Falkland Islands State of the Environment Report 2008

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Preface

In 1997, the 'Falkland Islands Environmental Baseline Survey Desk Study Report' was published and policy makers, land managers and scientists used the document to guide the development of new research programmes and the management of important wildlife, habitats and sites.

In 2004, Falklands Conservation was contracted to revise the Environmental Baseline Survey and produce a document describing current threats and pressures to Falkland Islands wildlife in order to guide the preparation of a Biodiversity Strategy for the Falkland Islands. These two documents were submitted to the FIG Environmental Planning Department in November 2004 and May 2005, respectively. However, neither report was formally adopted by FIG or released publicly.

The draft 'Conservation and Biodiversity Strategy for the Falkland Islands' submitted by May 2005 was also not accepted by FIG. In late 2006, Environmental Planning Department was able to direct staff resources towards the completion of the reports and strategy.

The 'Falkland Islands State of the Environment Report 2008' documents the current knowledge of the Falkland Islands environment, both on land and at sea, of the geology, metrology, oceanography and biology. It also describes the current human population, social infrastructure, and commercial and recreational activities undertaken within land and marine habitats. It highlights processes that threaten Falkland Islands wildlife and identifies key conservation policies required to mitigate the threats.

This document follows Pressure State Response framework, in describing the state (the resources), the pressures (uses and threats) and the responses (actions taken to address pressures) (Fig. 1).

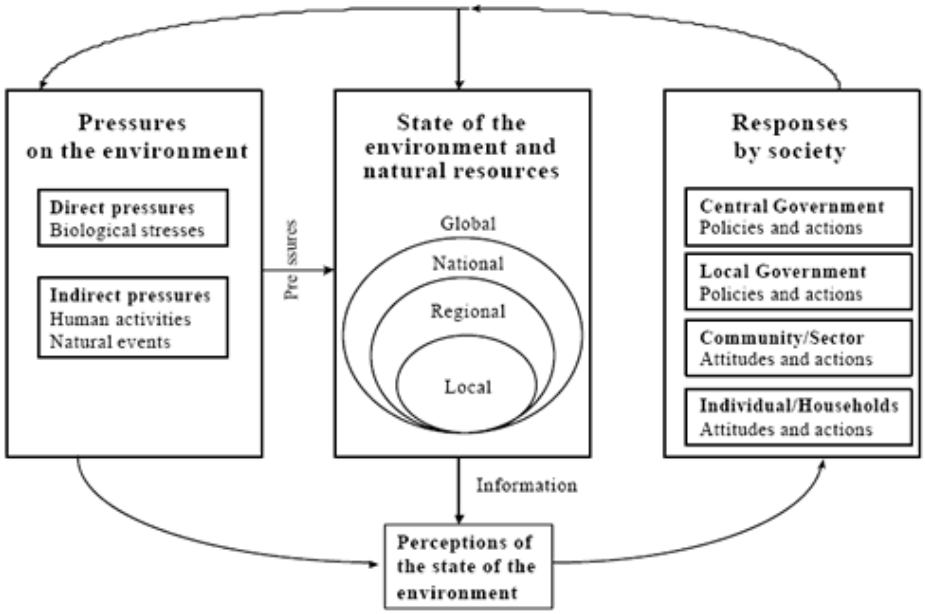


Fig. 1 Pressure State Response framework.

Accurate and available data on states, pressures and responses is critical in determining priorities tasks for biodiversity management (Fig. 2)

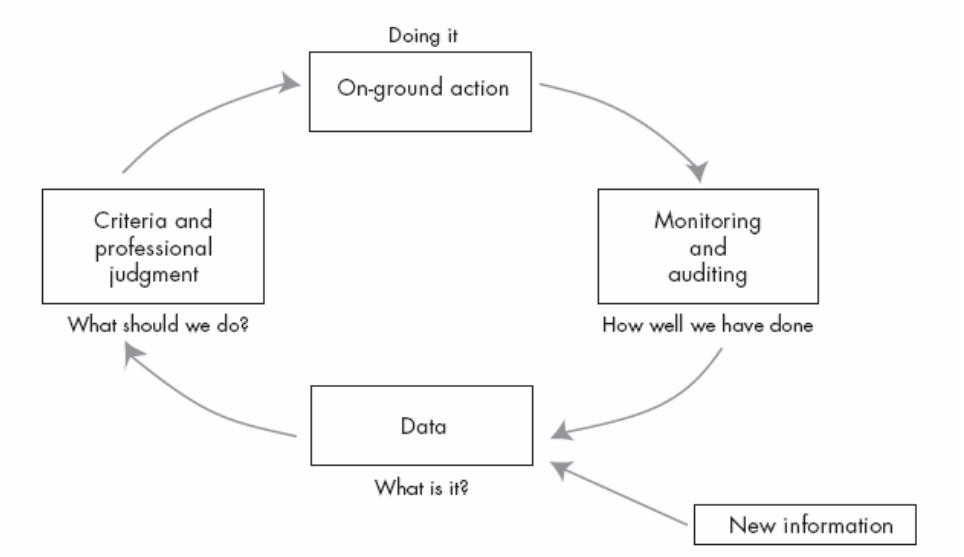


Fig. 2 The role of data and new information in deciding what to do.

The report is split into 12 chapters, and linkage is shown between chapters. It is envisaged that the report will be regularly updated, perhaps every two years.

Chapter 1 - Oceanography, geology and meteorology
Chapter 2 - Socio-economic features
Chapter 3 - Environmental policies
Chapter 4 - Vegetation
Chapter 5 – Land invertebrates
Chapter 6 - Birds
Chapter 7 - Freshwater life
Chapter 8 - Land use activities
Chapter 9 - Intertidal and shallow marine environment
Chapter 10 - Marine mammals
Chapter 11 - Offshore marine environment and use activities
Chapter 12 - Invasive species
Chapter 13 – References
Chapter 14 – Glossary of terms

The 'Falkland Islands State of the Environment Report 2008' acts as the background document to the soon to be adopted 'Falkland Islands Biodiversity Strategy' and 'Falkland Islands Species and Habitat Action Plans'.

Acknowledgements

Many thanks to everyone who contributed information, answered questions and corrected earlier drafts, most particularly Paul Brickle, Joost Pompert, John Barton, Vlad Laptikhovsky and Sasha Arkhipkin (FIFD), Tansy Newman and Jane Cameron (FIG Archives), Phyl Rendell, Neil Judd and Alex Blake (DoA/MR), Tim Cotter (FIDC), Manfred Keenleyside and Ross Chaloner (PWD), Rebecca Upson (Falklands Conservation), Robin Woods, Bob McDowall, Jim McAdam and other FIG Departments and organisations in the Falkland Islands and elsewhere. Also thanks to Leiv Poncet and Robin and Anne Woods for proof reading. The Foreign and Commonwealth Office funded early drafts of the document.

Any factual errors and omissions are ours and we welcome your input, which will assist in drafting the update in two years time.

Acronyms

ACAP	Agreement on the Conservation of Albatross & Petrels
APF	Antarctic Polar Front
APFZ	Antarctic Polar Frontal Zone
BOWG	Biosecurity Oversight Working Group
Camp	Land outside the capital, Stanley
CBD	Convention on Biological Diversity
CBFFI	Commander British Forces Falkland Islands
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CITES	Convention on International Trade in Endangered Species
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPUE	Catch per unit effort
Defra	Department for Environment, Food and Rural Affairs (UK)
DoA	FIG Department of Agriculture
EC	Environmental Committee
EEZ	Economic Exclusion Zone
EIA	Environmental Impact Assessment
EPD	FIG Environmental Planning Department
ESB	Environmental Studies Budget
FAO	Food and Agriculture Organisation
FC	Falklands Conservation
FCO	Foreign and Commonwealth Office (UK)
FI-BRIL	Falkland Islands - Biodiversity Research in Lakes Project
FICZ	Falklands Interim Conservation and Management Zone
FIDC	Falkland Islands Development Corporation
FIFD	Falkland Islands Fisheries Department

FIG	Falkland Islands Government
FIGAS	Falkland Islands Government Air Service
FINH	Falkland Islands National Herbarium
FIPASS	Falkland Interim Port and Storage System
FISMP	Falkland Islands Seabird Monitoring Programme (Falkland Conservation)
FIT	Falkland Islands Trust
FITB	Falkland Islands Tourist Board
FLH	Falklands Land Holdings
FOCZ	Falklands Outer Conservation Zone
GMOs	Genetically Modified Organisations
GSPC	Global Strategy for Plant Conservation
HAB	Harmful Algal Bloom
IBA	Important Bird Area
IPA	Important Plant Area
IPOA-S	International Plan of Action - Seabirds
IUCN	International Union for the Conservation of Nature
IUU	Illegal, Unreported and Unregulated Fishing
JNCC	Joint Nature Conservation Committee (UK)
KEMH	King Edward Memorial Hospital, Falkland Islands
Met Office	UK Meteorological Office
MPC	Mount Pleasant Complex
MoD	Ministry of Defence (UK)
MR	FIG Department of Mineral Resources
MT	MT = metric tonne (1,000 kilograms)
NICT	New Island Conservation Trust
NNR	National Nature Reserve
NPOA-S	National Plan of Action - Seabirds
NPOA-L	National Plan of Action – Longlining
NPOA-T	National Plan of Action – Trawling
OTEP	Overseas Territories Environmental Programme
POPs	Persistent Organic Pollutants
PVR	Post Visit Report
PWD	FIG Public Works Department
RAF	Royal Air Force (UK)
RSPB	Royal Society for the Protection of Birds (UK based)
SAF	Sub Antarctic Front
SAFC	South Atlantic Fisheries Commission
SMSG	Shallow Marine Surveys Group (Falklands based)
SMRU	Sea Mammals Research Unit (UK based)
UKOOA	United Kingdom Offshore Operators Association

Summary

The 'State of the Falkland Islands Environment 2008' report documents the current knowledge of the Falkland Islands environment, both on land and at sea, of the geology, meteorology, oceanography and biology. It also describes the current human population, social infrastructure, and commercial and recreational activities undertaken within land and marine habitats. The report highlights processes that threaten Falkland Islands wildlife and identifies some key conservation policies required to mitigate these threats. A summary of the geodiversity and biodiversity assets and land-use and marine-use activities are described below.

The Falkland Islands lie in the south-west region of the South Atlantic Ocean, approximately 600 km east of the mainland of South America, between latitudes 51°S and 53°S, and longitudes 57°W and 62°W. There are two main islands and about 780 smaller islands and islets, comprising a total land area of just over 120,000 ha. The Falkland Islands are an Overseas Territory of the United Kingdom and are self-sufficient in all areas except for defence and external relations. People first inhabited the Falkland Islands in 1764 and the current population stands at approximately 3,000 people. Most people live in the capital Stanley, with 360 people living in 70 settlements across the islands, and there is a British Military base in East Falkland.

The Falkland Islands have a cool temperate oceanic climate, dominated by westerly winds and low annual rainfall (450 – 600 mm/year). During the last 50 years, there has been a drying and warming of the climate, both on land and at sea, but in the long-term, it is likely to be cooler, more cloudy and rainy in the Falkland Islands. However, there has been little analysis of the land or oceanographic climate data available for the Falkland Islands to develop predictive models in order for the Falkland Islands community to prepare for the ramifications of global climate change.

The majority of Falkland Islands animals and plants show strong affinities to Patagonian South America. As the Falkland Islands is on the edge of the Patagonian shelf, there is an abundance of demersal and pelagic marine species, which provide rich foraging for seabirds and marine mammals, which often have strong connections with the land environment.

Nineteen land habitat types are recognised in the Falkland Islands. The lower and non-vascular plants (e.g. freshwater algae, liverworts, lichens and fungi) are poorly studied in the Falkland Islands, whilst 21 species of ferns and clubmosses have been recorded. The vascular flora consists of 363 species, with 171 native species and 13 endemic species. Most plant species found in the Falkland Islands, including endemic species, occur over a wide range of altitudes, soil types, habitats and exposures.

All 23 plant species (13% of native taxa) listed in the Falklands Red List are protected by legislation. There has been little or no data collected on long-term habitat change, and for this reason, it is difficult to determine whether the threatened species have a naturally limited distribution or frequency, or

whether there has actually been a significant change. Coastal tussac grass and boxwood/fachine scrub are recognised as having suffered major declines in the Falkland Islands.

A number of processes threaten the vegetation of the Falkland Islands. These include global climate change, livestock grazing, camp burning, visitors and invasive species. Seven species and habitats require action plans. Twelve Important Plant Areas have tentatively been identified and plans for their long-term management will be developed and adopted during 2008/09.

In a land without native trees, reptiles, amphibians or terrestrial mammals, insect life forms a very important part of the Falkland Islands ecology. Insects perform a critical role in the breakdown and recycling of organic matter, the formation of soil and at all stages of insects are important food sources for a variety of birds. Twelve species of earthworm, 43 species of spider and nearly 200 species of insect are reported for the Falkland Islands, although many collected specimens remain to be fully analysed. Thirteen terrestrial invertebrates are currently recognised as endemic.

With the exception of all butterfly species, the Conservation of Wildlife and Nature Ordinance 1999 has no provision for the general protection of the invertebrate fauna. However, this reflects that current lack of knowledge about invertebrates rather than a specific wish not to protect them. Tussac grass, scrub and montane habitats are considered the most critical habitats for invertebrates. The two key processes that threaten invertebrate biodiversity are climate change and alien introductions, but population data recorded over time is required to identify the nature and significance of each threat.

The avifauna of the Falkland Islands is fairly well documented, with 21 resident land bird species, 18 resident water birds, 22 breeding seabirds and 18 annual non-breeding migrants recognised and at least 143 species recorded as occasional visitors. The Falkland Islands support globally significant numbers of a number of species, as well as two endemic species and 14 sub-species. Under IUCN classification, there are ten species of global conservation concern here.

All bird species, except two, are protected in the Falkland Islands. There are seventeen processes that threaten birds, but due to the lack of knowledge about the habitat requirements of some species, assessing the risk posed by each threat to all species is difficult. Eleven species have been identified as requiring action plans and these will be developed during 2008. Twenty two Important Bird Areas were identified in 2006.

Only 22 10 km squares lack some coastline and therefore most of the land in the Falkland Islands has a coastal and/or freshwater connection and six species of fish, including zebra trout and Falklands minnow, are found in freshwater and brackish estuaries. Freshwater invertebrates, fish and birds are threatened by intensive grazing, pollution, physical damage to watercourses and invasive species. The zebra trout is fully protected under Falkland Islands legislation and a species action plan will be prepared during 2008.

There is limited information on the intertidal and shallow marine environment (down to 30 m water depth) in the Falkland Islands. Seaweeds make a major contribution to primary production, as well as providing a habitat and/or a food source for a wide range of marine fauna in the Falkland Islands, but they are not well inventoried or studied. Baseline surveying, habitat mapping and taxonomic identification of marine invertebrates are also a high research priority for the Falkland Islands. This knowledge is essential, as there are a number of processes that threaten the intertidal and shallow marine environment in the Falkland Islands, such as oil spills from vessels and oil exploration, inshore fisheries, aquaculture, invasive species and toxic algal blooms.

The inshore and offshore environment of the Falkland Islands support a variety of whale, dolphin, seal and sea lion species, including at least eleven species of cetaceans listed by the IUCN as being of global conservation concern. However, for each species of marine mammal in the Falkland Islands, there are some gaps in information about distribution, abundance, diet, and important foraging and breeding sites, and this hinders assessment of the effects of current and proposed activities in the marine environment.

Oil spills from vessels and drilling rigs, fisheries mortality, competition for food with fishing vessels and for space with aquaculture ventures, ingestion of and entrapment by marine debris, increased anthropogenic sound and visitor disturbance have the potential to affect marine mammals. In the Falkland Islands, species action plans are required for coastal cetaceans (Commerson's dolphin and Peale's dolphin) and for pelagic cetaceans (for 20 - 25 migratory and transient species).

There has been little assessment of the non-native land and marine invertebrates, but seven plants, 14 mammals and one fish species are recognised as invasive in the environment of the Falkland Islands. There is a programme of clearing rats from islands, but the distribution and optimum measures for control of invasive plants are not known.

Measures for protection of species and habitats and for the environmental management of land-use and marine-use activities are detailed in a variety of Falkland Islands environmental policies, including domestic legislation and international conventions. For instance, protected species and national nature reserves are designated under the Conservation of Wildlife and Nature Ordinance 1999. The Falkland Islands are also a signatory to, amongst others, the Ramsar Convention, the Convention on the Conservation of Migratory Species, the Agreement on the Conservation of Albatross and Petrels and the Kyoto Protocol.

The Falkland Islands Government has made significant infrastructure improvements in recent years to upgrade power, water, sewage and waste disposal services in Stanley, and these have had significant local environmental benefits. The major land uses outside Stanley are sheep and cattle farming, mineral exploration, military defence and nature-based tourism. The farming system in the Falkland

Islands is low intensity ranching of 530,000 sheep and 6,000 cattle, with only about 0.3% of the farmland under active improvement. There is a move towards different systems of farm management and grazing, which consider the need to protect threatened species and maintain ecosystem processes. There has been limited mineral exploration in the Falkland Islands and no extraction. The British Military run a joint services complex and a number of remote sites and all Ministry of Defence operations are run under British environmental legislation

Wildlife tourism is now a well-established industry in the Falkland Islands and the cruise ship sector has grown considerably in recent years, with 80,000 visitors expected during the 2007/08 season. The Falkland Islands Countryside Code was devised in 2001 and is included in all material produced for visitors. Many species and habitats are sensitive to visitor disturbance, physical damage and deleterious effects on breeding success, and from associated risks of invasive species and fire.

Since the late 1970s, the seas around the Falkland Islands have been an important area for commercial fisheries, although the Falkland Islands Government has only been able to regulate it since the late 1980s. The fishery has targeted eleven species of finfish, two species of cephalopod and one bivalve, and there is a well-developed system of setting licence fees, managing stocks and patrolling the waters. The second main commercial activity in the offshore marine environment of the Falkland Islands is an exploratory petroleum programme, which commenced in the 1970s, and has included seismic surveys and drilling test oil wells. These offshore activities have the potential to threaten species and habitats, not only inshore and offshore, but also on land through unsustainable catches of target and non-target species, the provision of artificial food sources, physical damage to the benthos, oil and plastic pollution and anthropogenic noise.

The importance and value of the biodiversity and ecosystem processes in the Falkland Islands is clear, both economically and in the sense of national awareness and well-being. The future of the Falkland Islands hinges on the sustainable use of our resources and on our success in balancing the needs of the community, government and environment. There are 15 processes that threaten the biodiversity of the Falkland Islands, some needing to be addressed more urgently than others. The development and implementation of a Biodiversity Strategy will prioritise required actions to address the critical threats. These actions should be developed in line with social and economic developments and policies currently in place in the Falkland Islands.

Chapter 1 - Oceanography, geology and meteorology

Introduction to environmental research in the Falkland Islands

There has been intermittent environmental research in the Falkland Islands, since 1910 when the Falkland Islands Government first employed a Government Naturalist and a Seal Fishery Officer. While much of the research is instigated locally, many externally funded and employed individuals and organisations come to the Falkland Islands to conduct research and surveys. Licences for research are issued for protected species and the submission of research reports and publications is required. However, this system does not capture research on all bird species, lower plants and seaweeds and most species of higher plant, invertebrate and freshwater fish. A system is needed that would enable FIG to be aware of current scientific work and that would allow information gained from such research programmes to be fed into strategies, policies and plans.

Environmental data is also not stored within one database. The Department of Agriculture is assisting farmers to map their land and classify in a basic sense the distribution of vegetation communities. This approach has been valuable for the farms and farmers concerned, but the disadvantage from an environmental perspective is that the mapping uses a habitat classification different from that used by botanists who have worked in the Falkland Islands.

Falklands Conservation holds a fairly comprehensive environmental dataset, primarily of plants and birds, which is stored in a geographical information system (ArcView). The biological recording programme Recorder 2000 was recently adapted for and installed at Falklands Conservation.

Recorder is used across the UK and has been designed to exploit the potential of a nationwide network of biodiversity data. It has been built so that individual recorders can quickly exchange and forward their data for collation centrally to provide more widespread access. Recorder 2002 does not include the ability to store geological information. Although Recorder 2002 is an excellent data storage system, it is not a geographic information system and has only limited capacity to analyse data in a geographic sense.

There is also no central publication database maintained in the Falkland Islands. The Falkland Islands Trust has developed a searchable publications database of all Falkland Islands scientific publications for the period 1967 to 1999 (http://www.ukfit.org.uk/). Individual FIG Departments and non-governmental organisations, such as Falklands Conservation, also have their individual libraries under electronic data management, but these are not publicly available.

A regular system of updating the 'State of the Environment Report' would be one method of raising awareness of current research programmes and recent scientific publications.

Setting

The Falkland Islands lie in the south-west region of the South Atlantic Ocean, on the south-easterly edge of the Patagonian continental shelf, where an abundance of demersal and pelagic marine species provide rich feeding for seabirds and marine mammals. The Falkland Islands are located approximately 600 km east of the mainland of South America, between latitudes 51°S and 53°S, and longitudes 57°W and 62°W (Fig. 1.1). The nearest part of the Antarctic Peninsula and the South Shetland Islands is over 1,000 km to the south, whilst South Georgia is located approximately 1,450 km to the southeast.

People first inhabited the Falkland Islands in 1764. The population steadily increased from around 300 in 1850 to a peak of 2,500 in the 1930s, before declining to around 1,800 by the early 1980s. Since the Falklands Conflict in 1982, there has been a steady influx of people, rising to 2,955 people in 2006 (FIG 2006).

Bathymetry and Seabed Features

The Falkland Islands is situated on a projection of the Patagonian continental shelf, which is bounded to the north by a steep slope (the Falklands Escarpment), separating it from the Argentine Basin. A gently north-eastward sloping area between the Falkland Islands and the Falklands Escarpment, at water depths of between 150 and 1,500 m, is known as the North Falklands Basin. The continental shelf extends some 200 km beyond the Falklands coast to the north, about 50 km to the south-west, and about 50-100 km offshore on the eastern side.

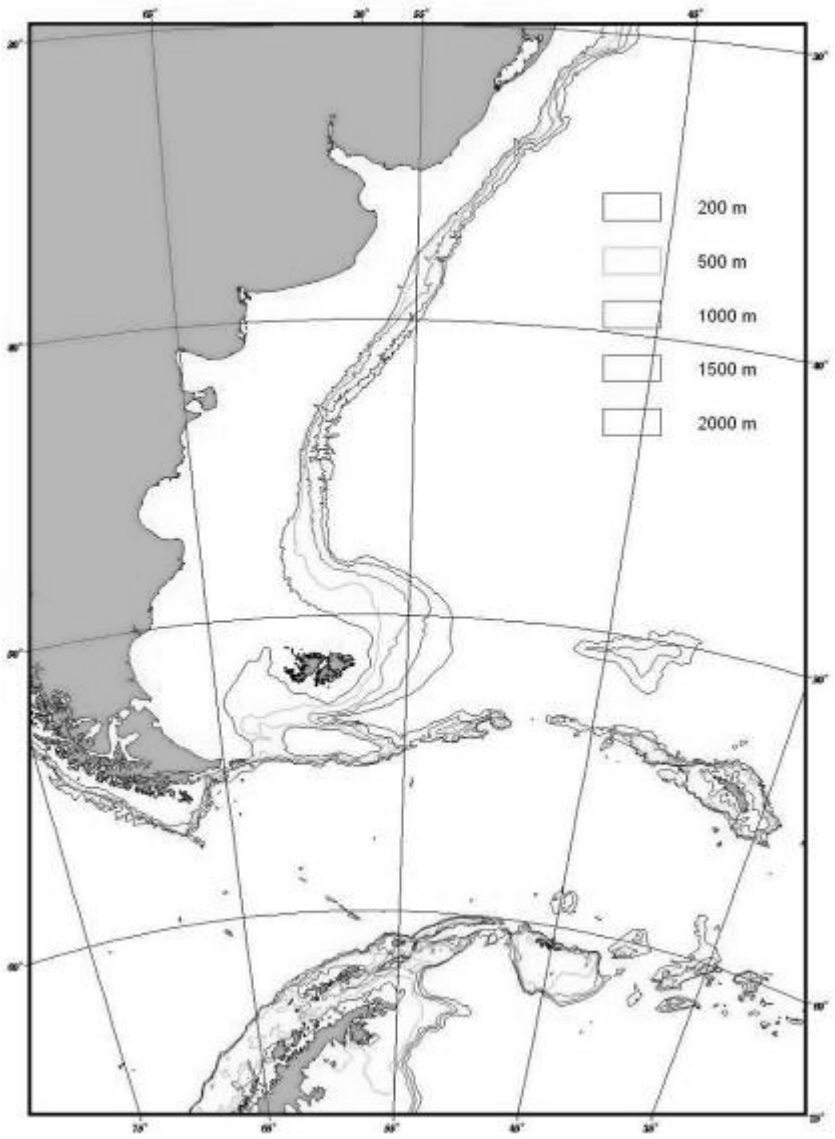


Fig. 1.1 The location of Falkland Islands relative to continental South America, South Georgia and Antarctica

To the south, a deep east-west trough (the Falklands Trough) divides the Falklands Plateau from the Burdwood Bank. The Burdwood Bank is one of a number of elevated blocks bound by submarine ridges and troughs, which were formed as a result of compression during the Cenozoic period along the northern margins of the Scotia Sea.

Information on bathymetry in inshore waters is limited. Within the main coastal embayments and inlets of East Falkland (for example the Bay of Harbours, Adventure Sound, and Berkeley Sound) and around the chain of north-westerly islands from Pebble Island to the Jason Islands, water depths are typically 20 - 40 m (Fig. 1.2). The most steeply shelving inshore seabed profile is to the south-west of the archipelago between New Island and Cape Meredith and directly southwest of Beaver Island, the 100 m isobath is only one km from the coast.

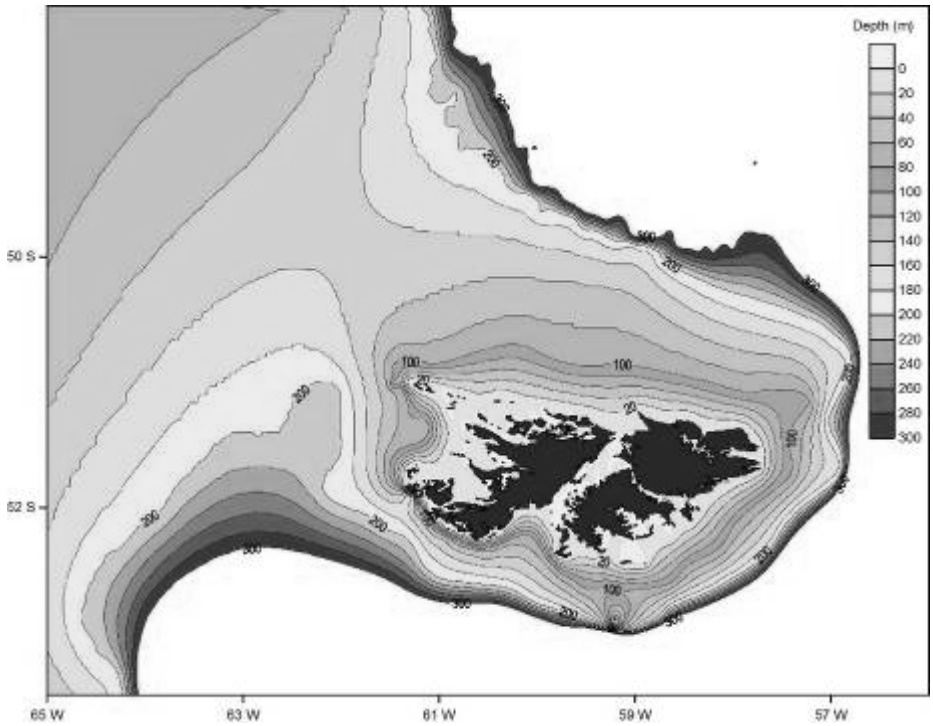


Fig. 1.2 Bathymetry of the Falkland Islands

The continental shelf, including the Falklands projection, is characterised by a layer of fine to medium sand, which in some areas is up to two m thick. Some areas have a higher percentage of gravel, small pebbles and bioclasts (calcified animals and algae). Although benthic sampling is scarce across the Falkland Islands, there are few hard-bottom areas (Bastida et al. 1992).

Ocean Currents

The Antarctic Polar Front (APF) forms the boundary between the cold Antarctic surface water and warmer sub-Antarctic water and is defined by water at 200 m depth measuring 2°C, which usually occurs at 50 – 60 °S (Park et al. 1993). Water between the APF and the Sub Antarctic Front (SAF) to the north is defined as the Antarctic Polar Frontal Zone (APFZ), which lies to the south and southeast of the Falklands Islands.

The Antarctic Circumpolar Current flow diverts sharply northwards after Cape Horn and at the Burdwood Bank and the Falkland Islands splits into two branches (Zyryanov and Severov 1979). The greater part of the current passes to the east of the islands and an anti-cyclonic ring is formed just north of the Falkland Islands. The East and West Falkland Currents meet again at around 49 °S and at about 100 km in width, continue northward at a relatively high speed (0.5 knots) roughly parallel to the 200 m isobath until it meets the waters of the warm Brazil Current (Upton and Shaw 2002). The Brazilian Current begins at approximately 8 ºS and carries subtropical waters southwards along the shelf edge until it meets at the subtropical front with the Falkland Current. At their confluence, both currents move offshore.

Static and drifting buoys measuring conductivity, temperature and depth that were operated during 1997 - 98 obtained reliable oceanographic data (Upton and Shaw 2002). The Falkland Islands Fisheries Department began monitoring aspects of the ocean surrounding the Falkland Islands in 1994. A programme of regular monitoring was started in 1999 with monthly surveys of two transects crossing the shelf from depths of 20 m to approximately 1,000 m to the east of Stanley and near Beauchêne Island.

Conductivity, chlorophyll levels, dissolved oxygen and temperature data are collected at various water depths from the surface to near the seafloor or to a maximum depth of about 1,000 m. More extensive oceanographic surveys are also conducted during regular fisheries research cruises, which are usually around two weeks in duration, and occur approximately three times a year in different regions of the FICZ and FOCZ.

Offshore sea-surface temperatures range from around 6°C in winter to 10-13°C in summer (February), whilst inshore sea surface temperatures range from 2°C in winter to 14°C in summer (FIFD, unpublished data).

Nutrient Mixing

The movement of water is important for the circulation of nutrients, which induce productivity. Tide induced mixing is an important process in shallow waters. In deeper water, the physical relief of the seabed, in particular major obstructions such as the continental shelf, undersea ridges and islands, combined with the strong oceanic and wind driven currents, cause the mixing (Glorioso 2002). Upwelling is the major cause of high marine productivity and the richness of marine life in the waters of the Falkland Islands.

Land features

The Falkland Islands consist of two large islands (East Falkland covers approximately 67,000 ha and West Falkland covers approximately 53,000 ha), and at least 780 smaller islands and islets, comprising a total land area of about 1,200 km^2. Five hundred and ten islands are no greater than five hectares in area and of these, 277 islands are less than 1 ha (Woods 2001). The archipelago extends approximately 250 km from east to west and 155 km north to south with one outlying island, Beauchêne Island, some 50 km further to the south. In United Kingdom terms, the land area of the archipelago is comparable to Northern Ireland.

There are three principal upland areas with land above 600 m: the Wickham Heights, including Mt Usborne (705 m) on East Falkland, and Mount Adam (700 m) and the Hornby Mountains on West Falkland. The upland areas in general are aligned in an approximate east - west direction. Much of the coastline is deeply indented forming sheltered inlets. However, some coastal cliffs, particularly in the south-west region, are as high as 50 - 100 m.

It is not possible to understand the nature of the ecology of the Falkland Islands without some consideration of the underlying geology, soils and climate. Due to the highly maritime nature of the Falkland Islands environment, it is often impossible to separate terrestrial and marine elements of the landscape and biodiversity.

Geology

In ancient times, the Falkland Islands were joined to South Africa along the margin of the Gondwana supercontinent and there are striking geological similarities between Falklands geology and South Africa's Cape Fold Belt and Karoo Basin. As Gondwana moved northwards and the Atlantic Ocean opened up, the Falkland Islands detached, rotated and moved towards South America, eventually settling on the edge of the Patagonian Shelf (Fig. 1.3 and 1.4).

Fig. 1.3 Gondwana reconstruction ca. 400 million years ago (Stone and Aldiss 2000)

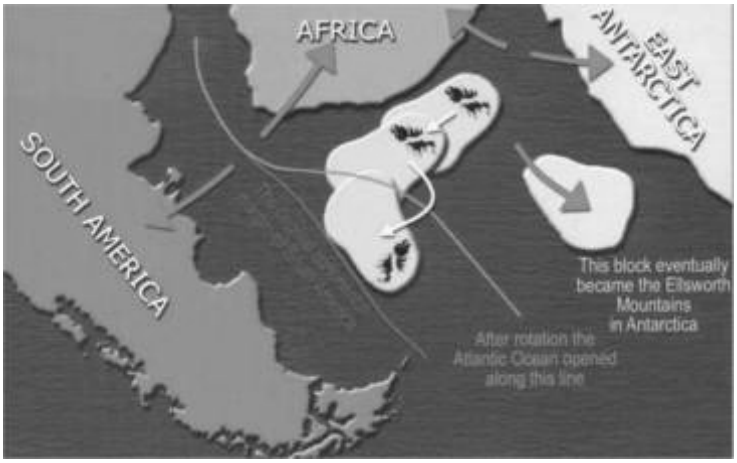


Fig. 1.4 Break up of Gondwana and rotation of the Falkland Islands ca. 150 million years ago (Stone and Aldiss 2000)

The oldest rock formations found in the Falkland Islands are the Proterozoic granites and gneisses, which outcrop at Cape Meredith, while the rest of the islands are mostly underlain by sedimentary rocks (Aldiss and Edwards 1999). The sedimentary rocks can be split into two main groups. The West Falkland Group, which underlies most of West Falkland and the northern upland areas of East

Falkland, consists of Silurian to Devonian quartzose and subarkosic sandstones with some siltstone and mudstone (Fig 1.5). These are more erosion- and weather-resistant rocks and hence tend to form a fairly rugged landscape and coastline. The Lafonia Group, which underlies the lowland areas of the southern part of East Falkland (predominantly Lafonia) and surrounding islands, consists mostly of younger Carboniferous to Permian tillites, mudstones, sandstones and siltstones. These rock formations produce a flatter landscape.

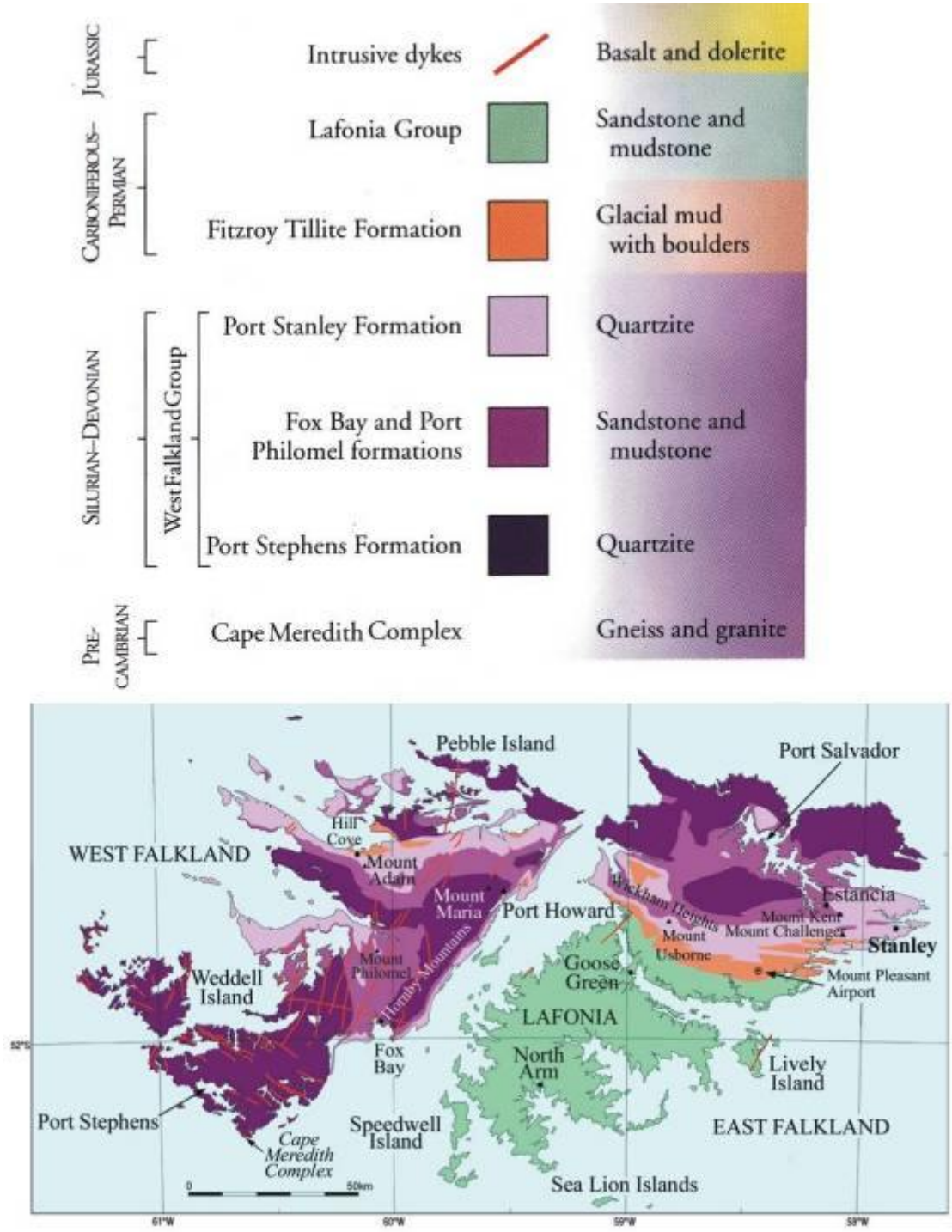


Fig. 1.5 Geological map of the Falkland Islands (Stone and Aldiss 2000)

Both rock groups are acidic in nature and weather to an acidic substrate. The Falkland Islands have no rocks from the most recent geological periods, Jurassic, Cretaceous, and Tertiary, which usually contain lime-rich rocks, and which could ameliorate the acidity of soil-forming substrate.

The Falkland Islands were not covered by ice sheets or subject to extensive glaciations during the last world glaciation, about 14,000 - 25,000 years ago, though there is evidence of glaciation at the highest altitudes on East and West Falkland. However, the Falkland Islands have been subject to a periglacial environment with repeated seasonal cycles of freezing and thawing of the soils. This has lead to wide-scale periglacial landforms.

Solifluction, the slow down-slope movement of soil and superficial debris, occurs in ground that is thawing after being frozen. In the Falkland Islands, it has led to the smoothing of slopes and the formation of stone-runs whilst leaving rock outcrops intact. Stone runs are an accumulation of boulders with no fine rock material and sparse vegetation and occur on slopes and in valley bottoms. They are a particularly distinctive component of the Falklands landscape and form a particularly sensitive niche environment.

Glacial deposits and landforms are limited in extent and occur only on hills above 500 m where small glaciers periodically formed. Corries and glacially eroded hollows are characterised by a vertical back wall, a semi-circular outline and a low hummock of moraine at their mouth, and often contain a small lake, such as Black Tarn on Mount Usborne (East Falkland) and the two tarns on Mount Adam in the Hill Cove Mountains of West Falkland. A notable feature of these glacial landforms is that they occur predominantly on the northeast and southeast facing slopes as their location was controlled by the prevailing wind direction rather than solar radiation.

A full description of the geology of the Falkland Islands and the origin of certain topographic features can be found in Aldiss and Edwards (1999).

A number of sites are tentatively recognised for their geo-diversity assets, due to being:

- Exposed type sections of a stratigraphic unit geologically unique to the Falkland Islands
- Geological unique to/characteristic of the Falkland Islands
- Contain important fossil beds
- Historical importance, such as sites visited by Charles Darwin.

The list is tentative only and a more comprehensive assessment is necessary. The suggested sites include Cape Meredith complex, West Point forest beds, Pebble Island, Jenesta Point and Purvis Point, South Harbour neptunian dykes, Devonian sequence along the Port North coast, Port Louis sites visited by Charles Darwin, Princes Street stone run, tillite cliffs to the east of Hill Cove (E. Edwards and P. Stone, personal communications).

Soils

Soils are a crucially important component of the Falkland Islands environment in providing a growth medium for plants. Natural soil fertility is low, the typical range of pH values is 4 – 5 and the organic matter content is high (Wilson et al. 1993). This leads to dwarf shrub heath on the drier areas and grass heath on the wetter terrain and where nutrient levels tend to be higher, finer grasses and sedges are found. Such greens can be a result of natural nutrient enrichment due to runoff from the surrounding land or mineral deposits, or from the droppings of animals such as penguins or geese. Equally, the high nutrient levels result from agricultural practices, such as the intensive grazing of livestock.

The upper reaches of mountains and ridges generally have clay or stony soils and these conditions, combined with the effects of exposure, often favour the growth of montane habitats, including balsam bog and other cushion-forming plants.

Much of the soil in the Falkland Island is either upland peat, lowland peat or tussac peat. The typical lowland soil is a peaty podzol with a 38 cm surface layer of peat, overlying a thin bleached horizon of 5-10cm, an iron pan of 1-2 cm thickness, which all lies above poorly drained and compacted silty clay subsoil (Cruickshank 2001). This soil profile is acidic and deficient in calcium, phosphate and nitrogen.

Upland peat usually overlies the resistant rocks of the West Falkland Group and generally forms upstanding blankets of peat banks. Lowland peat occurs close to drainage channels especially on near-level terrain where drainage channels are widest. Tussac peat is specifically derived from tussac grass (*Poa flabellata*) and this peat can exceed 10 m in depth. Tussac peat is very susceptible to erosion once the tussac grass vegetation has been removed by grazing or fire, and hence this soil type tends only to be preserved where there is at least partial cover of living vegetation.

The present climate appears too dry for peat formation. Although peat formation may have begun in an earlier, wetter period, it is likely that the surface peat was caused by the poorly drained clay rich subsoil holding moisture in the surface profiles, causing water logging.

Soil erosion is both widespread and currently active, though uneven in its distribution, occurring more so on coastal sand deposits and where sandy soils occur in inland areas (Wilson et al. 1993). Some soil erosion is natural, being initiated before the Falkland Islands were settled and stocked, whilst other erosion is due to land management practices, including grazing and firing practices and construction. The loss of grazing land to soil erosion is an increasing concern for some farmers, but there are few major initiatives in this area of management. Sand grass (*Ammophilia arenaria*) has been most commonly successfully used to stabilise eroded areas. The weight of dirt in the wool clip on Beaver Island was reduced by about 10 – 20% (meaning that the wool yield increased and the freight charges decreased) after bare tussac grass areas were fenced off (Farmer's Association 1994).

Freshwater habitats

Analysis of the 255 10 km grid squares covering the islands shows that only 9% are completely inland (Woods and Woods 1997). A variety of freshwater bodies occur in the Falkland Islands, including coastal barrier ponds, oxbow ponds, glacial tarns and erosion hollows, and slump features in peat. Inland fresh water bodies are especially numerous on peaty lowland areas.

The substrate on which the water stands affects the water pH, which is typically acidic (pH 4.0 - 5.3) in areas of peat, whilst sand bottomed features are less strongly acid (pH 6.0), less turbid and more productive and clay pan ponds have grey, turbid waters (Noon 2002). Freshwater is high in sodium and chloride, which has a marine origin.

Most of the freshwater bodies in the Falkland Islands are shallow, less than 2 metres deep and wind-induced sediment re-suspension is apparent in most standing bodies of water. This often leads to high turbidity, which affects photosynthesis, and planktonic and benthic community development (Noon 2002). Many sites lack active inflows and outflows and are fed through ground water replenishment with wind evaporation possibly accounting for significant moisture loss. Mount Adam Tarn (West Falkland) and Black Tarn (East Falkland) are probably the deepest freshwater bodies, and represent glacial features distinct from most other water bodies.

Terrestrial biogeography

McDowall (2005) undertook an extensive review of the biogeography of the Falkland Islands in relation to other sub-Antarctic islands, Patagonian South America, South Africa, and oceanic regions. The review covered both the terrestrial and marine biota, and the geology of the islands. The majority of Falkland Islands animals and plants show a strong affinity to Patagonian South America, especially Tierra del Fuego. Affinities with other remote sub-Antarctic islands, New Zealand and to a lesser extent Australia were also identified.

Despite a geological link with South Africa, there is now only negligible evidence remaining of a South African biotic connection (McDowall 2005). Given the strong prevailing westerly winds, it would seem probable that the strong Patagonian biotic orientation is the result of dispersal, much of it probably recent, with the new biota gradually replacing and displacing the South African biota present on the islands when they detached from South Africa.

Meteorology and oceanography

The UK Meteorological Office, Liverpool Proudman Oceanographic Laboratory, University of Durham, Ministry of Defence, the Falkland Islands Departments of Fisheries and Agriculture, New Island Conservation Trust, oil exploration companies and private individuals have continuous and non-continuous data sets of air temperature, rainfall, wind strength and direction, sea level fluctuations, ocean temperature and salinity, some of which go back to 1874. However, much of the data is not stored in a digital form to allow immediate analysis.

The Falkland Islands have a cool temperate oceanic climate, dominated by westerly winds. The annual mean maximum temperature is approximately 10°C and the annual mean minimum temperature is approximately 3°C. Average monthly temperatures range from around 9°C during the austral summer (January/February) to about 2°C during the austral winter (June/July). The temperature range is from 25°C to -10°C.

Unsurprisingly given the location of the Falkland Islands in the 'furious fifties', westerlies are the most common winds. The prevailing wind direction falls in a broad arc from south-south-west to north-north-west for 70% of the time (Upton and Shaw 2002). There is no significant seasonal variation in wind direction and strong winds are frequent throughout the year. The mean wind speed at Stanley is 16 knots. The wind is less than Force 5 (17 knots) for 60% of the time, between Force 6 (22 knots) and Force 7 (33 knots) for 20-25% of the time, and Gale Force 8+ (>34 knots) for 5% - 8% of the time in the nine months September to May and for 12% of the time in June through August.

Annual rainfall is low because the Falkland Islands lie in the lee of the South American continent. The low-lying nature of the islands also prevents the widespread occurrence of relief rainfall; only areas towards the eastern end of the mountain ranges are affected. Thus, areas on the eastern coast of the main islands tend to have higher annual rainfall than those on the western coasts. Stanley and Port Howard both have around 630 mm per annum, which is greater than on westerly islands such as West Point Island, which averages only 430 mm per annum. This has consequential effects on the vegetation and associated fauna.

Average monthly rainfall ranges from a maximum in December and January (71 mm and 69 mm, respectively) to a minimum in September and October (37 mm and 38 mm, respetcively). Although the Falkland Islands have a semi-arid climate, the combined effects of gentle relief and widespread impermeable soils combine to keep large areas of the ground wet for much of the year.

Climate change

Examination of meteorological data between 1923 and 1981 indicates a drying and warming of the climate in the Falkland Islands (Fig. 1.6a, b and c).

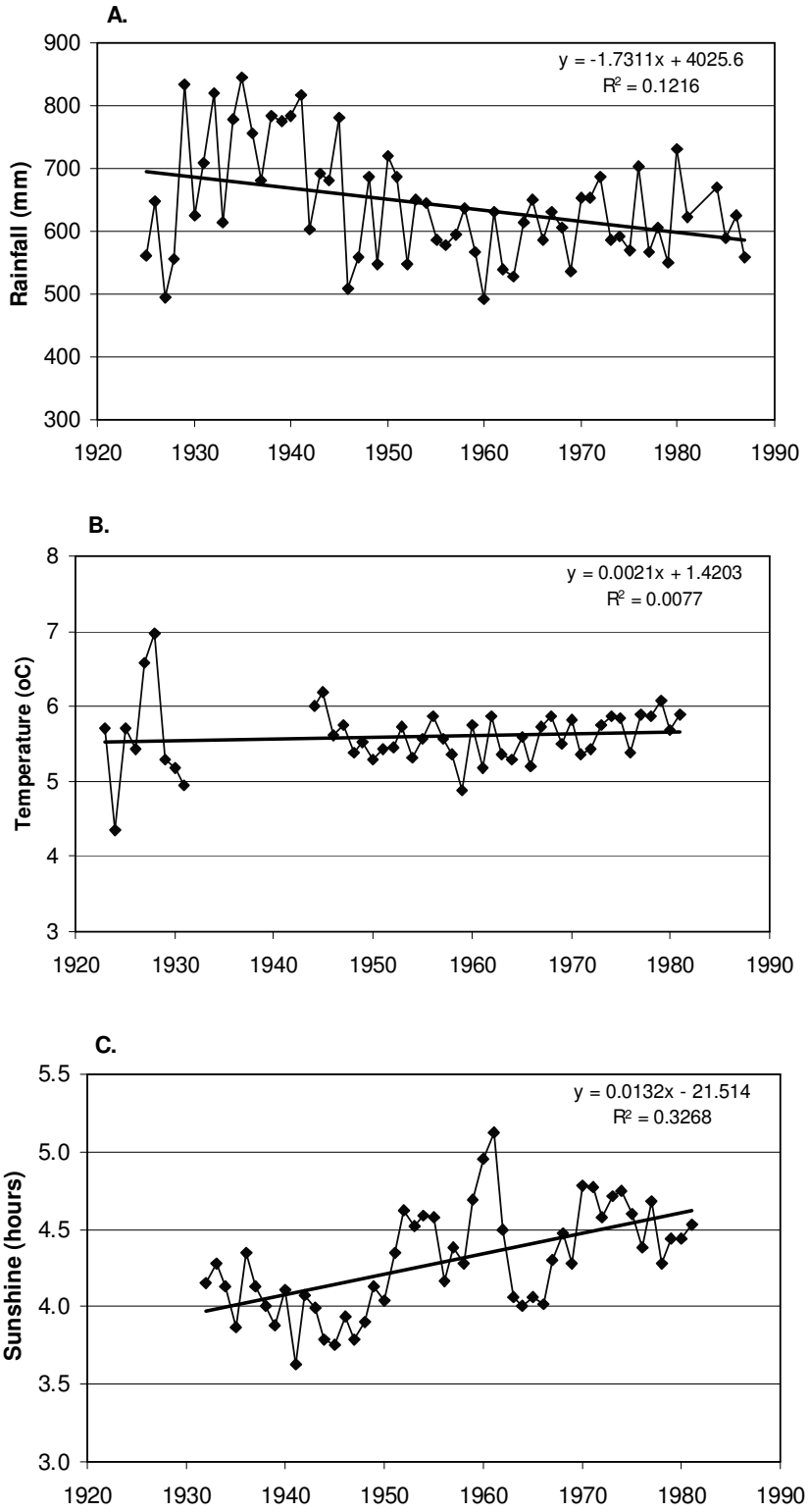


Fig. 1.6 Average annual meteorological data collected in Stanley by the UK Met Office and British Antarctic Survey between 1923 and 1981. A. rainfall, B. temperature and C. sunshine.

More recent climate data has not been not comprehensively analysed. One rainfall data set for Stanley held by PWD suggests that the annual rainfall increased during the period 1910 -1940, subsequently declined, but has been on the increase since 1995 (Fig. 1.7).

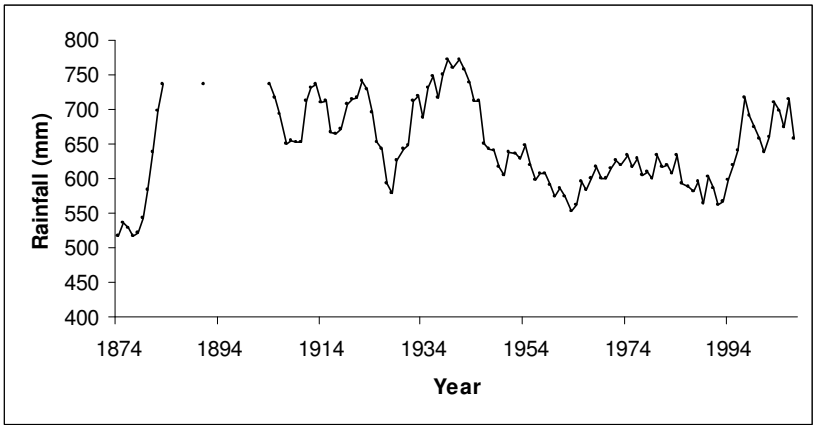
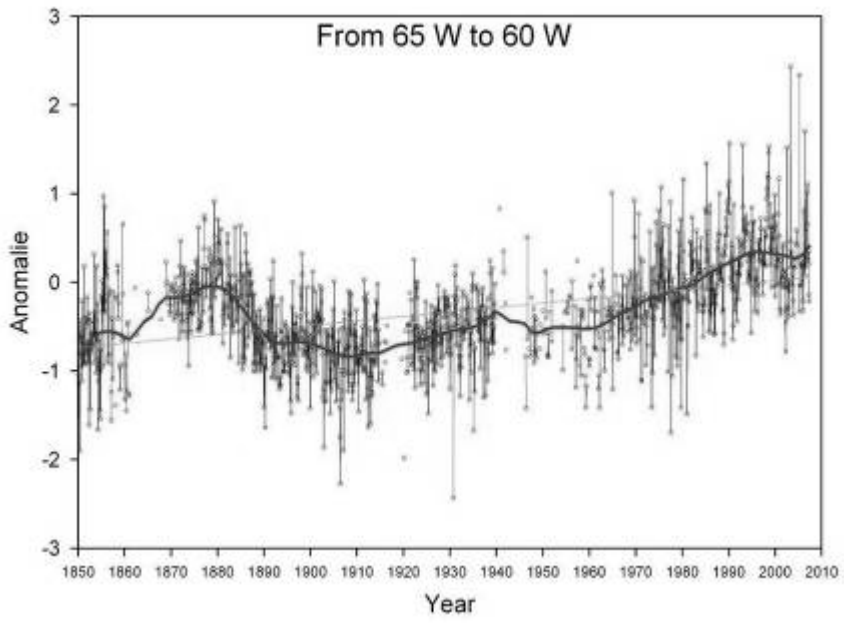


Fig. 1.7 Five year average annual rainfall 1874 – 2006 for Stanley (Source – M. Keenleyside, PWD)

However, rainfall data has been not analysed in any form in recent years, and this is necessary in order to predict impacts on freshwater quantity and also quality. Changes may result in a need to develop new infrastructure for extracting potable water for Stanley, Mount Pleasant Complex, farm settlements and sites with tourist lodges. Freshwater plants, invertebrates and fish may also be affected. Stream volumes could be monitored by electronic logging devices left in-situ.

Sea surface and land temperature data analysed by the UK Climatic Research Unit of the University of East Anglia (Rayner et al. 2003; Parker et al. 2004; http://www.cru.uea.ac.uk/cru/data/temperature/), show a steady increase in the number of warmer than normal sea conditions since the 1960s (Fig. 1.8 a and b).

(a)



(b)

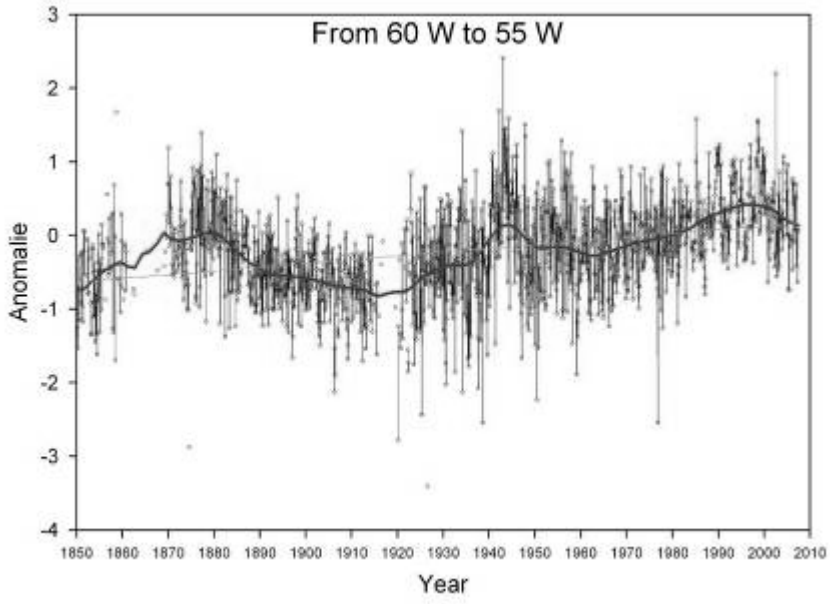


Fig. 1.8 a and b Anomaly index of changes in sea surface temperature (gray line series) around the Falkland Islands since 1850, with the local average shown as the smoothed black line (prepared by N. Huin, Falklands Conservation)

There has been constant monitoring of the marine environment through oceanographic surveys carried out by Falkland Islands Fisheries Department since 1999. In years studied, there were quite large fluctuations of sea temperatures on the shelf of the Falkland Islands comparable with the predicted value (Fig. 1.9).

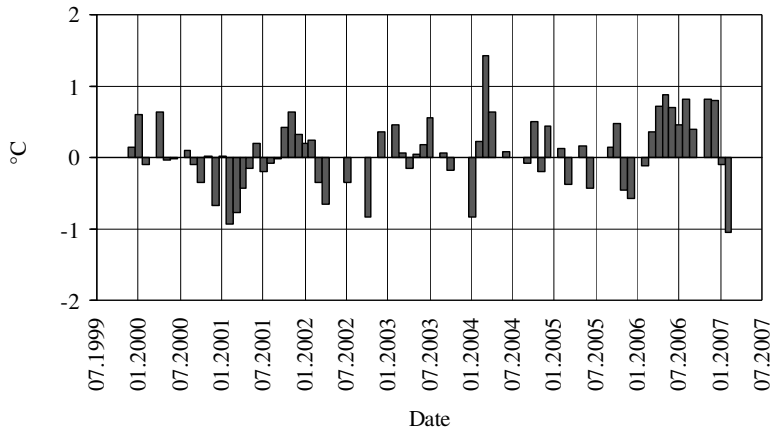


Fig. 1.9 Changes in sea surface temperature in Falkland Island waters since 1999 (FIFD, unpublished data)

Sea level has been measured at various sites in the Falkland Islands over multiple years, with the longest continuous monitoring in Port Stanley from 1964 onwards by Proudman Oceanographic

Laboratory (Liverpool, UK) using a conventional float and stilling well tide gauge, pressure transducers and more recently, a POL 'B' gauge as part of a the Global Sea Level Observing System (GLOSS). The data suggests a 0.7 to 1.3 mm/year sea level rise over the last 40 years; the "global average" rate of change of sea level during the 20th century is 1 – 2 mm/year (Woodworth et al. 2005). Priority should be given to supporting this long-term monitoring programme, both for the Falkland Islands, and for the South Atlantic and Southern Ocean, where it is difficult to maintain sea level monitoring systems.

Global projections of sea level rise reported by the Intergovernmental Panel on Climate Change Working Group indicate that sea level could rise on average about 5 mm/yr, within a range of uncertainty of 2 - 9 mm/yr. An important point to bear in mind is that the current best estimates represent a rate of sea-level rise that is about two to five times the rate experienced over the past 100 years (1.0 - 2.5 mm/yr).

Changes in sea level at regional and local levels in the Falkland Islands will not necessarily be the same as the global average change because vertical land movements affect sea level and there are dynamic effects resulting from oceanic circulation, wind and pressure patterns, and ocean-water density that cause variations in the level of the sea surface (Watson et al. 1997 and ref therein). Areas particularly vulnerable to a rise in sea level in the Falkland Islands include most of Lafonia and many low lying offshore islands.

The University of Durham is working on a palaeo-environmental history of the Falkland Islands by studying peat sections. A record of Falklands vegetation change – which is hoped to be proxy for climate – over the past 17,000 years will be established through radiocarbon dating and identification of the plants through preserved pollen (P. Stone, personal communication). Dating the change will allow the Falklands climate change to be compared with the established global climate pattern over the same period, thus establishing how the Falkland Islands interacts at a global level.

Effects of predicted climate change

In contrast to some other UK Overseas Territories, there is unlikely to be any climate warming in the Falkland Islands. Our scientists suggest that the initial strong melting of Antarctic ice due to global warming will result in cooler water and air temperatures, and increased cloud cover and levels of rainfall in the Falkland Islands. However, north of the Falkland Islands (e.g. 40-50 ^{o}S), water temperatures may be higher. There will be an increase in the intensity and frequency of extreme storm weather, which generally cause the most damage.

These are best guesses by scientists as there has been little analysis of land or oceanographic climate data to develop predictive models in order for the Falkland Islands Government and its people to prepare for the ramifications of global climate change. However, there is considerable data available for complex and informative modelling to be undertaken.

Even with only minor changes in atmospheric and oceanic circulation, local shifts in centres of production and mixes of species in marine- and fresh-waters are expected to occur as ecosystems are displaced geographically and change internally (Canziani and Diaz 1997). Any changes to the distribution of marine resources will potentially have huge detrimental effects on top marine predators, and thus major implications for the biodiversity and economy of the Falkland Islands.

- **Wildlife**

The Falkland Islands have an abundance of species and the interaction between them means that even terrestrial species rely to some degree on the marine environment or marine species for survival. The effect of climate change on Falklands wildlife could be direct, e.g. change in krill abundance or indirect, through changes in food webs and increased occurrences of algal blooms and epizootics. Due to the size of the Falkland Islands and its low lying land, it is likely that species and habitats have little room for manoeuvre in terms of latitudinal shifts and the rate of climatic change may exceed the ability of species to adapt and move. Documented results of climate change elsewhere include changes in the timing of breeding, population and plant and animal health (e.g. Barbraud and Weimerskirch 2006).

Little or nothing is also known of the effect of climate change on plants and vegetation communities in the Falkland Islands. A number of the nationally threatened plants in the Falkland Islands have small, isolated populations that are inherently vulnerable to chance natural events. It is possible that future climate change may increase the frequently of chance natural events such as severe droughts or storm surges (Broughton 2002).

In a trial using open top chambers that experimentally increased air temperature in acid grassland and dwarf scrub heath habitats in Lafonia, the total vegetation cover decreased in the chambers compared to test plots within a two-year period (Bokhorst 2007). Results from the research being undertaken by the University of Durham should also be available soon. The OTEP-funded Falklands Plant Conservation Programme that began in July 2007 will also establish some long-term monitoring sites.

There is a significant database of penguin information held by Falklands Conservation that could be incorporated with oceanographic data to investigate the effects of oceanographic anomalies. Although the fledging success of thin-billed prion chicks on New Island remains consistent year to year despite temperature anomalies, during periods of higher sea temperature, provisioning rates are lower and chicks fledge at a lower body weight, which is a significant factor determining subsequent recruitment of young birds to the adult breeding population (Quillfeldt et al. 2007).

Research on the French sub-Antarctic islands suggests that the predicted southward shift of the Polar Front caused by oceanic warming could lead to a significant decrease in the breeding performance of top predator seabirds (Inchausti et al. 2003).

A global review of the effects of climate change on marine mammals suggests that the potential effects on species range are unknown for the sei whale, sperm whale, all beaked whale species, Peale's dolphin, killer whale, long-finned pilot whale, South American fur seal, South American sea lion and southern elephant seal. Negative effects were suspected for Commerson's dolphin and hourglass dolphin (Learmouth et al. 2006). However, not enough is known about whales and dolphins in the Falkland Islands in order to predict or even determine effects of climate change.

One area of concern regarding climate change and wildlife in the Falkland Islands is the response of invasive species. There are many non-native species currently established in the Falkland Islands that may become invasive as the climate changes. There have been some studies on other sub-Antarctic islands of the effects of climate change on invasive species, but the results and predictions remain unclear (Ferreira et al. 2006). Little is known of our marine invertebrates, let alone introduced marine species, as to whether they are invasive or could become invasive due to changes in salinity and water temperature.

- **Falklands Community**

Given the current rate of increase in sea level, there is a threat in the longer term to buildings located close to rivers, estuaries and seafront, particularly for Stanley. However, in the short- to medium-term, an increase in the number of storms poses a risk of damage to all homes, buildings and built infrastructure such as roads, drainage systems, power production and water supplies. The current building regulations in the Falkland Islands require that buildings are constructed to withstand 100 knot winds, well beyond current storm winds experienced in the Falkland Islands (ca. 50 – 60 knots).

Reductions in temperature and light levels can also be associated with higher and lower incidences of certain medical disorders, such as depressive conditions and skin cancer.

- **Fisheries**

The Falkland Islands fishery is mainly a deep-sea fishery represented by large oceanic trawlers and jiggers that are able to work in almost all weather conditions, with an extremely small proportion of inshore artisanal fishery (inshore pot fishing for crabs and seine fishing for mullet).

Cooler and less saline waters may affect the distribution and abundance of the main species of inshore fauna and flora. However, the extent of this impact is poorly understood as the majority of shelf species have evolved high tolerance to environmental fluctuations. Stronger storms could cause more damage to sub-littoral kelp forests because of increased surge, which might lead to shrinkage of the spawning grounds of *Loligo* squid and thus, a decrease in their abundance.

With the initial predicted warming in ocean temperatures, temperature-sensitive toxins produced by phytoplankton could cause problems of wildlife health to top marine predators, as well as to

aquaculture (Canzianzi and Diaz 1997; Huin 2003). However, the predicted stronger winds and surge may in fact reduce the chances of toxic algal blooms, due to the stronger mixing of near-shore waters.

The cooling of the Antarctic Current and warming of the Brazilian Current might create a stronger gradient zone, which could potentially boost the primary production and correspondingly, favour aggregations of squid and commercial fishes within the economic waters of the Falkland Islands.

This sort of predicted oceanographic event did in fact occur during the autumn of 2006 and there were higher than usual commercial catches of *Illex* squid and demersal fish species, including hake, hoki and kingclip, in the northern part of the Falkland Conservation Zones.

However, squid, the most commercially important fisheries in the Falkland Islands, are very variable by nature and it would be difficult to tell whether a change in the amount of stock is symptomatic of climate change, or due to short-term oceanographic variability or fishing pressure.

- **Agriculture**

It is suspected that the changes in the amount of sunlight, rainfall and air temperature will negatively affect agricultural production. Focused monitoring of the climate by the Department of Agriculture will begin to build up a picture of the impact in time. The Department of Agriculture holds a significant amount of climatic data, but it lacks the resources to store, analyse and extract useful information.

- **Tourism**

The continued visits of cruise ships rely on both the wildlife and safe landing places. Climate change effects on wildlife are covered above. Most built infrastructure in place to facilitate safe landings (i.e. jetties and long ramps etc) is probably likely to need replacing well before any significant increase in sea level requires change. However, an increase in storm events may lead to more damage to landing infrastructure.

Domestic adaptations and mitigations to climate change

Mitigation of climate effects is wholly beyond the ability of Falkland Islands to implement, and the only means is through international protocols such as Kyoto. The Falkland Islands Government signed up to the Kyoto Agreement under the UK's ratification as an Annex 1 country in March 2007. The Falkland Islands are not required to reduce their emissions or place a ceiling on emissions in the first commitment period of 2008 - 2012 (and the same situation is likely for the following periods).

However, the Falkland Islands is expected to introduce policies in line with objectives of the UK Climate Change Programme and to this end, FIG has completed the 'Waste Heat Recovery Programme' infrastructure developments to the power station and has installed the first generators in a wind farm close to Stanley. The two projects together have required a budget of £2,715,000. The wind

farm is expected to reduce diesel fuel consumption for power generation for Stanley by 20%. The waste heat scheme will improve fuel efficiency in terms of energy recovered producing electricity but will not reduce fuel consumption by the Power Station. However, using the waste heat at the adjacent school and hospital, the scheme will reduce the consumption of heating fuel at the two sites by perhaps 20 - 25% of previous levels.

In addition, the FIG Camp Energy Policy - to install wind turbines at farm settlements - has been largely completed. Typically, about 80% of the farm energy requirements are now produced by wind power. FIG has also agreed in principle to supporting grants for better insulation of homes but money has not yet been allocated.

However, FIG needs to ensure that the issue of climate change is prioritised at a high level corporately with no onus on one particular government department and this will require support, commitment and action from all Councillors, Executive Council, Heads of Department, industry, business and the general community, as well as from the Foreign and Commonwealth Office

In terms of further limiting our own carbon emissions and planning for the future, FIG needs to consider:

- Increasing public awareness about climate change and its possible impacts on the Falkland Islands
- Increasing the use of renewable energy, e.g. solar and wind power, and improved building insulation standards. Grants could be provided to householders to encourage the installation of energy efficient measures, particularly draught proofing.
- Increasing the use of energy efficient equipment and heating systems, and re-use of waste oils and other flammable liquids
- Ensuring sustainable patterns of development in Stanley and in camp, i.e. efficient use of land close to facilities, continuing existing development patterns – such as the orientation of housing to the north (sun) and in sheltered north facing locations
- Encouraging sustainable forms of transport – walking, cycling, sharing of cars, taxis etc
- Ensuring existing FIG, MoD, local private and UK-based climate monitoring programmes are sufficiently funded and supported
- Supporting the establishment/continuation of long-term wildlife monitoring programmes, including studies of plant, insect and bird phenology (timing) and distribution along altitudinal gradients
- Nationally protecting areas with intact habitat from sea level to mountain areas, such as are found in the Hill Cove area, Beaver Island, Weddell Island and the Jason Island Group
- Seeking funds and international support for research, particularly for modelling of available data to determine predicted impacts of climate change on the Falkland Islands

Opportunities for International and UK involvement with Falklands climate change issues

Although many of these listed activities could be implemented domestically, the Falkland Islands Government does not have sufficient scientific resources to undertake the data analysis and modelling required to develop a better understanding of the likely impacts of global climate change on sunlight levels, air and sea temperature, rainfall, wind strength and direction, ocean currents and marine and terrestrial productivity in the Falkland Islands.

This type of scientific programme would be most suitable as an internationally-based collaborative project between the Falkland Islands Government, Falklands organisations involved in climate monitoring in the Falklands, the UK Government, the Foreign and Commonwealth Office, the UK Met Office and climate change institutions in the UK and perhaps also elsewhere. Significant funds, particularly for scientific time, are necessary.

It must also be recognised that the Falkland Islands community relies to a significant extent on climate monitoring systems funded and maintained by UK organisations whose involvement is not guaranteed into the future.

Chapter 2 – Socio-economic characteristics

Political framework

The Falkland Islands are an Overseas Territory of the United Kingdom, executive authority being vested in Her Majesty the Queen and exercised by the Governor on her behalf, with the advice and assistance of the Executive and Legislative Councils. The UK's relationship with its Overseas Territories is defined in the 1999 White Paper "Partnership for Progress and Prosperity". The UK is committed to encouraging the Overseas Territories to have the greatest possible control over their own affairs, but retains international responsibilities for the territories, including the obligation to ensure that international law is respected.

The Falkland Islands are self-sufficient in all areas except for defence and external relations, which remain the responsibility of the British Government. The right of self-determination and self-government has been extended to the Falkland Islands and in internal matters the Governor, as the Queen's representative, would not over-rule the decision of the elected councillors.

The present Falkland Islands Constitution came into force in 1985. The constitution determines the form of democracy and the division into Legislative and Executive Councils of the elected councillors. Legislative Councillors, five from Stanley and three from camp, are elected every four years. Each year, the Legislative Councillors elect three of their number to stand as members on the Executive

Council. The Governor is advised by Executive Council, over which he presides and which is composed of the three elected councillors and two ex-officio members, the Chief Executive and Financial Secretary. In addition, the Commander British Forces Falkland Islands and the Attorney General may attend Executive Council meetings and speak on any matter. Executive Council meetings are held monthly.

Legislative Council meets approximately every two months and until 2002, it was chaired by the Governor, but since then, it has been chaired by an independent speaker. The Legislative Council is empowered to pass laws for the maintenance of Law, Order, Legislation and the Government of the Islands, subject to the approval of the Queen acting through the Secretary of State for Foreign Affairs.

Environmental organisations

The Environmental Committee advises Executive Council on environmental issues. This committee meets bi-monthly and is comprised of two Councillors, local conservation groups and representatives of the key industries. It provides advice on the implementation of local environmental legislation, international environmental conventions, the issuing of research permits, and drafting and implementation of local environment strategies, action plans and site management plans.

FIG's Environmental Planning Department is tasked with environmental issues, planning and building control and consists of an Environmental Planning Officer, an Environmental Officer, a Building Control Officer and a Clerk. FIG also provides core costs to Falklands Conservation, a non-governmental environmental organisation, in order that the Falkland Islands have an independent environmental advocacy group, and so that Falklands Conservation can undertake environmental monitoring and education, and has the capacity to seek additional funds.

Additionally to Falklands Conservation, there are also a number of local and international non-governmental conservation and research organisations that work in the Falkland Islands, including New Island Conservation Trust, Falkland Islands Trust, Antarctic Research Trust and SubAntarctic Foundation Ecosystems Research. Many non-governmental organisations in southern South America are part of the 'Sea and Sky' project, which is a science-based programme for the conservation of the Patagonian seascape. Falklands Conservation will contribute data from the Falkland Islands to the project.

The Falkland Islands receive support and advice on wildlife and environmental policies from the Foreign Commonwealth Office (FCO), Joint Nature Conservation Committee (JNCC), Department for Environment, Food and Rural Affairs (Defra), Royal Botanic Gardens Kew and BirdLife International, the international arm of RSPB. The latter organisation's input to the Falkland Islands is channelled through the RSPB, whose support for Falklands environmental issues is given through Falklands Conservation.

In addition, the Falkland Islands receive input from a variety of overseas research institutes, including Instituto Superior de Psicologia Aplicada (Portugal), Max Planck Institute for Ornithology (Germany), University of Bath (UK), Hawk Mountain Acopian Center for Conservation Learning (USA), for a high proportion of its environmental monitoring and research.

Environmental funding

FIG provides an annual 'Environmental Studies Budget' of around £57 – 100,000 annually to the Environmental Planning Department for environmental research and management, which is allocated to landowners, environmental organisations, FIG departments and scientists by the Environmental Committee. Local funding is also sought for environmental work through community-based fundraising, local businesses and charitable trusts.

However, a greater source of funding is obtained internationally, through international scientists sourcing funds themselves and from the UK Overseas Territories Environment Programme (OTEP), which is sourced jointly by the FCO and Department for International Development and the Darwin Initiative, which is funded by Defra. There are some funding opportunities for UK Overseas Territories with the European Commission.

It was recently estimated that to meet all biodiversity priorities in the Falkland Islands approximately £716,000 per year would be needed, with the largest costs for survey, research and monitoring work, particularly in the implementing species action plans (GHK 2007).

Falkland Islands Population

The Falkland Islands were first inhabited in 1764, and the population steadily increased from around 300 in 1850 to a peak of 2,500 in the 1930s, before declining to around 1,800 by the early 1980s (Fig. 2.1). The decline in total population experienced in the mid 20th century was probably the result of emigration due to a lack of work and educational opportunities outside of the farming environment.

Since the conflict in 1982, there has been a steady influx of people, with the total population rising to 2,913 and 2,955 at the time of the 2001 and 2006 census, respectively (Fig. 2.1). The increase was due to active recruitment in the 1980s and early 1990s, and as well as significant economic growth from the late 1980s onwards.

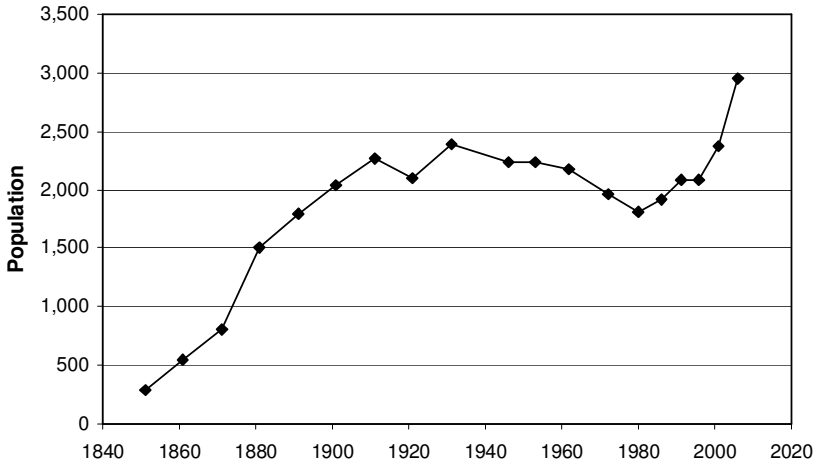


Fig. 2.1 Trend in Falkland Island population (FIG 2006)

Whilst data on total population in camp (land outside the capital) in earlier times was limited to the records of total number of labourers, it is clear that the population has shifted from camp to Stanley over the last 20 years (Fig. 2.2). Prior to the mid 1980s, the economy of the Falkland Islands was almost wholly reliant on the export of wool for income. But following the establishment of the Falkland Island Conservation Zone in 1986 for fishery purposes, and a concurrent significant decline in the value of wool, there were better paid work opportunities in Stanley as well as more new businesses.

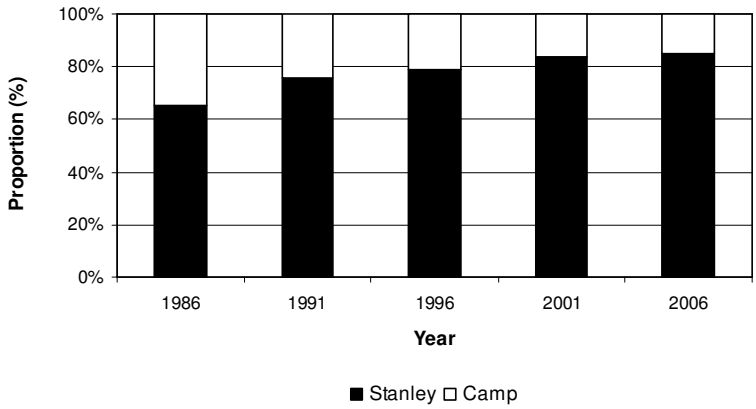


Fig. 2.2 Change in location of the Falkland Island population over time (Source - FIG 2006)

The increase in the population of Stanley has put significant demand on the town infrastructure, particularly the water, power, sewage and drainage services. Much of the infrastructure in Stanley is relatively old, but there is a gradual maintenance, replacement and upgrade programme for the town. However, demand for water and power has flattened out relative to the population over the past 10 years, which may be an indication of improved efficiency in usage.

Options and recommendations for the development of infrastructure, including for domestic, retail, industrial and communication purposes, are detailed in the Falkland Islands Structure Plan 2001-2016

(FIG 2004a) and Stanley Town Plan (FIG 2004d). These documents set out the balance between conflicting land-uses and between environmental impacts and economic development until 2016.

There are approximately 70 settlements in camp (Fig. 2.3), which are often surrounded by more intensively grazed paddocks and infrastructure such as houses, wool sheds, trees, cultivated gardens and wind turbines.

Military population

The Ministry of Defence (MoD) operates a joint army, airforce and navy complex at Mount Pleasant and a port at nearby Mare Harbour (Fig. 2.3). There are thought to be about 1,000 troops stationed at Mount Pleasant, supported by a further 400 civilian workers. MoD also has five manned remote sites for monitoring, refuelling and training purposes, as well as a few decommissioned sites that have not been fully dismantled or rehabilitated.

All MoD operations must meet the strictest environmental legislation, which is generally UK legislation rather than domestic Falkland Islands law. Consequently, Mount Pleasant Complex follows UK standards for treatment and disposal of sewage, and hazardous and other wastes. A Civil/Military Liaison Officer is employed by the military and is the first point of contact regarding environmental issues.

Most military personnel remain in the Falkland Islands for a period of up to four months. They receive an information pack on arrival but it is difficult to keep the information relevant and cover all issues. Maintaining high environmental awareness in the military community is challenging.

Education

Schooling is provided in the Falkland Islands for children aged 4 to 16 years, with a junior and senior school in Stanley, and children at the military complex attending junior school there and then the senior school in Stanley. Junior school aged children living on farms are educated by travelling teachers and phone lessons. Entitled students are eligible for higher education, including technical training, A levels and University, which is paid for by FIG.

In general, there is a high level of awareness of the environment among most long-term Falkland Islands residents, but the increasingly urbanised population, as well as a large military and visitor population has lead to a greater need to address specific Falkland Islands environmental issues. The risk associated with poor awareness is seen as high, but it is also perceived to be something that may be relatively easy to remedy with a number of education initiatives.

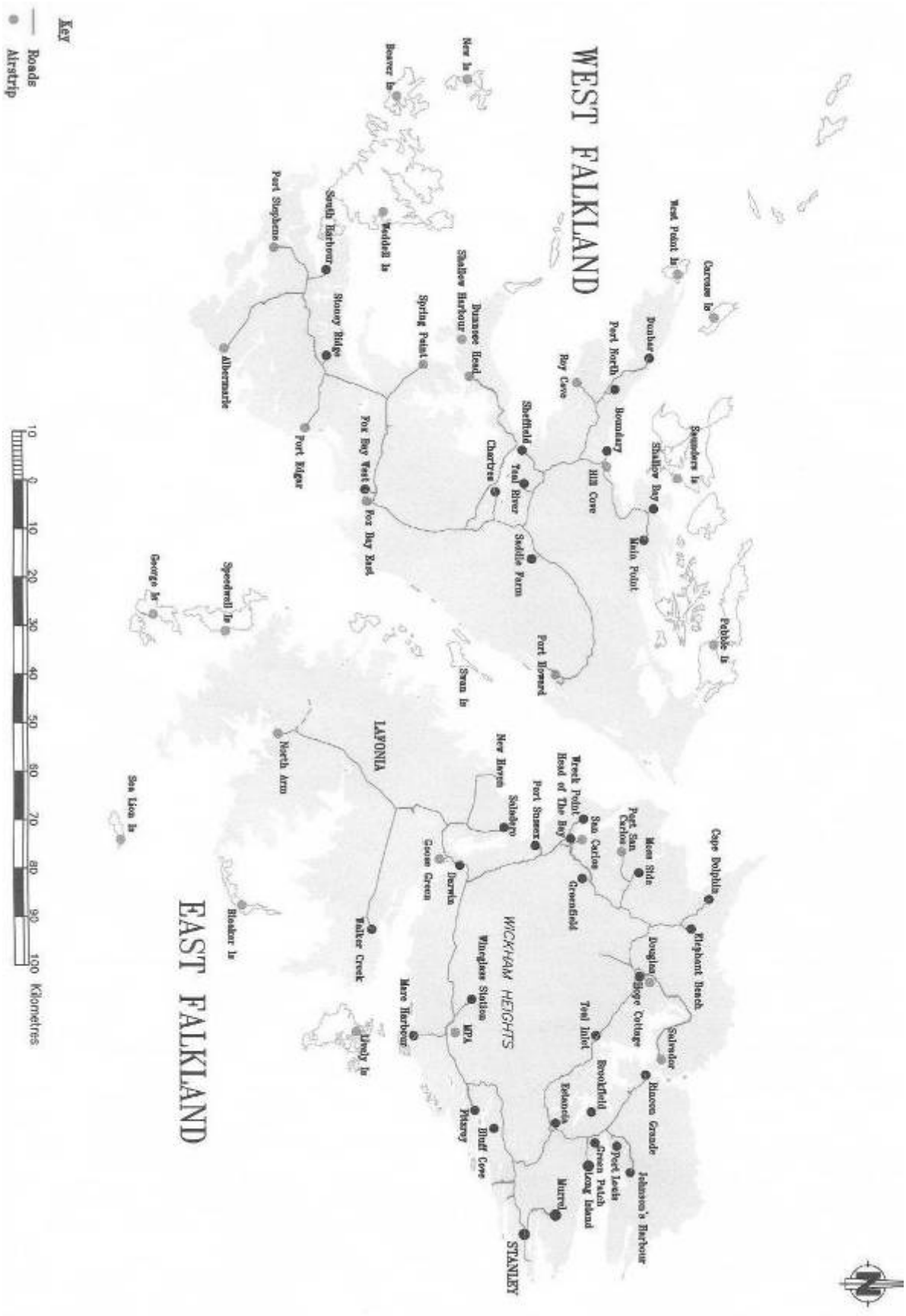


Fig. 2.3 Location of Stanley, Mount Pleasant Complex and camp settlements, and the road network and aircraft landing sites

Environmental education for school-aged children is taught within science and geography subjects across all year groups. Falklands Conservation completed a two-year environmental education programme during 2005 – 2007 with funds from OTEP and FIG. For junior school years, the programme co-ordinator adapted UK teaching lessons for the Falklands environments and streamlined topics between years. For senior school year groups, lesson packs for specific subjects were provided.

These environmental education materials are used extensively at all three schools. During 2007/08, Years 6 and 8 are being given an environmental subject as their key theme across all subjects and both classes obtained FIG funds to undertake one trip to an outer island with albatross, penguins and seals. However, there is little or no funding made available within the Education budget for any school trips beyond Stanley, despite the great need for and ability to undertake outdoor learning. Practical learning is essential for children to supplement the more academic-classroom learning.

In the last five years, there has been more environmental education initiatives directed towards the transient population in Stanley, military personal and visitors. A Falkland Islands Countryside Code was adopted in 2000/01 (see Chp. 8). Local radio and newspapers are used extensively by FIG, Falkland Islands Tourist Board and environmental groups to publicise environmental issues and achievements.

Books, pamphlets, posters and displays have been produced and whilst funds have been found for the production of such documents, there are limited on-going funds available for re-printing of pamphlets, particularly with the 80,000+ annual cruise vessel passengers. There has been a recent move towards the use of display boards, which have a higher initial cost, but may be cheaper over the longer term.

The Fisheries Department and Falklands Conservation also have a number of initiatives to raise environmental awareness within fishing fleets, particularly focusing on seabird bycatch and waste disposal, and posters and newsletters have been produced in various languages.

There are also a number of formal and informal opportunities for both adults and youth in the Falkland Islands to become involved with environmental work outside their work and school environments. Not only do these opportunities generate wider appreciation of environmental issues, there are often practical benefits. Recent community projects, mostly run by Falklands Conservation, have included practical activities such as tussac or tree planting and beach cleans, gathering data for surveys and biological programmes, and fundraising with sponsored walks etc. Falklands Conservation has a junior (35 children) and senior (15 teenagers) Watch group in Stanley and a junior Watch group (approx. 11-15 children) at the military complex which meet monthly as well as having one trip annually to an outer island. The Watch programme is the junior educational arm of the UK Wildlife Trust.

The use of volunteers, particularly for practical activities, raises a number of ancillary issues, such as health and safety, supervision, transfer and management of data and reimbursing expenses incurred. A

number of countries run conservation volunteer schemes (e.g. British/Australian Trust for Conservation Volunteers) and guidance about organising large practical volunteer schemes has previously been sought from these organisations.

Energy use

Historically, peat dug from the extensive bogs was the main fuel for heating homes in the Falkland Islands, while diesel-fuelled generators provided electricity. However, in the past 20 years, census reports show that imported diesel and kerosene have replaced peat as the fuel sources for heating homes island-wide (Fig. 2.4), and there is some usage of gas usage for cooking.

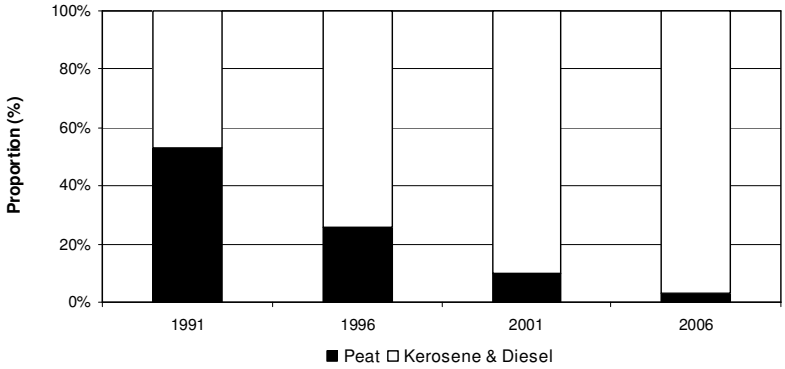


Fig. 2.4 Change in fuel type used for household heating in the Falkland Islands during 1991 - 2006 (FIG 2006)

Renewable power sources such as wind and solar have replaced diesel as the main source of electricity in camp (Fig. 2.5).

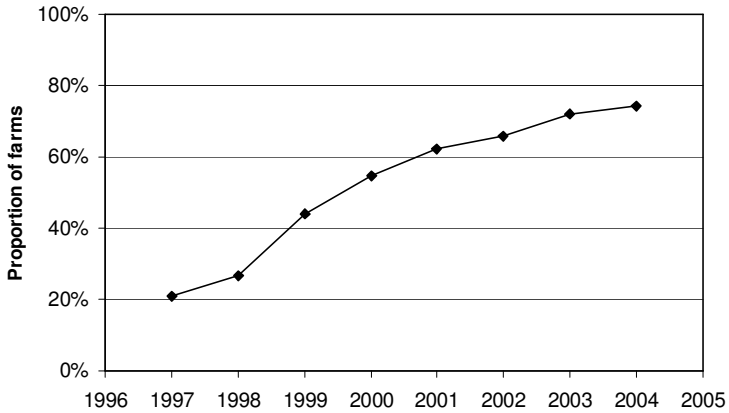


Fig. 2.5 Proportion of settlements in camp using wind power during 1997 – 2004 (FIDC unpublished data)

Diesel generators produce power for Stanley, and total power produced has steadily increased over the last 20 years, although this curve has noticeably flattened since 2002 (Fig. 2.6). The amount of diesel used by the Stanley power station should decline by approximately 20% in the near future, with the

production of energy by the wind farm. Improved efficiency will also result from the retro-fitting of an exhaust gas heat recovery infrastructure at the power station, which is supplying the majority of heating to the nearby senior school and hospital. The swimming pool, which is part of the senior school complex, has always been fully heated by energy recovered from the generator cooling system water.

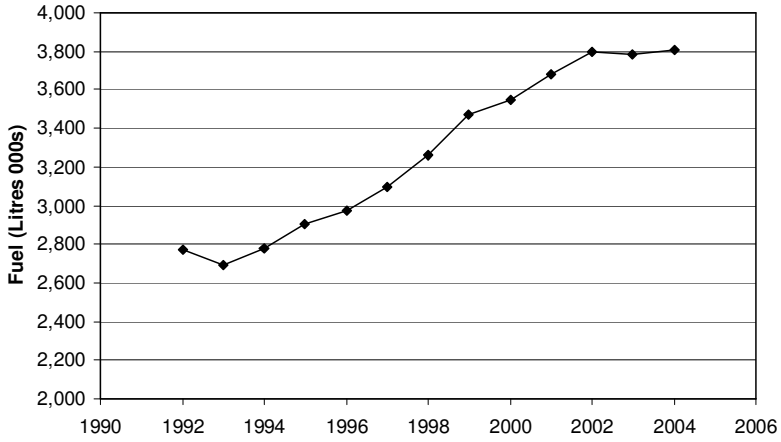


Fig. 2.6 Fuel consumption at the Stanley Powerhouse during the period 1991 and 2004 (PWD, unpublished data)

The wind farm is located at Sand Bay, 10 km southwest of Stanley, near the abattoir. The project, installed during 2007, consists of three 330 KW turbines, each standing 44 m high and with three 15 m long rotor blades. The three turbines stand about 200 m apart from one another. Generated power is fed to the Stanley power station via an underground cable.

An Environmental Impact Assessment accompanied the wind farm planning application, which suggested that there were no significant impacts and that the positive impacts, such as renewable energy production and increased local infrastructure skill development, appeared to outweigh the likely small negative impacts (EPD 2005).

Water usage

Farm settlements take water from nearby springs and creeks, and for most settlements, there are two to five residents and there is a low demand for water. However, at some settlements where there are tourist lodges, such as Sea Lion Island, the amount of water taken from the springs/fen habitat may represent a high proportion of the available water during dry periods. In the Falkland Islands, there is no need to provide water for livestock or to irrigate crops or pasture grasses.

Both Stanley and Mount Pleasant Complex take water from nearby streams and for both sources, the water is filtered and chlorinated. At Mount Pleasant Complex, approximately 400,000 tonnes of water is extracted annually from L'Antioja Stream, which feeds into Swan Inlet. In Stanley, there has been an upward trend in annual water consumption from 134,000 tonnes in 1980 to 219,000 tonnes in 2002, since when usage has remained relatively stable, despite the population increase. FIG has invested in

an upgrade to the water treatment plant and this should improve efficiency in treatment processes. It is currently assessed that Moody Brook can support current and projected demands for perhaps ten years, without the need for restricting usage except during periods of drought, unless there is a demand trigger such as oil development or sustained levels of oil exploration. The lowest recorded level of rainfall over a five month period (since records began in 1874) in 2000/01 did not result in even a hosepipe ban having to be implemented.

Stanley residents are vulnerable in having only one supply source because in the event of it being polluted, there would be an almost instant loss of supply of potable water. There is good treated water buffer storage and FIG has emergency plans in place to allow other sources to be used short term, which would be sufficient to sustain supply unless the pollution was extended or permanent. However, FIG has a development plan to extract water from the Murrell River below Mt Kent, and an Environmental Impact Assessment would be carried out prior to a final works plan being adopted.

Removal of water may affect freshwater life, including invertebrates and freshwater fish. The protected zebra trout species is not known to live in the catchments where water is taken for Stanley and Mount Pleasant Complex (McDowall et al. 2001). Regardless, the intended new extraction point for Stanley has been placed above two of the major tributary streams in order to ensure that at least some of the system remains unaffected.

Waste

All households are provided with one or two wheelie-bins by FIG and most offices and businesses in Stanley have a sealed rubbish bin or skip. However, most public litter bins and temporary skips around Stanley do not have lids and in combination with frequent strong winds, this results in an amount in an unacceptable amount of litter in Stanley. These issues are currently being addressed by FIG. Hospital waste is disposed of in the incinerator at the abattoir, which is used only infrequently for this material and additionally some abattoir waste and prohibited produce (e.g. fruits and vegetables) brought in at entry points.

Halcrow and Partners Ltd. (1998) conducted a complete review of current waste handling practices used in the Falkland Islands in 1997. They identified shortfalls and a variety of solutions were suggested along with costs and time-lines. The review considered health and safety issues, allocation of responsibility, economics, and environmental risks and environmental monitoring procedures. The report has not however stood up well to the tests of practicality as key assumptions were found to be in error so an alternative, slower strategy has had to be developed which is showing some progress.

General waste from Stanley is taken to a single coastal site, Eliza Cove, where some degree of burning followed by landfill takes place. This site was regarded as full beyond capacity in 1997 and recommended for immediate closure by Halcrow and Partners Ltd. (1998). However, in 2007, Eliza Cove tip remains the sole general disposal site for Stanley waste, due to some re-engineering at the site and activities to reduce both the volume of waste taken to the tip and the final compressed volume of

material landfilled. Other sites near to Stanley are under consideration where it is hoped improved systems can be implemented. Inert materials and larger items are dumped at the Mary's Hill Quarry on Cape Pembroke, which is slowly being filled and waste covered over. There is a policy in the Falkland Islands for some hazardous materials. For example, asbestos based materials have to be appropriately bagged and labelled, vehicle batteries are taken out of the waste stream and their liquid contents neutralised and commercial users of refrigerants are directed to ship their material elsewhere for disposal.

The current waste disposal system in Stanley is not sufficient for the Falkland Islands to offer reception facilities for much waste of any type from vessels calling into its ports. This contributes to a higher level of fisheries associated waste on beaches in the archipelago than is generally acceptable (Otley and Ingham 2003). Fishery vessel returns were particularly poor when information was sought by Halcrow and Partners Ltd., with virtually none having been made.

There are unlikely ever to be sufficient economies of scale to recycle materials in the Falkland Islands. It is inefficient to make the Falkland Islands the handling point when most vessels are not based here and call at ports in other countries, many of which have lower labour and energy costs. Facilities could be established, but if costs were to be recovered, this would potentially act as a disincentive to waste being brought ashore for disposal, unless there were close monitoring which would itself have a cost.

Part of the waste strategy is to encourage insofar as is possible the development of systems that are operated by the private sector with support from FIG but with a view to them being sustainable processes.

Stanley Growers collects old engine oils and fuel, from both vessels and on-shore machines, and burns it to heat their market garden poly-tunnels. This has been in part facilitated by FIG in providing funds for equipment to improve operating effectiveness and latterly, a scheme to improve the reception site has been recommended for approval. Some further recycling initiatives have occurred in 2007, including a trial of household composters and the installation of three glass imploders around Stanley to fragment glass products, with a view both utilising the cullet but also reducing the volume of material entering the tip, thus further extending its life. Road surfacing materials are and have been recycled for some time – being re-used for other, lower specification works – one example being to form a track to the Gypsy Cove wildlife site. Since late 2007, aluminium cans have been collected, baled and shipped out as scrap metal as a private sector initiative, supported by FIDC.

Waste from Mount Pleasant Complex is sorted, suitable materials are disposed of at a UK standard and bunded landfill site, and hazardous materials are shipped back to the UK. The cost of this is unknown, but considered likely to be well in excess of what FIG could sustain for the rest of the Falkland Islands.

In camp, waste has historically been burnt and/or dumped onto a convenient beach or off cliffs, but in recent years, there has been a move towards landfill options. Although most settlements have some sort of tractor available to spread soil back over land filled waste, few have a digger/jcb with the capacity to dig a trench of sufficient size. Waste management at the three largest camp settlements (i.e. 20 – 40 people) on East Falkland is variable. An old peat bank is used at North Arm, there is a small landfill site at Goose Green and there is no purpose built landfill site at Fitzroy. Approval was however given by Executive Council when the Halcrow report was considered to the use of PWD plant to create landfill sites, and this has been carried out at a number of locations. There has occasionally been a delay in requests being met due to other demands, but most are done within a year of being requested.

Sewage

There is a sewage treatment plant in operation at Mount Pleasant Complex, although performance can be poor due to a lack of volume. Houses in camp have septic systems or a direct drain to sea. In Stanley up until the late 1990s, the majority of sewage from homes and buildings drained directly into Stanley Harbour through 21 outfalls without any treatment or basic filtering. Although volumes were relatively low compared to a larger town, faecal coliform bacteria levels in Stanley Harbour during 1994/95 were found occasionally to be up to ten times higher than outside the harbour in Port William (FIG 1995).

However, infrastructure developments during the late 1990s were initiated to divert all the sewage from East Stanley eastwards along the waterfront and discharged at Rookery Bay into the open ocean. Subsequently, central Stanley has been connected to this sewage system. Water quality monitoring in Stanley Harbour in March 2000 indicated relatively low levels of faecal coliform bacteria, except at sites close to current sewage outfalls at the west end of town (KEMH unpublished data).

Annual infrastructure developments to the Stanley sewage system will, over time, reduce reliance on discharging untreated sewage into Stanley Harbour. However, there are some challenging infrastructure issues that need to be considered in determining the most cost-effective solution, such as the joint surface-water/foul-water system in central Stanley. The current estimate now that the pumped sewer scheme is operational is that less than 12% of total discharge enters Stanley Harbour, primarily being from the western end of the town.

Road network

Prior to 1985, there was less than 50 km of built road outside of Stanley and since then, a road network has been built on both East and West Falkland at a steady rate and now covers a total distance of almost 900 km (Fig. 2.3 and 2.7). This development of road networks has made travel between settlements and to Stanley much easier and quicker and by providing access to previously remote locations, the amount of recreational travel and tourism activities in camp has increased.

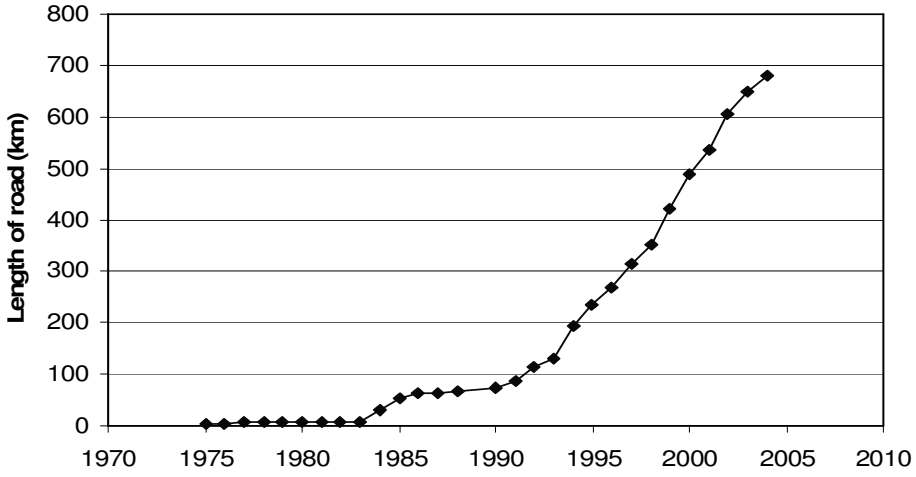


Fig. 2.7 Road development outside of Stanley from 1975 until 2005 (PWD, unpublished data)

Road building is exempt from the Planning Ordinance and as such, environmental issues do not have to be considered when locating or building roads in the Falkland Islands. However, the expansion of the road network and the associated disturbed ground is likely to have significantly expanded the range of some introduced species, both through natural colonisation and artificial translocation of seed by vehicles (Broughton and McAdam 2002a). In addition, the placement of roads and use of culverts across watercourses and drainage systems may have the potential to affect freshwater fish populations, including the protected zebra trout.

Three main quarries, at Ponies Pass, the Frying Pan and Mount Pleasant Peak, and a number of small borrow pits, have been opened to fulfil the need for rock and crushed aggregate for road building and construction. It is felt that due to the limited scale of these developments, no significant impacts are likely beyond the immediate vicinity of the development.

Local air transport

In the Falkland Islands, there are full-scale tarmac runways at Stanley and Mount Pleasant Complex, approximately 25 clay and grass airstrips (Fig. 2.3), and a number of identified helicopter landing sites. Most aircraft are stored, maintained and refuelled at the airports of Stanley and Mount Pleasant Complex. There are also a number of permanent helicopter refuelling stations, including at Fox Bay and Hill Cove, and temporary emergency tanks are occasionally set up at some locations, such as Sea Lion Island. Most landing sites for airplanes and helicopters are located at the safest and closest available suitable ground to the settlement and away from wildlife sites, where possible.

The main threat to wildlife from airplanes and helicopters is noise, aircraft flying at low altitudes and landing and taking off. Birds and marine mammals are particularly vulnerable, and adults may abandon young, temporarily or permanently. The flight map for the Falkland Islands identifies avoidance areas, under three sensitive wildlife site categories:

- Known sensitive breeding sites of penguins and seals – not to be overflown by helicopters below 500 ft;
- Very sensitive areas with high risk of bird strike – not to be overflown by any aircraft below 1500 ft except where operationally necessary and;
- New Island and Bird Island – should be avoided by helicopter below 500 ft at night due to prions and petrels which are nocturnal Sep – Apr.

A few years ago, Falklands Conservation also published a "Keep your distance!" poster, which recommends that helicopter landings should be at least at 3,300 feet (1,000 m) from wildlife breeding areas. Helicopter landing sites in the Falkland Islands are also described in a RAF regulations booklet.

In Antarctica, the Antarctic Treaty Consultative Parties agreed to regulations that seabird colonies should not be overflown below 2,000 ft and landings within 1/2 nautical miles should be avoided (Harris 2005). The same over-fly heights and landing distances are also enforced by the South Georgia Government, including for all beaches in order to protect breeding seals. Issues associated with landing sites and low flying over seabird breeding colonies have been reported at Sea Lion Island and Saunders Island.

The sensitive wildlife sites and guidelines were reviewed by FIG and Falklands Conservation during 2007. It was agreed that the regulations in the Falkland Islands need to be more flexible than for uninhabited or sub-Antarctic islands with research stations only, as aircraft travel is the only FIG provided form of inter-island transport. A number of penguin, giant petrel, seal and sea lion breeding sites can be over-flown at a height of 500 ft, which is lower than allowed elsewhere, but effects on the wildlife have not been documented. It was agreed that the regulations were appropriate and it was recommended that when the flight map and helicopter booklet are next updated (usually every 1-2 years), a few small changes/additions should be made.

Port facilities

There are two ports with significant infrastructure in the Falkland Islands: FIG's Falkland Interim Port and Storage System (FIPASS) in Stanley and MoD's Mare Harbour. Mare Harbour receives cargo and fuel for Mount Pleasant Complex and is operated to UK legislative standards. FIPASS receives cargo, fuel, fishing, military and passenger vessels. In addition, some passenger vessels anchor in Stanley Harbour and Port William, and fishing vessels discharge frozen product and receive fuel both in Port William and in nearby Berkley Sound.

In 2006, 257 vessels came alongside FIPASS, 138 vessels anchored in Stanley Harbour and 433 vessels anchored out in Port William, and annually Berkley Sound receives between 150 and 850 vessels visits, depending on catch volumes (FIFD records). Some of these vessels will dispose of sewage and bilge water into the harbours they visit and there are also associated risks of oil spills etc.

A number of reports have been commissioned regarding a new deep-water port for the Falkland Islands and any new port development would require an Environmental Impact Assessment.

Land use activities

The major land uses in the Falkland Islands, apart from settlement infrastructure, are sheep and cattle farming, mineral exploration, military defence and nature-based tourism, as well as recreational off-road driving, walking, fishing and shooting, and bird egg collecting. The non-commercial activities are discussed below and the commercial land use activities are covered in Chp 8.

Recreational off-road travel

Historically, the physical effort required in order to travel in camp limited most journeys to those between settlements and thus the most important wildlife sites on the mainland islands were afforded a high degree of protection by virtue of their isolation. Today, recreational travel is common due to the road network, rapid increase in four-wheel drive vehicle ownership and a more affluent lifestyle, which has given people a much greater amount of leisure time. Regardless of how carefully and sensibly camp driving is done, some damage to vegetation and watercourses may occur, particularly on montane, fern, marshland, stream and sand dune habitats.

Recreational walking

Walking is a popular recreational activity in the Falkland Islands, particularly around Stanley at sites such as Cape Pembroke and Moody Brook, and at wildlife sites in camp. Due to the open nature of the landscape, walkers tend to fan out across the land rather than keeping to one single trail. Only at a few sites, are walkers requested to keep to trails, such as to the settlement seabird colony on New Island and at Gypsy Cove. The fan out approach reduces environmental effects and walking trails are not very evident anywhere in the Falkland Islands.

Recreational fishing

Recreational fishing for brown trout is another popular recreational activity in the Falkland Islands. Fishing is concentrated to a few rivers, including the Murrell River, San Carlos River, Malo River, Frying Pan Creek and Swan Inlet on East Falkland and on the Chartres River, Warrah River and Blackburn River on West Falkland. The trout fishing season runs from 1st September until 30th April.

No national licence is required to fish and the national daily limit is six trout per person per day, except on the Murrell River where it is three trout per person per day, to ensure sustainability of the stocks. Most rivers are private, landowner permission must be sought, and some landowners have a costed licence system.

Recreational fishing does have the potential to cause environmental problems in the Falkland Islands, due to vehicle damage accessing sites, loss of fishing gear, general littering and the threat of introducing new species to waterways via fishing gear used outside the islands. The Falkland Islands

are free of all invasive freshwater alga and fish diseases, but algae in particular can survive on dry fishing line and felted waders. All gear should be checked, cleaned and dried before use in the Falkland Islands. Information regarding trout fishing can be obtained from the FIG Environmental Planning Department, Falkland Islands Tourist Board and MP Travel.

Recreational game shooting

Under the Conservation of Wildlife and Nature Ordinance 1999, the upland goose and domestic/feral goose may be shot year round and the yellow-billed teal and Patagonian crested duck may be shot from 1st April until 30th June. The popularity of game shooting has declined in recent times and it is not thought that, at the present time, any species are endangered due to the practice. However, it should be noted that some protected bird species closely resemble game species and therefore may be taken by mistake. For example, the yellow-billed teal may be confused with the protected yellow-billed pintail.

Egg Collecting

In the Falkland Islands, eggs of a number of species of wild birds are collected annually. Eggs of upland geese and feral geese may be collected without a licence as they are not protected species. Today, the total number of licensed eggs collected amounts to around 2,500 gentoo penguin eggs per annum, a drop of around 1,000 eggs per year from the numbers collected in the early 1990s and significantly less during the 1940s, when 4,000 gentoo penguin, 5,000 rockhopper penguin and 2,000 Magellanic penguin eggs were licensed for collection (FIG Archives data). Photographic evidence suggests that egging day trips to the penguin colonies were carried out with wheelbarrows, which were filled to overflowing.

The practise of egging is now closely controlled by landowners and the FIG Environmental Planning Department through the issuing of licences that specify the bird species, number of eggs and collection location, and licences are issued for personal consumption only. Only the eggs of gentoo penguin, Magellanic penguin, flightless steamer duck, Patagonian crested duck, yellow-billed teal and kelp gull are permitted to be collected. However, egg licences are only requested for gentoo penguins and occasionally for two to six flightless steamer ducks. For gentoo penguins, a licence to collect up to 33% of nests may be issued, and this is thought to be a sustainable practice. Generally, 15 – 20 gentoo penguin colonies are egged annually under 15 – 20 issued licences, with a total of 2 - 2,500 eggs taken (EPD records).

Chapter 3 – Environmental Policies and Legislation

Introduction

There is a range of current policies and legislation covering environmental and conservation matters in the Falkland Islands, which are linked to domestic, British and international policies, laws and conventions. For the purposes of this chapter, existing environmental law has been categorised as follows:

- Species and habitat protection
- Marine environmental protection
- Fisheries and oil-related measures
- Land use planning
- International conventions

For further details regarding Falkland Islands legislation, please contact the FIG Attorney General's Chambers

Domestic policies

There are a number of national policies that guide environmental management in the Falkland Islands. The principal policy is the Falkland Islands Environmental Charter, which was jointly signed in September 2001 by FIG and the UK Minister for the Overseas Territories. The need for Environmental Charters was identified in the 1999 UK Government White Paper "Partnership for Progress and Prosperity".

The Environmental Charter lays out eleven key commitments for FIG and UK Government, which are a mix of strategic policy objectives and specific actions, and the mutual support that will be provided (Fig 3.1).

Strategic national direction for the medium term in the Falkland Islands is clearly laid out in the 'Islands Plan 2008/011', which has as its Mission Statement: "To protect and improve the quality of life of Falkland Islands people and the community". The Islands Plan has nine objectives.

1. Right to Self Determination - In accordance with the principles set down in the Charter of the United Nations, we will ensure our right to self determination and continuing development of internal self government.

2. Sustainable Economy - We will manage the economy wisely so that all sectors of society can prosper.

3. Education - We will ensure that all residents have the opportunity to develop their abilities and skills through education and training taking into account the needs of society and the resources available.

Environment Charter

FALKLAND ISLANDS

Guiding Principles

For the UK government, for the government of the Falkland Islands and for the people of the Falkland Islands.

1 To recognise that all people need a healthy environment for their well-being and livelihoods and that all can help to conserve and sustain it.

2 To use our natural resources wisely, being fair to present and future generations.

3 To identify environmental opportunities, costs and risks in all policies and strategies.

4 To seek expert advice and consult openly with interested parties on decisions affecting the environment.

5 To aim for solutions which benefit both the environment and development.

6 To contribute towards the protection and improvement of the global environment.

7 To safeguard and restore native species, habitats and landscape features, and control or eradicate invasive species.

8 To encourage activities and technologies that benefit the environment.

9 To control pollution, with the polluter paying for prevention or remedies.

10 To study and celebrate our environmental heritage as a treasure to share with our children.

Mike Summers
FALKLAND ISLANDS
26 September 2001

Valerie Amos
UNITED KINGDOM
26 September 2001

Commitments

The government of the UK will:

1 Help build capacity to support and implement integrated environmental management which is consistent with the Falkland Islands' own plans for sustainable development.

2 Assist the Falkland Islands in reviewing and updating environmental legislation.

3 Facilitate the extension of the UK's ratification of Multilateral Environmental Agreements of benefit to the Falkland Islands and which the Falkland Islands has the capacity to implement.

4 Keep the Falkland Islands informed regarding new developments in relevant Multilateral Environmental Agreements and invite the Falkland Islands to participate where appropriate in the UK's delegation to international environmental negotiations and conferences.

5 Help the Falkland Islands to ensure it has the legislation, institutional capacity and mechanisms it needs to meet international obligations.

6 Promote better cooperation and the sharing of experience and expertise between the Falkland Islands, other Overseas Territories and small island states and communities which face similar environmental problems.

7 Use UK, regional and local expertise to give advice and improve knowledge of technical and scientific issues. This includes regular consultation with interested non-governmental organisations and networks.

8 Use the existing Environment Fund for the Overseas Territories, and promote access to other sources of public funding, for projects of lasting benefit to the Falkland Islands' environment.

9 Help the Falkland Islands identify further funding partners for environmental projects, such as donors, the private sector or non-governmental organisations.

10 Recognise the diversity of the challenges facing Overseas Territories in very different socio-economic and geographical situations.

11 Abide by the principles set out in the Rio Declaration on Environment and Development (See Annex 2) and work towards meeting International Development Targets on the environment (See Annex 3).

The government of the Falkland Islands will:

1 Bring together government departments, representatives of local industry and commerce, environment and heritage organisations, the Governor's office, individual environmental champions and other community representatives in a forum to formulate a detailed strategy for action. (See Annex 1).

2 Ensure the protection and restoration of key habitats, species and landscape features through legislation and appropriate management structures and mechanisms, including a protected areas policy, and attempt the control and eradication of invasive species.

3 Ensure that environmental considerations are integrated within social and economic planning processes; promote sustainable patterns of production and consumption within the territory.

4 Ensure that environmental impact assessments are undertaken before approving major projects and while developing our growth management strategy.

5 Commit to open and consultative decision-making on developments and plans which may affect the environment; ensure that environmental impact assessments include consultation with stakeholders.

6 Implement effectively obligations under the Multilateral Environmental Agreements already extended to the Falkland Islands and work towards the extension of other relevant agreements.

7 Review the range, quality and availability of baseline data for natural resources and biodiversity.

8 Ensure that legislation and policies reflect the principle that the polluter should pay for prevention or remedies; establish effective monitoring and enforcement mechanisms.

9 Encourage teaching within schools to promote the value of our local environment (natural and built) and to explain its role within the regional and global environment.

10 Promote publications that spread awareness of the special features of the environment in the Falkland Islands; promote within the Falkland Islands the guiding principles set out above.

11 Abide by the principles set out in the Rio Declaration on Environment and Development (See Annex 2) and work towards meeting International Development Targets on the environment (See Annex 3).

Fig 3.1 Environment Charter for the Falkland Islands

4. Transport and Communications - We will work to develop infrastructure, particularly transport and communications, to meet the Islands economic and social development.

5. Health - We will promote and maintain a healthy and fit society.

6. Management of Public Services and Finance - We will improve the efficiency of government services and maintain prudent fiscal management.

7. Camp - We will maintain Camp in order to encourage a well populated, economically and socially sustainable community integrated within the national economy.

8. Environment - We will conserve and enhance the natural diversity, ecological processes and heritage of the Falkland Islands in harmony with sustainable economic development.

9. Quality of Life and Community Safety - We will ensure a well-housed, well-served, safe community.

One of the key strategies to assist with meeting the nine objectives of the Islands Plan is the Falkland Islands Structure Plan 2001 – 2016, which was adopted in 2004 (FIG 2004a). The Structure Plan provides a framework for sustainable growth throughout the Falkland Islands via controlled development in Stanley and the revitalisation and diversification of Camp.

Under the Structure Plan, the overall approach to land use and the management of development in the Falkland Islands will be based on the following three key objectives, which define how the Falklands will be sustainably developed.

A. Today's resources, tomorrow's capital

- Sustaining the potential of natural and physical resources to meet the needs of Falkland Islanders and the reasonably foreseeable needs of future generations of Falkland Islanders
- Safeguarding the health of our air, water, soils and ecosystems
- Avoiding, remedying, or mitigating the negative effects of economic development activities on the environment and the Falkland Islands way of life
- Creating a physical infrastructure that supports those who wish to live, work and invest in the Falkland Islands with particular emphasis on Camp

B. A 'joined up' approach

A holistic approach to plan preparation and implementation will be employed which:

- Recognises the inter-related nature of issues and the need to develop integrated solutions which involve all relevant organisations, groups and individuals

- Uses 'joined up' thinking and integrates measures taken under different legislation and by different functions

C. Partnership

The Structure Plan will be effectively implemented by co-operation and partnership within and between:

- Government members, officials and departments
- private companies, partnerships and individuals
- the voluntary sector
- the wider community

National Biodiversity Strategy

A Conservation Officer was employed by FIG for a two year period during 2003 – 2005 using FCO funds to produce a Biodiversity Strategy and Biodiversity Action Plans for the Falkland Islands. At the end of the two years, a number of documents were at draft form.

- Munro G. 2004. Falkland Islands Environmental Baseline Survey 2004. A report to FIG by Falklands Conservation.
- Clausen A and Ingham B. 2005. Falkland Islands Biodiversity Trends and Pressures. A report to FIG by Falklands Conservation.
- Douse A. 2005. Natural Priorities. A Conservation and Biodiversity Strategy for the Falkland Islands. Falkland Islands Government.
- Douse A. 2005. Full and Abbreviated Species and Habitat Action Plans for the Falkland Islands. Falkland Islands Government. (19 plans).

Clausen and Ingham (2005) was sent out to local and British-based experts for review and subsequently amended in some areas and drafts of Douse (2005) were submitted to the Environmental Committee and the FIG Government Management Team (Heads of key Departments). No documents were formally adopted at that time.

Since mid 2005, no documents were reworked, revised or adopted, as there was little capacity within the Environmental Planning Department. In late 2006, FIG committed to the permanent employment of an Environmental Officer to progress the re-drafting and adoption of Biodiversity Strategy and Biodiversity Action Plans, amongst other tasks. Unfortunately, due to the time delay, the Environmental Baseline Survey needed updating to include new biological information, legislation and land management issues.

The Falkland Islands Biodiversity Strategy 2008 – 2018, when adopted, will be a daughter policy document under the Falkland Islands Structure Plan 2001 – 2016. The Biodiversity Strategy will set out how the environmental objectives for the protection and management of species, habitats and ecosystems will be achieved. As a daughter policy, effective implementation of the Biodiversity

Strategy will also require a 'joined up' approach and partnerships as described above for the Structure Plan.

Species and Habitat Action Plans

The following criteria will be used to select which species and habitats require action plans. These are not mutually exclusive and a species may only have to be covered by one to qualify for consideration. Given that some species and habitats in the Falkland Islands lack any robust population data, the extent of a decline may need to be made by educated guesswork, especially where a historical decline is suspected. The nature of the action plan will be determined by the need and potential for action to promote favourable conservation status.

International Convention criteria (A)

A(i) Classified as Critically Endangered, Endangered, or Vulnerable

A(ii) Annex I or Annex II species under Bonn Convention (Convention on Migratory Species) or listed in the Agreement on the Conservation of Albatross & Petrel (ACAP)

A(iii) An Appendix I species under CITES (where other factors combine to enhance the level of threat)

Conservation Status criteria (B and C)

B(i) A major decline of more than 50% in the last 25 years

B(ii) A substantial historical decline (>75%) even when species population size has stabilised

B(iii) Species inextricably linked with habitats that have declined by a substantial amount either recently or historically

C(i) Extremely rare or localised species1 under an identifiable threat

C(ii) Species that are extinct in the wild or where there are reasonable grounds to believe that it is extinct in the wild

C(iii) Charismatic/endemic species that are under identifiable threat

Selection Criteria for Habitats (D and E)

D(i) A major decline of more than 50% in the last 25 years

D(ii) A substantial historical decline (>75%) even when habitat extent has stabilised

E(i) Extremely rare or localised habitats under an identifiable threat

E(ii) Habitats that are extinct in the wild or where there are reasonable grounds to believe that it is extinct in the wild

E(iii) Charismatic/endemic habitats that are under identifiable threat

Conservation of Wildlife and Nature Ordinance

In 1995, the Foreign and Commonwealth Office (FCO) requested Falklands Conservation to commission a study of nature conservation law in the Falkland Islands. The document identified that the environmental legislation was more biased towards the protection of economic resources, such as livestock and grazing lands, rather than wildlife protection and should be updated. The advisory document (Standring 1995) was presented to the FIG Working Group on Nature and Conservation, and to the general public, its recommendations were broadly accepted.

This led to a radical overhaul of the existing legislation. The Conservation of Wildlife and Nature Ordinance 1999 was drafted to replace the previous Wild Animals and Birds Protection Ordinance 1964. It contains provisions for the protection of wild birds, wild animals and wild plants, introductions of new species and for the designation of National Nature Reserves.

It extends across all land and the territorial sea adjacent to the Falkland Islands up to a distance of twelve nautical miles to the baselines. However, the Fisheries (Conservation and Management) Ordinance 2005 also extends the Conservation of Wildlife and Nature Ordinance 1999 to the fishing waters beyond the territorial sea.

- Wild Birds

Under the terms of the ordinance, a wild bird is classed as any bird, except poultry, which is resident in or a visitor to the Falkland Islands in a wild state and it is prohibited to deliberately:

a) kill, injure or capture a wild bird;
b) disturb a wild bird while it is building a nest or is in, on, or near a nest containing eggs or young;
c) disturb dependent young of a wild bird;
d) damage or destroy the breeding site, nest or nesting place of any wild bird; or
e) take or destroy an egg of a wild bird.

The ordinance provides protection for all species. However, a schedule of de-listing is included which provides exclusion for certain species at certain times of year from the provisions of the ordinance. The upland goose, feral domestic goose and mallard are listed in schedule 1, part 1 and may be killed or captured by authorised persons at any time. The mallard duck should be removed from the ordinance because this species is not found in the Falkland Islands. Yellow-billed teal and Patagonian crested duck are listed in schedule 1, part 2 and may be captured and killed by authorised persons at any time outside a closed season defined as the period 1st July to 31st March. These groupings are equivalent to the old inclusion of pest species and game species.

The ordinance also restricts the methods by which wild birds (and animals) may be killed or captured. Notwithstanding the protected status of birds, licences exempting the authorised person from some conditions of the ordinance may be granted for the following reasons:

a) scientific or educational purposes;
b) ringing or marking;
c) conserving wild animals or introducing them to particular areas;
d) preserving public health;
e) preventing serious damage to livestock, foodstuffs for livestock, agricultural crops, fisheries or property;
f) improvement of agriculture or forestry;
g) collection of eggs for human consumption or scientific institution.

Egg collection was traditionally undertaken on a large scale for domestic consumption. However, due to the increasing additional pressures on populations and the greater accessibility of some colonies, it became evident that a greater level of control was necessary to protect some colonies. Only the eggs of gentoo penguin, Magellanic penguin, flightless steamer duck, Patagonian crested duck, yellow-billed teal, and kelp gull are permitted to be collected. The licence specifies the quantity, species and location from which eggs may be collected and is based upon the size and breeding success of the specific colony for which the licence is requested. It is also necessary to provide a return detailing the quantities collected and site collected from. Collection is permitted only for personal consumption. Albatross and petrel species are given full protection and no licence will be granted for the collection of the eggs of these species.

If damage to property or livestock occurs due to the presence of a protected species, a licence may be granted to control or kill that species. Licences are considered on an individual basis with regard to the species and the form of interaction occurring, and the licence would specify the area, methods and time over which the wild birds could be killed. This is particularly applicable to the striated caracara, which can raise high passions in both camps because of its extremely rare status and predatory nature on young or unhealthy sheep at certain times of the year. The provision to grant licences in extenuating circumstances may encourage farmers and other land-users to apply for licences rather than be tempted to conduct control measures independently.

Licences and return forms for egging and shooting may also allow assessment of sustainable harvesting levels and could help to determine conflicts.

- Wild Animals

Under the terms of the ordinance, an animal is considered as any kind of animate creature except human beings, birds, mammals and microbes and includes any egg or spawn of an animal and every stage of development of an animal. A wild animal is considered to be any animal except wild cattle and any bird, which is or (before it was killed or captured) was living wild.

It is prohibited to:

a) capture or kill a protected wild animal;
b) take or destroy the eggs or spawn of a protected animal; and
c) damage or destroy the breeding site or resting place of a protected animal.

Unlike birds, only listed wild animals are afforded protection. Protected wild animals are listed in schedule 2, part 1, and include only brown trout (*Salmo trutta*), Falkland zebra trout (*Aplochiton zebra*) and all species of butterfly. Brown trout is also listed in Schedule 2 Part 2 as a protected species that may be killed or captured by authorised persons at any time outside of the closed season (1st May to 31st August). Under the Murrell River Fishing Regulations 2006, the Murrell River has a daily bag limit of three trout and each fish must weigh over 1.5 lb or 0.5 kg, and no fish can be caught off the culverts or within 100 m of the culvert crossing on either side or upstream of Drunken Rock Pass. Recreational sport fishing in salt water is not licensed, and commercial fishing and hand netting is regulated under fisheries legislation.

The only protected invertebrate species are any resident butterfly species. However, this reflects that current lack of knowledge about invertebrates rather than a specific wish not to protect them. The recent Invertebrate Programme run by Falklands Conservation may identify some species or species groups or invertebrate habitat that may require formal protection. As with wild birds, licences can be requested to capture and kill higher numbers of protected animal or outside a closed season, primarily for scientific or educational purposes.

- Wild Plants

It is an offence to deliberately pick, collect, cut, uproot or destroy a protected wild plant. A wild plant is defined as any plant (any animate living organism including algae, fungi, lichens, mosses, bushes, shrubs, trees, seeds, spores and any stage in the growth cycle of a plant), which is or was growing wild and is of a kind that ordinarily grows in the Falkland Islands in a wild state. As with wild animals, protection is only afforded to listed species, of which there are 29 plants (Table 3.1). These species are further discussed in Chp. 4.

Under the legislation, a licence can be issued to authorise a person to pick, collect, cut or uproot or a protected wild plant for scientific or educational purposes. For collection of seed or leaf materials a 20%/20% rule is generally applied, that is collection of no more than 20% of the plant and disturbance to not more than 20% of the plants in a given area, and for herbarium vouchers, removal of a single plant should not jeopardise the sustainability of the sampled population.

A provision was also made for the granting of licences to exempt authorised persons from causing an offence through the conducting of certain land management practices if such practices are considered as necessary for the improvement of agriculture or forestry (i.e. pasture improvement). To date, no licences have been granted for such practices.

Table 3.1 Plants listed or scheduled to be listed under the Conservation of Wildlife and Nature Ordinance

Common name	Scientific name
Adder's tongue	*Ophioglossum crotalophoroides*
Antarctic cudweed	*Gamochaeta antarctica*
Chilean tall fern	*Blechnum cordatum*
Common violet	*Viola maculata*[1]
Dusen's moonwort	*Botrychium dusenii*
False-plantain	*Nastanthus falklandicus*
Felton's flower	*Calandrinia feltonii*[2]
Fir clubmoss	*Huperzia fuegiana*
Fuegian violet	*Viola magellanica*
Fuegian whitlowgrass	*Draba magellanica*
Gaudichaud's orchid	*Chloraea gaudichaudii*
Hairy daisy	*Erigeron incertus*
Leathery shield-fern	*Rumohra adiantiformis*
Maidenhair fern	*Adiantum chilense*
Moore's plantain	*Plantago moorei*
Mudwort	*Limosella australis*
Pale yellow orchid	*Gavilea australis*
Patagonian hawkweed	*Hieraceum patagonicum*
Pondweed	*Potamogeton linguatus*
Rock-cress	*Phlebolobium maclovianum*
Saxifrage	*Saxifraga magellanica*
Shrubby seablite	*Suaeda argentinensis*
Skullcap	*Scutellaria nummulariifolia*
Spider flower	*Arachnitis quetrihuensis*
Tasselweed	*Ruppia filifolia*
Yellow lady's slipper	*Calceolaria biflora*
Yellow maiden	*Sisyrinchium chilense*
Yellow orchid	*Gavilea littoralis*
	Schizaea fistulosa[3]

1. *Viola maculata* is given protected status not because it is rare or endangered, but because it is thought to be the larval food plant of the Queen-of-the-Falklands Fritillary (*Yramea cytheris*) a nationally rare butterfly and protected wild animal.
2. *Calandrinia feltonii* has recently been identified as an introduced species (*C. menziesii*) but has not yet been de-listed. However, the currently un-described species of *Calandrinia* may require listing.
3. *Schizaea fistulosa* is no longer believed to have been part of the flora (Broughton and McAdam 2002a).

- Introduction of New Species

It is an offence to release or allow to escape into the wild, any animal or bird which is of a kind not ordinarily resident or a visitor to the Falkland Islands. It is also an offence to plant or otherwise cause to grow in the wild any plant not ordinarily found growing in the wild. There is no enforcement of seed mixtures used within pasture improvement, although provision exists for the granting of licences. Biosecurity is discussed further below and invasive species are discussed further in Chp. 12.

- National Nature Reserves

The ordinance provides for the designation of National Nature Reserves on any area of crown land, marine area or on privately owned land with the agreement of the owner. All Nature Reserve Orders or Sanctuary Orders previously designated under the Wildlife and Birds Protection Ordinance 1964 and the Nature Reserves Ordinance 1964 were re-designated as National Nature Reserves under the new ordinance.

There are seventeen National Nature Reserves (that is, 17 separate sites, islands or geographically connected and wholly owned group of islands (Table 3.2, Fig. 3.2). Eight NNRs are owned by FIG, eight are privately owned and one is owned by Falklands Conservation.

Under provisions in the Conservation of Wildlife and Nature Ordinance 1999, absolute, temporal or seasonal NNR-specific regulations can be made regarding access and use of the land and native wildlife. These regulations would be in addition to those set out for protected animals and birds.

These could include specific regulations regarding the:

a) killing, taking, destruction, molestation or disturbance of animals, birds or plants of any type in the reserve;
b) taking or destruction of eggs of any animal or bird;
c) the picking, plucking or uprooting of any plant;
d) damaging or destroying of the breeding site or resting place of any animal or bird;
e) doing anything which interferes with the seabed or the bed of any water or disturbs or damages any object within the reserve;
f) depositing of rubbish or the discharge of any noxious or polluting substance;
g) bringing onto the reserve of any weapon or device designed for the purpose of capturing or killing animals or birds;
h) smoking or the lighting of any fire in the reserve;
i) bringing into the reserve of any animal, bird or plant;
j) introduction of carnivorous or domestic animals.

Table 3.3. National Nature Reserves listed geographically in an anticlockwise direction starting from the northwest corner

Date	Order	Designated Area	Landowner	Management plan
1973	Jason Islands	Flat Jason 51° 06'S 60° 53'W (Designated separately, 1966) Elephant Jason 51° 09'S 60° 51'W South Jason 51° 12'S 60° 53'W North Fur Is. 51° 08'S 60° 44'W South Fur Is. 51° 15'S 60° 51'W Jason East Cay 51° 00'S 61° 18'W Jason West Cay 50° 58'S 61° 25'W The Fridays 51° 03'S 60° 58'W White Rock 51° 17'S 60° 53'W Seal Rocks 51° 07'S 60° 48'W	FIG	None
1964	The Twins Islands	51° 15'S 60° 38'W Northwest of Carcass Island	Falklands Conservation	None
1964	Low Island	51° 19'S 60° 27'W Southeast of Carcass Island	Private	None
1966	Middle Island	51° 38'S 60° 20'W King George Bay, West Falkland	FIG	None
1998	Narrows	51° 41'S 60° 19'W Narrows Farm, West Falkland	Private	None
1998	East Bay	51° 48'S 60° 13'W East Bay Farm, West Falkland	Private	None
1993	New Island South	51° 43'S 61° 18'W	Private	Produced by NICT 2007
1978	Sea Dog Island*	Sea Dog Island 52 00'S 61 06'W	FIG	None
1969	Bird Island	Bird Island 52° 10'S 60° 54'W	FIG	None
1978	Arch Islands*	Big Arch Island 52 13'S 60 27'W Natural Arch Clump Island Tussac Island Pyramid Rock Last Rock and Albemarle Rock	FIG	None
1964	Beauchêne Island	52° 54'S 59° 11'W	FIG	None
1970	Bleaker Island	52° 18'S 58° 51'W Bleaker Island north of Long Gulch	Private	None
1973	Stanley Common	51° 43'S 57° 49'W	FIG	Adopted for: Murrell River 2006 Gypsy Cove 2007 Yorke Bay Pond 2007
1964	Kidney & Cochon Islands	Cochon Island 51° 36'S 57° 47'W Kidney Island 51° 38'S 57° 45'W	FIG	In preparation
1968	Volunteer & Cow Bay	51° 29'S 57° 50'W East Falkland	Private	None
1968	Cape Dolphin	51° 15'S 58° 51'W	Private	None
1996	Moss Side	51° 23'S 58° 49'W, Pond and sand-grass flats behind Elephant Beach	Private	None

* Sea Dog and Arch Islands designated jointly under the same order.

The Orders for Kidney and Cochon Islands, Bird Island, Jason Islands Group and Sea Dog and Arch Islands state that indigenous flora and fauna should be protected and, under suitable conditions and control, research can occur on the NNRs.

The Orders for The Twins, Low Island, Beauchêne Island, Middle Island, Volunteers and Cow Beach, Cape Dolphin, Bleaker Island south, Stanley Common, New Island south, Moss Side, Narrows and East Bay NNRs all prohibit the killing, injuring or taking of any wildlife animal or bird and the introduction of carnivores, excepting working dogs. The Orders for East Bay and Narrows specify that wildlife may be taken onto the NNR under the supervision of the landowner. In addition, the East Bay Order bans the visiting of the tussac islands off Conservation Point and those in Ree's Harbour, unless under the supervision of the landowner. The Order for New Island south also specifies that only people licensed to enter the NNR may do so.

Management of NNRs primarily by legislation is seen by the Falkland Islands community as being an ineffective or inappropriate method of management. Instead, joint adoption and implementation of agreed management plans by landowners and FIG is advocated as the most appropriate method of ensuring the best management of NNRs. FIG has adopted Management Plans for three sites within Stanley Common – Murrell River in 2006, and Gypsy Cove and Yorke Bay Pond in 2007.

Although there are no adopted management plans for the other FIG owned NNRs, visitor access is controlled by the Environmental Planning Department. Requests for access are decided on a case by case basis and for most NNRs, access is only allowed for scientific reasons. Visitor permits carry the following general guidelines:

1. All parties to be aware of, and carry, a copy of the Countryside Code.
2. No fires or naked flames, excepting the careful use of fuel stoves in huts and sandy or rocky areas.
3. Strictly no smoking on the island.
4. Extreme caution to be taken not to trample the burrows of nesting seabirds. Areas of high burrow density to be avoided.
5. No species of plant or animal known to be invasive or otherwise detrimental shall be knowingly taken to the islands.
6. Food must be stored in airtight containers and thoroughly checked before leaving the vessel.
7. Ensure boots are clean before going ashore.

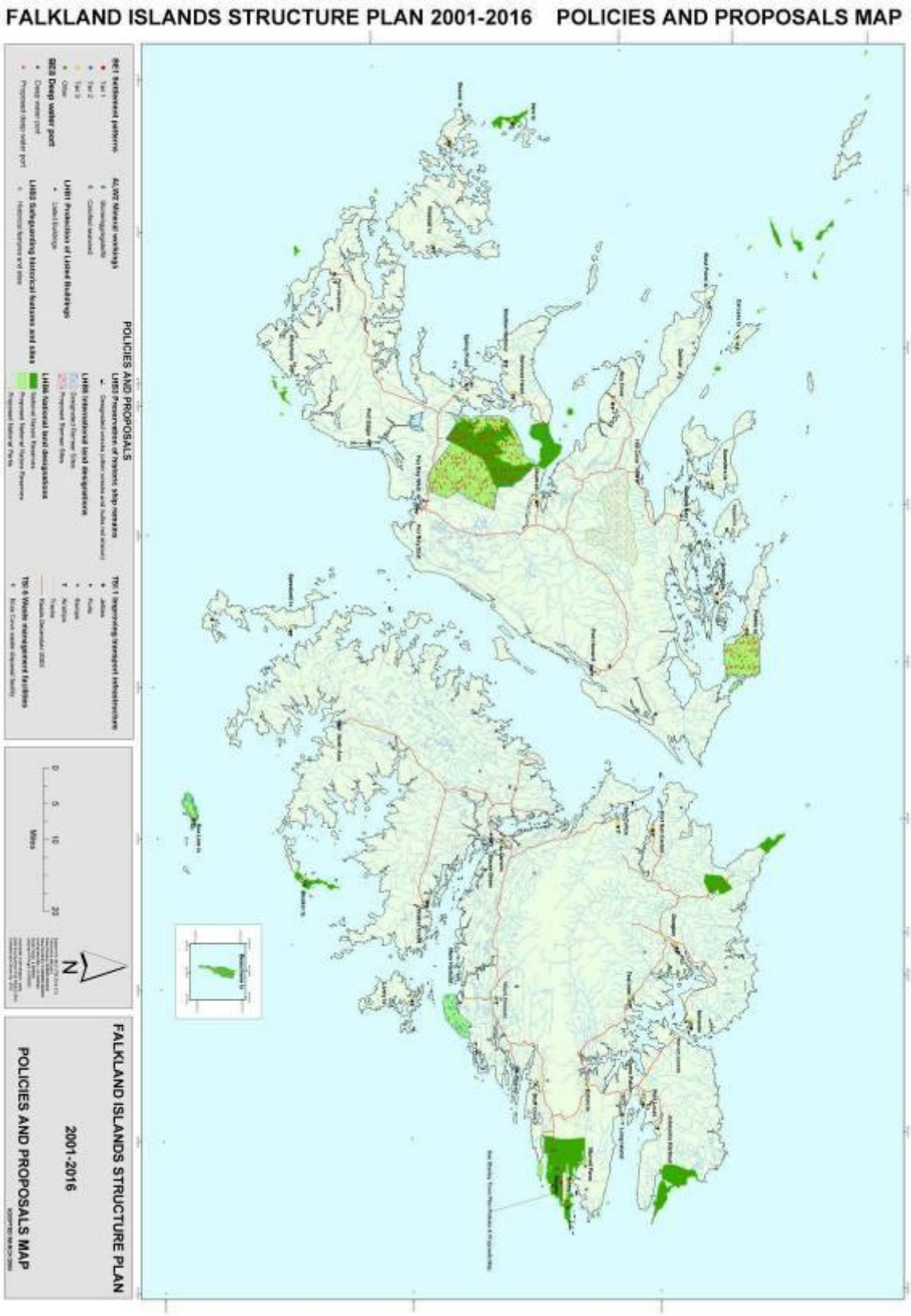


Fig. 3.2 Designated and proposed national nature reserves and proposed national parks (From FIG 2004a)

A site management plan is in preparation for Kidney Island. This includes imposing a group limit for commercial trips at 12 fare-paying passengers who should be accompanied by two guides, and the completion of a post-visit report by all visitors. A site management plan for the whole of New Island was produced in 2007 by the owner, New Island Conservation Trust, but the plan is yet to be adopted by FIG. It should be a priority for FIG to facilitate the development and adoption of site management plans for all remaining NNRs, both those privately owned as well as those on FIG land.

No new NNRs have been designated since the enactment of the Conservation of Wildlife and Nature Ordinance in 1999. There is a need for a number of biologically important sites to be formally designated as NNRs, including two Ramsar designated sites – Sea Lion Island and Bertha's Beach (Fig. 3.2). Under the legislation, the designation of a new NNR on private land requires that the owner of the land enters into a management agreement with FIG.

Provision exists under the Conservation of Wildlife and Nature Ordinance 1999 for the designation of a marine area as a NNR and this may extend up to the Falkland Islands territorial waters (12 nautical miles from baselines) or 3 nautical miles beyond (15 nautical miles from baselines). However, no marine areas to date have been designated.

As well as formally designated NNRs, a number of privately owned islands and areas of land are specifically managed for their biodiversity assets by the landowner. Management actions include restricting access by visitors, removal of livestock, eradication of invasive species and replanting of native species. The Department of Agriculture works with landowners with livestock to farm holistically, that is to value and conserve all native plants and animals within the workings of the farm enterprise.

National Parks Ordinance

Although, conservation is not the primary aim of the National Parks Ordinance 1998, the designation of National Park status allows certain controls to be implemented that may benefit conservation both directly and indirectly.

Under the National Parks Ordinance, the aims of a National Park are to:

a) Conserve and enhance the natural beauty, wildlife and cultural heritage of the area;
b) Promote opportunities for the understanding and enjoyment of the special qualities of those areas by the public; and
c) Confer upon the public at large the right to roam in the area.

The National Parks are not selected for their wildlife or conservation value but rather their natural beauty and the opportunities they afford for open air recreation, having regard to their character and geographical location. National Parks may be designated to include areas of private land, but only with the consent of the owner and where an access agreement has been entered into. Often land-use itself

has had a role to play in the formation of the landscape and the designation is thus not restrictive or prohibitive to existing land-uses, although greater scrutiny and monitoring of land-use effects may be entered in the management plan. Public access is secured, and foot and horseback travel may be encouraged and vehicular access limited.

Conserving the biodiversity may be a stated aim within the National Park's management plan if areas of high plant or bird value are seen as an important part of the site's heritage and value. In addition to site specific management criteria addressed in a national park's management plan, there are a number of general statutory restrictions with National Parks that may be considered of positive conservation value and the breaching of which constitutes an offence. It is forbidden to:

a) Light a fire;
b) Allow dogs not under proper control to enter the park;
c) To hunt, shoot, fish, snare, take or destroy animals, birds or fish or to carry an object that may be used for such;
d) Cause wilful damage to anything within the park and injure, destroy or remove any plant; and
e) Leave rubbish or litter.

To date, only the remaining areas of East and West Falkland that are still in FIG ownership have been considered for designation as National Parks, and these are Wickham Heights (East Falkland), Hill Cove Mountains and Hill Cove forest (West Falkland). During 2003 and 2004, site surveys and consultation with bordering land owners and the general public was undertaken (e.g. Broughton and Ingham 2002). The designation of Hill Cove forest was rejected after consultation with the public and the designations of Hill Cove Mountains and Wickham Heights was suspended in 2004, due to problems associated with leasing agreements and fencing.

FIG land designation system

In the Falkland Islands, there is not a formal framework for designating, reserving and managing specific islands and parcels of publicly or privately owned land, particularly in the criteria used to select sites and prepare and adopt approved management plans. Therefore, the coverage of currently designated NNRs is wholly atypical of the range and diversity of Falkland Islands habitats. Important Bird Areas have been identified for the Falkland Islands, and Important Plant Areas and Important Invertebrate Areas/Habitats will be identified in the near future by Falklands Conservation.

In addition, the principal historic reason for selecting sites appears to have been for the biological assets rather than geological or geomorphological values. There are a number of geological sites that would benefit from some form of statutory protection. The protection of important landscapes has received little attention. This is mainly because large scale developments that would have adverse impacts on landscape, such as extensive mineral developments, oil-related onshore developments and marine farming, have not yet taken place in the Falkland Islands.

Most NNRs do not have an adopted management plan or actions documented for future managers to continue implementing, and whilst a non-intervention or hands-off policy is perhaps appropriate, this is not universally true for all current NNRs. For most NNRs, there is little baseline knowledge and as such, preparation of site management plans would be significant.

It would be valuable for FIG to have a formal set of general guidelines to assist the management and use of all or selected NNRs. This should involve the:

- Identification of a clear purpose and rationale for having nature reserves
- Development of simple criteria for the selection of land and marine reserves, recognised for their biodiversity, geological and geomorphological features
- Development of management plans and/or management agreements for all FIG and privately owned designated reserves
- Development of an approval process for NNR management plans
- A review of management responsibilities for all or selected government owned NNRs

For land owners managing or wishing to manage sites for conservation purposes, a lack of finance is a hindrance. FIG should consider a financial incentive scheme, perhaps on similar lines to the England and Wales Countryside Stewardship Scheme or Scotland's Rural Stewardship Scheme or the LandCare movement in Australia.

Animals (Scientific Procedures) Ordinance

The Animals (Scientific Procedures) Ordinance 1998 enacts the UK Animals Scientific Procedures Act into Falkland Islands legislation. In essence if any scientific research may cause pain, injury or suffering however temporary to wildlife, a separate licence should be issued under this ordinance. Ethical decisions regarding research are already considered when issuing research licences under the Conservation of Wildlife and Nature Ordinance.

The Marine Mammals Ordinance

The Marine Mammals Ordinance 1992 protects all marine mammals (including whales, porpoises, dolphins, otters, seals, fur seals, sea lions and elephant seals), and makes it an offence to take, wound or kill any marine mammal in the Falkland Islands or in Falkland Islands waters with intent to do so, or to poison any marine mammal. Falkland Islands waters in this ordinance correspond to the boundaries of the Falkland Islands Outer Conservation Zone (FOCZ).

It is an offence to use on land or at sea any explosive in such a manner as, in all the circumstances of the case, is likely to cause harm to any marine mammal. There are also restrictions on the use of nets, trawl lines and hooks specified by regulations.

Contravention of these controls may, for a body corporate, result in a fine not exceeding £250,000. Powers of arrest are placed in the hands of police officers and fishery protection officers, and vessels

may be detained in port until the case has been heard and the fine paid. The ordinance also controls the import and export of any marine mammal or any part of a marine mammal living or dead.

Endangered Species Ordinance

The Endangered Species Ordinance 2003 was enacted in order that the Falkland Islands upholds the Convention on International Trade in Endangered Species (CITES). The ordinance controls the import and export of species listed under Appendix I, II and III of CITES and gives management authority of CITES to FIG (and delegated to the Department of Customs and Immigration). Under a Memorandum of Understanding, FIG can request advice regarding the trade of CITES species from the Joint Nature Conservation Committee in UK.

CITES regulates, by a permit system, international trade in wild animals and plants that are listed in three appendices and the level of control and prohibition of trade is dependent upon the appendix listing of the biological material. Designation is subject to nomination and agreement between the ratifying parties.

Appendix I species are those currently threatened with extinction generally based under IUCN classification and trade in such species is allowed only under exceptional circumstances, often only from material that was obtained before Appendix I listing was agreed or where there is clear (non-commercial) benefit such as scientific research.

Appendix II species are those species that are not sufficiently endangered to warrant inclusion in Appendix I and trade is much more permissible and generally requires parties to ensure that specimens were legally taken (or bred/propagated in captivity) without detriment to wild populations, and that the numbers taken and traded are monitored.

Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the co-operation of other countries to prevent unsustainable or illegal international exploitation.

The Falkland Islands have been party to the Convention since 1973, although there are only a few species normally resident in the Falkland Islands that are CITES listed (Table 3.4). There may be a need to review the listing for some of the uncommon genera that are listed and traded in UK, such as *Olsynium* and *Calceolaria*. But as there are relatively few requests to export CITES-listed species from the Falkland Islands, risks to Falkland Island biodiversity from such trade is considered low at present, and the regulatory regime is adequate to address the issue.

There has been a moratorium in the Falkland Islands since 2001 preventing the export of penguins or eggs for collections or breeding programmes. This will only change if there is a significant change in the conservation status of any of the penguin species and collection/capture is considered necessary for

the species survival.

Table 3.4 CITES listed species found in the Falkland Islands

Common name	Scientific name	Appendix	Notes and comments on species status
Birds			
Cattle egret	*Bulbuculus ibis*	III	Regular non-breeding vagrant, often in large numbers
Black-necked swan	*Cygnus melancoyphus*	II	Widespread breeding bird
Red-backed hawk	*Buteo polyosoma*	II	Widespread breeding species
Peregrine falcon	*Falco peregrinus cassini*	I	Widespread but uncommon breeding species
Striated caracara	*Phalcoboenus australis*	II	Uncommon breeding species. FI is main breeding locality for this species (~500 breeding pairs)
Southern caracara	*Caracara plancus*	II	Widespread but uncommon breeding species
Barn owl	*Tyto alba*	II	Rare breeding species
Short-eared owl	*Asio flammeus*	II	Rare breeding species
Mammals			
Arnoux's beaked whale	*Berardius arnuxii*	I	No information on status available in FI waters, but almost certainly rare as stranding
Southern bottlenose whale	*Hyperoodon planiformes*	I	No information on status available in FI waters, but almost certainly rare as stranding
Hector's beaked whale	*Mesoplodon hectori*	II	No information on status available in FI waters, but almost certainly rare as stranding
Gray's beaked whale	*Mesoplodon grayi*	II	No information on status available in FI waters, but almost certainly rare as stranding
Strap-tooth beaked whale	*Mesoplodon layardii*	II	No information on status available in FI waters, but almost certainly rare as stranding
Cuvier's beaked whale	*Ziphius cavirostris*	II	No information on status available in FI waters, but almost certainly rare as stranding
Sperm whale	*Physeter catodon*	I	Very occasional stranding, sometimes many individuals
Commerson's dolphin	*Cephalorhynchus commersonii*	II	Common in inshore areas but rarely strands
Long finned pilot whale	*Globiocephala melas*	II	Occasionally strands in large numbers. Appears to be common offshore.
Peale's dolphin	*Lagenorhynchus australis*	II	Common in inshore areas but rarely strands
Hourglass dolphin	*Lagenorhynchus cruciger*	II	Very rare. Only one record of a stranding.
Killer whale	*Orcinus orca*	I	Occasionally seen offshore. Not known to strand on FI beaches.
Southern minke whale	*Balaenoptera bonerensis*	I	Rare offshore and very rarely strands anywhere
Fin whale	*Balaenoptera physalus*	I	Rare offshore and very rarely strands anywhere
Sei whale	*Balaenoptera borealis*	I	Rare offshore and very rarely strands anywhere
Blue whale	*Balaenoptera musculus*	I	Rare offshore and very rarely strands anywhere
Humpback whale	*Megaptera novaeangliae*	I	Rare offshore and very rarely strands anywhere
Southern right whale	*Eubalaena australis*	I	Rare offshore and very rarely strands anywhere
Sea otter	*Lontra feline*	I	Introduced. Status unclear though, may be extinct.
South American fur seal	*Arctocephalus australis*	II	Scattered localities, numbers not great
Southern elephant seal	*Mirounga leonina*	II	Common breeding species
Argentine grey fox	*Pseudalopex griseus*	II	Introduced to six islands
Guanaco	*Lama guanicoe*	II	One introduced population
Fish & Invertebrates			
Basking shark	*Cetorhinus maximus*	III	GB only. Status uncertain in FI waters.
Black or wire corals	*Bathypathes patula*	II	No information on status available in FI waters.
Scleractinian (hard) coral	*Caryophyllia capensis*	II	No information on status available in FI waters.
Scleractinian (hard) coral	*Sphenotrochus gardineri*	II	No information on status available in FI waters.
Scleractinian (hard) coral	*Flabellum curvatum*	II	No information on status available in FI waters.
Scleractinian (hard) coral	*Flabellum thouarsii*	II	No information on status available in FI waters.
Scleractinian (hard) coral	*Balanophyllia malouinensis*	II	No information on status available in FI waters.

Common name	Scientific name	Appendix	Notes and comments on species status
Hydrocorals (lace corals)	*Errina antarctica*	II	No information on status available in FI waters.
Hydrocorals (lace corals)	*Errinopsis reticulum*	II	No information on status available in FI waters.
Hydrocorals (lace corals)	*Sporadopora dichotoma*	II	No information on status available in FI waters.
Plants			
Dog orchid	*Codonorchis lessonii*	II	Widespread in whitegrass and diddle-dee camp
Pale yellow orchid	*Gavilea australis*	II	Rare but locally very numerous
Yellow orchid	*Gavilea littoralis*	II	Widespread but rare to scarce
Gaudichaud's orchid	*Chloraea gaudichaudii*	II	Widespread but scarce

Grass fires

The Grass Fires Ordinance 2002 was enacted after considerable damage caused by a number of agricultural fires burnt out of control during the summer of 2001/02. Under the ordinance, fires may be started between 1 April and 15 September without permission but during the closed season, permission to burn areas on specific dates must be sought from the Department of Agriculture, which seeks guidance from the Fire Service. Dependent on the conditions of camp and weather, the FIG Fire Service does not usually permit burning after October/November.

The FIG Fire and Rescue Service will respond to fires in camp where life and/or property are threatened. Where there is a fire on an uninhabited island, the landowner has to request assistance and FIG may ask for payment. The Fire and Rescue Service has portable equipment for fighting fires in camp but their capacity is limited by air/sea access, the landscape of the site and access to water and the logistics of maintaining people at remote sites.

Biosecurity legislation for imports

There is an acknowledged increase in the number of cargo vessels and airplanes coming to the Falkland Islands, although it is difficult to obtain accurate data on the number of arrivals and goods (Department of Customs and Immigration, personal communication). These arrivals have a number of economical, social and environmental costs and benefits. The most critical threat is the accidental introduction of species and diseases that could have catastrophic impacts on local biodiversity, social well-being and economic revenue (see Chp. 12).

The import of plants and animals is controlled under legislation that is implemented by the Departments of Agriculture and Customs. Much of the biosecurity policy is driven by the Department of Agriculture's Senior Agricultural Advisor and Senior Veterinary Officer, and implemented by the Biosecurity Officer. In addition, the Customs Ordinance 2003 gives powers to the staff of both departments to declare any item prohibited goods in order to inspect it.

A report on biosecurity in the Falkland Islands was produced in 2004 by a New Zealand biosecurity consultancy (Simpson and Hellstorm 2004). The report made 22 recommendations around 82 proposed tasks associated with legislation, risk management, development and implementation of a biosecurity plan, importation restrictions, education, surveillance and inspection. A Biosecurity Oversight

Working Group (BOWG) was formed subsequent to the submission of the report and BOWG recognised that seven of these proposed tasks should be the key activities, and these were endorsed by Executive Council in June 2005, one of which was to create a Biosecurity Officer post within the Department of Agriculture. The biosecurity report remains a FIG framework document but has not been formally adopted.

The import of plants into the Falkland Islands is controlled by the Plant Disease Regulation Ordinance 1944 (plus various amendments), which allows the entry of packaged seeds and wood but all other plants require an import licence, including a phyto-sanitary certificate that declares the product free of soil, insects and diseases. This legislation is implemented by the Department of Agriculture and it is difficult in some cases to determine the biosecurity threat of some plants, particularly ornamental species.

The import of items of animal origin into the Falkland Islands is controlled under the Customs Ordinance 2003, which has proclamations under Section 143 for live animals, eggs, semen of animals and shearing equipment. Any applications to import finfish for aquaculture (e.g. salmon, cod) or ornamental fish for tanks and ponds (e.g. coy carp, goldfish) must meet import regulations which may include the need to undertake an environment impact assessment.

There are currently no legislative requirements for the control of animal feed importation, vehicles, machinery and agricultural implements, and in-transit goods but importers recognise the biosecurity threats associated with these items and liaise closely with the Biosecurity Officer. There is currently no checking of building materials (e.g. wood and sand) for introduced plants and insects.

During 2004 – 2006, the Biosecurity Officer designed and implemented a number of new import protocols, declaration forms, educational posters and leaflets for incoming air and sea visitors, as well as for importers (Department of Agriculture 2006).

The Falkland Islands have enacted the UK Zoonoses Order 1988 to cover the transmission of zoonoses, i.e. diseases that can be passed from animals to humans, such as rabies, avian influenza, etc. There is no contingency plan in the Falkland Islands to deal with the outbreak of zoonotic diseases in animal or human populations.

Intra-island biosecurity

Under the Conservation of Wildlife and Nature Ordinance, it is an offence to release, allow to escape or plant in the wild, any animal, bird or plant which is of a kind not ordinarily resident or a visitor to the Falkland Islands. However, this ordinance is generally not enforced for agricultural species.

There are a number of efforts, primarily educational, focused on preventing the spread of invasive species within the Falkland Islands. Making people aware of the issues particular to specific islands is

compounded by the facts that remote or small islands do not necessarily have fewer invasive species and that islands differ in the frequency and methods used to deliver people and goods.

The Environmental Planning Department is trying to improve intra-island biosecurity protocols, both for FIG- and privately-owned land. This is primarily through landowners educating visitors, a poster displayed at departure sites for FIGAS and helicopter flights and information contained in the FIG Ports and Harbours booklet issued to all arriving vessels.

Bioprospecting

In recent years, there has been much interest worldwide into researching the value of genetic resources for purposes such as pharmaceutical products and plant breeding. One objective of the Convention on Biological Diversity (CBD) is to ensure that benefits arising from the use of genetic resources are shared equitably between provider (i.e. the Falkland Islands community) and the user. The possible novel uses for plant genetic resources in the Falklands Islands are highlighted by Broughton (1999) as being horticultural, direct exploitation of berry crops, improved breeding of native plants as crops and medical. It was suggested that instead of sourcing plant material from the Falkland Islands, a central seed bank should be established. During 2004/05, a Falkland Islands seed bank was established at Kew Botanical Gardens, as part of the Millennium Seed Bank Programme.

There has only been one completed bioprospecting project in the Falklands, when the Department of Agriculture led and FIG licensed a collection and genetic analysis of six plants in 2002, but there has been some interest from international organisations, which have not gone ahead due to contractual and legal issues.

Currently, there is no legislation in the Falkland Islands to protect its sovereign rights to its biodiversity, but it should be urgently prepared in a way that it does not impede research activities. To guide countries as they develop national legislation to ensure equitable sharing of genetic resources, the Conference of the Parties of CBD adopted the 'Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilisation' in 2002, which works alongside the Food and Agriculture Organisation's 2001 International Treaty on Plant Genetic Resources for Food and Agriculture. The UK has signed to the FAO treaty but it has not ratified it, and it has not been extended to the Falkland Islands.

The Planning Ordinance

The Planning Ordinance 1991 introduced a simplified UK system of planning control in the Falkland Islands. The ordinance includes provisions for the preparation of development plans and for the handling of planning applications by the FIG Environmental Planning Officer. The Planning and Building Committee make decisions on all applications and there is a right of appeal for applicants to the Executive Council. Unlike the equivalent UK legislation, planning control extends to the territorial

sea of the Falkland Islands, i.e. up to 12 miles from the coastline, under the Falkland Islands (Territorial Sea) Order 1989.

Under section 33 of the ordinance, there is provision for the Governor to make regulations for the environmental effects of specified developments to be considered before planning permission is given. No such regulations have yet been produced, though the Mining Ordinances contain some provision for environmental impact assessments to be carried out for minerals developments. FIG is giving urgent priority to the drafting of such regulations.

There are no statutory requirements within the Falkland Islands for minimum levels of pollutants in the atmosphere (with the exception of those covered in the Offshore Minerals Ordinance 1994 and the Marine Protection Ordinance 1995), nor minimum standards for air, soil and water quality. Limited control exists within the Planning Ordinance 1991 to place industry in such a way as to minimise perceived environmental impact. In 2003, amendments were made to the Planning Ordinance to update legislation to ensure new activities, such as commercial onshore mining and removal of kelp and calcified seaweed would require planning. The Marine Farming Ordinance 2006 also brings marine farming under the Planning Ordinance.

Legislation with regard to waste disposal is also poor and there is no legislation for recycling. Although provision is made for the control of establishment and operation of waste dumps in the Planning Ordinance 1991, current practice is inadequate for all aspects of waste disposal.

Under the Planning Ordinance, development plan policies for the protection of the environment should be kept under review and steps taken to protect the environment should be considered before planning permission is granted.

Marine Farming Ordinance 2006

The Marine Farming Ordinance was created in 2006 to allow the licensing of farming of fish, crustaceans and molluscs. The ordinance has been enacted but is not yet in force. Under the ordinance, when making a decision about applications the Governor must consider the benefits to the Falklands Islands that the proposed fish farm will generate and the effects that the activities or infrastructure of the fish farm will have on the marine environment.

The Fisheries (Conservation and Management) Ordinance

The Falkland Islands declared the Falklands Interim Conservation and Management Zone (FICZ) in October 1986 (150 nautical miles around the islands) and Falklands Outer Conservation Zone (FOCZ) in 1990 (extended to the 200 nautical mile limit). Since 1986, eleven species of finfish, two species of cephalopod and one bivalve have been commercially targeted by various fishing vessels.

A new fisheries policy for the Falkland Islands was introduced in September 2005 with the implementation of new property rights and licence systems. The Fisheries (Conservation and Management) Ordinance 2005 gives legislative effect to a major review and modernisation of fisheries policy including the introduction of property rights in the Falkland Islands fishery. The increased security through the allocation of property rights for up to 25 years is intended to encourage diversification and value adding activities in the Falkland Islands, together with investment in research and development.

Under the Fisheries (Conservation and Management) Ordinance 2005, sustainability means maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and avoiding, remedying, or mitigating adverse effects of fishing on the marine environment so far as it is reasonably practicable to do so.

The ordinance has the following environmental and information principles:

- associated or dependent species shall be maintained at or above a level that ensures their long term viability
- biological diversity of the marine environment shall be maintained
- habitats of particular significance for fisheries management shall be protected
- decisions shall be based on the best available information
- decision-makers shall consider any uncertainty in the information available in any case
- decision-makers shall be cautious when information is uncertain, unreliable, or inadequate

The ordinance has the following objectives:

(a) The implementation of efficient and cost-effective fisheries management on behalf of the Falkland Islands;
(b) Ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the need to have regard to the impact of fishing activities on non target species and the long term sustainability of the marine environment.
(c) Ensuring, through proper conservation and management measures, that the living resources of the fishing waters are protected from over-exploitation;
(d) Achieving the optimum utilisation of the living resources of the fishing waters; and
(e) Ensuring that conservation and management measures in the fishing waters and the high seas are in accordance with the obligations of the Falkland Islands under international agreements that deal with fish stocks.

The Director of Fisheries may under the ordinance set or vary any sustainability measure for one or more stocks, which may relate to one or more of the following:

- for stock managed by effort, any Total Allowable Effort in relation to that stock;
- for stock managed by quota, any Total Allowable Catch for that stock;
- the size, sex, or biological state of any fish of any stock that may be taken;

- the areas from which any fish of any stock may be taken;
- the fishing methods by which any fish of any stock may be taken or which may be used in any area;
- the period for which fishing may take place in any fishery.

The waters covered by the ordinance include the internal waters and territorial seas, FICZ and FOCZ. The Fisheries (Conservation and Management) Ordinance 2005 also extends the Conservation of Wildlife and Nature Ordinance 1999 to the fishing waters beyond the territorial sea.

Control and conservation measures are exercised by effort-limitation, i.e. by the number of licensed vessels, duration of open seasons, closure of certain areas and net mesh sizes. Quota systems with fleet and vessel total allowable catches require significant manpower to manage and monitor and are less flexible for species with high variability in biomass and distribution, such as many of the squid and finfish exploited in the southwest Atlantic Ocean.

The waters of The Falkland Islands have been patrolled since 1987 by one or two fisheries protection vessels, two aircraft and occasionally by Royal Air Force (RAF) planes. FIG Fisheries Officers undertake inspections both in port and at-sea via the patrol vessel, and some monitoring of licence conditions is undertaken at sea by FIG Fisheries Observers.

Fisheries issues are further discussed in Chp. 11.

Offshore Minerals Ordinance

In the Offshore Minerals ordinance 1994, sections 14, 15 and 16 are the key sections of the ordinance relating to liability for damage to the environment. Sections 47 - 60 relate to abandonment of offshore structures, and sections 64 - 67 deal with requirements for environmental impact assessments to accompany applications for licences. Section 14 imposes on an operator strict liability (i.e. liability in law without proof of negligence on his part being necessary so as to establish his liability) for loss or damage in certain defined circumstances. Damage to the environment is defined as meaning any impact on the living or non-living components of the environment of the controlled waters or of the Falkland Islands or the ecosystems of the controlled waters or of the Falkland Islands.

Section 16 introduces the provisions of section 3 of the UK's Prevention of Oil Pollution Act 1971 into Falkland Islands law. Other sections of the 1971 Act were applied to the Falkland Islands by means of the Prevention of Oil Pollution Act (Overseas Territories) Order 1982. Section 16 thus specifies that an offence is committed if any oil (or mixture containing oil) is discharged to the sea from a pipeline or as a result of offshore exploration or production. The owner of the pipeline or person carrying out the operations, if convicted, may be liable to a fine without limit. Sections 47 to 60 of the ordinance, which are based on Part I of the UK Petroleum Act 1987, make provisions for abandonment and regulate the decommissioning of offshore installations and submarine pipelines.

In relation to Environmental Impact Assessment (EIA), the scope for requiring EIA to be prepared extends to applications for all licences, permissions and consents under the Offshore Minerals ordinance. There are no criteria or thresholds defining which types of development will or will not be subject to EIA. Instead, the Governor (in practice FIG) has complete discretion in deciding whether or not an EIA will be required.

Section 64(2) of the ordinance states that the Governor may commission an EIA himself, if he considers that the environment may be substantially affected, and additionally or instead require the applicant to submit an EIA. In such a case, consideration of the application will be deferred until the EIA has been prepared.

Schedule 4 to the ordinance sets out the information which must be contained in an EIA, the specified information and further information which may be included or shall be included if the Governor so directs. The classes of information are based on European and UK models for EIAs, although with a number of variations.

The Offshore Petroleum (Licensing) Regulations 1995 were made under section 7 of the Offshore Minerals Ordinance and contain, in Schedule 2, a set of model clauses for inclusion in licences. In addition, a set of indicative additional conditions and restrictions of an environmental nature have been drawn up by FIG. They are seen by FIG as being indicative of the types of conditions that will be imposed on licences in the interests of environmental protection. These are divided into four types: general, environmental seismic/drilling, oil spills and fisheries interests.

Key points include:

a) Control and restriction of seismic survey work and exploratory drilling
b) Monitoring of, and control of, the use and disposal of drilling muds and associated chemicals
c) Protection of cetaceans
d) Preparation of an oil spill contingency plan to cover licensed activities

Under the Offshore Minerals Ordinance 1994, marine mammals surveys should be conducted prior to seismic surveys and require that there should be a slow build up of power.

Rather than relying on detailed statutory controls over discharges, the present controls are broadly based on the regime of "strict liability" for environmental damage. The onus is on oil companies/licence applicants to furnish details of plans for environmental protection and their own corporate environmental policy as part of the application procedure. During appraisal of applications, it is expected that guidelines such as those of the United Kingdom Offshore Operators Association (UKOOA) for exploration operations in near-shore and sensitive areas will be used as a guide to determine the environmental commitment of applicants.

Legislation to control pollution at sea

A number of ordinances have been enacted in the Falkland Islands to protect the land and seas around the archipelago from at-sea activities and vessels within the 200 nautical mile limit. These include the Offshore Minerals Ordinance 1994 (as discussed above), the Environment Protection (Overseas Territories) (Amendment) Order1997, Merchant Shipping (Oil Pollution) Act 1971, Merchant Shipping Act 1995 and Oil in Territorial Waters Ordinance 1987. These are discussed below.

Environment Protection (Overseas Territories) (Amendment) Order 1997

The Environment Protection (Overseas Territories) (Amendment) Order1997 enables the provision of the London Dumping Convention to be implemented in Falkland Island waters. It is very closely based on Part II of the UK Food and Environment Protection Act 1985. Under Section 3, a licence is required for deposits in Falkland Islands waters or Falkland Islands controlled waters whether in the sea or under the sea-bed. A licence is required for deposits from a range of sources including vessels, platforms and other man-made structures, but excluding pipelines. Scuttling of vessels and incineration at sea also require licensing. The ordinance contains details of the offences that may be committed for failure to obtain a licence or non-compliance with the terms of a licence.

The Deposits in the Sea (Exemptions) Order 1995 sets out 25 categories of material that are exempt from the requirement to obtain a licence under the ordinance. The categories include disposal of sewage or domestic waste originating on a vessel or platform, certain types of cooling and ballast water, drill cuttings or muds under certain circumstances and the incineration of hydrocarbons. There is little legislative control over ballast water management and hull cleanliness in the Falkland Islands.

It should be noted that several of the exemptions relating to hydrocarbon exploration and production are caught by other legislation, notably the Offshore Minerals Ordinance and the Merchant Shipping (Oil Pollution) Act.

Merchant Shipping (Oil Pollution) Act 1971, Oil in Territorial Waters Ordinance & MARPOL

The UK Merchant Shipping (Oil Pollution) Act 1971 effectively implemented, and slightly extended, the International Convention on Civil Liability for Oil Pollution Damage (CLC) in the UK. The Act regulated the responsibilities of ship owners for damage caused by oil pollution from their ships. It has not been adopted in the Falkland Islands but Parts I and II have been applied by virtue of the Falkland Islands Merchant Shipping (Registration of Ships) Regulations 2001. The Falkland Islands does not have any port state control, as the UK does under the Act.

The Oil in Territorial Waters Ordinance (1987) controls the discharge of oil and oily mixtures in the territorial (12 nm) waters of the Falkland Islands from factories and during unloading and loading of vessels. It is closely based on the UK Oil in Navigable Waters Act of 1958. Many defences are provided for in the legislation, and it is likely that the strict liability regime in the Offshore Minerals Ordinance 1994 will be used in preference to the 1960 legislation for any future prosecutions in relation

to oil and gas exploration and production.

Declared harbours, i.e. Stanley Harbour, Port William, Berkeley Sound and Fox Bay, are controlled under the outdated Harbour Ordinance of 1902. Mare Harbour is a declared military port and has its own ordinance administered by an appointed Queen's Harbour Master.

The International Marine Organisation's convention on ballast water has not yet been adopted by the UK and the technology for ballast water cleaning is still being developed.

The adoption of the UK merchant shipping legislation has provided for tight control of pollution from ships registered in the Falkland Islands, following the International Convention for the Prevention of Pollution from Ships (MARPOL). Current Falkland Islands legislation obliges all Falkland Islands registered vessels to comply with MARPOL 73/78 regulations, with the exception of Annex IV (sewage from ships). It was specifically requested that this annex not be applied, as the Falkland Islands is unable to comply with the legislative requirement for adequate reception facilities (FIG Attorney General's Chambers, personal communication).

However, the regulations only apply to Falkland Islands registered ships and foreign flagged vessels operating within the territorial limits (12 nm) of the Falkland Islands. In the UK, the Merchant Shipping (Prevention of Pollution) (Limits) Regulations extend pollution regulations out to the 200 nautical mile limits and there is no reason why the Falklands should not do likewise apart from the political situation. Currently, where foreign flagged vessels working beyond 12 miles are in breach of MARPOL, FIG, through the FCO, may request that the flagging state make a prosecution in that country.

The Fisheries Department and Customs Department are tasked with the responsibility of enforcing MARPOL in the Falkland Islands. Monitoring for compliance is carried out by officers during port and at-sea inspections. Additional information is also obtained from both the Royal Air Force (RAF) and the Falkland Islands Government Air Service (FIGAS) during their regular patrols of Falkland Islands waters.

Since 1990, there have been eleven prosecutions for pollution offences (and representing a high percentage of reported incidents) under the Oil in Territorial Waters Ordinance 1987; these prosecutions all relate to incidents in Stanley Harbour and Berkeley Sound and no prosecutions have been made relating to the disposal of garbage. Under the legislation in the Falkland Islands, currently no prosecution could be brought against an offender if the spill is from a foreign registered vessel, rig or platform if the spill is outside twelve nautical miles from the coast. However, oil spills from rigs are covered by the Offshore Mineral Ordinance (as above).

Major incident and oil spill response plans, including for emergency services, have been drawn up to deal with shipping accidents in the Falkland Islands. The Fisheries Department's Marine Officer has

responsibility for responding to marine accidents but there is only limited legal provision for him to take responsibility for all decisions relating to a response.

During oil spills, the Falkland Islands National Oil Contingency Plan of 1998 is implemented (FIG 1998). A command structure with a response team is identified (Fig. 3.3). For all oil spills, the Fisheries Department notifies the Marine Officer, FIGAS, Environmental Planning Department and Falklands Conservation and additionally, Public Works Department, Police and Falkland Islands Defence Force, if the oil spill is more than 10,000 litres and the shoreline is threatened.

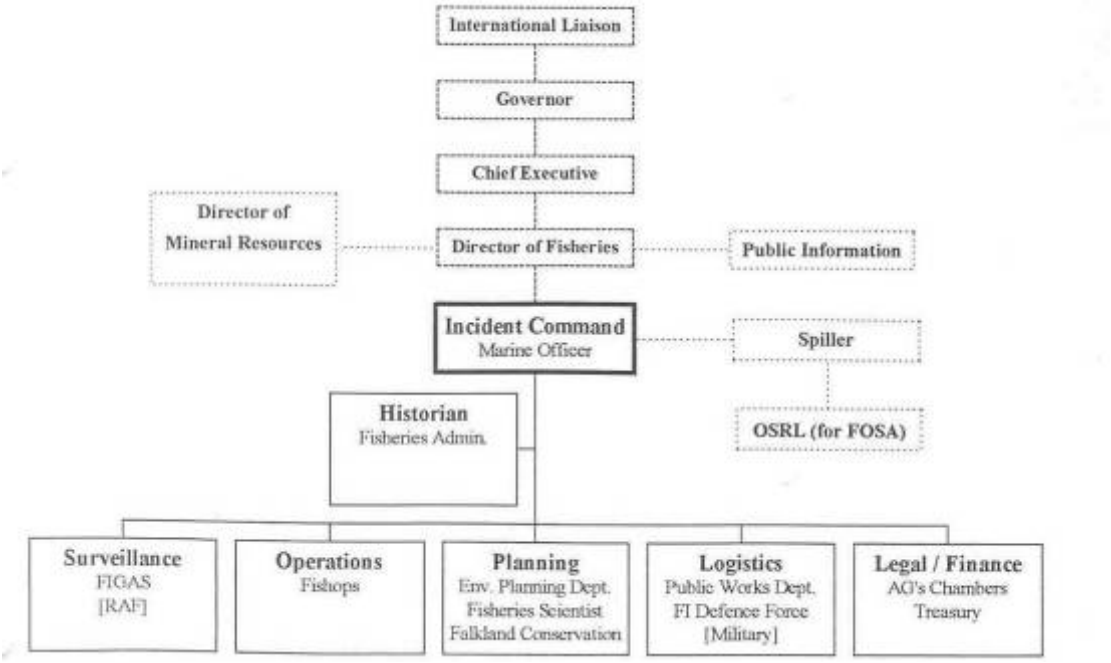


Fig. 3.2 Command structure for the Falkland Islands National Oil Contingency Plan (FIG 1998) (FOSA= Falklands Operators Sharing Agreement)

International Conventions

The Falkland Islands, through the United Kingdom as signatory, is included in a number of international conventions for the protection of wildlife. These include:

- The Convention on Wetlands of International Importance, especially as Waterfowl Habitat, known as the Ramsar Convention
- The Convention Concerning the Protection of the World Cultural and Natural Heritage
- The Convention on the Conservation of Migratory Species of Wild Animals
- Agreement on the Conservation of Albatross & Petrels
- United Nations Convention on Law of the Sea
- The Convention on the Conservation of Antarctic Marine Living Resources
- Convention on Biological Diversity
- Kyoto Protocol

In addition to these ratified and binding agreements, there are a number of hortatory agreements managed through the Food and Agriculture Organisation Committee of Fisheries (FAO-COFI). These include:

- Code of Conduct for Responsible Fisheries
- International Plan of Action - Seabirds
- International Plan of Action - Illegal, Unreported and Unregulated Fishing

Ramsar Convention

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat, known as the Ramsar Convention, was formally adopted in Ramsar, Iran in 1971, and ratified by the United Kingdom in 1976. The UK ratification was extended to the Falkland Islands. Initially, implementation of the Convention in the Falkland Islands was hampered by a lack of ecological data on many sites and the fact that under previous nature conservation legislation, a number of species of conservation value were categorised as pests, many animal and plant species and marine and sub-littoral areas were not protected by legislation, and there were no incentives to encourage landowners to cooperate in the designation of important sites. These shortfalls in legislation have been addressed in the Conservation of Wildlife and Nature Ordinance 1999.

The major obligations accepted by states that join the Ramsar Convention are:

a) To designate at least one wetland in their territory for inclusion in the Ramsar List of Wetlands of International Importance and to maintain the ecological character of sites so listed;
b) To make wise use of all wetlands in their territory, i.e. to develop a national plan or strategy for the conservation and sustainable development of all wetlands;
c) To promote the conservation of wetlands in their territory through the establishment of nature reserves on wetlands (whether they are included on the List of Wetlands of International Importance or not); and
d) To consult with other contracting parties about the implementation of the Convention.

The Ramsar Convention definition of wetland includes areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water where the depth at low tide does not exceed six metres. In global terms, wetlands are among the world's most productive environments, in supporting a high level of biological diversity and providing the water and primary productivity upon which many species and plants depend.

Under such definitions the majority of the Falklands land surface along with its many inshore waters may be classified as wetlands. The predominance of wetland habitat, the presence of several endemic waterfowl and internationally significant populations of various other species, make the Ramsar

Convention directly relevant to the Falkland Islands.

Although the majority of standing water bodies in the Falkland Islands are of relatively low biotic value, a number, particularly at low altitude, support emergent and submergent vegetation of value to waterfowl. Of 13 endemic plant species in the Falkland Islands, only *Phlebolobium maclovianum* is associated with wetlands. Twenty-five species of waterfowl (as defined under Ramsar Convention definitions) breed regularly in the Falkland Islands (two grebes, two cormorants, a heron, a swan, three sheldgeese, eight ducks, four shorebirds, three gulls and a tern). Of these bird species, the Falkland flightless steamer duck is an endemic species, and the white tufted grebe, imperial shag, black crowned night heron, upland goose and kelp goose are endemic races. The endemic zebra trout is now reliant on landlocked freshwater sites for its survival.

Specific proposals for applying the Ramsar Convention in the Falkland Islands were proposed by Standring (1982) and Hepburn et al. (1992a, b). Ten sites were originally identified by Hepburn et al. (1992a) as having particular value under the criteria for Ramsar designation: Swan Inlet, Hawks Nest Ponds, Pebble Island East, Lake Sulivan, Volunteer Point to MacBride Head, Cape Dolphin, Bull Point, Sea Lion Island, Bertha's Beach and Cow Point. Seven additional sites were identified following further surveys and research (Hepburn et al. 1992b). Of these 17 sites, four were initially selected to proceed to designation, two on government owned land - Bertha's Beach and Sea Lion Island - and two on private land - Lake Sulivan and Pebble Island East.

Comprehensive details of sites must be collected, in relation to the qualifying criteria, before the designation process can start. In addition, liaison with all interested parties and land-users must be conducted and management plans detailing the site, management objectives and practical measures specific to the site must be completed. For practical reasons, the two sites in government ownership – Sea Lion Island and Bertha's Beach (Fig. 1) - were proposed first and were accepted as Ramsar sites by the contracting parties in 1999/2000.

However whilst the two sites are legally designated Ramsar sites, the UK position on designation is that wetlands can only be designated for the Ramsar list if they have some statutory protected status. In the Falkland Islands, this would require the designation of National Nature Reserve Status; neither Sea Lion Island nor Bertha's Beach have NNR status. Management plans are being drafted and once all parties are supportive of the designation, only enactment of the NNR legislation will be necessary for the two Ramsar sites in the Falkland Islands.

World Heritage Convention

The World Heritage Convention aims to protect natural and cultural sites of outstanding global value. No sites have so far been designated in the Falkland Islands under the terms of this convention.

International Union for the Conservation of Nature

The International Union for the Conservation of Nature (IUCN) through the Species Survival Commission (SSC) has for more than 30 years been assessing the conservation status of species on a global scale in order to highlight taxa threatened with extinction, and therefore to promote their conservation. The aim is to provide scientifically-based information on the status of species and sub-species at a global level, to draw attention to the magnitude and importance of threatened biodiversity, to influence national and international policy and decision making, and to provide information to guide actions to conserve biological diversity.

Assessment is conducted according to strict scientific criteria and is assessed by a committee at the IUCN congress. Assessment criteria consider the population size, the geographical range and the reduction in population size in relation to the generation length of the assessed species. For those species where adequate data exists, seven levels of threat are identified; Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX). A designation of Data Deficient (DD) is assigned for species that have been evaluated but for which insufficient data is available to make an accurate assessment. All species assigned with a rating (including Data Deficient) except for Least Concern are considered a 'red listed' species.

Approximately 36 species that are found in the Falkland Islands are red listed, i.e. having a global conservation status, although a reassessment is required for invertebrates (Table 3.5). One species is considered as extinct, six are endangered and eleven are vulnerable.

Table 3.5. Breeding and/or common species in the Falkland Islands identified as under threat by IUCN

Common Name	Scientific Name	Date of assignment
Extinct		
Falkland Island wolf	*Dusicyon australis*	1994
Endangered		
Antarctic cudweed	*Gamochaeta antarctica*	2001
Graytail skate	*Bathyraja griseocauda*	2007
Black-browed albatross	*Thalassarche melanophris*	2001
Blue whale	*Balaenoptera musculus*	1994
Fin whale	*Balaenoptera physalus*	1994
Sei whale	*Balaenoptera borealis*	1994
Vulnerable		
False plantain	*Nastanthus falklandicus*	2001
Hairy daisy	*Erigeron incertus*	2001
Moore's plantain	*Plantago moorei*	2001
Rock cress	*Phlebolobium maclovianum*	2001
Cobb's wren	*Troglodytes cobbi*	1994
Macaroni penguin	*Eudyptes chrysolophus*	1994
Rockhopper penguin	*Eudyptes chrysocome*	1994, currently being revised
Southern giant petrel	*Macronectes giganteus*	1994
White-chinned petrel	*Procellaria aequinoctialis*	1994
Humpback whale	*Megaptera novaeangliae*	1994
Sperm whale	*Physeter macrocephalus*	1994
Near threatened		
Silvery buttercup	*Hamadryas argentea*	1994
Gentoo penguin	*Pygoscelis papua*	1994
Magellanic penguin	*Spheniscus magellanicus*	1994
Striated caracara	*Phalcoboenus australis*	1994
Porbeagle shark	*Lamna nasus*	1994
Spiny dogfish	*Squalus acanthias*	1994
Lower risk – conservation dependent		
Arnoux's beaked whale	*Berardius arnuxii*	1994
Killer whale	*Orcinus orca*	1994
Southern bottlenose whale	*Hyperoodon planifrons*	1994
Southern minke whale	*Balaenoptera bonerensis*	1994
Southern right whale	*Eubalaena australis*	1994
Data deficient		
Commerson's dolphin	*Cephalorhynchus commersonii*	1994
Cuvier's beaked whale	*Ziphius cavirostris*	1994
Dusky dolphin	*Lagenorhynchus obscurus*	1994
Gray's beaked whale	*Mesoplodon grayi*	1994
Hector's beaked whale	*Mesoplodon hectori*	1994
Hourglass dolphin	*Lagenorhynchus cruciqer*	1994
Peale's dolphin	*Lagenorhynchus australis*	1994
Southern right whale	*Lissodelphis peronii*	1994
Strap tooth beaked whale	*Mesoplodon layardii*	1994

Convention on the Conservation of Migratory Species

The Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) came into force in 1983 under the United Nations Environmental Program (UNEP). The fundamental objective of the agreement is to protect and conserve terrestrial, marine and avian migratory species throughout their range. Migratory species are defined by the convention as those that regularly cross international boundaries, including international waters.

Parties to CMS provide strict protection for endangered migratory species listed in Appendix I of the convention. This covers those species which are in danger of extinction throughout all or a significant proportion of their range. Five species recorded regularly in the Falkland Islands have Appendix I listing (Table 3.6).

Appendix II lists migratory species that have an unfavourable conservation status requiring international agreement for their conservation and management or have a conservation status that would benefit significantly from international cooperative agreements. There are a number of genera and individual species commonly recorded in the Falkland Islands that are listed on Appendix II (Table 3.6).

Table 3.6 Breeding and/or common species in the Falkland Islands listed under CMS

Common name	Scientific name	Appendix
Black-browed albatross	*Thalassarche melanophris*	Appendix II
Commerson's dolphin	*Cephalorhynchus commersonii*	Appendix II
Fin whale	*Balaenoptera physalus*	Appendix I/II
Grey-headed albatross	*Thalassarche chrysostoma*	Appendix II
Killer whale	*Orcinus orca*	Appendix II
Peale's dolphin	*Lagenorhynchus australis*	Appendix II
Peregrine falcon	*Falco peregrinus cassini*	Appendix II
Ruddy-headed goose	*Chloephaga rubidiceps*	Appendix I
Sei whale	*Balaenoptera borealis*	Appendix I/II
South American fur seal	*Arctocephalus australis*	Appendix II
Southern caracara	*Caracara plancus*	Appendix II
Southern giant petrel	*Macronectes giganteus*	Appendix II
Southern minke whale	*Balaenoptera bonerensis*	Appendix II
Southern right whale	*Eubalaena australis*	Appendix I
Southern royal albatross	*Diomedea epomophora*	Appendix II
Southern sea lion	*Otaria flavescens*	Appendix II
Sperm whale	*Physeter macrocephalus*	Appendix I/II
Striated caracara	*Phalcoboenus australis*	Appendix II
Turkey vulture	*Cathartes aura*	Appendix II
Two-banded plover	*Charadrius falklandicus*	Appendix II
Variable hawk	*Buteo polyosoma*	Appendix II
Wandering albatross	*Diomedea exulans*	Appendix II
White-chinned petrel	*Procellaria aequinoctialis*	Appendix II
White-rumped sandpiper	*Calidris fuscicollis*	Appendix II

Agreement on the Conservation of Albatross and Petrels

The Agreement on the Conservation of Albatross and Petrels (ACAP) is included under the umbrella of CMS. At the 6th meeting of the Conference of Parties to the CMS, the threats posed by fisheries bycatch to a wide range of species in general, but particularly albatrosses and petrels, was noted, and it was requested that relevant parties develop an agreement under the convention for the conservation of Southern Hemisphere albatrosses and petrels. ACAP came into force in February 2004 with the ratification of the required five states. The agreement was ratified by the UK in April 2004 and extended to the UK Overseas Territories in the South Atlantic Ocean.

ACAP is a binding agreement that requires signatory countries to produce an action plan that addresses all threats relevant to albatrosses and petrels. Not only does this include addressing accidental mortality related to fisheries, but also the long-term protection of their terrestrial breeding sites from threats such as fire, tourism, disturbance and introduced predators. ACAP also promotes education and regional collaboration across the biological ranges of ACAP species.

ACAP currently includes 21 species of albatross and seven species of petrel. Three of these species, white-chinned petrel, southern giant petrel and black-browed albatross breed in the Falkland Islands. A further four ACAP listed species - wandering albatross, southern royal albatross, grey-headed albatross and northern giant petrel - regularly forage within Falkland Islands waters (White et al. 2002).

A workshop was held in the Falkland Islands in March 2006 to identify conservation priorities to achieve ACAP in the UK Overseas Territories of the Falkland Islands, South Georgia, British Antarctic Territory and Tristan da Cunha. The meeting proceedings (Falklands Conservation 2006a) effectively form a Falklands Species Action Plan for black-browed albatross, southern giant petrels and white-chinned petrels.

United Nations Convention on Law of the Sea

The United Nations Convention on Law of the Sea (UNCLOS) 1982 entered into force in the Falkland Islands in 1994. UNCLOS provides a framework for the better management of marine resources and a new legal regime that affords ocean and coastal states rights and responsibilities for the management and use of fishery resources within their EEZs, which embrace 90% of the world's marine fisheries.

Article 61 of the agreement is related to the impact of the incidental mortality of seabirds and other non-target species and requires coastal states and states fishing on the high seas to consider the effects on species associated with or dependent upon harvested species, with a view to maintaining or restoring populations of such associated or dependent species above levels at which reproduction may become seriously threatened. The convention also introduces the concept of precautionary management.

For Falkland Islands flagged vessels to fish on the high seas, a licence must be issued by FIG and vessels must be equipped with a vessel monitoring system. In addition, Falkland Islands licensed

longline vessels fishing on the high seas are obliged to carry an observer to monitor the implementation of mitigation measures to reduce incidental mortality of seabirds.

Convention on the Conservation of Antarctic Marine Living Resources

Although the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) is strictly aimed at protecting the marine ecosystem south of 60 ºS, it is also relevant to conservation measures and resource management in Falkland Islands waters. The main signatories to the agreement, an offshoot of the Antarctic Treaty, include the UK and Argentina.

The aim of CCAMLR is to protect the ecology of the marine environment as far north as the Antarctic Convergence Zone. It seeks to protect fish, molluscs and crustaceans with the aim of ensuring exploitation is sustainable, thus conserving populations of whales, seals, and penguins, which depend upon these species for food. CCAMLR recognises that fish stocks in the southwest Atlantic Region are involved in the Antarctic ecosystems and thus maintains an interest in agreements by participating countries, even outside the Antarctic treaty area.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is the first global agreement to address all aspects of biological diversity (at genetic, species and ecosystem level) and is a commitment to conserve biological diversity, to use biological resources sustainably and to share equitably the benefits arising from the use of genetic resources. The Convention was opened for signature at the 1992 UN Conference on Environment and Development in Rio de Janeiro (subsequently known as the Earth Summit) and came into force 18 months later, on 29th December 1993.

CBD is a framework agreement in that it leaves it up to individual parties to determine how most of the provisions are to be implemented. There are no species lists or designated sites, instead CBD sets out overall goals and policies and requires each party to develop national strategies, plans or programmes for conservation of biodiversity and sustainable use particular to their extant situation. In 2002-03, both the World Summit on Sustainable Development and the Conference of CBD parties agreed to a '2010 Biodiversity Target' to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level.

CBD was ratified by the UK in 1992 with the facility for UK Overseas Territories to ratify through the UK. So far, six UK Overseas Territories have ratified the Convention. The Falkland Islands have not yet ratified the agreement, although significant steps have been made towards meeting the obligations. An important step towards implementation by UK Overseas Territories was taken with their inclusion in the UK Biodiversity Action Plan (HMSO 1994).

Within this, it is stated that the UK Government will encourage individual Overseas Territories to develop strategies for biodiversity conservation, including updating existing legislation and developing

new legislation to protect species and habitats as appropriate. Overseas territories are also encouraged to consider ways to develop their institutional capacity to implement CBD, to identify priority areas for biodiversity conservation and to exchange information for the development of wider biodiversity databases.

Internationally, parties to the Convention on Biological Diversity adopted the Global Strategy for Plant Conservation (GSPC) in 2002, which lists 16 broad-reaching and challenging targets under five main objectives that should be met by 2010. A strategy document was prepared in 2003 in order for the UK to meet the 16 targets and Royal Botanical Gardens Kew may, as part of their OT work programme, assist UK Overseas Territories prepare an equivalent document. In the Falkland Islands, many of these targets have been met or there is current work towards meeting them (see Chp. 4 for more details). Falklands Conservation's Plant Conservation Programme 2007 – 2009 should produce a plant conservation strategy for the Falkland Islands.

It is anticipated that the Biodiversity Strategy and Biodiversity Action Plans, alongside the 'Islands Plan', the 'Falkland Islands Structure Plan' and the 'Environmental Charter' should meet the principal obligations of CBD.

Food and Agriculture Organisation - Code of Conduct for Responsible Fisheries

These guidelines were born of the need to address continuing concern regarding unregulated fishing on the high seas, particularly of migratory fish species of stocks of fish that straddle the waters of various nations. In 1991, the Food and Agriculture Organisation Committee of Fisheries (FAO-COFI) called for the development of new concepts, which would lead to responsible, sustained fisheries. Subsequently, the International Conference on Responsible Fishing, held in 1992, further requested FAO to prepare an international Code of Conduct to address these concerns. In November 1993, the 'Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas' was adopted at the 27th Session of the FAO Conference.

In response to these developments, the FAO Governing Bodies recommended the formulation of a global 'Code of Conduct for Responsible Fisheries' to be consistent with these instruments and, in a non-mandatory manner, establish principles and standards applicable to the conservation, management and development of all fisheries. The Code, which was unanimously adopted in October 1995 by the FAO Conference, provides a necessary framework for national and international efforts to ensure sustainable exploitation of aquatic living resources in harmony with the environment (FAO 1995).

The objective of the 'Code of Conduct for Responsible Fisheries' was to provide guidance that may be used, where appropriate, in the formulation and implementation of international agreements and other legal instruments, both binding and voluntary (FAO 1995). The 'Code of Conduct for Responsible Fisheries' contains several references to the protection of the marine environment and both non-target and dependent species, which relate directly to a holistic approach to marine ecosystem management.

International Plan of Action - Seabirds

Within the framework of the 'Code of Conduct for Responsible Fisheries', the 'International Plan of Action - Seabirds (IPOA-S)' was developed. The issue of the incidental mortality of seabirds in longline fisheries first received official international recognition with the passing of a resolution at the IUCN World Conservation Congress in 1996 that called for concerted action to reduce seabird mortality.

This was followed in 1997 by the FAO-COFI establishing a Seabird Technical Working Group to draft guidelines on reducing incidental mortality and prepare a draft Plan of Action to implement the mitigation guidelines. The Seabird Technical Working Group met in Tokyo in 1998 and considered three technical papers (which were combined and published, Brothers et al. 1999) as background information on longline fishing, incidental mortality and measures to reduce such mortality. This meeting and subsequent meetings of FAO-COFI in 1998 resulted in the production of the IPOA-S (FAO 1999).

The Falkland Islands Government and fisheries industry adopted in 2004 a National Plan of Action (NPOA) – Longlining 2004 – 2008 and a National Plan of Action – Trawling 2004 - 2008. The process of plan preparation and adoption was led by Falklands Conservation and the RSPB. The plans set out the adoption of fishing licence conditions, which include aspects to protect seabirds, and for the NPOA – Longlining a framework to monitor seabird bycatch targets, and for the NPOA – Trawling to adopt and monitor new seabird bycatch mitigation measures, but no target rates were established.

FAO IPOA-Illegal, Unreported and Unregulated Fishing

Subsequent to the adoption of IPOA-Seabirds in 1999, FAO adopted the IPOA - Illegal, Unreported and Unregulated Fishing (IUU) in 2001. The objective of IPOA-IUU is to prevent, deter and eliminate IUU fishing by providing all States with comprehensive, transparent measures by which to act, including through appropriate regional fisheries management organisations established in accordance with international law.

The IPOA-IUU encourages countries to develop legislation, and to join regional agreements to control IUU fishing and to develop National Plans of Action (NPOA-IUU). The development and implementation of a NPOA-IUU should help reduce pressure on fish stocks and also significantly reduce incidental mortality of seabirds as IUU longline fisheries use fewer mitigation measures than regulated fisheries to reduce bird mortality.

FIG introduced a High Seas Fishing Ordinance in 1995, which was repealed and new provisions made under the Fisheries (Conservation and Management) Ordinance 2005. Thus, all fishing vessels registered in the Falkland Islands require licences to fish on the high seas and they must provide frequent position and catch reports.

Kyoto Protocol

The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratify this protocol commit to reducing their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases. The Kyoto Protocol now covers more than 160 countries globally and more than 60% of countries in terms of global greenhouse gas emissions. This treaty expires in 2012, and international talks began in May 2007 on a future treaty to succeed the current one.

Ratified governments are separated into two general categories: developed countries, referred to as Annex I countries (who have accepted greenhouse gas emission reduction obligations and must submit an annual greenhouse gas inventory); and developing countries, referred to as Non-Annex I countries (who have no greenhouse gas emission reduction obligations but may participate in the Clean Development Mechanism).

The Falkland Islands Government agreed to sign up to the Kyoto Agreement under UK's ratification as an Annex 1 country in April 2006. Annually, the UK produces a greenhouse gas inventory to aid assessment of UK compliance with the Kyoto Protocol. The report takes into account net emissions from afforestation, reforestation, deforestation and forest management, and includes emissions for the UK Overseas Territories of Bermuda, Cayman Islands, Falkland Islands, Gibraltar and Montserrat.

Atmospheric pollution in the Falkland Islands is primarily combustion-related products from vehicle emissions, burning of fuel for domestic heating and for power and this is a small scale contribution to global carbon emissions. There are no air pollution problems in the Falkland Islands. Under the Kyoto Agreement, the Falkland Islands is not required to reduce its emissions or place a ceiling on emissions in the first commitment period of 2008-2012, and the same situation is likely for the following periods.

However, it is expected to introduce policies in line with objectives of the UK Climate Change Programme and to this end, FIG has completed the 'Waste Heat Recovery Programme' infrastructure developments to the power station and is in the process of installing a wind farm close to Stanley. The two projects together have a current budget of £2,715,000 and are expected to displace about 23% of the fossil fuel imports to the Falkland Islands. In addition, the FIG Camp Energy Policy, to install wind turbines at farm settlements, has been largely completed. Typically, about 80% of the farm energy requirements are now produced by wind power. FIG has also agreed in principle to supporting grants for better insulation of homes but money has not yet been allocated.

Climate change is further discussed in Chp. 1.

Other conventions under consideration by FIG

- Aarhus Convention on Access to Information and Environmental Justice

The Aarhus Convention grants the public rights and imposes on Parties and public authorities obligations regarding access to information and public participation and access to justice. It was ratified by the UK in June 1998. In January 2004, Executive Council decided to consider joining this convention at a later date.

- Cartagena Protocol

The Cartagena Protocol on Biosafety, a treaty under the Convention on Biological Diversity, seeks to protect biological diversity from the potential risks posed by genetically modified organisations (GMOs). The protocol establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of a GMO into their territory. The UK ratified the Cartagena Protocol in November 2003 and Executive Council has indicated that FIG may ratify at some later stage, when ratification of CBD. Few GMOs are thought to be brought into or grown in the Falkland Islands, although many genetically modified crops are grown in, and exported, from Argentina and Chile. In September 2003, Executive Council decided to consider joining this convention at a later date.

International Agreements on Hazardous Waste and Chemicals

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

The aim of the Basel Convention is to help reduce the trans-boundary movements and amounts of hazardous wastes and non-hazardous wastes from specific industries/processes to a minimum, and to manage and dispose of these wastes in an environmentally sound manner. Hazardous wastes include materials that are explosive, flammable, oxidizing, poisonous, corrosive and toxic. Under the convention, hazardous wastes can only be exported if the state of export does not have the technical capacity and facilities to dispose of them in environmentally sound management. The UK ratified the convention in 1994 but it has not been extended to the Falkland Islands. Although it is currently of limited relevance to the Falkland Islands, it may be important with the disposal of material such as asbestos and wastes associated with drilling for oil.

- Rotterdam Convention on Prior Informed Consent

Rotterdam Convention on the Prior Informed Consent procedure is for certain hazardous chemicals and pesticides in international trade. Governments started to address the problem of toxic pesticides and other hazardous chemicals in the 1980s by establishing a voluntary Prior Informed Consent (PIC) procedure. PIC required exporters trading in a list of hazardous substances to obtain the prior informed consent of importers before proceeding with the trade.

In 1998, governments adopted the Rotterdam Convention, which made PICs legally binding. The Convention establishes a first line of defence by giving importing countries the tools and information they need to identify potential hazards and exclude chemicals they cannot manage safely. If a country agrees to import chemicals, the convention promotes their safe use through labelling standards, technical assistance, and other forms of support. It also ensures that exporters comply with the requirements. The UK ratified the convention in June 2004, with the Falkland Islands Executive Council deciding in March 2004 to consider joining this convention at a later date.

- Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. POPs circulate globally and can cause damage wherever they travel. In implementing the convention, Governments will take measures to eliminate or reduce the release of POPs into the environment. The Stockholm Convention on Persistent Organic Pollutants entered into force on 17 May 2004 and the UK is a signatory to the Convention but has not ratified it and it is of limited relevance to the Falkland Islands. It has not been considered by FIG.

Chapter 4 - Vegetation

Introduction

Moore (1968), Davies and McAdam (1989), Broughton and McAdam (1999), Woods (2000a) and Broughton and McAdam (2002b, c, 2003b) have studied the terrestrial vegetation and habitats of the Falkland Islands and as a result, the vascular flora is well documented. The key document for vascular plants in the Falkland Islands is Broughton and McAdam (2002c), which provides a species checklist, an atlas and parental electronic database held at Falklands Conservation.

The checklist provides a concise overview of species present in the Falklands flora and provides brief information on ecology, phenology and conservation status. The atlas provides a detailed understanding of the current status and distribution of the flora, and is an important management tool in identifying and preserving priority areas. However, the mapping of plant distribution is incomplete and requires considerably more fieldwork. With accurate knowledge of the flora (and other environmental parameters), as well as effective land-use planning controls, resource management and conservation measures, the impact of threats to flora can be minimised without compromising economic development (Oldfield and Sheppard 1997).

Apart from specimens collected since the late 18th century and now preserved at several herbaria, notably the Natural History Museum, London and the Royal Botanic Gardens, Kew, a collection of Falkland Islands plants has only recently been established in Stanley. The development of the Falkland Islands National Herbarium (FINH) from 2000 has provided the first collection of this type for identification of specimens and to increase conservation awareness and knowledge of the flora within the Falkland Islands. Since then, additions to the herbarium to most native species have increased its value significantly. Collections of various Falkland Island plant groups are also held in herbaria/ institutions across the world, including in USA, Germany, New Zealand, Australia and Chile.

In 2003, work began to include Falkland Islands species into the Millennium Seed Bank under the auspices of the Royal Botanic Gardens at Kew. An initial visit to the Falkland Islands by Kew researchers resulted in the collection of seeds from over 20 species and this offers both a safeguard against catastrophic natural events, and also the chance to study these species ex-situ. Further collections are needed to cover all the threatened and endemic species.

Freshwater algae, mosses, lichens and fungi

In contrast to the vascular plant families, the non-vascular flora (freshwater algae, liverworts, lichens and mosses), as well as the mycoflora of the Falkland Islands are poorly studied. Information on other lower plants comprises predominantly recorded species lists with limited data on abundance and distribution.

Studies of freshwater algae were completed as part of the 'Falkland Islands - Biodiversity Research in Lakes Project' (FI-BRIL) conducted by University College London Environmental Change Research Centre during 2001 - 2003. Diatom flora was investigated in 28 lake, pond and stream habitats, with eleven new taxa described, and approximately one third of taxa having a restricted regional distribution (Flower 2005).

One stonewort (Charophyte) species, *Nitella opaca* (dark stonewort), is known from ponds at two locations. It is a freshwater alga, despite its relatively large, rigid and upwards-growing appearance.

Bryophyte and lichen collection occurred in the Falkland Islands particularly in the summer of 1967-1968 by H. Imshaug and co-workers of Michigan State University, and also by Galloway (1988) and Dalby (2000). The Imshaug expedition collected almost 3,000 lichens and 1,779 bryophytes and from these, Imshaug estimated the total lichen flora to consist of about 235 species, of which he identified approximately 170 known species (A. Fryday, personal communication).

Since 2000, A. Fryday at the Michigan State University Herbarium has been reappraising Imshaug's lichen collections and has described several new species, determined that many are un-described species, and reported many species as new to the Falkland Islands. Other workers have also described several new lichen species and a new genus of bryophilous fungi from Imshaug's collections. Details of all of Imshaug's lichen collections are available on-line at the Michigan State University Herbarium web-site http://www.herbarium.msu.edu/

Around 168 species and subspecies of moss and liverwort across 53 genera are recorded from the Falkland Islands, with 43 species possibly being endemic (Greene 1986; Ochyra and Broughton 2004). However, there has been limited survey work in the Falkland Islands and in adjacent territories (McDowall 2005). All but six of the non-endemic mosses are also present in Patagonia and a number are also widespread across the cool temperate zone in the northern and southern hemispheres. There

are 131 recorded species of liverworts, including three endemic species, almost all exclusively from the southern hemisphere (Engel 1990).

Over 337 species of macro- and micro- non lichenised fungi, including ten endemics, are listed for the Falkland Islands, although survey effort has been limited in effort and extent (Watling 2000, 2002). It has been estimated that to obtain an almost complete record of fungi species present could take between 5 – 10 years. Using experience and studies from elsewhere, Watling (2000) estimated that there could be 500 species of larger fungi and 1,850 total fungi species in the Falkland Islands. Many of the recorded fungi species are familiar European and North American species and have probably been introduced to the Falkland Islands. Additionally some have been introduced with exotic plantings such as the mycorrhizal associations with conifer tree roots and false truffles with eucalyptus (Watling 2000).

Few typically Antarctic fungi have been found in the Falkland Islands (Jalink and Nauta 1993; Watling 2000). However, Watling (2000) identified a number of species that have a very restricted distribution and/or specialised habitat niches. For example, moss cushions in the Falkland Islands control their own microclimate, and this has been found to encourage specialised associations with fungi.

Baseline surveying and taxonomic identification of lower plants, particularly lichen and mosses, are a high research priority.

Vascular plants

The vascular flora of the Falkland Islands consists of 363 species (75 families and 215 genera) of which 171 species (54 families and 120 genera) are believed to be native and 13 species are endemic (Broughton and McAdam 2002b, c, McAdam and Broughton 2008). The flora of the islands has been reported to be much more diverse than that of many other South Atlantic or sub-Antarctic islands, probably because the Falkland archipelago is much larger and more diverse than other Southern Ocean island groups (Davies and McAdam 1989).

Several Falkland Island species are widespread in South America or considered cosmopolitan (Moore 1968). Of the species recorded by Moore (1968) and by Davies and McAdam (1989), almost 90% (144 species) of the native species in the Falkland Islands are also found on the South American mainland south of latitude 40ºS, and almost 80% of the Falkland Islands flora is recorded in Tierra del Fuego. Approximately 20% (33 species) of the native flora of the Falkland Islands occurs in some part of the sub-Antarctic zone, New Zealand or south-eastern Australia, and about 20 species are also found on South Georgia (Davies and McAdam 1989).

Most species of the Falklands flora are widespread throughout the islands where suitable habitats occur (Broughton and McAdam 2002c). Their survey sampled 10-km grid squares across the archipelago and found that 5% of the flora was found in all surveyed grid squares. Fifty-six percent of the 10 km

grid squares covered by the islands was surveyed. With further work, it is likely that these species would be found in other grid squares, thus adding more species to the list of very common species. It is commonly accepted that the number of observed species increases with the level of survey undertaken and although the work by Broughton and McAdam (2002c) is the most extensive survey undertaken to date, it can still only be considered as a baseline from which to develop a more extensive database of plant distribution.

Most species found in the Falkland Islands appear to have a broad ecological tolerance and occur over a wide range of altitudes, soil types, habitats and exposures. However, a small subset of species has a restricted geographic distribution in the Falkland Islands, being only on West or East Falkland (Broughton and McAdam 2002c). Of those species restricted to West Falkland, one group of narrow range endemics are restricted to the south coast of West Falkland around Port Stephens and Port Albemarle and another group of species is restricted to the north-west of West Falkland (Table 4.1). Both these areas are considered to have a localised environment; the former due to geology and climate, and the latter due to climate.

Table 4.1 Native flora only known from West Falkland (Broughton and McAdam 2002c)

English name	Scientific name
Boxwood	*Hebe elliptica*
Chilean tall-fern	*Blechnum cordatum*[1]
False plantain	*Nastanthus falklandicus*[2]
Fuegian whitlowgrass	*Draba magellanica*
Leathery shield-fern	*Rumohra adiantiformis*[1]
Maidenhair-fern	*Adiantum chilense*[1]
Moore's plantain	*Plantago moorei*[2]
Patagonian hawkweed	*Hieracium patagonicum*
Pondweed	*Potamogeton linguatus*
Shrubby seablite	*Suaeda argentinensis*[1]
Skullcap	*Scutellaria nummulariifolia*
Twisted filmy-fern	*Hymenophyllum tortuosum*[1]
Yellow lady's slipper	*Calceolaria biflora*
Yellow maiden	*Sisyrinchium chilense*[3]

1. Restricted to the north-west of West Falkland
2. Narrow range endemic restricted to southern West Falkland
3. Populations on East Falkland are likely to be introductions

Six species are restricted to East Falkland (Table 4.2). The low number compared with West Falkland may simply reflect a lack of detailed surveys on West Falkland.

Table 4.2 Native flora only known from East Falkland and adjacent islands

English name	Scientific name
Berg's hair-grass	*Koeleria permollis*
Dwarf saltmarsh-grass	*Puccinellia pusilla*
Fuegian violet	*Viola magellanica*
Saxifrage	*Saxifraga magellanica*
Southern dock	*Rumex magellanicus*
Spider flower	*Arachnitis quetrihuensis*

Ferns and clubmosses

Ferns and clubmosses, along with horsetails and quillworts, form an ancient group of plants collectively termed pteridophytes. Twenty-one species have been recorded in the Falkland Islands out of a global total of 12,000 species (Broughton and McAdam 2003b). The pteridophyte flora of the Falkland Islands is therefore of low significance in world terms but is nonetheless locally important.

No endemic fern species has been identified in the Falkland Islands, although the shieldfern (*Polystichum mohrioides*) is a widespread but scarce near-endemic found only in the Falklands and South Georgia.

A number of pteridophytes are rare and many of these are confined to West Falkland, especially to the far north and west. These species include maidenhair-fern (*Adiantum chilense*), which is recorded only on Saunders Island, Chilean tall-fern (*Blechnum cordatum*) and leathery shield-fern (*Rumohra adiantiformis*), which are recorded only in the north-west and twisted filmy-fern (*Hymenophyllum tortuosum*), which is recorded only in the north (Broughton and McAdam 2003b). Their restricted distribution suggests that these species are at the southern and eastern limits of their range, possibly due to specific climatic requirements.

Five rare pteridophytes are protected under the Conservation of Wildlife and Nature Ordinance 1999: maidenhair-fern, leathery shield-fern, Dusen's moonwort (*Botrychium dusenii*), fir clubmoss (*Huperzia fuegiana*) and adder's-tongue (*Ophioglossum crotalophoroides*). Chilean tall-fern is scheduled to be listed at the end of 2008.

Endemic Flora

Thirteen species are currently considered endemic to the Falkland Islands:

Antarctic cudweed	*Gamochaeta antarctica*
Clubmoss cudweed	*Chevreulia lycopodioides*
Coastal naussauvia	*Nassauvia gaudichaudii*
False-plantain	*Nastanthus falklandicus*
Hairy daisy	*Erigeron incertus*
Lady's slipper	*Calceolaria fothergilli*
Moore's plantain	*Plantago moorei*
Rock-cress	*Phlebolium maclovianum*
*S*ilvery buttercup	*Hamadryas argentea*
Smooth ragwort	*Senecio vaginatus*
Snake plant	*Nassauvia serpens*
Vanilla daisy	*Leucheria suaveolens*
Woolly ragwort	*Senecio littoralis*

Calandrinia feltonii (Felton's flower) has recently been removed from the list of endemic plants because DNA analysis has shown that the Falkland plants are identical to a weedy roadside species of California, which is properly named *Calandrinia menziesii* (Hershkovitz 2006). However, during the course of survey work for Falklands Conservation and private research on offshore islands between 1997 and 2006, a second species of *Calandrinia* has been recognised on six islands off West Falkland. This is genetically distinct from C. menziesii and may prove to be a hybrid between two southern South America species (Hershkovitz 2006, Woods 2007b).

Most endemic species in the Falkland Islands are found over a remarkably diverse range of habitat niches, which is somewhat unusual (Clark et al. 1990). However, two of the endemic species, false-plantain (*Nastanthus falklandicus*) and Moore's plantain (*Plantago moorei*), appear to be narrow range endemics restricted in distribution to the southern coast of West Falkland, which makes them very susceptible to any localised threats such as changed land use or climatic variables (Broughton and McAdam 2002a).

In addition to the endemic flora, the Falkland Islands is the international stronghold for a number of species. Falkland cudweed (*Gamochaeta malvinensis*) and shieldfern are both near-endemics with severely restricted geographical range within the south-west Atlantic Ocean region. *G. malvinensis* is restricted to the Falklands and Staten Island, while shield fern is restricted to the Falklands and South Georgia. The Falkland Islands also holds a significant proportion (approximately 20%) of the world population of tussac grass (*Poa flabellata*), despite its range being severely reduced in the archipelago due to inappropriate grazing (Broughton and McAdam 2002c).

Protected flora

Protection for native flora is now provided for at both the national and international level. Prior to the adoption of the Conservation of Wildlife and Nature Ordinance 1999, no national protection was given to native species except, it could be argued, within the confines of Nature Reserves and Sanctuaries where land use and access could be restricted. The Conservation of Wildlife and Nature Ordinance 1999 provided protection to 20 species and a further ten species – then unprotected Falklands Red List species (Broughton and McAdam 2002a) – are scheduled to be added by the end of 2008 (Table 3).

It is an offence to deliberately pick, collect, cut, uproot or destroy a protected wild plant. A wild plant is defined as any plant (any animate living organism including algae, fungi, lichens, mosses, bushes, shrubs, trees, seeds, spores and any stage in the growth cycle of a plant), which is or was growing wild and is of a kind that ordinarily grows in the Falkland Islands in a wild state.

Under the legislation, a licence can be issued to authorise a person to pick, collect, cut or uproot a protected wild plant for scientific or educational purposes. For collection of seed or material, a 20%/20% rule is generally applied, that is collection of no more than 20% of the plant and disturbance to not more than 20% of the plants in a given area, and for herbarium vouchers, removal of a single plant should not jeopardise the sustainability of the sampled population.

A provision was also made for the granting of licences to exempt authorised persons from committing an offence through the conducting of certain land management practices if such practices are considered as necessary for the improvement of agriculture or forestry (i.e. pasture improvement). To date, no licences have been granted for such practices.

The mapping of species distribution and frequency during 1998 – 2001 highlighted some species that were limited in geographical extent and/or number and consequently, a 'National Red Data List for Falklands flora' was published, listing 23 species (Table 4.3). Six plant species in the Falkland Islands are listed under IUCN legislation (Table 4.3), although the list is incomplete or not entirely appropriate and should be upgraded to include the species noted on the National Red List. All orchid species in the Falkland Islands are listed under Appendix II of CITES, which means that trade is permitted but strictly controlled. See Chp. 4.3 for more details about these international conventions.

Although the survival in the wild of some species is at risk, there has been no confirmed recorded extinction within the native flora in the Falkland Islands. Five species are classified as critically endangered: yellow lady's slipper (*Calceolaria biflora*), Fuegian whitlowgrass (*Draba magellanica*), saxifrage (*Saxifraga magellanica*), skullcap (*Scutellaria nummulariifolia*) and shrubby seablite (*Suaeda argentinensis*). Yellow lady's slipper and shrubby seablite are found at one location only and the remaining three are known only from historical records (Broughton and McAdam 2002a).

Table 4.3 Plants listed or scheduled to be listed under the Conservation of Wildlife and Nature Ordinance, the National Red Data List for Falklands flora (Broughton and McAdam 2002a), IUCN 2001 and CITES.

English name	Scientific name	FI Ordinance	FI Red list	IUCN 2001	CITES
Adder's tongue	*Ophioglossum crotalophoroides*	Protected	Vulnerable		
Antarctic cudweed	*Gamochaeta antarctica*	To be protected	Endangered	Endangered	
Chilean tall fern	*Blechnum cordatum*	To be protected	Vulnerable		
Common violet	*Viola maculata*[1]	Protected	Not listed		
Dog orchid	*Codonorchis lessonii*	Not protected	Not listed		II
Dusen's moonwort	*Botrychium dusenii*	Protected	Vulnerable		
False-plantain	*Nastanthus falklandicus*	Protected	Vulnerable	Vulnerable	
Felton's flower	*Calandrinia feltonii*[2]	Protected	Critically endangered		
Fir clubmoss	*Huperzia fuegiana*	Protected	Endangered		
Fuegian violet	*Viola magellanica*	To be protected	Vulnerable		
Fuegian whitlowgrass	*Draba magellanica*	To be protected	Critically endangered		
Gaudichaud's orchid	*Chloraea gaudichaudii*	Protected	Not listed		II
Hairy daisy	*Erigeron incertus*	Protected	Vulnerable	Vulnerable	
Leathery shield-fern	*Rumohra adiantiformis*	Protected	Endangered		
Maidenhair fern	*Adiantum chilense*	Protected	Endangered		
Moore's plantain	*Plantago moorei*	To be protected	Vulnerable	Vulnerable	
Mudwort	*Limosella australis*	To be protected	Vulnerable		
Pale yellow orchid	*Gavilea australis*	Protected	Vulnerable		II
Patagonian hawkweed	*Hieraceum patagonicum*	Protected	Endangered		
Pondweed	*Potamogeton linguatus*	Protected	Near threatened		
Rock-cress	*Phlebolobium maclovianum*	Protected	Vulnerable	Vulnerable	
Saxifrage	*Saxifraga magellanica*	Protected	Critically endangered		
Shrubby seablite	*Suaeda argentinensis*	Protected	Critically endangered		
Skullcap	*Scutellaria nummulariifolia*	To be protected	Critically endangered		
Spider flower	*Arachnitis quetrihuensis*	To be protected	Vulnerable		
Tasselweed	*Ruppia filifolia*	To be protected	Vulnerable		
Yellow lady's slipper	*Calceolaria biflora*	Protected	Critically endangered		
Yellow orchid	*Gavilea littoralis*	Protected	Not listed		II
Yellow pale maiden	*Sisyrinchium chilense*	Protected	Not listed		
	Schizaea fistulosa[3]	Protected	Not listed		
Antarctic prickly-burr	*Acaena antarctica*	Not protected	Data deficient		
Barros sedge	*Carex barrosii*	Not protected	Data deficient		
Berg's hair-grass	*Koeleria permollis*	Not protected	Data deficient		
Blood-beak sedge	*Carex aematorrhyncha*	Not protected	Data deficient		
California club-rush	*Schoenoplectus californicus*	Not protected	Near threatened		
Fuegian foxtail	*Alopecurus magellanicus*	Not protected	Data deficient		
Fuegian sedge	*Carex magellanica*	Not protected	Data deficient		
Silvery buttercup	*Hamadryas argentea*	Not protected	Near threatened	Near threatened	
Strap-fern	*Grammitis poeppigiana*	Not protected	Data deficient		
Clubmoss cudweed	*Chevreulia lycopodioides*	Not protected	Least concern	Least concern	
Coastal nassauvia	*Nassauvia gaudichaudii*	Not protected	Least concern	Least concern	
Smooth ragwort	*Senecio vaginatus*	Not protected	Least concern	Least concern	
Snakeplant	*Nassauvia serpens*	Not protected	Least concern	Least concern	
Vanilla daisy	*Leucheria suaveolens*	Not protected	Least concern	Least concern	
Woolly ragwort	*Senecio littoralis*	Not protected	Least concern	Least concern	

1. *Viola maculata* is given protected status not because it is rare or endangered, but because it is almost certainly the larval food plant of the Queen-of-the-Falklands Fritillary (*Yramea cytheris*) a nationally rare butterfly and protected wild animal.
2. *Calandrinia feltonii* has not yet been de-listed. The currently undescribed *Calandrinia* sp. may however require listing in future.
3. *Schizaea fistulosa* is no longer believed to have been part of the flora (Broughton 2000a).

That twenty-three species or 13% of native taxa are seen as threatened (i.e. listed on the Falklands Red List) to some degree might be seen as a significant and critical situation. However, since there are little historical distribution data and only partial recent data, it is impossible to decide whether these species have a naturally limited distribution or frequency, or whether there has been some significant change. Some unprotected species have undoubtedly become less common due to human-induced habitat degradation. For example, tussac grass covers less than 20% of its former range due to grazing and fire (Strange et al. 1988) and snake plant (*Nassauvia serpens*) is now limited to upland stone runs and rocky sites where it has escaped grazing (Broughton and McAdam 2002c).

Introduced Flora

Initial survey efforts found 92 introduced species (Moore 1968) but recent work found 177 introduced species, exceeding the total for native taxa (Broughton and McAdam 2002b; Varnham 2006). The increase in the number of alien species can be attributed to a number of factors. Whilst it is certain that new species continue to be introduced, both purposefully and accidentally, the greater part of the increase is due to an increased recognition of introduced taxa and a more inclusive approach to list all naturalised species. Early botanists concentrated on the indigenous species and it is only relatively recently that introduced species have been given full significance.

It is impossible to assess exactly how and when introduction and establishment of non-native species occurred, thought it is estimated that 50 species (29% of non-native species) were introduced for their ornamental or culinary value (Broughton and McAdam 2002b). A further 32 species (18%) were introduced for their agronomic value in pasture improvement, whilst many other species were introduced accidentally in impure seed batches and animal feed or accidentally in ship cargo.

The majority of introduced species originate from Europe (155 species, 88%), although they may not necessarily have been introduced directly from there. Most non-native flora (131 taxa, 75%) shows an association with human habitation and of these, 50% are dependent upon it (Broughton and McAdam 2002b). Eighty-five taxa (49% of non-native flora) can be considered as local and rare in occurrence, suggesting that they are unable to fully adapt to the Falkland Islands conditions and are, for the most part, restricted to modified, nutrient rich, sheltered or disturbed ground associated with human settlement.

Twenty-nine species (17% of non-native flora) are widespread, successfully colonising unmodified natural vegetation. In some localities, especially in areas such as sheltered valleys, pond margins and coasts, communities of non-native vegetation predominate and it is hard to discern the original native vegetation type. So common are these few species that it is likely that Beauchêne Island is the only island to remain free of non-native plant species (Broughton and McAdam 2002b). The expansion of the non-native flora is likely to continue with increased development in camp, particularly with the increasing road network.

To date, the majority of non-native species have not caused any major ecological impacts and no non-native plants are associated with the decline of the four native species suspected of extinction. However, in any analyses of the impact of non-native flora, it is very hard to differentiate effects of the flora from the effects of the land use activities. Human activities that disturb native ground cover, such as burning, drainage of the water table, soil cultivation, grazing or erosion, are probably of more significance to the establishment of non-native flora than natural extension from existing areas.

Whilst the ecological impact is hard to assess, some species have the potential to cause land management problems and economic impact. According to an assessment by Whitehead (2008), the top 12 invasive plants in the Falkland Islands are:

Broom	*Cytisus scoparius*
Calafate	*Berberis buxifolia*
Chilean rhubarb	*Gunnera tinctoria*
Creeping thistle	*Cirsium arvense*
Darwin's barberry	*Berberis darwinii*
European ragwort	*Senecio jacobea*
Gorse	*Ulex europaeus*
Hemlock	*Conium maculatum*
Oxford ragwort	*Senecio squalidus*
Scotch heather	*Calluna vulgaris*
Slender/ winged thistle	*Carduus tenuiflorus*
Spear thistle	*Cirsium vulgare*

These species are discussed in greater detail in Chp. 12.

Habitat Types

The terrestrial environment can be categorised according to recognised physical characteristics and key component species. The main terrestrial habitat types are formed from the interplay of geology, soils, climate, aspect, exposure and drainage, resulting in specific habitats that favour the formation of distinct plant communities. Various attempts have been made to provide a classification of the major vegetation community/habitat types in the Falkland Islands (Skottsberg 1913; Moore 1968; McAdam 1980).

In the past, the most widely used nomenclature for the vegetation classification corresponded to descriptions detailed in Moore's definitive flora of the Falkland Islands (Moore 1968). Davies and McAdam (1989) and Woods (2000a) adopted these categories in their plant identification guides and for the native plant survey undertaken by Falklands Conservation during 1980s and early 1990s (Bingham 1995, 1996). Baseline plant surveys conducted as part of the Falkland Islands Environmental Baseline Survey by Falklands Conservation from 1994 to 1996 used an expansion of this basic nomenclature to match classifications and methodology adopted by the Nature Conservancy

Council and Marine Nature Conservation Review. McAdam (1996) used a further modified classification.

All these systems of vegetation classification were appropriate to the needs of the work being conducted at the time. However, the need to establish a standard vegetation classification and a consistent data format was identified to allow a database of extant vegetation distribution to be developed. Broughton and McAdam (2002c) provided the most extensive and detailed description of the current distribution and abundance of Falklands flora and hence the opportunity to review the division of vegetation classification. A new system of classification was adapted from the strengths and weaknesses of previous classifications and also the UK Broad Habitat Classification (UK Biodiversity Group 1998) and hopefully will provide a relevant framework for more detailed community analysis in the future (Broughton 1999; Broughton 2000a).

The Falkland Islands Broad Habitat Classification (Broughton 2000a) sets out a framework of 19 habitat types, which provide a comprehensive, exclusive, structured and measurable set of vegetation groupings.

1. Tussac
2. Improved grassland
3. Greens and neutral grassland
4. Acid grassland
5. Dwarf shrub heath
6. Montane habitats
7. Fern beds
8. Scrub
9. Coniferous woodland
10. Fen, marsh and swamp
11. Bogs
12. Standing open water
13. Rivers and streams
14. Inland rock
15. Built up areas and gardens
16. Arable and horticulture
17. Sand dunes
18. Maritime rock, shingle, cliff and slope
19. Littoral sediments

1. Tussac

This formation is confined to coastal areas and is generally restricted to areas below 200m and at distances less than 300m from the coast (Strange et al. 1988, Strange 1989). This restricted distribution is probably due to a lack of essential requirements and possibly competitive exclusion. Therefore, with the exception of small islands of less than about 600 m diameter, tussac grass usually occupies the coastal zone, extending inland from high water mark. This natural pattern has been disrupted over the last couple of hundred years by the introduction of livestock, and the sensitivity of tussac grass to over-grazing.

It has been estimated that over 80% of the original tussac grass has been lost since the Falkland Islands were first settled and the total area of tussac grass remaining in the Falkland Islands is approximately 10,272 acres (4,159 ha), of an estimated original area of 54,788 acres (22,181 ha) (Strange et al. 1988,

Strange 1992). On East and West Falkland alone, the original area covered by tussac grass before grazing started was estimated to be about 24,500 ha (10,000 ha). Only about 160 acres (65 ha) was estimated to remain on the two main islands by 1988.

Tussac grass typically grows to a height of 2 – 3 m and occasionally 4 m and features a tussock-like growth form around a fibrous pedestal. The pedestals accumulate slowly within a skirt of dead leaves, and many of the larger specimens may be 200 or more years of age (McAdam and Walton 1990). The leaves provide nesting area for grass wrens, whilst striated caracaras often nest in the crowns of tussac grass (Woods 1970). Kelp geese and flightless steamer duck often nest on ground beneath tussac grass, whilst Magellanic penguins and sooty shearwaters burrow into the tussac grass peat below.

Within stands of dense tussac, the closed canopy provides a hostile environment for most vascular plant species, leaving an almost monoculture of tussac with just a few lower plant species and lichens capable of growing in the low light conditions. Amongst the higher plant species, which are adapted to surviving with tussac grass, is sword grass (*Carex trifida*) whose survival is almost dependent upon this habitat, as well as wild celery (*Apium australe*) and chickweed (*Stellaria media*).

Tussac communities remain in good condition where they are protected from grazing, predominantly on offshore islets (Moore 1968). The steady decline of tussac, and its importance as a feeding and nesting habitat for birds and invertebrates, requires that measures should be taken to protect the remaining areas, and to encourage the re-establishment in areas where tussac has been lost. Fencing tussac grass from livestock is often all that is required to allow long-term regeneration, as can be seen in areas such as Gypsy Cove, the end of Cape Pembroke, Hadassa Bay and Seal Point (Port Harriet) in the Stanley area.

The Department of Agriculture and Farmer's Association held a Farmers Forum in 1994 on the planting of tussac grass and sand grass for grazing and soil erosion, during which the successes and failures of previous replantings and restorations through fencing were analysed (Farmer's Association 1994). A practical guide to the establishment and management of tussac grass is also available from Falklands Conservation.

Given the importance of tussac and the limited extent of this habitat on the mainland, mainland tussac has been identified as a priority habitat and Strange et al. (1988) identified areas of tussac grass of high conservation value.

2. Improved grassland

Improved grassland or pasture is characterised by grass-dominated swards of low species diversity, normally forming a short turf of fine grasses, as opposed to the coarse grasses of grass heath. Such areas have been actively modified having either been sown or been created by modification of unimproved grassland by fertilizers and selective herbicides, for agricultural or recreational purposes.

Whilst improved grassland can be found on all soil types, it is most common on higher fertility or sheltered areas, which have been selected by land managers as most suitable for improvement. Fine grasses, whilst providing a higher nutritional value for grazing, require a more fertile soil and in the case of pasture, these nutrients are provided by the droppings of livestock, which tend to be kept at fairly high densities in such areas at certain times of year. Other improved grasslands rely upon fertilizer input or lime to lower acidity and free nutrients in the soil.

Several introduced plant species with a tolerance of being grazed at ground level such as *Bellis perennis* (daisy) and *Trifolium spp*. (clovers) are associated with improved grassland.

In general, pasture is too short to provide shelter or nesting habitat for birds, and seems only to be of any real benefit to upland geese, rabbits and hares, which graze on the nutritionally rich grasses.

3. Greens and neutral grassland

The category of greens and neutral grassland includes all semi-improved and unimproved grassland occurring on circum-neutral soils or in areas of nutrient flushing on otherwise acid soils. These areas are nutrient rich due to associated wildlife (e.g. seabird colonies, geese, rabbits and hares), topography, or soil or rocks with a high mineral content. Whatever the process involved, such areas tend to attract grazing geese, which will help maintain the green and keep it short.

The associated flora very much depends on the nature of the green, but will predominantly be plants that are tolerant of being grazed at ground level, predominantly fine grass but also ranker grasses such as cinnamon grass (*Hierochloe redolens*) and tall rush (*Marsippospermum grandiflorum*).

4. Acid grassland

Acid grassland includes all semi-improved and unimproved grasslands dominated by *Cortaderia pilosa* (whitegrass) and other rough grasses. Acid grassland covers the largest areas on East and West Falkland and is widespread on level or undulating land up to an altitude of approximately 180 - 200 m (Moore 1968). Acid grassland is generally absent from smaller offshore islands.

On fairly well drained sites, whitegrass is tussock-like and can be associated with pigvine (*Gunnera magellanica*), lawn lobelia (*Pratia repens*) and chickweeds (*Cerastium* sp.). On poorly drained plains, such as much of Lafonia, whitegrass has a less tufted form and is associated with rushes, sedges, astelia (*Astelia pumila*) and oreob (*Oreobolus obtusangulus*). Acid grassland provides habitat for a wide variety of inland birds, invertebrates and flowering plants.

5. Dwarf shrub heath

Dwarf shrub heath includes vegetation types dominated by low growing shrubs and tends to form on acidic, free-draining, shallow soils, such as hard peat overlying rocky ridges. Whilst diddle dee (*Empetrum rubrum*) is usually the dominant species, Christmas bush (*Baccharis magellanica*) and mountainberry (*Gaultheria* spp.), teaberry (*Myrteola nummularia*), tall-fern and small-fern (*Blechnum penna-marina*) can be locally important. Diddle dee - balsam bog (*Empetrum-Bolax gummifera*) heath is also included in this habitat category.

Dwarf shrub heath provides habitat for numerous invertebrates, inland birds, and other flowering plants such as pale maiden (*Olsynium filifolium*), scurvy grass (*Oxalis enneaphylla*), vanilla daisy (*Leucheria suaveolens*), almond flower (*Luzuriaga marginata*), common violet (*Viola maculata*) and dog orchid (*Codonorchis lessonii*).

6. Montane Habitats

Montane habitat tends to be found on higher hills and exposed ridges, where the combination of shale soils and exposure to wind excludes faster growing species. Cushion plants dominate, such as balsam bog and cushion plant (*Azorella* sp.), often in association with tall-fern and small-fern. The habitat category also includes moss and lichen dominated heaths of mountain summits.

Although montane habitat does provide habitat for specific invertebrates and birds, the harsh conditions and more open nature of this habitat mean it generally lacks the diversity of species found in other formations such as tussac or dwarf shrub heath.

7. Fern Beds

Fern beds include areas with a continuous cover of tall fern greater than 0.25 ha. As the fern and clubmoss flora of the Falkland Islands often forms associations with other habitat types, this habitat category is relatively rare.

8. Scrub

The habitat category of scrub includes patches greater than 0.25 ha where there is a continuous canopy rather than loose associations of bushes. Only two native species grow as bushes: fachine (*Chiliotrichum diffusum*) and boxwood (*Hebe elliptica*). Both species are sensitive to grazing by livestock, and as such have declined significantly since human settlement and are now virtually absent from much of East and West Falkland. The small stands are probably remnant of much larger stands existing prior to the introduction of grazing livestock.

Fachine favours damp but reasonably well drained soil in more sheltered situations, conditions often found alongside stream and riversides. However, as good stands of fachine can also be found on sandy soils near the coast (Moore 1968), the association with streamsides may merely reflect the grazing patterns of sheep, which tend to avoid waterlogged ground. Where livestock is excluded, fachine will

often re-establish in a matrix of well-spaced fachine bushes and whitegrass (whitegrass-fachine acid grassland). This suggests that whitegrass-fachine acid grassland was once a common habitat type that is now all but absent (Broughton 2000a).

Both whitegrass-fachine acid grassland and fachine scrub have been highlighted as priority habitat because they have a high species conservation value (Broughton 2000a). They are often associated with the scarce endemics silvery buttercup (*Hamadryas argentea*) and snake plant and are also important for birds, invertebrates and fungi (Broughton 2000a).

Uncultivated boxwood is restricted to coastal locations on the western and northern coasts of West Falkland where it normally occurs as scattered bushes, generally on rocky areas or on remote ungrazed islands. The distribution, if not the abundance, of boxwood has benefited from use as a hedging plant around gardens in Stanley and outlying settlements. Boxwood scrub has also been identified as a priority habitat in need of conservation (Broughton 2000a). Boxwood supports unique fungal and bryophyte flora, invertebrate fauna, the endemics woolly ragwort (*Senecio littoralis*) and lady's slipper (*Calceolaria fothergillii*), and shelter and nesting habitat for several passerines, such as thrushes and siskins.

There is also a handful of non-native plants that form bushes. These are mostly hedges around settlements but some, including gorse and calafate, have spread, formed thickets and become locally important habitat for wildlife.

9. Coniferous Woodland

Although there are no trees native to the Falkland Islands, several species have been planted around settlements for amenity and windbreak purposes. Monterey cypress (*Cupressus macrocarpa*), Sitka spruce (*Picea sitchensis*) and Alaskan lodgepole pine (*Pinus contorta*) along with some other *Pinus* sp. are the most frequent introductions and are well established in limited areas. Deciduous trees, although planted in gardens, are not widespread.

Although such trees provide roosting and nesting sites for some bird species, and provide shelter in their lee, they are unlikely to be of major importance to native wildlife. The planting of non-native species cannot generally be advocated as a conservation measure, although there may be commercial and social requirements for tree planting, such as the ongoing shelterbelt project by the Department of Agriculture (Low and Kerr 2004).

10. Fen, marsh and swamp

Fen, marsh and swamp habitat occurs in areas that are ground water fed and are permanently, seasonally or periodically, waterlogged such as ponds, lakes and streams. Grasses do not predominate in this habitat and it features instead tall freshwater plants such as willow herb (*Epilobium ciliatum*), Californian club-rush (*Schoenoplectus californicus*) and spike-rush (*Eleocharis melanostachys*) and

low-growing plants such as marigold (*Caltha sagittata*), water-milfoil (*Myriophyllum quitense*), starwort (*Callitriche antarctica*) and blinks (*Montia fontana*). Herb-rich, grass-poor vegetation found on damp level ground near the coast dominated by native rush (*Juncus scheuchzerioides*) and/or pigvine are also categorised as this habitat type.

Fen, marsh and swamp are not particularly abundant in the Falkland Islands. However, where it does occur, it provides important cover for nesting waterfowl, smaller passerines and invertebrates and as such, this habitat type has a high priority for protection from damage such as burning, overgrazing or excess disturbance.

The Californian club-rush bed has been identified as a priority habitat. It is a nationally scarce species, limited to eight water bodies mainly on West Falkland. The habitat provides shelter for locally important populations of waterfowl and breeding populations of the endemic sub-species of black-crowned night heron (*Nycticorax nycticorax falklandicus*). The invertebrate fauna found associated with Californian club-rush beds, although as yet unstudied, is likely to be distinct and of national importance.

11. Bog

Bog consists of wetlands that are not nutrient flushed and supports vegetation that is normally peat forming. It includes short rushes and cushion bog habitat dominated by soft-camp-bog (*Astelia pumila*), dwarf marigold (*Caltha appendiculata*), gaimardia (*Gaimardia australis*) and sundew (*Drosera uniflora*). This category also includes valley raised bog communities, which are dominated by sphagnum, bristle sedge (*Carex microglochin*), blinks, lawn lobelia, lilaeopsis (*Lilaeopsis macloviana*), buttercup (*Ranunculus trullifolius*) and pimpernel (*Anagallis alternifolia*).

12. Standing Open Water

Standing open water includes naturally occurring lakes and ponds as well as manmade waters. The vegetation includes submerged, free-floating or floating-leaved vegetation, which can occur in the open water zone, the vegetation along the water fringe and the adjacent wetland habitats.

The nature of standing open water varies enormously depending on soils, topography, geology, surrounding vegetation, weather patterns and farming practices. Common flora species include water-milfoil, tasselweed, marigold, starwort, blinks, spike rush and native rush. This habitat category is important for aquatic macro-invertebrates, ducks, geese, swans and grebes.

Tasselweed is a relatively rare aquatic plant of saline ponds and lakes, having been recorded at Fox Bay, Ten Shilling Bay peninsula (Port Stephens), Laguna Isla, Swan Inlet and in parts of Salvador Waters. It is suspected to be an important food source for some populations of black-necked swan (*Cygnus melanocoryphus*).

13. Rivers and Streams

The category of rivers and streams consists of the habitat from bank top to bank top including the open water zone, water fringe vegetation and exposed sediments. Plant species may be submerged, free floating or floating-leaved.

14. Inland Rock

The thin soils and underlying geology in the Falkland Islands result in many areas of exposed bedrock, surface stones, cliffs, ledges, caves, screes, stone runs, man-made quarries and quarry waste. Whilst these areas are mostly devoid of vegetation, they can be colonised by lichens and specialist plants, such as snake plant. Such areas provide nesting sites for certain birds such as ground tyrants, variable hawks, southern caracaras and peregrine falcons.

15. Built up areas and gardens

This habitat category includes urban and rural settlements, domestic gardens, farm buildings, industrial estates, waste and derelict ground and transport infrastructure. Areas of human habitation often provide niches for various species of plants and animals, including introduced trees, shrubs, mice and rats, house sparrows, and black-chinned siskin and thrush.

16. Arable and Horticulture

This habitat category is of minor importance in the Falkland Islands but there is some arable cropland, commercial horticultural land, annual leys, rotational set-aside and fallow areas. Arable and horticultural areas are of little conservation interest and do not have an associated flora or fauna that can be considered as characteristic.

17. Sand Dunes

Sand dunes are classified as areas of loose, shifting or semi-stabilised sand found both in coastal areas and further inland. This habitat category includes the vegetation of the supra-littoral zone, such as sea cabbage (*Senecio candidans*) and curled dock (*Rumex crispus)*, and also the more permanent vegetation types dominated by the introduced grass species, marram grass (*Ammophila arenaria*) and lyme grass (*Leymus arenarius*). Native rush and shore meadow-grass (*Poa robusta*) may also be present.

18. Maritime rock, shingle, cliff and slope

Land above the high water mark influenced by wave splash and sea spray (supra-littoral zone), including vertical rock, boulders, gullies, ledges and pools, are part of this habitat type. It is generally species poor, often dominated by lesser sea-spurry (*Spergularia marina*), sheep's sorrel (*Rumex acetosella*), pearlwort (*Colobanthus* spp.), stonecrop (*Crassula moschata*) and *Ranunculus acaulis* (Skottsberg's buttercup) in rock crevices and thrift (*Armeria maritima*), wild celery and nodding club-rush (*Isolepis cernua*) amongst shingle.

19. Littoral Sediments

Stretching from the high water and low water mark, the littoral zone can contain a variety of plant species. Salt marsh species, including thrift plantain (*Plantago barbata*), shore meadow-grass, Andean pearlwort (*Colobanthus quitensis*), Antarctic hair-grass (*Deschampsia antarctica*) and stonecrop (*Crassula moschata*), form a narrow fringe around the sheltered muddy mouths of larger creeks and on beaches and intertidal mudflats. On lower mudflats, lesser sea-spurry may be important, whilst on coarser sediments goosefoot (*Chenopodium macrospermum*) and sea knot-grass (*Polygonum maritimum*) are found.

Littoral and shallow marine habitats, including marine algae, are further described in Chp. 9.

Trends and changes in vegetation

Up until the 1970s and before wool prices declined, nearly all available land in the Falkland Islands, including smaller adjacent and offshore islands, was grazed and this has had a significant effect on some plant communities and species. However, in terms of actual quantitative or qualitative assessment, little or no long-term data has been collected on habitat change. It has been possible to look for broad changes in plant habitats using recent satellite imagery and a vegetation map from 1938 (Davies 1938). Following the identification of some representative areas, it can be seen that some areas have experienced slight changes in species composition with diddle-dee and Christmas bush replacing white grass and species associated with bog communities between 1938 and present day.

Changes in other areas are not so easily detected using these broad habitat analyses. Cawkell et al. (1960) noted that over-grazing and indiscriminate burning had lead to a decline in some plant species, including cinnamon grass, velvet bent *(Agrostis* sp.), mountain blue grass (*Poa alopecurus*) and tussac grass, in some areas.

But the two habitat types to have suffered major declines in the Falkland Islands are coastal tussac grass, and boxwood and fachine scrub. There are little or no data on distribution changes of scrub habitat, or an understanding of what might be a sustainable level of grazing. In contrast, declines in tussac habitat have been noted since the Falkland Islands was colonised in 1764 (Cawkell et. al. 1960), although it is not easily detected on the habitat and satellite image maps. Recent protection and more careful management of tussac grass have resulted in the tussac habitat remaining relatively stable over the past 20 years (Fig. 4.1; Strange 1989).

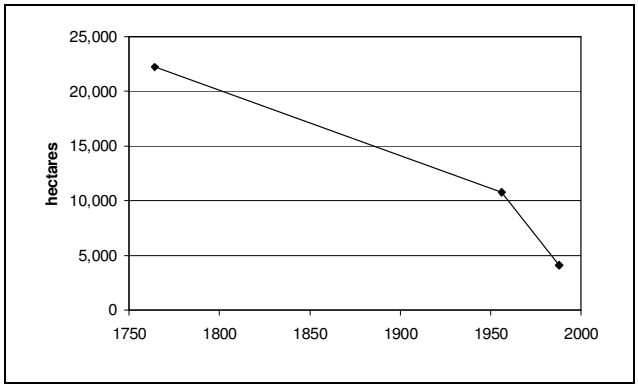


Fig. 4.1 Trend in tussac grass cover in the Falkland Islands.

A programme of long-term vegetation monitoring should be designed and implemented at representative habitat types at sites across the Falkland Islands. The Department of Agriculture is assisting farmers to map their land and classify in a basic sense the distribution of vegetation communities (Department of Agriculture 2006). This approach has been valuable for the farms and farmers concerned, but the disadvantage from an environmental perspective is that the farm mapping programme does not use the same habitat types as detailed above. Also, inaccuracies in the interpretation of the satellite imagery used have been noted, for example in the overestimation of areas covered by 'greens'.

The potential for integrating the farm and Falklands Conservation-orientated habitat mapping, as well as the suitability of photographic and satellite imagery needs to be examined. This may be undertaken within Falklands Conservation's Falklands Plant Conservation Programme, which is funded from July 2007 until June 2009. Falklands Conservation has begun work on the production of a habitat map for Elephant Beach Farm in relation to the rotational grazing trials to be carried out there by the Department of Agriculture (R. Upson, personal communication).

Threats

All plant species and habitats are threatened by a number of processes, particularly land-use activities (Broughton 2002). These are discussed in various chapters as indicated below.

Threat	More information in Chapter
Global climate change	Chp. 1 – Oceanography, geology and meteorology
Grazing	Chp. 8 - Land use activities
Pasture improvement programmes	Chp. 8 - Land use activities
Uncontrolled and controlled camp burning	Chp. 8 - Land use activities
Visitors	Chp. 8 - Land use activities
Invasive species	Chp. 12 - Invasive species

Conservation Actions

There are a number of conservation actions that are required to manage important plant species and habitats in the Falkland Islands. Internationally, parties to the Convention on Biological Diversity adopted the Global Strategy for Plant Conservation (GSPC) in 2002, which lists 16 broad-reaching and challenging targets under five main objectives that should be met by 2010.

Objective A: Understanding and Documenting Plant Diversity

1. A widely accessible working list of known plant species, as a step towards a complete world flora
2. A preliminary assessment of the conservation status of all known plant species, at national, regional and international levels
3. Development of models with protocols for plant conservation and sustainable use, based on research and practical experience

Objective B: Conserving Plant Diversity

4. At least 10% of each of the world's ecological regions effectively conserved
5. Protection of 50% of the most important areas for plant diversity assured
6. At least 30% of production lands managed consistent with the conservation of plant diversity
7. 60% of the world's threatened species conserved in situ
8. 60% of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes
9. 70% of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained
10. Management plans in place for at least 100 major alien species that threaten plants, plant communities and associated habitats and ecosystems

Objective C: Using Plant Diversity Sustainably

11. No species of wild flora endangered by international trade
12. 30% of plant-based products derived from sources that are sustainably managed
13. The decline of plant resources, and associated indigenous and local knowledge, innovations and practices that support sustainable livelihoods, local food security and health care, halted

Objective D: Promoting Education and Awareness about Plant Diversity

14. The importance of plant diversity and the need for its conservation incorporated into communication, educational and public-awareness programmes

Objective E: Building Capacity for the Conservation of Plant Diversity

15. The number of trained people working with appropriate facilities in plant conservation increased, according to national needs, to achieve the targets of this Strategy;
16. Networks for plant conservation activities established or strengthened at national, regional and international levels.

A strategy document was prepared in 2003 in order for the UK to meet the 16 targets and Royal Botanical Gardens, Kew may, as part of their OT work programme, assist UK Overseas Territories preparing an equivalent document. In the Falkland Islands, many of these targets have been met or there is current work towards meeting them. Falklands Conservation's Plant Conservation Programme 2007 – 2009 should produce a plant conservation strategy for the Falkland Islands. The current initiatives are discussed below.

- **Plant surveying**

The plant atlas is an excellent start for a baseline understanding of plant species distribution. Surveying is still required over a substantial area of the islands; about one third of the 255 10km squares have significant areas of un-surveyed land (Broughton and McAdam 2002c; A. Douse, personal communication; R. Upson, personal communication). The Falklands Plant Conservation Programme will survey as much of the remaining area as possible during 2007 – 2009. There would perhaps be little value in re-doing the atlas for at least another 10 - 15 years.

- **Species and Habitat Action Plans**

Broughton (2000a, 2002) identified 22 key species and X habitats with high conservation values and which require action plans:

Species		Habitats
Adder's-tongue	Moore's plantain	Boxwood scrub
Antarctic cudweed	Mudwort	Californian club-rush stands
Chilean tall-fern	Pale yellow orchid	Fachine scrub
False-plantain	Patagonian hawkweed	Mainland tussac
Fir clubmoss	Rock-cress	
Fuegian violet	Saxifrage	
Fuegian whitlowgrass	Shrubby seablite	
Hairy daisy	Skullcap	
Leathery shield-fern	Spider-flower	
Maidenhair-fern	Tasselweed	
Moonwort	Yellow lady's slipper	

It is anticipated that these species and habitat action plans will be developed as part of Falklands Conservation's 'Plant Conservation Programme 2007 – 2009', in conjunction with the FIG Departments of Agriculture and Environmental Planning, and subsequently adopted and where possible, put under an appropriate plan of management. This programme will also work with the Department of Agriculture's grazing trials, by monitoring plant diversity and species abundance.

- **Important Plant Areas**

The identification of certain priority habitats allows conservation effort to be directed at the most critical and valuable areas. IPAs can be defined as areas that are important because of their overall botanical richness, or because they are crucial for the protection and survival of a species, suite of species or a threatened habitat.

To qualify as an international IPA, a site needs to satisfy one or more of the following criteria (Plantlife 2004):
Criterion A - The site holds significant populations of one or more species that are of global or regional conservation concern.
Criterion B - The site has an exceptionally rich flora in a regional context in relation to its biogeographic zone.
Criterion C - The site is an outstanding example of a habitat or vegetation type of global or regional plant conservation and botanical importance.

National IPAs (NIPAs) can be agreed on within a given country based on specific national plant conservation concerns. Given the wide geographical and ecological range of the vast majority of plants, it is difficult to identify important plant areas on the basis of Criterion B. Overall, though, IPA criteria can be seen as providing an extremely useful tool for the identification of important plant areas in the Falkland Islands and consistently identified IPAs can be clearly justified (Upson 2007).

It is anticipated that final Important Plant Areas will be identified as part of Falklands Conservation's 'Plant Conservation Programme 2007 – 2009', in conjunction with the FIG Departments of Agriculture and Environmental Planning, and subsequently adopted and implemented.

At present there are suspected to be at least 15 internationally and six nationally important areas for the conservation of several specific plant species and habitats (Broughton and McAdam 2002c, Upson 2007, R. Upson, personal communication).

- **Potential Important Plant Areas (IPAs)**

1. Saunders Island

IPA category A: Two of the five globally threatened species, Antarctic cudweed and hairy daisy, occur on Saunders Island. The altitudinal range and geographic location of Saunders Island results in significant botanical value. It has a particularly rich vascular plant flora comprising of 118 native taxa (69% of the native flora) and nine of the 13 Falkland Islands endemics (Keville 1997; Broughton 2000b; Broughton et al. 2000). Saunders Island is especially important for its rich biodiversity of fern species and assemblages of a number of narrow range endemics restricted to the northwest of the Falklands archipelago.

Species of note in the area include maidenhair fern, spleenwort, cushion plant, Chilean tall-fern,

Fuegian sedge, dwarf hair-grass (*Deschampsia parvula*), hairy daisy, Antarctic mountainberry, Antarctic cudweed, pale yellow orchid, coral fern, silvery buttercup, twisted filmy-fern, mudwort and leathery shield-fern.

2. Empire Beach Camp, Port Stephens

IPA category A: Two of the five globally threatened species, false plantain and Moore's plantain occur in the Empire Beach Camp. The site is also important for the conservation of tasselweed, as well as a record, awaiting verification, from Stephens Peak of the critically endangered yellow lady's slipper.

3. Cross Island (Port Stephens)

IPA category A: One of the five globally threatened species, false plantain, occurs on Cross Island.

4. Pebble Island and Islet

IPA category: A: Two of the five globally threatened species, hairy daisy and Antarctic cudweed (record awaiting confirmation), occur on Pebble Island. In the context of the Falkland Islands, Pebble Island has a moderately rich vascular flora including 95 native taxa and six of the 13 endemic species, including yellow lady's slipper (awaiting confirmation), clubmoss cudweed, coastal nassauvia and woolly ragwort.

5. Carcass Island

IPA category A: Two of the five globally threatened species, hairy daisy and rock-cress, occur on Carcass Island. There are additionally five more of the 13 endemic species on Carcass Island, including lady's slipper, clubmoss cudweed, vanilla daisy, coastal nassauvia and woolly ragwort. The near endemic Falkland cudweed also occurs on this island.

6. Keppel Island

IPA category A: One of the globally threatened species, hairy daisy, occurs on Keppel Island. Six of the other 13 endemic species occur here: smooth ragwort, woolly ragwort, coastal nassauvia, vanilla daisy and lady's slipper. Other species of note are the scarce coral fern and the near endemics Falkland cudweed and shieldfern.

7. Middle Island (nr Lively Island)

IPA category A(i): One of the five globally threatened species, rockcress, occurs on Middle Island. Three other endemic species have also been recorded on the island: lady's slipper, woolly ragwort and vanilla daisy.

8. Vantan Arroyo Valley

IPA category A: One of the five globally threatened species, rockcross, occurs in the Vantan Arroyo Valley. Also recorded at this site are two endemic species (smooth ragwort and vanilla daisy) and two near endemics (Falkland cudweed and shieldfern).

9. Port Louis Area

IPA category A: Three of the five globally threatened species, Antarctic cudweed, hairy daisy and rockcress have been recorded in the Port Louis Area. Four other endemics also grow in the area – lady's slipper, Clubmoss cudweed, vanilla daisy, and coastal nassauvia – as well as the near endemic Falkland cudweed.

10. Hill Cove Mountains

IPA category B: The Hill Cove Mountains area holds botanically rich examples of acid grassland and inland rock. The altitudinal range and geographic location of the Hill Cove Mountains has resulted in a moderately rich native vascular plant flora (Broughton and McAdam 2002c). Notable species include: twisted filmy fern, cushion plant, Antarctic prickly-burr, silvery buttercup and small dusky sedge. The unusually high prevalence of dwarf prickly-burr is also significant as this species is usually only a rare constituent of communities elsewhere.

The bryophyte flora is also likely to be significant, particularly those communities found on the summit of Mt. Adam. The latter includes the only known Falkland Islands population of the moss *Racomitrium orthotrichaceum.* The French Peaks have a small population of the nationally scarce spleenwort (*Asplenium dareoides*), whilst some of the heaths on the lowest slopes towards the sea are home to Chilean tall-fern and leathery shield-fern.

11. Bull Point

IPA category B: The Bull Point beaches area holds a botanically rich example of the sand dune habitat, including the most extensive known populations of the nationally scarce southern dock (*Rumex magellanicus*), whilst the neighbouring greens hold a large population of eyebright. A small population of Dusen's moonwort is also known from Bull Roads.

12. Cape Pembroke (including Yorke Bay Pond Area)

IPA category B: The Yorke Bay Pond area holds a botanically rich example of neutral grassland, with both indicator species for this habitat type occurring here - spiderflower and eyebright (Upson 2007). The only Falklands record for spiderflower is at Cape Pembroke, as well as 90% of the population of Dusen's moonwort (at three sites). It is also the only known East Falkland locality for the pale yellow orchid.

13. Big Pond, Ceritos, East Falkland

IPA category B: Big Pond, Ceritos holds a botanically rich example of standing open water, with the indicator species lagoonwort (*Tetrachondra patagonica*) occurring here (Upson 2007). It is the only known Falkland Islands population of *Carex banksii*, a population of the recently rediscovered and nationally rare dark stonewort and the only East Falkland populations of the near threatened pondweed and *Elatine* (?) *triandra.*

14. Long Mountain, East Bay Farm, West Falkland

IPA category C: Important to the survival of a priority threatened habitat, fachine scrub. The slopes facing Lake Sulivan are covered in the largest (and thus most significant) stand of fachine scrub to survive in the Falkland Islands. This habitat type would once have been extensive but has been decimated by grazing pressure. It is possible that relict populations of taxa associated with the habitat, particularly invertebrates, may still survive in the Long Mountain stand. On the lower slopes of Long Mountain, fachine forms a perhaps unique association with the scarce coral fern. Between the shrubs, there is also a lush herb layer, including the nationally scarce silvery buttercup.

15. The Horse Paddock, Chartres, West Falkland

IPA category A: One of the five globally threatened species rockcress occurs at this site

C: Important to the survival of a priority threatened habitat, fachine scrub

The Chartres horse paddock holds populations of one plant species of global conservation concern and is home to an outstanding example of a habitat type of global plant conservation and botanical importance. Six of the 13 endemic plant species grow in the horse paddock including clubmoss cudweed, silvery buttercup, vanilla daisy and woolly ragwort. In addition, both Falkland near endemic plant species are present.

Other notables of national importance are the large population of the nationally protected *Chloraea gaudichaudii* (Gaudichaud's orchid) found within areas of dwarf shrub heath and acid grassland and the nationally rare *Epilobium ciliatum* (American willowherb), found growing on the eastern side of the lower reaches of the Old House Stream.

- **Potential Nationally Important Plant Areas (NIPAs)**

1. Sea Lion Island

This island has a moderately rich flora and has the only known locality for Fuegian violet in the Falkland Islands, and Long Pond has a stand of Californian club-rush.

2. Beauchêne Island

This island has an extremely poor flora but is important for not only its pristine cover of the globally scarce tussac grass but also because of the total absence of introduced plants, a state no longer found anywhere else in the Falkland Islands. A small population of the endemic smooth ragwort is also present.

3. West Lagoons Pond, West Lagoons Farm

This pond has a large stand of Californian club-rush, a species only known from a few Falkland Island localities. The species forms a nationally rare habitat type that may be important for other nationally rare biota (particularly macro-invertebrates). The pond is also the only known West Falkland location

for *Elatine* (?) *triandra* and has a historical record of the nationally rare charophyte *Nitella opaca*.

4. Hawk's Nest Ponds, Little Chartres

These two ponds have large stands of Californian club-rush, a species only known from a few Falkland Island localities, which forms a nationally rare habitat type.

5. Byron Sound Coasts

This area is a stronghold for sea knotgrass (*Polygonum maritimum*), which is rare elsewhere, shrubby seablite and the narrow range endemic maidenhair fern.

6. Little Chartres (gully 100m from house), Narrows Island and Big Arch Island, West Falkland

These three locations all support small lowland populations of the endemic snake plant. Traditionally, this species has been considered an upland species. However, the discovery of these lowland populations suggests that high altitude sites reflect reduced grazing pressure. The three lowland populations may also represent locally adapted genotypes not present in upland populations, and as such, the sites should be conserved to ensure the conservation of maximum genetic diversity.

Chapter 5 – Terrestrial invertebrates

Introduction

Invertebrates consist of annelids and four extant subphyla of arthropods: chelicerates (spiders, mites and scorpions), myriapods (millipedes and centipedes), hexapods (6 legged insects) and crustaceans (woodlice) (Jones 2004). Up until the last few years, there has been sparse knowledge of the terrestrial invertebrate fauna of the Falkland Islands. Robinson (1984) compiled a checklist of all insects that have been recorded in the Falkland Islands but this does not contain information regarding habitats, ecology, distribution or abundance.

However, the Falkland Islands Invertebrates Conservation Project 2004 – 2007 was recently completed, which filled the significant knowledge gaps. In a land without native trees, reptiles, amphibians or terrestrial mammals, insect life forms a very important part of the Falkland Islands ecology. Insects perform a critical role in the breakdown and recycling of organic matter and the formation of soils and at all stages of insects are important food sources for a variety of birds (Jones 2004).

The Falkland Islands Invertebrates Conservation Project 2004 – 2007 began as an initial pilot study during 2002/03. The project collection now holds approximately 200,000 individual invertebrates. Sampling has been conducted at a variety of sites, including 15 main localities, using a variety of recognised methods (Jones 2008b).

Many specimens remain to be fully described and analysed and initial taxonomic analyses have identified many species never before recorded for the islands including many, which are likely to be new to science (Jones 2008b). The genetics of a number of the species are currently being studied. It is entirely possible that this group of animals could provide the largest genetic resource within the islands. It is recognised that there may be a number of other keystone species in the terrestrial and freshwater invertebrate, but due to a lack of study, their importance has not yet been realised.

Although not currently fully explored, it is estimated that two thirds of the invertebrate fauna of the islands is endemic, although only 13 terrestrial invertebrates currently recognised as endemic. The invertebrate species recorded in the Falkland Islands have close affinities to the fauna of South America and form a link between the continent and South Georgia. Several native species have reduced or even absent wings, a feature in common with other island systems.

Falklands Conservation holds all invertebrate data on its Recorder database and an Invertebrates Collection will be available publicly from mid-2008 onwards.

Annelids

Twelve species of earthworm reported in the Falklands, with nine species found in recent times and three historical records (Reynolds and Jones 2006). The species are a mix of South American, South African or cosmopolitan-range species.

Chelicerates

Chelicerate representatives in the Falkland Islands include spiders, harvestmen, psuedoscorpions and mites. Lavery (2004) records 43 native and introduced species of spiders present in the Falkland Islands, although there is a degree of taxonomic identification work required. Sixteen spider species (405) are suggested to be endemic (Lavery 2007). There are also two harvestmen (Opiliones) species and one species of pseudoscorpion, although further work to differentiate the species is required. There are at least 32 species of mite in the Falkland Islands (Stary and Block 1996).

The spiders, harvestmen and pseudoscorpions of the Falklands have close affinities to the fauna of South America and form a link between the continent and South Georgia. Only one native spider (*Beauchenia striata*) does not have a clear affinity to South American, and its relationship to the Falkland Islands is yet to be resolved (Lavey 2004).

Hexapods

The hexapods are categorised by having various stages of life, including eggs, nymphs or larvae and adults, and often the juvenile nymph or larvae occupy a completely different environmental niche to the adult. The number of species of hexapods in the Falkland Islands will increase with the remaining taxonomic work of the Falkland Islands Invertebrates Conservation Project (Jones 2008b). Currently, there are over 50 species of true flies (Diptera), including many species of sub-Antarctic kelp fly and hoverfly, 12 species of parasitic wasp (Hymenoptera) and 20 breeding species of moths and one butterfly (Lepidoptera). The beetle diversity is particularly high (Fuller 1995; Jones 2004), with at least 110 species identified, with 15 species of ground beetles (Carabidae), 20 species of weevils (Curculionidae), 16 species of darkling beetle (Tenebrionidae), 15 Hemipteran bugs and 12 booklice species (Psocoptera).

Protected and threatened invertebrates

With the exception of all butterfly species (of the genus *Rhopalocera*), the Conservation of Wildlife and Nature Ordinance 1999 has no provision for the general protection of the invertebrate fauna. However, this reflects that current lack of knowledge about invertebrates rather than a specific wish not to protect them.

The current Invertebrate Programme run by Falklands Conservation may identify some species or species groups or invertebrate habitat that may require some form of legislative protection. Jones (2008c) suggests that five years of annual monitoring would be necessary in order to draw up a potential Red List for Falkland terrestrial invertebrate species along with a plan to collect any remaining data needed to confirm or deny their place on such a list. However, Jones (2008c) proposed that the Queen of the Falklands Fritillary is a potential threatened species due to its apparent rarity in the islands.

Introduced invertebrates

A number of non-native species have become established in the Falkland Islands, some during the 1800s and some much more recently. The successful spread of so many introduced invertebrate species may, at least in part, arise from the depauperate nature of the indigenous fauna and the opportunities that this provides. Indeed, a number of the species, such as some of the lumbricid worms and predatory staphylinid beetles, fill ecological roles that previously seem to have been empty (Jones 2008c).

Important habitats

The Falkland Islands Broad Habitat Classification sets out 19 habitat types (Broughton 2000). Some of these habitat types are more critical to the survival of invertebrates, including tussac grass, scrub and montane habitats (Fuller 1995; A. Jones, personal communication). The physical complexity of the tussac grass and scrub (i.e. fachine and boxwood) habitat provides a range of niches for invertebrates.

Threats

In the Falkland Islands, there are three main threats to invertebrate biodiversity: habitat loss/degradation, climate change and alien introductions (Jones 2008c). Habitat loss/degradation is not recognised as one of the key threatening processes in the Falkland Islands.

- Climate change

The potential impacts of climate change on invertebrate biodiversity in the Falkland Islands are considerable and varied, including changes in rainfall and sunlight levels, sea level, fire risk, soil processes and the interplay of the responses of native and introduced plant and animals. Jones (2008c) identifies that the most critical potential impact of climate change comes from a possible change in the abundance and range of invasives species, such as rats and mice.

- Introduced species

Introduced species can affect invertebrates directly by competitively excluding, or predating on native species or indirectly by modifying the local nutrient cycles. In terms of vertebrates, islands with rodents have a significantly less diverse and abundant invertebrate community compared to rodent-free islands (Jones 2008c). This is clear when comparing the invertebrate species present on mouse free Grand Jason Island and Steeple Jason Island where mice are present.

There is little detailed historical and current information necessary to determine what effects the introduced invertebrates are having on the Falkland Islands indigenous species. Only a few introduced invertebrates are recognised as being or potentially being invasive. The green bottle fly lays eggs in open wounds/orifices of sheep, which can lead to death, but it is not thought to have any biodiversity impacts.

Five of seven introduced spider species appear to be confined to houses and other buildings, indicating they can not survive in the natural environment. Two species pose a degree of threat as they survive in the wild beyond the confines of Stanley, although it is difficult to decide whether either species is biologically invasive (Lavery 2007). The three currently recognised invasive species are two greenbottle fly species (*Lucilia sericata* and *Protophormia terraenovae*) and the European earwig (*Forficula auricularia*) (Whitehead 2008).

All invertebrates that have been introduced into the Falkland Islands are well established and it is impractical to attempt eradication. In terms of effort and benefit, the best investment of time and effort would be to prevent the arrival of new alien species. Without the most draconian and economically impractical quarantine procedures, the complete prevention of future alien introductions is extremely unlikely. However, sensible quarantine action will minimise the rate new species introductions.

Conservation Action

While it is likely that introduced species and climate change are detrimental to native invertebrate species in the Falkland Islands, population data recorded over time is required to identify the nature and significance of the two threats. Jones (2008c) prioritises the need for a regular monitoring of species presence at defined sites via surveys, such that conservation threats may be understood, and if necessary responded to at the earliest opportunity.

Preserving invertebrate diversity is likely to be best achieved through the protection of key habitat types and with predicted air temperature rises, conserving higher altitude sites, particularly where there is continuous habitat from the sea to the mountain top. This may allow some species that might become extinct in their current range, to migrate to higher altitude sites previously outside its known distribution. Working adaptively to conserve as large a shifting regional biodiversity as possible is likely to be easier and more valuable than fighting to maintain current species distributions in the light of a changing environment (Jones 2008c).

Chapter 6 - Birds

Introduction

The avifauna of the Falkland Islands is fairly well documented. A total of 227 bird species have been recorded in the Falkland Islands, although this list includes some unsubstantiated sightings. There are 21 resident land birds, 18 resident water birds, 22 breeding seabirds, 18 annual non-breeding migrants and at least 143 species recorded as occasional visitors (Woods and Woods 2006). The close proximity of the Falkland Islands to the South American mainland means that many southern South American species are occasionally seen in the Falkland Islands. Species from sub-Antarctic islands, especially South Georgia, may also occur in the Falkland Islands.

All bird species, except upland goose and feral domestic goose are protected in the Falkland Islands under the Conservation of Wildlife and Nature Ordinance 1999. Yellow-billed teal and Patagonian crested duck may be captured and killed by authorised persons at any time outside the period 1st July to 31st March. Licences may be issued under the Conservation of Wildlife and Nature Ordinance 1999 to shoot turkey vultures to protect livestock, to collect eggs from various bird species for personal consumption, to conduct scientific research on birds and to collect bird specimens for educational purposes.

The Falkland Islands are particularly important for their birdlife and support globally significant numbers of some species, as well as two endemic species and 14 sub-species. The populations of seabirds are the most significant component of the avifauna, due to the upwelling of the northerly flowing Falkland Islands Current bringing cold, deep, nutrient-rich water from the Antarctic, and in contrast, Falkland terrestrial habitats are comparatively poor for supporting birdlife (Woods 1988).

There is no Falkland Islands National Red Data List for birds but various breeding bird species have a global conservation status by the IUCN, are listed under the Convention of Migratory Species (CMS) and its daughter agreement, the Agreement on the Conservation of Albatrosses and Petrels (ACAP) or Convention on the International Trade on Endangered Species (CITES) (Table 5.1). See Chp. 3 for more details about these international conventions.

Sources of Information

Bird records exist from over 200 years ago, with some population and ecology data available from the 1930s onwards. Until the early 1980s, there were only ad hoc surveys and studies (e.g. Cawkell and Hamilton 1961; Croxall et al. 1984; Woods 1975, 1984, 1988; Strange 1992).

In 1983, during his expedition to census songbirds in tussac habitat (Woods 1984), Robin Woods produced a draft census form listing all breeding species and used this in discussion with some landowners. The Breeding Birds Survey was developed from this stimulus with support from Tom Davies and Shane Wolsey of the local Falkland Islands Trust and some financial input from the Falkland Islands Foundation in UK. Robin believed that local people knew their birds well enough and, with the right recording materials and encouragement, could record basic data on most species.

Table 5.1. The taxonomic status of Falkland Islands breeding birds and species listed by IUCN, CMS and CITES

Breeding species	Taxonomic status	IUCN	CMS	CITES
Barn owl				Appendix II
Black-browed albatross		Endangered	ACAP	
Black-crowned night heron	Sub-species			
Black-necked swan				Appendix II
Black-throated finch	Sub-species			
Cobb's wren	Endemic	Vulnerable		
Common diving petrel	Sub-species			
Dark-faced ground-tyrant	Sub-species			
Falkland steamer duck	Endemic			
Falkland pipit	Sub-species			
Falkland thrush	Sub-species			
Gentoo penguin		Near threatened		
Grass wren	Sub-species			
Kelp goose	Sub-species			
King shag	Sub-species			
Long-tailed meadowlark	Sub-species			
Macaroni penguin		Vulnerable		
Magellanic penguin		Near threatened		
Magellanic snipe			Appendix I	
Peregrine falcon			Appendix II	Appendix II
Ruddy-headed goose			Appendix I	
Rufous chested dotterel			Appendix I	
Short-eared owl	Sub-species			Appendix II
Southern caracara			Appendix II	Appendix II
Southern giant petrel		Vulnerable	ACAP	
Southern rockhopper penguin		Vulnerable *- under review*		
Striated caracara		Near threatened	Appendix II	Appendix II
Turkey vulture			Appendix II	
Tussac bird	Sub-species			
Two-banded plover			Appendix I	
Upland goose	Sub-species			
Variable hawk			Appendix II	Appendix II
White-chinned petrel		Vulnerable	ACAP	
White-rumped sandpiper			Appendix I	
White-tufted grebe	Sub-species			

He undertook to collect, collate and analyse all records submitted and wrote letters to people in remote areas to request records. After two seasons, a volunteer, Mike Riddy, was engaged on a daily subsistence rate only, to cover the more inaccessible 10km squares in East Falkland, using a motorbike, tent and a radio. In 1988/89 Mike repeated the exercise on West Falkland, with a small remuneration as reward for his enthusiasm and commitment.

By 1993, sufficient material had been gathered to make a useful publication; 234 of the 255 10km squares containing land had been at least partly sampled. The Atlas of Breeding Birds (Woods and Woods 1997) was the first attempt at a systematic survey and mapping of all confirmed breeding birds and was based on records from about 160 observers who completed more than 550 breeding birds survey forms over a period of ten breeding seasons between 1983 and 1993. It was the first (and still the only) breeding birds atlas for any South American country and remains of considerable value as a baseline and historical review.

Falklands Conservation (then known as the Falkland Islands Foundation) initiated the Falkland Islands Seabird Monitoring Programme (FISMP) in 1985/86 and this programme continues annually. The population size, breeding success and diet were examined each year at selected colonies of gentoo penguins, rockhopper penguins, Magellanic penguins, king penguins, king shags, rock shags and black-browed albatrosses (Clausen 2002). For the two shag species, the number of breeding pairs in selected colonies was monitored between 1986 and 1992 (Ingham 1998). A complete census of all colonies of gentoo, rockhopper and king penguins, and black-browed albatrosses is aimed to be completed every five years, e.g. for penguins, 1995/96 (Bingham 1998), 2000/01 (Clausen and Huin 2003), 2005/06 (Huin 2007a) and for black-browed albatross, 2000/01 (Huin 2001) and 2005/06 (Huin and Reid 2007).

A number of local and overseas scientists have also undertaken short- and long-term studies of several bird species in the Falkland Islands. Reference is made to studies where reports are available and the research activities of on-going studies are described.

Penguins

Sixteen species of penguin occur in the Southern hemisphere, mainly between 45ºS and 60ºS; the Falkland Islands and the area around New Zealand hold more species than any other region (Woods 1988). Ten species of penguin have been seen in the Falkland Islands and five of these breed regularly in the islands. Four of the breeding species - king penguin, gentoo penguin, rockhopper penguin, macaroni penguin – have a circumpolar distribution, while the Magellanic penguin is restricted to South America. The remaining five species seen in the Falkland Islands, emperor penguin (*Aptenodytes forsteri*), Adelie penguin (*Pygoscelis adeliae*), chinstrap penguin (*Pygoscelis antarctica*), Snares erected crested penguin (*Eudyptes robustus*) and erect-crested penguin (*Eudyptes sclateri*) are infrequent vagrants from Antarctic or New Zealand waters. An erect-crested penguin has been sighted annually at Pebble Island in recent years (A. White, personal communication) and Snares crested penguin was recorded at New Island (Lamey 1990).

King penguin

The king penguin is at the extremity of its global range in the Falkland Islands, and its rate of population increase in the islands is likely to be due in part to immigration from South Georgia, with one bird banded at South Georgia sighted at the colony at Volunteer Point (Olsson 1997). The Falkland Islands population is almost entirely concentrated at Volunteer Point, although a few individuals can be found nesting usually amongst gentoo penguins at four - six locations around the islands (Huin 2007a).

King penguins prefer to nest on low coastal plains fairly close to sheltered sandy or shingle beaches. They make no nest, and instead hold the single egg on their feet for the entire incubation period of about 55 days. The breeding cycle of the king penguin is extended over 12 months in contrast to the summer breeding of other penguin species. Hence, breeding pairs of king penguins may be found at different stages of the breeding cycle at the same time. Elsewhere, breeding pairs are able to raise one or two chicks during a three year period (Weimerskirch et al. 1992).

The behaviour of ten king penguin pairs breeding at Volunteer Point and survival of 23 chicks was examined during 2001/02 (Otley et al. 2007a). Breeding activities commenced in October with a first peak of pre-nuptial moulting individuals and eggs were laid between early November and mid March. Incubation shifts lasted 10 to 18 days and shifts undertaken during the 34 d brood period were four to nine days in duration. Over-winter chick survival, even of chicks that hatched in February, was high at 89% and was suggested to be associated to lower rates of avian predation and less severe weather conditions in the Falkland Islands compared with other breeding sites. However, further research is required to confirm these initial findings.

The non-synchronous breeding cycle complicates assessments of breeding populations. In the Falkland Islands, population estimates are obtained by counting chicks in November. The 2005/06 Penguin Census counted 260 chicks at Volunteer Beach (Huin 2007a) and based on chicks from the 1980s until 2001, the Volunteer Beach breeding population was estimated at between 344 - 516 breeding pairs and with an additional 12 - 15 more chicks per year, although the increase appears to have slowed during the last three years (Huin 2007a). The Falkland Islands population is only about 0.04% of the world population, so it is clearly of local rather than global importance (Williams 1995).

Analyses of summer and winter diet in king penguins in The Falkland Islands have shown that myctophid fish, especially *Protomyctophum choriodon*, are the most important component of the diet, as found elsewhere (Piatkowski et al. 2001; Cherel et al. 2002). Smaller amounts of squid, including *Gonatus antarcticus*, *Martialia hyadesi* and *Moroteuthis knipovitchi* are also consumed.

Global location sensors and satellite transmitters were used to track king penguins breeding at Volunteer Point in May, June, August and February (Pütz 2002; Pütz and Cherel 2005). During

February, breeding adults foraged 300 km to the north east at the Antarctic Polar Front Zone (APF) where large concentrations of myctophid fish are likely to be found. In May and June, tracked birds from the Falkland Islands initially followed the same feeding pattern as other sub-Antarctic populations with travel south beyond the APF. However, by August, birds returned northwards and began to forage north. The at-sea sightings reflect these foraging patterns (White et al. 1999).

As the king penguin in the Falkland Islands breeds almost entirely at one site, it is vulnerable to disturbance, particularly as it is a popular tourist site. From the summer of 2001/02 onwards, there has been more active management of the site, including a full-time warden, co-ordinated by Falklands Conservation for the first three years and subsequently by the landowner.

A study of visitor behaviour at Volunteer Point demonstrated that because the pattern of visitor presence was predictable, the penguins might be able to become accustomed to human presence (Otley 2006). Further research is required to investigate the effects of visitors on penguin breeding behaviour, particularly for king penguins, and the effectiveness of the current visitor control and education programs in the Falkland Islands.

Gentoo penguin

In the Falkland Islands, the gentoo penguin (*Pygoscelis papua*) population was estimated at 65,857 breeding pairs in 2005/06, 113,571 in 2001/02 and 64,426 in 1995/96 and represents, of 12 major breeding regions, the second largest gentoo penguin population in the world after South Georgia (Huin 2007a). Colonies are scattered across the archipelago, with the largest colonies at Bull Point, Kidney Cove and Cape Dolphin on East Falkland, at Albemarle, Carcass Bay, Grave Cove, Shallow Bluff and Lucas Hill on West Falkland and on the islands of New, Steeple Jason, Grand Jason, Saunders, Sea Lion and Speedwell (Clausen and Pütz 2002). In total, 101 breeding colonies are known, including 41 sites with colonies containing more than 1,000 breeding pairs.

Only colonies in the northeast section of East Falkland did not show reductions in the last five years (Huin 2007a). The decline in the number and size of colonies elsewhere across the Falkland Islands between 2000 and 2005 reflects the effect of the paralytic shellfish poisoning, which occurred as a result of a red algal bloom during November 2002 and resulted in a high level of adult mortality and total breeding failure at some colonies during the 2002/03 breeding season (Huin 2003).

A licence can be obtained to collect eggs of gentoo penguins. Fifteen to 20 licences for approximately 1,500 – 2,500 eggs are issued by the Environmental Planning Department, using a guide to take eggs from less than 33% of the nests in each colony.

The preferred nesting sites for the gentoo penguin in the Falkland Islands are low coastal plains fairly close to a sand or shingle beach and an open ocean area free of kelp. Gentoo penguins are resident in the Falkland Islands throughout the year and resume breeding and nest building in September. Egg

laying is usually completed by late October, with two eggs being laid, and incubation takes about 34 days (Otley et al. 2005). The young form crèches during January, prior to undergoing their moult into adult waterproof plumage. Chick production can be very variable, but it does not seem to be linked to variations in weather, predation or any other changes to the terrestrial part of the lifecycle (Pütz et al. 2001; Clausen and Pütz 2002).

The diet of the gentoo penguin in the Falkland Islands varies a surprising extent according to location and season, although fish generally dominates. Nototheniid species such as *Patagonotothen ramsayi*, *P. tessellata*, *P. wiltonii* and juvenile *Dissostichus eleginoides*, the latter a commercial fish, are the most commonly taken fish species (Pütz et al. 2001; Clausen and Pütz 2002). Juvenile *Salilota australis* (red cod) and *Micromesistius australis* (blue whiting), both commercial species, also feature in the diet. Other diet items include various species of crustaceans and cephalopods. Significant amounts of crustaceans are taken at western and southern locations, while larger proportions of squid are found only in the diet of western and northern colonies (Clausen and Pütz 2002). At Cow Bay, *Loligo gahi* predominates during the incubation period.

Diet sampling over 1986 – 2004 has also shown a gradual shift in diet composition, with crustaceans replacing cephalopods in the diet of southern, whereas in the north, there has been an increase in the quantity of krill taken (Clausen and Pütz 2002). Gentoo penguins are generally opportunistic to prey species available but there is evidence to suggest that they select prey of certain sizes (Clausen et al. 2005).

Satellite tracking of breeding gentoo penguins on New Island, one immature adult in March and at-sea surveys has shown that the species remains almost wholly in Falkland waters, predominantly within 10 km of the coast (White et al. 1999; Boersma et al. 2002, 2004). However, some birds from Kidney Cove tracked during the winter made foraging trips up to 300 km from the coast and also stayed ashore for short periods at nearby colonies (Clausen and Pütz 2003).

Southern rockhopper penguin

Jouventin et al. (2006) recently split the rockhopper penguin *Eudyptes chrysocome* into the northern rockhopper penguin *E. moseleyi* and southern rockhopper penguin *E. chrysocome*, and BirdLife International has adopted this treatment. The proposed splitting of the eastern rockhopper penguin *E. filholi* from *E. chrysocome* by Banks et al. (2006) was not adopted, primarily owing to the weak degree of morphological differentiation involved. Thus, the southern rockhopper penguin breeds in the Falkland Islands, southern Patagonia, Marion Island, Crozet Island, Kerguelen Island, Macquarie Island and Campbell Island, and the northern rockhopper penguin breeds on the islands of Tristan, Gough, St Paul and Amsterdam (Williams 1995).

Southern rockhopper penguins (*Eudyptes chrysocome*) breed on rocky cliffs at some 52 sites around the Falkland Islands, often in association with black-browed albatross or king shags, and 25 colonies have

more than 1,000 breeding pairs (Clausen and Huin 2003). Whilst the species is found across the Falkland Islands, most colonies are located on the outer islands of West Falkland.

The nests of rockhopper penguins are generally little more than a depression between rocks or tussac, occasionally lined with bits of grass, mud or peat. Males arrive at the breeding sites in early October and females in mid to late October (Strange 1982). Egg laying is usually completed by mid November, and two eggs are laid, the first egg being smaller than the second egg (Lamey 1993). Chicks form into crèches around January, moult during February, and leave the colony late February or early March. After the chicks have left, the adults spend a couple of weeks feeding at sea, before they return to undergo their annual moult (Strange 1982). Adults leave the colony completely around mid April.

The total Falkland Islands population was estimated in 2005/6 to be 211,000 breeding pairs (Huin 2007a). The three most important colonies are on Beauchêne Island (71,343 pairs, 31%), Steeple Jason (59,033 pairs, 28%) and Grand Jason (10,496 pairs, 5%). Forty-eight percent of the world's population of the southern rockhopper penguin (excluding the colonies of the 'eastern' species) is found on islands in southern Chile, 29% on the Falkland Islands and 24% in southern Argentina (Huin 2007a).

Over the last century, the worldwide population of rockhopper penguins has declined drastically and the species is currently classified as threatened by the IUCN (Birdlife International 2004), although the conservation status may be upgraded to endangered with the splitting of the species. An incomplete postal survey of rockhopper penguin numbers in 1932/33 by the FIG Government Naturalist, A.G. Bennett (Bennett 1933) suggested a population of over three million breeding pairs. However, errors in the estimate of the colony areas in the 1932/33 census may have led to an over-estimate in population size and a reanalysis suggested that 1.5 million breeding pairs might be more accurate for 1933 (Pütz et al 2003a). The Bennett figures were never published but were submitted to FIG and a copy filed in Cambridge, where it was discovered at the Scott Polar Institute in about 1984.

The decline from historical times has been 80%, at an average rate of decline of 2.75% per annum (Pütz et al. 2003a), mirroring the rate documented elsewhere for the species. Annual surveys conducted at selected sites during the late 1990s and 2000s suggests that the rockhopper population has stabilised, but there are occasional periodic annual declines due to starvation during the moulting period, and toxic poisoning (Keymer et al. 2001; Huin 2003; Uhart 2004; Huin 2007a). Populations appear to stabilise between events but do not recover, thus resulting in an overall downward trend in population over time. More stable or increasing populations are recorded at Beauchêne Island, Saunders Island, Keppel Island and Pebble Island (sites that were not affected by the 2002/03 harmful algal bloom, see below).

Low breeding success and deaths during the moult period may be related to oceanographic events, particularly cooler than normal sea temperatures (A. Clausen and A. Arkhipkin, personal communication). The large spatio-temporal scale over which the population declines of three sub-

species of rockhopper penguin has occurred implies that ecosystem-scale, at-sea factors are likely to be involved (Hilton et al. 2006). Analysis of historical and contemporary levels of stable isotopes measured in feathers at a number of breeding sites (not including the Falkland Islands) indicated there had been a shift in diet to prey of lower trophic status, which is probably related to decreases in primary productivity and sea surface temperatures (Hilton et al. 2006). Analysis of contemporary feathers in the Falkland Islands showed strong bi-modal patterns, which suggests two alternative foraging regions, and hence prevented comparisons with historical museum specimens.

In 2002/03, from mid-November onwards, a large number of sick and dead birds were recorded around both rockhopper and gentoo colonies. The cause was identified as paralytic shellfish poisoning resulting from a widespread red algal bloom (Uhart et al. 2004). The occurrence ultimately led to high levels of adult mortality and some colonies experienced total breeding failure (Huin 2003).

The rockhopper penguin diet in the Falkland Islands is predominantly crustacean prey, with varying proportions of *Euphausia lucens*, *Euphausia vallentini*, *Thysanoessa gregaria*, *Thermisto gaudichaudi*, and *Munida gregaria*. Cephalopods, such as *Gonatus antarcticus*, *Teuthowenia sp*., *Loligo gahi* and *Enteroctopus megalocyatus*, and fish are also taken (Croxall et al. 1985; Pütz et al. 2001; Clausen and Pütz 2002). Falklands Conservation and the Fisheries Department are currently performing a re-evaluation of historic data and it is hoped that this will reveal more obvious trends (A. Clausen, personal communication).

Satellite tracking of rockhopper penguins has been conducted during incubation, brood, pre-moult and winter dispersal periods at New Island and at Seal Bay, on the north coast of East Falkland (Boersma et al. 2001, 2002, 2004; Pütz et al. 2002; Pütz et al. 2003b). Birds from northern colonies followed an anticlockwise track from the colony following the major ocean current patterns in the area, travelling first north, then east before turning west at approximately 49ºS, continuing as far as the edge of the FOCZ and returning to the colony (Pütz et al. 2003b).

Breeding birds tracked from New Island did not demonstrate any clear patterns, with foraging occurring at the continental shelf slope to almost the coast of Tierra del Fuego, and in inshore waters around Weddell Island (Boersma et al. 2001, 2002, 2004). Two juvenile (one year old) rockhopper penguins tracked during February from New Island also foraged within 90 km west of New Island (Boersma et al. 2004). Few rockhopper penguins from Seal Bay or New Island headed south to feed around Burdwood Bank or an easterly direction to feed in oceanic waters.

During winter, the foraging trips of the majority of rockhopper penguins included near-shore areas of both the Falkland Islands and South America, and in a triangle stretching from the Falkland Islands, to the Straits of Magellan to as far north as 39ºS (1,400 km north of the Falkland Islands) (Pütz et al. 2002). The at-sea sightings reflect these foraging patterns (White et al. 1999).

The breeding biology of the rockhopper penguin in the Falkland Islands has not been studied on a long-term basis in the Falkland Islands. However, Dr. P. Quillfeldt initiated a three-year study on New Island in 2006/07 and she has aspirations for the research to continue into the future.

Macaroni penguin

The macaroni penguin (*Eudyptes chrysolophus*) is the least common breeding penguin species in the archipelago, with 24 pairs recorded recently at 19 rockhopper penguin colonies, mostly on the eastern side of the Falkland Islands (Huin 2007a). Mixed pairs of macaroni and rockhopper have been recorded at various locations in the Falkland Islands, and there is some evidence to suggest that hybridisation may occur between rockhopper penguins and macaroni penguins (White and Clausen 2002).

The macaroni penguin is the most numerous penguin species in the world and has a world population of around nine million pairs distributed on various islands in the southern Atlantic and Indian Oceans, including 5.4 million pairs on South Georgia (Croxall et al. 1984).

Magellanic penguin

The Magellanic penguin (*Spheniscus magellanicus*) is much more loosely colonial than the other Falkland Islands penguins, and nests in burrows, which it excavates behind the coastline in any suitable soil type, especially tussac peat or former tussac grass areas. Although their low density distribution and burrowing nature complicate estimates of population, 200,000 breeding pairs over 90 locations is reported and this is thought to approach one third of the world's population (Thompson 1993). Breeding success measured in the study plots averaged 0.78 chicks per year, which would result in a just stable population (Pütz et al. 2001).

Adult Magellanic penguins arrive at nest sites to breed in September and after a period of burrow excavation and repair, begin laying eggs in mid October. Two eggs are laid, and incubation takes around 40 days (Otley et al. 2004). Fledglings leave the burrows in early February, after which the adults have a period of feeding at sea ready for moulting in March. They leave the nest sites in April.

Breeding biology studies in northern colonies in Argentina and in southern colonies in Patagonia have shown significant difference in foraging trip length during incubation and chick rearing, chick weight at fledging and breeding success (Boersma et al. 1990; Frere et al. 1998). Further study is required in the Falkland Islands to more accurately determine the foraging strategies and factors affecting breeding success, and the decline of Magellanic penguins. Weather, predation, egging, tourism or other disturbance are not suspected to have significant effects; food shortages associated with changes in oceanographic conditions, and also oil pollution, are thought to be critical factors (Gandini et al. 1994; Frere et al. 1998; Pütz et al. 2001; Walker et al. 2006). In the Falkland Islands, a licence can be obtained to collect eggs of Magellanic penguin, although no licence requests were received during the period 2001 - 2006.

In 2002/03, from mid-November onwards, a large number of sick and dead Magellanic penguins were recorded in the Falkland Islands (Huin 2003). The cause was identified as paralytic shellfish poisoning resulting from a red algal bloom (Uhart 2004).

Magellanic penguins feed on a wide range of prey and take varying proportions of fish, including *Patagonotothen ramsayii*, other *Patagonotothen* sp., *Agonopsis chiloensis*, juvenile *Micromesistius australis* and *Sprattus fuegensis*, and squid species such as *Loligo gahi*, *Gonatus antarcticus* and *Moroteuthis ingens*, and small amounts of lobster krill (*Munida gregaria*) (Pütz et al. 2001; Clausen and Pütz 2002).

Magellanic penguins breeding at Seal Bay and New Island have been equipped with satellite transmitters (Boersma et al. 2001, 2002; Pütz et al. 2000a). Birds tracked from Seal Bay showed trips of different length. Short trips of less than four days were all within 50 km of the colony in depths of less than 200 m (Pütz et al. 2000a). Trips of between 5-11 days followed a loosely anticlockwise route in water depths less than 200 m 60 - 165 km from the colony. Trips over 11 days showed a similar pattern, but covered a larger distance to the boundary of the FOCZ and returns through the northern tranches of oil exploration. Magellanic penguins breeding on New Island foraged between 10 and 90 km from the colony (Boersma et al. 2001, 2002)

Two fledgling Magellanic penguins equipped with satellite transmitters on New Island headed in a north-westerly direction towards South America (Boersma et al. 2004). During winter, birds are absent from Falkland waters and undertake extended foraging trips on the Patagonian shelf, feeding close to the Argentine coast from Puerto Deseado to Puerto Madryn and further north along the Patagonian shelf and shelf break (Pütz et al. 2000b). The at-sea sightings reflect these foraging patterns (White et al. 1999).

Albatrosses, Petrels and Shearwaters (Procellariiformes)
Albatrosses

Black-browed albatross
The black-browed albatross (*Thalassarche melanophrys*) has a circumpolar distribution, breeding on Kerguelen, Crozet, Heard, Macquarie, Antipodes, South Georgia, islands off Chile including Diego de Almagro and Ildefonso, and in the Falkland Islands. The population in the Falkland Islands is genetically distinct from all other populations, although individuals on the Crozet Islands, Heard and Antipodes have yet to be sampled (Alderman et al. 2005).

The black-browed albatross is the only species of albatross that breeds in the Falkland Islands. It breeds on coastlines and steep sea cliffs at 17 predominantly island sites, often in association with

rockhopper penguins (Strange 1992). The Jason Islands and Beauchêne Island have particularly large colonies.

There have been a few censuses of black-browed albatross colonies at some colonies in the Falkland Islands (Prince 1981; Thompson and Rothery 1991; Huin 2001 [which cited unpublished data from R. Napier and Falklands Conservation for the period 1962 – 1995]; Strange 2001; Huin and Reid 2007; New Island Conservation Trust 2007). These censuses have employed different methodology, including direct counts, estimates extrapolated from direct transect counting and on colony perimeter and inter-nest distances, and counts based on photographs taken from vessels and from helicopters, and at different times of the breeding season, although predominantly in early incubation.

I. Strange has conducted aerial surveys of selected black-browed albatross colonies by helicopter in various years, including 1986, 1995 and 2005 (New Island Conservation Trust 2007). Island wide surveys have been conducted by Falklands Conservation in 2000 and 2005 (Huin and Reid 2007).

No one method is recognised as the standard method for censusing nesting seabirds. However, vessel- or aerial-based photography, combined with ground counts and corrections to account for diurnal variation in attendance and breeding failure, appears to be the most comprehensive and repeatable method, particularly for large colonies (Lawton et al. 2003; Moore 2004; Poncet et al. 2006). One study of black-browed albatross breeding on a steeply sloped tussac grass island in Chile showed that ground-truthed aerial photography was the most accurate method and yacht-based photography underestimated population size by 55%, ground counts by 13%, quadrat sampling by 11% and point-distance sampling by 9% (Robertson et al. 2008).

The Falkland Islands population is currently estimated by Falklands Conservation, using colony perimeter/inter-nest distances and photographs taken from a boat, to be around 400,000 breeding pairs (Huin and Reid 2007), which represents 70% of the estimated world population of 534,000 breeding pairs, and makes the Falkland Islands of critical international importance for the conservation of this species.

Falklands Conservation estimates that there were 506,000 pairs in 1980/81, 468,000 pairs in 1995/96, 382,000 pairs in 2000/01 and 400,000 pairs in 2005/06 (Huin and Reid 2007). This represents a decline of 28% in the last 20 years and just below 1% per annum over the last five years; one colony (North Island, 5% of Falklands population) showed an increase in breeding pairs between 2001 and 2005 (Huin and Reid 2007). In contrast, a number of sites counted from aerial photographs taken during the last 30 years show increases of between 21 to 141% (New Island Conservation Trust 2007). The speed of the decline estimated by Falklands Conservation led to the reclassification in 2004 of the black-browed albatross from vulnerable to endangered (Birdlife International 2004).

The biology, including breeding behaviour, diet and foraging range, of the black-browed albatross was studied during 1999/2000 at Saunders Island and Beauchêne Island (Huin 2000), and since 2003/04, annually on New Island by Dr. P. Catry and others, with over 500 albatross now colour-banded. Falklands Conservation has also commenced a long-term study of banded black-browed albatross on Steeple Jason Island.

Adults return to the same nest site each September to breed, and make repairs to the large pot-shaped nests made of mud, peat and vegetation (Strange 1992). They lay a single egg in mid-October (mean 13 October, ± 19 day range) and the chick hatches in late December (mean 21 December, ± 19 day range) after an incubation duration of around 70 days (Huin 2002). Chicks are brooded for a further 25 days (until mean day of 4 January) and then left unguarded in order for both parents to feed at sea. Both males and females take equal roles in nest and feeding duties. The chicks are fed until mid-April (mean 16 April, ± 18 days) when they abandon the nest and after approximately five days on flatter ground on slope and cliff tops exercising their wings, fledge, aged approximately 122 days (Huin 2000).

The breeding success in the Falkland Islands is approximately 60% (Huin 2000; Strange 2001; P. Catry unpublished data), which compares favourably with results in other areas of the species' range and signifies a high breeding success with no major terrestrial factors affecting breeding. The most intense period of the breeding cycle is the brood period when parents must conduct short foraging trips (2-3 days) in order to return frequently to feed the chick. As the chick grows, its capability to ingest larger meals and fast between meals improves, and once a critical mass is reached both parents can feed at sea simultaneously (Huin 2000). Visits by tourists to colonies on New Island do not appear to affect breeding success (New Island Conservation Trust 2007).

Black-browed albatrosses in the Falkland Islands sometimes suffer from wildlife diseases, including avian pox (Munro 2007). In 2002/03, from mid-November onwards, some sick and dead black-browed albatross were recorded (Huin 2003). The cause was identified as paralytic shellfish poisoning resulting from a widespread red algal bloom (Uhart 2004).

Breeding black-browed albatross have been equipped with satellite transmitters and/or geo-locating devices at New Island, Saunders Island and Beauchêne Island (Gremillet et al. 2000; Huin 2002a and b). During the incubation period, foraging trips are confined to the Patagonian shelf between Cape Horn, Peninsula Valdez and the Falkland Islands (Gremillet et al. 2000; Huin 2002a and b). Birds from the northern colonies forage only to the north but birds from Beauchêne forage to both the north and the south of the Falkland Islands.

During the chick-rearing period, birds feed entirely within Falkland waters, with those from the northern colonies feeding exclusively to the north of the islands, whilst birds to the south feed exclusively to the south of the islands (Huin 2002b). Overall, between both northern and southern

colonies during the breeding season, 70% of foraging occurs in Falklands waters, 26% of foraging in Argentine waters and 3% in international waters (Huin 2002b). The identified foraging patterns are reflected in the at-sea sightings (White et al. 1999).

Outside the breeding season, adult black-browed albatross spend all their time at sea. Males forage predominantly over the Patagonian shelf in an area of 1.5 million km^2, initially moving northwards as far as 42ºS in April and June before returning southwards as far as the Drake Passage prior to returning to their breeding grounds in September (Huin 2002b). Females are on average smaller and they disperse further; whilst they still utilise the Patagonian shelf, they travel further north and further offshore being recorded almost half way to South Africa and as far north as 30ºS in Brazilian waters (Huin 2002b). Females do not start to return southwards until the end of August. In total, females disperse over 2.3 million km^2 of ocean. It is estimated that annually males travel 98,000 km and females 110,000 km (Huin 2002b).

Fledgling black-browed albatross disperse more northerly and more offshore than adult males and females, perhaps due to exclusion behaviour by adult birds (Woods and Woods 1997, Sullivan 2004, Falklands Conservation unpublished data). This is based on banding recoveries from 6,000 fledglings from West Point during the 1960s, at-sea observations of 16,500 colour marked fledglings on Steeple Jason in April 2002 and satellite tracking of fledglings from Steeple Jason during March 2007.

Black-browed albatross generally do not breed until about seven years of age, but may continue breeding aged 35 years or more (Gales 1998). Breeding pairs are formed for life and if one of the pair is lost, it takes at least two to three years for the remaining partner to form a new pair and re-enter the breeding population. If mortality occurs during the breeding season, the chick will also be lost as the remaining partner is unable to feed the chick alone (Gales 1998). The late maturity of the species, longevity and high investment in chick rearing makes the population highly vulnerable to increased levels of adult mortality.

The diet of the black-browed albatross has been examined both by the examination of the stomach contents of chicks on Saunders Island and New Island, and observations of items scavenged from fishing vessels (Thompson 1992; Thompson and Riddy 1995; Huin 2003; P. Catry, personal communication). They feed on a variety of prey items, predominantly fish (including *Micromesistius australis*, *Macruronus magellanicus* and *Sprattus* sp.) and squid (*Illex argentinus*, *Loligo gahi*, *Gonatus antarcticus* and *Ommastrephid* sp.), with some jellyfish, octopus, lobster krill (*Munida gregaria*) and other crustaceans (Pütz et al. 2001; Clausen and Pütz 2002).

Other Albatross

Nine other albatross species have been seen in Falkland Island waters (White et al. 1999; Falklands Conservation records) and these species are red listed by IUCN (Birdlife International 2004) and are listed under ACAP.

Endangered	Southern royal albatross	*Diomedea epomophora*
	Sooty albatross	*Phoebetria fusca*
	Yellow-nosed albatross	*Thalassarche chlororhynchos*
Vulnerable	Wandering albatross	*Diomedea exulans*
	Northern royal albatross	*Diomedea sanfordi*
	Grey-headed albatross	*Thalassarche chrysostoma*
	Buller's albatross	*Thalassarche bulleri*
Near Threatened	Light-mantled sooty albatross	*Phoebetria palpebrata*
	Shy albatross	*Thalassarche cauta*

Petrels and shearwaters

A number of species of petrel, storm-petrel and diving petrel, and two shearwater species, also breed in the Falkland Islands (Woods and Woods 2006). The most common breeding petrel species is the southern giant petrel (*Macronectes giganteus*).

Southern giant petrel

The southern giant petrel has a circumpolar distribution, breeding on a number of regions, including the Falkland Islands, Argentina, South Georgia, Antarctic Peninsula, Signy Island, Heard Island and Macquarie Island. Ms. M. Techow and Dr. P. Ryan at the University of Cape Town are currently undertaking genetic analysis of the southern giant petrel, based on feather samples collected from across its range.

Both the southern giant petrel and its congener, the northern giant petrel (*Macronectes halli*) are seen throughout the waters surrounding the Falkland Islands, with highest numbers over Patagonian Shelf waters, particularly in areas occupied by fishing vessels (White et al. 2002). In addition to those breeding within the Falkland Islands, the population at sea is likely to be bolstered by individuals from South Georgia, Argentina, the South Orkneys, South Shetlands and the Antarctic Peninsula (Croxall and Wood 2002; Quintana and Dell'Arciprete 2002; White et al. 2002; Otley et al. 2006).

The southern giant petrel breeds at 38 locations around the Falkland Islands, in colony sizes ranging between one and 111,000 breeding pairs (Reid and Huin 2005). Most colonies are concentrated around the south of Falkland Sound, and to the west of West Falkland. Whilst there has been no previous census of the total population of the Falkland Islands, there is clear evidence that the population has increased at least since the 1950s. The Falkland Islands, with nearly 20,000 pairs counted in 2004/05, hold a significant percentage (40%) of the global population (Reid and Huin 2005).

The reasons for such an increase in population were investigated by Reid and Huin (2005), but remain unclear in light of the current knowledge. From the recent census in the Falkland Islands, it seems likely that the conservation status of the southern giant petrel, currently listed as vulnerable, should be downgraded.

Development of our understanding of the breeding biology and demography of this species in the Falkland Islands is necessary, as is the need to conduct a census every five years, with a few key colonies to be monitored every season, where possible. Using the limited observations gathered for the species in the Falkland Islands and more extensive data obtained at South Georgia, it is known that southern giant petrels in the Falkland Islands commence breeding in September, with egg laying occurring between mid October and early November, and chicks fledge in late March.

Southern giant petrels are predominantly scavengers and will take dead or weakened sheep, seals, seabirds, animal regurgitates and faeces, sewage, and at sea, a variety of natural prey and discard from fishing vessels (Gonzalez et al. 2000). The habit of feeding on sheep carcasses and the occasional report of attacking weak sheep brought the species into conflict with land managers in the Falkland Islands and many colonies were purposefully destroyed (Woods 1975). In the past, eggs were also collected for eating.

The species is now given full protection under the Conservation of Wildlife and Nature Ordinance 1999; egging is no longer practised and prejudices within the farming community have lessened such that persecution no longer takes place. However, the species is very sensitive to human disturbance during incubation and will often abandon the nest if approached. This is an increasing threat with the expansion of tourism in the islands. At two frequently visited sites - Sea Lion Island and Pebble Island - hides have been constructed to allow safe viewing of the colonies, and there is island-wide education by tour guides and land managers with visitors about the southern giant petrel's sensitivity to disturbance.

White-chinned petrel

The white-chinned petrel (*Procellaria aequinoctialis*) breeds on a number of archipelagos throughout the southern hemisphere, including a very large population on South Georgia, and also on the islands of Prince Edward, Crozet, Kerguelen, Antipodes, Campbell and Auckland (Marchant and Higgins 1990). Survey work during the summers of 2004/05 and 2005/06 was the first systematic attempt to census the population of white-chinned petrels in the Falkland Islands. Twenty-seven occupied burrows were found on Kidney Island, two burrows on Bottom Island in Port William and 26 pairs on New Island (Reid et al. 2007).

The population of white-chinned petrels in the Falkland Islands is therefore a very small proportion of the total world population (<1%). Nevertheless, as the species only breeds on eight archipelagos

around the southern ocean, the population in The Falkland Islands have the potential to be an important genetic reserve for the wider conservation of the species.

The white-chinned petrel is often seen in Falkland Islands waters; most individuals are likely to be from South Georgia (Berrow et al. 2000a). The species has a seasonal distribution and abundance, being widespread in shelf and oceanic waters during summer and autumn, and more common in shallower waters during the winter (White et al. 2002).

White-chinned petrels nest in burrows in wet southerly facing tussac grass-covered coasts on Kidney and Bottom Islands, and in grassy areas high above the sea on New Island (Reid and Catry 2006). No studies of breeding biology have been conducted in the Falkland Islands. During 1960-1962, 71 white-chinned petrels were banded on Kidney Island and five were recaught there at intervals of between two and six years after banding.

Based on local knowledge and data obtained from South Georgia (Berrow et al. 2000b), white-chinned petrels return to nesting burrows in late September to repair the nesting site and the single egg is laid in late October or November and incubated for approximately seven weeks. The chick remains in the burrow for over three months, leaving the nest in late April or early May. White-chinned petrels feed on squid, crustaceans and fish taken from the surface or caught by diving (Berrow et al. 2000b).

Sooty shearwater

The sooty shearwater (*Puffinus griseus*) is found on islands in the southern regions of South America, Australia, and New Zealand, and the world population is estimated to be in the millions (Marchant and Higgins 1990). No accurate count of the Falkland Islands sooty shearwater population has been made; this would be extremely difficult to achieve, given their burrowing habitats and the fact that they nest in soft peat beneath mature tussac grass on Kidney Island. The population has certainly increased since the 1960s but the Falkland population is not considered to be globally important. The species has a very large breeding population on Kidney Island, estimated at 100,000 pairs or more at a density of perhaps one pair per 2 m^2, with very small numbers on a few offshore islands and on the north east coast of East Falkland (Woods and Woods 1997, Falklands Conservation 2006b).

The breeding biology of the sooty shearwater has not been studied in detail in the Falkland Islands. Records show that sooty shearwaters return to breeding grounds from early September and lay eggs in late November in burrows beneath tussac grass. Adults leave colony areas in late March and the fledglings by late April for a winter migration to the northern hemisphere. One bird from Kidney Island was found dead in a fishing net in Barbados, West Indies (9,200 km) 28 days after being banded and another banded sooty shearwater was recovered from a fishing net off Newfoundland, Canada (10,800 km) (Woods and Woods 1997). W. Montevecchi (University of Newfoundland, Canada) started a study of the migration route of sooty shearwaters breeding on Kidney Island in December 2007, by attached geo-locator devices to several birds.

Sooty shearwaters feed on squid, crustaceans, small fish, and discards from fishing vessels (Marchant and Higgins 1990). Around the Falkland Islands, they are generally sighted in inshore and shelf waters, with peak numbers reported between September and March (White et al. 2002).

Great shearwater

The great shearwater (*Puffinus gravis*) is another migratory species, which returns to the Falkland Islands in very small numbers in summer months to breed. A very small number (perhaps 20 pairs) breed on Kidney Island and possibly also on other offshore tussac islands (Woods 1970). The Falkland Islands birds are the only recorded breeding population outside the Tristan da Cunha and Gough Island group, although at-sea sightings suggest that some may breed in the Magellanic region of South America (Woods and Woods 1997). The small Falkland Islands population is of local importance given the estimate of five million pairs on the Tristan da Cunha and Gough Island group.

At Gough Island, they return to breeding colonies in late September, with eggs being laid towards the end of October in burrows beneath tussac grass (Marchant and Higgins 1990). Chicks and adults have all departed nests in late April for an austral-winter dispersal as far north as 66ºN in the North Atlantic. At-sea records of greater shearwaters in Falkland Islands waters are most frequent between December - April over shelf slope and oceanic waters to the east and north of the Falkland Islands, which fits with their breeding cycle reported elsewhere (White et al. 2002).

Greater shearwaters are proficient divers on squid, fish, crustaceans and also fisheries discards. At-sea surveys also found great shearwaters are the most frequently recorded bird species associating with cetaceans, most notably hourglass dolphins (White et al. 2002).

Thin-billed prion

The thin-billed prion (*Pachyptila belcheri*) is the most abundant petrel species in the Falkland Islands, with very large breeding populations at New Island, the Jason Island group and other islands off the west coast of West Falkland (Woods and Woods 1997). Global distribution includes Kerguelen Island, Crozet Island and Isla Noir (Chile) and the Falkland Islands population is recognised as probably the most important of the three (Croxall et al. 1984).

A population census conducted within New Island South National Nature Reserve in 2002 estimated 1,081,000 active burrows, which, extrapolated to the entire island, would give a population estimate of two million pairs for New Island (Catry et al. 2003). Several offshore islands that could also hold significant populations have yet to be surveyed.

In 2002/03, from mid-November onwards, some sick and dead thin-billed prions were recorded (Huin 2003). The cause was identified as paralytic shellfish poisoning resulting from a widespread red algal bloom (Uhart 2004).

The breeding biology of the thin-billed prion has been studied on New Island in a series of studies by Strange, Silva and Quillfeldt. Thin-billed prions return to breeding grounds in September, and a single egg is laid between late October and early November in burrows up to two metres long in soft peat and sandy soil. Incubation lasts around seven and half weeks and young are generally fledged by late February, with males and females equally responsible for chick rearing duties (Strange 1980, Quillfeldt et al. 2003; Quillfeldt et al. 2006, 2007a; Silva et al. 2007).

At-sea surveys have shown prions to be present in Falkland waters at all times of year, with highest concentrations over Patagonian shelf waters to the west and northwest of the islands during the breeding season, September to February (White et al. 2002). During winter months, lower numbers were present and are more widely dispersed, possibly due to migration of the species to foraging grounds to the north and over the Argentinean Patagonian shelf during winter.

Thin-billed prions prey mainly on amphipods, and when sea surface temperatures are elevated, food availability is lower and consequently, breeding success and chick fledging rates are reduced (Quillfeldt et al. 2007b). The study of the breeding biology, foraging behaviour and diet of thin-billed prions at New Island lead by Quillfeldt is to be continued long-term. Research focuses on developing non-invasive methods of monitoring and investigation.

The species was formerly listed in the Falkland Islands as a pest under the Wild Animals and Birds Protection Ordinance 1964 and was able to be killed at any time as it was claimed that its burrows undermined pasture. This was apparently solely due to pressure from the former owner of New Island, where the prion colonies made shepherding on horseback dangerous due to undermining. However, the species was given full protection under the Conservation of Wildlife and Nature Ordinance 1999.

Fairy prion

The fairy prion (*Pachyptila turtur*) is found in the Pacific, Indian and Atlantic Oceans, including at South Georgia and the Falkland Islands, and the total world population may be several million birds (Marchant and Higgins 1990). In the Falkland Islands, the species is uncommon, with a breeding population on Beauchêne Island in the region of several thousand pairs (Lewis Smith and Prince 1985; Strange 1992).

At-sea surveys have shown the species to be present in Falkland Island waters throughout the year with more records in the vicinity of the colony at Beauchêne Island year-round (White et al. 2001). More colonies may exist on other remote and outlying islands, although the distribution at sea does point to Beauchêne Island being the principal colony.

Fairy prions nest in burrows beneath rock debris and boulders on storm beaches. Little is known of its breeding ecology but eggs have been found in mid December and chicks in mid January. It feeds on small marine invertebrates including squid and crustaceans.

Wilson's storm petrel

Wilson's storm petrel (*Oceanites oceanicus*) is found in the Pacific, Indian and Atlantic Oceans, including at South Georgia and the Falkland Islands. The Falkland Islands population is possibly not significant in world terms, with breeding sites at Beauchêne Island, Steeple Jason and Grand Jason, and probably at a number of other offshore tussac islands. New colonies were recently found at Steeple Jason in 2004 (N. Huin, personal communication), at South Jason in 2006 (G. Harrison and J. Meiburg, personal communication). There is no population monitoring of Wilson's storm petrel in the Falkland Islands but its status and breeding biology in the Falkland Islands are little known.

Wilson's storm petrels return to breeding grounds in early November and lay eggs during November to January in burrows in soft soil and rock crevices. Incubation lasts around six and a half weeks, with young fledging around mid February to March (Woods 1988). At-sea surveys show the species to be most frequent in Falkland waters between November and January when highest densities occur over Patagonian shelf waters to the west of the islands (White et al. 2002). This petrel feeds on small shrimp, squid and very small pieces of fish offal from trawlers. Post-breeding, the majority of birds migrate northwards, although a few birds remain in the Falkland Islands during the winter and from the moult stages of birds recorded, these are likely to be failed or pre-breeders (White et al. 2002). Migration is trans-equatorial and the species is common in the North Atlantic between April and August.

Grey-backed storm petrel

The grey-backed storm petrel (*Garrodia nereis*) has a circumpolar distribution but the only two breeding colonies confirmed in the Falkland Islands during the 1983-93 Breeding Birds Survey were on Carcass Island and Kidney Island. Neither population levels nor trends are known due to an almost complete lack of extended observations during their breeding season. However, since adults normally return to nests two to three hours after sunset, their presence is difficult to record, and it is probable that other breeding colonies exist, particularly on offshore tussac islands free of introduced predators. These include Sea Lion Island, Elephant Jason and Flat Jason, where freshly predated remains have been found (Woods and Woods 1997).

Nesting is loosely colonial in dense tussac grass stands. Details of the breeding ecology of this petrel are unclear, however, eggs may be laid between mid-October and mid-December and young birds fledge from early February to mid-April (Woods and Woods 1997).

At-sea surveys recorded the presence of grey-backed storm petrels in Falkland Islands waters at all times of year with greatest occurrence between November and March over Patagonian shelf waters to

the north-west and north-east of the islands. The lowest occurrence was during the austral winter from April to August and these birds are suggested to be failed or pre-breeders as successful breeders moult in winter and no moulting birds were recorded in this period (White et al. 2002). Winter movements of the majority of the Falkland Islands population are unknown.

Diet study of grey-backed storm petrels in New Zealand has shown them to be highly dependent on goose barnacles associated with free-floating debris, which is supported by coastal and at-sea sightings of the species with floating kelp-patches and debris in waters in the Falkland Islands (White et al. 2002).

Common diving petrel

The common diving petrel (*Pelecanoides urinatrix*) has a circumpolar distribution, with five or six sub-species or races, which breed at Tristan da Cunha and Gough, islands off south-eastern Australia and New Zealand, Chatham Islands, and at other sub-Antarctic islands. The Falklands race has been separated as *P. u. berard*.

In the Falkland Islands, it is commonly found on offshore tussac islands, including Steeple Jason, New Island, Kidney Island, Beauchêne Island and Bird Island (Woods and Woods 1997). No detailed surveys have been carried out and there is no information available on population levels and trends in the Falkland Islands, but the population may form only a small part of the world population of the species. As for other ground nesting birds, the common diving petrel is susceptible to the introduction of cats, rats and mice to offshore breeding islands.

The common diving petrel nests in burrows predominantly below tussac grass but has occasionally been reported from heathland and clay slopes. It returns to breeding sites in early September and it is thought that eggs are laid in late October and early-November with fledglings leaving nests around mid-February (Woods 1988).

Although the common and South Georgian diving petrel species (*Pelecanoides georgicus*) could not be reliably differentiated during surveys at-sea surveys, White et al. (2002) assumed that the most commonly observed species was the common diving petrel. It was recorded in all months with the highest frequency between September and February over Patagonian shelf and slope waters to the west and southwest of the Falkland Islands (White et al. 2002). It feeds on crustaceans and possibly small fish.

In 2002/03, from mid-November onwards, some dead common diving petrels were recorded, associated with the red algal bloom, which through paralytic shellfish poisoning killed a number of seabird species (Huin 2003).

Diet analysis of Falkland Island seabirds

The current knowledge of the diet of some of the species described above was based on stomach flushing the adults and/or chicks, which can be invasive. However, recently less invasive methods have been developed by measuring the chemical composition (e.g. stable isotopes of carbon and nitrogen) of feathers, tissues and blood, and these techniques are starting to be used in the Falkland Islands. The diet of the black-browed albatross, thin-billed prion and rock shags on New Island is studied by analysis of feathers and blood. Falklands Conservation has also started a collection of feathers from various seabird species, which are available for analysis.

During 2006/07, samples of eggshell, bone, feather, and nail were collected from gentoo penguins at a variety of sites in the Falkland Islands, as part of a pygoscelid penguin dietary study across the Antarctic Peninsula, South Orkneys and South Georgia by the University of North Carolina, USA (Contact - Dr. S. Emslie).

The Stuttgart Naturkunde Museum in Germany also has a selection of bird bones from the Falkland Islands, which will be used for a number of different investigations, including looking at bone deformation, which is a reflection of food quality and quantity (Contact – Dr. G. Nikolaus).

Cormorants and Shags (Pelecaniformes)

Two species of shag breed in the Falkland Islands. Rock shags (*Phalacrocorax magellanicus*) and king (or imperial) shags (*P. atriceps albiventeris*) breed at a variety of sites.

Rock shag

The rock shag (*Phalacrocorax magellanicus*) occurs in the southern part of South America, including the Falkland Islands. There is no information available on its population or trends in the Falkland Islands or globally. In the Falkland Islands, the rock shag is widely distributed around coastal areas, nesting singly or in colonies of between six and several hundred pairs, usually on cliff ledges with nests constructed of tussac grass and seaweed (Woods and Woods 1997). Nest building begins in late September, eggs are laid from November onwards and chicks fledge during January and February.

A study in Patagonia has shown that the diet comprises small fish, crustaceans and cephalopods taken from the seabed in waters of between 2 to 12 m (Wanless and Harris 1991). At-sea surveys in the Falkland Islands indicated that during summer months, there are no records of rock shags more than 5 km from the shore, while adults occurred up to 16 km and immatures up to 27 km from the shore during winter months (White et al. 2002).

In 2002/03, from mid-November onwards, some sick and dead rock shags were recorded (Huin 2003). The cause was identified as paralytic shellfish poisoning resulting from a widespread occurrence of the red toxic algae bloom (Uhart 2004).

King shag

The king (or blue-eyed or imperial) shag (*Phalacrocorax atriceps*) has a circumpolar range, with several distinctive races, including *P. a. albiventer* which breeds only on the Falkland Islands. There is no information available on its population or trends in the Falkland Islands or globally. Populations counts of king shag were undertaken annually at a number of sites by the Falklands Conservation between 1986 and 1996, which suggested a possible decline, although the species has inter-annual variability in both timing of breeding and breeding population size elsewhere (Woods and Woods 1997).

King shag colonies are common and widely distributed around coastlines, mostly on level cliff-top sites. Colonies are closely packed and often in association with rockhopper or gentoo penguins and black-browed albatrosses. Nests of mud and tussac are built during September and October, with eggs laid during November and young fledging in February.

King shags feed further offshore than rock shags, with the average sighting at 12 km from the shore during summer months and at 37 km during June to October (White et al. 2002). They generally forage in small flocks, shallow diving for crustaceans in particular during pre-laying and incubation and for mainly small nototheniid fish during chick rearing.

In 2002/03, from mid-November onwards, some sick and dead king shags were recorded (Huin 2003). The cause was identified as paralytic shellfish poisoning resulting from toxins produced by the red algal bloom (Uhart 2004).

The breeding and foraging biology of king shags is being on New Island during 2006-09 by Quillfeldt and others. The British Antarctic Survey also conducts long-term studies of population, diet and foraging behaviour of the species at South Georgia and South Orkneys.

Grebes

Grebes (Podicipediformes) are small to large diving birds that rarely fly and feed by surface diving. Four species with a wide distribution in South America have been recorded in the Falkland Islands. Two are resident, white-tufted or Rolland's grebe (*Rollandia rolland*) and silvery grebe (*Podiceps occipitalis*). Great grebe (*Podiceps major*) is an occasional vagrant and the pied-billed grebe (Podilymbus Podiceps) was recorded at least once in 2002 (Woods 1988).

White-tufted grebe

The white-tufted (Rolland's) grebe (*Rollandia rolland*) is found in central and southern South America with three races, including one on Andean lakes, one in lowland continental areas and the larger *R. r. rolland* in the Falkland Islands. The taxonomy of the three races is currently under investigation because there is some evidence that the Falkland Islands form is sufficiently different to be considered an endemic species (R. Woods, personal communication).

The white-tufted grebe is widely distributed but only locally common in wetlands in wetlands throughout the Falkland Islands. There is no information on population trends for this species because its biology has not been studied. During the breeding season, it is usually found on freshwater ponds and slow moving rivers and streams that support aquatic vegetation, particularly in the low-lying parts of the Falkland Islands such as Lafonia. Nests are floating, and constructed of waterweeds and grass, and are often found placed under the overhangs of stream banks or amongst brown swamp rush (*Rostkovia magellanica*). The breeding season begins with courtship and nest building towards the end of September and lasts until January. One to three eggs are laid, normally during October but occasionally as late as December (Woods and Woods 1997).

All food appears to be acquired by diving, with an average dive time of 15 seconds. Favoured prey appears to be small fish up to 15 cm in length, crustaceans, insects and aquatic plants (Woods 1988). During the winter months, the white-tufted grebe is found in greater numbers in coastal areas where shelter is provided by kelp beds.

Silvery grebe

The race (*Podiceps occipitalis occipitalis*) of the silvery grebe is found in the Falkland Islands and in southern South America as far north as approximately 25ºS. In the Falkland Islands, the silvery grebe appeared to be less common than the white-tufted grebe during the Breeding Birds Survey of 1983-93. However, the silvery grebe is often more conspicuous because it is gregarious when breeding and prefers large freshwater ponds supporting dense growths of emergent water milfoil in which ten or more nests may be built a few metres from each other. It nests between November and January but during autumn and winter, frequents coastal waters and forages amongst kelp beds (Woods and Woods 1997).

Herons and egrets

Herons and egrets (Ciconiiformes) are large waterside birds with long legs, bills and necks. Of the six species recorded in the Falkland Islands, only the black-crowned night heron (*Nycticorax nycticorax falklandicus*) breeds. Five species are wind-blown vagrants; the cattle egret (*Bubulcus ibis*) is an almost annual vagrant since 1974 during the autumn, the cocoi heron (*Ardea cocoi*) is almost annual while the green-backed heron (*Butorides striata*), great white egret (*Ardea alba*) and snowy egret (*Egretta thula*) arrive very infrequently (Woods and Woods 2006).

Black-crowned night heron

The black-crowned night heron (*Nycticorax nycticorax*) is widespread worldwide (except Australasia) between the latitudes 53 ºN and 55 ºS, with three separate races within the Americas. The endemic race of this species in the Falkland Islands, *N. n. falklandicus*, tends to be smaller, darker, and more sedentary than the continental South American races (Woods 1988).

In the Falkland Islands, the black-crowned night heron is a widely distributed and common resident around coasts. There is no evidence that numbers have declined in recent times. Breeding often occurs in small colonies, with rock shags, on low cliffs with shrubby plants or tussac, in beds of California club-rushes in ponds and in planted Monterey cypress at settlements (Woods and Woods 1997).

There is some uncertainty regarding the breeding strategy of the species because it has not studied in the Falkland Islands. Most pairs begin egg laying around mid to late October, with up to four eggs laid, but some eggs have also been found in December and into January (Woods 1988). There is a possibility that first year breeders may, in some cases, lay later, or that some pairs may double brood.

Favoured foraging areas are coastal shallows and rock pools, up to 300 m offshore in kelp and short distances up freshwater streams. Small fish and aquatic insects are favoured prey, but they have a catholic taste that includes rats, grey-backed storm petrels, tussacbirds and house sparrows (Woods and Woods 1997).

Swans, geese and ducks

Swans, geese, and ducks (Anseriformes) inhabit freshwater, marine and grassland habitats. Twenty-two species have been recorded in the Falkland Islands, including fourteen native and one introduced species breeding in the wild. These are black-necked swan, coscoroba swan, ashy-headed goose, ruddy-headed goose, upland goose, kelp goose, feral goose, crested duck , Falkland Islands flightless steamer duck, flying steamer duck, yellow-billed teal, Chiloe wigeon, yellow-billed pintail, silver teal and cinnamon teal (Woods and Woods 1997).

Six species are apparently non-breeding vagrants from South America: spectacled duck (*Anas specularis*), white-cheeked pintail (*Anas bahamensis*), red shoveler (*Anas platalea*), rosy-billed pochard (*Netta peposaca*), lake duck (*Oxyura vittata*) and black-headed duck (*Heteronetta atricapilla*), though the red shoveler quite probably breeds in very small numbers (R. Woods, personal communication).

Black-necked swan

The black-necked swan (*Cygnus melancoryphus*) is found across South America and is an uncommon species in the Falkland Islands, being most numerous in Lafonia on East Falkland and on Pebble Island (Woods and Woods 1997). It is also possible that there might be some influx of individuals from South America. The Falkland Islands population is only a small proportion of the global total.

Breeding commences between early August and mid September, with individual pairs often choosing isolated sites close to ponds or on islets within them. Up to seven eggs are laid in large nests built of twigs, grass and reeds, incubated for five weeks and the cygnets fledge after three months (Woods and Woods 1997). During this time, black-necked swans inhabit large freshwater ponds that support aquatic vegetation, whilst during winter, flocks form on tidal estuaries and sheltered creeks, particularly

in parts of Lafonia, in Swan Inlet estuary and also in the Murrell River estuary. Feeding is mainly on aquatic plant material, probably including water milfoil (*Myriophyllum quitense*), tasselweed (*Ruppia filifolia*) and pondweed (*Potamogeton linguatus*).

Coscoroba swan

The coscoroba swan (*Coscoroba coscoroba*) has occurred most years since 1996 as a visitor from South America and is not well known in the Falkland Islands. Recent breeding has been documented on Pebble Island and Bertha's Beach, East Falkland (Morrison et al. 2005).

Upland Goose

The upland goose (*Chloephaga picta*) is found in southern South America, with a race *C. p. leucoptera* on the Falkland Islands, which is larger than the continental race. There is no information available on its population or trends in the Falkland Islands or globally. Here the upland goose is widely distributed in coastal, freshwater and inland areas, with largest concentrations on coastal and waterside greens, where the grazing and nutrient input from the geese help to maintain the short fine grasses. The main food resource of adult birds is grass, although they also feed on seaweeds and the berries of shrubs (Douse 1987; Summers and McAdam 1993). Breeding adults move out into longer grasses or dwarf shrub heath to make their nests during September and October, with chicks fledging about 70 days after hatching.

In the past, there was a great deal of conflict between sheep farmers and the upland goose, as it was seen as competing for herbage. This led to a Government Ordinance being passed in 1905, which created a bounty system for upland goose beaks. Over 500,000 beaks were bought by 1912 when the ordinance ceased effect. Attitudes have started to change in recent years and studies have shown that geese probably take no more than 2% of herbage compared with 20% of herbage consumed by sheep (Summers and McAdam 1993). Although the upland goose can be killed at any time of year under the Conservation of Wildlife and Nature Ordinance 1999, it is generally only shot for human or animal consumption.

During the 1970s, J. Harradine, R. W. Summers and A. Douse studied upland geese and ruddy-headed geese and sheep farming through the Department of Agriculture, but since then it has only been the subject of occasional research on New Island (e.g. Quillfeldt et al. 2005; A. Gladbach, personal communication).

Ruddy-headed goose

The ruddy-headed goose (*Chloephaga rubidiceps*) is found in southern South America, including Tierra del Fuego and the Falkland Islands. On the continent, the ruddy-headed goose was formerly common on lowland grasslands from 52ºS down to Tierra del Fuego. However, due to the introduction and spread of foxes, loss of habitat and poisoning, there has been a spectacular decline in numbers over

the last 35 years, with less than a thousand birds reported in Tierra del Fuego (Madge and Burn 1988) and very breeding near Punta Arenas, Chile (R. Matus, personal communication).

The Falkland Islands population is stable, although possibly historically it was more abundant, and represents the majority of the world's population (Woods 1988). Ruddy-headed geese are smaller than, but resemble, a female upland goose to the inexperienced eye. The breeding cycle of the ruddy-headed goose is very similar to that of the upland goose, except that laying does not begin until October.

Until 1985, the ruddy-headed goose was listed as a pest species and was shot on a regular basis, particularly by farmers. The species now has full statutory protection within the Falkland Islands under the Conservation of Wildlife and Nature Ordinance 1999, as well as internationally under Appendix I of the Convention on Migratory Species (CMS). However, it is still feasible that this species could be mistaken for an upland goose and shot as game or egged.

In August 2007, Chile and Argentina signed an agreement under CMS to coordinate conservation measures, including working closely with local farmers, hunters and reserve managers, to halt the recent declines in the mainland South American population of the ruddy-headed goose.

Ashy-headed goose

The ashy-headed goose (*Chloephaga poliocephala*) is found in South America from 37°S to Tierra del Fuego. It occurs in the Falkland Islands as a rare visitor that occasionally breeds (Woods 1988). Individual birds may be overlooked because it is usually seen singly with ruddy-headed or upland geese.

Kelp goose

The kelp goose (*Chloephaga hybrida*) is distributed on coasts of southern South America from about 42 °S, with a larger race (*C. h. malvinarum*) on the Falkland Islands. It is found on most coastlines, particularly on rocky and shingle beaches and also occasionally on coastal freshwater ponds. The kelp goose is a specialised marine herbivore, foraging within the intertidal zone on sea lettuce, red algae and other seaweeds, and during autumn, also on grasses and berries (Woods 1988). It usually nests in tussac or other grasses or rushes just above high water mark. There is some evidence that pairs migrate locally from offshore tussac islands to sheltered inlets and bays for the winter (Woods 1975).

Crested duck

Two races of the crested (or grey) duck (*Lophonetta specularioides*) occur in South America, with one race. The Falkland Islands race, *L .s. speculariodes*, is also found in the lower Andean and coastal areas south of 36ºS. Genetic testing of three individuals in the Falkland Islands revealed some unique alleles but further sampling is required (K. McCracken, personal communication).

In the Falkland Islands, it is a common species in coastal areas, particularly in sheltered coves and creeks characterised by shallows and tidal reaches, and freshwater ponds (Woods and Woods 1997). The breeding season is extended, with territories being held throughout the year. Although eggs can be laid from August through to April, the main peak is from September to November, and double brooding is not uncommon (Woods 1988). The prey of small invertebrates, crustaceans and molluscs, is obtained by sieving and dabbling in shallow water.

The crested duck is one of the two waterfowl species that can be taken outside the closed season (1st July to 31st March) under the Conservation of Wildlife and Nature Ordinance 1999. Whilst they were taken extensively during the 1960s, their popularity as a game species has declined in recent years. A licence can also be obtained to collect eggs, although there have been no licence requests in recent years.

Yellow-billed teal

The yellow-billed (or speckled) teal (*Anas flavirostris*) found in the Falkland Islands is a race (*A. f. flavirostris*) that is found across southern South America. However, genetic testing of 15 individuals captured in the Falkland Islands suggests a genetic makeup distinct to individuals on continental South America (K. McCracken, personal communication).

In the Falkland Islands, it is a widespread species occupying a variety of habitats, predominantly freshwater but also marine (Woods and Woods 1997). Speckled teal feed on a variety of aquatic flora and fauna, which are normally obtained by straining surface water and by diving, and also berries, seeds and leaves. Nesting and egg laying begins in mid-August, double brooding is common and ducklings have been observed as late as April (Woods 1988).

Speckled teal is one of two waterfowl species that can be taken in the Falkland Islands outside the closed season (1st July to 31st March) under the Conservation of Wildlife and Nature Ordinance 1999. Whilst they were taken extensively during the 1960s, their popularity as a game species has declined in recent years. A licence can also be obtained to collect eggs, although there have been no licence requests in recent years.

Falkland steamer duck

The Falkland steamer duck (*Tachyeres brachypterus*) is endemic to the Falkland Islands, and it is thought to have a stable population. It is widely distributed along coastlines and up to three miles offshore. Breeding adults are particularly common in sheltered bays and creeks where there is offshore kelp, whilst non-breeding and immature birds are more likely to be found on exposed rocky shores and cliffs (Woods 1988). A wide variety of marine prey including molluscs, crustaceans and seaweeds are taken by diving or up-ending in shallow water. Dead Falkland steamer ducks were reported during the 2002/03 HAB (Huin 2003). Territories are retained throughout the year and are aggressively defended by the male during the mid-September to January breeding season.

Considerable egg-collecting from Falkland steamer duck nests occurred historically but now a licence must be obtained and annually one to four licences are issued, which permit the collection of 6 – 12 eggs per licence.

Flying steamer duck

The flying steamer duck (*Tachyeres patachonicus*) is widely distributed in southern South America and in the Falkland Islands. It closely resembles the Falkland steamer duck but is much more wary, two characteristics which have often led to it being unrecognised and therefore considered more uncommon than it is. The flying steamer duck is considered scarce across the Falkland Islands and shows a preference for inland freshwaters. The occurrence of steamer ducks on large ponds several kilometres inland is a very strong clue to their identity as flying rather than flightless ducks. The breeding and feeding ecology of the flying steamer duck are very poorly known and need investigation (Woods and Woods 1997).

Chiloe wigeon

The Chiloe wigeon (*Anas sibilatrix*) is found across southern South America and in the Falkland Islands. It is an uncommon but widely distributed species on both coastal waters and larger freshwater ponds and lakes, particularly in Lafonia (Woods and Woods 1997). It often leaves the water and grazes on waterside vegetation but when on a pond with other ducks, wigeon are usually the first to fly. It is no longer listed as a game species and is protected under the Conservation of Wildlife and Nature Ordinance 1999. Genetic testing of nine individuals captured in the Falkland Islands revealed some unique alleles but further sampling is required (K. McCracken, personal communication).

Yellow-billed pintail

The yellow-billed pintail (*Anas georgica*) has three races, with one race (*A. g. spinicauda*) in southern South America and the Falkland Islands. It is scarce but widely distributed in the Falkland Islands, with somewhat higher numbers in Lafonia (Woods and Woods 1997). Although apparently uncommon, its population status has been confused by its superficial similarity to the speckled teal, a species which is still classified as a game bird.

In southern areas of South America, it migrates and it may be partly migratory in the Falkland Islands as few are seen during winter. Surveys of freshwaters, like those by M. Winter south of MPA during 1990, are needed to investigate its status during winter months (Winter 1991). Only one individual from the Falkland Islands has been sampled for genetic analysis (K. McCracken, personal communication).

Silver teal

The silver teal (*Anas versicolor*) has two races, with one *A. v. fretensis* in southern South America and the Falkland Islands. The genetics of one individual from the Falkland Islands were distinct from samples taken in Argentina (K. McCracken, personal communication).

It is generally fairly rare but can be locally common in some areas of the Falkland Islands, particularly on larger freshwater ponds and wetlands with aquatic flora, such as Lafonia and north of Fox Bay (Woods and Woods 1997). It is no longer listed as a game species and is protected under the Conservation of Wildlife and Nature Ordinance 1999.

Cinnamon teal

Cinnamon teal (*Anas cyanoptera*) seen in the Falkland Islands are of the race (*A. c. cyanoptera*) found in South America. Little information is available on the ecology, distribution and population in the Falkland Islands of this rarely-sighted species but it probably breeds in very small numbers at larger freshwater ponds (Woods and Woods 2006).

Raptors

Species of raptor that breed in the Falkland Islands include turkey vulture, variable (or red-backed) hawk, southern (or crested) caracara, striated caracara and peregrine falcon. The cinereous harrier (*Circus cinereus*) bred in the Falkland Islands up to the mid-19th century but is no longer resident, probably due to habitat destruction and hunting. The sharp-shinned hawk (*Accipiter striatus*), chimango caracara (*Milvago chimango*), long-winged harrier (Circus buffoni), Aplomado falcon (*Falco femoralis*) and American kestrel (*Falco sparverius*) are rare vagrants, though the latter species possibly breeds in extremely small numbers.

Turkey vulture

Turkey vultures (*Cathartes aura*) are found from Canada to Tierra del Fuego and the race *C. a. falklandica* inhabits southern South America and Falkland Islands. This species is common and widely distributed across the Falkland Islands, except for Beauchêne Island and possibly others (Woods 1988). It is particularly attracted to seal colonies. A recent survey suggests a population on East and West Falkland of between 4,170 and 6,050 birds (Breen and Bildstein 2008). Wing tagged turkey vultures caught in Stanley have been re-sighted as far as Cape Dolphin (north-west tip of East Falkland) away (Falklands Conservation unpublished records).

It nests on the ground, usually under cover of overhanging tussac grass on tussac islands, especially where seals breed. Eggs are laid between September and November, with the young normally fledging during January. A carrion eater, it feeds on carcasses and faeces of sheep, cattle, seals and birds, and thus fills an important ecological role as a scavenger and disposer of otherwise toxic animal matter (Woods 1988). In some areas, it attacks weakened and young sheep and lambs, also well as harassing healthy ewes as they give birth.

From 1908 until 1959, a bounty could be collected from both the Falkland Islands Government and farm managers for beaks of turkey vultures and within the provisions of the provisions of the Wild Animal and Birds Protection Ordinance 1964, turkey vultures could be killed by any means. The Conservation of Wildlife and Nature Ordinance 1999 afforded some protection to the species. Under certain conditions only, a licence to control or kill the species may be granted if the applicant can show that it is required to prevent serious damage to livestock and foodstuffs. A licence to shoot up to 20 turkey vultures could be issued every three months by the Environmental Planning Department. Breen and Bildstein (2008) found that farmers who perceived vultures as a problem had, in general, higher vulture densities on their farms than neighbouring farms.

Variable hawk

The variable (or red-backed) hawk (*Buteo polyosoma*) is a widespread species across most parts of the Falkland Islands. The race found in the Falkland Islands (*B. p. polyosoma*) is also found in the Andean and southern parts of South America. There are several colour phases and sexual differences, ranging from grey above and white below to very dark ruddy brown all over.

Breeding can begin as early as September, but more often, attempts begin in October (Woods 1988). The same breeding sites on cliff sides are used and new vegetation is added to old nests annually, particularly diddle-dee. Several nests have been recorded almost at ground level in discard rolls of old fencing wire. Variable hawks lay two or three eggs, and incubation takes 45-50 days, a duty shared between the male and female. Breeding success may be low; of seven breeding pairs monitored in 1994/95, 15 eggs were laid and only four chicks fledged. Young fledge late December/early January and one radio-tracked fledging remained within 5 km of its natal nest, whilst one transmitter was found 12 months later 40 km away (Clark 2006).

Variable hawks feed on a variety of birds and mammals including mice, rats, rabbits, hares, goslings, passerines and gulls, and occasionally carrion. The introduced mammals have probably benefited the species (Woods 1988). The species is afforded full protection under the Conservation of Wildlife and Nature Ordinance 1999.

Southern caracara

The southern caracara (*Caracara plancus*) is found in Central and South America, with one race *C. p. plancus* distributed from mid to southern South America. The Falkland Islands hold only a small percentage of the world population, and it is uncommon but widely distributed around coasts and inland areas throughout the archipelago. It is possible that the species arrived in the Falkland Islands in the late 19th century, when the sheep population was increasing (Woods and Woods 1997).

The biology of the species has not been studied in any detail in the Falkland Islands. The main egg-laying month is September, with bulky twig nests on cliff ledges used annually (Woods 1988). An

opportunistic scavenger, southern caracaras take dead or weakened sheep and lambs, cattle, seabirds, mice, hares, insects, and on occasion, some marine prey such as octopus.

Due to a reputation, justified or not, of attacking sheep, southern caracaras have been subject to bounty payments since the 1908 Ordinance and vermin status continued through several Ordinance including the Animals and Birds Protection Ordinance 1964, which allowed it to be killed at any time. The species is now afforded protection under the Conservation of Wildlife and Nature Ordinance 1999.

Striated caracara

Striated caracara ('Johnny rook') (*Phalcoboenus australis*) has a global conservation status of Near Threatened and is found in the Falkland Islands, islands south of the Beagle Channel and on the southern coasts of Tierra del Fuego (Marin et al. 2006; Meiburg 2006). Hence, the population in the Falkland Islands is of world importance. The striated caracara is highly dependent on colonial seabirds, seals and sea lions for its food and the future of this wildlife, such as the declining black-browed albatross, will also influence its numbers by reducing food availability (Woods 2007a).

Information on the ecology, behaviour, population and distribution of the striated caracara can be found in Strange (1996), Woods and Smith (1999) Marin et al. (2006) and Meiburg (2006). The species is limited to a number of islands off West Falkland to Sea Lion Island and Beauchêne Island. An island wide census of the breeding population conducted in 1997/98 estimated 500 breeding pairs, with their Falklands stronghold on the Jason group and on Beauchêne Island and Bird Island (Woods and Smith 1999).

The estimated population in 2006, based on surveys of 18 islands and previous records (1997 – 2005) on 77 islands was 520 pairs (Woods 2007a). A number of research priorities were identified for the species in the Falkland Islands, including investigations of habitat requirements, behaviour, diet, population dynamics, migration and particularly, conflict with sheep farming (Woods 2007a).

In the Falkland Islands, the striated caracara lays eggs during late October and early November, and chicks fledge approximately 10 weeks later. It takes several years for juveniles to reach maturity, by which time the skin around the beak and the legs has changed gradually from ashy grey to yellow. Whilst breeding adults may remain at their islands, juveniles and pre-breeders tend to disperse over a much wider area and flocks of 100 or more around settlements in winter, give the impression of a more numerous population (Woods and Smith 1999).

The presence of striated caracaras near settlement areas brings the species into conflict with some farmers who perceive them as a threat to livestock. It is a carrion eater and often it is difficult to determine whether sheep and lambs eaten were dead, weakened or healthy individuals. The species also naturally eats invertebrates, eggs and chicks of birds, and the excreta of penguins and sea mammals and call kill adult upland geese and king shags (Strange 1996).

Striated caracaras suffered persecution after being labelled as a pest in the early part of this century and a bounty system existed until the 1920s because of its reputation for attacking sheep and lambs, which led to its extinction on East Falkland and near extinction on West Falkland (Woods 1988). The striated caracara was afforded full protection in 1964 under the Wild Animals and Birds Protection Ordinance 1964 and more recently by the Conservation and Wildlife Ordinance 1999. However, a licence can be issued to shoot striated caracaras if a severe interaction with livestock can be proven. Over the last five years, two licences to shoot about five birds have been issued in some years on two farms in southern sections of West Falkland.

Peregrine falcon

The peregrine falcon (*Falco peregrinus*) is widespread across the world and the race found in the Falkland Islands (*F. p. cassini*) is also found southern South America. The genetic affinities of the many races are currently being investigated, with six nestlings from six nest sites in the Falkland Islands sampled in 2001 (B. Anderson and S. Talbot, personal communication).

It is known to be uncommon but widely distributed in the Falkland Islands, perhaps more common in coastal areas (Woods and Woods 1997). Nesting occurs on cliff ledges, with up to four eggs laid between late September and the end of October, with fledging about 10 weeks later. Peregrine falcons take a variety of prey, mainly birds in flight including passerines, small petrels and geese (Woods 1988). Offshore feeding records during autumn suggest possible migration but these individuals may represent dispersing juveniles following seabird prey.

Waders, skuas, sheathbills, gulls and terns

The Falkland Islands are relatively rich in species from the Charadriiformes family.

Magellanic oystercatcher

The Magellanic oystercatcher (*Haematopus leucopodus*) is found in southern Chile and Argentina and in the Falkland Islands, it is common and widespread in coastal areas, particularly where sandy beaches are backed by grassy slopes (Woods 1988). Food consists of a wide variety of invertebrates found along low shorelines of sand, shingle, rock and weed and it will also dig for food in grass paddocks near shores. Pairs of Magellanic oystercatchers vigorously defend territories against intruders, including humans, skuas and caracaras during the breeding season from late September to December.

Blackish oystercatcher

The blackish oystercatcher (*Haematopus ater*) is also found across coastal South America, northwards to Peru and in the Falkland Islands, it is common and widespread in coastal areas. Its less conspicuous colouration, more solitary nature and preferred rocky habitat means that the species appears less numerous than the Magellanic oystercatcher. Food consists of a wide variety of invertebrates found along rocky shorelines, particularly mussels. Pairs vigorously defend territories when breeding.

Plovers

Two plovers, the two-banded plover (*Charadrius falklandicus*) and the rufous-chested dotterel (*Charadrius modestus*) breed in the Falkland Islands whilst a further three species, the southern lapwing (*Vanellus chilensis*), American golden plover (*Pluvialis dominica*) and tawny-throated dotterel (*Eudromias ruficollis*) are vagrants. Plovers are generally migratory but it appears that one of the plovers breeding in the Falkland Islands is sedentary and the other, partly migratory. The breeding biology of the two-banded plover and the rufous-chested dotterel and the effects of introduced predators are being studied in the Falkland Islands by the University of Bath (UK) in parallel with their on-going plover studies in Argentina (Contact T. Szekely and J. St Clair).

Two-banded plover

The two-banded plover (*Charadrius falklandicus*) occurs widely around the coasts of southern Chile, southernmost Argentina and in the Falkland Islands. There is debate as to whether an endemic race exists in the Falkland Islands as plumage seems to differ slightly from the mainland species and the Falkland Islands population is almost certainly sedentary. If the Falkland Islands population is distinct, it would be described as *Ch. f. falklandicus* and the mainland population as *Ch. f. fasciatus* (Woods and Woods 1997).

In the Falkland Islands, the two-banded plover has a localised distribution, favouring low lying coastal areas, particularly sand beaches and muddy creeks for feeding. It nests in short grass or low diddle-dee up to 1.5 km inland, less frequently on beaches between hummocks of kelp and sand (Woods and Woods 1997). Nesting and egg laying may start in mid-September and lasts until mid January, with double brooding apparently quite common (J. St Clair, unpublished data).

Rufous-chested dotterel

The rufous-chested dotterel (*Charadrius modestus*) occurs widely in southernmost South America. Whilst the species is abundant and widely distributed in the Falkland Islands, the wintering flocks of migrants in central Argentina have declined (Woods and Woods 1997). Dotterels are found in a variety of habitats at different times of year but it prefers heathlands with dwarf shrub and rushes for nesting and intertidal beaches and mudflats during spring and autumn. Egg laying begins in October and may continue through into January (Woods 1988).

Dotterels may be under-recorded in the Falkland Islands between April and July, when small flocks gathering on grasslands, because they are quiet and their winter plumage is dull and inconspicuous. However, it seems that a substantial part of the breeding population does migrate to South America (Woods 1998).

Godwits, sandpipers and snipes - Scolopacidae

Most Scolopacidae species are northern hemisphere breeders of moorland and tundra that migrate south during the northern winter. The characteristic long slender bill with its flexible tip evolved for probing into soft mud and shallow water, and for taking insects from low vegetation.

Nineteen species have been recorded in the Falkland Islands, but only the South American snipe (*Gallinago paraguaiae magellanica*) is confirmed as breeding. Fuegian snipe (*Gallinago stricklandii*) has nested in the past and there are two authenticated records of single birds in the past ten years but it is no longer resident (R. Woods, personal communication).

The remaining 17 species are migrants from the arctic (Woods and Woods 2007). A few species occur regularly, particularly the white-rumped sandpiper (*Calidris fuscicollis*), which occurs in very large numbers during the austral summer, while sanderling (*Calidris alba*), Baird's sandpiper (Calidris bairdii) and whimbrel (*Numenius phaeopus*) are seen in very small numbers.

Magellanic snipe

The South American snipe (*Gallinago paraguaiae magellanica*) is widespread across the southern part of South America, including the Falkland Islands, where it is found in a variety of habitats, from damp acid grassland and dwarf shrub heath to open tussac grass paddocks and beaches with accumulating rotting kelp (Woods and Woods 1997).

The snipe feeds on a variety of invertebrate species obtained by careful probing and the main breeding season is between August and October, although eggs and young have been recorded as early as July and as late as February. Some are present in the Falkland Islands during winter but they are even more inconspicuous in behaviour.

Skuas - Stercorariidae

Skuas are strongly built predatory seabirds that will also scavenge and harass other seabirds in a piratical fashion to obtain food and regurgitate. The larger species are bipolar in breeding distribution and are pelagic over most oceans out of the breeding seasons. In the Falkland Islands, the Falkland skua (*Catharacta antarctica*) is a breeding species, whilst the south polar skua (*Catharacta maccormicki*) is a transitory migrant in Falkland Islands waters. The Chilean skua (*Catharacta chilensis*) has been found several times but is probably a vagrant from the continent.

The smaller skuas are all northern breeding species that migrate south during November to March. The long-tailed skua (*Stercorarius longicaudus*) and the arctic skua (*Stercorarius parasiticus*) are non-breeding visitors, mainly to northern Falkland waters (Woods 1988; White et al. 2002).

Falkland skua

The Falkland skua (*Catharacta antarctica*) is mostly restricted to the Falkland Islands, but also occurs from Punta Tombo to Puerto Deseado in Argentina. Different species/races breed on other sub-Antarctic islands and the Antarctic Peninsula.

In the Falkland Islands, the species lays two eggs between late November and mid-December, with pairs nesting individually or in colonies. Eggs are incubated for four weeks, and normally one chick fledges after a further five weeks (Lamey 1995).

Adult and fledgling skuas depart the Falkland Islands during April and apparently range across pelagic waters as far north as 20ºS in southern oceans (White et al. 2002). Falkland skuas from New Island tracked with geo-locators spent most of their winter in the shelf-break areas off central Patagonia (Phillips et al. 2007). Study of pellets and prey remains of Falkland skuas on New Island, and also observations made elsewhere in the Falkland Islands revealed a summer diet of predominantly goose barnacles, thin-billed prions and lobster krill (Reinhardt et al. 2000; Matias 2005).

Gulls - Laridae

Seven gull species have been recorded in the Falkland Islands: dolphin gull (*Leucophaeus scoresbii*), kelp gull (*Larus dominicanus*) and brown-hooded gull (*Larus maculipennis*) are breeding residents, whilst grey gull (*Larus modestus*), band-tailed gull (*Larus belcheri*), grey-headed gull (Larus cirrocephalus) and Franklin's gull (*Larus pipixcan*) are vagrants.

Dolphin gull

The dolphin gull (*Leucophaeus scoresbii*) breeds in southern South America and the Falkland Islands. Although there is limited information on numbers, the Falkland Islands probably holds the majority of the world's population (Woods and Woods 1997). Thus, it would be advantageous to conduct research into the species in the Falkland Islands, including location and sizes of breeding colonies and aspects of breeding biology.

The dolphin gull is a widely distributed resident of all coasts of the Falkland Islands, especially around seal, penguin and shag colonies (Woods and Woods 1997). A wide variety of food is taken, including marine invertebrates, carrion, excreta, eggs, jellyfish, shellfish (dropped to break shells), and food scraps and regurgitate obtained by harassing other bird species.

It breeds in small closely packed colonies, usually associated with larger numbers of kelp gulls, brown-headed gulls or South American terns, on sand, shingle, cobble or rocky shores, and adjoining coastal grassland or heath land. Nests are hollows lined with vegetation or seaweed, and two or three eggs are laid, usually in early December with juveniles finally fledging from early March onwards (Woods 1988).

Kelp gull

The kelp gull or Dominican gull (*Larus dominicanus*) has a circumpolar distribution in the southern hemisphere, and the Falkland Islands hold only a small proportion of the world population. In the Falkland Islands, it is common on low-lying coasts with kelp beds and around settlement areas. Kelp gulls generally nest in large colonies on sandy and stony beaches, or on adjoining grassland and heathland from late November onwards. It is an opportunistic feeder, taking whatever food it can find, including marine and terrestrial invertebrates, eggs, chicks, carrion, offal and even human refuse. Dead kelp gulls were reported during the 2002/03 harmful algal bloom (Huin 2003).

Due to the interaction with farming, when it was perceived by some to attack live sheep rather than just feeding on carrion, the destruction of eggs and nests at breeding colonies near lambing grounds was still an accepted activity until 15 years ago. Kelp gulls are now fully protected under the Conservation of Wildlife and Nature Ordinance 1999, and farmer perceptions of the species are changing. A licence can be obtained to collect eggs of kelp gulls, although no licences have been requested in the last 10 years.

Brown-hooded gull

The brown-hooded gull (*Larus maculipennis*) is widely distributed in southern South America, and the Falkland Islands holds only a small percentage of the world population (Woods and Woods 1997). It is the least common of the gulls found in the Falkland Islands, although across its patchy distribution on coastal and inland sites, it can be locally quite abundant. Nesting birds are easily disturbed, which could be one reason for the preference for more remote sites. The favoured feeding habitats of brown-hooded gulls are offshore kelp beds and along shorelines, where small fish, *Munida* krill and other invertebrates are taken (Woods 1988).

Terns

Terns (Sternidae) occur in the coastal waters of all continents. Eight species have been recorded in the Falkland Islands, but only the South American tern (*Sterna hirundinacea*) breeds, whilst Antarctic terns (*Sterna vittata*) and Arctic terns (*Sterna paradisaea*) are reported offshore as long distance migrants, and the common tern (*Sterna hirundo*) has been recorded at least once, although it may be present more frequently. The other four species are vagrants from warmer waters. Identification of some tern species is difficult in winter or immature plumage.

South American tern

The South American tern (*Sterna hirundinacea*) is found from southern South America north to Peru and Brazil. The Falkland Islands population is a small proportion of the world population, with a wide distribution and larger numbers around coastal sites from late-September to early-April, while smaller numbers are present through the winter, especially offshore from northern West Falkland (Woods and Woods 1997, White et al. 2002).

In the Falkland Islands, South American terns generally breed in dense colonies, often in association with gulls, on shingle and rocky beaches, peninsulas, rocky points and at inland freshwater ponds. Their food, including lobster krill and small fish, is obtained by hovering and diving into the water, or by collection from the surface of kelp beds (Woods 1988). When nesting, they can be very aggressive towards intruders and may abandon a nest site if disturbed. Any tourism near sites with breeding South American terns should be well managed.

Pale-faced sheathbill

Pale-faced sheathbills (*Chionis alba*) seen in the Falkland Islands are regular, non-breeding, predominantly winter visitors from the Antarctic Peninsula and sub-Antarctic islands (Woods 1988). During winter months, sheathbills feed along shores taking algae and limpets, as well as farm and other wastes. In early summer, they scavenge at albatross, penguin, shag and seal colonies, taking eggs, regurgitate, and faeces. Few sheathbills are seen in the Falkland Islands after December; these tend to wait around shag or penguin colonies and are probably immature, pre-breeders.

Owls - Strigiformes

Owls are mainly nocturnal hunters, with soft plumage, and short and strongly hooked beaks and claws. Two owl species - the barn owl (*Tyto alba*) and short-eared owl (*Asio flammeus*) - are resident and breed in the Falkland Islands, while the burrowing owl (*Athene cunicularia*) and great horned owl (*Bubo virginianus*) have been recorded as rare vagrants.

Barn owl

There are 36 races of barn owl (*Tyto alba*) across the world, with the race *T. a. tuidara* inhabiting South America and the Falkland Islands (Woods 1988). The species is widely distributed in South America and the Falkland Islands population is important only at a local level. The barn owl is a rare species in the Falkland Islands and its distribution is not fully known, due to its secretive, quiet and predominantly nocturnal behaviour. As one of the rarest breeding species in the Falkland Islands, more detailed information on distribution and abundance is required if effective conservation is to be achieved.

In the Falkland Islands, barn owls appear to be strongly associated with human settlements where dense gorse thickets and sometimes buildings provide safe shelter for nesting and where introduced mice and rats are more numerous. Some nests have also been recorded in crevices and cliff overhangs. From analysis of pellets, it appears that mice and rats are the preferred food source, with some passerines and songbirds also being taken (Woods and Woods 1997).

Short-eared owl

There are about eight races of short-eared owl (*Asio flammeus*) in the world, with the Falklands birds recognised as the distinct race *A. f. sanfordi*. It has a widespread distribution across the Falkland Islands but is relatively rare, with tussac islands being strongholds (Woods and Woods 1997).

Offshore islands may have populations of Wilson's storm petrel, grey-backed storm petrels and diving petrels, which are the favoured prey of the short-eared owl. It also takes weevils, camel crickets and small rodents. Short-eared owls construct nests on the ground in thick grasses or below tussac grass and lay two eggs from late September/early October (Woods 1988).

Ovenbirds - Furnariidae

The majority of ovenbirds are dull coloured birds that live in dense vegetation habitats. Over 200 species occur in South America from the tropics to Tierra del Fuego and although 74 species occur in Argentina, only one species, the tussacbird (*Cinclodes antarcticus*), is resident in the Falkland Islands (Woods and Woods 2006). The bar-winged cinclodes (Cinclodes fuscus), widespread in southern Southern America has been seen at least twice since 1991.

Tussacbird

The tussacbird (*Cinclodes antarcticus*) found in the Falkland Islands is an endemic race of the species - *C. a. antarcticus.* The South American race, *C.a. maculirostris*, is slightly larger and is restricted in range to the most southerly islands of South America including the Cape Horn area, Staten Island, Diego Ramirez and islands south of Tierra del Fuego (Woods 1988). The Falkland Islands probably hold a significant proportion of the world population.

In the Falkland Islands, the tussacbird is generally limited in distribution to islands free of cats and rats, but on these islands, it is relatively common (Hall et al. 2002). Its preferred habitats are boulder and sand beaches with kelp, which provide plenty of invertebrate food and which are backed by dense tussac grass, to provide cover and nesting ground. Tussacbirds are famous for their lack of fear when humans are present. Breeding may occur between September and February, with one to three eggs laid, and double brooding is common (Woods 1988).

Tyrant-flycatchers - Tyrannidae

Tyrant-flycatchers are the largest family of birds in South America. Only one species - the dark-faced ground-tyrant (*Muscisaxicola maclovianus*) - breeds in the Falkland Islands, whilst a further eleven species have been recorded as vagrants (Woods and Woods 2006).

Dark-faced ground-tyrant

The dark-faced ground-tyrant (*Muscisaxicola maclovianus maclovianus*) of the Falkland Islands is an endemic race, with a second race (*M. m. mentalis*) found throughout Chile to Tierra del Fuego and Cape Horn. In the Falkland Islands, the dark-faced ground-tyrant is widespread and common in coastal, inland and rocky outcrop areas and around settlements. It can co-exist in small numbers with cats, rats and mice on tussac islands, possibly because it usually feeds on the wing and nests in crevice of caves or cliff sides. Breeding begins in October and lasts until December, and double brooding is common (Woods 1988).

Swallows - Hurundinidae

Nine species of swallow breed in Argentina but only one species, the Chilean swallow (*Tachycineta meyeni*), has been recorded as breeding once in the Falkland Islands. A further eleven species have been recorded as vagrants.

Pipits - Motacillidae

Pipits are ground feeding birds with a worldwide occurrence, with only one species – Falkland pipit - breeding in the Falkland Islands.

Falkland pipit

The Falkland (Correndera) pipit (*Anthus correndera*) is found in the Andean and southern parts of South America. The race *A. c. chilensis* is one of four on the continent, while the race *A. c. grayi* of the Falkland Islands is somewhat larger. Although it is probably resident, there is a slight possibility that some Falkland pipits migrate to the continent in autumn (Woods 1988).

The Falkland pipit is common over a range of habitats, being particularly numerous in areas of open whitegrass, but also on sand beaches, coastal heath and tussac grass paddocks with interspersed low grasses (Woods and Woods 1997). A ground feeding bird, its prey includes a range of invertebrates. Breeding lasts from September to December, with up to three broods recorded per pair.

Wrens - Troglodytidae

Wrens are a widespread family of small birds that live in low dense cover and take small invertebrates from vegetation. Two species are resident in the Falkland Islands: Cobb's wren and grass wren.

Cobb's wren

The Cobb's wren (*Troglodytes cobbi*) is endemic to the Falkland Islands, and has the globally recognised vulnerable conservation status because it is restricted to offshore islands free of rats, mice and cats and has a scattered population within a small geographic range. It is known from 29 islands or islets (Woods 2000b). Its favoured habitat is boulder beaches with accumulated dead kelp and adjacent dense tussac grass. Breeding occurs from October through to December, and pairs probably double brood (Woods 1993, Woods and Woods 1997).

The species feeds on a variety of prey including insects, amphipods, camel crickets and moth larvae. About 20 singing adult males were colour-banded on Carcass Island in 1995 and followed up annually. Mapped sightings showed that they generally remained very close to their original trapping sites and could survive until at least six years old (R. Woods, personal communication).

Grass wren

The grass wren (*Cistothorus platensis*) has a wide distribution throughout North and South America, with many races described, including an endemic race, *C. p. falklandicus*, in the Falkland Islands. The species is widespread but uncommon in the Falkland Islands, with a small total population, due to its requirement of habitat with considerable dense cover. This includes dense tussac grass, whitegrass and cinnamon grass, tall rush, sword grass, diddle-dee and gorse (Woods and Woods 1997).

Population density is highest in tussac grass areas, where a high abundance of diverse insects and seeds, as well as shelter is available. It survives in the presence of rats and cats, probably due to its above-ground feeding behaviour. Breeding occurs between October and early December, with one brood of five to seven eggs produced; there is no evidence that the species has more than one brood. A sample of adult males colour-banded in dense tussac habitat on Kidney Island in 1995, survived at least five years and apparently remained within about 100 m of their original place of trapping (R. Woods, personal communication).

Thrushes - Turdidae

Only one true thrush, the Falkland thrush (*Turdus falcklandii*) is resident in the Falkland Islands, whilst the North American wood thrush (*Hylocichla mustelina*) has only been recorded once as a vagrant.

Falkland thrush

There are two races of Falkland thrush (*Turdus falcklandii*): one in southern Chile and Argentina, and the somewhat larger *T. f. falcklandii* on the Falkland Islands. It is widespread in the Falkland Islands in a variety of habitats, with higher densities on islands free from introduced predators. It also favours inland crags, rocky coasts and areas of human settlement. Thrushes can survive on islands with introduced predators, perhaps because several broods (up to four) are possible each season. A wide range of food, including earthworms, insect larvae, berries and domestic scraps are taken (Woods and Woods 1997).

Buntings - Emberizidae

Four bunting species are recorded in the Falkland Islands, with the black-throated finch (*Melanodera melanodera*) being a common breeding species. The mourning sierra-finch (*Phrygilus fruticeti*) is a rare vagrant, whilst the yellow-bridled finch (*Melanodera xanthogramma*) may be a rare vagrant or represent a former breeding species lost through habitat change (Woods and Woods 2006). The rufous-collared sparrow (*Zonotrichia capensis*) is an occasional vagrant that is becoming more frequent with occasional over-wintering individuals and with the development of further shrub cover, may become established as a breeding resident in the Falkland Islands.

Black-throated finch

There are two races of black-throated finch (*Melanodera melanodera*): one in southern Chile and Argentina and *M. m. melanodera* on the Falkland Islands. Birdlife International formerly classified the species as near-threatened due to a population decline in South America. However, it has since been categorised as Least Concern, due in part to the large and stable population in the Falkland Islands (BirdLife International 2004). It does not appear to be significantly affected by overgrazing but introduced predators seem to reduce populations of offshore islands (Woods and Woods 1997).

In the Falkland Islands, the black-throated finch is widespread across coastal and inland areas on heathlands, open grasslands, beach greens and marram grass dunes, but does not inhabit dense tussac grass areas (Woods and Woods 1997). It feeds on seeds and berries of a variety of plants, and breeds amongst ground vegetation between September and December, with up to three broods being raised.

Finches - Fringillidae

Only one species of finch – the black-chinned siskin (*Carduelis barbatus*) - is resident in the Falkland Islands.

Black-chinned siskin

The black-chinned siskin (*Carduelis barbata*) is found in southern South America and the Falkland Islands, where it is locally common in both inland and coastal areas, particularly on offshore tussac islands and settlement areas that have introduced trees and bushes (Woods and Woods 1997). The species feeds predominantly on seeds, particularly those of tussac grass, wild celery, dandelion and diddle-dee, and also small insects. Breeding occurs between September and December and triple brooding is not uncommon. It nests above ground, in tussac grass, boxwood and other shrubs, and can survive in good numbers in the presence of introduced predators (R. Woods, personal communication).

American orioles

American orioles are a varied family and although 23 species are found in southern South America, only one species, the long-tailed meadowlark (*Sturnella loyca*) is resident in the Falkland Islands.

Long-tailed meadowlark

The long-tailed meadowlark (*Sturnella loyca*) is found in Chile and Argentina southwards from 25 ºS and in the Falkland Islands, there is an endemic race, *S. l. falklandica*. In the Falkland Islands, it is an abundant species with a wide distribution across a range of habitats including white grass, settlement short turf, open and shrubby heath, and open and fringe areas of tussac grass (Woods and Woods 1997). Long-tailed meadowlarks feed amongst vegetation and kelp for earthworms and invertebrates. Breeding can occur between mid-August and January; double brooding is normal and triple broods are not uncommon.

Introduced species

The house sparrow (*Passer domesticus*) and domestic goose (*Anser anser*) are the only two established introduced bird species in the Falkland Islands and neither species are considered to be particularly invasive.

The house sparrow reached the Falkland Islands in 1919 on one or more steamers, probably whaling vessels travelling south from Montevideo, Uruguay (Woods and Woods 2006). Dependent on human settlement for survival, it is locally common around Stanley, with small populations at a number of other settlements and out-houses. Sparrows take a wide range of food items, including plant seeds, fruits and buds, food scraps and animal feed (Woods 1988).

The first domestic geese were probably introduced to the Falkland Islands with the British settlement on Saunders Island in about 1765. Others were introduced later and they have since gone feral and naturalised successfully in several localities, usually near settlements (Woods 1988). Domestic geese naturally graze grass, but the degree of damage that they can cause to habitats is undocumented and likely to be negligible.

Threats

A number of actual and potential processes threaten birds in the Falkland Islands, but due to the lack of knowledge about the habitat requirements of some species, assessing the degree of each threat to all species is difficult. Many processes that threaten birds also affect other flora and fauna groups, thus these threats are collectively discussed in land- and marine-use chapters, as indicated below:

Threat	More information in Chapter
Global climate change	Chp. 1 – Oceanography, geology and metrology
Recreational game shooting	Chp. 2 – Socio-economic characteristics
Egging	Chp. 2 - Socio-economic characteristics
Grazing	Chp. 8 - Land use activities
Shooting to protect livestock	Chp. 8 - Land use activities
Camp burning	Chp. 8 - Land use activities
Nature-tourism	Chp. 8 - Land use activities
Harmful algae bloom	Chp. 9 - Shallow, marine environment
Unsustainable catch of non-target species	Chp. 11 - Offshore fisheries
New food source	Chp. 11 - Offshore fisheries
Removal of food source	Chp. 11 - Offshore fisheries
Oil and plastic pollutants	Chp. 11 - Offshore fisheries
Invasive species	Chp. 12 - Invasive species
Chemical pollutants	This chapter
Wildlife diseases	This chapter
Changes in oceanographic conditions	This chapter

Wildlife Diseases

Birds worldwide suffer from infectious diseases, the effects of harmful algal blooms and accumulation of heavy metals and manufactured chemicals etc. Epidemics of particular diseases such as avian pox and avian flu have caused death of significant proportions of populations of seabirds worldwide. Avian cholera is probably the major cause of the decrease on Amsterdam Island of the yellow-nosed albatross (Weimerskirch 2004). In the southwest Atlantic region, there was an outbreak of avian cholera at one chinstrap penguin colony at South Georgia during November 2004 and in the Falkland Islands, black-browed albatrosses have been suspected to have had or shown to have avian pox in 1962 and 1987 and gentoo penguins were found to have avian pox during the summer of 2005/06 (Munro 2007).

The health of some seabird species has been evaluated in the Falkland Islands. Gross pathology, histopathology, eco-parasites, endo-parasites and levels of heavy metals and radio-activity were determined for a number of rockhopper penguins that died in 1986 and healthy individuals in 1987 (Keymer et al. 2003). In 2003 and 2007, a sample of healthy black-browed albatross, gentoo penguins, rockhopper penguins, and Magellanic penguins were tested for infectious diseases by the Field Veterinary Program of the Wildlife Conservation Society. This work has shown that seabird populations in the Falkland Islands have had remarkably little exposure to infectious diseases compared to populations sampled on the mainland of South America (Keymer et al. 2003; Uhart et al. 2004; W. Karesh, unpublished data).

Necropsies were performed on ten dead black-browed albatross chicks aged less than 22 days collected from New Island in 2006/07. Bacteriology results showed a large number and variety of bacterial growth on nearly all organs swabbed, but none of the detected strains that have been linked with deaths in albatrosses before (Bowgen 2007). No foreign material was found but open skin of all chicks and the ulcers on three chicks had high numbers of the tick *Ixodes uriae*. These ticks may cause irritation, starvation and dehydration and are prime vectors for the transmission of avian pox viruses and other diseases.

This suggests that the Falkland Island seabird populations would be susceptible to many wildlife diseases, and thus tourism and research visitation procedures should not increase the spread or introduction of infectious agents. Some disease outbreaks could potentially be zoonoses, in that the disease can be passed from animals to humans, such as rabies, avian influenza, etc. There is no contingency plan in the Falkland Islands for the outbreak of such wildlife diseases in animal or human populations.

Chemical pollutants

During the late 1970s, the levels of organochlorine (e.g. DDT pesticides) and polychlorinated biphenyls (PCBs) in the eggs of sea, coastal and inland birds of the Falkland Islands were measured. The levels of these persistent organic pollutants in the Falkland Islands were of a magnitude less than that reported for comparable northern Germany species (Hoerschelmann et al. 1979).

The Stuttgart Naturkunde Museum in Germany also has a selection of bird bones from the Falkland Islands, which will be used for a number of different investigations, including residual levels of pollutants (Contact G. Nikolaus).

Bycatch seabirds from fishing vessels in Falkland Island waters have also been sent to the British Antarctic Survey for analysis of heavy metals and other pollutants (Contact - R. Phillips and O. Anderson).

Conservation actions

- **Bird surveys**

Falklands Conservation initiated a second survey of breeding birds in November 2005. As in the privately developed Breeding Birds Survey that led to the Atlas of Breeding Birds of the Falkland Islands (Woods and Woods 1997), this survey aims to cover all 255 10km squares over a period of five years. If it is organised with enthusiasm and encouragement of local people, it could update information on the distribution and populations of the bird species breeding in the Falkland Islands and provide an invaluable comparison with data obtained from the first survey between 1983 and 1992. The survey forms can be obtained from Falklands Conservation.

- **Species Action Plans**

The descriptions of species as above indicate those that particularly require conservation action. Full Species Action Plans will be prepared, adopted and implemented for the black-browed albatross, southern rockhopper penguin, striated caracara and Cobb's wren, and Abbreviated Species Action Plans will be prepared, adopted and implemented for the flightless steamer duck, white-tufted grebe, ruddy-headed goose, white-chinned petrel, southern giant petrel, gentoo penguin and Magellanic penguin.

Full Species Action Plans will detail action required to restore status, while Abbreviated Species Action Plans will be more limited in their scope and may do little more than promote or publicise a species or habitat and facilitate status monitoring.

Currently conservation actions in the Falkland Islands for the black-browed albatross, white-chinned petrel and southern giant petrel are guided by 'Albatross and Petrels in the South Atlantic:

Conservation Priorities', the workshop proceedings of an International Meeting for UK Overseas Territories held in March 2006 (Falklands Conservation 2006a).

- **Important Bird Areas**

The Important Bird Areas (IBA) programme is an initiative of Birdlife International – a global partnership of bird-focused conservation organisations - that works together on shared priorities, policies and programmes of conservation action, exchanging skills, achievements and information. Although Important Bird Areas do not form any part of an international agreement or convention, they have the potential to feed into agreements such as CBD and Ramsar.

Birdlife International aims to conserve birds, their habitats and global biodiversity and to work towards the sustainable use of natural resources. The central secretariat, based in the UK, feeds to a global council, regional committees and regional partners in all unique geographical areas or territories. Falklands Conservation is a Birdlife Partner in the Falkland Islands.

The Important Bird Areas program was created to address the increasing global threat to birds from habitat loss and fragmentation. The program aims to conserve a network of sites that provide critical habitat for birds throughout the world by identifying and documenting these sites to serve as the basis for developing and implementing conservation action at each site. Whilst the inventory of sites does not provide protection *per se*, it has the potential to serve several functions to:

- Assist in the development of national conservation strategies and in particular to identify and conserve areas of high biodiversity value;
- Inform political decision-makers and their advisers at local, national, and international levels of the existence and importance of these vital sites;
- Assist governments in participation in international and regional agreements, such as the Biodiversity Convention and Ramsar Convention;
- Provide information necessary for conservation activities and educational purposes and to identify future priorities for research and survey; and
- Act as a benchmark of current knowledge so that this can be built upon in the future.

IBAs are identified according to a specific standardised set of criteria applied consistently throughout the world. A site qualifies as an IBA if it holds species that trigger one of four specific criteria:

A1 Globally threatened bird species – based on IUCN Red List criteria

A2 Restricted-range species – with distribution of 50,000 km^2 or less

A3 Biome-restricted species – found only within a particular biome, and or habitat

A4 Congregations of significant numbers of birds – based on global population estimates

The area should be amenable to conservation, and as far as possible form an easily defined management unit and the potential to be integrated into a wider conservation and sustainable use approach.

IBA inventories were compiled in the Falkland Islands by Falklands Conservation and/or landowners, using existing data in conjunction with some targeted fieldwork. Twenty-two sites were identified in the Falkland Islands (Falklands Conservation 2006b). The sites cover a total area of 656 km^2, which is approximately 5.4% of the total land area of the Falkland Islands. Although the IBAs are widely distributed around the whole of the Falklands coastline, only five IBAs are situated on East or West Falkland.

The remaining seventeen IBAs consist of islands and island groups, totalling 186 islands and dependent islets. The predominance of island sites is due to the importance of seabirds within the Falklands avifauna and of the threats affecting these species (Falklands Conservation 2006b). Additionally, restricted range species such as Cobb's wren and tussacbird are now limited to offshore, rat free, tussac-covered islands where human impact has been lessened by their inaccessibility.

The 22 IBA sites are:

Beauchêne Island
Beaver Island Group
Bird Island
Bleaker Island Group
Elephant Cays Group
Hummock Island Group
Jason Islands Group
Keppel Island
Kidney Island Group
Lively Island Group
New Island Group
Passage Islands Group
Pebble Island Group
Saunders Island
Sea Lion Island Group
Speedwell Island Group
West Point Island Group
Bertha's Beach (East Falkland)
Bull Point (East Falkland)
Hope Harbour (West Falkland)
Seal Bay (East Falkland)
Volunteer Point (East Falkland)

It should be noted that designation in the Falkland Islands does not change the status or ownership of the land or what can be done with it.

In the Falkland Islands, designated IBAs have not been extended in the marine environment, as has occurred in other countries. However, if Falkland Islands seabird species are to be adequately managed, protection of their habitat must include foraging ranges. Designation of marine IBAs in the Falkland Islands could be based on those areas identified by White et al. (2002) as having particularly high seabird abundance at certain periods of the year.

Chapter 7 - Freshwater life

Freshwater habitats

Analysis of the 255 10-km grid squares containing land across the Falkland Islands shows that only 9% are completely inland (Woods and Woods 1997). A variety of freshwater bodies occur in the Falkland Islands, including coastal barrier ponds, oxbow ponds, glacial tarns and erosion hollows, and slump features in peat. Inland fresh water bodies are especially numerous on peaty lowland areas.

Most of the freshwater bodies in the Falkland Islands are shallow, less than 2 m deep and wind-induced sediment re-suspension is apparent in most standing bodies of water. This often leads to high turbidity and extreme pH values, which effect photosynthesis and planktonic and benthic community development (Noon 2002). Nutrient-rich lakes with dense algal growth are rare, occurring only where there drainage is from seabird colonies or geese grazing areas (Clark et al. 1994).

Deficiency of nutrients and presence of humic acids derived from peat means that most lakes and rivers have a low pH level (4.0 – 5.0), although some are extremely acidic (3.1) (Clarke et al. 1994). Freshwater is high in sodium and chloride, which have a marine origin (Noon 2002).

Many sites lack active inflows and outflows, and are fed through ground water replenishment with wind evaporation possibly accounting for significant moisture loss. Mount Adam Tarn (West Falkland) and Black Tarn (East Falkland) are probably the deepest freshwater bodies, and represent glacial features distinct from most other water bodies.

Freshwater vegetation

Freshwater algae are found growing on substrates in various waterbodies, most especially in flowing streams and rivers, but there has not been any identification of the species present. Common plants found in freshwater bodies include willow herb, Californian club-rush, spike-rush, marigold, water-milfoil, starwort and blink.

Freshwater invertebrates

The invertebrate community in freshwater ponds, streams and rivers in the Falkland Islands have been studied in an ad hoc manner but there is a relatively comprehensive understanding of the general faunal composition at studied sites. Sampling has occurred as part of broad scale ecology surveys (e.g. Clark et al. 1990, 1994), sampling for specific invertebrates (e.g. amphipods, Stock and Platvoet 1991), in conjunction with freshwater fish surveys (R. McDowall, unpublished data) and specific freshwater invertebrate surveys, completed in 1993 by Dartnall and Hollwedel (2007) and in 2001 by Brooks et al. (2005).

While the presence of molluscs, amphipods, caddis larvae, waterboatmen, parasitic cercaria, and truly planktonic rotifers make the Falkland Islands fauna markedly richer than any sub-Antarctic, or maritime Antarctic island, it is nevertheless sparse when compared with other temperate and tropical locations (Dartnall and Hollwedel 2007). The fauna lacks many insects with aquatic larvae, including dragonflies, damselflies and mayflies. There is no evidence that the low abundance and diversity of aquatic invertebrates results from anything other than isolation, low nutrients and generally harsh environmental conditions.

Dartnall and Hollwedel (2007) suggest, based on surveys at 48 waterbodies and other published records, that there are 129 species of freshwater invertebrates in the Falkland Islands, including 79 rotifer, 34 arthropoda, six Platyhelminthes, three gastrotricha, two nematoda, two annelida, two molluscs and one tardigrada, with additionally two arachnid mites (Bartsch 2001). However, the records for and the identification of some species are not agreed between all scientific groups. For example, Pugh and Scott (2002) list five freshwater molluscs for the Falkland Islands and Dartnall and Hollwedel (2007) do not support some of the records of Cladocera reported by Brooks et al. (2005).

Most freshwater invertebrate species found in the Falkland Islands are restricted to Southern Hemisphere or South America. Two endemic amphipods and one endemic stonefly are recognised (Stock and Platvoet 1991; McLellan 2001). But most of the survey reports include unidentified specimens, which may also be endemic species.

Whilst the freshwater fauna may not be particularly diverse, there is a sufficient abundance to support the various freshwater fish and waterfowl present in the waterways. Only the gammarid amphipods, trichopterans, chironomids, cladocerans and copepods) are likely to be important prey (Brooke et al. 2005).

Freshwater fish

The most extensive survey of the freshwater fish of the Falkland Islands was undertaken over five weeks in 1999 when 146 sites were studied (McDowall et al. 2001, 2005). However, coverage was not

exhaustive and many waterbodies remain to be examined to obtain a full knowledge of the distribution of Falklands freshwater fishes.

Six species of fish are found in freshwater and the brackish water in estuaries and in the lower reaches of rivers in the Falkland Islands. The zebra trout (*Aplochiton zebra*) and Falklands minnow (*Galaxias maculatus*) are native species and widely found in freshwater bodies. The brown trout (*Salmo trutta*) is an introduced species that is also widely found in the Falkland Islands. These three species follow a diadromous life cycle but can survive in landlocked water bodies. In addition, three marine fish, mullet (*Eleginops maclovinus*) and two species of smelt/pejerrey (*Odontesthes nigricans* and *Odontesthes smitii*) are also found in the lower reaches and estuaries of streams and rivers in the Falkland Islands.

Two further fish species have been recorded in the Falkland Islands: *G. puyen* (*Galaxias platei* = *Galaxias smithii*) and southern pouched lamprey (*Geotria australis*). However, as these records date from early sampling during the late 1800s and early 1900s and because neither has been recorded subsequently, it would seem probable that the samples were incorrectly attributed to the Falkland Islands.

Zebra trout

The zebra trout is a native species to the Falkland Islands, southern Argentina and Chile (McDowall et al. 2005). The species is widely distributed across southern Argentina and Chile, but its range in The Falkland Islands have become severely reduced in recent years, possibly due to the expansion in range of the introduced brown trout.

The zebra trout is predominantly a mid-water swimming species and can be seen swimming freely in pools and streams. It does not appear to hide amongst boulders or under banks. Very little is known about the life history of the zebra trout. It seems probable that it spawns in freshwater in autumn near where they normally live and larvae are carried downstream into the sea. The larvae feed and grow as marine plankton for several months before returning to freshwater. The zebra trout has also been found in landlocked freshwater, completing its entire life cycle there without migrating. Its diet consists of Falklands minnows, caddis flies and amphipods and (Perry 2007).

Throughout the surveys, on only two occasions have zebra trout been found co-occurring with brown trout (McDowall et al. 2001). It appears that brown trout returning to freshwater to breed out compete and prey upon zebra trout and as the spread of brown trout continues, it appears inevitable that zebra trout will become extinct in the Falklands except in some landlocked waters. Brown trout can also survive in landlocked freshwater but are unlikely to thrive in small landlocked ponds that lack the tributary streams with coarse gravel substrates required for spawning.

Falklands minnow

The Falklands minnow is widely distributed in freshwater habitats in the Falkland Islands, especially in the lower reaches of streams. The species is found widely across the cool temperate zone of the southern hemisphere, including South America, Australia and New Zealand. Genetic testing shows that the distribution of the species is due to marine dispersal (McDowall et al. 2005).

Falklands minnows are most often found in gently flowing waters swimming in mid water in small loose shoals, generally not far upstream from the sea. There are also some populations in lakes and ponds throughout the islands. The life history of the minnow has been studied across its range but not specifically in the Falkland Islands.

Spawning is typically in autumn when mature (one year old) fish move downstream until they encounter the salt wedge in the stream estuaries. The migration often occurs at the time of spring tides when the rising tide floods across the estuary banks allowing the minnows to spawn amongst the bank vegetation.

After spawning, adults probably die, whilst the eggs develop on land amongst the vegetation where plentiful moisture stops the eggs from dehydrating. In the cool temperature of the Falkland Islands, the eggs probably take three to four weeks to develop and during the next very high tide are washed from the vegetation and dispersed to sea (McDowall et al. 2005). Little is known about the marine life of the larvae, but it is assumed that they live in the surface waters.

The larvae spend the winter at sea feeding and growing, and the young fish begin to return to freshwater during the following spring. Minnows returning from the sea are translucent (because they lack haemoglobin), which is a possible adaptation to reduce visibility in the marine habitat. Upon returning to freshwater, the fish change from using haemocyanin to haemoglobin and rapidly develop colour. The diet of the Falklands minnow is predominantly amphipods and chironomids (Perry 2007).

Whilst the species generally follows a diadromous lifecycle, they are also found in landlocked lakes and ponds. The adjustments in behaviour to facilitate this adaptation are not known.

No fishery for Falklands minnow exists as in other countries where returning juveniles are targeted.

Brown trout

Brown trout were introduced to the Falkland Islands through several consignments of British and Chilean eggs and fry being released in various rivers from 1946 through to 1952. They quickly became established in the release rivers and estuaries by 1957 and since then have gradually extended their range through the archipelago due to their adaptability and sea going habit (McDowall et al. 2005). The locally referred to rainbow trout is merely a more brightly coloured brown trout, more common in the peaty upper reaches of rivers. It is assumed that with time, the brown trout will colonise all waters

with the exception of some small landlocked ponds that lack the necessary aerated gravel substrates for spawning.

During autumn, brown trout migrate up river to gravel beds in smaller headwater streams to spawn. Eggs develop over winter and hatch during the spring. The young alevins remain associated with the gravel beds until the yolk sack is spent, after which they move into the streams to feed and grow. It is assumed that their main food is chironomid larvae and amphipods (McDowall et al. 2005; Perry 2007).

Some young will migrate downstream to the sea, whilst others will remain to feed and grow in freshwater. Those that migrate to the sea will probably spend several years feeding and growing rapidly, some possibly moving in and out of the river estuaries on a daily basis, until they eventually move back into freshwater to spawn. After spawning, the adult fish will move back down river to the sea where food supplies are richer.

The brown trout is a generalised carnivore and in the Falkland Islands feeds on amphipods, krill, molluscs, small fish and insects including chironomid larvae and pupae, caddisfly and stonefly nymphs (McDowall et al. 2005; Perry 2007). Sea run trout are much larger than trout resident wholly in freshwater due to the impoverished food resources in rivers in the Falkland Islands. A study of the diet of brown trout and zebra trout at one site in East Falkland found no evidence of brown trout predating on zebra trout or Falklands minnow, though the salmonids examined were mostly small (< 250 mm) (Perry 2007).

The brown trout population is currently expanding and as a non-native species is causing significant impact on the populations of native zebra trout, which is in danger of extinction in much of its former range, in the Falkland Islands and in South America. Perry (2007) suggested that, while salmonid predation may be important amongst the larger size classes, resource competition particularly as competition for food is the main cause for the apparent displacement and decline of native galaxiids.

The brown trout fishery is an important recreational asset to the Falkland Islands. Many residents of the islands, as well as military personnel and overseas tourists, fish for trout. There is a small scale supply of trout to people and restaurants via one local company (Falklands Fresh) as well as by local anglers.

Rainbow trout (*Oncorhynchus mykiss*), brook char (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) were also released into waterways in the Falkland Islands, but they did not become established.

Smelt

Two species of smelt are present in the Falklands: *Odontesthes smithii* and *Odontesthes nigricans*. Both species are found widely in southern Argentina and Chile, and in the Falkland Islands, they are thought to be widely distributed, but there is little information on their range or biology (McDowall et

al. 2005). They are primarily an inshore coastal and estuarine species that feed on crustaceans and small fishes and may be an important prey species for some bird species.

Mullet

The Falklands "mullet" (*Eleginops maclovinus*) belongs to the family Nototheniidae or Antarctic cods. The Falklands mullet is a stout bodied fish widely distributed in rivers and estuaries along the South American coast as far north as Uruguay on the east coast and Talcahuano, Chile on the west coast (McDowall et al. 2005). In the Falkland Islands, it is found primarily in shallow coastal waters in river estuaries and coastal lagoons and is also occasionally caught in deeper waters by the commercial fishing fleet.

The mullet is a benthic-living omnivore that feeds on a range of benthic fauna and flora including polychaetes, crustaceans and macro-algae in tidal estuarine areas. Since 2000, a small artisanal beach seine fishery for mullet has existed and a long-term research project was undertaken by the Fisheries Department to investigate the biology and standing biomass of mullet in the Falkland Islands (Brickle et al. 2003b).

This research has shown that mullet exhibit protanderous hermaphroditism, that is the fish start life as males and then turn into females. Fish that are smaller than 40cm are predominantly male, whilst fish greater than 50 cm are female (Brickle et al. 2003b). Mullet have small eggs and a high fecundity, and it is probable that the change to female at larger sizes is an adaptation to maximise the female reproductive success and fecundity allowing mullet to take advantage of an environmental niche.

The inshore marine water of the Falkland Islands has a poor diversity of fish species and may not be a favourable environment for fish. Part of the reason for this may be the periodic changes in salinity and temperature due to rainfall. Rainfall and runoff are detrimental to the survival of juveniles and may be one reason why mullet spawn in deeper water (Brickle et al. 2003b). Mullet are omnivorous and due to the lack of competition, the species has a high growth rate. The only other large fish that may compete in inshore waters in the Falkland Islands is the relatively recently introduced brown trout.

Parasite, physical tagging and recapture experiments suggest that smaller fish (< 45cm) remain resident in the bays and estuaries, whereas larger fish may migrate to deeper water (Brickle et al. 2003b). There is an absence of larger commercial fish in winter. Larger fish return to inshore creeks in August to feed before they spawn in September in slightly deeper waters. The inshore niche is taken over by the juvenile- and medium-sized fish, perhaps to avoid food competition and cannibalism with adults. In October, November and December, the number of larger fish present in the lower reaches of streams increases steadily as larger fish return downstream after spawning.

At present levels of exploitation, there is no perceived risk to stock sustainability. If, however, the level of exploitation were to grow, careful monitoring would be required as the commercial fishery targets fish of greater than 50cm, which are the reproductive females (Brickle et al. 2003b).

Threats

A number of threats have been identified for freshwater life, particularly for the endemic fish, in the Falkland Islands. These include intensive grazing and associated damage to streamsides, changes to water quality due to the pollutants (e.g. effluent from homes, and livestock sheds), physical changes to watercourses (such as installation of culverts, creation of dams, removal of water), accidental or deliberate introduction of trout or other fish to trout-free rivers, or introduced pathogens or algae and unsustainable fish catches. The effect of the predicted change in climate, including higher levels of rainfall, on freshwater fish should be investigated.

The zebra trout is fully protected under the Conservation of Wildlife and Nature Ordinance 1999. The Falklands minnow appears able to co-exist with brown trout, albeit at a possible reduced abundance (McDowall et al. 2001) and although there does not appear to be any significant present threats, the situation should be monitored.

Brown trout are protected but six trout may be caught daily by rod and line from September 1st until April 30th. Under the Murrell River Fishing Regulations 2006, the Murrell River has a daily bag limit of three trout and each fish must weigh over 1.5lb or 0.5kg, and fishing is not permitted off the culverts or within 100m of the culvert crossing on either side or upstream of Drunken Rock Pass.

Recreational fishing does have the potential to cause environmental problems in the Falkland Islands, due to vehicle damage accessing sites, loss of fishing gear, general littering and the threat of introducing new species to waterways via fishing gear used outside of the islands. The Falkland Islands is free of all invasive freshwater alga and fish diseases, but algae in particular can survive on dry fishing line and felted waders. All gear should be checked, cleaned and dried before use in the Falkland Islands. The biosecurity risks associated with invasive freshwater organisms associated with fishing gear is highlighted in the Falkland Islands Trout Fishing poster.

Recreational sport fishing in salt water is not licensed, and commercial fishing and hand netting is regulated under fisheries legislation. A small mullet netting fishery was established in 2000 in creeks in the Goose Green, North Arm and Port Louis areas. Annually, 10 to 61 tonnes of fish are caught, catch reports are sent to the Fisheries Department and the fishery is sustainable (Brickle et al. 2003b). The market, which is local, is relatively small.

Little water is removed from streams and rivers in the Falkland Islands, with the largest amounts taken for potable water needs for Stanley and Mount Pleasant Complex. The protected zebra trout species is not known to live in either catchment where water is taken.

Conservation Actions

A Species Action Plan for zebra trout is also currently being prepared, including seeking local and external funds for monitoring surveys and studies of zebra trout reproductive biology and life history, and behavioural interactions between zebra trout and brown trout. McDowall et al. (2001) suggested that Red Pond at Port Howard and Horse Paddock Pond at East Bay (both West Falkland) should be special protected areas.

Tasmanian and New Zealand Galaxias Action/Recovery Plans (Jackson 2004; DOC 2005) include the following actions:

- Protecting existing populations by determining current geographic range and abundance, surveying for new populations and identifying requirements and threats
- Determining and addressing information gaps relevant to management
- Maximising the number of populations and/or area of occupancy by protecting habitats and migratory pathways and determining population trends and range contraction/expansion
- Determining species genetic structure and then maintaining species genetic structure and diversity
- Increasing public awareness and involvement in the recovery process

In the Falkland Islands, the zebra trout is one of three species under trial as part of the Falkland Islands Development Corporation's Aquaculture Programme. The possibility of captive breeding and growing fish in tanks is currently being investigated, and the research programme also includes studying the distribution and habitat requirements of the species.

Chapter 8 - Land Use Activities

Introduction

The major land uses in the Falkland Islands, apart from settlement infrastructure, are sheep and cattle farming, mineral exploration, military defence and nature-based tourism, as well as recreational off-road driving and shooting, and bird egg collecting. The commercial land use activities are discussed below and the social land-use activities are covered in Chp. 2.

There are few manufacturing activities in the Falkland Islands, the largest being the EU accredited export meat plant at Sand Bay 10 km south east of Stanley. The abattoir was established in 2003 and processes approximately 35,000 sheep and lambs annually for export and local markets. Animal waste is dumped from a rocky ledge at Port Harriet into the open ocean through a licence issued under the Environment Protection (Overseas Territories) Order 1988. A small scale tannery, using non-hazardous chemicals, began operations at Hill Cove (West Falkland) in 2007.

Historical farming

Wool production was the key economic activity of the Falkland Islands up until the development of the fishing industry in the late 1980s and the majority of the land is still devoted to extensive ranch-style sheep farming. Farming began in the Falkland Islands when Louis Antoine de Bougainville landed seven heifers, two bulls, three horses, one goat plus a few pigs and sheep in 1764 (Palmer 2004). Sealers continued this trend, placing animals on many off-shore islands to provide a source of food. Some of the earliest records of stock numbers in the Falkland Islands stated that there were 78 sheep and 80,000 cattle on the Falkland Islands by 1847 (Cawkell et al. 1960).

The cattle were almost exclusively left wild on the open grasslands, with an additional domestic herd of 400. By 1900, the cattle population had been reduced to around 5 - 10,000 head, and it has remained close to this level ever since, with some 6,000 cattle in 2006/07 (Fig. 8.1). However, the commercial value of beef has been realised in recent years and many farmers are now working to increase their herd size and quality (Department of Agriculture, personal communication). Cattle tend to be less selective than sheep and this may allow a level of grazing that is more sustainable.

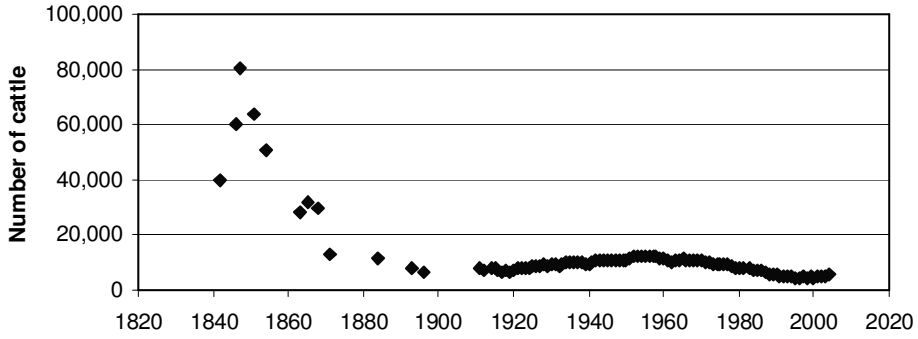


Fig. 8.1 Trend in number of cattle in the Falkland Islands (Annual farming statistics, 1935-2004)

As the number of cattle reduced, the population of sheep rapidly expanded, and peaked at around 800,000 in 1898, after which it declined to around 600,000 in the 1950s, where it has since remained (Fig. 8.2). Cawkell et al. (1960) attributed this pattern to early favourable wool prices and rich pastures, and then subsequently, reduction in pasture quality due to poor long-term farming practices, including the indiscriminate burning of camp (using the logic that sheep prefer new young shoots of white grass), overgrazing of all habitats, in particular the rich tussac fringe, and little or no stock control.

Currently there are approximately 530,000 sheep in the Falkland Islands, producing a wool clip of 2,500,000 kg greasy, of an average 26 microns quality (Department of Agriculture Farming Statistics 2006/07). Lambs and surplus sheep are sold to the abattoir.

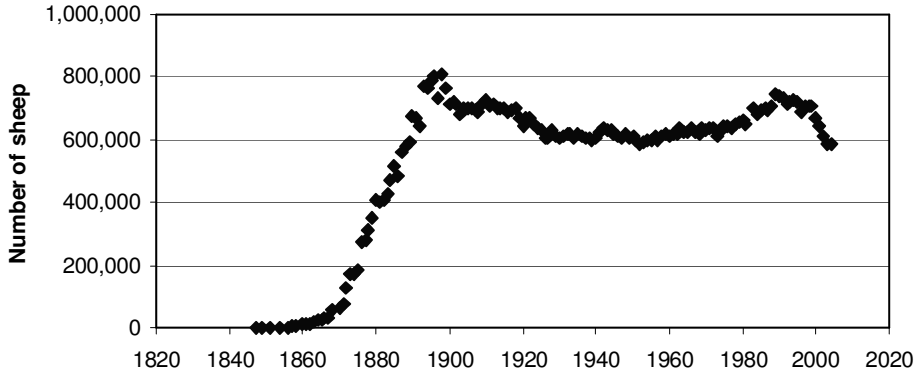


Fig. 8.2 Trend in number of sheep farmed in the Falkland Islands (Cawkell et al. 1960; Annual farming statistics, 1935 - 2004).

At various stages, a number of other agricultural livestock have been introduced to the Falkland Islands, including goats, pigs, various fowl and reindeer. Currently, there are a total of 502 goats in four flocks in the Falkland Islands, two on East Falkland and two on islands, and a total of 171 pigs (Department of Agriculture Farming Statistics 2006/07). Two separate programmes of importing reindeer (*Rangifer tarandus*) from South Georgia have resulted in one reindeer in Stanley, 10 castrated males on Weddell Island, a herd of 16 in the Cape Meredith (southeast West Falkland) and 98 animals on Beaver Island (Department of Agriculture Farming Statistics 2006/07). Most livestock in the Falkland Islands are actively and responsibly managed for agriculture. However, some livestock are managed poorly or not at all, which are identified as invasive species and are discussed further in Chp. 12.

Around 30,000 ha of farmland had been improved by the mid-1960s, but during the 1970s and 1980s, the rate of pasture improvement slowed (Fig. 8.3) (FIC archives; Annual farming statistics, 1935-2004). This included burning, rotovating, and reseeding of more productive grasses, cereals and crops. During the 1990s and 2000s, pasture improvement programmes and alternative grazing systems were reinstated, with to date as much as 40,000 ha (although only representing 0.3 % of total farmed land) under active 'improvement' to increase the carrying capacity and improve the quality of the stock for both wool and meat production. Only 3,685 ha of improved pasture have been laid down in the last 10 years (Department of Agriculture Farming Statistics 2006/07).

Improvement practices have included cropping of swedes and turnips for winter feed, general cropping of oats, triticale and other cereals, active legume cropping through rotovating, addition of rock phosphate and calcified seaweed, legume cropping by direct drilling and broadcasting on whitegrass habitat, subdivision fencing and small scale burning.

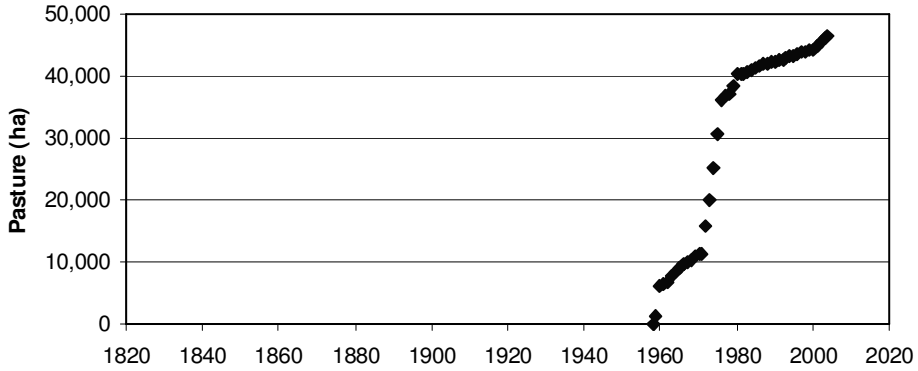


Fig. 8.3 Trend in pasture improvement in the Falkland Islands (FIC archives, Annual Farming statistics, 1935-2004).

Overall stocking rates have decreased since the widescale sub-division of the farms during the late 1980s, due to changes in farming practices. However, with pasture improvement programmes, smaller paddocks and rotational grazing (mob-grazing), there may be periods of high stocking in certain

areas/periods. The smaller farm profitability margins also led to reduced rates or removal of stock from small, outer islands.

Agriculture today

Many farmers are now taking an active interest in conservation and perceptions and attitudes about land management and conservation of wild species have changed rapidly over the last five to ten years. Many farmers now have habitat restoration projects and other active conservation projects on their land.

Grazing pressure across areas and habitats is not uniform, and some areas are more productive for and also preferred by sheep and cattle, including the coastal margins, and the sheltered and generally fertile valleys (Kerr 2002). Relatively little of the coastline is fenced, and livestock are free to graze on coastal vegetation, including on tussac grass, which has been become absent along most coastlines on the larger islands. The underlying tussac peat is highly susceptible to erosion once the overlying vegetation cover is removed and large patches of eroded land can be found along some coastlines in the Falkland Islands.

The traditional system of agricultural management is a low intensity, low management system, which places an unequal amount of grazing pressure onto the more palatable native plant species. Approximately 0.3% of the farmed land in the Falkland Islands has any active pasture improvement by the addition of non-native species, chemicals or mechanical disturbance. Plants for agriculture purposes are exempt from import restrictions, but to date the majority of non-native species have not caused any major ecological impact. The current programme is not thought to affect wildlife, except at a very local scale.

Apart from pasture improvement programmes, rotational grazing has been piloted at some farms since 2004, which forces livestock to eat less desirable plant species, as well as the more palatable species. Heavy grazing pressure opens up the large amounts of dead vegetation, allowing sunlight to penetrate onto more productive finer grasses, which can then start persisting between the large grass bogs. However, the greatest benefit from rotational grazing is the rest periods for the plants, allowing them to re-grow and set seed without grazing animal interference.

Early results suggest increased productivity in wool and meat production, although some problems and negative effects were also noted (Department of Agriculture 2006). The effects of rotational grazing on livestock, pastures and wildlife will continue to be closely monitored, including as part of the Falklands Conservation ‘Plant Conservation Programme 2007 - 2009’.

Burning of camp is still carried out during early spring, particularly in Lafonia. Generally one to six areas in the region of 100 - 300 ha are burnt lightly in a controlled manner. The Grass Fires Ordinance was enacted in 2002 after considerable damage was caused by a number of fires that got out of control

during the dry year of 2001. Fires may be started between 1 April and 15 September without permission but during the closed season, permission to burn areas on specific dates must be sought from the Department of Agriculture, who seeks guidance from the Fire Service. Generally, the Fire Service does not give approval after October/November, depending on the condition of camp and weather conditions.

The short-term and long-term effects of camp burning are not well understood in the Falkland Islands. The only assessment of the effects on agricultural productivity showed that burnt whitegrass pastures were greener, more digestible and were grazed preferentially by sheep for up to 18 months post fire, after which time period, burnt pastures returned to their pre-burnt rank state (McAdam 1984). The timing of camp burning occurs during the early egg laying period for many ground nesting birds such as South American snipe, Falkland pipit, rufous-chested dotterel and black-throated finch.

Fortunately, the Falkland Islands is free of sheep external parasites and internal parasites are not very common, which means that sheep are not dipped or drenched at any stage in their lives. Nor are growth promoters, high impact lot feeding and grain finishing used in meat production. In fact, few, if any, chemicals need to be used on any farms in the Falkland Islands. Two organic farms in the Falkland Islands are certified under the domestic Organic Food Ordinance 2000, which follows the European Commission Regulation 2092/91.

Threats from agricultural activities

The effects of Falkland Islands agricultural practices on species and habitats can be difficult to quantify and are very dependent on the species composition, topography and stocking management of the area.

- Grazing

Livestock grazing hardens soil, which potentially increases the risk of fire and soil erosion, as well as changes in vegetation and invertebrate structure and composition. Habitats and species most affected by grazing include tussac grass, scrub habitat, fachine, native boxwood and snake plant (Broughton and McAdam 2002c). However, under low grazing pressure by horses only, such as on Cape Pembroke, these species and habitats respond well. Compared to lightly grazed pastures, heavily grazed pastures have less plant diversity and although intensive grazing in the summer months produced a grassier and more productive sward, these species were almost always non-native, whilst native species diversity was reduced (Kerr 2002).

Early results of a new system of rotational grazing suggest that native species such as mountain blue grass and cinnamon grass are returning to areas where they have not been seen for some time (Department of Agriculture, unpublished data).

The effect of grazing on birds in the Falkland Islands is somewhat difficult to determine. Joint research by the Department of Agriculture (DoA) and Falkland Conservation on landbird abundance on an

intensively and rotationally grazed whitegrass pasture was conducted during the period 1995 – 2000 but the results of the study were not reported.

- Camp burning

The effect of controlled and regulated camp burning are not well understood, both economically and environmentally. However, uncontrolled fires are of greatest threat, whether started naturally or when camp fires become unmanageable and burn across extensive areas and enter deep peat beds. Since the regulation of camp fires, there have not been as many uncontrolled fires, although conditions have not been as dry as during 2001/2002.

- Shooting of native wildlife

Two groups of birds - raptors and geese – interact with agriculture. During most of the 1900s, upland geese were culled as it was thought that they competed with the sheep and a bounty was paid for over 500,000 upland geese beaks delivered to FIG (Palmer 2004). These days, in some areas, geese cause problems by consuming seeds and seedlings planted to improve pasture quality. However, advice on the sighting of reseeds may not always have been heeded.

Historically, all birds of prey, but most particularly striated caracaras and turkey vultures, were also shot, as it was perceived that the raptors preyed on livestock, both on weakened or injured sheep and lambs, as well as healthy animals. This tradition led to the extinction of the striated caracara on East Falkland and near extinction on West Falkland (Woods and Woods 1997).

Only upland geese and domestic geese may be shot without a licence in all areas of the Falkland Islands except on National Nature Reserves. Licences may be obtained under the terms of the Conservation of Wildlife and Nature Ordinance 1999 for the culling or control of certain species, if there is damage to property or livestock that results in operational or financial loss. Licences are considered on an individual case-by-case basis with due regard to the species and the form of interaction occurring, and each licence is specific for area, methods and time over which a set number of offending species can be killed.

Four licences for 20 turkey vultures each were issued during 2006, whilst a licence for five striated caracaras was issued in 2004 and again in 2005. Recent population surveys of striated caracaras and turkey vultures conducted by Falklands Conservation may be useful to guide the FIG policy of issuing licences to shoot raptors on agricultural land.

Onshore mineral exploration/exploitation

The first assessment of the economic potential of the Falkland Islands geology was undertaken in the 1920s but there were no encouraging results. In ancient times, the Falkland Islands was joined to South Africa along the margin of the Gondwana super-continent and there are striking geological similarities between Falklands geology and South Africa's Cape Fold Belt and Karoo Basin (see Chp. 1). This has

led to speculation that the Falkland Islands might contain mineral deposits of the same style as the well-known, world-class African examples and since 1998, with improved exploration techniques and technologies, more extensive surveys have taken place in the Falkland Islands, primarily for diamonds, gold and calcified seaweed.

One intriguing possibility is the extension of the southern African diamond-bearing kimberlite province into the Falkland Islands. Recent exploration activity has found some possible diamond-indicator minerals such as chromite and garnet, although doubt remains as to whether the precise chemistry of these minerals is indicative of an origin in a kimberlite pipe (Department of Mineral Resources web site).

There is also good prospect for gold mineralisation in the Falkland Islands as the break up of Gondwana involved massive, crustal-scale dislocation and widespread magmatism. Gold grains have been panned from a number of Falklands streams, suggesting that the grains have not travelled far from their bedrock source. Intensive exploration by Falklands Gold and Minerals Ltd. has occurred at a number of sites north of Goose Green and on West Falkland during 2004 – 2007, involving trench/drill sampling.

In the Falkland Islands, mineral exploitation is controlled under both the Planning Ordinance and various Mining Ordinances and consideration can be given for the completion of an Environmental Impact Assessment. The current exploratory gold drilling programme includes a requirement for all drill holes and trenches to be refilled immediately following sample collection and the vegetation and top soil is kept separate from soil/peat to facilitate rehabilitation. Mineral extraction is not likely in the near future and it is not known what form of extraction may be used.

Calcareous red alga accumulates on some beaches in the Falkland Islands and during 1998 - 2003, the Department of Mineral Resources and Falkland Islands Development Corporation investigated the feasibility of calcified seaweed extraction to use as a fertiliser for pastures (Stone et al. 2003). Extraction licences were issued to extract material from the back of the beaches at Spring Point and Shallow Bay, West Falkland and Ruggles Bay, East Falkland. A total of 3,704 tonnes were extracted between 2001 and 2004 at the three sites and further extraction is planned for Spring Point.

No significant impacts were predicted by an Environmental Impact Assessment for the Spring Point extraction (Ingham 2000) and no effects were noted after the first year of extraction at Ruggles Bay (Environmental Planning Department, unpublished data). The carting of the calcified seaweed from the beaches to the road network has caused some damage to camp, although it is not expected to be long-lasting damage.

Military issues

The Ministry of Defence (MoD) operates a joint army, airforce and navy base at Mount Pleasant Complex (MPC), a port nearby at Mare Harbour, five manned remote sites for monitoring, refuelling and training. All MoD operations must meet the strictest environmental legislation, which is generally UK legislation rather than domestic legislation in the Falkland Islands.

There are a few military activities that have the potential to affect native species in the Falkland Islands. There is some use of Hagglund BVs that, due to their weight (6 tonnes) and wide caterpillar wheels, can cause significant damage to sensitive areas, such as montane, wet and coastal habitats and where soft peaty soils exist.

There is also the threat of fire during ordnance disposal, as occurred on South Jason Island in 2001. Whilst certain precautions are used by the military, the nature of this task means it is not always possible to guarantee fire prevention.

Operation of remote sites was previously facilitated by the use of a Chinook helicopter, which can transport heavy loads, including loaded shipping containers. However, MPC has been without a Chinook helicopter for the last 12 months and this has created a number of logistical problems. Road access to two military sites on West Falkland has been upgraded to allow the safe transport of goods by road rather than by air.

The MoD employs an Environmental Officer at MPC, who facilitates environmental management across all the MoD sites and activities, and liaises with FIG and other organisations on various environmental issues.

Nature-based tourism

Tourism is now a well-established industry in the Falkland Islands and the cruise ship sector in particular has grown considerably in recent years. The Falkland Islands Tourist Board (FITB) was established in 1985 to promote tourism in the Falkland Islands. Considerable efforts have been made by FITB, FIG and the Falkland Islands Development Corporation (FIDC) to develop the industry both through marketing and through assistance in providing accommodation in areas close to the main attractions. The appeal in the predominantly European and North American markets is of an unspoilt coastal and marine environment of very high nature conservation interest, where it is possible to observe wildlife in a close and intimate manner. However, by marketing this level of interaction, the industry must be well managed if it is to be sustainable in the long term.

The rapid increase in the level of tourism in the Falkland Islands has raised concerns that negative effects on the flora and fauna of the Falkland Islands may occur. However, the amount of visitor exposure at one wildlife colony in the Falkland Islands during 2001/02 was less than that reported at one site on the Antarctic Peninsula (Otley 2005). Strange (1990) carried out the first assessment of the

environmental impact of tourism in the Falkland Islands and many of his recommendations are equally relevant today and were endorsed by subsequent assessments by Summers (2000) and Ingham and Summers (2002).

However, until very recently, tourism has not been considered to be an important economic industry or to have the potential to affect the environment and as such, few recommendations identified in the reviews of, and strategies for, Falklands tourism have been implemented (Ingham and Summers 2002; FITB 2002).

In 2001, a Falkland Islands Countryside Code was adopted by FIG and the code is incorporated in visitor information.

1. Always ask permission before entering private land.
2. Keep to paths wherever possible. Leave gates open or shut as you find them.
3. Be aware of the high fire risks throughout the Islands. Be extremely careful when smoking not to start fires. Take cigarette butts away with you.
4. Do not drop litter*. Take your rubbish home with you.
5. Do not disfigure rocks or buildings.
6. Do not touch, handle, injure or kill any wild bird or other wild animal*.
7. Never feed wild animals.
8. Always give animals the right of way. Remember not to block the routes of seabirds and seals coming ashore to their colonies.
9. Try to prevent any undue disturbance to wild animals. Stay on the outside of bird and seal colonies. Remain at least 6 m (20 ft) away. When taking photographs or filming stay low to the ground. Move slowly and quietly. Do not startle or chase wildlife from resting or breeding areas.
10. Some plants are protected and should not be picked*. Wildflowers are there for all to enjoy.
11. Whalebones, skulls, eggs or other such items may not be exported from the Falkland Islands*. They should be left where they are found.

* Such actions (with a few special exceptions) may constitute an offence in the Falkland Islands and could result in fines up to £3,000.

Cruise ship tourism

Cruise-based wildlife tourism began in 1968 in the Falkland Islands by eco-tourism pioneer Lars-Eric Lindblad and local landowners Ian Strange and Roddy Napier with itineraries based around West Point Island, Carcass Island and New Island. There was a relatively low level of cruise ship tourism in the Falkland Islands during the 1970s, 1980s and into the 1990s, with small expedition cruise ships (<200 passengers) most common and the cruise ship passenger numbers did not exceed around 4,000 passengers annually (Ingham and Summers 2002). Since 1997, cruise ship passenger numbers have increased significantly and in 2006/07, a record of 41 different cruise ships made 182 calls within the

Falkland Islands bringing 51,282 passengers (FITB 2007a). The annual rate of increase in cruise ship passenger numbers between 2000 and 2007 was between 1 and 26% (FITB 2007a).

Cruise ship tourism in the Falkland Islands is categorised by the size of the vessel, the nature of the itinerary and the interests of the passengers onboard (Ingham and Summers 2002). Expedition vessels, the pioneers of the Antarctic cruise industry, carry fewer than 200 passengers and have an environmental and educational focus and the passengers generally have a high awareness of environmental issues. Large cruise vessels are defined as carrying between 400 and 800 passengers and although there is greater focus on entertainment and quality of onboard service, they are of a size that still permits access to wildlife sites, and land excursions are offered.

Luxury cruise vessels have a capacity to carry more than 800 passengers and these vessels can only access ports where there are established facilities for tender operations and thus visits are limited to Stanley. These vessels are often en route between Buenos Aires/Rio de Janeiro and Valparaiso and offer a far cheaper cruise compared to the expedition and large cruise vessels, which may mean that comparatively passengers on the luxury vessels have a lower interest and awareness of the environment (Ingham and Summers 2002).

During the 2006/07 season, 50% of the cruise ship visits to Stanley were of small expedition cruise ships carrying 9% of the total passengers and 22% of the ship visits were by larger cruise vessels (200-800 passengers) with 16% of total passengers (FIG Customs data). Although 28% of ship visits were of luxury cruise vessel category, this vessel type brought 75% of the total passengers cleared to land in Stanley.

The level of awareness of the environment and the potential impact of visitor numbers is related to some extent to the type of vessel. Vessels with less than 500 passengers and vessels with 500+ passengers that cruise but do not make landings in the Antarctic may join the International Association of Antarctic Tour Operators (IAATO) and thus must follow the strict environmental and visitor management regulations agreed by full members of IAATO. This includes specific wildlife approach distances for visitors on foot, swimming and in zodiacs, total numbers of passengers ashore at any one time and passenger-guide ratios.

Only two of 27 vessels that were scheduled to call at sites outside Stanley during the 2006/07 season were not IAATO members and these two vessels had 600 – 850 passengers and have their own environmental policies, which are in fact not dissimilar to IAATO regulations. For vessels with large passenger numbers, with the often lower level of environmental awareness and the large scale of the operation, the tight supervision of larger numbers of passengers ashore becomes more difficult. IAATO vessels began completing post-visit reports during the 2006/07 season and this will be continued, and extended to the non-IAATO vessels, during the 2007/08 season.

The most popular sites in camp are Carcass Island, New Island and West Point Island (Table 8.1). Of 91 visits to camp by cruise vessels during 2006/07, only eight visits were made by four different vessels with more than 300 passengers, of which two were IAATO registered (Customs data). However, this does not include data on numbers of ship-based tourists that visit some wildlife sites close to Stanley, such as Gypsy Cove, Kidney Cove and Bluff Cove.

Table 8.1 Numbers of cruise ship visits and passengers cleared to land at nine sites in the Falkland Islands in the season 2006/07 (FITB 2007a)

Site	No. cruise ship visits	No. of passengers cleared to land
Stanley	91	50, 781
Carcass Island	27	2,402
New Island	24	2,282
West Point Island	17	3, 415
Bleaker Island	7	553
Steeple Jason Island	6	591
Sea Lion Island	4	212
Saunders Island	3	219
George and Barren Islands	3	262

Private yacht tourism

There are currently few yachts making recreational or commercial trips around the Falkland Islands but there is significant potential for development in this sector. Three yachts that advertise charter work in the Falkland Islands are IAATO members. The 'Falkland Islands Ports and Harbours Booklet', which is given to Captains of all vessels, highlights biosecurity issues, the need to seek landowner permission and the Falkland Islands Countryside Code.

Whale-watching tourism

There is little commercial or recreational "whale-watching" in the Falkland Islands, due to the windy weather and a lack of available and suitable vessels. Worldwide, there has been considerable advance in whale-watching research in recent years, with some studies showing that whale-watching can have behavioural impacts, which translate into biologically significant effects for populations (Scarpaci et al. 2007). Therefore, any commercial whale-watching ventures in the Falkland Islands should be closely monitored and regulated, if required.

Land-based tourism

The number of land-based visitors to tourism sites in the Falkland Islands, including residents, military personnel and overseas tourists, is difficult to determine annually and thus subsequently to identify trends over time. The number of independent visitor arrivals by air over the last ten years has fluctuated between 1,000 and 1,600 visitors annually, and is increasing over time at a very slow rate

compared to the cruise ship sector (FITB 2007b). Land-based visitors are transported between sites by vehicles and by aircraft. The effects of these forms of travel are discussed in Chp. 2.

Current land-based visitor numbers to Sea Lion Island are suggested to be around 3,500, whilst approximately 1,000 land-based visitors were recorded at Volunteer Point (East Falkland) during the 2001/02 season (Otley 2005). Land-based visitors visit some but not all the sites visited by cruise ships, with few land-based tourists at popular cruise ship sites such as New Island, West Point Island, and George and Barren Islands. However, sites such as Volunteer Point, Bertha's Beach, Long Island, Cape Dolphin (East Falkland) and Pebble Island receive many more land-based visitors than cruise ship passengers.

Whilst the profile of the land-based overseas tourist has broadened, the majority are still focused on a speciality interest such as wildlife or photography and they normally have a strong interest in the locations that they visit as well as environmental awareness. In addition, there has been a considerable increase in the 'local' tourism made by military personnel, contract officers and local residents, due to the increased road network, higher disposable income and more recreational time. The level of environmental awareness appears to differ little between these groups (Otley 2005).

Threats from nature-based tourism

The effects of nature-based tourism can be demonstrated at various levels (individual, colony, species, community and habitat), at various time scales (temporary or long-term) and can be direct or indirect (Green and Higginbottom 2000; Burger 2002). However, in order to judge whether the effect is an important conservation issue, it is necessary to determine the consequences at the population level and to weigh these against the benefits of public education and awareness (Gill 2007; Sutherland 2007). The understanding of visitor disturbance effects is still limited, even for birds, which have the most impact studies of any fauna or flora group (Nisbet 2000). In the Falkland Islands, montane, fern, marshland, sand dune and tussac grass habitats, seabirds, waders, waterfowl, sea lions and dolphins are particularly visibly affected by human presence.

- Physical damage

Humans may cause physical damage to soil, vegetation, nests and burrows, particularly if people use the same landing sites, viewing areas and walking trails (Simeone and Schlatter 1998; Poncet 2003). Visitors may also disrupt animal foraging behaviour, travel between breeding and feeding sites, both during breeding, moulting, non-breeding and migrating periods (McClung et al. 2004; Otley 2005). Access methods need to be considered as most animals react differently to people on foot, in vehicles, zodiacs, large ships and aircraft (van Heezik and Seddon 1990; Harris 2005; van Polanen Petel et al. 2006).

- Breeding success

Seabirds and marine mammals may suffer reduced breeding success, breeding attempts, chick fitness at fledgling/weaning, young survival rates and adult fitness, which can be reflected at an individual and colony level (Cobley and Shears 1999; McClung et al. 2004; Walker et al. 2006). For most vertebrates, a common reaction to visitor presence is temporary abandonment of the eggs and young, to exposure and predation (Nisbet 2000). Most bird species are very sensitive to disturbance, particularly southern giant petrels breeding in the Falkland Islands, whereas southern elephant seals and southern sea lions are less affected by humans at close range.

Research elsewhere has demonstrated that some penguin, petrel and albatross species at some sites experience physiological stress with the presence of humans, such as changes in hormone levels and heart rate, despite no outward physical reactions (Yorio et al. 2001; Pfeiffer and Peter 2004; de Villiers et al. 2005, 2006).

Studies of the colony breeding success of gentoo penguins, black-browed albatrosses, king cormorants and rockhopper penguins at well-visited sites compared to less-visited sites in the Falkland Islands suggest that these species are little affected by managed wildlife tourism (Otley 2005; New Island Conservation Trust 2007).

- Introduction of invasive species

Visitor presence also means a risk of accidentally introducing invasive species, such as rats, mice, calafate and thistles, which can lead to the loss of native species. The issues associated with invasive species are covered in Chp. 12.

- Fire

There is a high risk of uncontrolled fires started by cigarettes and cooking fires etc seriously affecting habitats and species. In the Falkland Islands, irresponsibility with fire by visitors has resulted in the almost total loss of habitat and species at some locations recently, including at South Jason Island in 2001 and Green Island (north of Lively Island) in 2003, which has one of the largest sea lion colonies in the Falkland Islands. However, South Jason seems to have recovered substantially and tussac grass has regrown (J. Meiburg and G. Harrison, personal communication). Many landowners, both of remote islands and farms on East and West Falkland, request that visitors do not smoke and/or have fires.

Current site management solutions

In the Falkland Islands, landowners and managers use a variety of methods to minimise the impacts of visitors at wildlife sites, including the provision of educational pamphlets, posters and display boards, pre-visit briefings, on-site wardens, tour guides, specifying approach distances and preventing access to some areas.

Wildlife in the Falkland Islands, as well as elsewhere, shows reduced responses to visitors that are kept at specific distances by markings such as white stones, pathways and fencing (Otley 2005; Pearce-Higgins et al. 2007). Maximum approach distances have been determined for many sub-Antarctic species at a number of sites, with a general rule of 5 m, but 25 m for breeding wandering albatross at Marion Island and Macquarie Island, 25 and 10 m for displaying and breeding wandering albatross at South Georgia, 15 m and 100 m for breeding northern and southern giant petrels on Marion Island (IAATO guidelines; de Villiers et al. 2006).

There have been few specific visitor-wildlife impact or approach distance studies in the Falkland Islands; the Falkland Islands Countryside Code recommends approaching wildlife slowly and quietly to a maximum distance of 6 m/20 feet, and Falklands Conservation recommends a distance of 200 m for breeding giant petrels.

There is no general consensus amongst scientists and site managers worldwide as to whether the effects of nature tourism are best minimised by spreading visitors out thinly throughout a reserve or by aggregating them in a small area. The most appropriate management system has been shown to be species- and site-specific and dependent on the number of people and the distances between the people and the wildlife. However, generally visitors should be aggregated at sites with high disturbance pressures and encouraged to spread out at sites with low disturbance pressures (Beale 2007).

In the Falkland Islands, at only a few sites has there been the need for the installation of warning signs or construction of pathways, fencing and/or viewing platforms to reduce environmental damage. One such site is Gypsy Cove near Stanley, which is most visited wildlife site in the Falkland Islands. Gypsy Cove is particularly well-visited by passengers on luxury cruise vessels (> 1,000 passengers). These vessels tend to offer cheaper cruises, and in Stanley many passengers can not afford the relatively expensive shore excursions on offer and consequently, Gypsy Cove is a cheap alternative option for most passengers.

Up until 1999, there was no site management at Gypsy Cove and this led to extensive erosion, damage to the habitat of the burrowing Magellanic penguins and reduced visual amenity. During 1999 – 2001, a road, car park and pathway were constructed, toilets and signed were installed, sensitive areas were roped off, and wardens were employed on days when more than 600 cruise vessel passengers were expected.

Over time, the Gypsy Cove infrastructure and services have been adapted and improved. A Gypsy Cove Management Plan was adopted by Executive Council in July 2007, which commits FIG to providing, within current budgets, Wardens, maintenance of paths and installation of interpretative signs (EPD 2007).

Chapter 9 - Intertidal and Shallow Marine Environment

Introduction

There is limited information on the intertidal and shallow marine environment (down to 30 m water depth) in the Falkland Islands. Within the main coastal embayments and inlets of East Falkland (for example the Bay of Harbours, Adventure Sound, and Berkeley Sound) and around the chain of north-westerly islands from Pebble Island to the Jason Islands, water depths are typically 20-40 m (Fig. 1.2). The most steeply shelving inshore seabed profile is to the south-west of the archipelago between New Island and Cape Meredith and directly southwest of Beaver Island, the 100 m isobath is only one km from the coast.

Biogeographically, the marine flora of The Falkland Islands have features in common with Antarctica, other sub-Antarctic Islands and the continents of the southern hemisphere, particularly South America. The rich marine flora of Patagonia, Tierra del Fuego and the Falkland Islands appears to form a particular biogeographical grouping (John et al. 1994).

A number of studies have been or are currently being undertaken to fill specific knowledge gaps of this important environment.

These studies include:

- micro-algae, coliform bacteria and biotoxin monitoring
- seaweeds
- inter-tidal habitat surveys
- shallow marine invertebrates

Intertidal habitats

There are twice daily tides around the islands, ranging from 0.3m to 3.5m above local datum. Six intertidal habitats were recognised during the baseline Falkland Islands intertidal survey work of 1994 - 1996 (Bingham 1995, 1996).

1. Boulder shore

Shores with stones of an average diameter of more than 300 mm are boulder beaches. Boulder beaches provide cover for marine invertebrates trying to avoid desiccation during low tide, and for this reason, they attract shorebirds such as blackish oystercatchers and black-crowned night herons. They are also prime feeding habitats fro Cobb's wren. Boulder shores are generally subject to high-energy waves and do not offer safe nesting sites for birds or suitable habitat for plants, except at the very upper reaches of boulder shores.

2. Stony shore

Stony shores have stones with an average diameter of between 2 mm and 300 mm. The shifting nature of stones provides a poor substrate for plants to gain a foothold and little cover for fauna. Stony beaches also provide foraging habitat for the endemic Cobb's wren, and on the upper reaches, shore birds such as Magellanic oystercatchers, gulls and terns nest.

3. Sandy shore

Sandy shores have visible grains with an average diameter of less than 2 mm. They provide important feeding grounds for waders and nesting grounds for waders and gull species. Elephant seals tend to breed and haul out on sandy beaches, and gentoo penguins and king penguins often breed at sites above sandy beaches. On the upper reaches of sandy shores, plants such as sea cabbage, thrift and sand grass are able to grow and these species frequently grow on dune systems behind sandy shores.

4. Muddy shore

A shoreline of soft sediment with grains too small to be visible with the naked eye defines the muddy shore habitat. Muddy shores often provide a rich feeding area for waders because of the invertebrates living in the mud. The low energy, estuarine environment is usually covered during high tides, which precludes nesting by birds.

5. Rocky shore

Rocky shores have exposed bedrock and rock pools, which provide secure attachment for marine invertebrates and marine algae, and these in turn support other marine creatures. This wealth of marine life provides rich feeding for birds such as blackish oystercatchers, black-crowned night herons and gulls. The often high-energy waves prevent nesting by birds and the establishment of terrestrial plants, except in the upper reaches where species such as native stonecrop (*Crassula moschata*) may be found. Rocky shores are the preferred breeding sites of the fur seal.

6. Cliff shore

These are shorelines with a steep slope that exceeds 8 m in height. The steepest and tallest cliffs and the deep water below are unsuitable as feeding or breeding areas for birds, except for the peregrine falcon. Shallow, less sheer cliffs are suitable nesting sites for rock shags, rockhopper penguins and black-browed albatrosses.

There has been little comprehensive survey work to categorise the coastlines around the Falkland Islands. Bingham (1995, 1996) recorded coastline habitat at 12 sites in Berkeley Sound, Kidney Island, Elephant Bay on Pebble Island, Brazo del Mar (Salvador, East Falkland), Fanning Harbour (Port San Carlos), Stanley Harbour, Mare Harbour (Mount Pleasant) and Fox Bay West and the whole coastlines of Pebble Island and Saunders were surveyed by RAF Ornithological Society in 1995. Mapping of the coastal habitats is important in order to be able to identify the key sites for coastal plants, birds and marine mammals, as well as planning for and dealing with oil spills (FIG 1998).

Shorelines habitats in the Falkland Islands have been assessed for their vulnerability to oil spill damage based on the potential degree of exposure to oil pollution and the residence time of oil within the habitat, following the Gundlach and Hayes Index (FIG 1998). Along the Falklands coastline the most sensitive habitats are likely to be sandy and muddy shores, with rocky and cliff shores being the least sensitive, although the degree of protection/exposure may be more critical than the habitat type.

Bacteria and phytoplankton monitoring

Falkland Islands Development Corporation (FIDC) has coordinated since 2003 regular monitoring of coliform bacteria, diatoms and dinoflagellates, as well as harmful toxins produced by some phytoplankton, including paralytic shellfish, diarrheic shellfish and amnesic shellfish poisoning, at two sites near to Goose Green (mussel farm site) and at Darwin (oyster farm site). This is primarily done to ensure that the harvested shellfish is safe for human consumption. Although there are not sample points for every month for 2003-2007, there appears to be a March peak in the numbers of diatom and dinoflagellate species present, which correlates with the warmer sea temperature and day length (FIDC 2007).

It is anticipated that the monitoring programme will be extended to other key sites to act as an early warning indicator system, and to characterise biotoxin dynamics in waters of the Falkland Islands to guide appropriate aquaculture development.

Seaweeds

Seaweeds inhabit the intertidal and shallow marine environment and they make a major contribution to primary production, as well as providing a habitat and/or a food source for a wide range of marine fauna including crustaceans, cephalopod and fish (Tingley et al. 1996). The seaweeds of the Falkland Islands are somewhat poorly inventoried and studied. Three studies have been conducted, one nearly one hundred years ago (Cotton 1915), and more recently, a 15-site study during 1999 (Westermeier and

Patino 1999) and a four-week survey of 12 sites during 2002/03 (Clayton 2003). Cotton (1915) identified 180 species and Clayton (1993; M. Clayton, personal communication) identified at least 74 brown and green species, with a number of red seaweed species requiring further taxonomical work.

Abundant and dominant species in Falkland Islands waters include tree kelps (*Lessonia* sp.), gull kelp (*Durvillea* sp.), giant kelp (*Macrocystis pyrifera*), *Iridaea* sp. and sea lettuce (*Ulva* sp.). Suitable anchor points, light penetration and exposure appear to influence the distribution of giant kelp (Tingley et al. 1996), whilst tree kelps are found on most open coasts. *Iridaea* and *Ulva* are important food items for steamer ducks and kelp geese.

Marine invertebrates

During 1920 to 1950, the British Colonial Office and the Falkland Islands Government funded a number of research expeditions coordinated by the Discovery Committee around Antarctica, South Orkneys, South Sandwiches, South Orkneys and the Falkland Islands. Discovery Investigations were intended to provide the scientific background to the stock management of the commercial Antarctic whale fishery, but a number of specific research projects were carried out in the region of the Falkland Islands, including shallow and deep water trawling surveys and monographs on many groups of the marine fauna were published.

This was the starting point for all subsequent shallow marine surveys. In 1996, the first detailed shallow marine survey was commissioned by FIG as part of a Falklands Environmental Baseline Survey and approximately 250 sites at 15 locations were surveyed (Tingley et al. 1996). Locations were selected using a number of different criteria focusing on areas that might be affected by anthropogenic activities, and marine species were recorded in accordance with the UK Marine Nature Conservation Review survey guidelines (Hiscock 1990).

An extensive amount of data and specimens were collected and approximately 445 likely species were identified, mostly molluscs, echinoderms and sea squirts, many of which had not previously been recorded in the Falkland Islands (Tingley et al. 1996). A vast amount of reference material was preserved and further taxonomic work was subsequently carried out on these specimens, but not all specimens could be identified to species level and the total number of species was estimated to be less than that previously reported (Gardline Surveys 1998h).

During 1994 – 1996, the life cycle, including reproduction, spat settlement, growth and condition, of the native blue mussel (*Mytilus edulis chilensis*) was studied at several sites around the Falkland Islands (Gray 1997).

Despite this early research, baseline surveying, habitat mapping and taxonomic identification of shallow marine invertebrates remain a high research priority for the Falkland Islands. The 'Shallow Marine Surveys Group' (SMSG) is currently conducting surveys of the shallow marine environment,

including full taxonomic identification of all species collected. SMSG is comprised of fisheries scientists, naturalists and dive enthusiasts, and all work is undertaken in a voluntary capacity. SMSG has funds from the FIG Environmental Studies Budget and Antarctic Research Trust, and in-kind support from the Falkland Islands Fisheries Department and a variety of marine experts located across the world. SMSG will produce a series of scientific publication as well as a comprehensive marine life reference book for the Falkland Islands.

Cephalopods, elasmobranches and finfish

Relatively few squid, octopuses, skates, sharks and fish species spend their entire life in the shallow marine environment (see Chp. 11). However, coastal waters are important breeding grounds for the squid *Loligo gahi*, southern red octopus (*Enteroctopus megalocyathus*) and icefish (*Champsocephalus esox*). In addition, all the freshwater fish species in the Falkland Islands complete part of their lifecycle in the marine environment and this is further discussed in Chp. 7.

Seabirds and marine mammals

Seabirds and marine mammals, which are coastal species in the Falkland Islands, are discussed in Ch. 6 and 10, respectively.

Threats

There are a number of activities that threaten the intertidal and shallow marine environment in the Falkland Islands, including oil spills from vessels and oil exploration, inshore fisheries, aquaculture, invasive species, toxic algal blooms and climate change.

- **Oil spills**

The amount of oil that can be potentially spilled from vessels or leaked during oil exploration activities is significant. The habitats that are most sensitive to oil pollution are sandy and muddy shores, although the degree of protection/exposure may be more critical than the habitat type. Oil pollution is further discussed in Chp. 11.

- **Inshore fisheries**

A number of inshore fisheries have occurred in the Falkland Islands. In 1987, an exploratory survey fishery for the false king (snow) crab (*Paralomis granulosa*) was conducted for 7-11 months in sheltered inshore waters around southern Lafonia, but a regular commercial catch and market could not be found (Fortoser Ltd. 1986; Hoggart 1993). *P. granulosa* is typically found in relatively shallow (10 – 40 m) sheltered inshore waters with weak tides and stiff substrates of mud, sand, shell or stones (Fortoser 1986). Juvenile crabs live in shallower waters than adults, adults are not thought to move significantly between seasons and spawning grounds are located in the deepest parts of bays (Hoggart 1993).

Since the late 1990s, there have been sporadic crab fishing effort, particularly during 2000 in Choiseul Sound and around George Island, and the crabs were processed locally for domestic sales of fresh, frozen and tinned product. Annually 8 - 15 tonnes of crab was collected during 2003 – 2006, with little bycatch, strict minimum size restrictions and catch reports being sent to the Fisheries Department (Fisheries Department, unpublished data). There is currently little effort in the fishery due to a lack of a commercial market overseas.

A small mullet netting fishery for the domestic market was established in 2000 in creeks in the Goose Green, North Arm and Port Louis areas. Annually, 10 to 61 tonnes of fish are caught, catch reports are sent to the Fisheries Department and the fishery was found to be biologically sustainable (Brickle et al. 2003b).

There is a number of other shallow marine species in the Falkland Islands that could potentially be exploited, such as sea urchins, volutid snails, clams, whelks and smelt (P. Brickle, personal communication).

- **Aquaculture**

Aquaculture is relatively new to the Falkland Islands. Salmon fish-farming was trialed at Fox Bay during early 1990s, which showed that commercial growth rates could be achieved. However, no commercial external market for Falkland Islands grown salmon was found. The native blue mussel (*Mytilus edulis chilensis*) is farmed at Goose Green, with approximately 20 tonnes of mussels farmed on ropes at any one time. Spats naturally settle on the ropes, which cover an area of 22 ha. The market is local only.

A total of 500,000 pacific oyster (*Crassostrea gigas*) spats have been imported into the Falkland Islands since the mid 1980s, although no biosecurity or environmental impact assessments were carried out prior to their introduction. The largest grow-out site is at Darwin with currently about 250,000 oysters in a trestle and bag system spread over an area of approximately 200 ha. The market is local only and the current demand means that no spats have been imported since 2004.

Current inshore fisheries and aquaculture are estimated to have an annual turn over of £50,000 per annum (Fisheries Department, unpublished data).

The current small-scale mussel and oyster farming in the Falkland Islands means that it is unlikely that there will be any major negative impact on the surrounding marine environment. However, aquaculture has been identified as a potential economic diversification and the viability of an expansion of the industry is currently being assessed by FIDC and the private sector.

The Marine Farming Ordinance 2006 was created to allow the licensing of farming of fish, crustaceans and molluscs. The ordinance has been enacted but is not yet in force. Under the ordinance, when

making a decision about applications the Governor must consider the benefits to the Falklands Islands that the proposed fish farm will generate and the effects that the activities or infrastructure of the fish farm will have on the marine environment. All aquaculture developments also require planning permission, which may require an environmental impact assessment. Aquaculture impacts are also relatively easily controlled through regulation to limit operation size, location and so on.

A National Aquaculture Strategy (FIDC 2006) was developed using the following principles:

1. Creation of an internationally competitive and economically viable industry - creation of jobs in Stanley and Camp.
2. Minimising the impact on the environment, by initial investigation at a demonstration level to understand ecosystem impacts and appropriate remediation methods - investigating indigenous species before considering the introduction of exotics.
3. Community involvement in the development of the sector through transparent development and regular dissemination of findings.
4. Regulation for the sector, but with flexibility that can support during initial development periods.
5. Use of renewable energies in demonstration and extension projects.
6. Adoption of best practices from around the world and at an appropriate scale for the Island.
7. Use of sound scientific methodology to guide development.

Four native species were chosen for feasibility trials: polychaete worms, zebra trout and sea-grown brown trout. Toothfish farming is also being investigated by a local fishing company venture.

The potential for environmental impacts from aquaculture is highest where large scale ventures are proposed. Intensive mussel and oyster and fish farming has the potential to negatively impact the benthic communities, with increased organic sedimentation derived from faecal pellets and fish food waste (FIDC 2002). In extreme cases, this can lead to anoxic areas, both vertically within the sediments and in the water column.

- **Invasive species**

The shallow marine environment in the Falkland Islands is species rich in some groups but poor in others and any new predatory species would face little competition. Vessel hulls and ballast water are two potential methods of transporting invasive marine species (Lewis et al. 2005), although in the Falkland Islands, the threat of introductions from ballast water is low because relatively few vessels carry or discharge ballast water here. However, the chance of vessel hulls carrying foreign species is high. There is little legislative control over ballast water management and hull cleanliness in the Falkland Islands.

Two introduced marine invertebrates– a polychaete worm (*Chaetopterus variopedatus*) and a sea squirt (*Ciona intestinalis*) – have been recorded in the Falkland Islands but it is not known if they are invasive (Shallow Marine Surveys Group, unpublished data). Pacific oysters are considered to be invasive

elsewhere (e.g. France) and this is also a possibility in the Falkland Islands, although they do not currently breed here possibly due to the low water temperatures.

Any applications to import finfish for aquaculture (e.g. salmon, cod) or ornamental fish for tanks and ponds (e.g. coy carp, goldfish) must meet import regulations (see Chp. 3), which may include the need to undertake an environment impact assessment

- **Toxic algae blooms**

Algal blooms tend to occur in shallow inshore waters where flushing and action from wind and wave are limited. Algal blooms are not common in the Falkland Islands due to the typically windy conditions, which keep the seawater well mixed. Toxic algal blooms are particularly hazardous to inshore feeding vertebrates because their prey tends to accumulate toxins.

Micro-alga testing currently occurs only at three sites in the Goose Green/Darwin area. In November 2002, large numbers of many seabird species, including gentoo, rockhopper and Magellanic penguins, black-browed albatrosses, thin-billed prions, common diving petrels, rock shags, king shags and flightless steamer ducks, were reported at colony areas sick or dead, particularly in the north and west sectors of the Falkland Islands (Huin 2003). Water samples were collected at the time from between West Point and New Island, south of Falklands Sound, Beaver Island, New Island, Queen Charlotte Bay and Goose Green/Darwin area and although dinoflagellate algae capable of producing toxin were found in two of the samples taken, the levels were not quantitatively large enough to qualify has an algae bloom (Huin 2003). However, analysis of tissue samples taken from sick and dead seabirds revealed paralytic shellfish poisoning, which results from the bio-toxins produced by red algae (Uhart et al. 2004).

Harmful algal blooms (HABs) are generally difficult to predict and it is equally difficult to imagine how and what intervention could prevent top predators dying. However, they may form an important, currently understated, role in the life history of seabird species found in the Falkland Islands (Shumway et al. 2003). A Falklands-wide programme of chlorophyll and micro-algae monitoring in coastal waters could provide an early warning system for HABs.

- **Climate change**

Climate change forecasters suggest that the initial strong melting of Antarctic ice due to global warming will result in cooler water and air temperatures and increased cloud cover, rainfall and intensity and frequency of extreme storm weather in the Falkland Islands. Cooler, less saline waters may particularly affect the distribution and abundance of the main species of inshore fauna and flora.

However, the extent of this impact is poorly understood as the majority of inshore and shelf species have evolved high tolerance to environmental fluctuations. Stronger storms could cause damage to the

sub-littoral kelp forests because of the increased surge, which might lead to shrinkage of the spawning grounds of *Loligo* squid and thus, a decrease in their abundance.

With the initial predicted warming in ocean temperatures, temperature-sensitive toxins produced by phytoplankton could cause contamination of seafood, jeopardising seafood safety, as well as affecting the health of top marine predators. However, the predicted stronger winds and surge may in fact reduce the chances of toxic algal blooms, due to the stronger mixing of near shore waters.

Conservation actions

The current knowledge suggests that the shallow marine habitat is extremely important to a range of seaweeds, invertebrates, crabs, fish, cephalopods, birds and marine mammals. Inshore waters are for example nursery grounds for *Loligo gahi* and icefish (*Champsocephalus esox*), home to false king and king crab (*Lithodes antarcticus*), and foraging habitat for mullet, Falklands minnow, zebra trout and sea-going brown trout. The kelp forests have been recognised as important foraging habitat for Commerson's and Peale's dolphins and gull and tern species, as well as being habitat for the eggs of *L. gahi*.

There are no formally designated inshore protected areas in the Falkland Islands *per se*, although no commercial fishing is allowed within three nautical miles of any coastlines, except for some exceptions such as the licensed and managed small scale fisheries for mullet and crab.

It is anticipated that there will be a number of complementary research programmes during 2007 - 2009 to describe the marine invertebrate communities, investigate the natural history of coastal dolphins and identify key foraging and breeding areas for coastal birds and marine mammals. These initiatives should lead to the ability to produce Species and Habitat Action Plans for specific coastal species and habitats, as well Site Management Plans, and lead towards strategic management planning, such as Marine Protected Areas, Integrated Coastal Zone Management plan or the like.

Chapter 10 - Marine mammals

Introduction

There are insufficient data available for most species of marine mammal in the Falkland Islands. There are more Falklands-specific data for pinniped species (seals and sea lions) compared to cetaceans (whales and dolphins). Information on foraging and breeding areas, seasonal distribution and abundance and diet is particularly scarce. There is much anecdotal information about marine mammal species in the Falkland Islands but it is not documented or collated in a form that is easily available.

The at-sea bird and marine mammal surveys conducted between 1998 and 2000 by the Falklands Conservation's 'Seabirds at Sea Team' added greatly to the knowledge of the frequency and distribution of wildlife in Falkland Islands waters (White et al. 2002). Many whale species sighted in the waters of the Falkland Islands are passing through on their migration routes and thus it is difficult to decide which species should be regarded as constituting the cetacean fauna of the Falkland Islands (Bonner 1986). There are probably more than 20 species that occur in Falkland Islands waters but probably only two or three species live in the waters of the Falkland Islands for their entire life. It is suggested that a significant proportion of the world's populations of Peale's dolphin and Commerson's

dolphins may exist in the Falkland Islands, with perhaps a closed population of Commerson's dolphins in Falkland Islands waters.

There is no Falkland Islands National Red Data List of marine mammals, though eleven cetacean species seen in the Falkland Islands are categorised as globally threatened by the IUCN, including three species as endangered (Table 10.1). Ten species are listed under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and 16 species are CITES listed species, such that trade/export must be regulated by FIG (see Chp. 3).

Four pinniped species occur in the Falkland Islands, with three breeding species (South American fur seal, southern sea lion and southern elephant seal) and one vagrant (leopard seal). The fur seal and sea lion are eared seals (Otariidae), while the elephant seal and leopard seal are phocids and are less agile on land than eared seals, due to their less flexible hind limbs. None of three pinniped species are red listed by the IUCN, but all three species are listed under CMS and trade in southern elephant seals and South American fur seal must be regulated under CITES (Table 10.1).

In the Falkland Islands, the Marine Mammals Ordinance 1992 protects all marine mammals in all waters, from the coast to the edge of the economic exclusion zone.

Table 10.1. IUCN Conservation Status, CMS and CITES listings for the regularly sighted cetaceans and pinnipeds in Falkland Islands waters.

Species	IUCN Conservation Status	CMS	CITES
Arnoux's beaked whale	Lower risk – conservation dependent	Not listed	Appendix I
Blue whale	Endangered	Appendix I	Appendix I
Commerson's dolphin	Data deficient	Appendix II	Appendix II
Cuvier's beaked whale	Data deficient	Not listed	Appendix II
Fin whale	Endangered	Appendix I/II	Appendix I
Gray's beaked whale	Data deficient	Not listed	Appendix II
Hourglass dolphin	Not listed	Not listed	Appendix II
Humpback whale	Vulnerable	Appendix I/II	Appendix I
Killer whale	Lower risk – conservation dependent	Appendix II	Appendix II
Peale's dolphin	Data deficient	Appendix II	Appendix II
Sei whale	Endangered	Appendix I/II	Appendix I
Southern bottlenose whale	Lower risk – conservation dependent	Not listed	Appendix I
Southern minke whale	Lower risk – conservation dependent	Appendix II	Appendix I
Southern right whale	Lower risk – conservation dependent	Appendix I	Appendix I
Sperm whale	Vulnerable	Appendix I/II	Appendix I
Strap tooth beaked whale	Data deficient	Not listed	Appendix II
South American fur seal	Least concern	Appendix II	Appendix II
Southern elephant seal	Least concern	Appendix II	Appendix II
Southern sea lion	Least concern	Appendix II	Not listed

Blue whale

Historically, the blue whale (*Balaenoptera musculus*) was regularly seen off the Falkland Islands during its migration north for winter but these days, it is very rarely seen (Strange 1992). Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill (*Munida* sp.) in the Falkland Islands (Bonner 1986).

Fin whale

The fin whale (*Balaenoptera physalus*) was once commonly sighted in the Falkland Islands as they migrated from the coast of Brazil to the summer feeding grounds in the Antarctic. However, as it was one of the main species hunted from the whaling station on New Island, fin whales are now not often sighted in Falkland Islands waters. During at-sea surveys in 1998 – 2000, 57 fin whales, singularly and in groups of up to 12 individuals were recorded on 27 occasions, particularly between November and January (White et al. 2002). They were most commonly sighted in waters greater than 200 m on the continental slope and adjacent to the Burdwood Bank. They did not appear to associate with other cetaceans and on only one occasion were aggregations of seabirds seen to be associating with the species (White et al. 2002). Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill in the Falkland Islands (Bonner 1986).

Sei whale

Bonner (1986) reported that sei whales (*Balaenoptera borealis*) passed the Falkland Islands on migration, which supported a whaling industry at New Island in the early part of this century. One to three sei whales were recorded on 31 occasions during the at-sea surveys of 1998 – 2000, most commonly during the austral summer between November and April on the Patagonian shelf and shallower waters to the east of the Falklands (White et al. 2002).

Particular hotspots around East Falkland include Sea Lion Island, MacBride Head, Cape Dolphin and Berkeley Sound, whilst King George Bay, Saunders Island and Carcass Island are sites where sei whales are regularly reported around West Falkland (White et al. 2002; A. Black personal communication; A. Marsh personal communication). Sei whales have not been observed associating with cetaceans or seabirds (White et al. 2002). Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill in the Falkland Islands (Bonner 1986).

The sei whale has an endangered conservation status and although a change in classification to vulnerable may be appropriate, there is a distinct lack of reliable survey data that could serve as the basis for reassessment (Reeves et al. 2003).

Southern minke whale

Following the distinctions made by CMS, it is now thought the southern (or Antarctic) minke whale (*Balaenoptera bonerensis*) rather than the common minke whale (*B. acutorostrata*) occurs in the Falkland Islands (IUCN website). The southern minke whale has a circumpolar distribution from Antarctica to almost equatorial regions (Carwardine 1995).

In the Falkland Islands, minke whales were recorded on 60 occasions during the at-sea surveys of 1998 – 2000, usually alone and mostly during the austral summer from September to April over the Patagonian shelf around East Falkland and to the northwest of the Falklands zone (White et al. 2002). There were rarely associated with other cetaceans and seabirds. Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill in the Falkland Islands (Bonner 1986).

Humpback whale

Humpback whales (*Megaptera novaeangliae*) are recorded infrequently in Falkland Islands waters but they were probably more widespread pre-whaling. It has a circumpolar distribution from Antarctica to almost equatorial regions (Carwardine 1995). Seven humpback whales were recorded during the at-sea surveys of 1998 – 2000 and the records were all in Patagonian shelf waters during the austral summer between October and March (White et al. 2002). Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill in the Falkland Islands (Bonner 1986).

Southern right whale

The southern right whale (*Eubalaena australis*) has a circumpolar distribution from Antarctica to almost equatorial regions (Carwardine 1995). It was one of the main whale species hunted by early whalers and was close to extinction by 1937. However, anecdotal and systematic sighting effort suggests that the southern right whale population may be on the increase around the Falkland Islands, with infrequent records in coastal waters, enclosed bays and harbours (White et al. 2002; A. Black personal communication). Baleen whales feed on small shoaling fish and swarms of planktonic crustaceans, which could include lobster krill in the Falkland Islands (Bonner 1986).

Sperm whale

Sperm whales (*Physeter macrocephalus*) found north and south of the equator are thought to be separate breeding stocks, with seasonal movement from the equator to the polar regions. Sperm whales sighted in Falkland Island waters are most likely to be males, as most females and their calves do not venture this far south (Carwardine 1995). Sperm whales have stranded in the Falkland Islands on four occasions (Strange 1992). During the at-sea surveys of 1998 - 2000, 28 individuals were sighted on 21 occasions throughout the year, particularly in waters greater than 200 m around the Burdwood Bank and in the extreme north (White et al. 2002). Toothed whales have a diet of fish, squid and krill.

Fisheries observers have reported that sperm whales associate with fishing vessels, particularly with longliners (Nolan and Liddle 2000). Fishing grounds may well be areas with naturally high numbers of sperm whales, as often there is also high catch per unit, indicating high prey availability (Falkland Islands Fisheries Department and Consolidated Fisheries Limited [CFL], personal communication). However, the association appears very strong, with sperm whales often appearing once line hauling commences.

The association between whales and longline vessels is a world-wide phenomenon and it is not known if the whales are targeting fish lost from hooks, discarded fish or taking fish directly from hooks, either on the seafloor or from the line as it is hauled upwards (Ashford and Martin 1996; Moreno et al. 2003; Purves et al. 2004). Interaction rates and photo-identification studies are being conducted across the world, including in the Falkland Islands by fisheries observers (Yates and Brickle 2007). Depredation issues in the Falkland Islands need to be fully investigated. CFL are currently trialing a new method of fishing, involving a net sleeve around hooks (Moreno et al. 2008).

Sperm whales are not likely to suffer effects of feeding on toothfish caught by licensed longliners working in the Falkland Islands. However, elsewhere they are probably shot at or damaged by explosives directed at them.

Beaked whales

Seven species of beaked whale have been recorded stranded or seen at-sea in the Falkland Islands (Lichter 1986; Strange 1992; White et al. 2002; MacLeod et al. 2006; Smith and Otley in prep): Andrew's beaked whale (*Mesoplodon bowdoini*), Arnoux's beaked whale (*Berердius arnuxii*), Cuvier's beaked whale (*Ziphius cavirostris*), strap-toothed whale (*Mesoplodon layardii*), Gray's beaked whale (*M. grayi*), Hector's beaked whale (*M. hectori*), Andrew's beaked whale (*M. bowdoini*) and southern bottlenose whale (*Hyperoodon planifrons*). Only the southern bottlenose whale has been recorded as a live sighting in the Falkland Islands, with 18 sightings of 34 animals between September and February in deep oceanic waters off East Falkland (White et al. 2002).

These species appear to have circumpolar distributions from Antarctica to the low latitudes (Carwardine 1995). Few beaked whale species can reliably be identified at sea, so it is impossible to accurately determine the population status of any species, although stranding records suggest that some of species that occur in the Falkland Islands such as Gray's beaked whale and strap-tooth beaked whale are more common relative to Andrew's beaked whale and Hector's beaked whale (Pitman 2002).

Most beaked whales normally inhabit deep ocean waters (>2,000 m) or continental slopes (200 - 2000 m) where they feed on deep-water mesopelagic squid and some fish species (Pitman 2002). Their anatomy and behaviour makes beaked whales very sensitive to anthropogenic noises such as sonar and airgun arrays, and which cause strandings (Barlow and Gisiner 2006).

Killer whale

The killer whale (*Orcinus orca*) is the largest member of the dolphin family and has a worldwide distribution in both coastal and oceanic waters. Behaviour varies within its range but killer whales often form strong family groups, with pods specialising in one prey and/or water area (Carwardine 1995).

During the summer months in the Falkland Islands when penguins and pinnipeds are breeding, killer whales are commonly sighted in coastal waters and there appears to be at least one resident pod to the southeast of the archipelago between Cape Meredith, Sea Lion and Beauchêne Island (Falklands Conservation Cetacean Watch data). Killer whales seen off Sea Lion Island have been photographed each November between 2004 and 2006. Two pods have been observed with up to eight identifiable individuals recognised in 2004 (Yates et al. 2004) and six of these were re-sighted in 2006 (Dawson 2006).

Records of killer whales in the oceanic waters of the Falkland Islands are rarer, with seven records of individual killer whales and small pods of less than five whales in coastal and shelf waters recorded during at-sea surveys during 1999 - 2000 (White et al. 2002). However, they are also reported infrequently at longline fishing vessels, particularly in the northern and eastern deeper waters at the edge of the 200 nautical mile limit (Yates and Brickle 2007). Fishing grounds may well be areas with naturally high numbers of killer whales, as often there is also high catch per unit, indicating high prey availability (Falkland Islands Fisheries Department and Consolidated Fisheries Limited, personal communication).

The association between whales and longline vessels is a world-wide phenomenon and it is not known if the whales are targeting fish lost from hooks, discarded fish or taking fish directly from hooks, either on the seafloor or from the line as it is hauled upwards (Ashford and Martin 1996; Moreno et al. 2003; Purves et al. 2004). Interaction rates and photo-identification studies are being conducted across the world, including in the Falkland Islands by fisheries observers (Yates and Brickle 2007). Depredation issues in the Falkland Islands need to be fully investigated. CFL are currently trialing a new method of fishing, which involves a net sleeve around a group of hooks (Moreno et al. 2008).

Killer whales are not likely to suffer effects of feeding on toothfish caught by licensed longliners working in the Falkland Islands. However, elsewhere they are probably shot at or damaged by explosives directed at them.

Long-finned pilot whale

The long-finned pilot whale (*Globicephala melaena*) has a worldwide distribution in both coastal and oceanic waters. In the Falkland Islands, it was one of the more frequently recorded cetacean species during the 1998 – 2000 at-sea surveys, with 27 records of 872 animals in pods of between two to 200 whales, particularly so in water depths greater than 200 m and during winter months (White et al.

2002). Long-finned pilot whales are often seen in association with other cetacean species, particularly southern right whale dolphins and hourglass dolphins, as well as eleven species of seabirds.

The long-finned pilot whale has a propensity to strand and it is the most commonly stranded whale in the Falkland Islands. The structure (i.e. sex and age), diet and genetic relationships of five pods of pilot whales totalling 500 individuals were investigated by the Fisheries Department during 2005 – 2006 (Otley et al. 2006; Shaw 2006; FIFD unpublished data).

Hourglass dolphin

The hourglass dolphin (*Lagenorhynchus cruciqer*) probably has a circumpolar distribution in pelagic waters of the sub-Antarctic and Antarctic zones and as far north as the southern subtropical convergence (Carwardine 1995). The diet of this deep-water species includes myctophid fish, squid and crustaceans, but nothing else is known about their ecology and behaviour (Carwardine 1995).

In the waters of the Falkland Islands, the hourglass dolphin was frequently recorded during at-sea surveys of 1998 – 2000 in continental slope and oceanic waters greater than 200m, singularly and in pods of up to 50 animals, particularly between September and March (White et al. 2002). However, the species may have been under-recorded in surveys, as it is a more wary species and does not approach vessels. Their oceanic preference contrasts with the coastal and shallow water distribution of both the Peale's dolphin and the Commerson's dolphin (White et al. 2002).

Peale's dolphin

The Peale's dolphin (*Lagenorhynchus australis*) ranges in coastal waters of southern South America from Valdivia, Chile (38°S), and Golfo San José, Argentina (44°S), south to Drake Passage at 59°S and Falkland Islands (Goodall 2002). It has a continuous distribution from the Falklands to South America (Gillon et al. 2000). In the Falkland Islands, it is the most numerous and most frequently encountered cetacean because it is very inquisitive and will approach vessels to bow-ride (White et al. 2002). A total of 864 sightings totalling 2,617 animals, in groups of one to 15 animals, were recorded during the at-sea surveys of 1998 - 2000, and no seasonality in distribution or abundance was found.

In the Falkland Islands, the species appears to be restricted to shelf waters less than 200 m deep. Photo-identifiable individuals around Isla Chiloe (Chile) showed limited or low site fidelity (Heinrich 2006). Based on focal studies conducted of the species in southern Chile and Argentina and sightings in the Falkland Islands, the kelp forest is a particularly important habitat for Peale's dolphins (Fathala et al. 2002; Viddi and Lescrauwaet 2005; Falklands Conservation Cetacean Watch records). Its diet consists of demersal fish, cephalopod, mollusc and crustaceans, including some commercial species (Carwardine 1995).

A number of organisations in Patagonia study the biology and population structure of the species but it has not been studied in any detail in the Falkland Islands. The populations in continental South

America are threatened by artisanal fisheries, directly and indirectly (Crespo et al. 1997; Iniguez et al. 2003).

Commerson's dolphin

There are two populations of Commerson's dolphin (*Cephalorhynchus commersonii*), being in southern South America and Kerguelen, which are separated by 8,500 km. Commerson's dolphins at Kerguelen are a recognised subspecies because they are larger than the South American animals and are black, grey and white, as opposed to black and white markings of South American specimens (Robineau et al. 2007). In South America, Commerson's dolphins range from 30 - 40 ^{o}S down to South Shetland Islands (61^{o}S) and Falkland Islands.

In the Falkland Islands, Commerson's dolphins are relatively commonly sighted in inshore coastal waters all year, particularly in sheltered waters of less than 100 m in depth, such as bays, harbours, river mouths and around kelp beds (Strange 1992; Lescrauwaet et al. 2000; Falklands Conservation Cetacean Watch records;). Almost all of the records made during the at-sea surveys of 1998 - 2000 are within 10 km of the shore and no records were made further than 25 km offshore (White et al. 2002). In a study of Commerson's dolphin in an estuarine study site, individuals were often sighted in the river entrance than up river and coastal marine areas (Iniguez and Tossenberger 2007). They appear to be opportunistic bottom feeders, taking mysid shrimps, fish and squid (Carwardine 1995).

It appears that populations form well-defined territories, although mean group size at one long-term study site in Patagonia was 1.88 (Iniguez and Tossenberger 2007). They are also able to recognise a number of photo-identifiable individuals within the 3 x 1 km study site. Current and on-going genetic studies suggest that there are separate populations along Argentina and Chile (Hevia et al. 2005; Coscarella et al. 2007; Pimper et al. 2007). It is thought that Commerson's dolphins do not range across the Patagonian Shelf (Gillon et al. 2000), and as such that there is a closed population in the Falkland Islands. However, a current study of the genetics of the Chilean, Tierra del Fuego, Argentine and (possibly also) Falkland Islands populations should resolve this question (L. Pimper and E. Crespo, personal communications). The populations in continental South America are threatened by artisanal fisheries, directly and indirectly (Crespo et al. 1997; Iniguez et al. 2003).

Infrequent Delphinidae and Phocoenidae species

Southern right whale dolphin (*Lissodelphis peronii*), dusky dolphin (*Lagenorhynchus obscurus*), spectacled porpoise (*Phocoena dioptrica*) and bottlenose dolphin (*Tursiops truncatus*) have all been recorded in the Falkland Islands (Strange 1992). Of these species, only the southern right whale dolphin was sighted during the at-sea surveys of 1998 - 2000, infrequently but in large pods (>50 – 100 individuals) with long-finned pilot whales in deep oceanic waters to the east of the Falkland Islands (White et al. 2002).

Dusky dolphins have been seen by several observers (A. Black personal communication) and two bottlenose dolphins stranded as part of a mass pilot whale stranding on West Falkland (Strange 1992). Both species should be considered as vagrants in Falkland Islands waters (White et al. 2002). For the dusky dolphin, it is not known if the specimens seen in the Falkland Islands are from a discrete population or are part of the population from eastern South America (Reeves et al. 2003).

Spectacled porpoise has not been recorded during recent at-sea or inshore surveys (White et al. 2002; Falklands Conservation Cetacean Watch records). However, it still may be present occasionally in the Falkland Islands, because in Tierra del Fuego, it has been recorded mainly as strandings and is rarely sighted at sea (Goodall 1978).

South American fur seal

The South American fur seal (*Arctocephalus australis*) is found in southern parts of continental South America as well as on the Galapagos Islands, Tierra del Fuego and the Falkland Islands. It is known to breed at 15 sites in the Falkland Islands, choosing rocky coastal strips and undercut cliff edges that have reefs and kelp beds offshore and tussac grass onshore (Strange 1992). No dedicated population censuses have been conducted in the Falkland Islands; the estimated population is over 10,000 adults. It is likely that there has been a steady population increase this century following its near extermination by fur traders during the last century, although the rate of population increase has not been as rapid as that experienced for sub-Antarctic fur seals at South Georgia.

South American fur seals commence breeding in early November with the establishment of territories by the dominant bulls. Pups are mostly born around mid-December and are suckled for six to 12 months, which constrains females to foraging grounds close to breeding sites. Diet and foraging studies were conducted at Bird Island (southwest Falklands) during 1999 and 2000 (Thompson and Moss 2001).

Analysis of 168 scats collected on Bird Island in January and May showed that fish appeared in 55 and 60% of scats, squid in 25 and 30% of scats and krill in 10 and 20%, respectively (Thompson and Moss 2001). The species of fish could not be identified except for some otoliths of hoki (*Macruronus magellanicus*), the identifiable squid beaks were mostly *Loligo gahi* and the lobster krill was *Munida* sp. The presence and size range of *L. gahi* in the diet indicates a potential for competition between fur seals and fisheries. However, in order to accurately determine overall annual diet, further faecal and stomach sampling is needed (Thompson and Moss 2001).

Sixteen adult female fur seals and one sub-adult male fur seal were satellite tracked for 10 to 163 days during October 1999 to June 2000. Early in the pup rearing cycle, the foraging effort was limited to short duration night time foraging trips within 10 km of the breeding site and by autumn, seals were foraging for up to six days more than 195 km away from the colony (Thompson et al. 2003). During

this period of the season, greater levels of foraging effort occurred to the south-west of the Falkland Islands.

The at-sea surveys of 1998 - 2000 showed the species is widespread in all regions, water depths and at various distances from land, but with the largest concentrations recorded inshore and during winter months (White et al. 2002). During winter, non-breeding individuals appear to remain in the Falkland Islands, hauling out at breeding sites and at other localities (Strange 1992).

Southern sea lion

The southern sea lion (*Otaria flavescens*) is widely distributed along the coast of South America as far north as Peru and Brazil, and the Falkland Islands holds no more than five percent of the world population, with fairly small colonies at some hundred or so sites, mainly on remote sandy beaches with adjacent tussac grass habitat (Thompson et al. 2005). The Falkland Islands sea lion population shows low genetic diversity compared to the Argentine population, suggesting that the current population was created from a small number of founding members (Freilich et al. 2005).

The UK-based Sea Mammals Research Unit (SMRU) conducted a census of southern sea lions on the Falkland Islands in 1995 and 2003 to update partial surveys conducted between 1934 and 1937 by the Discovery programme and in 1990 by I. Strange (Thompson et al. 2005). The current Falkland Islands population is approximately 7,047 animals, with an estimated 2,744 pups born annually at 63 breeding colonies and an annual population growth rate of 3.8% between 1995 and 2003 (Thompson et al. 2005). However, this analysis does not take into account population structure, risks associated with many small populations and possible movements between colonies of breeding males, as sea lions are polygamous.

Regardless, the current population remains tiny compared to that recorded in the 1930s when a population of 380,000 animals produced 80,000 pups per annum. Sea lions in the Falkland Islands were subjected to severe exploitation during the 18th and 19th centuries and reduced levels of hunting continued until the 1960s. Whilst hunting was undoubtedly the primary reason for the decline, it appears that the decline was in excess of reported cull numbers and that a decline continued after the cessation of hunting in the 1960s (Thompson et al. 2005).

The Falkland Islands population trajectory is similar to that of the adjacent Argentinean population and the cause of the population decline are not clear (Thompson et al. 2005). There have also been similar declines reported in the Uruguayan population, including mass die-offs due to epidemic diseases, toxic algal blooms and environmental fluctuations (Vaz Ferriera 1981).

In the Falkland Islands, southern sea lions begin breeding in December when bulls establish territories, with the females arriving during late December to January to pup. Females mate shortly after pupping, but continue to look after the pups for up to twelve months or more. Lactating female sea lions

breeding on an island near Beaver Island equipped with satellite transmitters were found to forage in a range of benthic habitats from shallow waters close to the breeding site, as well as up to 45 km away in water depths near to 200 m (Thompson et al. 1998). This is supported by the at-sea surveys of 1998 – 2000, with most sightings made in the shallower waters of the shelf waters (White et al. 2002). Patterns of return and attendance at the breeding site of the tracked breeding female sea lions suggest that they do not haul out just to feed their pups but for other reasons that may include predation and thermoregulation (Thompson et al. 1998).

Breeding females from the Beaver Island group took a variety of fish (e.g. Nototheniid sp., hakes, southern blue whiting, hoki and red cod), cephalopods (e.g. *L. gahi*, *Gonatus antarcticus*, *Moroteuthis knipovitchi*, *Martialia hyadesi*, *Semirossia patagonica* and various octopods) and lobster krill (*Munida gregaria*) (Thompson et al. 1998). Adults occasionally prey on penguins and even young elephant seals.

Southern elephant seal

The Falkland Islands holds only a very small percentage of the world's population of the southern elephant seal (*Mirounga leonina*), which is found on the South American mainland and most sub-Antarctic islands including South Georgia. Worldwide, the elephant seal was heavily exploited as a source of high quality oil in the 19th century, which led to an almost complete extermination of the species in the Falkland Islands by 1871 (Strange 1992).

The population in the Falkland Islands slowly recovered and annual pup production in the 1950s was estimated at about 1,000 (McCann, 1985), but has since declined, with for example the population on Saunders Islands decreasing from 400 females in 1981 to less than ten in 1997 (D. Pole-Evans, personal communication). The two biggest colonies are thought to be about 50 and 500 breeding females on Carcass Island and Sea Lion Island, respectively (A. Henry, personal communication; Galimberti et al. 2001).

The population on Sea Lion Island is almost stable, based on counts made 1989 – 1999, although the time series used is not long enough to safely detect small trends and for any small populations (of any species), any trend estimates do not have a sufficiently high statistical power on which to base conservation policies (Galimberti et al. 2001; Galimberti 2002). The population at Sea Lion Island is philopatric to the site, with little interbreeding with individuals from colonies at Peninsula Valdes, South Georgia and on the Antarctic Peninsula (Fabiani et al. 2003).

For breeding sites, elephant seals prefer gently sloping sandy beaches that have a shallow water approach. Elephant seals are ashore between mid-September and February for breeding and subsequently, moulting. Pups are born in late September and early October and are suckled on average for 23 days. Most females that haul out give birth and pup mortality to weaning is less than 2% at Sea Lion Island (Galimberti and Boitani 1999).

The population on Sea Lion Island has been monitored and studied annually since 1995 by the Italian-based Elephant Seal Research Group lead by F. Galimberti and S. Sanvito. All elephant seals in particular areas around Sea Lion Island are tagged and there have been/currently are various studies of male and female breeding strategies and parental investment, genetic relationships, body size and vocal communication. See www.eleseal.it for a full publication list. Sightings of tagged elephant seals at sites other than at Sea Lion Island should be sent to F. Galimberti (fil_esrg@eleseal.it) or Falklands Conservation.

The diet and foraging behaviour of elephant seals has been well studied at most breeding sites across their range, except in the Falkland Islands. Elephant seals tagged at Sea Lion Island have been sighted hauled out almost 4,000 km away at Peninsula Valdes, South Shetland Islands and Gough Island (Galimberti and Sanvito 2003). Elsewhere, elephant seals have been recorded undertaking deep (>1,000 m), long (i.e. 120 minute) dives, feeding on squid and fish (Slip et al. 1994). Male and female elephant seals breeding at Peninsula Valdes travel to the edge of the Patagonian Shelf and Argentine Basin, whilst juveniles remain in the northerly confluence of the Brazilian and Falklands currents (Campagna et al. 2006).

In the Falkland Islands, it is probable that elephant seals feed in deeper oceanic waters off the continental slope to the east of the islands, associating with the Antarctic Polar Front and Falklands current where food resource are higher. Only five elephant seals were sighted over two years of at-sea survey effort (White et al. 2002). The foraging locations of the elephant seals that breed in the Falkland Islands should be determined, possibly working collaboratively and in parallel with the international 'SeaOS – Southern elephant seals as oceanographic samplers' and 'MEOP - Marine Mammal Exploration of the Oceans' programmes, in order to identify areas of overlap in elephant seal foraging areas and fisheries and oil exploration effort.

The small size and restricted occurrence of elephant seals in the Falkland Islands presents specific conservation problems, with the population being at risk from catastrophic events such as an oil spill or a fire as well as inter-annual variation in environmental factors such as reduced food supply, which could lead to reduced or altered breeding success, demographic imbalance and reduced genetic diversity (Galimberti and Boitani 1999; Galimberti et al. 2001). A Falkland Islands-wide census and continuation of the life history studies of the population at Sea Lion Island will be an essential part of the conservation efforts in a Species Action Plan to be prepared.

Leopard seal

A solitary animal with a circumpolar distribution, the leopard seal (*Hydrurga leptonyx*) breeds on sub-Antarctic pack ice and feeds on a varied diet of fish, squid, krill, birds, small seals and penguins. It is a winter visitor to the Falkland Islands (Bonner 1986; Falklands Conservation records). Strange (1992) describes one unconfirmed report of breeding.

Vagrant leopard seals also visit South Georgia and at Bird Island, they are tagged and identified photographically (Forcada and Robinson 2006). Leopard seals hauled out on beaches in the Falkland Islands should, with care, be checked for hind flipper tags and multiple photos taken of the left and right sides of the head and body, throat and underbelly area, and any scars or wounds. Details should be sent to Jaume Forcada at British Antarctic Survey (jfor@bas.ac.uk) or to Falklands Conservation.

Threats

Marine mammals in the Falkland Islands are threatened by a number of current and proposed activities including oil spills from vessels and oil exploration, direct exploitation and incidental fisheries mortality, competition for food with fishing vessels and for space with aquaculture ventures, ingestion of and entrapment by marine debris, increased anthropogenic sound from seismic airguns, disturbance by whale watching vessels and wildlife diseases. For seals and sea lions ashore, human disturbance and fire are additional threats.

All proposed new activities in the Falkland Islands require an Environmental Impact Assessment. However, for each species of marine mammal in the Falkland Islands, there are some gaps in information about distribution, abundance, diet and important foraging and breeding sites, and this hinders assessment of the effects of these current and proposed activities.

- **Oil pollution**

Although marine mammals would normally be expected to actively avoid spilled oil, any oil on their coat, inhaled or ingested could have significant effects. For pinnipeds, the problem may be more acute if coastal pollution occurs during the breeding season when lactating females and pups cannot disperse. Oil pollution may also affect the marine life that marine mammals fed on. Oil pollution is discussed further in Chp. 11.

- **Direct exploitation and incidental fisheries mortality**

Licensed whaling took place in the Falkland Islands for a short period during the early 1900s, with 148 sei whales, 99 fin whales, 15 humpback whales, three blue whales and one southern right whale caught during 1912 – 14 (White et al. 2002). However, a station fire and better catches at South Georgia led to the Norwegian company moving their operations further south. In the foreseeable future, it is not likely that the current ban on whaling would ever be lifted.

Effects of fisheries on marine mammal populations, including prey competition and incidental bycatch, have been assessed in Patagonia (Crespo et al. 1997). Although there is some direct exploitation of small cetacean species (Peale's and Commerson's dolphins) and incidental fisheries mortality in Argentina and Chile (Reeves et al. 2003), it is has not been documented in the Falkland Islands.

The diet of most marine mammals in Falkland Islands waters is not well known, except for some studies of fur seals, sea lions and pilot whales, and this knowledge gap should be urgently filled. Sea

lions and squid trawlers target *L. gahi* of a similar size, whilst the size range of fish prey taken by sea lions does not suggest an overlap with the finfish trawl fishery (Thompson et al. 2005). There is also considerable overlap in the species composition and size ranges of prey taken by sea lions, gentoo penguins and Magellanic penguins. However, it is extremely difficult to prove a causal link between patterns of fisheries exploitation and changes in populations of seabirds and marine mammals.

Fisheries observers aboard vessels in Falkland Islands waters have reported a low number of sea lion and fur seals mortalities from entanglements in nets during the period 1998 – 2007 (FIFD, unpublished data). Most mortality has occurred during August to October in the southwest region, particularly near Cape Meredith, by trawlers targeting aggregated spawning fish including southern blue whiting, hake and hoki.

- **Anthropogenic sound**

Beaked whales worldwide are particularly sensitive to sonar and seismic survey sounds but detailed research in this field, including developing mitigation measures, is difficult. The current seismic survey regulations in the Falkland Islands under the Offshore Minerals Ordinance 1994 request that marine mammal surveys are conducted prior to the start of seismic survey transects and that there should be a slow build up of power in order to alert (and scare away) marine mammals before the maximum strength of noise is generated.

- **Visitor disturbance**

Young and adult elephant seals are generally little disturbed by visitors or researchers, perhaps due to their large size (McMahon et al. 2005). However, the effect of human presence on southern sea lions has been studied; South American fur seals are less disturbed when people approach within 10 m and remain calm and quiet (Cassini et al. 2004). In the Falkland Islands, the breeding sites of South American fur seals are little visited and are mostly below steep high cliffs, whilst there are a number of southern sea lion colonies at accessible locations at popular visitor sites.

Visitors are also associated with an increased risk of fire. For example, in 2004, a fire on Green Island, home to the Falkland Islands' second largest breeding colony of southern sea lion, was most likely started by visitors from a yacht

Despite the potential, there is little commercial or recreational "whale watching" in the Falkland Islands, due to a lack of whales until recently, an excess of wind and a lack of suitable available boats. Worldwide, there has been considerable advance in whale watching research in recent years with more studies showing that whale watching can have behavioural impacts, which translate into biologically significant effects for marine mammal populations (Scarpaci et al. 2007). Therefore, should whale watching develop in the Falkland Islands, it should be closely monitored.

- **Disease and pollutants**

Marine mammals worldwide suffer from infectious diseases, harmful algal blooms and accumulation of heavy metals and manufactured chemicals (Gulland and Hall 2007). No wildlife diseases have been observed for marine mammals in the Falkland Islands, although no specific health evaluations have been made. Marine mammals also ingest and become entangled in plastic debris.

- **Climate change**

Climate change is also likely to affect marine mammals due to changes in prey distribution and abundance, and for pinnipeds, due to possible changes in sea level, the suitability of current haul out sites (Simmonds and Issac 2007). The effects of climate change are dependent on species adaptability, but scientists suggest that the effects are currently unknown for the sei whale, sperm whale, all beaked whale species, Peale's dolphin, killer whale, long-finned pilot whale, South American fur seal, South American sea lion and southern elephant seal, and are suggested to be negative for Commerson's dolphin and hourglass dolphin (Learmouth 2006).

- **Strandings**

Stranded whales and dolphins should be reported to Falklands Conservation who will advise on re-floating options. As some marine mammals are extremely rare, any that are found dead ashore could be of interest to specialists around the world, who are interested in occurrence, body size, diet, genetics etc. Please notify Falklands Conservation or Environmental Planning Department.

Conservation Actions

The 'World Action Plan for Cetaceans' (Reeves et al. 2003) lists three key actions to conserve whales and dolphins:

1. Ensuring catches or other uses of cetaceans are sustainable
2. Habitat protection and restoration
3. Enhancing the capacity and governance framework for cetacean conservation.

There are additionally specific actions for the South America region (Reeves et al. 2003) but only Action 33 – Investigate stock identity of endemic species in South America – is of relevance to the Falkland Islands for Peale's dolphin, Commerson's dolphin and dusky dolphin.

Hucke-Gaete (2000) also identified a number actions required to conserve small cetaceans in southern South America, including biological studies of distribution and abundance, stock identity, natural history studies and in each region, to make a local reassessment of marine mammal species conservation status and to establish a local conservation programme.

A Species Action Plan will be prepared and adopted in the Falkland Islands for Coastal Cetaceans (Commerson's dolphin and Peale's dolphin) and for Pelagic Cetaceans (for 20-25 migratory and transient species).

Chapter 11 - Offshore marine environment and use activities

NB. In this chapter, MT = metric tonne (1,000 kilograms).

Introduction

The Falkland Islands are situated on a projection of the Patagonian continental shelf, which is bounded to the north by a steep slope (the Falklands Escarpment), separating it from the Argentine Basin. The Falkland Islands claims the sea out to the internationally recognised 200 nautical mile limit, and the area is separated into the Falklands Interim Conservation and Management Zone (FICZ) and Falklands Outer Conservation Zone (FOCZ) (Fig. 11.1).

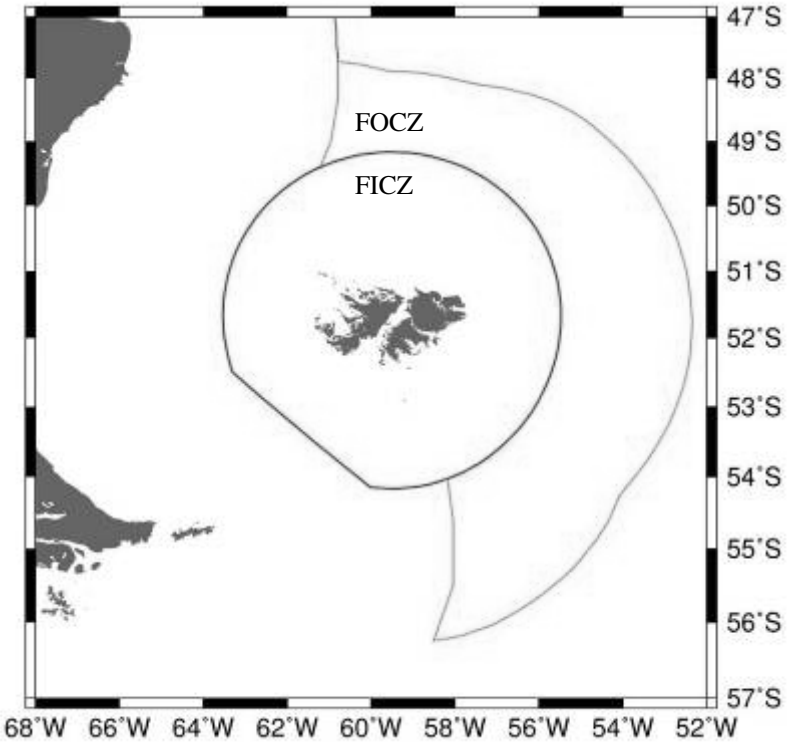


Fig. 11.1 The location of the FICZ and FOCZ relative to the Falkland Islands and continental South America.

A gently north-eastward sloping area between the Falkland Islands and the Falklands Escarpment, at water depths of between 150 and 1,500 m, is known as the North Falklands Basin. The continental shelf extends some 200 km beyond the Falklands coast to the north, about 50 km to the south-west, and about 50-100 km offshore on the eastern side. Productive waters upwell on the edge of the continental shelf, but most particularly to northwest of the Jason Island Group, Beauchêne Island and the Burdwood Bank. These areas are important foraging ground for seabirds, marine mammals and fish (White et al. 2002).

Historical survey effort

During 1920 to 1950, the British Colonial Office and the Falkland Islands Government funded a number of research expeditions coordinated by the Discovery Committee around Antarctica, South Orkneys, South Georgia and the Falkland Islands. Discovery Investigations were intended to provide the scientific background to the stock management of the commercial Antarctic whale fishery, and

included aspects of biology of whales, seals, krill, fish, marine invertebrates, plants, geology and oceanography. These expeditions were reported in scientific papers, compiled and published by the Discovery Committee during 1926 to 1986.

A number of specific research projects were carried out in the region of the Falkland Islands, including shallow and deep water trawling surveys, and the results were published in single reports, as well as specimens collected in Falkland Islands waters contributing to monographs of particular species groups.

Offshore marine use activities

Since the 1950s, the seas around the Falkland Islands became an important area for fisheries and consequently much of the scientific research conducted in the offshore marine environment has concentrated on stock assessment of commercial species, including determining the oceanographic features that influence their distribution, abundance and life history.

The second main commercial activity in the offshore marine environment of the Falkland Islands is an exploratory petroleum programme, which commenced in the 1970s, and has included seismic surveys and drilling test oil wells.

Commercial fisheries

The Falkland Islands declared the FICZ, 150 nautical miles around the islands, in October 1986 and the FOCZ (extended to the 200 nautical mile limit) in 1994. Since 1986, the fishery has targeted eleven species of finfish, two species of cephalopod and one bivalve. There is a well developed system of setting licence fees and it collects up to £25 million annually, with approximately £6 million being subsequently re-invested into managing the fisheries (Harte and Barton 2007b).

A new fisheries policy for the Falkland Islands was introduced in September 2005 with the implementation of new property rights and licence systems. The Fisheries (Conservation and Management) Ordinance 2005 gives legislative effect to a major review and modernisation of fisheries policy including the introduction of property rights in the Falkland Islands fishery. The increased security through an up to 25 year property rights is intended to encourage diversification and value adding activities in the Falkland Islands, together with investment in research and development.

Under the Fisheries (Conservation and Management) Ordinance 2005, sustainability means maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations; and avoiding, remedying, or mitigating adverse effects of fishing on the marine environment so far as it is reasonably practicable to do so.

The ordinance has the following environmental and information principles:

- associated or dependent species shall be maintained at or above a level that ensures their long term viability
- biological diversity of the marine environment shall be maintained
- habitats of particular significance for fisheries management shall be protected
- decisions shall be based on the best available information
- decision-makers shall consider any uncertainty in the information available in any case
- decision-makers shall be cautious when information is uncertain, unreliable, or inadequate

The ordinance has the following objectives:

(a) The implementation of efficient and cost-effective fisheries management on behalf of the Falkland Islands;

(b) Ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the need to have regard to the impact of fishing activities on non target species and the long term sustainability of the marine environment.

(c) Ensuring, through proper conservation and management measures, that the living resources of the fishing waters are protected from over-exploitation;

(d) Achieving the optimum utilisation of the living resources of the fishing waters; and

(e) Ensuring that conservation and management measures in the fishing waters and the high seas are in accordance with the obligations of the Falkland Islands under international agreements that deal with fish stocks.

The Director of Fisheries may under the ordinance set or vary any sustainability measure for one or more stocks, which may relate to one or more of the following:

- for stock managed by effort, any Total Allowable Effort in relation to that stock;
- for stock managed by quota, any Total Allowable Catch for that stock;
- the size, sex, or biological state of any fish of any stock that may be taken;
- the areas from which any fish of any stock may be taken;
- the fishing methods by which any fish of any stock may be taken or which may be used in any area;
- the period for which fishing may take place in any fishery.

The waters covered by the ordinance include the internal waters and territorial seas, FICZ and FOCZ. The Fisheries (Conservation and Management) Ordinance 2005 also extends the Conservation of Wildlife and Nature Ordinance 1999 to the fishing waters beyond the territorial sea.

The various fisheries are now very closely monitored and managed in-house by the FIG Fisheries Department (FIFD) and prior to this, the Renewable Resources Assessment Group (Imperial College, UK) was contracted by FIG to provide stock assessment advice.

FIFD collects the following information:

- Information on fish stocks;
- Daily catch reports documented in vessel logbooks;
- Monitoring of catches and collection of biological data on target and bycatch species by FIFD fisheries observers;
- Specific surveys and research for stock assessment of commercially important species;
- Routine monitoring of commercial landings during transhipments that take place within Falkland Islands waters

From 1991 until 2005, there was an active joint process with Argentina under the auspices of the South Atlantic Fisheries Commission (SAFC). The SAFC is composed of delegations from Britain and Argentina, with participation of observers from the Falkland Islands as part of the British delegation. It provides a forum for exchanging information on marine living resources, and for discussing the implementation of measures to improve the conservation of commercially significant stocks in the southwest Atlantic. SAFC includes joint research cruises for *Illex* and some finfish species. Since 2005, Argentina has withdrawn from this process.

Fishing effort

The main target species are short-finned squid (*Illex argentinus*), Patagonian squid (*Loligo gahi*), southern blue whiting (*Micromesistius australis*), hakes (*Merluccius hubbsi* and *M. australis*), hoki (*Macruronus magellanicus*), Patagonian toothfish (*Dissostichus eleginoides*), skates and rays (Rajidae), red cod (*Salilota australis*) and Patagonian scallop (*Zygochlamys patagonica*) (Barton 2002). *Illex*, hake, hoki and southern blue whiting are pelagic species, whilst the other species are demersal. In Falkland Islands waters, annual catches are typically of the order of 150,000 MT of squid, fish and shellfish, composed of around 50% *Illex*, 25% *Loligo* and 25% finfish and other species (FIFD 2006; Harte and Barton 2007b).

In terms of effort, the two main types of fishing activity in Falkland Islands waters since 1986 have been trawling and jigging, although demersal longlining, pelagic trawling and potting have been or are currently employed (FIFD 2006). Various licences are issued, including specific licences for demersal toothfish longlining, bottom scallop trawling, jigging for *Illex* and trawling for squid, skate and fish species.

Finfish trawl licences can be unrestricted finfish, restricted finfish for surimi (targeting southern blue whiting and hoki) and for finfish/*Illex*. Licences are limited to meet conservation objectives, which are framed in terms of total allowable effort or catch. Fisheries for various finfish species can effectively take place throughout the year, although there are seasonal peaks in both effort and catch per unit effort. The ca. 9 – 12 vessels with unrestricted finfish licences target common hake, red cod, hoki and kingclip, with a further ca. 18 vessels with restricted finfish licences (FIFD 2006). All trawl licences

set a minimum mesh size of 90 mm, except for the *Loligo* squid fishery and pelagic trawling for *Illex*, where the squid are very small.

Vessels from 25 flag states have fished in the Falkland Islands since 1989. In 2005, most licences were issued to vessels registered in the Falkland Islands, Spain, Korea and Taiwan (FIFD 2006). The Falkland Islands fishing fleet includes 19 trawlers, three longliners and one combination jigger/longliner (FIFD records).

Oceanographic monitoring

Reliable oceanographic data were obtained by static and drifting buoys measuring conductivity, temperature and depth operated during 1997-98 (Upton and Shaw 2002). The Falkland Islands Fisheries Department began monitoring aspects of the ocean surrounding the Falkland Islands in 1994. A programme of regular monitoring was started in 1999 with monthly surveys of two transects crossing the shelf from depths of 20 m to approximately 1000 m to the east of Stanley and near Beauchêne Island.

Conductivity, chlorophyll levels, dissolved oxygen and temperature data are collected at various water depths from the surface to near the seafloor or to a maximum depth of about 1000 m. More extensive oceanographic surveys are also conducted during regular fisheries research cruises, which are usually around two weeks in duration, and occur approximately three times a year in different regions of the FICZ and FOCZ.

Offshore sea-surface temperatures range from around 6°C in winter to 10-13°C in summer (February), although there have been quite large fluctuations during the period of monitoring (Fig. 11.2) (Upton and Shaw 2002; FIFD, unpublished data). The inshore sea surface temperatures range from 2°C in winter to 14°C in summer.

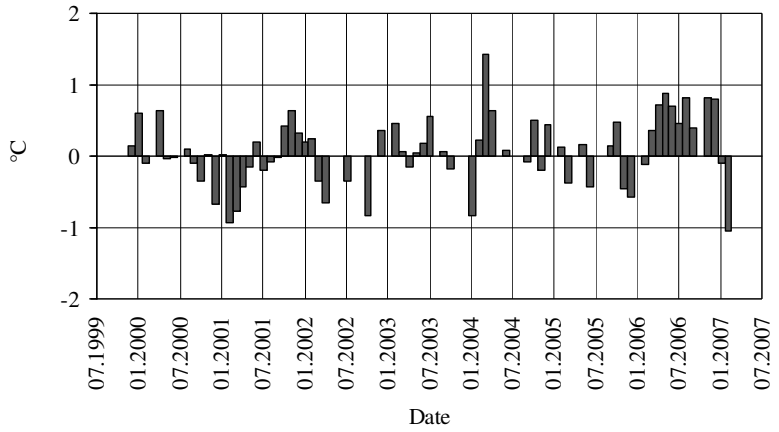


Fig. 11.2 Deviation from the expected sea surface temperature in Falkland Island waters since 1999 (FIFD, unpublished data).

Phytoplankton

Little is known about the distribution, abundance and spawning areas of phytoplankton (micro-algae such as dinoflagellates and diatoms) in the Falkland Islands. Scientists working as part of the Discovery Programme studied plankton taken in trawls whilst travelling from South Georgia to the Falklands and from the Falklands to South America (Hardy 1928). There were relatively few phytoplankton species and high diatom abundance south of 44 ºS, whilst the northern waters were comparatively dominated by dinoflagellates and infusoria (Ingram Hendley 1937). This composition has been confirmed by more recent surveys (Rodhouse et al. 1992), although a number of new species and subspecies of dinoflagellates and diatoms were recorded during a research cruise from the Argentine coast to the north of the Falkland Islands (Balech 1971).

Zooplankton

The oceanography and topography of the Patagonian shelf and the strong Falklands Current create areas of very high zooplankton productivity immediately to the north and south west of the Falkland Islands (Agnew 2002). Zooplankton is a key part of the food chain because they are consumed by squid, fish, sea lions, seals, baleen whales and penguins (Thompson and Riddy 1995; Thompson et al. 1998; Pütz et al. 2001; Thompson and Moss 2001; Quillfeldt et al. 2006).

Important zooplankton species include the swarming epipelagic 'krill' species such as *Munida gregaria* (lobster krill), *Euphausia lucens*, *E. vallentini* and *Thysanoessa gregaria*. *T. gregaria* is most abundant in the southern part of the continental shelf, *E. lucens* is more common on the northern shelf area, whilst *E. vallentini* is most common in the cold Falklands Current (Agnew 2002). Amphipods, particularly of genus *Themisto*, such as *T. gaudichaudi*, also occur in Falkland Islands waters.

Benthic invertebrates

Knowledge of molluscs, bryozoans (tiny colonial animals that build themselves stony skeletons), echinoderms and annelids in the offshore environment beyond 30 m water depth is scarce, although a variety of marine invertebrates are hauled up incidentally with nets, lines, pots and dredges of a variety of vessels targeting finfish, squid, rays and scallops. It is a priority research area for Falkland Islands.

Benthic macro-invertebrate surveying from north to south along the Patagonian Shelf showed that there are three benthic biogeographic provinces: the Argentine province on the warmer, inner shelf off Buenos Aires, the Patagonian province on the south part of the shelf and the Malvinean province in the outer shelf under the influence of the Falklands Current (Bastida et al. 1992). Molluscs were most dominant by number, followed by bryozoans and echinoderms.

The Malvinean province was relatively species-rich compared to the Patagonian province and 15-20% of the species in the former province were endemic to the region (Bastida et al. 1992; Mein 1992). For example, Tierra del Fuego and the Falkland Islands are one bioregion for polychaetes, with an extremely diverse and high level of endemism compared to other sub-Antarctic and Antarctic regions

(Knox 1977). Endemicity in places such as the Falkland Islands, South Georgia and Antarctica is that the dominant invertebrates produce demersal larvae that can not disperse far due to the lack of shallow water bridges.

Baseline benthic surveys were conducted at six exploratory well sites in the North Falkland Basin in 1998 prior to drilling and at one well post-drilling (Gardline Surveys 1998a, b, c, d, e, f and g). The invertebrate fauna were identified only to family level, with no unusual results and no significant changes in invertebrate diversity post-drilling. The specimens are probably still in storage in the UK and thus available for further study.

There are some deepwater mollusc species in the waters of the Falkland Islands, but they have been little studied. The Patagonian scallop (*Zygochlamys patagonica*) is found both inshore and in waters up to 145 m in depth, mainly along the north-eastern, eastern and southern edge of the Falkland shelf (Bizikov and Middleton 2002). A small experimental but commercial fishery for Patagonian scallop has existed since 2001, concentrating in an area to the northeast of the Falkland Islands at depths of 130 – 142 m (Bizikov and Middleton 2002).

Between 59 and 1358 MT of scallops have been taken annually, which is sustainable (FIFD unpublished data). Previous stock assessments were relevant to the fishing activity undertaken at that time, but will need to be updated if the nature or intensity of fishing changes. Catches are 92% scallops, which are processed aboard, and the annual mean discard is 68 MT, mostly being benthic invertebrates (Table 1). There were no seabird bycatch issues associated with the fishing vessel and methods employed so far (FIFD, unpublished data).

Several species of crab are found around the Falkland Islands including the inshore false king crab (*Paralomis granulosa*) and the larger southern king crab (*Lithodes antarcticus*) (see Chp. 9). In deeper waters, experimental trawling on the southern continental slope to the south of the Falkland Islands, as well as bycatch reports from longline vessels, suggest a significant population of the stone crab (*Neolithodes* sp.).

Cephalopods

The sub-Antarctic surface waters of the Falkland Current contain a rich assemblage of cephalopod species, including sub-tropical, sub-Antarctic and Antarctic species such as *Histioteuthis atlantica, H. eltaninae*, *H. macrohista*, *Batoteuthis skolops* and *Gonatus antarcticus* (Rodhouse et al. 1992). Cephalopod species recorded on the shelf area include *Loligo gahi*, *Gonatus antarcticus*, *Martialia hyadesi*, *Moroteuthis knipovitchi*, *Batoteuthis skolops*, *Semirossia patagonica* and various species of octopus (*Benthoctopus* spp.).

A few giant squid (*Architeuthis* sp.) have been caught in Falkland Islands waters, as well as their beaks in the stomachs of sampled toothfish. An 8.6 m long *Architeuthis dux* caught in March 2004 is now on display at the UK Natural History Museum.

Adult cephalopods are regarded as active predators occupying a position near the top of the food chain, consuming fish, crustaceans and other cephalopods, and the stock of squid varies from year to year, depending mainly on the success of the previous spawning season (Hatfield 1990). Squid are exploited, both commercially and by a variety of fish, cephalopod, seabird, pinniped and cetacean species (Rodhouse et al. 1992; Thompson and Riddy 1995; Thompson et al. 1998; Pütz et al. 2001; Thompson and Moss 2001; Agnew 2002). The two commercial species in the Falkland Islands are *Illex argentinus* and *Loligo gahi*.

Illex fishery

Illex is found in the western sector of the South Atlantic Ocean, both on the high seas and in the economic waters of the Falkland Islands, Argentina and Uruguay. In summer, it is abundant on the lower shelf (50 to 200 m water depth) where it feeds on pelagic crustaceans, including species of the genera *Themisto* and *Euphausia* (Agnew 2002). In late autumn, *Illex* squid migrate up the Patagonian Shelf to spawn and here they are taken by fishing vessels, as well as by seabirds and marine mammals (FIFD 2006). The migration and dispersal of *Illex* is highly dependent upon the major oceanic currents and resultant water temperature and thus, its abundance in Falkland waters is highly variable (Sacau et al. 2005).

Illex is mostly caught north of the Falkland Islands from late February until June at between 80 – 800 m water depth by specialised Korean, Taiwanese and Chinese squid jigging vessels (FIFD 2006). The open season in the Falkland Island generally runs between 15 February to 15 June and up to 125 licensed vessels have bought fishing licences in previous seasons for fishing in Falkland Islands waters. Stock management includes leaving 40,000 MT of spawning stock biomass of *Illex* and early closure and restrictions have been applied in past years to achieve this.

The *Illex* fishery in Falkland waters is monitored by FIFD. Between 1991 and 2005, the SAFC undertook joint research cruises to determine the pre-recruitment abundance of *Illex*, data from respective zones and the high seas fishery was exchanged, and conservation action were coordinated to ensure that the conservation target of 40,000 MT of spawning stock biomass remaining was achieved. Although SAFC actions resulted in the early closure of the *Illex* fishery in both the Falkland Islands and Argentine zones in some seasons, measures suggested by the British Government to extend conservation measures to the high seas were not accepted by Argentina. Since 2005, Argentina has withdrawn from the SAFC process, which is a backward step for *Illex* conservation.

Little non-target species are caught by *Illex* jiggers and 93% of the squid caught is processed whole, leaving little offal to be discarded (a mean of about 1,000 MT annually) (Laptikhovsky et al. 2006b).

***Loligo* fishery**

Loligo gahi is a demersal, schooling species that is found in the eastern Pacific Ocean from southern Peru to southern Chile and in the western Atlantic Ocean from Uruguay to Tierra del Fuego. In the Falkland Islands, it is found on the shelf and inshore waters to the south and east of the islands (FIFD 2000). The species feeds in the outer shelf and shelf break (200 – 300 m) on euphausiids and other zooplankton and before 12 months of age, *Loligo* squid migrate to shallow inshore grounds in September/October or March/April where they spawn and die (Agnew 2002). *Loligo* appears to preferentially lay eggs on the above-seabed sections of thin solitary strands of kelp (FIFD 2000). The stock in the Falkland Islands remains wholly in our waters.

Loligo is the second most important species in terms of volume and value in the Falkland Island fishery, with seven companies representing approximately 16 vessels currently having property rights extending up to 25 years into the fishery. The vessels trawl demersally mostly within 30 - 40 miles (50 – 60 km) of the coast in the eastern and southern parts of the Falklands shelf during 24 February to 14 April and 15 July and 30 September (Arkhipkin et al. 2006). FIFD scientists conduct recruitment surveys prior to the opening of the two seasons, including using both the patrol vessel and a commercial trawler.

The fishery is thought to be stable or decreasing (FIFD 2006). Stock management includes leaving 10,000 MT of spawning stock biomass of *Loligo* and early closure and restrictions have been applied in past years to achieve this. A mean of 46,000 MT of *Loligo* is caught annually, as well as about a mean of 2,400 MT of discards of non-commercial fish and invertebrates (Laptikhovsky et al. 2006b). As *Loligo* is processed whole, there is little offal (an annual mean of approximately 1,200 MT of heads and guts of processed fish).

Elasmobranchs

A number of elasmobranchs species are found in the Falkland Islands, including skates and sharks. The IUCN lists the graytailed skate as globally endangered and the porbeagle shark spiny dogfish are globally near threatened. The graytailed skate occurs in the southwest Atlantic and off Chile from, with documented declines off the Falkland Islands and direct targeting and bycatch pressure continuing throughout its range, the species is assessed as endangered on the basis of observed and inferred past and suspected future declines (McCormack et al. 2007).

All skates in the Falkland Islands are demersal dwellers, feeding mostly on polychaetes, isopods, crabs, whelks, rockcod, squid and crustaceans (Brickle et al. 2003a), and they lay their eggs in a horny case. Sixteen species of elasmobranchs have been recorded in the Falkland Islands (FIFD 2004). Catsharks (e.g. *Schroederichthys bivius*) and dogfish (*Squalus acanthias*) have been bycaught by fishing vessels. Although they form vast shoals elsewhere, the maximum catch reported by observers has been in the order of several hundred kilograms per trawl (FIFD 2003).

The porbeagle shark (*Lamna nasus*) is a rare by-catch species in the Falkland Islands (FIFD 2003). The species is found worldwide from the mid-temperate areas to sub-Antarctic islands such as South Georgia. The porbeagle shark is ovoviviparous with one to five youngsters per litter.

The Pacific sleeper shark (*Somniosus pacificus*), one of the largest living sharks, appears to have a worldwide distribution in cold water regions feeding on a variety of fish, and scavenging pinniped, cetacean and giant squid carcasses. In the Falkland Islands, it is a rare by-catch species, predominantly caught in the longline fishery, where one individual was captured with hooked toothfish in its stomach (FIFD 2003; D. Brake personal communication). Both juvenile (less than 0.5 m in length) and large adult Pacific sleeper sharks up to 5 m in length have been caught in Falkland Island waters (FIFD, unpublished data).

Skate fishery

A small skate fishery using specialised Korean flag demersal trawlers has been in operation since 1994. A management objective to limit catches to 4,000 MT per annum means that four to twelve licences are issued per year. Four main species are targeted to the shallower waters to the south, west and north of the Falkland Islands. The vessels target skate (30% of the catch) but also hoki (38% of the catch) and other commercial species (23%). About a mean of 1,543 MT of bycatch species and a mean of 1,297 - 1,535 MT of offal are discarded (Table 11.1). A comprehensive assessment of seabird bycatch for the skate fishery is required.

Renewable Resources Assessment Group (Imperial College) has since 1998 completed an annual assessment of the northern ray fishery in the Falkland Islands. Skates were heavily exploited during 1991 – 1995 but the stock is now in the process of recovering and the current catches are sustainable (Renewable Resources Assessment Group 2006).

FIFD have completed growth and ageing studies of a number of skate species (Henderson et al. 2005; Arkhipkin et al. 2008). To study the migration patterns and life history parameters of the commercial skate species, over 2,000 skates of 11 species have been tagged and injected with a chemical in order to determine age and growth rates. A few skates have already been recaptured by vessels in the skate fisheries.

Finfish

At least 80 species of fish have been recorded in Falkland Islands waters, ranging from small rock cod to larger tuna and toothfish, with about 40-50 species being relatively common (FAO 1985: FIFD 2003). No endemic species have been found. Data on non-commercial finfish species is very limited, whereas the distribution and lifecycle of most of the seven main commercial species is well known.

A number of non-commercial species are important to wildlife in the Falkland Islands, including lanternfish (Myctophidae sp.) for king penguins, crocodile fish (*Agonopsis chiloensis*) for Magellanic penguins and Falkland herring (*Sprattus fuegensis)* for hakes, gentoo penguins, Magellanic penguins, black-browed albatrosses and seals (Pütz et al. 2001; Thompson and Moss 2001; Clausen and Pütz 2002; Huin 2003).

Southern blue whiting

The southern blue whiting (*Micromesistius australis*) is one of the largest finfish resources in the southwest Atlantic Ocean region. This pelagic species migrates from deeper to shallower waters (200 – 300 m) to spawn, with pre-spawning fish congregating in July in a small area 16 to 20 km south of the south west tip of West Falkland (Patterson 1986). Post spawning, southern blue whiting migrate into deeper water dispersing south and west where they are thinly distributed over the Patagonian Shelf (FIFD 2006). The main prey items of southern blue whiting are krill, copepods, amphipods, octopods and small fishes. Small southern blue whiting are found in the diet of sea lions, gentoo penguins, Magellanic penguins and black-browed albatrosses (Thompson 1992; Thompson et al. 1998; Pütz et al. 2001; Thompson and Moss 2001; Huin 2003).

The main fishery for southern blue whiting in the Falkland Islands occurs from mid August to the end of October/mid November, with a secondary period during December and January. As the fishery progresses, the post-spawning stocks move offshore, into water deeper than 300 - 400m and are fished until they disperse.

A proportion of southern blue whiting specimens are heavily parasitised by *Kudoa allaria*, which releases protolytic enzymes into the flesh when the fish dies and hence reduces the quality of the flesh. For this reason, the species is of low commercial value and much of the catch is taken by surimi vessels that process the flesh into a paste to be used as a protein base for a wide variety of products such as imitation crabsticks and fish cakes. A proportion of the blue whiting stock is suitable for processing to fillets etc.

The southern blue whiting caught in the Falkland Islands is part of a stock found across the Patagonian shelf, which is assessed annually by Renewable Resources Assessment Group (Imperial College) using data from the Falkland Islands and Argentina including data obtained from a joint annual research cruise under the auspices of the SAFC. The stock is thought to have been decreasing, although the long-term pattern of decline in spawning biomass has been slowed (Renewable Resources Assessment Group 2006).

The target allocation for the species in the Falkland Islands is 25,000 MT, normally up to 18,000 MT is caught by two pelagic surimi trawlers, and 7,000 MT is bycatch on finfish and *Loligo* trawlers. On trawl vessels, about 88% of the southern blue whiting catch is filleted, producing a mean of about 2500 - 3500 MT of offal (Table 11.1). On the surimi vessels, a mean of 15 MT of unwanted fish and squid

are caught per year and except the squid, all bycatch and 1,535 MT of offal are made into fishmeal (Laptikhovsky et al. 2006b). A comprehensive assessment of seabird bycatch is required in the surimi fishery (Crofts 2006a).

Hakes

Within the Falkland Islands, there are two main hake species: Patagonian hake (*Merluccius hubbsi*) and common hake (*Merluccius australis*). Patagonian and common hake found in the Falkland Islands are probably part of stocks that range over the southern Patagonian Shelf region. Both Patagonian and common hake feed on the Falklands shelf area during summer months, but they do not spawn in the Falkland Islands (Arkhipkin et al. 2003a). From the stomach samples of hake species taken within Falkland Islands waters, their main prey would appear to be zooplankton, squid, myctophids and small hake (Agnew 2002). Small hake are found in the diet of penguins (Pütz et al. 2001).

Hakes, usually as 20% Patagonian hake and 80% common hake, are targeted by demersal trawlers to the west and north of the Falkland Islands, with the highest monthly catches tending to occur in August – September in the western part of the FICZ (FIFD 2006). Hakes are headed and gutted and from a mean catch of 2,225 MT, a mean of about 800 - 1,000 MT of offal is produced. The stock of hake is assessed periodically and the Falkland Islands appears to be at the edge of the distribution of a large hake stock that occurs in Argentine waters.

Hoki

Whiptail hake/hoki (*Macruronus magellanicus*) is a near-bottom fish that inhabits shelf and slope waters of the south-western Atlantic and southern Pacific Ocean, generally between 48 and 55 °S (Cohen et al. 1990). The species is present in Falkland Islands waters year round and is generally associated with the warmer waters of the shelf up to 200 m depth in the north and west of the archipelago (Middleton et al. 2001). The Falkland Islands waters are primarily a foraging ground for hoki with zooplankton, sprat and *Loligo* taken. Small hoki are found in the diet of fur seals, sea lions, gentoo penguins and black-browed albatrosses (Thompson et al. 1998; Pütz et al. 2001; Thompson and Moss 2001; Huin 2003).

Hoki is targeted by general demersal finfish trawlers and to a lesser extent, surimi vessels to the west and north of the Falkland Islands throughout the year. As 59% of the hoki catch (a mean of 20,000 MT) is filleted, the amount of offal produced is relatively high (a mean of about 9,500 – 13,300 MT) (Table 1). Hoki is part of a stock found across the Patagonian shelf and has been assessed annually using catch, reproductive and growth data from the Falkland Islands by Renewable Resources Assessment Group (Imperial College). Catch per unit effort data suggests an increase in population size over the past seven to eight years after a decline in the early 1990s (Renewable Resources Assessment Group 2006).

Kingclip

Kingclip (*Genypterus blacodes*) is a common non-target species caught, particularly in June and October, by finfish trawlers targeting hoki, hake and red cod, and a mean of 1,600 MT of kingclip are headed and gutted annually, which produces a mean of 571 - 871 MT of offal. The stock of kingclip is monitored by FIFD. In the Falkland Islands, kingclip prey on rockcod, benthic isopods, *Loligo* and eelpouts (Nyegaard et al. 2004).

Red cod

Red cod (*Salilota australis*) is a demersal species that utilises the shelf area (100 – 300 m water depth) and spawning fish congregate in August to October in a small area 16 to 20 km south of the south west tip of West Falkland (FIFD 2006). Small red cod are found in the diet of sea lions and gentoo penguins (Thompson et al. 1998; Pütz et al. 2001).

Demersal trawlers also specifically target spawning concentrations of red cod in the south-western part of the FICZ during August to September. The mean annual catch is 3,500 MT and as 93% of the catch is headed and gutted, a mean of about 1,194 – 1,740 MT of offal are produced (Table 11.1). The catch of red cod appears to have remained fairly stable over the last five years (FIFD 2006; Renewable Resources Assessment Group 2006). Red cod catches and stock parameters are monitored, and spawning surveys were carried out in October during 2005 - 2007 to collect basic reproductive information.

Finfish vessels collectively

During 2000 – 2005, finfish vessels caught annually a mean of 35,358 MT of finfish and 3,308 MT of squid (mostly *Illex*, by vessels with an *Illex*/finfish licence), of which 90% is commercial species that is processed and 10% is bycatch, which is discarded. The bycatch species is predominantly rockcod (mostly *Patagonotothen ramsayi*), frogmouth (*Cottoperca gobio*) and redfish (*Sebastes oculatus*). To investigate the potential for a sustainable rockcod fishery, the biology of the species were investigated during 2003 - 2004 (Brickle et al. 2005) and subsequently, large rockcods now are increasingly processed (FIFD records). Rockcods are an important prey for gentoo penguins, Magellanic penguins and rock shags (Clausen and Pütz 2002).

Most finfish is headed and gutted, and a smaller proportion is filleted, which results in about 7,400 MT per annum being discarded (Table 11.1). There is no offal management by finfish vessels beyond discarding it, except on surimi vessels, which make fishmeal.

Patagonian toothfish

Patagonian toothfish (*Dissostichus eleginoides*) in the Falkland Islands have a long juvenile and sub-adult period in the relatively shallow and warm waters of the outer shelf and upper slope (Laptikhovsky et al. 2006a). With age, adult Patagonian toothfish migrate to deeper waters and spawn around the

Burdwood Bank, mostly during July to August. Small and medium-size toothfish living on the shelf are active predators taking mostly one or two relatively large prey item at a time (Arkhipkin et al. 2003b). Large toothfish (>60 cm length) switch their diet to other large fishes and also seasonally *Loligo*, and in their deepest habitat (>1,000 m depth), toothfish are opportunistic predators eating relatively small and inactive prey, mainly crustaceans. Gentoo penguins take small toothfish (Pütz et al. 2001).

A Falkland Islands registered longline fishing company, which is a consortium of local fishing companies, holds the property rights for the toothfish fishery, which amounts to two one-year licences. Longliners must fish in waters deeper than 600 m (to avoid interacting with trawlers and catching juvenile fish). Whilst the catch of Patagonian toothfish in deep waters has remained stable over the last five years, the bycatch of juvenile fish in shallower water by finfish trawl fisheries has declined, suggesting that the recruitment to the longline fishery may be reduced over the next few years (Laptikhovsky and Brickle 2005). Stock assessment models show strong declines in biomass with the current stock size at about 50% of its unexploited state, and the fishery is only just within its limits of sustainable use (Laptikhovsky and Brickle 2005).

The toothfish is headed, gutted and frozen whole, which produces a mean of 592 - 722 MT of offal annually (Table 11.1). A mean of 282 MT of bycatch fish is discarded annually, including grenadier (*Macrourus holotrachys*), *Antimora rostrata* and a number of deepwater skate species. Until 2006, all bycatch was discarded, although skates were always processed by Korean longliners that fished periodically during 1998 – 2003. However, skates and grenadier are currently being processed on an experimental basis (Consolidated Fisheries Limited, personal communication). The longline fishery also has the propensity to hook and drown seabirds during setting, although successful mitigation measures have been employed since 2001 (see below).

Fate of discards

The annual discard rate of all the fisheries combined represents 4.2% of the commercial catch, with 7,000 - 8,000 MT of discards and 18,000 - 25,000 MT of offal generated from processing. Most of the discarded fish is returned to the sea dead, although rays can have high survival rates (Laptikhovsky 2004) and also possibly crabs. Demersal fish (i.e. all fish apart from hoki and southern blue whiting) generally feed on live prey, with fisheries waste only representing 1-3% of food items (Laptikhovsky et al. 2006b). Both offal and bycatch are an important source of food for seabirds but their association with fishing vessels also has a number of negative effects, which are discussed later in this chapter.

Table 11.1 Mean metric tonnes of annual catch during the period 2000 - 2005 and offal and bycatch discarded for each fishery (adapted from Laptikhovsky et al. 2006b and V. Laptikhovsky personal communication). The amount of offal discarded is approximate due to the uncertainty with conversion factors.

Fishery	Mean catch (MT)	Mean offal discarded (MT)	Mean bycatch discarded (MT)
Scallop	1,358	?	68
Illex	77,795	1,259	23
Loligo	45,805	178	2,372
Skate	4,265	1,297 - 1,535	1,543
Surimi	18,702	Minimal*	15*
Finfish	34,087	16,861 - 20,495	3,358
Blue whiting	7,085	3,100 – 3,500	
Hoki	19,715	10,200 - 13,300	
Hakes	2,225	950 - 1,050	
Redcod	3,430	1,740	
Kingclip	1,632	871	
Toothfish	1,875	592 - 722	282

* All offal and bycatch, except squid, is processed into fish meal

Seabirds and Marine Mammals

A number of seabird and marine mammal species are found in the offshore environment in the Falkland Islands and these are discussed in Chp. 6 and 10, respectively.

Seismic surveying

In 1977/78, the first offshore seismic surveys were carried out in Falkland Islands waters. This was very much frontier exploration covering depths around and slightly greater than 200 m, and was born out of the desire to ascertain whether the petro-carbon rich continental shelf adjacent to the Argentinean coast spread as far as the Falkland Islands.

The data was re-processed in 1991 and the Falkland Island Government approached exploration companies to see if there was sufficient interest to commence more detailed surveys. In 1993, FIG issued the first licences for exploration, which covered the entire FICZ and FOCZ. Subsequently further in-fill data was collected from 1995 onwards and by 2004, almost 1.3 million square km had been seismically surveyed. Over time, as the key areas have been identified, the density of surveys increased and the area surveyed annually decreased (Fig. 11.2).

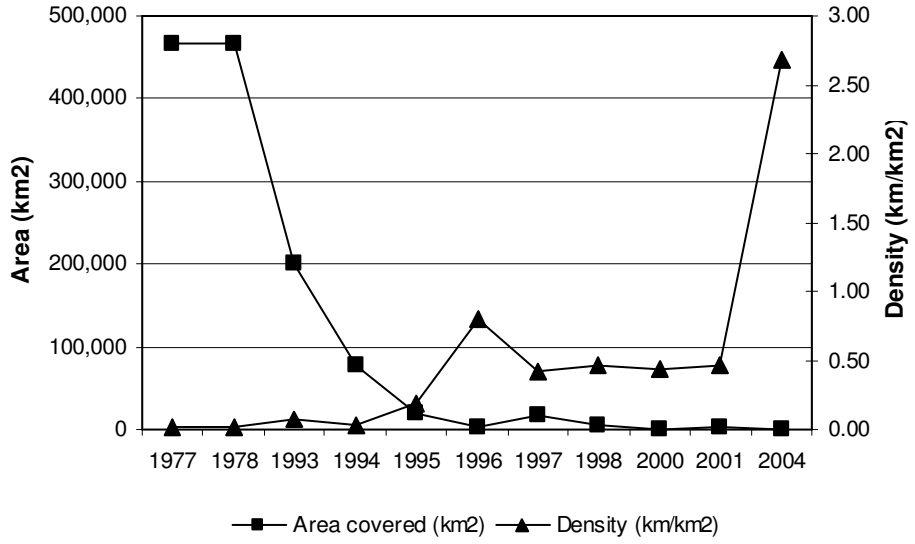


Fig. 11.2 Trends in seismic surveys in the Falkland Islands during 1977 - 2004, in terms of annual area and density covered

Modern large-scale seismic surveys are conducted using a towed array of 'airguns' – cylinders of compressed air. The array, typically containing tens of such cylinders, is discharged simultaneously, to generate a pressure pulse, which travels downwards into the seabed. The pulses, reflected back from the seabed and underlying strata, are recorded, interpreted and plotted on the vessel. As the survey proceeds, the airguns are continually fired and recharged with compressed air at intervals of approximately every ten seconds, dependent on the objectives of the survey.

The extent to which seismic disturbance from airguns affects cetaceans, fish and squid is not well known due to the limited research carried out to date (JNCC 2004; Hirst and Rodhouse 1996), although there is some evidence that beaked mammal strand in the presence of frequent anthropogenic noise (Barlow and Gisiner 2006). Legislation provided in the Falkland Islands Offshore Minerals Ordinance 1994 states that marine mammal surveys should be conducted prior to seismic surveys and there should be a slow build up of power in order to warn and scare away marine mammals.

The ordinance also prohibits seismic surveying within 12 miles of the coastline of the Falkland Islands and in two areas seasonally. This regulation was implemented following the recommendations of the FIG commissioned assessment of the effects of seismic operations on squid fisheries (Hirst and Rodhouse 1996). Two areas were recommended to be avoided at particular times of the year in order to reduce the risk of commercial squid species making behavioural changes that could impact on population and catch rates.

One area is north of 52°S and west of 58°W in water depths of less than 200 m during February to June because fishing for *Illex* squid takes place in this area at this time and the other is north of 53° 15' S in water depths less than 400 m during mid-October to mid-January due to the *Loligo* squid fishery.

The companies that have conducted seismic surveys in the Falkland Islands have conducted their own environmental impact assessments (e.g. Environment & Resource Technology Ltd. 1996) and survey work during 2007 was conducted with a marine mammal observer aboard (RPS Energy 2007).

Test oil wells

A number of companies were granted licences to explore specific areas of the Falkland Islands waters during three licence rounds held since 1998. Currently five companies hold oil exploration licences (Fig. 11.3).

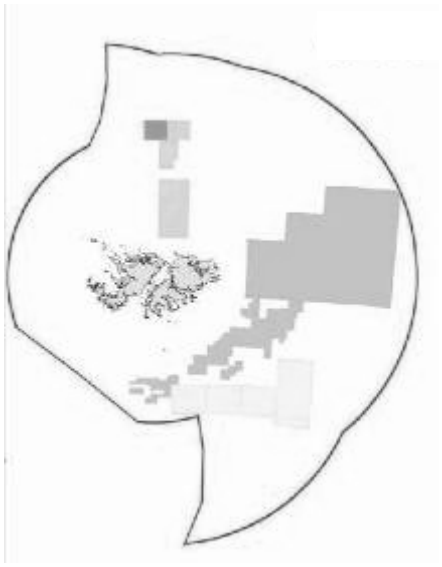


Fig. 11.3 The location of the current oil exploration licences (Source -http://www.falklands-oil.com/)

In 1998, after a comprehensive Environmental Impact Assessment, six wells were experimentally drilled in the North Falkland Basin (part of the area now licensed to Desire Petroleum) and subsequently capped. At each well, a baseline survey of the surrounding benthos was conducted prior to drilling (Gardline Surveys 1998a, b, c, d, e, and f) and at one well post-drilling (Gardline Surveys 1998g). These reports will stand as baseline data for assessment against future drilling and oil extraction at the well sites.

As EIAs were being prepared during the late 1990s, knowledge gaps for the distribution of marine mammals and seabirds were identified and a programme of at-sea surveys for seabirds and marine mammals, and penguin and albatross tracking studies were undertaken during 1998 - 2001 (e.g. Clausen and Pütz 2003; Huin 2002; Pütz et al. 2000, 2003; White et al. 2002).

Environmental Impact Assessments have been produced and accepted or are currently in preparation for further experimental drilling in the north, east and south basins (e.g. RPS Energy 2006). These plans include plans to prevent oil spills, and to mitigate damage to the sea floor and other impacts of having an inhabited drill rig within Falkland Islands waters. Significant impacts might be expected to occur if commercial drilling and oil/natural gas extraction occurs because of the construction of

pipelines, onshore development and processing, as well as through the increased shipping volume around the Falkland Islands.

The policies, structure and infrastructure for commercial oil extraction is not fully decided at this early stage but will be designed to minimise environmental impacts, both at sea and on land.

Threats

A number of processes associated with seismic surveys, test well drilling and commercial fisheries, which occur within the Falkland Islands, the waters of other countries and international sea areas, threaten directly or indirectly the offshore marine environment.

- Unsustainable catch of target and non-target species

To date, despite some apparent declines in catch of commercial species, FIFD maintain that generally all the fisheries are sustainable at their current levels (FIFD 2006). However, the sustainability of by-catch rates of non-commercial fish species has not been fully realised. Of greater concern, is the incidental mortality of seabirds by fishing vessels (BirdLife International 2004). Of the 23 albatross species for which the current conservation status is known, 42% are decreasing and interactions with fishing gear is identified as the key threat (Gales 1998).

Longlining for toothfish in the Falkland Islands is of relatively low year round effort and the fishery is well managed (Laptikhovsky and Brickle 2005; Otley et al. 2007b). FIG and Consolidated Fisheries Limited adopted a National Plan of Action – Longlining (NPOA-L) in March 2004 (FIG 2004b). The plan sets out long-term guidelines and fisheries policy to ensure that seabird mortality is maintained at a negligible level by the use of mitigation measures and observer coverage. Longliners working in Falkland Islands waters, and also any Falkland Islands flagged longliners fishing elsewhere, must follow very specific licence conditions to avoid seabird mortality, and the Fisheries Department employs two longline observers to educate longline fishermen, and monitor the use and effectiveness of mitigation devices (Otley et al. 2007b).

The estimated catch rate, predominantly of black-browed albatross, has declined from a catch rate of 0.016 seabirds/1,000 hooks in 2001/2002 to about 0.005 seabirds/1,000 hooks in 2004/05 and 2005/06 (Reid et al. 2004; Otley et al. 2007b; Falklands Conservation unpublished data). The stated aim in the NPOA-L is to have a catch rate below 0.002 birds/1,000 hooks by 2006/2007 (FIG 2004b). During 2007/08, the NPOA-L will be revised and should cover the period 2007 - 2012.

Another cause of seabird mortality in the longline fishery is associated with the secondary hooking (being hooked on the line as it is hauled aboard) and the consumption of bycatch and offal containing hooks. Injuries caused by the hooks, whether external or internal, may lead to the death of the adult seabird and/or chicks if they are fed any discards with the hooks. Estimating the level of this form of mortality can not be estimated and is a significant cause for concern. In 2003/04, 46 seabirds were

estimated to have been secondarily hooked in the Falkland Islands longline fishery and there was 93% compliance of hook removal from by-catch, offal and used bait (Otley et al. 2007b).

Seabirds are also accidentally killed in trawl fisheries, resulting predominantly from seabirds being attracted to discharged offal and bycatch, and subsequently colliding with trawl warps (95% of mortalities) or becoming entangled and trapped in nets during deployment or retrieval (5% of mortalities) (Sullivan et al. 2006b). Various bird-scaring devices were trialled and an adapted version of the tori line used by longline vessels was found to be most effective (Sullivan et al. 2006a)

FIG and the Falkland Islands fishing companies adopted a National Plan of Action – Trawling (NPOA-T) in 2004 (FIG 2004c), and the finfish and squid trawl licences included the use of bird-scaring lines from July 2004 onwards. The current seabird mortality rate in the finfish and squid trawl fishery is monitored by FIFD Fisheries Observers and during specific periods by one observer employed by Falklands Conservation. The reduction in seabird deaths on finfish trawlers subsequent to the employment of a bird-scaring line is reported to be 90% (Reid and Edwards 2005) and whilst the annual bycatch rate by the squid trawler fishery has not been properly quantified, it is thought to be lower when bird-scaring lines are employed (Crofts 2006b). A comprehensive assessment of seabird bycatch is required in the southern blue whiting (surimi) fishery (Crofts 2006a).

The ultimate solution would be associated with the better management of offal, and Munro (2005) identified the various management options suitable the Falkland Islands trawl fisheries. No work has proceeded in this area, primarily due to the lack of space aboard the trawlers to for example, store offal or install a meal plant.

The squid jigging fishery in the Falkland Islands does not directly catch seabirds. However, albatross carcasses are sighted floating amongst the squid jigging fleet and jiggers are seen trailing baited hooks, presumably to catch fish and seabird for consumption (Reid et al. 2006). Part of the solution to reduce this practice involves educational activities, improving humanitarian issues aboard jiggers and prosecuting intentional seabird take. Falklands Conservation prepared an 'Assessment Directive for Falkland Islands *Illex* Jigging' in 2004 as a starting point for any future development of a NPOA-jigging (Falklands Conservation 2004).

Black-browed albatrosses that breed in the Falkland Islands spend 50% of their time outside of the waters of the Falkland Islands and on the high seas and in the waters of other countries, they meet a range of less-well managed fisheries, particularly the pelagic longline tuna, swordfish and dolphin fish, fisheries. High rates of seabird mortality are estimated or suspected in these fisheries and the problem must be tackled on a regional scale, using the support of the Agreement on the Conservation of Albatrosses and Petrels (ACAP) (ACAP-SBWG 2007).

Fisheries observers aboard vessels in Falkland Islands waters also reported a low level of sea lion and fur seal net entanglement mortality (FIFD, unpublished data). Most mortality has occurred during August to October in the southwest region, particularly near Cape Meredith, by trawlers targeting aggregated spawning fish including southern blue whiting, hake and hoki. Due to the low level of the mortality, no measures are required to be employed by trawlers.

- New food sources

Many species of seabird, marine mammal and fish in the Falkland Islands have been documented or are suspected of exploiting caught fish, discarded bycatch and offal. The addition of new opportunities to obtain prey (e.g. fishing discards) within marine food webs is not well understood. Elsewhere, there is some evidence that the population of scavenging seabirds have increased considerably at sites where discards are plentiful (Votier et al. 2004 and references therein).

- Damage to benthic communities

Bottom trawling and drilling for oil and natural gas can significantly affect the benthic environment but it has been little studied in the Falkland Islands and thus is a priority for research and assessment. The impacts are considered as part of the EIA process for test wells but they are currently not investigated within demersal fisheries, although currently, there is no heavy dredging in the Falkland Islands.

- Removal of food source

The diet of some seabird and pinniped species has been studied in the Falkland Islands, whilst most cetaceans have been little studied locally. A number of marine mammal and seabird species in the Falkland Islands utilise some of the species taken by the commercial fishery, but there is no conclusive evidence that this interaction amounts to direct competition or that it is having a negative impact on population levels or breeding success at an individual level (Thompson and Riddy 1995; Thompson et al. 1998; Pütz et al. 2001; Clausen and Pütz 2002; Thompson and Moss 2001; FIFD unpublished data).

However, it is difficult to determine if the removal of certain size ranges particular commercial species may indirectly affect marine dependent species due to subsequent changes in stock structure and food webs. As well, for seabirds and marine mammals that feed or migrate outside of the Falkland Islands, little is known about the removal of fish from the north foraging grounds affect them.

The only commercial species that is taken at the commercial size in any significant amount by any seabird species in the Falkland Islands is *L. gahi* by the gentoo penguin (Pütz et al. 2001; Clausen and Pütz 2002). The decrease in catch per unit effort (CPUE) for *L. gahi* is mirrored by a gradual disappearance of the species from the diet of the gentoo penguin, which has been replaced by an increase in nototheniid fish. It is still impossible to say whether the shift in diet is the result of depletion by fishing vessels or an increase the availability of nototheniid fish, and also whether greater foraging effort must be expended in targeting fish rather than squid (Pütz et al. 2001).

- Marine debris

The amount of marine debris in all ocean systems has at least doubled in the last decade, particularly in the form of plastics (Barnes 2002). In the Falkland Islands, monthly beach surveys during the 2001/02 summer at Volunteer Beach (East Falkland) showed an accumulation rate of 77 items/km/month of mean weight of 17.3 kg, with most debris being discarded fishing equipment and household waste that appeared also to have come from fishing vessels (Otley and Ingham 2003).

Marine debris can have significant acute and chronic effects on marine mammals and seabirds. They have been observed entangled with packing tape, string, line and netting, and 36% of all seabird species are known to ingest small plastic pieces, which can contain toxic chemicals and cause obstruction or damage to the digestive system of adults and chicks (Derraik 2002). Little is also known about the impacts of lost fishing gear, which can continue to capture wildlife (ghost fishing).

Falkland Islands registered vessels are required by FIG to comply with MARPOL 73/78 regulations, but many other nations do not enforce their flagged vessels to meet this international marine pollution legislation. There is no provision under any Falkland Islands fishing licence legislation to set specific standards of waste management, for example for having an incinerator. There is a waste management plan on the seismic survey vessels that operate in Falkland Islands waters and waste management plans will be specified in EIAs for oil test wells.

- Oil pollution

Under MARPOL 73/78 regulations, no oily wastes should be disposed of at sea. However, one of the most widely accepted threats to seabirds worldwide is surface pollution, particularly from mineral oils, at littoral breeding habitats, shallow inshore areas and oceanic foraging grounds. In the southwest Atlantic Ocean region, it has been estimated that 40,000 Magellanic penguins in Argentina alone die annually as a result of contamination with oil (Gandini et al. 1994) and the number of reported oiled penguins has greatly increased since the early 1990s and is strongly correlated with petroleum exports from Argentina (Garcia-Borboroglu et al. 2006). It is thought that chronic petroleum pollution (i.e. small but frequent oil discharges) account for most long-term environmental damage (USNRC 2003).

Although there is yet to be commercial oil extraction in the Falkland Islands, domestically within Falkland Island waters, there has been a number of small acute light fuel (i.e. marine gas oil) spills from vessels unknown, ones with mechanical problems and vessels that have run aground. However, few long lasting effects on the inshore or offshore environment have been documented (e.g. Nicholson and Harrison 2001).

The number of oiled seabirds reported in the Falkland Islands is relatively low, possibly due to the oceanic nature of the waters and the low shipping activity (Smith 1998). However, most seabirds and marine mammals occurring in the Falkland Islands are forage in areas beyond the waters of island, visiting areas where there is petroleum extraction and processing, as well as well-used shipping routes.

Three years of dedicated at-sea bird surveys were utilised to assess and define areas that contain significant concentrations of seabird assemblages that are vulnerable to surface pollution at different times of the year (White et al. 2001). The oil-sensitivity of a seabird species is based on four parameters: the proportion of the time spent on the waters surface, the size of the biogeographical population, the potential rate of recovery after a reduction in number and the reliance on the marine environment (Tasker et al. 1990).

Penguins, albatrosses, petrels and shags were rated as being most vulnerable to oil pollution and the period of high vulnerability stretched from October to March, but February is the most critical month, whilst the month of lowest vulnerability is July (White et al. 2001). Vulnerability in inshore waters is high at all times of year due to resident coastal species. The most important area for oil-vulnerable seabirds is the western sector of the Falkland Islands, and the northwest and southern regions to a lesser extent.

Although marine mammals would normally be expected to actively avoid spilled oil, any oil on their coat, inhaled or ingested could have a significant effect. For pinnipeds, the problem may be more acute if coastal pollution occurs during the breeding season when lactating females and pups cannot disperse.

- Anthropogenic noise

Some wildlife, such as beaked whales and some fish species are particularly sensitive to sonar and seismic survey sounds but detailed research in this field, including developing mitigation measures, is difficult (Barlow and Gisiner 2006). The current seismic survey regulations in the Falkland Islands include regulations to reduce the potential effects of seismic survey noise and marine mammal observers were employed during 2006/07. These observers reported no adverse responses by seabirds and marine mammals sighted prior to or during seismic survey operations (RPS Energy 2007).

- Climate change

Climate change forecasters suggest that the initial strong melting of Antarctic ice due to global warming will result in cooler water and air temperatures and increased cloud cover, rainfall and intensity and frequency of extreme storm weather in the Falkland Islands. However, north of the Falkland Islands (e.g. 40-50 ^{o}S), water temperatures may be higher.

Cooler, less saline waters may particularly affect the distribution and abundance of the main species of inshore fauna and flora. However, the extent of this impact is poorly understood as the majority of inshore and shelf species have evolved high tolerance to environmental fluctuations. Stronger storms could cause damage to the sub-littoral kelp forests because of the increased surge, which might lead to shrinkage of the spawning grounds of *Loligo* squid and thus, a decrease in their abundance.

With the initial predicted warming in ocean temperatures, temperature-sensitive toxins produced by phytoplankton could cause contamination of seafood, jeopardising seafood safety, as well as affecting the health of top marine predators. However, the predicted stronger winds and surge may in fact reduce the chances of toxic algal blooms, due to the stronger mixing of near shore waters.

The cooling of the Antarctic Current and warming of the Brazilian Current might create a stronger gradient zone, which could potentially boost the primary production and correspondingly, favour aggregations of squid and commercial fishes within the economic waters of the Falkland Islands. This sort of predicted oceanographic event did in fact occur during the autumn of 2006 and there was higher than usual commercial catch of *Illex* squid and demersal fishes such as hake, hoki and kingclip in the northern part of the FICZ.

However, squid species are very variable by nature and it would be difficult to tell whether a change in the amount of stock is symptomatic of global climate change, small scale short-term oceanographic variability or fishing pressure.

Chapter 12 - Invasive species

Introduction

The IUCN has identified that the introduction of non-native species is one of the major threats to native biological diversity. The impact of invasive and alien species can be immense, insidious and often irreversible. In the past, the natural ocean barrier in the Falkland Islands has provided effective biological isolation that has allowed unique species, ecosystems or wildlife behaviours to develop. However, just a few hundred years of human trade and travel has removed these barriers and introduced alien species to areas were the native species are not adapted to the new threat.

Island ecosystems are particularly vulnerable to alien introductions as the native flora and fauna often have limited biotic resistance to predation, grazing or competition. A wide range of plants and animals has been introduced to the Falkland Islands but introduced livestock such as sheep, horses and goats, as well as rats, mice and cats have had the biggest environmental effects. In the Falkland Islands, the native avifauna is predominantly ground nesting species and this makes them very susceptible to introduced predators. Indeed, the presence of introduced mammalian predators such as cats, rats and mice is the major factor controlling the distribution and abundance of nine Falkland Islands passerine bird species (Hall et al. 2002).

Not all non-native species in the Falkland Islands are invasives. The Convention on Biological Diversity defines an invasive alien species as one whose introduction and/or spread threatens biological diversity. In the Falkland Islands, this excludes non-native grazing animals (e.g. sheep, cattle, horses

and others) that are actively and responsibly managed for agriculture or recreation but it does include livestock that is feral and/or has uncontrolled/unmanaged land access.

A brief risk assessment was conducted of known introduced species in the Falkland Islands (Whitehead 2008). The assessment asked ten questions on the invasiveness potential for each non-native species to provide each species with an invasiveness ranking. Species with a ranking above a set target were identified as most appropriate for control effort because they had most, if not all, of the following characteristics:

- recorded as invasive on the Falklands or elsewhere
- have the ability to spread
- likely to cause economic, ecological and/ or agricultural damage
- pose risks to human and/ or livestock health
- their current distribution on the Falklands is localised
- effective control methods are available
- control would be supported by the community

A number of individuals and organisations in the Falkland Islands are involved in the research, control and eradication of invasive species, including landowners, FIG, UK Ministry of Defence, Stanley Growers, Falklands Conservation, New Island Conservation Trust, SubAntarctic Foundation for Ecosystem Research and most recently, the 'South Atlantic Invasive Species Programme, which has funding from the European Commission for the period 2006 – 2009.

Invasive micro-organisms

There are relatively few introduced animal and plant micro-organisms in the Falkland Islands that could be considered invasive. Such potential invasive micro-organisms include foot and mouth disease, bird flu and freshwater algae such as didymo (*Didymosphenia geminata*) which adversely affects freshwater fish, plant and invertebrate species in the southern parts of New Zealand. The biosecurity risks associated with invasive freshwater organisms associated with fishing gear is highlighted in the Falkland Islands Trout Fishing poster.

Invasive plants

The list of introduced plant species is certainly not complete, with many species observed in Stanley gardens not yet recorded. Of the known introduced plants, the risk assessment procedure identified 22 introduced plants scoring above 15, which are therefore considered invasive species in the Falkland Islands (Table 12.1) (Whitehead 2008).

Table 12.1 Potentially invasive plant species scoring 15 or above in the risk assessment

Common Name	Scientific Name	Score
Calafate	*Berberis buxifolia*	19
Gorse	*Ulex europaeus*	19
Broom	*Cytisus scoparius*	18
Darwin's barberry	*Berberis darwinii*	18
European ragwort	*Senecio jacobea*	18
Oxford ragwort	*Senecio squalidus*	18
Creeping thistle	*Cirsium arvense*	16
Chilean rhubarb	*Gunnera tinctoria*	16
Spear thistle	*Cirsium vulgare*	16
Slender thistle	*Carduus tenuiflorus*	16
Hemlock	*Conium maculatum*	16
Scotch heather	*Calluna vulgaris*	16
Stone crop	*Sedum acre*	16
Curled/yellow dock	*Rumex crispus*	15
Broad-leaved dock	*Rumex obtusifolius*	15
Mouse-ear hawkweed	*Hieracium pilosella*	15
Orange hawkweed	*Hieracium aurantiacum*	15
Lupin	*Lupinus arboreus*	15
Spiny sow-thistle	*Sonchus asper*	15
Smooth sow-thistle	*Sonchus oleraceus*	15
Marram Grass	*Ammophila arenaria*	15
Rowan	*Sorbus aucuparia*	15

These plants are categorised as invasive because they out-compete local flora species, reduce agricultural productivity (e.g. spines become entrapped in fleeces and pierce the skin of sheep creating entry points for disease) and some are poisonous to livestock (Summers 2007). However, some of the species also have agricultural and conservation benefits, with gorse for example providing shelter for livestock and breeding habitat for landbirds.

Calafate and gorse are locally widespread and the other species are limited to various locations such as Stanley, Mount Pleasant/Mare Harbour, Fox Bay and Saunders Island. Only European ragwort and Oxford ragwort are thought to be recent introductions and have a very limited distribution around Mount Pleasant/Mare Harbour (Summers 2007). Distribution data, cost-effective and achievable control and/or eradication methods applicable to the Falkland Islands for most invasive plants are limited. Consequently, few control/eradication programmes are in operation.

Invasive land and marine invertebrates

Analysis of native land invertebrate survey data for the Falkland Islands is soon to be completed (see Chp. 5). However, from this baseline data, the presence of introduced species and whether some species are invasive may well be difficult to determine with any great certainty. Knowledge of the shallow and offshore marine environment in the Falkland Islands is relatively poor (see Chp. 9 and 11).

The shallow marine environment in the Falkland Islands is species rich in some groups but poor in others and any new predatory species would face little competition. Vessel hulls and ballast water are

two potential methods of transporting invasive marine species (Lewis et al. 2005), although in the Falkland Islands, the threat of introductions from ballast water is low because relatively few vessels carry or discharge ballast water here. However, the chance of vessel hulls carrying foreign species is high. There is little legislative control over ballast water management and hull cleanliness in the Falkland Islands.

Two introduced marine invertebrates– a polychaete worm (*Chaetopterus variopedatus*) and a sea squirt (*Ciona intestinalis*) – have been recorded in the Falkland Islands but it is not known if they are invasive (Shallow Marine Surveys Group, unpublished data). Pacific oysters are considered to be invasive elsewhere (e.g. France) and it is also a possibility in the Falkland Islands, although they do not currently breed here possibly due to the low water temperatures.

Invasive animals

Nineteen introduced animals scored above 15 and are therefore considered invasive species in the Falkland Islands (Table 12.2) (Whitehead 2008).

Table 12.2 Potentially invasive animal species scoring 15 or above in the risk assessment

Common Name	Scientific Name	Score
Black rat	*Rattus rattus*	20
Norway rat	*Rattus norvegicus*	19
House mouse	*Mus musculus*	17
Patagonian fox	*Lycalopex griseus*	17
Cat	*Felis catus**	17
Greylag goose	*Anser anser**	17
Goat	*Capra hircus**	17
Greenbottle fly	*Lucilia sericata*	17
Greenbottle fly	*Protophormia terraenovae*	17
European earwig	*Forficula auricularia*	16
Sheep	*Ovis aries**	16
Brown hare	*Lepus europaeus*	16
South American guanaco	*Lama guanicoe*	15
Cattle	*Bos Taurus**	15
European rabbit	*Oryctolagus cuniculus*	15
Nth American cotton-tail rabbit	*Sylvilagus* spp.	15
Reindeer	*Rangifer tarandus**	15
Brown trout	*Salmo trutta*	15
Pig	*Sus scrofa**	15

Feral grazing animals

In the Falkland Islands, up until the 1980s, livestock was put seasonally onto most ground, including offshore islands. However, today due to the low prices for wool and meat, small offshore islands and some farmland areas have been fenced and de-stocked. Most livestock in the Falkland Islands are actively and responsibly managed for agriculture, with currently approximately 530,000 sheep and 6,000 cattle island-wide. There are also 502 goats, with two flocks on East Falkland and two on islands and 171 pigs (see Chp. 8 for further details).

There are few unmanaged livestock in the Falkland Islands, with some cattle and goats on Wickham Heights (East Falkland), which is owned by FIG. When unmanaged, of the current livestock animals, sheep would probably most rapidly kill the tussac grass, pigs would have the greatest impact in the long term as they uproot vegetation, whilst goats might have the highest breeding success and survival.

Grazing in general has had a significant impact on many habitats and species in the Falkland Islands, but mostly particularly on tussac grass, fachine, native boxwood and snake plant. Compared to lightly grazed pastures, heavily grazed pastures have less plant diversity and intensive grazing in the summer months produces a grassier and more productive sward but these species are almost always non-native, whilst native species diversity is reduced (Broughton and McAdam 2002c).

Early results of the rotational grazing system promoted by the Department of Agriculture suggest that native species such as mountain blue grass and cinnamon grass are returning to areas where they have not been seen for some time (Department of Agriculture, unpublished data). Joint research by the Department of Agriculture and Falklands Conservation on the effects of intensively rotating sheep over whitegrass pasture on small passerine bird abundance showed that the bird numbers increased slightly when the whitegrass sward was opened up, although the bird population was too small to obtain statistically significant results (A. Kerr, personal communication).

Reindeer

Two separate programmes of importing reindeer (*Rangifer tarandus*) from South Georgia have resulted in currently one reindeer in Stanley, nine castrated males on Weddell Island, a herd of 16 in the Cape Meredith area of Albemarle Station and 98 animals on Beaver Island (Department of Agriculture Farming Statistics 2006/07). All these herds are actively managed, particularly the herd on Beaver Island, which is regularly culled, and there is no evidence of over-grazing of their favoured plants, being mostly lichen and dock, and little tussac grass is eaten (S. Poncet, personal communication). Under the current circumstances, reindeer are not currently considered to be an invasive species in the Falkland Islands.

Rabbits and hares

In the Falkland Islands, the European rabbit (*Oryctolagus cuniculus*) is found in scattered localities on East and West Falkland, the European hare (*Lepus europaeus*) is found on East Falkland. Rabbits are also found on Pebble Island, Saunders Island, Bense Island and West Tyssen Island (in Falklands Sound). It is not clear if the rabbit on New Island is the European rabbit or the cottontail rabbit (*Sylvilagus* sp.), although one specimen was identified by the British Museum as the European rabbit (Woods and Woods 1997). The effect of rabbits and hares on the biodiversity of the Falkland Islands is not well understood but is thought to be negative (Summers 2007).

Guanaco

The Patagonian guanaco (*Lama guanicoe*) was introduced at various sites around the Falkland Islands during the 1860s and 1930s, but the species only became established on Staats Island at the western edge of the Falklands archipelago (Franklin and Grigione 2005). The number of guanacos present on Staats Island has fluctuated over time due to culling and natural causes; 15 animals were initially introduced and by the late 1950s, the population was close to extirpation due to a concerted culling effort as the animals and vegetation were both in poor state.

Since the late 1980s the population has not been culled and the current population size is suggested to be around 400 animals (Franklin and Grigione 2005). A number of habitats have been heavily grazed, with few remaining areas of grazing-sensitive species such as native boxwood and tussac grass. As well, there are large areas of sheet erosion, although these vegetation changes are also likely to be associated with the historical overgrazing by sheep and natural fires.

Although the guanaco is an invasive species on Staats Island, this group of animals offers unique opportunities to investigate questions of ungulate population ecology. It may be possible to mark and genetically recognise all individuals on Staats Island to assess the influence of relatedness, ancestry and genetic health on the behaviour, distribution and survival of the closed population (Franklin and Grigione 2005).

The owners of Staats Island manage the island as a guanaco research island and camelid biologist W. Franklin has undertaken research during the period 1999 to 2005, conducting population surveys, tagging, blood sampling for genetic analysis, measurement of skulls of dead animals, as well as mapping the vegetation. Differences between animals in guanaco populations on Staats Island and in Chile have been identified, including Staats Island specimens being smaller, having a lower newborn weight and a higher frequency of premature births and births of defected animals (Franklin 2005).

The guanaco is listed under CITES Appendix II and thus the export of live guanacos or guanaco material from the Falkland Islands would require an export permit.

Grey fox

The Argentine grey fox (*Lycalopex griseus*, previously *Pseudalopex griseus* and previous to that *Dusicyon griseus*) is native across southern South America and was introduced to the Falkland Islands during the 1930s. The species is found on Beaver Island, Staats Island, Tea Island, Weddell Island and Split Island (south of West Point Island) on the western edge of the Falklands archipelago and River Island, out from the north coast of West Falkland. Grey foxes were also present on Sedge Island but 15 years of continual shooting and trapping of 300 foxes eventually lead to their eradication (Franklin and Grigione 2005).

In South America, the grey fox generally feeds at dawn and dusk, and is an opportunistic omnivore, preying mostly on rodents, arthropods, carrion and berries (Zapata et al. 2005 and references therein). However, the species appears to target lambs on farmland across its native distribution and in the Falkland Islands (Bellati and von Thungen 1990; Miller 1998). On Weddell Island, birds and mammals represented about 80% of the diet of the fox, with all shot foxes during the early lambing season having eaten lambs (Miller 1998). However, insects, mussels, plants and berries and rat were also found in examined fox faeces and digestive tracts.

Efforts to control foxes on Weddell Island and to eradicate them on Beaver Island were initiated during the 1990s. On Weddell Island, a 5.2 km electrified 10-wire fence and/or 0.9 m high chain-link fence was constructed during 1993/94 to cut off the Loop Head area (3,550 ha) and FOXOFF poison, a manufactured bait, pre-poisoned with sodium monoflouroacetate (1080) was laid across Loop Head and adjacent to the fence line during 1997 (Fig. 12.1). Although the control required the regular inspection and maintenance of the fox-proof fence, which was not fox-proof at very low water, Loop Head was thought to be clear of foxes by 1998 (Ferguson and Ferguson 1998). Subsequent anecdotal observations and systematic shoreline bird surveys during 1998 indicated an increase in the abundance in adult and fledglings of a variety of bird species (Ferguson and Ferguson 1998; Scott 1998).

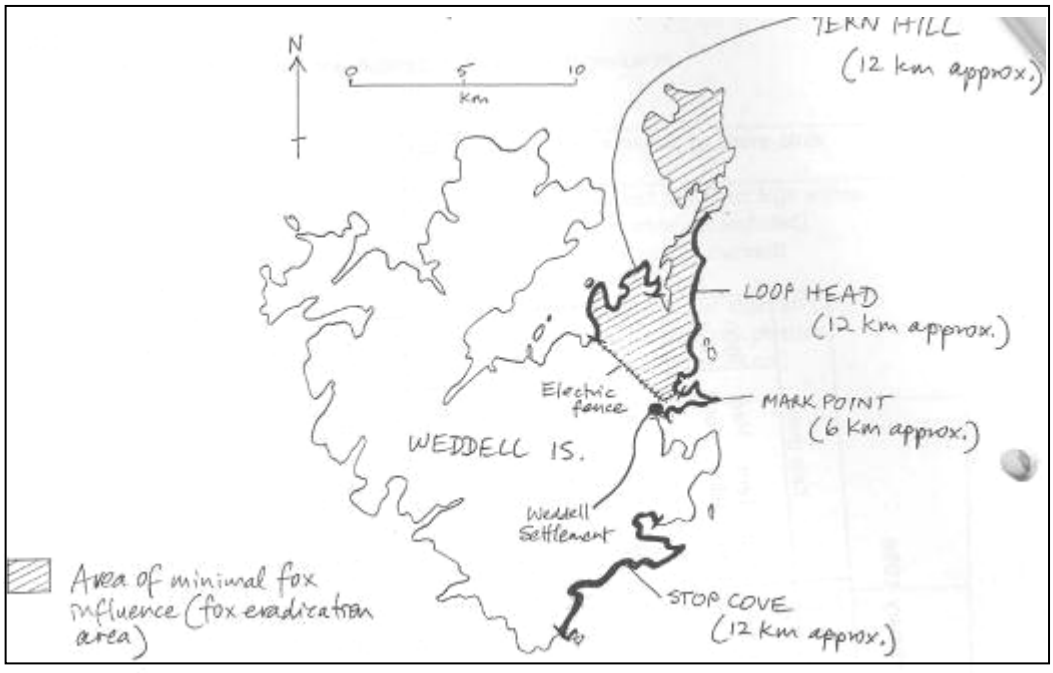


Fig. 12.1 Weddell Island, showing the Loop Head area where foxes were eradicated, and the baseline shorebird survey routes (Source Scott 1998).

However, Weddell Island was sold to a private company based in UK in 1999 and the new owners reduced the number of sheep from 23,000 to approximately 400, maintained workers on the island only during the summer season, and the daily effort necessary to maintain Loop Head free of foxes was not

sustained and foxes returned to the area. Surveys during 2005 indicated that shorebird abundance in the Loop Head area had reduced compared to surveys carried out during the fox-free period of 1998 (Garland 2005), although fox abundance inside Loop Head was suggested to be lower than in other areas of Weddell Island (Philip 2005).

There are contrasting views on the degree of effects of the foxes on the gentoo penguin colonies on Weddell Island, with Ferguson and Ferguson (1998) suggesting the gentoo penguins had abandoned/relocated their colony, Philips (2005) suggesting possibly that the rate of predation was higher during the moulting period and Garland (2005) indicating that species was little affected and breeding success was high compared to colonies at fox-free sites elsewhere.

On Beaver Island (3,900 ha), foxes were thought to take at least 15% of lambs and an island-wide FOXOFF baiting programme was conducted during 1997. Approximately only 10–15 foxes were thought to remain by the following summer (S. Poncet, personal communication). Replicate shoreline bird surveys in February 1997 and 1998 showed that the near-eradication of the fox on Beaver Island resulted in an increase in the abundance of adults and fledglings of steamer ducks, crested ducks and kelp geese (Poncet 1998). However, the landowners did not have the sufficient expertise and resources to locate and kill the remaining foxes. At the time and even today, there are few if any successful fox eradication programmes anywhere in the world, except on the Aleutian Islands, where over 40 islands have been cleared of Arctic foxes.

The future of fox control by the overseas-based owners of Weddell Island is uncertain. Beaver Island Farm gained funds from the Overseas Territories Environment Programme (OTEP), Falkland Islands Government, Falklands Conservation and Antarctic Research Trust to attempt the eradication of foxes from the smaller adjacent Tea Island (300 ha) during 2008, in conjunction with the eradication of black rats. An eradication plan is currently being formulated, in conjunction with fox eradication specialists in Alaska, and it is likely the plan will have to be a combination of poisoning, chemical lures, trapping, tracking with dogs and shooting. The capacity built during the Tea Island programme will allow a feasibility plan to be prepared for Beaver Island and, subsequently for Weddell Island. The owners of Split Island and River Island do not currently wish to proceed with control or eradication programmes.

The grey fox is listed under CITES Appendix II and thus the export of live foxes or fox material from the Falkland Islands would require an export permit.

Feral cat

The domestic cat lives feral across West and East Falkland and also on some islands, including the islands of New, Keppel, Pebble, Saunders, Weddell, Great (Adventure Sound) and Great (Falkland Sound) (Woods and Woods 1997). This is substantiated by the high prevalence of toxoplasmosis and sarcocystis (diseases that cats carry) in sheep killed at the abattoir (Department of Agriculture unpublished report). Fortunately, neither disease is of major importance to the agricultural industry.

Cats were eradicated during the 1980s and 1990s from Beaver, Bleaker, West Point and Speedwell Islands. Approximately 900 cats carrying a microchip live in Stanley (Department of Agriculture records).

Islands in the Falkland Islands with cats have reduced bird diversity compared to cat-free islands (Hall et al. 2002). Analysis of gross contents and stable isotope levels of cat faeces on New Island showed that mice, rats and rabbits are the predominant prey, with prions present in 13 - 22% of scats, rockhopper penguin remains in less than 2% of scats and there was no evidence that black-browed albatrosses were consumed (Matias 2005; Quillfeldt et al. 2008).

Rats and mice

The impact of introduced rodents in the Falkland Islands does not appear to have been as severe as reported in other areas of the world, where rapid extinction of native species have occurred following the introduction of rats and/or mice. The distribution of mice (*Mus musculus*) in the Falkland Islands is poorly known but they are clearly widespread (Woods and Woods 1997). Both the Norway (or brown) rat (*Rattus norvegicus*) and the black (or ship) rat (*Rattus rattus*) are present in the Falkland Islands, although the black rat is only currently known to be on New Island (Brown and Chadderton 2001). The Norway rat is a ground dwelling rodent that is a particularly efficient predator of birds, reptiles, amphibians, invertebrates and plants, and although the black rat is more arboreal, it is also a quite competent ground forager, and as a consequence, both species threaten a wide variety of birds, plants and insects across the world (Towns et al. 2006).

The diet of the Norway rat in the Falkland Islands is little known. On Bense Island, initial results suggest a diet high in seeds (P. Carey, personal communication), whilst faeces collected from the Arch Islands and other rat-infested islands seemed to consist mostly of coastal crustaceans rather than vegetable matter (R. Woods, personal communication). At South Georgia, the most dominant dietary items are tussac grass shoots, beetles, marine crustaceans and other plants (Pye and Bonner 1980). Despite the reliance on tussac grass as the primary food source at South Georgia, the effect of Norway rats on vegetation has not been documented in the Falkland Islands. However, vegetation surveys have been conducted on islands pre- and post-eradications and results should be reported in three to five years time.

In the Falkland Islands, research has been conducted of the diet of the black rat on New Island during the summer months when seabirds are breeding. Although rat diet varied with the age of individuals and the habitat in which they were caught, vegetation was the important component, followed by animal matter, insects and insect larvae (Quillfeldt et al. 2008). Despite the fact that black rats are believed to have existed on New Island for around 100 years, their impact upon the world's largest population of the thin-billed prion appears to be minimal, except for the small fraction of the population that nests in tussac grass habitat (Catry et al. 2006).

On many sub-Antarctic islands, including on New Island, stomach content and stable isotope analysis indicates that mice are omnivorous, but tend to concentrate on vegetable matter, seeds, and insects, rather than meat (ISSG 2006; Quillfeldt et al. 2008). In the Falkland Islands, adjacent islands that are mice-infested and mice-free show significant differences in invertebrate diversity and abundance (A. Jones, personal communication). The consumption of invertebrates by rats and mice has been shown to have multiple direct and indirect effects. For example, the removal of earthworms and moth larvae impacts on both soil decomposition processes and the winter survival of small land birds (Jones et al. 2002).

In the Falkland Islands, the presence of rodents has led to the localised reductions in range and/or extirpation of certain passerines and petrels on some islands (Hall et al. 2002). The species most affected by rodents are Cobb's wren (endemic), tussacbird (endemic race), Falkland diving petrel (possible endemic race), grey-backed storm petrel, Wilson's storm petrel, thin-billed prion and sooty shearwater. The black-throated finch, Falkland thrush, fairy prion and white-chinned petrel also appear to be affected by the presence of rodents at breeding sites in the Falkland Islands. The effect of mice on birds is thought to be minimal, except perhaps where rats are absent. For example, on Gough Island, which has mice but not rats, it has been shown conclusively that mice are responsible for breeding failures in seabirds through predating eggs and chicks (Wanless et al. 2007).

The combined effects and interplay between mice and rat populations and the follow on effects due to the selective removal of rats have not been studied in the Falkland Islands or elsewhere and should be given more attention within the current Falklands rat eradication programme (Forster 2007).

During 2001 to 2006, Falklands Conservation has led a programme of island restoration by eradicating Norway rats from 18 offshore islands, ranging from a few hectares to North East Island at 305 ha (Christie and Munro 2006). During 2007, a number of small islands within the North-West Islands (Falklands Sound) were also cleared and Beaver Island Farm Landcare Group attempted an eradication of rats from six islands around Beaver Island, and they have funds to clear a further two islands in 2008.

The rat eradication programme began in 2001 when three New Zealand habitat restoration experts developed a list of priority islands to be cleared in the Falkland Islands, with guidelines for eradications (Brown et al. 2001). The 18 islands cleared so far were selected based on their available habitat for Cobb's wren and burrowing petrels, offshore location, vicinity to rat-free islands and also an ability for researchers to undertake future management and monitoring.

Four small islands in close vicinity to Saunders Island were also eradicated of rats in 2001 in order to discover under what distances/conditions (e.g. rock reefs, kelp forests) rats can re-colonise islands in the Falkland Islands (Christie and Munro 2006). All cleared islands and three of the four experimental

islands remain rat free. Passerine bird numbers seem to have increased but successful breeding is yet to be confirmed at any cleared islands (Christie and Munro 2006).

Brown trout

The brown trout population is currently expanding and as an invasive species is causing significant effect on the populations of native zebra trout, which is in danger of extinction in much of its former range (see Chp. 7). However, the brown trout fishery is an important recreational asset to the Falkland Islands and although there are no plans to eradicate the species from any waterways, it is illegal under the Conservation of Wildlife and Nature Ordinance to accidentally or deliberately introduce trout to trout-free rivers.

National biosecurity

There is an acknowledged increase in the number of cargo vessels and aircraft coming to the Falkland Islands, although it is difficult to obtain accurate data on the number of arrivals and goods (Department of Customs and Immigration, personal communication). These are the key transport routes that non-native species have taken to get to the Falkland Islands.

A report on biosecurity in the Falkland Islands was produced in 2004 by a New Zealand biosecurity consultancy (Simpson and Hellstorm 2004). The report made 22 recommendations around 82 proposed tasks associated with legislation, risk management, development and implementation of a biosecurity plan, importation restrictions, education, surveillance and inspection. A Biosecurity Oversight Working Group (BOWG) was formed subsequent to the submission of the report and BOWG identified that seven of the tasks proposed by Simpson and Hellstorm (2004) should be the key activities, one of which was to create a Biosecurity Officer post within the Department of Agriculture, and these were endorsed by Executive Council in June 2005. The biosecurity report remains a FIG framework document but has not been formally adopted.

The import of plants and animals is controlled under legislation that is implemented by the Department of Agriculture and Department of Customs. Much of the biosecurity policy is driven by the Department of Agriculture's Senior Agricultural Advisor and Senior Veterinary Officer, and is implemented by the Biosecurity Officer. In addition, the Customs Ordinance 2003 gives powers to the staff of both departments to declare any item a prohibited good in order to inspect it.

The import of plants into the Falkland Islands is controlled by the Plant Disease Regulation Ordinance 1944 (plus various amendments), which allows the entry of packaged seeds and wood, but all other plants must arrive in the islands with an import licence, including a phyto-sanitary certificate that declares the product free of soil, insects and diseases. In some cases it has been difficult to determine the exact biosecurity threat posed by some plants, particularly ornamental species.

The import of items of animal origin in the Falkland Islands is controlled under the Customs Ordinance 2003, which has proclamations under Section 143 for live animals, eggs and semen of animals and shearing equipment. Any applications to import finfish for aquaculture (e.g. salmon, cod) or ornamental fish for tanks and ponds (e.g. coy carp, goldfish) must meet import regulations which may include the need to undertake an environment impact assessment.

There are currently no legislative requirements for the control of animal feed importation, vehicles, machinery and agricultural implements, and in-transit goods but importers recognise the biosecurity threats associated with these items and liaise closely with the Biosecurity Officer. There is currently no checking of building materials (e.g. wood and sand) for introduced plants and insects.

During 2004 – 2006, the Biosecurity Officer designed and implemented a number of new import protocols, declaration forms, educational posters and leaflets for incoming air and sea visitors, as well as for importers (Department of Agriculture 2006).

Intra-island biosecurity

Under the Conservation of Wildlife and Nature Ordinance, it is an offence to release, allow to escape or plant in the wild, any animal, bird or plant that is of a kind not ordinarily resident or a visitor to the Falkland Islands. However, this ordinance is generally not enforced for agricultural species.

There are a number of efforts, primarily educational, focused on preventing the spread of invasive species within the Falkland Islands. Making people aware of the issues particular to specific islands is compounded by the fact that more remote or smaller islands do not necessarily have fewer invasive species, and that islands differ in the types and frequency of transport methods used for people and goods.

The Environmental Planning Department is trying to improve intra-island biosecurity protocols, both for FIG- and privately-owned land. This is primarily through landowners educating visitors, a poster displayed at departure sites for FIGAS and helicopter flights, and information contained in the FIG Ports and Harbours booklet issued to all arriving vessels.

Chapter 13 - References

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Chapter 14 - Glossary

Adaptive management: An experimental approach to management, or "structured learning by doing".

Allele: A form in which a gene may occur.

Biological biodiversity (biodiversity): The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Components include:

- ***Genetic Diversity:*** The variability in the genetic make up among individuals within a single species.
- ***Species Diversity:*** The variety of species — whether wild or domesticated — within a particular geographical area.
- ***Ecological (ecosystem) Diversity:*** The variety of ecosystem types (for example, forests, deserts, grasslands, streams, lakes, wetlands and oceans) and their biological communities that interact with one another and their non-living environments.

Bioprospecting: The search among biological organisms for commercially valuable compounds, substances or genetic material.

Biosafety: The policies and actions taken to manage risks from the intentional introduction of new organisms, including genetically modified organisms, which could adversely affect biodiversity, people or the environment.

Biosecurity: The protection of people and natural resources, including biodiversity, from unwanted organisms capable of causing harm.

Biota: All the living organisms at a particular locality.

Border control: The policies and actions taken to prevent the accidental or illegal introduction of unwanted organisms across national borders. Border control includes pre-import pest control, certification, inspection and surveillance, and emergency responses.

Capacity: The technical and technological ability, skills, knowledge and organisational structure required to undertake management actions, and to collect and interpret information.

Coastal environment: An environment in which the coast is a significant element or part. The extent of the coastal environment will vary from place to place depending on how much it affects, or is affected by, coastal processes and the management issues concerned.

Conservation: While distinguished from "sustainable use" and "sustainable management", conservation embraces both the protection and judicious use and management of biodiversity for the benefit of human society and for ethical reasons, including its intrinsic value and its importance in maintaining the life-sustaining systems of the biosphere.

Convention on Biological Diversity: An international agreement on biological diversity that came into force in December 1993. The objectives of the Convention are: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

Data: The facts that result from direct observations or measurements. They can take the form of raw results from monitoring — such as the number of species in a particular area.

Ecologically sustainable fishing: Fishing which does not impair the ability of the target fish population to reproduce and which leaves a healthy aquatic ecosystem. In a healthy ecosystem ecological processes are maintained and the ability of all of the species present (or dependent on those present), to reproduce, is maintained.

Economic value: Economic value may be assigned according to the following components:

- ***Direct use value:*** The value of all goods and services derived from the direct use of biodiversity.
- ***Indirect value:*** The value derived from services from biodiversity (ecosystem services) that protect and support direct use activities.
- ***Passive value:*** The value of biodiversity in terms of potential future uses (option value), its existence for its own sake (existence value), and the willingness of present generations to pay to preserve biodiversity for the benefit of future generations (bequest value).

Ecosystem: An interacting system of living and non-living parts such as sunlight, air, water, minerals and nutrients. Ecosystems can be small and short-lived, for example, water-filled tree holes or rotting seaweed on the beach, or large and long-lived such as grasslands or lakes.

Ecosystem management: A management philosophy intended to sustain the integrity of ecosystems.

Endemic Species: An indigenous species that breeds only within a specified region or locality and is unique to that area. Falkland Islands' endemic species or subspecies include birds that breed only in Falkland Islands, but which may disperse to other countries in the non-breeding season or as sub-adults.

Environmental domains: Areas with similar physical environmental conditions, as defined by factors (including solar radiation, temperature, moisture and geological substrate) that have been demonstrated to have high correlations with plant and animal distributions.

Environmental education: A multi-disciplinary approach to learning that develops the knowledge, awareness, attitudes, values and skills that will enable individuals and the community to contribute towards maintaining and improving the quality of the environment.

Ex situ conservation: The conservation of species outside their natural habitat

Gene: The functional unit of heredity; the part of the DNA molecule that encodes a single enzyme or structural protein unit.

Genetic resources: Genetic material of plants, animals or micro-organisms (including modern cultivars and breeds, primitive varieties and breeds, domesticated animals or landraces and wild or weedy relatives of crop plants) that has value as a resource for people or future generations.

Genetically modified organisms: Organisms whose genetic make-up has been altered by the insertion or deletion of small fragments of DNA from the same or another species in order to create or enhance desirable characteristics.

Gondwana (or Gondwanaland): The southern supercontinent that started to break up about 150 million years ago, consisting of what are now South America, Africa, Antarctica, Arabia, Australia, India, Madagascar and Falkland Islands.

Good ecological condition: A state in which an ecosystem can sustain all indigenous species which occur naturally within it, including those most sensitive to the effects of human activities (and of pests and weeds).

Habitat: The place or type of area in which an organism naturally occurs.

Healthy ecosystem: An ecosystem that is stable and sustainable, maintaining its organisation and autonomy over time and its resilience to stress. Ecosystem health can be assessed using measures of resilience, vigour and organisation.

Indicator: A measure (for example, distance from a goal, target, threshold or benchmark) against which some aspects of performance can be assessed. The use of an indicator enables the significance of a statistic to be determined, for example, the extent to which an objective is met.

Indicator species: A species whose presence or absence is indicative of a particular habitat, community or set of environmental conditions.

Indigenous species: A plant or animal species that occurs naturally in Falkland Islands. A synonym is "native".

Indigenous vegetation: Any local indigenous plant community containing throughout its growth the complement of native species and habitats normally associated with that vegetation type or having the potential to develop these characteristics. It includes vegetation with these characteristics that has been regenerated with human assistance following disturbance, but excludes plantations and vegetation that have been established for commercial purposes.

Information: Data that has been organised, integrated, and to some extent analysed. It is made meaningful because of collection, processing, organisation and interpretation in light of some hypothesis.

In-situ conservation: The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

Introduced species: A plant or animal species that has been brought to Falkland Islands by humans, either by accident or by design. A synonym is "exotic species".

Invasive species: An animal pest or weed that can adversely affect indigenous species and ecosystems by altering genetic variation within species, or affecting the survival of species, or the quality or sustainability of natural communities. In Falkland Islands, invasive animal pests or weeds are almost always species that have been introduced to the country.

Invertebrate: An animal without a backbone or spinal column. Insects, spiders, worms, woodlice and many marine animals such as corals, sponges and jellyfish are examples of invertebrates. Invertebrates make up the vast majority of all animal species; only fish, amphibians, reptiles, birds and mammals are not invertebrates.

Knowledge: The theoretical or practical understanding, knowing and familiarity gained by experience.

Landrace: An ancient or primitive cultivar of a crop plant.

Marine environment: Includes all areas in which the ocean and coast are significant parts, and all natural and biological resources contained therein. It includes the area from mean spring high water mark to the full extent of our Fisheries Conservation Zones (to 200 nautical miles offshore).

Environments covered in the "marine environment" include estuarine, near-shore coastal, continental shelf, seamounts, and sea trenches.

Monitoring: The act of measuring change in the state, number or presence of characteristics of something.

Native species: *See Indigenous species.*

Natural areas: *See Natural habitats and ecosystems.*

Natural character: The qualities of an area that taken together give it a particular recognisable character.

Natural habitats and ecosystems: Habitats and ecosystems with a dominant or significant indigenous natural character. Most habitats in the Falkland Islands are 'semi-natural' because they have been to some extent by humans.

Naturalised: A species or other taxon originating from a region outside Falkland Islands, but reproducing freely and maintaining its position in competition with indigenous biota in Falkland Islands.

New organism: Any plant, animal or micro-organism intentionally introduced to Falkland Islands for the first time or a new species developed through genetic engineering (genetically modified organism).

Production landscapes and seascapes: Areas that are used predominantly for the production of primary products, for example meat, fish, fibre.

Protected area: A geographically defined area that is protected primarily for nature conservation purposes or to maintain biodiversity values, using any of a range of legal mechanisms that provide long-term security of either tenure or land use purpose. It may be either publicly or privately owned.

Protected Natural Area: A legally protected area characterised by indigenous species or ecosystems or landscape features, in which the principal purpose of management is retention of the natural state. The term used in the Falkland Islands is national nature reserve.

Ramsar Convention: An international convention to protect internationally important wetlands.

Resilience: The ability of a species, or variety or breed of species, to respond and adapt to external environmental stresses.

Restoration: The active intervention and management of degraded biotic communities, landforms and landscapes in order to restore biological character, ecological and physical processes and their cultural and visual qualities.

Species: A group of organisms capable of interbreeding freely with each other but not with members of other species. *(See also Species diversity under Biological Diversity).*

Survey: Systematically observing, counting or measuring characteristics at a defined location over a defined period of time.

Sustainable use: The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Sympathetic management: The management of land in a way that recognises or supports the needs of indigenous biodiversity. For example, exotic production forests can be managed in a manner that provides for the habitat of native bird species.

Taxon: (pl. taxa) A named biological classification unit assigned to individuals or sets of species, for example species, sub species, genus or order.

Threatened species: A species or community that is vulnerable, endangered or presumed extinct.

Unwanted organism: Any organism capable of causing unwanted harm, including animal pests, weeds and diseases.

Vascular plants: Include ferns, flowering plants and trees, but does not include mosses and liverworts.

Vertebrate: Animal with backbone such as amphibians, reptiles, birds, mammals and fish.