

Management Plan for Antarctic Specially Protected Area No 128

WESTERN SHORE OF ADMIRALTY BAY, KING GEORGE ISLAND, SOUTH SHETLAND ISLANDS

Introduction

The Western Shore of Admiralty Bay is located on King George Island, South Shetland Islands, ~125 kilometers from the northern Antarctic Peninsula. Approximate area and coordinates: 16.8 km² (centered at 58° 27' 40" W, 62° 11' 50" S). The Area is wholly terrestrial, and the primary reasons for designation are its diverse avian and mammalian fauna and locally rich vegetation, providing a representative sample of the maritime Antarctic ecosystem. Long term scientific research has been conducted on the animals within the Area. The Area is relatively accessible to nearby research stations and tourist ships regularly visit Admiralty Bay, and the ecological and scientific values of the area need protection from potential disturbance.

The Area was originally designated as Site of Special Scientific Interest (SSSI) No. 8 in Recommendation X-5 (1979, SSSI No. 8) after a proposal by Poland. The SSSI designation was extended through Recommendation XII-5 (1983), Recommendation XIII-7 (1985) and Resolution 7 (1995). A revised Management Plan was adopted through Measure 1 (2000). The site was renamed and renumbered as Antarctic Specially Protected Area (ASPA) No 128 by Decision 1 (2002). The Area lies within Antarctic Specially Managed Area (ASMA) No. 1 Admiralty Bay, King George Island, South Shetland Islands, designated under Measure 2 (2006).

The biological and scientific values of the Area are vulnerable to human disturbance (e.g. oversampling, disturbance to wildlife, introduction of non-native species). Therefore, it is important that human activities in the Area are managed to minimize the risk of impacts. A small area of the introduced species *Poa annua* has been noted within the Area, and this is being given priority management attention. The Area is considered of sufficient size to protect the values for which special protection is required because it includes within the boundaries numerous examples of the features represented (e.g. plant and animal communities), which should ensure that the Area is able to withstand changes that could arise from local or regional pressures, particularly when considered in combination with other instruments that apply in the region such as Antarctic Specially Managed Area No.1 Admiralty Bay, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Agreement on the Conservation of Albatrosses and Petrels (ACAP).

The Area comprises environments within three of the domains defined in the Environmental Domains Analysis for Antarctica: Environment A – Antarctic Peninsula northern geologic; Environment E – Antarctic Peninsula, Alexander and other islands; and Environment G – Antarctic Peninsula offshore islands. Under the Antarctic Conservation Biogeographic Regions classification the Area lies within ACBR3 – Northwest Antarctic Peninsula.

1. Description of values to be protected

The western shore of Admiralty Bay possesses a diverse avian and mammalian fauna and locally rich vegetation which is representative of the maritime Antarctic terrestrial ecosystem. The breeding colonies of Adélie (*Pygoscelis adeliae*) and gentoo penguin (*Pygoscelis papua*) within the Area are among the largest on King George Island, and the site is one of only a few protected areas where all three *Pygoscelid* penguins are found breeding together at the same location. Ten other birds breed within the Area, including chinstrap penguins (*Pygoscelis antarctica*), southern giant petrel (*Macronectes giganteus*), cape petrel (*Daption capense*), Wilson's storm petrel (*Oceanites oceanicus*), black-bellied storm petrel (*Fregetta tropica*), sheathbill (*Chionis alba*), south polar skua (*Stercorarius maccormicki*), brown skua (*Stercorarius lonnbergi*), Dominican gull (*Larus dominicanus*), and Antarctic tern (*Sterna vittata*).

Elephant seals (*Mirounga leonina*), Antarctic fur seals (*Arctocephalus gazella*), Weddell seals (*Leptonychotes weddellii*) rest and/or breed on a number of beaches within the Area. Leopard seals (*Hydrurga leptonyx*) and

crabeater seals (*Lobodon carcinophagus*) frequent Admiralty Bay, and are occasionally present on beaches within the Area.

Rich terrestrial plant communities exist within the Area, including one of the most extensive areas colonized by the Antarctic hairgrass *Deschampsia* and the pearlwort *Colobanthus* in Antarctica. Extensive stands of moss from the families Andreaeaceae, Bryaceae, Polytrichaceae, Pottiaceae and Grimmiaceae are present, particularly near the coast up to 60 m a.s.l. Lichen assemblages are more dominant at higher elevations. Rich microbial communities are also represented, including algae (e.g. *Prasiola*, *Phormidium*), mites (from the Orders / Suborders Prostigmata, Mesostigmata and Oribatida) and nematodes (e.g. *Plectus* and *Panagrolaimus*).

The values to be protected are those associated with the exceptionally diverse assemblage of plants and animals, which is a representative example of the Maritime Antarctic ecosystem, and the long-term scientific studies that have been undertaken within the Area, especially since 1976. In particular, scientific studies undertaken within the Area have been important in relation to documenting and interpreting large-scale regional shifts in pygoscelid penguin populations that have been observed on the Antarctic Peninsula and its offshore islands over recent decades.

Recent exposure of new areas of ice-free ground as a result of glacial recession offers opportunities for studies of colonisation processes, which represents an additional scientific value of the Area. The status of the non-native species *Poa annua* on the deglaciated moraines near Ecology Glacier is systematically monitored. The whole Area is also monitored for the presence of other unintentionally introduced species.

2. Aims and objectives

Management at the western shore of Admiralty Bay aims to:

- Avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance;
- Allow scientific research on the ecosystem of the Area, in particular on the avifauna, pinnipeds and terrestrial ecology, while ensuring protection from oversampling or other possible scientific impacts;
- Allow other scientific research, scientific support activities and visits for educational and outreach purposes (such as documentary reporting (visual, audio or written) or the production of educational resources or services) provided that such activities are for compelling reasons that cannot be served elsewhere and will not jeopardise the natural ecological system in the Area;
- Minimize the possibility of introduction of additional alien plants, animals and microbes to the Area;
- Minimise the possibility of the introduction of pathogens that may cause disease in faunal populations within the Area;
- To prevent the spread of the non-native grass *Poa annua* present within the Area beyond its current limits of location and extent while further research is undertaken and management strategies for long-term control are developed, and to coordinate these strategies with those developed for the management of non-native species within ASMA No. 1 Admiralty Bay more generally; and
- Allow visits for management purposes in support of the aims of the management plan.

3. Management activities

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

- Signs showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently, and a copy of this management plan shall be kept available, in the research hut facilities within the Area and at all permanent scientific stations located within Admiralty Bay;
- Copies of this management plan shall be made available to all vessels and aircraft visiting the Area and/or operating in the vicinity of the adjacent stations, and all pilots and ship captains operating in the region shall be informed of the location, boundaries and restrictions applying to entry and overflight within the Area;

- National programs shall take steps to ensure the boundaries of the Area and the restrictions that apply within are marked on relevant maps and nautical / aeronautical charts;
- Markers, signs or structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition, and removed when no longer required;
- National Antarctic programs operating in the Area should maintain a record of all new markers, signs and structures erected within the Area;
- The non-native species *Poa annua* present within the Area near Ecology Glacier should be monitored annually for changes in its extent and / or density, and policies on containment or eradication of the species within the Area be developed as a matter of urgency, then implemented and kept under review;
- Before an informed decision can be made on the likely success and benefits relative to the environmental damage of an eradication attempt, more information on the species distribution and current and likely future ecosystem impacts is needed, and further research to address these questions should be supported. However, should an appropriate authority approve it as necessary to protect the values of the Area, mechanical removal of non-native species by hand tools may be undertaken in accordance with procedures to be set out as part of an assessment of impacts in advance;
- Personnel (national program staff, field expeditions, tourist expedition leaders and pilots) in the vicinity of, accessing or flying over the Area shall be specifically instructed by their national program, tour operator or appropriate national authority to observe the provisions and contents of the Management Plan;
- Visits shall be made as necessary (no less than once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate;
- National Antarctic Programs operating in the region shall consult together with a view to ensuring that the above provisions are implemented.

4. Period of designation

Designated for an indefinite period.

5. Maps and photographs

Map 1. ASPA No. 128 Western Shore of Admiralty Bay, King George Island – Regional overview.

Inset: Location of King George Island, South Shetland Islands, Antarctic Peninsula.

Projection: Lambert Conformal Conic; Standard parallels: 1st 62°00' S; 2nd 62°15' S; Central Meridian: 58°15' W; Latitude of Origin 64°00 S; Spheroid and horizontal datum: WGS84. Topography and coastlines provided by Proantar, Brasil. Bathymetry: International Bathymetric Chart of the Southern Ocean (IBCSO) v1 (2013). Other data supplied by Environmental Research & Assessment.

Map 2. ASPA No. 128 Western Shore of Admiralty Bay: access, facilities & wildlife.

Map specifications: Projection: UTM Zone 21S; Spheroid and horizontal datum: WGS84. Topography and bathymetry provided by Proantar, Brasil. Coastline updated from WorldView-1 imagery (Mar 2008; imagery © Digital Globe courtesy of US NGA Commercial Imagery Program). Streams digitized from orthophoto map by Pudelko (1979). Location of *Poa annua*, small boat landing sites, marker and HSM No.51 supplied by Polish Antarctic Program. Other data supplied by Environmental Research & Assessment.

6. Description of the Area

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

General description

The Area is situated on the western shore of Admiralty Bay on the south side of King George Island, which is the largest of the South Shetland Islands archipelago. Arctowski Station (Poland) is situated 0.5 km to the north. The Area comprises ice-free terrain including steep crags of up to 400 m in elevation with more gentle

morainic slopes interspersed by several glaciers extending down to the coast. The shoreline consists of broad pebbly beaches interrupted by rocky headlands. The Area is ~17 km².

Boundaries and coordinates

The eastern boundary of the Area follows the coastline on the western shore of Admiralty Bay from the SE extremity of Halfmoon Cove (58°27'49"W, 62°09'44"S) for ~ 6 km SSE to Demay Point (Map 2). The boundary thence follows the coastline SW around Paradise Cove and Utchatka Point approximately 3.5 km to Telefon (Patelnia) Point (58°28'28"W, 62°14'03"S). From Telefon Point the boundary extends northward in a straight line for ~2.3 km to The Tower (367 m; 58°28'48"W, 62°12'55"S), a distinctive peak above Tower Glacier. The boundary continues in this direction a further 5.3 km to Jardine Peak (285 m; 58°29'54"W, 62°10'03"S). The boundary descends eastward in a straight line from Jardine Peak for ~1.7 km to the highest point on Penguin Ridge, ~ 550 m from Arctowski Station. The boundary thence extends NE for ~0.3 km to the SE coast of Halfmoon Cove. A marker is placed in Halfmoon Cove on the northern boundary of the Area at 58°27'48.7" W 62°09'43.7" S, ~500 m southeast of Arctowski station (Map 2).

Climate

The climate of the Area is typical of maritime Antarctica. Based on complementary data obtained at Arctowski Station (Poland) between 1977-2000 and from 2006 and at the Comandante Ferraz Station (Brazil) since 1984, the microclimate of Admiralty Bay is characterized by an average annual temperature of around -1.8 °C and an average annual wind speed of approximately 6.5 m s⁻¹. Annual average precipitation equals 508.5 mm, humidity is 82% and pressure 991 hPa. The waters of Admiralty Bay have an annual temperature range of -1.8° to +4°C, being well mixed by tides and strongly influenced by currents and coastal upwelling (from ASMA No.1 Admiralty Bay Management Plan).

The climate has recently been changing under the influence of unstable pressure systems such as the Southern Annular Mode (SAM) and the El Nino Southern Oscillation (ENSO) (Bers *et al.* 2012). Rapid regional warming of air temperature on the Western Antarctic Peninsula (WAP) observed over the last 50 years is exceptional and unprecedented in comparison with the record from ice core data over the past 500 years (Vaughan and Doake 1996). The most recent reconstructions show a warming trend between 1957 - 2006 of 0.12 °C per decade for the whole Antarctic continent, and of 0.17 °C per decade for West Antarctica (Steig *et al.* 2009). Schloss *et al.* (2012) show the 50-year warming trend has yielded an average increase of air temperature of about 2.0 °C in summer and 2.4 °C in winter at nearby Carlini Station (Map 1). Kejna *et al.* (2013), analysing data from all available meteorological sources on King George Island and on Deception Island, showed a 1.2 °C increase in annual average air temperature and a 2.3 hPa decrease in atmospheric pressure over a comparable time period.

Geology, geomorphology and soils

Geological investigations on King George Island prior to 1980 were performed by British, Argentinian, Russian and Chilean scientists, although the area within ASPA No. 128 was not described because it does not have any paternal lithostratigraphic rock sequences (for details see Birkenmajer 2003). The first geological map covering this area was presented by Birkenmajer (1980), republished with minor modifications in Birkenmajer (2003). The area of ASPA No.128 is included by Birkenmajer (2003) in the Warszawa tectonic block (terrane), that consists of Cretaceous, Paleocene, Eocene volcanic and pyroclastic rock with trace participation of sedimentary rocks. Volcanic rocks belong mainly to basal, basaltic andesite, andesite intercalated with tuffs, scoria and volcanic breccia. Sediments bearing plant remains occur only in the thin horizon (<1 m) of the upper part of Zamek sections. Moreover, dispersed petrified wood is present in agglomerates of the Tower, and abundant fossil flora was present in reworked clastics of the Błaszczyk moraine. A rich collection of dicotyledonous leaf, represented mainly by the genus *Nothofagus* and by laurophyllous plant frond impressions as well as conifer shoot imprints, was gathered and described from this site (Birkenmajer & Zastawniak 1989; Zastawniak 1994; Dutra & Batten 2000). Several hypabyssal intrusions (plug, dykes, sills) of diversified petrographic and geochemical composition cut stratiform volcanic complexes of Warszawa Terrane (Barbieri *et al.* 1987). Recently performed isotopic analyses (⁴⁰Ar-³⁹Ar of rock and U-Pb of zircons) gave Eocene ages for most of the rocks from the Area considered previously as Cretaceous, including the fossil flora bearing formations (Nawrocki *et al.* 2011).

Poor tundra soils occurring in the maritime Antarctic climate are difficult to describe according to criteria used in traditional soil classification systems. The first ecological and intuitive soil classification covering the maritime Antarctic, including ASPA No.128, was proposed by Everett (1976). Schaefer *et al.* (2007) identified 20 soil-scape units in the Arctowski Station vicinity and classified them according to their vulnerability in a geo-environmental map, partly comparable to that of more formal soil units proposed by Blume *et al.* (2002). Particular attention has been focused in this region on coastal soils around penguin colonies, since their fertile ecosystems are highly productive and biologically diverse. Ornithogenic soils were fully described and mapped (or indicated on air photographs) in papers by Tatur & Myrcha (1984); Tatur (1989) and Tatur (2002). Ornithogenic soils of the maritime Antarctic were subdivided into: organic soils of the rookery (with hydroxyapatite); soils of the phosphatized zone (with Al-Fe phosphates bearing K and NH₄ ions) and soils accumulated from inactive reworked phosphates. Moreover, relic soils at the locations of abandoned penguin colonies were distinguished and are an important feature in the Area. The phosphatization was described as a soil forming process, investigated also in other papers (e.g. Simas *et al.* 2007). Blume *et al.* (1997) and Beyer *et al.* (1999) identified the phosphatization as a podzolization and, using the new version of the US Soil Taxonomy, summarised the dry permafrost-affected soils (which they identified as occurring within the Area) as Anhydrous soils and Gelisols, where pedogenetic processes like cryoturbation, brunification and podzolization occurred.

Glaciology, streams and lakes

The Area is shaped by valley glaciers draining the Warszawa icefield, which are constrained at the sides by exposed bedrock. Isolated rocky hills are covered by rock rubble, with glaciers and glacial deposits filling depressions among them. Prominent early Holocene cliffs may be observed in the coastal zone. Holocene raised beaches (up to 16 m a.s.l.) and more recent beaches are comprised of sand with pebbles and boulders.

Several glaciers descend into the Area, flowing eastward from the Warszawa Icefield (Map 2). These have been in continuous retreat for at least the last 30 years, with former tidal glacier fronts retreating up to 900 m inland between 1997–2007 (Battke *et al.* 2001; Pudelko 2007), which is consistent with a global warming trend and a local reduction in the size of floating glaciers in Admiralty Bay (Braun & Gossmann 2002). The ice-free area of ASPA No128 has increased from 20% in 1979 to more than 50% in 1999 (Battke *et al.* 2001) and continues to increase. Retreating glaciers deposited bands of ridges formed by fresh lateral moraines and ground moraines on the flat areas at the front of glaciers, often with brackish water lagoons collecting glacial meltwaters mixed with seawater (Ecology, Baranowski, and Windy glaciers). Newly exposed land and new water bodies are colonized by biota that create a unique opportunity to study succession processes in the Antarctic environment (Olech & Massalski 2001).

A number of small meltwater streams are present within the Area, mainly originating from the outlet glaciers flowing down from the Warszawa Icefield (Map 2).

Terrestrial ecology

Vegetation typical of the maritime Antarctic has partially colonised the ice-free terrain within the Area. Dry areas and rocks are colonised by lichens, with flowering plants such as *Deschampsia antarctica* and *Colobanthus quitensis* locally numerous and occupying fairly large areas particularly in the vicinity of Arctowski Station. This constitutes one of the largest areas covered by these species in the Antarctic. Bryophyta and flowering plants dominate the vegetation from 0 to 60 m a.s.l., while lichens are more dominant above this elevation. Mosses can be found from the families Andreaeaceae, Bryaceae, Polytrichaceae, Pottiaceae and Grimmiaceae. Around penguin colonies the species richness and diversity is lower due to the high nitrate and ammonia content of the soil (Olech 2002; Victoria, Pereira, and Pinheiro 2009).

One alien species of grass, *Poa annua*, was observed in 2008-09 within the Area on the deglaciated moraines of the Ecology Glacier (Olech & Chwedorzewska 2011) (approximate location 58° 27' 54"W 62° 10' 7"S, Map 2). This species was first recorded outside of the Area, at Arctowski Station, in summer 1985-86 (Olech 1996), first in places where the soil structure had been disturbed by human activities and later within native vegetation communities (Olech unpublished, after Chwedorzewska 2008)). High genetic variability suggests

several separate immigration events from different sources, including Europe and South America (Chwedorzewska 2008).

Recently, propagules and pollen of the rush *Juncus bufonius* were found in one location within the Area (Cuba-Diaz *et al.* 2012).

Three different types of mite are present in the Area: Prostigmata, Mesostigmata and Oribatida. Prostigmata is the dominant community and Oribatida is only found in ice free areas that have been ice-free for more than 30 years (Gryziak 2009).

Glacial recession has exposed new ice-free areas that are being successively colonized by microbial and invertebrate communities including algae, mites and nematodes, as well as lichens, mosses and vascular plants. The pioneer species that appeared first were the moss *Bryum pseudotriquetrum*, and then the grass *Deschampsia antarctica*. In the second stage of succession the dominance of *Colobanthus quitensis* was marked. The first rock-inhabiting lichens (*Caloplaca johnstoni*, *C. sublobulata*, *Lecanora* spp.) appeared in the third stage of succession. The substantial influence of penguin colonies, which occur in the Telefon (Patelnia) Point region, was revealed in the fourth stage. On rocks the ornithocoprophilous communities of epilithic lichens dominated, while on soil the grass *Deschampsia antarctica* with the nitrophilous algae (*Prasiola crista*, *Phormidium* spp.) and mosses (e.g. *Syntrichia magellanica*) were prominent (Olech & Massalski 2001). The abundance of nematodes increases with the age of the ice free area and common species present are *Plectus* and *Panagrolaimus* (Ilieva-Makulec & Gryziak 2009).

Breeding birds

Twelve bird species regularly breed within the Area, the most numerous of which are penguins. In 2012-13 there were 6017 breeding pairs of Adélie penguin (*Pygoscelis adeliae*), 984 breeding pairs of chinstrap penguin (*Pygoscelis antarctica*) and 5396 breeding pairs of gentoo penguin (*Pygoscelis papua*) (unpublished data US Antarctic Marine Living Resources (AMLR) program). Interannual variation in breeding pairs is large for all these species, with changes in some years in excess of 40% (Ciaputa & Sierakowski 1999). Significant decreases in average penguin breeding numbers were observed between the four-year periods of 1978-81 and 2009-12, when an average decrease of almost 69% was observed for Adélie penguins and over 83% for chinstrap penguins, while gentoo penguins have increased by 64%. These trends are consistent with those observed for these species at other nearby colonies on King George Island, in particular those at Lions Rump (Korczak-Abshire *et al.* 2013) and Stranger Point (Carlini *et al.* 2009). The regional trends and breeding data suggest differential over-winter survival between the species (Hinke *et al.* 2007, Carlini *et al.* 2009), which relates to influences remote from nesting sites within the Area. Therefore, the changes being observed in populations at breeding sites within the Area are not considered related to human pressures or impacts occurring within the Area.

Table 1: Four-year averages of numbers of penguin breeding pairs within ASPA 128 (based on data from Ciaputa & Sierakowski 1999, US AMLR program unpublished data).

Species	Location	Census Period			Average change (1978-81 to 2009-12)	Percent change (1978-81 to 2009-12)
		1978-81	1992-96	2009-2012		
<i>Pygoscelis adeliae</i>	Llano Point	10859	6073	2454	-8405	
	Point Thomas	11899	9886	4578	-7321	
	Total	22758	15959	7032	-15726	-69.1%
<i>Pygoscelis antarctica</i>	Telefon Point	2029	1511	604	-1425	
	Uchatka Point	1944	909	292	-1652	
	Demay Point	819	263	52	-767	

	Llano Point	347	8	2	-345	
	Point Thomas	541	1	0	-541	
	<i>Total</i>	<i>5681</i>	<i>2692</i>	<i>950</i>	<i>-4731</i>	<i>-83.3%</i>
<i>Pygoscelis papua</i>	Llano Point	2174	1765	4646	2472	
	Point Thomas	715	267	90	-625	
	<i>Total</i>	<i>2889</i>	<i>2032</i>	<i>4736</i>	<i>1847</i>	<i>+63.9%</i>

Nine other bird species breed within the Area: Southern giant petrel (*Macronectes giganteus*); cape petrel (*Daption capense*); Wilson's storm petrel (*Oceanites oceanicus*); black-bellied storm petrel (*Fregetta tropica*); American sheathbill (*Chionis alba*); Dominican gull (*Larus dominicanus*); Antarctic tern (*Sterna vittata*); south polar skua (*Stercorarius maccormicki*) and brown skua (*S. lonnbergi*). Data for the latter two species show successful breeding was rare in the 2012-13 season (Table 2), when no south polar skua or mixed pairs bred. Despite the poor skua breeding performance in that season, numerous birds were present on territories (Hinke pers. comm. 2013, US AMLR program).

Table 2: Skua breeding pair census (Carneiro *et al.* 2009, US AMLR program unpublished data)

Location	Brown Skua			South Polar Skua			Mixed Skua			Total		
	2012-2013	2004-2005	1978-1979	2012-2013	2004-2005	1978-1979	2012-2013	2004-2005	1978-1979	2012-2013	2004-2005	1978-1979
Llano Point to Telefon Point	11	21	24	0	27	5	0	6	2	11	54	31
Point Thomas	7	21	23	0	45	7	0	10	7	7	76	38

Four other penguin species (king (*Aptenodytes patagonicus*), emperor (*Aptenodytes forsteri*), rockhopper (*Eudyptes chrysocome*) and Magellanic (*Spheniscus magellanicus*)) are occasionally observed within the Area. Other Antarctic bird species (e.g. snow petrel (*Pagodroma nivea*)) are also occasionally observed within the Area (Poland 2002).

Seven South American bird species have been observed within the Area as stray visitors that remained only temporarily: cattle egret (*Bubulcus ibis*), black-necked swan (*Cygnus melanocoryphus*), Chiloe wigeon (*Anas sibilatrix*), Yellow-billed pintail (*Anas georgica*), white-rumped sandpiper (*Calidris fuscicollis*), Wilson's phalarope (*Phalaropus tricolor*) and barn swallow (*Hirundo rustica*) (Poland 2002; Korchak-Abshire, Lees & Joczzyk 2011; Korchak-Abshire, Angiel & Wierzbicki 2011).

Breeding mammals

Elephant seals (*Mirounga leonina*), Antarctic fur seals (*Arctocephalus gazella*) and Weddell seals (*Leptonychotes weddellii*) are present on beaches at numerous sites, although only elephant seals breed within the Area. In 2009-10 six elephant seal harems with 238 pups were observed within the Area (Map 2), while in the same year the maximum number of fur seals exceeded 1290 individuals (Korchak-Abshire, pers. comm.). Annual seal censuses have been conducted by Poland year-round once every ten days since 1988 (Ciaputa

1996; Salwicka & Sierakowski 1998; Salwicka & Rakusa-Suszczewski 2002). A strong annual cycle in numbers is evident, with the number of elephant seals reaching a maximum from December to February and Antarctic fur seals showing a high peak around February and another lower peak around June. Leopard seals (*Hydrurga leptonyx*) and crabeater seals (*Lobodon carcinophagus*) are frequently seen on ice floes during the winter, although rarely come ashore (Salwicka & Rakusa-Suszczewski 2002).

Human activities / impacts

The permanent year-round station Henryk Arctowski (Poland) (58°28'15"W, 62°09'34"S) situated 0.5 km north of the Area (Map 1) has been occupied continuously since 1977 and can host up to 70 people during the summer, and 20 during winter. Several other permanent national program stations are located nearby within Admiralty Bay, including Ferraz (Brazil) (~9.5 km from the Area), Machu Picchu (Peru) (~7.6 km from the Area) and Vincente (Ecuador) (~5.2 km from the Area). Activities of national programs operating with the region are coordinated under the management plan for ASMA No. 1 Admiralty Bay.

A semi-permanent summer-only field camp (US) (58°26'49"W, 62°10'46"S) is situated within the Area south of Llano Point (Map 2). Known as 'Copacabana', the field camp, which has capacity for up to six people, has been occupied by ornithologists every summer season since it was established in 1985.

A small (16 m², 4 berth) wooden refuge (Poland) (58°26'32"W, 62°13'03"S) is situated ~300 m NW of Uchatka Point near the shore of Paradise Cove. The hut is used mostly by researchers who study the pinniped and penguin colonies located in the southern part of the Area. The refuge also serves as a base camp for glaciologists, geologists and botanists working on Baranowski and Windy Glaciers.

Admiralty Bay has been a perennial destination for tourism due to its location, historic and ecological values, and the interest provided by permanent scientific stations. Arctowski Station has been particularly popular (Chwedorzewska & Korczak 2010), with the number of visitors peaking in 2007-08 (Table 3). The principal activities conducted are station visits, with extended walks, kayaking and small boat cruises also being undertaken near to but outside of the Area.

Table 3: Number of tourist visits to Arctowski Station (Source: IAATO)

Season	Number of Tourists (landed and non landed)	Number of Tourists Landed only	Number of Vessels
2003-04	3284	3284	10
2004-05	2684	2684	8
2005-06	3178	3178	9
2006-07	3969	3969	12
2007-08	5772	5772	11
2008-09	1896	1896	6
2009-10	4022	1501	9
2010-11	387	387	4
2011-12	624	624	4
2012-13	1368	1350	7

The high level of visitation at Arctowski Station makes the Area relatively vulnerable to the introduction of non-native species. One such species, the grass *Poa annua*, has established a stable population at Arctowski Station (Olech 1996), and is present on a deglaciated moraine inside the Area (approximate location 58° 27'

54°W 62° 10' 7" S, Map 2). At this site in 2011 approximately 70 individuals were reported spread over an area of 100 m² (Olech and Chwedorzewska 2011). Poland is supporting further research on survival and dispersion of *Poa annua* in the region, which is expected to help inform decisions about management responses to the alien species within and nearby to the Area (Kidawa, pers. comm. 2013)

6(ii) Access to the Area

The Area may be accessed by traversing over land or sea ice, by sea or by air. Particular routes have not been designated for access to the Area. Small boat access, overflight and aircraft landing restrictions apply within the Area, the specific conditions for which are set out in Section 7(i) below.

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

Two structures are located within the Area (Map 2): Copacabana Field Camp (US)(58° 26' 49.27" W 62° 10' 45.89" S), located ~500 m south of Llano Point and consisting of three wooden huts to accommodate up to six people. A four-berth wooden refuge (Poland) (58° 26' 32.27" W 62° 13' 2.9" S) is located in Paradise Cove ~1.2 km SW of Demay Point.

6(iv) Location of other protected areas in the vicinity

ASPA No.125, Fildes Peninsula, King George Island (25 de Mayo), and ASPA No 150, Ardley Island, Maxwell Bay, King George Island (25 de Mayo), lie ~27 km west of the Area (Map 1). ASPA No.132, Potter Peninsula, , and ASPA No.171 Narebski Point, Barton Peninsula, lie ~15 km and ~19 km to the west respectively on King George Island (25 de Mayo). ASPA No.151, Lion's Rump, King George Island, lies ~20 km to the east of the Area (Map 1). Historic Monument No.51, consisting of the grave of Włodzimierz Puchalski surmounted by an iron cross, is situated ~80 m outside of the northern boundary of the Area (Map 2).

The Area lies within Antarctic Specially Managed Area (ASMA) No. 1 Admiralty Bay, King George Island, South Shetland Islands, designated under Measure 2 (2006) (Map 1).

6(v) Special zones within the Area

There are no zones designated within the Area.

7. Permit Conditions

7(i) General 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 for the Area are that:

- It is issued for scientific research, and in particular for research on the avifauna in the Area, or for compelling scientific, educational or outreach reasons that cannot be served elsewhere, or for reasons essential to the management of the Area;
- The actions permitted are in accordance with this Management Plan;
- The activities permitted will give due consideration via the environmental impact assessment process to the continued protection of the environmental and scientific values of the Area;
- Approach distances to fauna must be respected, except when the scientific projects may require otherwise and this is specified in the relevant permits;
- The Permit shall be issued for a finite period;
- The Permit, or a copy, shall be carried when in the Area.

7(ii) Access to, movement within or over, the Area

Access into the Area is permitted on foot, by small boat or by aircraft. Vehicles are prohibited within the Area. Access to bird breeding areas during the breeding season (01 October to 31 March) is restricted to

visitors conducting or supporting scientific research, carrying out educational or outreach activities consistent with the aims and objectives of the management plan, or undertaking essential management activities.

Foot access and movement within the Area

Persons on foot should at all times avoid disturbance to birds and seals, and damage to vegetation. Pedestrians entering the Area from the vicinity of nearby Arctowski Station should be particularly mindful of the potential to transfer plant material or seeds of the invasive non-native grass *Poa annua* and observe the precautions set out below in Section 7(v) to minimize the risk of further spread.

Pedestrians should maintain the following minimum approach distances from wildlife, unless it is necessary to exceed these for purposes allowed for by the permit:

- Southern giant petrels (*Macronectes giganteus*) – 50 m
- breeding/moulting other birds and seals – 15 m
- non-breeding birds and seals – 5 m.

Pilots, air, or boat crew, or other people in boats or aircraft are prohibited from moving on foot beyond the immediate vicinity of their landing site or the hut facilities unless specifically authorised by Permit. Visitors should move carefully so as to minimize disturbance to flora, fauna, and soils, and should walk on snow or rocky terrain where practical and avoid vegetated areas. Where possible avoid moist ground where foot traffic can easily damage sensitive soils, plant and algal communities, and degrade water quality. Pedestrian traffic should be kept to the minimum consistent with the objectives of any permitted activities and every reasonable effort should be made to minimize effects.

Small boat access

Access from the sea is permitted only by small boat. Access to the beach area between Llano Point and Sphinx Hill (Map 2) from the sea is prohibited in order to avoid interference with animal communities that are the subject of long-term and ongoing research, except for the purpose of visiting ‘Copacabana’ Field Camp for purposes allowed for by Permit, or in an emergency. The recommended landing sites for small boats are at the following locations (Map 2):

- 1) on the beaches at Halfmoon Cove or Arctowski Cove, both of which are outside of the Area where no permit for entry is required;
- 2) on the beach immediately in front of ‘Copacabana’ Field Camp (US); or
- 3) on the beach immediately in front of the refuge (PL) in Paradise Cove.

Access from the sea to any sites suitable for landing south of Sphinx Hill is allowed, provided this is consistent with the purposes for which a Permit has been granted. Visitors to the Area by small boat should inform Arctowski Station.

Aircraft access and overflight

Due to the widespread presence of seabirds and pinnipeds within the Area during the breeding season (01 October – 31 March), access to the Area by aircraft in this period is strongly discouraged. All restrictions on aircraft access and overflight apply between 01 October – 31 March inclusive, when aircraft shall operate and land within the Area according to strict observance of the following conditions:

- 1) Aircraft should maintain a horizontal and vertical separation distance 2000 ft (~610 m) from the coast generally, and from the breeding wildlife colonies in particular, as identified on Map 2, unless otherwise authorized by permit;
- 2) Weather with a low cloud ceiling often prevails over King George Island, particularly in the vicinity of the permanent ice caps such as the Warszawa Icefield, Aircraft should avoid the Area unless it is possible to maintain safely the minimum horizontal and vertical separation distance of 2000 ft (~610 m) given above;

- 3) Landing of helicopters within the Area is generally prohibited, except on permanent glaciers or in an emergency;
- 4) Helicopters operating in the region may land at the designated landing site located at Arctowski Station (58°58.849"W, 62°11.577"S), which should be approached from the NE over Admiralty Bay. Overflight of the northern boundary of Area where many birds and seals are present should be avoided;
- 5) Use of smoke grenades to indicate wind direction is prohibited within the Area unless absolutely necessary for safety, and any grenades used should be retrieved;
- 6) In circumstances not covered above pilots should, as a minimum standard, comply with the *Guidelines for the Operation of Aircraft near Concentrations of Birds* appended to Resolution 2 (2004);
- 7) These provisions do not apply to small unmanned aircraft which may be deployed for scientific or management purposes.

7(iii) *Activities that may be conducted within the Area*

- Scientific research that will not jeopardize the ecosystem or values of the Area;
- Activities with educational and / or outreach purposes that cannot be served elsewhere;
- Activities with the aim of preserving or protecting historic resources within the Area;
- Essential management activities, including management of non-native species within the Area, monitoring and inspection;
- Activities at the site within the Area known to be colonised by the invasive grass *Poa annua* (Map 2) are specifically restricted to research or management related to the non-native species, and other access to this site is prohibited unless access is necessary for other compelling scientific or management reason(s) that cannot be served elsewhere. Those accessing the site shall take precautions not to spread the grass further by thoroughly inspecting and cleaning footwear, equipment and clothing before moving to another location both within or outside of the Area.

7(iv) *Installation, modification or removal of structures / equipment*

- No structures are to be erected within the Area except as specified in a permit and, with the exception of permanent survey markers and signs, additional permanent structures or installations are prohibited;
- All structures, scientific equipment or markers installed in the Area must be authorized by permit and clearly identified by country, name of the principal investigator, year of installation and date of expected removal. All such items should be free of organisms, propagules (e.g. seeds, eggs) and non-sterile soil, and be made of materials that can withstand the environmental conditions and pose minimal risk of contamination or damage to the values of the Area;
- Installation (including site selection), maintenance, modification or removal of structures or equipment shall be undertaken in a manner that minimizes disturbance to values of the Area, preferably avoiding the main breeding season (01 Oct – 31 Mar);
- Removal of specific structures / equipment for which the permit has expired shall be the responsibility of the authority which granted the original permit, and shall be a condition of the permit.

7(v) *Location of field camps*

The facilities 'Copacabana' Field Camp (US) and refuge (Poland) at Paradise Cove (Map 2) provide limited accommodation for scientific use subject to the permission of the appropriate authority. Camping is prohibited elsewhere within the Area.

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

In addition to the requirements of the Protocol on Environmental Protection to the Antarctic Treaty, restrictions on materials and organisms which may be brought into the area are:

- Deliberate introduction of animals, plant material, micro-organisms and non-sterile soil into the Area is prohibited. Precautions shall be taken to prevent the accidental introduction of animals, plant material, micro-organisms and non-sterile soil from other biologically distinct regions (within or beyond the Antarctic Treaty area).
- Visitors shall ensure that sampling equipment and markers brought into the Area are clean. To the maximum extent practicable, footwear and other equipment used or brought into the area (including backpacks, carry-bags and other equipment) shall be thoroughly cleaned before entering the Area. This is particularly important when travelling to the Area from nearby Arctowski Station where the invasive grass *Poa annua* has become established, and footwear and equipment that has potential to be contaminated should be cleaned before departing the station and not worn or used around the station before entering the Area. Visitors should also consult and follow as appropriate recommendations contained in the Committee for Environmental Protection Non-native Species Manual (CEP 2011), and in the Environmental Code of Conduct for terrestrial scientific field research in Antarctica (SCAR 2009);
- All poultry brought into and not consumed or used within the Area, including all parts, products and / or wastes of poultry, shall be removed from the Area or disposed of by incineration or equivalent means that eliminates risks to native flora and fauna;;
- No herbicides or pesticides shall be brought into the Area;
- Fuel, food, chemicals, and other materials shall not be stored in the Area, unless specifically authorized by permit and shall be stored and handled in a way that minimises the risk of their accidental introduction into the environment;
- All materials introduced shall be for a stated period only and shall be removed by the end of that stated period; and
- 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*.

7(vii) *Taking of, or harmful interference with, native flora or fauna*

Taking or harmful interference with native flora and fauna is prohibited, except in accordance with a permit issued under Article 3 of Annex II of the Protocol on Environmental Protection to the Antarctic Treaty. Where animal taking or harmful interference 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(viii) *The collection or removal of materials 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. This includes biological samples, rock specimens, whale bones, artefacts of the whaling industry, and any other historical item.
- 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 authorized, may be removed from the Area, unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority must be notified and approval obtained.

7(ix) *Disposal of waste*

All wastes shall be removed from the Area, except human wastes and domestic liquid wastes, which may be removed from the Area or disposed of into the sea.

7(x) *Measures that may be necessary to continue to meet the aims of the Management Plan*

Permits may be granted to enter the Area to:

- 1) Carry out monitoring and Area inspection activities, which may involve the collection of a small number of samples or data for analysis or review;
- 2) Install or maintain signposts, markers, structures or scientific or essential logistic equipment;

- 3) Carry out protective measures, which may include mechanical removal of non-native species by hand tools;
- 4) Carry out research or management in a manner that avoids interference with long-term research and monitoring activities or possible duplication of effort. Persons planning new projects within the Area should consult with established programs working within the Area, such as those of Poland and the US, before initiating the work.

7(xi) *Requirements for reports*

- The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority as soon as practicable, and no later than six months after the visit has been completed.
- Such reports should include, as appropriate, the information identified in the visit report form contained in the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas. If appropriate, the national authority should also forward a copy of the visit report to the Parties that proposed the Management Plan, to assist in managing the Area and reviewing the Management Plan.
- Parties should, wherever possible, deposit originals or copies of such original visit reports in a publicly accessible archive to maintain a record of usage, for the purpose of any review of the Management Plan and in organising the scientific use of the Area.
- The appropriate authority should be notified of any activities / measures undertaken, and / or of any materials released and not removed, that were not included in the authorized permit.

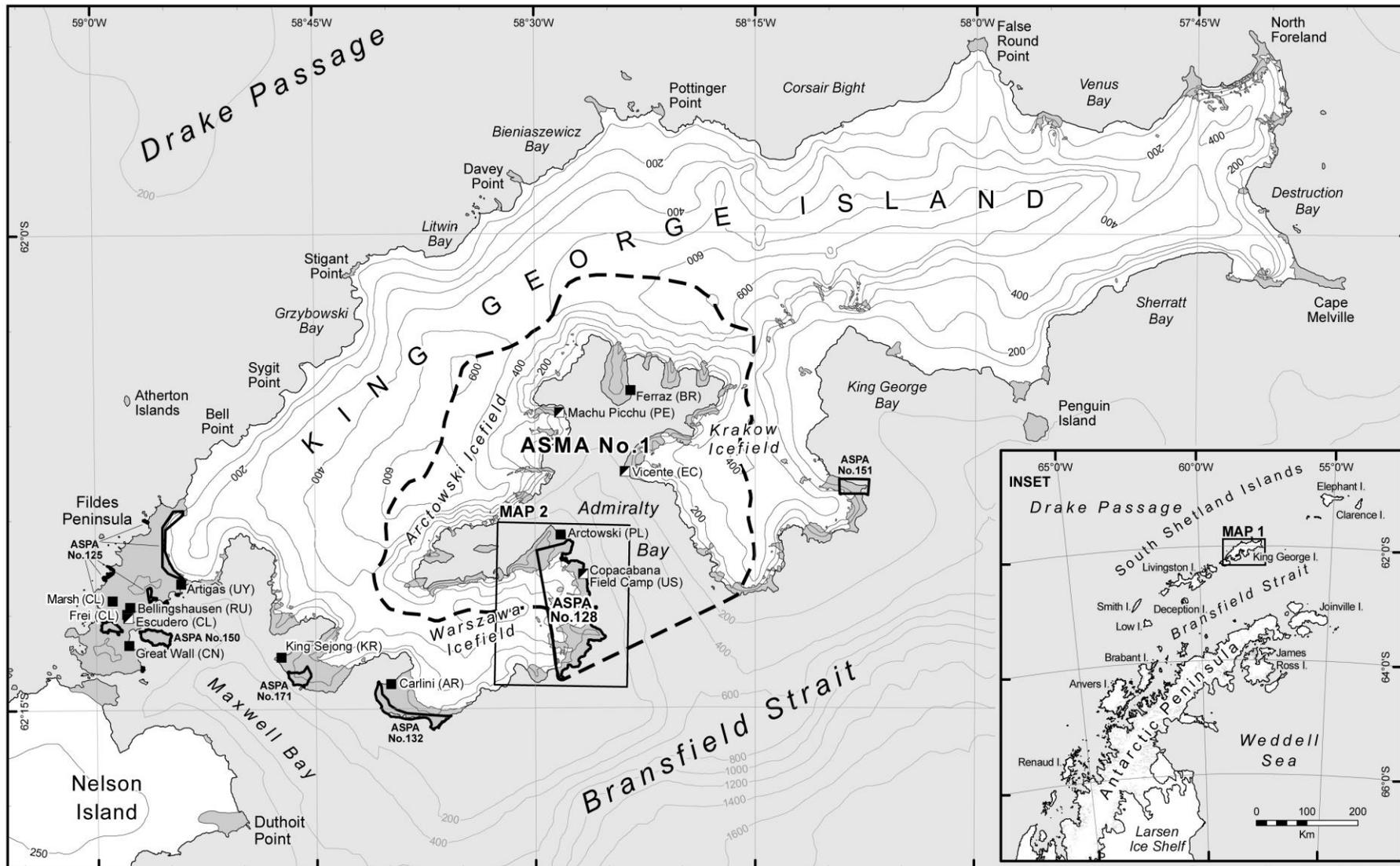
8. Supporting documentation

- Barbieri, M, K Birkenmajer, MC Delitala, L Francalanci, W Narbski, M Nicoletti, A Peccerillo, A Petrucciniani, L Tolomeo, and C Trudu. 1987. Preliminary geological, geochemical and Sr isotopic investigations on Mesozoic to Cenozoic magmatism of King George Island, South Shetland Islands (West Antarctica). *Mineralogical and Petrological Acta (Bologna)* **37**: 37–49.
- Battke, Z, A Marsz, and R Pudelko. 2001. Procesy deglacjacji na obszarze SSSI No. 8 i ich uwarunkowania klimatyczne oraz hydrologiczne (zatoka Admiralicji, Wyspa Króla Jerzego, Sztetlandy Południowe). *Problemy Klimatologii Polarnej* **11**: 121–135.
- Bers, AV, F Momo, IR Schloss, and D Abele. 2012. Analysis of trends and sudden changes in long-term environmental data from King George Island (Antarctica): relationships between global climatic oscillations and local system response. *Climatic Change*. doi:10.1007/s10584-012-0523-4.
- Beyer, L, JG Bockheim, IB Campbell, and GGC Claridge. 1999. Genesis, properties and sensitivity of Antarctic Gelisols. *Antarctic Science* **11** (4): 387–398. doi:10.1017/S0954102099000498.
- Birkenmajer, K. 1980. Geology of Admiralty Bay, King George Island (South Shetland Islands). An outline. *Polish Polar Research* **1**: 29–54.
- . 2003. Geological Results of Polish Antarctic Expeditions: Admiralty Bay, King George Island, South Shetland Islands West Antarctica. Geological map. *Studia Geologica Polonica* **120**: 1–73.
- Birkenmajer, K, and E Zastawniak. 1989. Late Crataceous-Early Tertiary floras of King George Island, West Antarctica: their stratigraphic distribution and paleoclimatic significance. In *Origin and Evolution of Antarctic Biota. Geological Society of London, Special Publication, 47*, edited by A J Crame, 227–240.
- Blume, H-P, L Beyer, M Bölter, H Erlenkeuser, E Kalk, S Kneesch, U Pfisterer, and D Schneider. 1997. Pedogenic zonation in soils of southern circumpolar region. *Advances in GeoEcology* **30**: 69–90.
- Blume, H-P, D Kuhn, and M Bölter. 2002. Soils and Soilsapes. In *Geoecology of Antarctic Ice-free Coastal Landscapes, Ecological Studies 154*, edited by L. Beyer and M Bölter, 91–113. Springer, Berlin.

- Braun, M, and H Gossmann. 2002. Glacial changes in the areas of Admiralty Bay and Potter Cove, King George Island, maritime Antarctica. In *Geoecology and Antarctic Ice-Free Coastal Landscapes*, edited by L. Beyer and M Bölker, 75–89. Springer, Berlin.
- Carlini, AR, NR Coria, MM Santos, J Negrete, M a. Juares, and G a. Daneri. 2009. Responses of *Pygoscelis adeliae* and *P. papua* populations to environmental changes at Isla 25 de Mayo (King George Island). *Polar Biology* **32** (10) (May 16): 1427–1433. doi:10.1007/s00300-009-0637-y. <http://link.springer.com/10.1007/s00300-009-0637-y>.
- Carneiro, APB, MJ Polito, M Sander, and WZ Trivelpiece. 2009. Abundance and spatial distribution of sympatrically breeding *Catharacta* spp. (skuas) in Admiralty Bay, King George Island, Antarctica. *Polar Biology* **33** (5) (November 8): 673–682. doi:10.1007/s00300-009-0743-x. <http://link.springer.com/10.1007/s00300-009-0743-x>.
- Chwedorzewska, KJ. 2008. *Poa annua* L. in Antarctic: searching for the source of introduction. *Polar Biology* **31**: 263–268. doi:10.1007/s00300-007-0353-4.
- Chwedorzewska, KJ, and M Korczak. 2010. Human impact upon the environment in the vicinity of *Arctowski* Station, King George Island, Antarctica. *Polish Polar Research* **31** (1) (January 1): 45–60. doi:10.4202/ppres.2010.04. <http://versita.metapress.com/openurl.asp?genre=article&id=doi:10.4202/ppres.2010.04>.
- Ciaputa, P. 1996. Numbers of pinnipeds during 1994 in Admiralty Bay, King George Island, South Shetland Islands. *Polish Polar Research* **17**: 239–244.
- Ciaputa, P, and K Sierakowski. 1999. Long-term population changes of Adelie, chinstrap, and gentoo penguins in the regions of SSSI No. 8 and SSSI No. 34, King George Island, Antarctica. *Polish Polar Research* **20** (4): 355–365.
- Cuba-Diaz, M, JM Troncoso, C Cordero, VL Finot, and M Rondanelli-Reyes. 2012. *Juncus bufonius*, a new non-native vascular plant in King George Island, South Shetland Islands. *Antarctic Science* **1** (1): 1–2.
- Dutra, TL, and DJ Batten. 2000. Upper Cretaceous floras of King George Island, West Antarctica, and their palaeoenvironmental and phytogeographic implications. *Cretaceous Research* **21**: 181–209. doi:10.1006/cres.2000.0221. <http://linkinghub.elsevier.com/retrieve/pii/S0195667100902210>.
- Everett, KR. 1976. A survey of soils in the region of the South Shetland Islands and adjacent parts of the Antarctica Peninsula. *Ohio State University Institute for Polar Studies Reports* **58**: 1–44.
- Gryziak, G. 2009. Colonization by mites of glacier-free areas. *Pesquisa Agropecuária Brasileira* **44** (8): 891–895.
- Hinke, JT, K Salwicka, SG Trivelpiece, GM Watters, and WZ Trivelpiece. 2007. Divergent responses of *Pygoscelis* penguins reveal a common environmental driver. *Oecologia* **153** (4) (October): 845–55. doi:10.1007/s00442-007-0781-4. <http://www.ncbi.nlm.nih.gov/pubmed/17566778>.
- Ilieva-Makulec, K, and G Gryziak. 2009. Response of soil nematodes to climate-induced melting of Antarctic Glaciers. *Polish Journal of Ecology* **57** (4): 811–816.
- Kejna, M, A Arażny, and I Sobota. 2013. Climatic change on King George Island in the years 1948 – 2011. *Polish Polar Research* **34** (2): 213–235. doi:10.2478/popore.
- Korczak-Abshire, M, PJ Angiel, and G Wierzbicki. 2011. Records of white-rumped sandpiper (*Calidris fuscicollis*) on the South Shetland Islands. *Polar Record* **47** (3): 262–267.
- Korczak-Abshire, M, AC Lees, and A Jojczyk. 2011. First documented record of barn swallow (*Hirundo rustica*) in the Antarctic. *Polish Journal of Ecology* **32** (4): 355–360. doi:10.2478/v10183.
- Korczak-Abshire, M, M Węgrzyn, PJ Angiel, and M Lisowska. 2013. *Pygoscelid* penguins breeding distribution and population trends at Lions Rump rookery, King George Island. *Polish Polar Research* **34** (1): 87–99. doi:10.2478/popore.

- Nawrocki, J, M Pańczyk, and IS Williams. 2011. Isotopic ages of selected magmatic rocks from King George Island (West Antarctica) controlled by magnetostratigraphy. *Geological Quarterly* **55** (4): 301–322.
- Olech, M. 1996. Human impact on terrestrial ecosystems in West Antarctica. In *Proceedings of the NIPR Symposium on Polar Biology*, 9, 299–306.
- . 2002. Plant communities on King George Island. In *Geoecology of Antarctic Ice-Free Coastal Landscapes. Ecological Studies*, edited by L. Beyer and M Bölker, 215–231. Springer, Berlin.
- Olech, M, and KJ Chwedorzewska. 2011. The first appearance and establishment of an alien vascular plant in natural habitats on the forefield of a retreating glacier in Antarctica. *Antarctic Science* **23** (2): 153–154.
- Olech, M, and A Massalski. 2001. Plant colonization and community development on the Sphinx Glacier forefield. *Geographia* **25**: 111–119.
- Poland, G of. 2002. The long-term monitoring of avifauna in Admiralty Bay in light of the changes in the sea-ice zone ecosystem (South Shetland Islands, Antarctica). In 25th ATCM Information Paper IP-001 Agenda Item CEP 5. 2002.
- Pudelko, R. 2007. Orthophotomap Western Shore of Admiralty Bay, King George Island, South Shetland Islands. Warsaw, Poland: Dept. Antarctic Biology PAS.
- Salwicka, K, and S Rakusa-Suszczewski. 2002. Long-term monitoring of Antarctic pinnipeds in Admiralty Bay. *Acta Theriologica* **47**: 443–457.
- Salwicka, K, and K Sierakowski. 1998. Seasonal numbers of five species of seals in Admiralty Bay (South Shetland Islands, Antarctica). *Polish Polar Research* **3-4**: 235–247.
- Schaefer, CEGR, RM Santana, FNB Simas, MR Francelino, EI Fernandes Filho, MA Albuquerque, and MI Calijuri. 2007. Geoenvironments from the vicinity of Arctowski Station, Admiralty Bay, King George Island, Antarctica: vulnerability and valuation assessment in Antarctica: A keystone in a changing world. In *Online Proceedings of the ISAES, USGS Open-File Report 2007-1047, Short Research Paper 015*, edited by A K Cooper and C.R. Raymond, 1–4.
- Schloss, IR, CA Michaud-Tremblay, and D Dumont. 2012. Modelling phytoplankton growth in polar coastal areas. International Polar Year (IPY) Conference “From knowledge to action”. Montréal, Canada.
- Simas, FNB, CEGR Schaefer, VF Melo, MR Albuquerque-Filho, RFM Michel, V V. Pereira, MRM Gomes, and LM da Costa. 2007. Ornithogenic cryosols from Maritime Antarctica: Phosphatization as a soil forming process. *Geoderma* **138** (3-4): 191–203. doi:10.1016/j.geoderma.2006.11.011.
- Steig, EJ, DP Schneider, SD Rutherford, ME Mann, JC Comiso, and DT Shindell. 2009. Warming of the Antarctic ice-sheet surface since the 1957 International Geophysical Year. *Nature* **457**: 459–462. doi:10.1038/nature08286.
- Tatur, A. 1989. Ornithogenic soils of the maritime Antarctic. *Polish Polar Research* **10** (4): 481–532.
- . 2002. Ornithogenic ecosystems in the Maritime Antarctic – Formation, development and disintegration. In *Geoecology of Antarctic Ice-free Coastal Landscapes. Ecological Studies 154*, edited by L. Beyer and M Bölker, 161–184. Springer, Berlin.
- Tatur, A, and A Myrcha. 1984. Ornithogenic soils on King George Island, South Shetland Islands (Maritime Antarctic Zone). *Polish Journal of Ecology* **5** (1-2): 31–60.
- Vaughan, DG, and CSM Doake. 1996. Recent atmospheric warming and retreat of ice shelves on the Antarctic Peninsula. *Nature* **379**: 328–331. doi:10.1038/379328a0.

- Victoria, FDC, AB Pereira, and D Pinheiro. 2009. Composition and distribution of moss formations in the ice-free areas adjoining the Arctowski region, Admiralty Bay, King George Island, Antarctica. *Inheringia Botanical Series* **64** (1): 81–91.
- Zastawniak, E. 1994. Upper Cretaceous leaf flora from Błazczyk Moraine (Zamek Formation), King George Island, West Antarctica. *Acta Palaeobotanica* **34** (2): 119–163.



Map 1: ASPA No. 128 Western Shore of Admiralty Bay - Regional overview

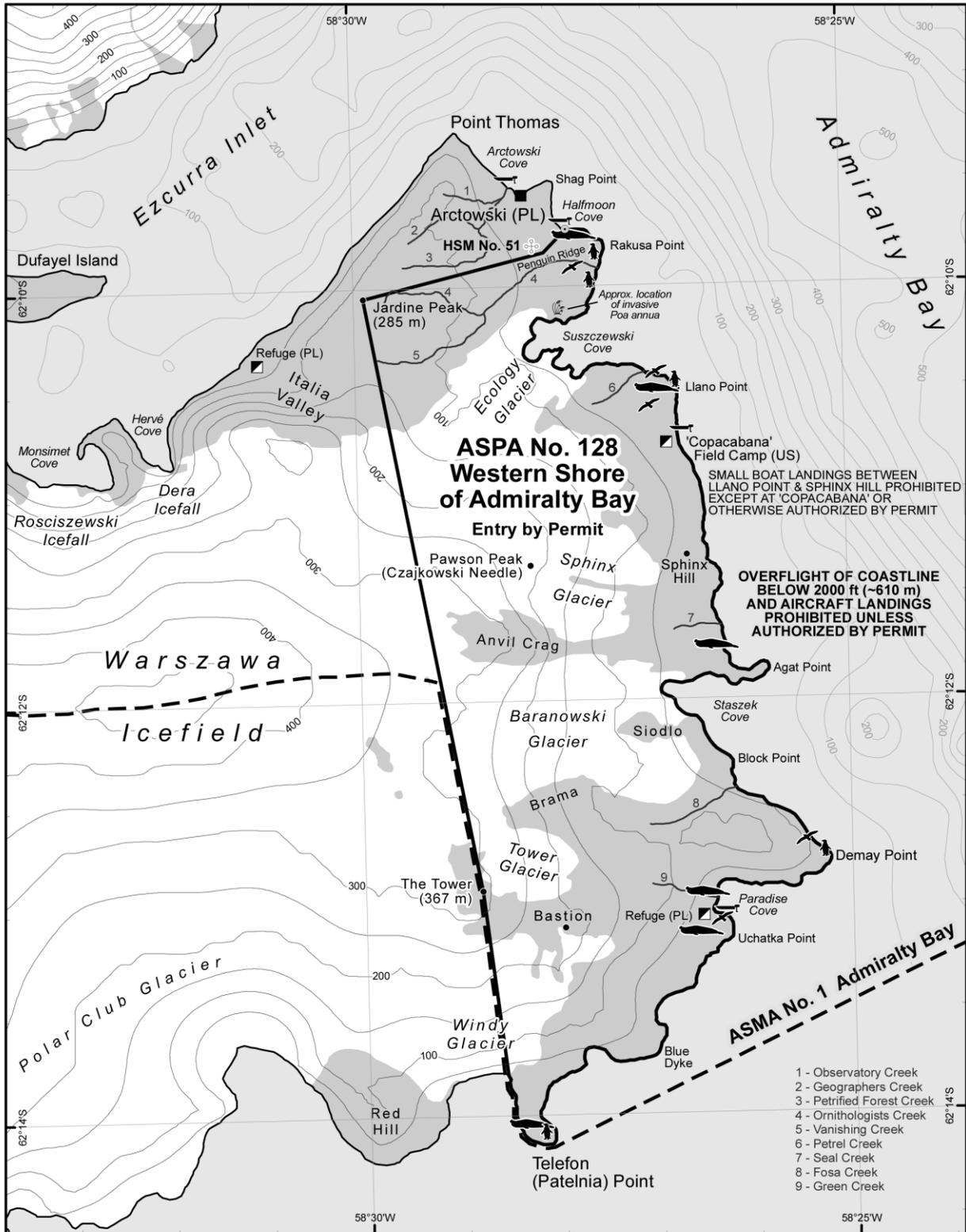
21 Feb 2014
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 Environmental Research & Assessment



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Projection: Lambert Conic Conformal
 CM 58°15' W, SP1 62°00' S, SP2 62°15' S, LO 84°00' S
 Spheroid and Datum: WGS84
 Data sources: Topography: Proantar, updated by ERA, ADD v.6;
 Bathymetry: IBCSO (2013); Contours, ASMA: Proantar;
 ASPA: ERA (2013); Stations: COMNAP, updated by ERA.



Map 2: ASPA No. 128 Western Shore of Admiralty Bay - access, facilities and wildlife

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- Peak
- Contour (50 m)
- Isobath (50 m)
- Coastline
- Creek
- Ice free ground
- Permanent ice
- Ocean
- ASMA boundary
- ASPA boundary
- Station (year round)
- Station (summer only)
- Historic Site & Monument (HSM)
- Marker
- Small boat landing site
- Penguin colony
- Southern giant petrel colony
- Southern elephant seal colony

0 0.5 1
Kilometers

Projection: UTM Zone 21S
Spheroid and horizontal datum: WGS84
Data sources: Topography, Stations: Proantar;
ASPA, ASMA: Proantar (updated by ERA);
Wildlife: ERA; Creeks: digitized by ERA using
aerial imagery 1979; Coastline: updated from
WV-1 imagery © Mar 2008 Digital Globe;
NGA Commercial Imagery Program);
Boat landing sites: Polish Antarctic Program.