

ENVIRONMENTAL RESEARCH OF THE FEDERAL MINISTRY FOR THE
ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY

**Risk assessment for the Fildes Peninsula and Ardley Island, and
development of management plans for their designation as specially
protected or specially managed areas**

ABSTRACT

by

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COMISSIONED BY
THE FEDERAL ENVIRONMENT AGENCY

December 2007

The Antarctic continent and the Antarctic Ocean have unique biological, geological and hydrological characteristics. **Their importance for science has been recognised in the Antarctic Treaty by the signatory states entered into force in 1959.** Fundamental for **maintaining the pristine nature of the Antarctic** is the **protection extended to the flora and fauna** and, specifically, to **sites of scientific interest**, by the coming into force of the Protocol on the Environmental Protection to the Antarctic Treaty (EP). The EP contains a **multiplicity of regulations** on these aspects that are applicable particularly to areas subject to human use.

The Antarctic Peninsula and the group of islands surrounding it are home to the richest variety of terrestrial plant and animal life in the Antarctic. As a result there is great scientific interest in this region which at the same time has the highest level of tourist activity in the Antarctic. In addition to this relatively high biodiversity, reasons for the intense human activity (scientific and logistic activity, and tourism) include, in particular, the region's proximity to South America, i.e. its easy accessibility and mild climate compared to other areas of the Antarctic. This also results in there being limited quantities of pack ice in the summer months. These factors also explain the large number of research stations in this region. King George Island, the largest island of the South Shetland archipelago, has the highest density of research stations in the Antarctic. The Fildes Peninsula, the largest ice-free area of King George Island, accommodates the Chilean stations "Profesor Julio Escudero" and "Presidente Eduardo Frei Montalva" as well as the Chilean airport, China's "Great Wall Station", the Russian station "Bellingshausen" and the Uruguayan station "Base Científica Antártica Artigas".

For this reason the logistical activities of the entire region are concentrated here. Research work takes place not only in the two protected areas, Antarctic Specially Protected Area (ASPA) No. 125 'Fildes Peninsula' and ASPA No. 150 'Ardley Island' but is concentrated much more in areas close to the stations. As a result scientific field work, station activities and the transport of people and cargo regularly overlap in space and time. In addition, alongside major events such as marathons, there are frequent visits to stations and specific natural areas by station staff, tourists and international delegations.

The potential and the actual negative effects on the, in Antarctic terms, species-rich animal and plant communities, and to areas and objects of geological and historical value, lead to conflicts of interest between the different forms of utilisation of the region – research, logistics and tourism on the one hand and nature conservation and environmental protection on the other hand. Up to now management has only partly addressed the complexities of human activity in the Fildes Region.

The aim of this study, which involved field work in the Fildes Region during three summer seasons from December 2003 to February 2006, was to create a scientific, GPS- and GIS-based description of the biotic and abiotic parameters of this region. It also included a quantification of human activities and environmental impacts in the Fildes Region. A risk analysis is made to assess the data and provide the basis for essential management measures.

Germany informed the community of Antarctic Treaty Parties about the aims and content of this research project in 2004 and reported its progress in the following year. Additional publications followed in 2006 and 2007.

On the basis of the main results from the field studies a first draft of a management plan for a proposed Antarctic Specially Managed Area (ASMA) ‘Fildes Peninsula Region’ was prepared in 2006. This was presented for discussion at the Committee for Environmental Protection (CEP) of the Antarctic Treaty Parties.

The **terrestrial environmental situation** was analysed in detail. Key elements of this were **former waste dump sites** and **current waste distribution**. Researchers recorded finds of waste at more than 2,600 locations, mainly in the surroundings of the stations and along the coast. Wood was found in around half of the find locations and this was overwhelmingly classified as flotsam and jetsam. Next came plastic and metal finds, the former not only belonging to the category flotsam and jetsam but also drifted or blown about by the wind. Particular attention was paid to mapping hazardous items, approximately half of which were fuel drums. Only around 1 % of find locations were clearly identified as being recent. Whereas waste was mainly disposed of by burying or by open incineration from the 1960s to the 1980s, currently, independently of each other, stations use fairly similar methods of waste management. One problem that has not been satisfactorily solved is how stations deal with their organic waste. It was shown that such waste is used as a food source by skuas and gulls.

Despite efforts by stations to avoid **oil contamination**, numerous instances of contamination of the surface of the soil were recorded in all three field seasons, especially in the area of the Neftebasa tank farm and along the road network. Another important place was a stream that flows from the airport to the Biologenbucht. Researchers noted evident severe oil contamination of the soil in the Biologenbucht. This originated both from the stream that flowed into the bay and from a large oil spill in the 1980s. Oil contamination was also recorded in the grounds of all stations except those of the Artigas station. Substantial new oil contamination was recorded during the observation period at the Great Wall and Bellingshausen stations. These were caused by leaks from diesel tanks and diesel hoses.

Furthermore, researchers recorded **noise emissions**, particularly from aeroplanes, other vehicles, and generators. Although the stations’ diesel generators represented a permanent source of noise due to their constant use for producing power, there were skuas and storm petrels nesting no more than 50 m from the generator houses. This leads to the assumption that the animals tolerate the constant noise. Air traffic caused the loudest noise, which was also, by Antarctic standards, the most frequently occurring.

At the end of the 2005/06 season there were 159 **constructions** in the Fildes Region, for which five nations were responsible. Together these constructions occupied a total surface area of about 1.9 ha. Because of the periglacial conditions, however, many buildings were set on stilts to avoid thermal contact between the building and the ground. Research stations and their grounds occupy a total surface area of around 40 ha.

An analysis of the condition and use of four regularly-used **field huts** in the Fildes Region showed that they principally serve to accommodate scientists and are consequently in a good state of repair. They comprise three field huts on Ardley Island and one Russian field hut in the north of Fildes Peninsula. Waste produced in the huts is collected and taken back to the stations. Visits to the 'Priroda' hut, which are increasingly effected by motorised transport, represent a potential threat to a nearby colony of Southern Giant Petrels, a species considered to be especially sensitive to human disturbance. A number of unused huts and containers were also recorded, which were damaging their immediate environment due to their advanced state of dilapidation. Of these, the unused Brazilian field hut 'Padre Balduino Rambo', an old research container, and severely dilapidated sections of the field hut complex 'Base Ripamonti' have been dismantled and removed.

The stations on Fildes Peninsula are connected by a **road network** 13.4 km in length. These unsurfaced roads are mainly used to transport people and fuel. In the 2004/05 season some sections of the road network were widened during airport extension work.

Records of **vehicle traffic** showed that transport of people and fuel were by far the most important use of the roads. Different reasons for using transport were usually linked and trips purely for the purposes of tourism were hardly ever observed. The sections of road between the Bellingshausen/Frei stations and Great Wall, and between Artigas and the Neftebasa tank farm were most heavily used. In all, around 6 % of the surface area of Fildes Peninsula was shown to be affected by vehicles and more than half of this (approximately 4 %) related to rutting of areas outside the marked main routes.

Outdoor land-based activities are severely limited during the winter months as a rule due to the weather conditions that prevail there. Occasional outings and visits to other stations are mainly carried out using motor vehicles – various motor sleds or tracked vehicles. **Winter space use** occurs predominantly along the network of marked roads or more rarely on the way to the Collins glacier and 'Priroda' field hut. Provided that the snow is sufficiently deep, damage to vegetation is not to be expected except in exposed areas. However, the noise from motorised vehicles and presence of visitors poses a potential disturbance factor for seals at their pupping beaches and haul outs along the coast.

The survey of scheduled **air traffic** included the registration of practically all flight activity and the estimation or precise measuring of the flight course over the central area of the Fildes Region. The measurement was carried out using a Rangefinder-GPS combination equipment. In contrast to the relatively constant number of days on which flights occurred, the total number of overflights increased greatly. This was particularly true for overflights by helicopter. A large proportion of the light aircraft overflights of the Fildes Region can be assigned to the tourist activities of the Chilean company 'Aerovías DAP'. However, flights by DAP helicopters play only a subsidiary role. These flights are, in part, purely touristic. The majority, however, are for logistic purposes (e.g. transport of scientists). In every season some

extremely low-altitude, tourism-motivated flights by passenger jets have been observed over the Fildes Region.

In respect of flight altitude and flight route, particular attention was paid to Ardley Island and the Fildes Strait because of the existence there of penguin and Southern Giant Petrel breeding colonies. Numerous flights were recorded, particularly over Ardley Island, below the minimum altitude of 610 m recommended by the Antarctic Treaty community (e.g. in 2003/04: two helicopter flights at only 38 m directly over Southern Giant Petrel and penguin colonies). Both small and large aircraft made low altitude flights over Ardley Island and the Fildes Straits, in particular repeated landing approaches or training flights. This should be seen as extremely problematic because of the many Southern Giant Petrel colonies there. An overflight at 89 m, the lowest measured by Rangefinder-GPS combination, was recorded directly over the islands of the Fildes Strait. The recommended minimum distances and minimum altitudes should, above all, protect breeding birds from disturbance and from the consequent negative effects such as low breeding success. The data demonstrate that the proscribed minimum distances are regularly and clearly violated. This has negative effects on the fauna. It is therefore possible that the decline in Southern Giant Petrel, detected as early as the 1980s in this area, has been caused by disturbance from low-flying aircraft among other things. During the observation period, however, there a clear decline has been observed in overflights of Ardley Island and the Fildes Strait.

Observations focused on the **ship and boat traffic** in Maxwell Bay produced a comprehensive picture of the shipping movements and space use in this area. Precise measurements of position by Rangefinder GPS combination demonstrated that the most frequented area was that north of Ardley Island. There was a clear increase in the numbers of ships entering Maxwell Bay during the course of the three summers of observation, a trend matching that detectable in the Antarctic as a whole. The trend was dominated by cruise ships entering the bay for various reasons (landing or embarking tourists, transporting scientists, or supplying research stations). These ships, with a single exception, all carried fewer than 200 passengers and operated by IAATO members. In addition to cruise ships the Bay was entered by diverse research, supply, and naval patrol vessels as well as large motor yachts, all small or medium sized ships. Along with the number of ships there were also increases in the number of ship arrivals and landing frequency. Supply ships were the most frequent arrivals in Maxwell Bay, followed by cruise ships and research vessels. There were, in addition, clear increases in the number of days on which there was at least one ship in the Bay and in the average duration of stay. All ships, Fildes Peninsula research stations, as well as neighbouring stations on King George Island use zodiac inflatable for transporting people and freight in the Maxwell Bay area. The number of days on which zodiacs were in use increased greatly over the field seasons investigated. However, this is of limited significance because of the strong dependence on weather. Nevertheless, over the observational period, a clear increase could be shown in the number of ship and boat movements in Maxwell Bay.

During the period of investigation the environmental effects of two large **construction projects** were investigated. In the 2003/04 season a wooden church was built north of the Russian station Bellingshausen using prefabricated, untreated, sections. Direct environmental effects were limited in the main to vehicle tracks in an area already greatly degraded by waste deposition and deep rutting, and treading damage around the building site and between the station and the church.

An analysis was also made of the environmental effects of constructing a parking apron for aircraft at the airport. This was carried out in the 2004/05 season and covered all aspects of the process. Negative effects were recorded over an area totalling 8.36 ha and were caused by the extraction and deposition of building materials, and by traffic. It was even possible to detect a direct effect on breeding birds. There was destruction, in some places, of breeding holes, some occupied, of two of the locally breeding species of storm petrels (Wilson's and Black-bellied).

The survey of the **coastal environmental situation** revealed another aspect. Here an important role is played by the anthropogenic factors of waste water discharge (differing between research stations) and its treatment before discharge. It became clear from the analysis of the waste survey that practically the entire beach area had a high density of waste. Much of this was wood washed on to the shore but also included plastic, metal or glass, as well as hazardous items. Noticeable was the great quantity of jetsam that evidently came from the fisheries industry, e.g. floats and nets. Finding a hook from long-line fishing and of an Elephant Seal with a deep neck wound caused by a tight plastic loop **clearly demonstrates the threat to Antarctic seals and birds from fisheries and flotsam.**

ASPA No. 125 'Fildes Peninsula', which is separated into two different areas, was first put under protection mainly because of its **fossils**. The most recent survey of fossils recorded 41 fossil locations (from which 199 samples were analysed) in six fossiliferous regions, and these included two regions, the Holzbachtal area and the glacier margin, which are fossil-rich regions but currently unprotected. Remains of the tertiary flora were found as impressions in volcani-clastic rocks, carbonised plant remains, and as petrified wood. To this should be added the finding in the Fossil Hill area of well preserved bird footprints of tertiary origin.

Fossil beach ridges can often be found in clear parallel series along the coasts of the study area. These are of particular importance for the scientific investigation of palaeoclimate and palaeogeography, but can also be interesting in palaeobiological and paleoecological research. The merely haphazard sampling that has taken place so far has nevertheless demonstrated the scientific potential of beach ridges, amongst other things on the basis of their easily identifiable morphology and availability of datable material. A particular threat to beach ridges is their suitability as sources of building material.

Of the 105 lakes surveyed in the area, four were particularly obviously affected by waste deposition. Wind-drifted waste affects very many more. Oil contamination was

recorded in five lakes. An **acute danger of contamination** exists for at least one lake that is currently used as the **source of drinking water for a research station**.

The survey of **flora and fauna** of the area formed a further focus: particularly the distribution of colonies and the number of breeding pairs of Chinstrap, Gentoo, and Adélie Penguins (*Pygoscelis antarctica*, *P. papua*, *P. adeliae*) on Ardley Island. The populations and breeding success of these three species show wide annual variations. To be emphasised here are the wide fluctuations in the numbers of Gentoo breeding pairs (max. 7.546 breeding pairs (= BP) in 1993/94, min. 1.656 BP in 1984/85) as well as the huge decrease in the Chinstrap population at the beginning of the 1980s and of the Adélie Penguins between the 1990s (1.516 BP) and 2005/06 (334 BP). It can be suspected that the Adélie situation is connected with the similarly rapid climate change in the Antarctic Peninsula region.

An appropriate indicator for anthropogenic environmental influences is the Southern Giant Petrel (*Macronectes giganteus*) which is seen as particularly sensitive to disturbance. The breeding pair numbers of this species declined after the building of a new station in the 1980s and have only recently recovered. This recovery is greatest on islands far from research stations (the total in the Fildes Region are between 297 and 342 BP). The spatially and temporally variable **breeding success** in the various regions is between 12 and 82 % but **was distinctly greater in the 1980s**.

Breeding areas were surveyed for the first time of Wilson's Storm Petrel (*Oceanites oceanicus*) (~3.500-5.000 BP) and Black-bellied Storm Petrel (*Fregetta tropica*) (~500-1.000 BP). During the investigation period between 31 and 85 pairs of Brown Skua (*Catharacta antarctica lonnbergi*) were breeding in the Fildes Region along with 132-232 pairs of South Polar Skua (*C. maccormicki*) and 9-29 hybrids between these two taxa. The nests of all other breeding bird species were also counted and located by GPS. This revealed that over the three years of research there were 323-449 BP Cape Petrel (*Daption capense*), a maximum of 3 BP Pale-faced Sheathbill (*Chionis alba*) and 124-142 BP of Dominican Gull (*Larus dominicanus*). It is clear that Antarctic Tern (*Sterna vittata*) populations undergo wide variations (from fewer than 100 to more than 700 BP). Distribution maps are available for all breeding birds and for all observations of visitor and vagrant species. During the study a total of 31 bird species were recorded in the region.

Monthly **seal counts** during the summer show that a maximum of 1226 Antarctic Fur Seals (*Arctocephalus gazella*), 841 Southern Elephant Seals (*Mirounga leonina*), 102 Weddell Seals (*Leptonychotes weddelli*), five Crabeater Seals (*Lobodon carcinophagus*), and a single Leopard Seal (*Hydrurga leptonyx*) can be observed on the shore during moulting, while in winter a maximum of 621 Crabeater could be observed on the ice at the same time. There are also data available on reproduction for Elephant, Fur, Weddell and Leopard Seals.

The occurrence of the gnat species *Parochlus steinenii* in the 105 lakes of the Fildes Region was investigated. Up to now this is the only gnat species that occurs in the region.

For the first time in the Fildes Region a **vegetation survey** of an area of 5.4 km² was carried out using GPS and presented on a map in order to identify sensitive areas. The surveyors thus identified a number of areas with several hundreds of m² size covered in moss on Ardley Island and in humid areas protected from the wind, such as Nebles Point and the Biologenbucht. The survey of treading and tyre tracks had already revealed noticeable areas of damage to moss by motor vehicles. This demonstrates the **necessity of further protection measures** in the region.

In a comparison to investigations in the 1980s and in 2000/01, new records of the occurrence of *Deschampsia antarctica* confirmed the continuing expansion of the species as a result of climate warming. **The first accidentally introduced non-native species in the area were also recorded**, including not only foreign grass species but also a rodent.

The **effects of scientific work** on the flora and fauna of the Fildes Region (e.g. lasting and repeated disturbances to breeding areas) are not inconsiderable. Duplication of field work by scientists from different countries can be considerably reduced through improved coordination and cooperation between scientists. In some cases this would also reduce the cumulative effects that result from different types of work being carried out in the same area.

Tourist activity has also increased in the area in recent years. Most tourists reach the coast of King George Island by cruise ship (more than 8.600 people in 2005/06). Relatively new forms of tourist activity include air tourism, the combination of air tourism and ship-based tourism, and participation in the Antarctic marathon on the Fildes Peninsula, which represent **a potential threat** (from increased disturbance, treading, etc.) **to the flora, fauna and fossil deposits that are worthy of protection.**

An enquiry among research station members (n = 216) revealed divided views of the positive and negative effects of the region's growing tourism.

The analysis of space use by **people on foot** showed that they concentrate on the existing track network, preferred visitor areas where there are interesting animals, and on refuge huts where they can rest. This enquiry further indicated that a large proportion of the station personnel and scientists were working in the region for the first time. Therefore, more effort should be put into providing local informational material and presentations that refer to regional points of interest. Over 75 % of those asked, spent free time outside the stations at least once a week and on these occasions watched animals, went for nature walks or visited other stations. **Environmental education and the support of local management recommendations could be fostered by specific opportunities such as guided hikes, presentations and informational material. This would help to minimise disturbing or damaging the flora and fauna.**

The evaluation of the assets to be protected in the context of the risk analysis carried out made clear the high scientific value of the region. It likewise identified the environmental and wilderness value and the historical, aesthetical and touristic values of the Fildes Region. **The most important anthropogenic sources of disturbance and risk were detailed. These**

were station operation, traffic, scientific activities, and the resulting high risk of accidental introduction of alien organisms, as well as tourism and visitor behaviour. The potential for conflicts in the various areas of the Fildes Region were derived from the spatial distribution of sea birds and seals (*Faunal Index*) and the various activities of visitors (*Visitor Index*). This information was then presented in map form. **The future risk of negative effects from human activities on the flora, fauna and natural ecosystem processes must be estimated as being higher than they are now unless additional management measures are applied.**

The report presents concrete **management proposals** based on the data collected and developing the management applied currently. These proposals concentrate on research station operation, in particular waste management, hindering oil pollution, recommendations for building construction and demolition, waste water treatment, and the provision of information on the local environment. More attention should, however, be paid to the recommendations on land, air and ship traffic, such as adherence to the international recommendations on minimum distances and minimum altitudes from animal colonies.

Future nature protection tasks ought to address not only the native flora and fauna but also preventing the introduction of alien species and limiting the non-scientific collection of fossils and minerals. An important task of scientific management in the future is **the improved coordination of research** but with **environmental monitoring** as a prerequisite for checking efficiency by management. Improved management of visitors can be achieved by visitor direction and the introduction of locally specific guidelines. The **establishment of a management group** of research station leaders, scientists, and environmentalists would be a further tried and tested means of ensuring better coordination on site.

The **designation of the region as an Antarctic Specially Managed Area (ASMA)** is seen as the **best means of improving cooperation and coordination** and the draft of a management plan for this purpose is presented. This serves as the basis for discussion within the Committee for Environmental Protection (CEP) of the Antarctic Treaty Parties.

The proposed draft of an **ASMA Management Plan** for the Fildes Region commences with a Preamble and an Introduction. The values of the region are then listed and the scheme's aim defined. The main aim is the resolution of conflicts that already exist, and those that may occur in the future, between the different forms of use and the protection of nature and the environment, while including all stakeholders in the Fildes Region and safeguarding as many interests as possible. The suggested management activities then follow and then a description of the region. The protected areas within the region are listed and shown on maps. A suggestion for a **zoning concept** is drawn up for the region, mapped and integrated in the management plan. This divides the whole Fildes Region into *Facility Zones*, *Visitor Zones*, *Sensitive Zones*, *Restricted Zones* (those with restricted access) and *Wilderness Zones*. The aim of this concept is to guarantee the current uses of the region while protecting the environment, in particular the sensitive flora and fauna, from further harm by spatially

separating the diverse interests. A Code of Conduct for the *Facility Zones* will contribute to making the permitted uses of these zones environmentally friendly and safe to humans.

The appendices comprise, together with the management plans for the existing ASPAs ‘Ardley Island’ and ‘Fildes Peninsula’, a **Code of Conduct for the suggested *Facility Zones* in each one for scientific research and for visitors**. These codes contain proposals for concrete guidelines, prohibitions, rules and restrictions, for particular activities. These all have the aim of making the activities concerned as environmentally friendly as possible. Alternative management proposals for the Fildes Region comprise, among other items, the creation of an extended ‘Maxwell Bay ASMA’. This clearly goes beyond the Fildes Region and takes in not only a South Korean station but also an Argentinean one with an German/Dutch/Argentinean annex base.

The **open questions and future research needs** emphasise the necessity of continuing environmental monitoring and of compiling information material. A much greater necessity for intensive research would arise, because of its greater spatial extent, if the ‘Maxwell Bay ASMA’ suggested as an alternative to a ‘Fildes Peninsula Region ASMA’ will be pursued.