. The Frozen Sea Expedition spent seven days at the colony, 27 September - 3 October and on 18 October 1983, and expeditioners made additional observations on sea ice offshore from the colony. This was the most recent thorough census, although observations during subsequent periodic visits from research stations in the Larsemann Hills and Vestfold Hills confirm the continued presence of the colony.

Other Biota

There are limited accounts of other fauna and no published accounts of flora in the immediate vicinity, although lichens have been collected from Hovde Island and the emergent headland moraine at the head of the bay at the edge of the polar plateau and the nunataks beyond. Adélie penguins (*Pygoscelis adeliae*), south polar skuas (*Catharacta maccormicki*), Wilson's storm petrels (*Oceanites oceanicus*) and Weddell seals (*Leptonychotes weddelli*) have been observed.

Climate

Limited data exists for the meteorology of Amanda Bay. The nearest areas with a substantial record of meteorological data are the Vestfold Hills (Davis), 75 km to the north-east, and the Larsemann Hills (Zhongshan and Progress II station), 22 km to the south-west. The prevailing wind within Amanda Bay appears to be highly variable east-south-east. The prevailing winds at Davis are north-east to east and of moderate strength, but in the Larsemann Hills violent southerly winds are often encountered. For most quarters of the wind, Amanda Bay would present ice cliffs to windward and leeward of the colony. Aerial photography has shown Amanda Bay to be almost completely filled by fast ice even during summer months.

Approximately 22 km to the south-west of Amanda Bay are the Larsemann Hills, where there are permanent Russian and Chinese research stations. A major feature of the climate of the Larsemann Hills is the existence

of persistent, strong katabatic winds that blow off the plateau from the north-east on most summer days. Daytime air temperatures from December to February frequently exceed 4°C and can exceed 10°C, with the mean monthly temperature a little above 0°C. Mean monthly winter temperatures are between -15°C and -18°C. Pack ice is extensive inshore throughout summer months, and the fjords and embayments are rarely ice-free. Precipitation occurs as snow and is unlikely to exceed 250 mm water equivalent annually.

Davis station, 75 km to the south-west, experiences a mean monthly temperature range from +1°C in January to -18°C in July. Winds are predominantly from between north to east. The mean annual wind speed is 18 km/hr. The windiest month is November, while the lightest winds are on average recorded in April. Snowfall is very light at Davis, and most snow accumulation is a result of drift snow blown from the plateau between March and October. The Vestfold Hills area is subject to frequently cloudy skies, very low absolute humidity, and a small amount of snowfall. The climate of Davis is less severe than most other locations in Antarctica because of the sheltering from katabatic winds by the Vestfold Hills. The extent of pack ice in September and October can reach as far north as 55°S. The fast ice edge in winter is usually between 5 km to 15 km south-west of Davis; the fast ice breaks up and is carried out to sea, usually in January.

Geology

Rock outcrops in southern Prydz Bay, comprising the Svenner Islands, the Brattstrand Cliffs, Amanda Bay, the Larsemann Hills, Bolingen Island, Søstrene Island, the Munro Kerr Mountains and Landing Bluff consist of interleaved paragneiss with high temperature mineral assemblages and structures about 500 Ma in age (Pan African). The paragneiss preserves no conclusive evidence of earlier metamorphism, but the orthogneiss has local relics of high-grade metamorphism at 1000 Ma The Pan-African event involved crustal thickening and burial of the paragneiss, followed by exhumation. There are also a number of intrusions that post-date peak metamorphism, including granitoid plutons and widespread pegmatic dykes which cross-cut both paragneiss and the plutons. One such granitoid pluton is found at Amanda Bay. This is K-feldspar rich and post-dates early foliations in the country gneiss. It has biotite foliation and contains garnet, spinel, apatite, and is thought to be syn-tectonic.

7(ii) Special Zones within the Area

There are no special zones within the Area.

7(iii) Location of structures within and adjacent to the Area

There are no structures within the Area.

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

There are no other protected areas in the near vicinity of Amanda Bay. Marine Plain, Antarctic Specially Protected Area No. 143 (68°36'S, 78°07'E) and Hawker Island, Antarctic Specially Protected Area No. 167 (68°35'S, 77°50'E) are located approximately 75 km north-east in the Vestfold Hills. The Larsemann Hills, Antarctic Specially Managed Area No. 6, is located approximately 22 km to the south-west (69°30'S 76°19'58"E).

8. 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:

- the actions permitted will not jeopardise the values of the Area;
- the actions permitted are in accordance with this 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 finite period;
- Permit Holders shall notify the appropriate authority of any activities or measures undertaken that were not authorised permit; and

- all census and GPS data shall be made available to the permitting authority and to the Parties responsible for the development of the Management Plan.

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

The coastline of Amanda Bay is partially comprised of a very large ice wall. Whenever possible, vehicle access should be from sea ice to the north of the colony, or overland from the south of the Area. Visitors to the Area are to take precautions to reduce vehicular and other disturbance to the penguins, and should avoid crossing between the colony and the sea.

It should be noted that conditions at Amanda Bay are seasonably variable, and when traversing the Area caution should be exercised. As a consequence it is not possible to be prescriptive about helicopter landing sites and access routes. Conditions should be assessed on each visit and caution exercised in accordance with the provisions of this management plan.

Vehicles should be kept at least 500 m from any bird or concentrations of birds.

The following conditions apply to the use of helicopters:

- overflight of the colony is prohibited;
- helicopters may not land, take off or fly within 1000 m of the colony;
- helicopters are to approach the Area from the north over the sea ice and, where sea ice conditions permit, land outside the Area, with access being by foot;
- helicopters approaching to land in the Area must fly low over the sea ice to avoid disturbing breeding penguins in the colony; and
- helicopters are not to be refuelled within the Area.

There are no marked pedestrian routes within the Area. Unless disturbance is authorised by permit, pedestrians should keep at least 50 m from the penguins.

8(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 avifauna or the ecosystem of the Area.
- Essential management activities, including monitoring.
- Sampling, which should be the minimum required for the approved research programs.

As the penguins are particularly sensitive to disturbance during the following periods:

- from mid-May to late July, when they are incubating eggs;
- from late July to late September, when adults are brooding chicks; and
- from late November to late December when the chicks moult and fledge, and also during moult in late summer,

authorised visitors should exercise particular care not to unduly disturb or interfere with the birds during these periods.

8(iii) Installation, modification or removal of structures

Field huts should be placed well away from the penguin colony at a point outside the Area. As conditions at Amanda Bay are seasonally variable, specific locations are not designated. Other structures may be installed within the Area subject to a Permit.

Markers, signs, equipment and structures erected in the Area for scientific or management purposes must be secured and maintained in good condition, and removed when no longer required. All such items should be made of materials that pose a minimum risk of environmental harm and must be marked to clearly identify the permitting country, name of principal investigator, year of installation and date of expected removal.

8(iv) Location of field camps

Temporary camping is allowed within the Area when necessary for purposes consistent with this Management Plan and where authorised in a Permit. As conditions at Amanda Bay are seasonally variable, specific campsite locations are not designated, but camping within 500 m of the emperor penguin colony should be avoided.

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

No poultry products are to be taken into the Area, other than foods containing pasteurized egg powder, stock cubes, powdered soups and canned soups that contain poultry.

No depots of food or other supplies are to be left within the Area beyond the time period or activity for which they are required.

No live animals, plant material or micro-organisms shall be deliberately introduced into the Area.

The precautions listed in section 8(ix) shall be taken to minimise the risk of accidental introductions.

No herbicides or pesticides shall be brought into the Area. Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in a 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 required for essential purposes connected with the activity for which the Permit has been granted. All such fuel shall be removed at or before the conclusion of the permitted activity. Permanent or multi-year fuel depots are not permitted.

All material introduced shall be for a stated period, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so as to minimise the risk of environment impacts.

8(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 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.

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

Material may be collected or removed from the Area only in accordance with a Permit and should be limited to the minimum necessary to meet scientific or management needs.

Material of human origin likely to compromise the values of the Area, 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*. If this is the case, the appropriate national authority must be notified and approval obtained.

8(viii) Disposal of waste

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

8(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 biological monitoring and Area inspection activities, which may involve the collection of samples for analysis or review; the erection or maintenance of scientific equipment and structures, and signposts; or for other protective measures.

Any specific sites of long-term monitoring shall be appropriately marked and a GPS position obtained for lodgement with the Antarctic Data Directory System through the appropriate national authority.

Ornithological research shall be limited to activities that, where practicable, are non-invasive and non-disruptive to the breeding birds present within the Area. Invasive and/or disruptive research shall only be authorised if it will have only a temporary and transient effect on the population.

Visitors shall take special precautions against the introduction of alien organisms to the Area. Of particular concern are pathogenic, microbial or vegetation introductions sourced from soils, flora or fauna at other Antarctic sites, including research stations, or from regions outside Antarctica. To minimise the risk of introductions, before entering the Area, visitors shall thoroughly clean footwear and any equipment to be used in the Area, particularly sampling equipment and markers.

8(x) Requirements for reports

Visit reports shall provide detailed information on all census data; maps and a description of locations of any new colonies or nests not previously recorded; a brief summary of research findings; comments indicating measures taken to ensure compliance with Permit conditions; and, where appropriate, copies of photographs take to illustrate reported matters.

Visitors are requested to make recommendations relevant to the management of the Area, in particular as to whether the values for which the ASPA was designated are being adequately protected and whether management measures are effective.

The report should be submitted as soon as practicable after the visit to the ASPA has been completed, but no later than six months after the visit has occurred. A copy of the report should be made available to the Permit issuing authority and to the parties responsible for development of the Management Plan (if different) for the purposes of reviewing the Management Plan in accordance with the Antarctic Treaty system requirements. Reports should include a completed SCAR Visit Report, or such information as required by national laws. The permitting authority should maintain a record of the report for an indefinite period and shall make this available to SCAR, CCAMLR, COMNAP, and to interested parties upon request.

8(xi) Emergency provision

Exceptions to restrictions outlined in the Management Plan are in an emergency as specified in Article 11 of Annex V of the Protocol on Environmental Protection to the Antarctic Treaty (the Protocol).

9. Supporting Documentation

Some or all of the data used within this paper were obtained from the Australian Antarctic Data Centre (IDN Node AMD/AU), a part of the Australian Antarctic Division (Commonwealth of Australia).

Budd, G.M. (1961). The biotopes of Emperor Penguin Rookeries. *Emu*, 61, 171-89.

Budd, G.M. (1962). Population studies in rookeries of the Emperor Penguin *Aptenodytes forsteri. Proceedings of the Zoological Society*, London 139, 365-388.

Cracknell, G.S. (1986). Population counts and observations at the emperor penguin *Aptenodytes forsteri* colony at Amanda Bay, Antarctica. *Emu*, 86(2): 113-117

Crohn, P.W. (1959). A contribution to the geology and glaciology of the western part of the Australian Antarctic Territory. *Bull. Bur. Miner. Resour. Geol. Geophys.*, Aust., No. 32.

Easther, R. (1986). Winter journey to the Amanda Bay emperor penguin rookery. *ANARE News* September 1986: 14.

Fitzsimons, I. (1988). Amanda Bay region geology studies fill important information gap. *ANARE News*, March 1988: 5.

Fitzsimons, I. (1997). The Brattstrand Paragneiss and the Søstrene Orthogneiss: A Review of Pan-African Metamorphism and Grevillian Relics in Southern Prydz Bay. In *The Antarctic Region: Geological Processes*. 121-130.

Gales, N.J., Klages, N.T.W., Williams, R. and Woehler, E.J. (1990). The diet of the emperor penguin, *Aptenodytes forsteri*, in Amanda Bay, Princess Elizabeth Land, Antarctica. *Antarctic Science*, 2(1): 23-28

Giese, M. and Riddle, M. (1999). Disturbance of emperor penguin *Aptenodytes forsteri* chicks by helicopters. *Polar Biology*, 22 (6): 366-371

Horne, R.S.C. (1983). The distribution of penguin breeding colonies on the Australian Antarctic Territory, Heard Island, the McDonald Islands and Macquarie Island. *ANARE Res. Notes No. 9.*

Johnstone, G.W., Lugg, D.J. and Brown, D.A. (1973). The biology of the Vestfold Hills, Antarctica. Melbourne. Department of Science, Antarctic Division, *ANARE Scientific Reports, Series B (1) Zoology*. Publication No. 123.

Kirkwood, R. and Robertson, G. (1997). Seasonal change in the foraging ecology of emperor penguins on the Mawson Coast, Antarctica. Marine *Ecology Progress Series* 156: 205-223.

Kirkwood, R. and Robertson, G. (1997). The energy assimilation efficiency of emperor penguins, *Aptenodytes forsteri*, fed a diet of Antarctic krill, Euphausia superba. *Physiological Zoology* 70: 27-32.

Kirkwood, R. and Robertson, G. (1997). The foraging ecology of female emperor penguins in winter. *Ecological Monographs* 67: 155-176.

Kirkwood, R. and Robertson, G. (1999). The occurrence and purpose of huddling by Emperor penguins during foraging trips. *Emu* 99: 40-45.

Korotkevich, E.S. (1964). Observations on birds during the first wintering of the Soviet Antarctic Expedition in 1956-1957. *Soviet Antarctic Expedition Information Bulletin,* Elsevier Publishing Company, Amsterdam. 149-152.

Lewis, D. (1984). Icebound in Antarctica. *National Geographic*, 166, 5: 634-663.

Lewis, D. (1987). *Icebound in Antarctica*. William Heinemann Australia, Richmond, Victoria

Lewis, D. and George, M., eds. (1984). The Initial Reports of the Mawson Anniversary and Frozen Sea Expeditions, nos. 4 and 11. Oceanic Research Foundation Occasional Publication 1:

Robertson, G. (1990). Huddles. *Australian Geographic*, 20: 76-94.

Robertson, G. (1992). Population Size and Breeding Success of Emperor Penguins *Aptenodytes forsteri* at the Auster and Amanda Glacier Colonies, Mawson Coast, Antarctica. *Emu*. 92: 62-71.

Robertson, G. and Newgrain, K. (1992). Efficacy of the tritiated water and 22Na turnover methods in estimating food and energy intake by Emperor penguins *Aptenodytes forsteri*. *Physiological Zoology,* 65: 933-951.

Robertson, Graham G. (1994). *The Foraging Ecology of Emperor Penguins (*Aptenodytes forsteri*) at two Mawson Coast Colonies, Antarctica*. PhD Thesis, University of Tasmania.

Robertson, G., Williams, R. Green, K. and Robertson, L. (1994). Diet composition of Emperor penguin chicks *Aptenodytes forsteri* at two Mawson Coast colonies, Antarctica. *Ibis,* 136: 19-31

Robertson, G. (1995). The foraging ecology of Emperor penguins *Aptenodytes forsteri* at two Mawson Coast colonies, Antarctica. *ANARE Reports* 138, 139.

Schwerdtfeger, W. (1970). The climate of the Antarctic. In: *Climates of the Polar Regions* (ed. S. Orvig), pp. 253-355.

Schwerdtfeger, W. (1984). Weather and climate of the Antarctic. In: *Climates of the Polar Regions* (ed. S. Orvig), p. 261.

Todd, F.S., *et. al.,* (1999). Observations in some Emperor Penguin *Aptenodytes forsteri* Colonies in East Antarctica. *Emu* 99:142-145.

Wienecke, B., Kirkwood, R., Robertson, G. (2004). Pre-moult foraging trips and moult locations of Emperor penguins at the Mawson Coast. *Polar Biology* 27: 83-91.

Wienecke, B.C., and Robertson, G. (1997). Foraging space of emperor penguins *Aptenodytes forsteri* in Antarctic shelf waters in winter. *Marine Ecology Progress Series* 159: 249-263.

Willing, R.L. (1958). Feeding habits of Emperor Penguins. *Nature*, 182: 194-95.

Willing, R.L. (1958). Australian discoveries of Emperor Penguin Rookeries in Antarctica during 1954-57. *Nature*, London, 182, 1393-1394.

Woehler, E.J. [comp.]; Poncet S. International Council of Scientific Unions. Scientific Committee on Antarctic Research. Bird Biology Subcommittee.; Scott Polar Research Institute. (1993). *The distribution and abundance of Antarctic and subantarctic penguins*. Cambridge: Scientific Committee on Antarctic Research (SCAR).

Woehler, E.J. *et. al.,* and International Council of Scientific Unions. Scientific Committee on Antarctic Research, Bird Biology Subcommittee, Commission for the Conservation of Antarctic Marine Living Resources, National Science Foundation [U.S.]. (2001). *A statistical assessment of the status and trends of Antarctic and sub-Antarctic seabirds.* Scientific Committee on Antarctic Research (SCAR)

Woehler, E.J.; and Johnstone, G.W. (1991). Status and conservation of the seabirds of the Australian Antarctic Territory Islands. In *Seabird - status and conservation: a supplement*, Cambridge: International Council for Bird Preservation, 279-297

Appendix 1. History of emperor penguin population observations at Amanda Bay, 1956-1997

Date	Estimated number of penguins present in colony	Comments	Reference
1956/57	5000 birds along Ingrid Christensen Coast	General reference, no systematic census	Korotkevich 1964
September, 1957	1000 – 2000 birds	No systematic count, no distinction between adults and chicks	Willing 1958
1961	1500 adults	Unspecified reference, no date given, no systematic count conducted	ANARE in Horne 1983
29/30 Sep 1983	2339 ± 69 chicks, 2448 ± 23 adults	Adults: en masse count after Budd (1961), chicks: Combined en masse count group I and indirect count of group II (see Budd 1961)	Cracknell 1986
1987	9000 ?	Unspecified reference, no date, no specification of unit, no systematic census	ANARE in Woehler & Johnstone 1991
13 Dec 1992	5500 – 6000 chicks	Chicks in five groups, estimate based on grid counts	Todd 1999
21 Dec 1996	1000 – 5000 total birds	Rough estimate from overflight	Todd 1999
Nov 1997	8000 chicks	No systematic count, rough estimate	J. Gallagher, pers. comm, in Giese and Riddle 1999