

JOINT
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SEABIRD AND MARINE MAMMAL DISPERSION

IN THE WATERS AROUND THE FALKLAND ISLANDS 1998-1999



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Seabird and marine mammal dispersion in the waters around the Falkland Islands

1998–1999

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Cover photographs

Top left: Cape petrel *Daption capense*, Richard White/JNCC

Top right: Falkland steamer duck *Tachyeres brachydactyla*, Richard White/JNCC

Bottom left: Black-browed albatross *Thalassarche melanophris*, Richard White/JNCC

Bottom right: Peale's dolphin *Lagenorhynchus australis*, Richard White/JNCC

Back: Trawler attended by Black-browed albatross *Thalassarche melanophris*, Richard White/JNCC

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Summary

Between February 1998 and January 1999, the JNCC systematically surveyed seabirds and marine mammals in the waters around the Falkland Islands using vessels of opportunity. For the first time, year-round at-sea dispersion patterns of these species have been recorded for this important sub-Antarctic region.

The results of the surveys have been used to map dispersion patterns of the seabird and marine mammal species encountered. The waters around the Falkland Islands were found to support important concentrations of seabirds all year. Prions were the most abundant 'species', with highest densities over the Patagonian Shelf waters to the west and south-west of the islands in late winter, spring and summer. Black-browed albatrosses were also abundant throughout the year over Patagonian Shelf waters to the west and north-west of the islands. The inshore waters around the islands were also important: resident species, such as gentoo penguin, imperial shag and flightless steamer duck, were to be found there in all months, while Magellanic and rockhopper penguins were present during the breeding season. A number of species that do not breed in the Falkland Islands was also recorded, including royal

albatrosses; these were found in significant numbers over Patagonian Shelf waters to the west and north-west of the islands all year, with a distinct peak in numbers in autumn. Deeper, oceanic waters supported smaller concentrations of seabirds, as well as a number of species that were uncommon or rare over shallower Patagonian Shelf waters.

Cetacean distribution maps show that many species exhibit a preference for either shallower shelf waters or deeper oceanic waters. For example, Peale's dolphin and sei whale were recorded mostly in the shallower Patagonian Shelf waters, whereas hourglass dolphin and fin whale were mostly in the deeper, continental shelf slope and oceanic waters. Species such as minke whale were recorded throughout the survey area and did not show a preference for waters of a particular depth.

This 12-month survey has greatly enhanced our knowledge of at-sea dispersion patterns of the internationally important seabird and cetacean communities around the Falkland Islands. Continued study will fill gaps in survey coverage, and may reveal whether the patterns observed are consistent from year to year.

1 Foreword

The Seabirds at Sea Team (SAST), first of the Nature Conservancy Council (NCC) and now of the Joint Nature Conservation Committee (JNCC), was established in 1979 to study the distribution and abundance of seabirds in the seas around the United Kingdom. The need for this information was driven by seabird mortality, resulting from chronic oil pollution from vessels at sea in the 1970s, and also the threat of oil spills from tankers associated with oil exploration and exploitation in the North Sea.

The NCC/JNCC has developed standardised methods for survey of seabirds at sea, and has applied them since 1979 in most waters of north-west Europe. The results of at-sea surveys have been used to advise Government and the hydrocarbon industry on best practice, and on ways of minimising the effects of potentially damaging activities on seabirds, marine mammals and the marine

environment generally. The JNCC has also co-ordinated data collection and storage with a number of European organisations to form the European Seabirds at Sea database.

Drilling exploration for hydrocarbons in Falkland Islands waters began in 1998, and the perceived threat to seabirds of potential surface pollution demanded that the locations of important concentrations of seabirds in these waters be determined. Consequently, the Falklands Operators Sharing Agreement (FOSA), comprising Shell Exploration and Production, Amerada Hess (Falkland Islands) Limited, LASMO International Limited and IPC Falklands Limited contracted Falklands Conservation (FC) and, in turn, the JNCC, to carry out at-sea surveys of seabirds and marine mammals in Falkland Islands territorial waters. This report summarises the results of the first year of these surveys.

2 Introduction

2.1 Seabird populations of the Falkland Islands

Seabird populations in the Falkland Islands are of international importance (Croxall *et al.* 1984). For a number of species the majority of the world population breeds in the Falkland Islands. For example, more than 60% of the world population of the southern rockhopper penguin,^{1,2} *Eudyptes chrysocome chrysocome* (Bingham 1998), and more than 80% of the world population of the black-browed albatross *Thalassarche melanophris* (Gales 1998), breed here. In total, the Falkland Islands probably supports over two million pairs of breeding seabirds (Table 1). These populations and others feed over the Patagonian Shelf in the productive waters surrounding the Falkland Islands. The importance of Patagonian Shelf waters, and the south-west Atlantic generally, as a habitat for seabirds is well known (Cooke and Mills 1972; Brown *et al.* 1975; Veit 1995). The seabirds here depend almost entirely on the marine environment for their food, and are therefore sensitive to the effects of human activity, such as fisheries and hydrocarbon exploration and exploitation.

Increasingly, seabirds are becoming the focus of systematic study in the Falklands Islands. For example, in 1985 Falklands Conservation (FC) established the Falkland Islands Seabird Monitoring Programme (FISMP). This programme aims to monitor population sizes and diet during the breeding season of a number of seabird species for which the Falkland Islands are important, but includes no information on distribution

of birds at sea. Similarly, the very few autecological studies of Falkland Islands seabirds provide little indication of foraging ranges and areas. Most existing information on seabird dispersion in Falkland Islands waters has been collected by a limited number of observers (e.g. Tickell and Woods 1972, Thurston 1982, Bourne and Curtis 1985, Curtis 1994). In addition, staff at the British Antarctic Survey (BAS) have observed seabird distribution in these waters (BAS, unpublished data). These observations have largely been casual, and to date there has been no systematic study of the dispersion of seabirds at sea around the Falkland Islands.

This report outlines the results of an intensive programme of at-sea surveys conducted throughout the year, aimed at identifying patterns of seabird distribution and abundance around the Falkland Islands. While the principal objective of these surveys was to determine the seasonal dispersion of all seabirds using Falkland Islands waters, a secondary objective aimed to record marine mammal distribution and abundance. The influence of various factors that might govern dispersion patterns, such as fisheries and oceanography, is also considered in this report. A longer-term aim of the study is to use information on bird and mammal dispersion to assess the potential effects on populations of these organisms of the hydrocarbon industry and other human uses of the waters around the Falkland Islands.

2.2 Marine mammal populations

Three species of pinniped³, the southern elephant seal *Mirounga leonina*, the South American fur seal *Arctocephalus australis* and the South American sea lion *Otaria byronia*, are known to breed in the Falkland Islands. Another species, the leopard seal *Hydrurga leptonyx* occurs as a regular migrant or vagrant. The

populations of the three breeding species are at very low levels compared with historical levels. The reasons for the decreases are not clear but are partly due to the extensive hunting of all three species in the 19th and 20th centuries. The populations have failed to recover since the cessation of hunting (Strange 1992).

1 Scientific names of species mentioned in the text may be found in Appendix I

2 Unless stated otherwise the taxonomy and nomenclature of marine mammals follow Harrison (1983)

3 Unless stated otherwise the taxonomy and nomenclature of marine mammals follows Jefferson *et al.* (1993)

Table 1. Population sizes of seabird species breeding in the Falkland Islands.

<i>Species</i>	<i>Number of pairs</i>	<i>Source</i>
King penguin	300	Ingham 1998
Magellanic penguin	76,000–142,000*	Woods & Woods 1997
Macaroni penguin	50	Bingham 1998
Gentoo penguin	65,000*	Bingham 1998
Rockhopper penguin	300,000*	Bingham 1998
Falkland steamer duck	9,000–16,000*	Woods & Woods 1997
Black-browed albatross	521,424–576,424*	Gales 1998
Southern giant petrel	5,000–10,000*	Woods & Woods 1997
Thin-billed prion	1,000,000*	Croxall <i>et al</i> 1984
Fairy prion	10000	Woods & Woods 1997
White-chinned petrel	1,000–5,000	Woods & Woods 1997
Great shearwater	50–100	Woods & Woods 1997
Sooty shearwater	10,000–20,000	Woods & Woods 1997
Grey-backed storm-petrel	1,000–5,000*	Woods & Woods 1997
Wilson's storm-petrel	5,000+	Woods & Woods 1997
Common diving-petrel	5,000–10,000	Woods & Woods 1997
Rock shag	32,000–59,000*	Woods & Woods 1997
Imperial shag	45,000–84,000*	Woods & Woods 1997
Antarctic skua	5,000–9,000*	Woods & Woods 1997
Brown-hooded gull	1,400–2,600*	Woods & Woods 1997
Kelp gull	24,000–44,000*	Woods & Woods 1997
Dolphin gull	3,000–6,000*	Woods & Woods 1997
South American tern	6,000–12,000*	Woods & Woods 1997

*exceeds 1% of the world population

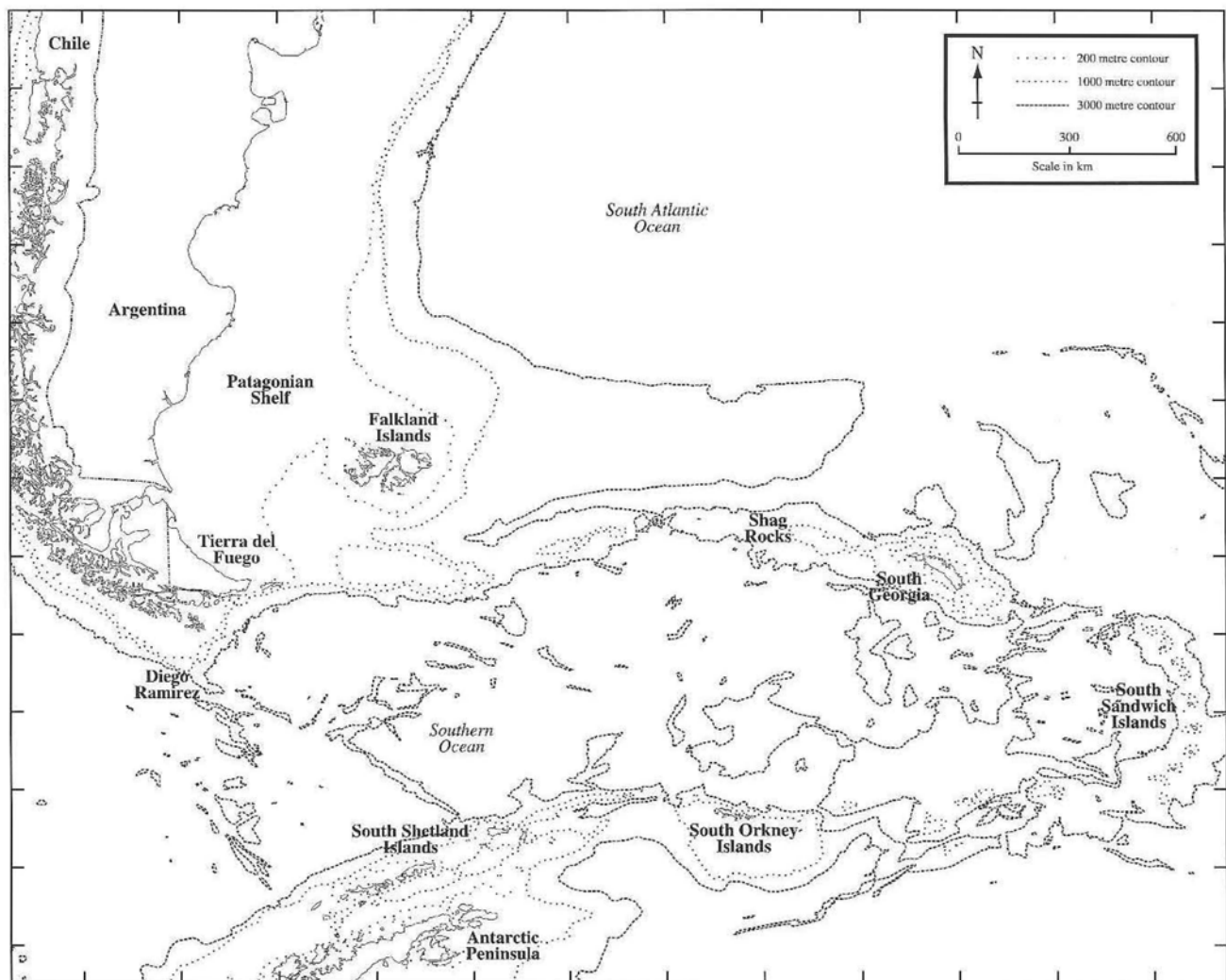


Figure 1. The position of the Falkland Islands in relation to South America, Antarctica and the islands of the Scotia Arc.

At least 23 species of cetacean are known to occur in the waters of the Falkland Islands (Strange 1992). However, little is known about the size of the populations of any of these species. Peale's dolphin *Lagenorhynchus australis* and Commerson's dolphin *Cephalorhynchus*

commersonii are both common in inshore waters. Less is known about the larger cetacean species and small pelagic cetaceans that occur in offshore waters. A whaling station existed on New Island between 1908 and 1916 (Strange 1992).

2.3 Study area

The Falkland Islands are located about 500 km north-east of the closest point of South America at the southern end of the Patagonian Shelf (Figure 1). They lie between 51° and 53°S, and 57° and 62°W. The archipelago comprises two main islands, East and West Falkland; combined, these have an east-west extent of 260 km and a north-south extent of 140 km. There are also either 340 (Richards 1997), 420 (Strange 1992) or 778 (Woods 1986) smaller satellite islands. The total land area of the Falkland Islands is 12,173 km² (Richards 1997).

The island of South Georgia lies about 1,200 km to the east of the Falkland Islands, and the Antarctic Peninsula lies about 1,000 km to the south (Figure 1).

For the purposes of this report the study area was defined as the territorial waters of the Falkland Islands. These are divided into two regions (Figure 2): the Falklands Islands Interim Fishery Conservation and Management Zone (FICZ), established in 1986; and the Falklands Outer Conservation Zone (FOCZ), established in 1990. The outer zone extends some 360 km to the

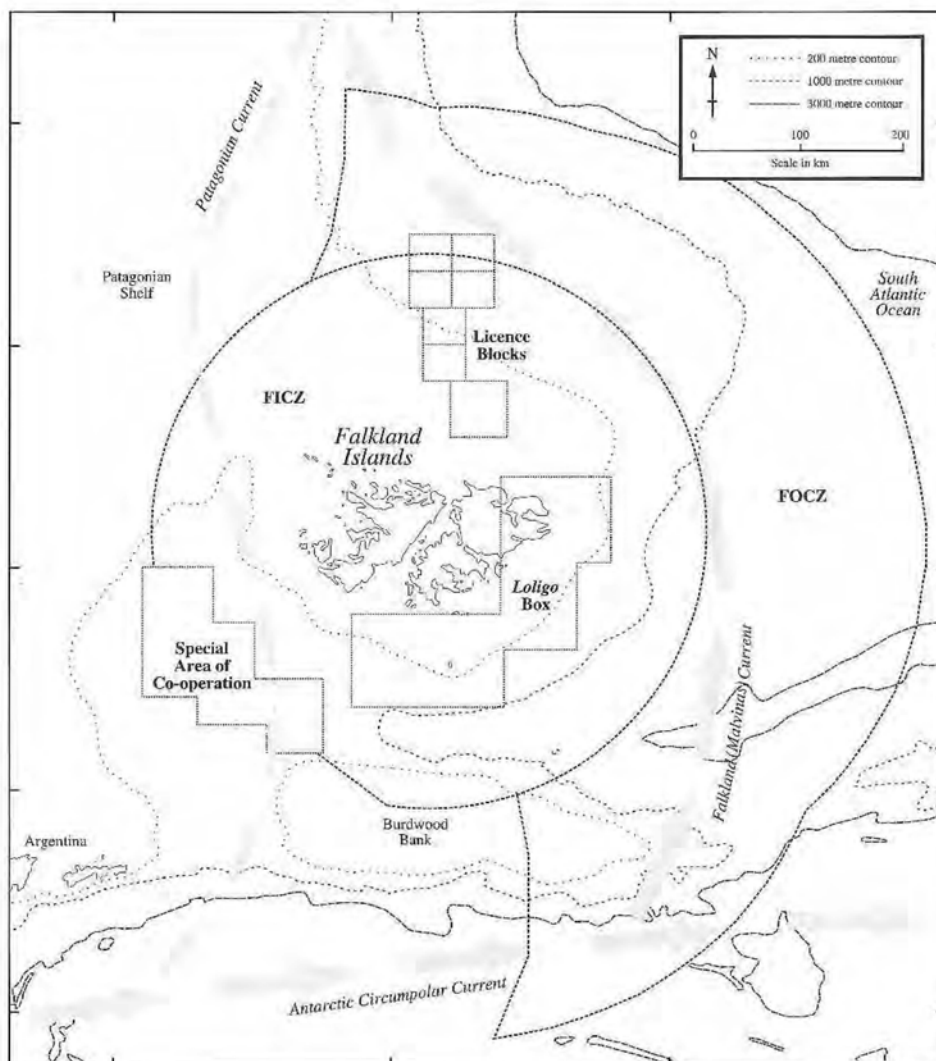


Figure 2. The limit of the territorial waters of the Falkland Islands, the position of the area licensed for hydrocarbon exploration and the area proposed for the future hydrocarbon exploration (Special Area of Co-operation), the position of the *Loligo* box, and the major currents in the area.

north, south and east of the islands. To the west, the boundary of FICZ meets the boundary of the Argentine Exclusive Economic Zone (EEZ) some 110 km west of West Falkland. Falkland Islands territorial waters thus encompass over 400,000 km², an area about 50% larger than the UK sector of the North Sea (Richards 1997).

The areas licensed for offshore hydrocarbon exploration to the north of the islands (see below and Figure 2) were a particular focus of interest in this study since these are the areas potentially most vulnerable to inimical effects of hydrocarbon exploration. However, it was considered important to survey all parts of Falkland Islands waters as far as possible for several reasons:

- ◆ to place observations in the licence blocks in a wider geographical context;

2.4 Climate

At a similar latitude south as London, UK, is north, variation in seasonal day length in the Falkland Islands is similar to that in the UK. The climate is temperate; mean daily temperature ranges from 4.8 °C in winter to 9.6 °C in summer, and relative humidity ranges from 75% in November to 89% in July. The prevailing winds are in the

2.5 The marine environment

The Falkland Islands coastline is heavily indented with many sheltered harbours and bays. Most of the coastline is rocky but there are many white sandy beaches. In the east the rocky coast is generally low, but in the west there are cliffs up to 200 m high. Extensive beds of kelp (mostly *Macrocystis pyrifera* and *Lessonia flavicans*) grow in the shallow waters (less than 30 m deep) around the coast. Most kelp beds are 20 or 30 m wide, but in some areas they may extend up to 1 km (Strange 1992). Kelp beds provide shelter and feeding grounds for a diverse range of invertebrates, molluscs and fish (Castilla 1985). These, in turn, make kelp beds a rich feeding ground for seabirds in inshore waters. In strong winds and storms, patches of kelp frequently dislodge from their holdfast and float out to sea, offering a rich feeding habitat for a number of seabird species.

The islands are surrounded by the shallow (<200 m) waters of the Patagonian Shelf. Patagonian Shelf waters extend about 100 km to the north of the islands, about 25 km to the east and about 40 km to the south. However, Beauchêne Island on the southern edge of the Patagonian Shelf lies within 5 km of the 200-m depth contour (Figure 3). The waters to the west, between the Falkland Islands and South America, are Patagonian Shelf waters or gently shelving continental shelf slope waters less than 300 m deep.

To the north and north-east of the islands the continental shelf slopes gradually to the 1,000-m depth

- ◆ because surface pollution, if it occurred in the licence blocks, might not be confined locally due to prevailing winds and currents;
- ◆ because surface pollution whose origin lay beyond Falkland Islands waters (e.g. in international waters or the Argentine EEZ), might drift or be blown into Falkland Islands territorial waters;
- ◆ other areas in Falkland Islands waters (notably within the Special Area of Co-operation to the south-west of the islands) may be subject to hydrocarbon exploration in the future; and
- ◆ to improve understanding generally of seabird ecology in this globally important and increasingly threatened region.

westerly quadrant for 70% of the year and they average about 17 knots throughout the year. There is a marked increase in the frequency of storms between June and September. Rainfall is evenly distributed throughout the year, averaging 625 mm in Stanley and as little as 310 mm in the south-west of the islands (Richards 1997).

contour, resulting in extensive continental shelf slope waters (>200 m, <1,000 m). To the east and south of the islands the continental shelf slope is steeper, and there are no extensive areas of continental shelf slope waters.

Deep oceanic waters (>1,000 m) begin approximately 280 km north of the islands, 110 km to the east and 100 km to the south (Figure 2).

About 200 km to the south of the islands is an area of shallower waters over the Burdwood Bank. The Burdwood Bank forms part of the Scotia Ridge that extends from Tierra del Fuego to Shag Rocks, South Georgia, the South Sandwich and South Shetland Islands before forming the Antarctic Peninsula (Figure 1).

East of the Drake Passage a branch of the Antarctic Circumpolar Current flows north. This branch becomes the Falklands/Malvinas Current (Glorioso and Flather 1995) that flows north along the shelf slope (Figure 2) as far as 35°S where it mixes with the warmer, southerly-flowing Brazil Current (Peterson *et al.* 1996). As the current flows north it passes either side of the Falkland Islands and is forced up onto the Patagonian Shelf around the islands. The resultant upwelling of water produces rich feeding grounds for many seabirds and marine mammals (Strange 1992). Farther north, the prevailing westerly winds that blow off the Patagonian Shelf cause upwellings of nutrient-rich waters that also

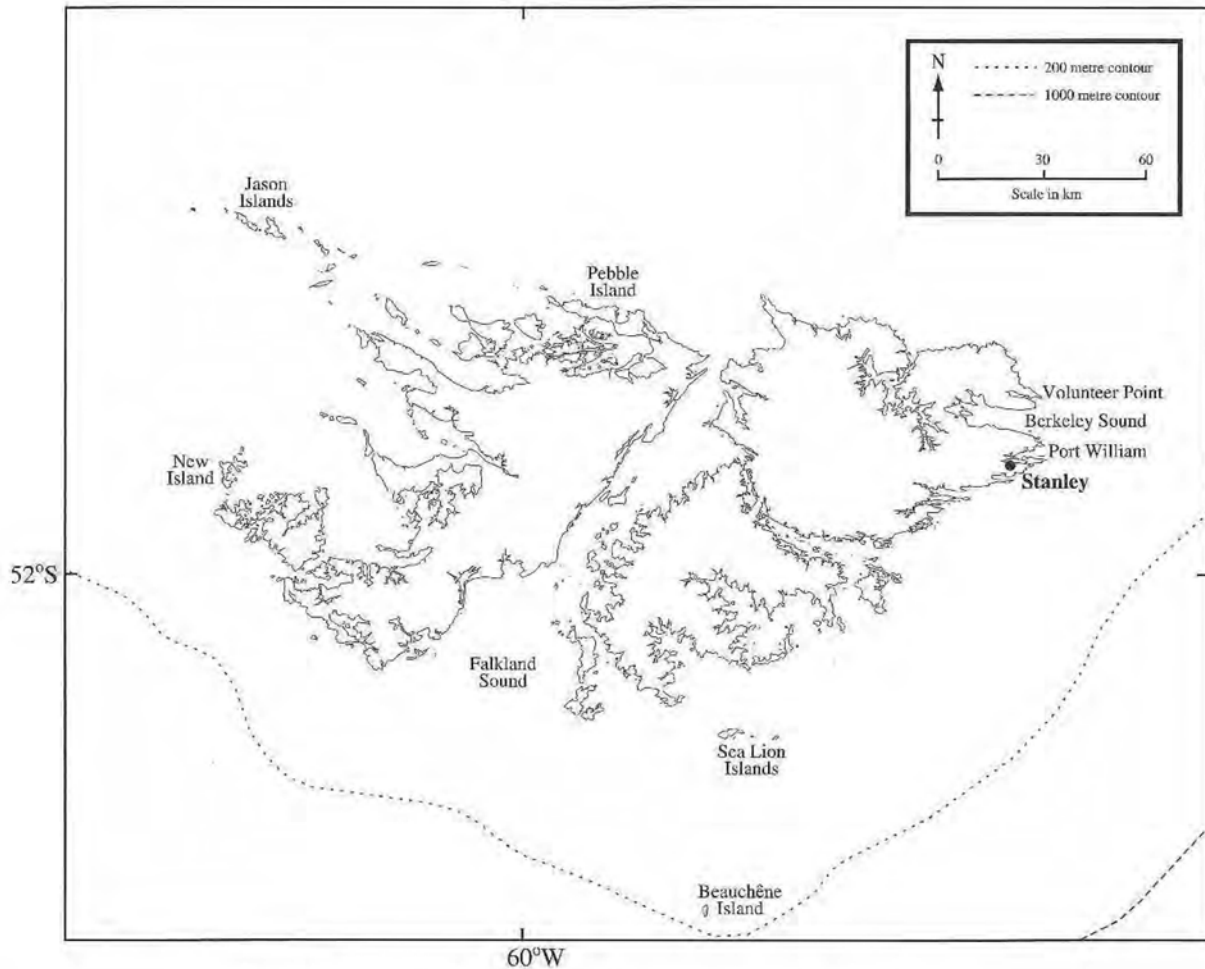


Figure 3. The Falkland Islands showing locations of places mentioned in text.

provide productive feeding waters over the Patagonian Shelf to the north of the Falkland Islands (Harris 1998).

The Falkland Islands are in the southern cold-temperate zone of surface water. Offshore sea surface

temperature ranges from around 6 °C in the austral winter to 13 °C in the austral summer (Richards 1997).

The Antarctic Polar Front lies about 300 km to the south and 400 km to the east of the islands (Figure 1).

2.6 Fisheries

Since the mid 1970s there has been a well-established fishing industry around the Falkland Islands, primarily for squid (both the Argentine shortfin squid *Illex argentinus* and the Patagonian squid *Loligo gahi*) as well as for a number of finfish species (e.g. southern blue whiting *Micromesistius australis*). Initially, growth of this industry was unregulated, but since the introduction of the FICZ in 1986, and the FOCZ in 1990 by the Falklands Islands Government (FIG), fishing within these zones has been regulated. However, most of the Patagonian Shelf around the Falkland Islands and southern Argentina falls within territorial waters. The sale of fishing licences is the main source of income for FIG and is regulated by the FIG Fisheries Department (FIGFD), which also has responsibility for the policing of the fishery and fisheries research.

Fishing in the waters of the Falkland Islands takes four main forms:

- ◆ the *Loligo* fishery which has two seasons: from February to May and August to October. Fishing activity is restricted to the area within the *Loligo* box to the south and east of the Falkland Islands (Figure 2). The squid are caught by trawling, with up to 21 trawlers in the fleet in 1998 (FIGFD 1999).
- ◆ The *Illex* fishery which operates from February to June. The main area of fishing activity is to the north and west of the Falkland Islands. The squid are caught mainly by jigging, but some trawlers also fish for *Illex* as well as finfish. Up to 79 jiggers and 22 trawlers were licensed to catch *Illex* in the 1998 season (FIGFD 1999).

Table 2. Catch size by fishing vessels in the waters of the Falkland Islands during the survey period.

Month	Catch by species (tonnes)										
	Loligo	Illex	Hake	Blue Whiting	Hoki	Kingclip	Toothfish	Red Cod	Skate	Other	Total
Feb 98	8,618	47	112	8,454	1,432	59	110	310	46	713	19,901
Mar 98	12,324	26,747	427	3,814	2,711	248	136	851	80	227	47,565
Apr 98	6,835	49,246	540	514	3,808	359	195	1,145	74	288	63,004
May 98	4,984	8,794	1,063	363	4,488	502	212	2,055	96	346	22,903
Jun 98	507	119	312	66	930	83	112	517	22	151	2,819
Jul 98	761	0	77	0	441	58	103	95	48	8	1,591
Aug 98	9,617	0	305	150	1,223	277	238	797	121	252	12,980
Sept 98	5,915	1	401	1,279	1,293	259	242	803	314	539	11,046
Oct 98	1802	1	152	1,305	2,807	181	207	744	138	394	7,731
Nov 98	6	0	57	3,677	1,492	131	266	541	78	134	6,382
Dec 98	47	0	2	5,987	383	23	127	66	19	36	6,690
Jan 99	415	2	7	4,884	432	17	93	104	9	55	6,018

Table 3. Numbers of fishing vessels licensed to operate in the waters of the Falkland Islands during the survey period (data from FIGFD 1999).

Month	Number of vessels licensed					Total
	Trawler			Longliner	Jigger	
	Finfish or Ray	Loligo	Finfish and Illex	Toothfish	Illex	
February 98	8	14	—	2	4	28
March 98	9	14	11	2	68	104
April 98	7	14	14	2	79	116
May 98	3	13	22	2	77	117
June 98	6	—	—	2	31	39
July 98	5	—	—	3	—	8
August 98	13	21	—	2	—	36
Sept 98	18	19	—	2	—	39
October 98	17	17	—	2	—	36
November 98	17	—	—	3	—	20
December 98	4	—	—	3	—	7
January 99	6	—	—	3	—	9

- ◆ The finfish fishery which operates year round, although there is some seasonal variation in the number of trawlers present—there were up to 22 trawlers in any one month in 1998 (FIGFD 1999). Most trawling takes place to the north and west of the islands on the Patagonian Shelf. Finfish trawlers are prevented from operating within the *Loligo* box. The target species include hake *Merluccius* spp., southern blue whiting, skates *Bathyraja* spp. and rays *Raja* spp.
- ◆ the longline fishery for Patagonian toothfish *Dissostichus eleginoides* which operates year round, generally along the 1,000-m depth contour around the Burdwood Bank and to the north and east of the Falkland Islands. Up to three longline vessels operated in the waters of the Falkland Islands in 1998 (FIGFD 1999).

The size of catches of various target species of the different fisheries in 1998 are presented in Table 2, and the numbers of vessels licensed in the different fisheries are given in Table 3.

Fisheries waste, or discards, comprised 5.1% of the total catch reported to the FIGFD in 1994 and 1995, and amounted to 22,254 tonnes (Nolan and Yau 1997). Very large numbers of seabirds, particularly black-browed

albatrosses and Cape petrels *Daption capense*, scavenge on discards from fishing vessels, particularly *Loligo* and finfish trawlers (Thompson 1992, Thompson and Riddy 1995). Jiggers produce a lower volume of discards and attract fewer seabirds.

Longlining activity in the waters of the Falkland Islands has been well managed and bycatch of seabirds is generally low (A. Black pers. comm.; see Schiavini *et al.* (1998) for details of albatross bycatch over the wider Patagonian Shelf). The longliners attract seabirds in smaller numbers, mainly because fewer seabirds occur over the continental shelf slope than on the continental shelf. However, the longliners attract large numbers of wandering albatrosses *Diomedea exulans* spp.; indeed, a recent study of longliners operating in the waters of the Falkland Islands has demonstrated the importance of the waters of the Falkland Islands for wandering albatrosses from South Georgia (Croxall *et al.* 1999).

Possible competition between seabirds and fisheries in the waters of the Falkland Islands has been investigated by the Falkland Islands Foundation (now Falklands Conservation; Thompson 1989). Thompson (1989) concluded that there was potential for conflict between the fisheries and various seabird species that feed on commercially exploited fish species. However,

the degree to which these seabirds and fisheries did compete, and the extent to which seabird diet had been modified by the fishing industry, could not be quantified.

Some of the recommendations from Thompson's (1989) study are addressed by the FISMP (Ingham 1998).

2.7 Hydrocarbon exploration

Seismic surveys were first shot in the region in the 1950s, and the first drilling began in 1974 on the Maurice-Ewing Bank (outside the current FOCZ). Seismic surveys resumed in the late 1970s with further work since 1993 (Richards 1997). Licences for exploration and production in tranches to the north of the Falkland Islands (Figure 2) were awarded in 1996 and the rig *Borgny Dolphin* undertook exploratory drilling from May to November 1998. All hydrocarbon development has been under licence from the FIG and is administered by the Department of Mineral Resources in Stanley. While exploration in the tranches to the north of the islands has ceased at the time of writing, it is possible that exploration in this area may resume in the future. There is also the prospect of hydrocarbon exploration to the southwest of the islands in the Special Area of Co-operation (Figure 2).

To date there has been little contamination of seabirds as a result of oil pollution in the waters of the Falkland

Islands. There have been a number of small-scale incidents, for example in 1986/87 when small numbers of oiled rockhopper penguins were observed on New Island (K. Thompson pers. comm.). However, in the winter of 1998 (June–August) a series of oil pollution incidents resulted in the contamination of at least 50 penguins of three species, and a small number of other seabirds, mostly shags (Smith 1998). The source(s) of contamination were not identified, but since shags, which do not forage far offshore, were present amongst the affected birds, at least some of the oil was in inshore waters. The situation in the Falkland Islands is not as bad as along the coast of Argentina. Here as many as 40,000 Magellanic penguins *Spheniscus magellanicus* may die as a result of contamination with oil each year (Gandini *et al.* 1994). Some of these birds are likely to be of Falkland Islands origin as birds from the Falkland Islands winter off the coast of Argentina (Pütz *et al.* 1998).

3 Methods

Seabirds and marine mammals were surveyed using vessels of opportunity as survey bases. These were primarily the year-round cruises of the Fisheries Patrol Vessels (FPVs) of FIG, and the oil rig supply vessels operating between May and October. Three FPVs were used: MV *Cordella*, MV *Dorada* and MV *Criscilla* with survey platform heights of 10, 12 and 8 m respectively. The MV *L'Espoir* was conducting site surveys for FOSA members and has a viewing height of 10 m. The two supply vessels used, MV *Mærsk Puncher* and MV *Mærsk Mariner*, have viewing heights of 16 and 18 m. All surveying was conducted at speeds ranging from 4–14 knots on known, fixed bearings.

Similar methods to those deployed in the north-east Atlantic were used to survey seabirds at sea around the Falkland Islands. All seabirds on the water within a 300-m strip transect on one side of the vessel (the side offering the better viewing conditions) were counted. The 300-m transect limit was defined using calipers with the jaw width determined using Heinemann's (1981) formula. In addition to the continuous strip transect for birds on the water, a second set of counts of flying birds were made using a 'snapshot' technique. The 'snapshot' is designed primarily for recording flying birds, and its timing is dictated by a combination of vessel speed and the distance ahead of the vessel over which the observer is able to detect flying seabirds. Full details of the survey method may be found in Tasker *et al.* (1984) and Webb and Durinck (1992).

All seabirds observed on survey cruises were identified, where possible, to species level. In some cases, e.g. prions, this was rarely possible. In addition to species, age, sex, plumage type, direction of flight and behaviour (e.g. sleeping, feeding) were also recorded if possible or appropriate.

Seabirds associating with the survey base, and those obviously associating with fishing vessels, were not counted. This may have led to under-recording for those species that are most likely to associate with vessels, such as giant petrels *Macronectes* spp., Cape petrels and wandering albatrosses. Interspecific associations were noted, and all marine mammals observed were also recorded using the same method as for birds on the water. All floating patches of kelp within the transect were recorded.

The use of vessels of opportunity introduces a number of unavoidable biases in survey effort and coverage. Oil-rig supply vessels were available only from May to October, biasing coverage to the north of the islands in these months. FPV movements clearly focus on fishing areas, introducing a bias to those targeted areas, and perhaps also to those seabird species that scavenge around fishing vessels, e.g. black-browed albatross. Attention is drawn to such possible biases in interpreting species dispersion maps in the species accounts (below).

In addition to seabird and marine mammal data, routine environmental and base (i.e. survey platform) information was collected during surveys. Environmental data collected included wind strength and direction, sea state, precipitation, sun strength and orientation, and visibility. Such environmental data allow examination of the relationship between survey conditions, and the numbers and species of birds and mammals recorded. For example, detection rates of seabirds on the sea are likely to decrease as wind strength and, consequently, sea state increases. Certainly, this is the case for small cetaceans (Bravington *et al.* 1999). Some, perhaps most, Procellariiformes also spend less time at sea and more time in their breeding colonies, or more time on the water not flying, in calmer conditions (Dott 1975; Manikowski 1971). While no analyses of the results of surveys in relation to environmental variables are presented in this report, bias and error due to poor observing conditions were minimised by rarely surveying in wind speeds of Beaufort force 6 or greater. Sometimes, however, conditions did allow for surveys to be conducted in wind strengths greater than Beaufort force 6, especially, for example, when surveying sheltered waters.

Base data collected allow seabird observations to be related to specific locations. A position, base speed and base direction was recorded at the start and finish of each recording period. This information was updated whenever the survey base changed speed or course during the recording period. This allows interpolation of the position of the survey base at ten-minute intervals, and subsequent linking of the species data to unique locations.

All species, environmental and base data were recorded on specially designed forms (see Appendix II).

4 Data handling

During and after each survey cruise all data are transcribed from data sheets onto computer using custom-built software. Data storage is on a fully relational database that allows a full range of standard, query-based manipulations. Several automatic checks

for errors in the data are made at the transcription phase, and before their final storage on the Seabirds at Sea (SW Atlantic) database. Data are checked manually (but never by the data collector) for remaining errors.

5 Results

At-sea surveys were carried out in every month from February 1998 until January 1999. Surveys have continued since then but are not considered here. The most frequently used survey platforms, the FPVs, restricted most of their patrols to within FICZ and FOCZ, and did not venture into the Argentine EEZ. On several

occasions, surveys were conducted to the north and east of FOCZ, but in general these results have not been included in this report (although the data collected during these surveys are held on the Seabirds at Sea (SW Atlantic) database). All survey data for the area south of 47°S and west of 52°W are presented here.

5.1 Survey effort

Thirty-five survey cruises were carried out during the 12 months of study. Single observers were on board during most survey cruises, although five cruises were conducted with two observers on board. A complete list of the cruises including dates and survey effort is given in Appendix III.

Total survey effort during the year is shown in Figure 4, and survey effort in each month of the study is shown in Figures 5 to 16. Survey effort is depicted as the area surveyed (km²) in all ¼ International Council for the Exploration of the Sea (ICES) rectangles (cells measuring 15' latitude × 30' longitude). Survey effort in each month is also shown in Table 4.

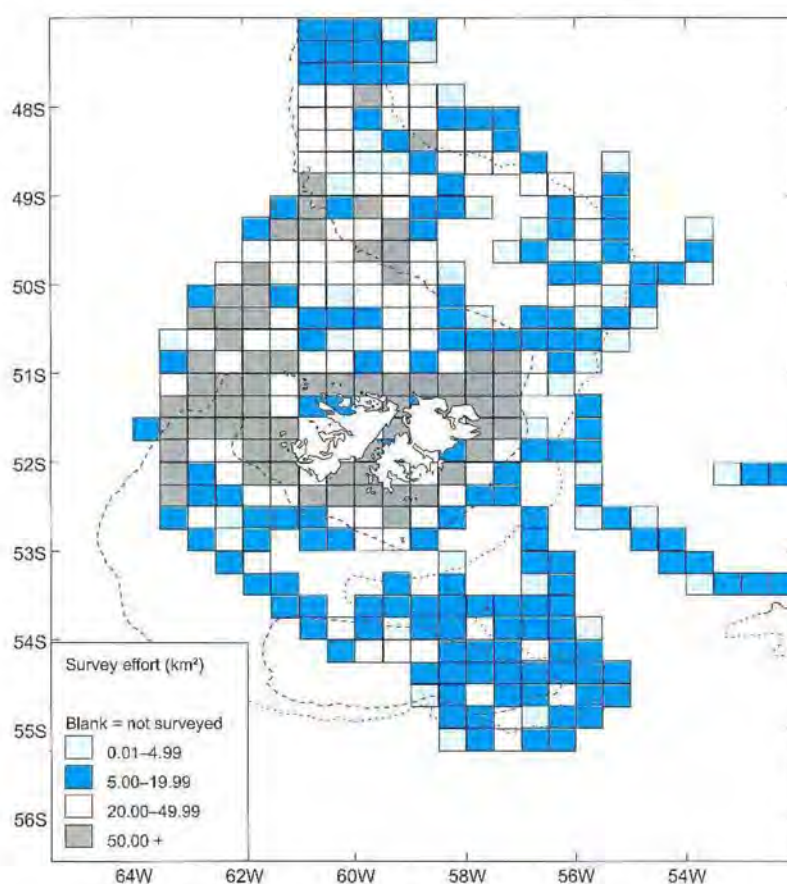


Figure 4 Distribution of survey effort, February 1998–January 1999

Table 4. Survey effort and distance travelled (i.e. length of cruise track) when surveying in each month.

Month	Survey effort (km ²)	Cruise track (km)
January	1,164	3,881
February	413	1,376
March	438	1,461
April	414	1,381
May	426	1,419
June	885	2,951
July	733	2,555
August	965	3,221
September	1,051	3,506
October	725	2,417
November	1,653	5,516
December	1,110	3,699
Total	9,977	33,383

It is important to highlight here the variation in seasonal survey coverage when interpreting survey results. The most important seasonal variation in survey effort is the lower level of survey effort from February to May (the project team was not fully established until June) compared with the rest of the year. Seasonal survey effort is also constrained by short day length in the winter

months (June–August). In summer (December–February), the amount of survey effort is usually limited only by the observers' need to sleep. The rough weather experienced in the 1998 winter also limited the amount of survey effort, since surveys are not usually conducted in winds above Beaufort force 6.

There is also important variation in the spatial distribution of survey coverage. Some of this variation is dictated by changes in patrol duties of the FPVs in different fishing seasons. For example, the higher levels of survey coverage to the north-west of the islands reflect the presence of the *Illex* jigging fleet in that area in those months. On the other hand, there was no survey coverage in the deep waters to the south of the islands between February and May. As a result, it is to be expected that the numbers of oceanic species of seabird and cetaceans recorded will be low in these months, rendering any interpretation of seasonality very difficult for these species.

Weather conditions also caused some seasonal variation in the spatial distribution of survey effort. The rougher weather in the winter months, in particular, resulted in a higher level of inshore survey coverage when vessels sheltered in inshore waters.

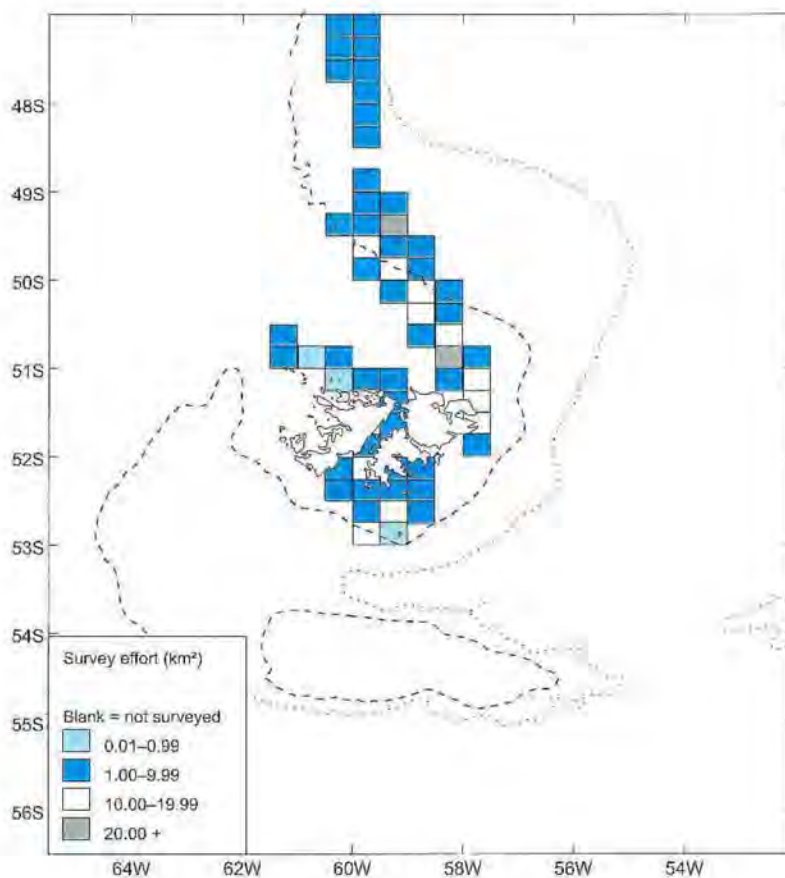


Figure 5 Distribution of survey effort, February 1998

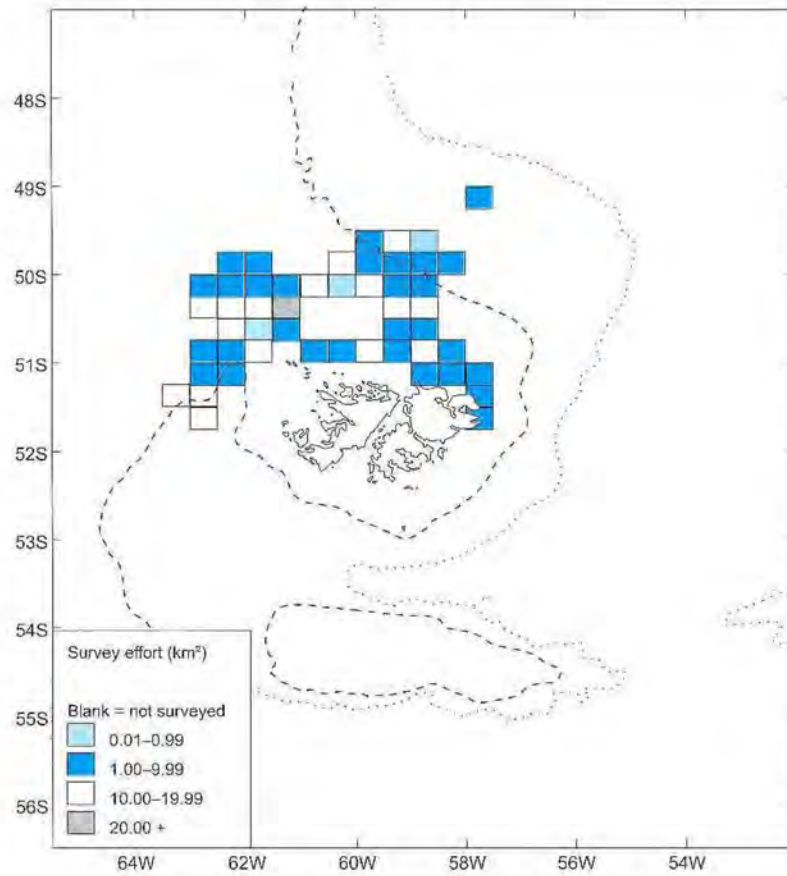


Figure 6 Distribution of survey effort, March 1998

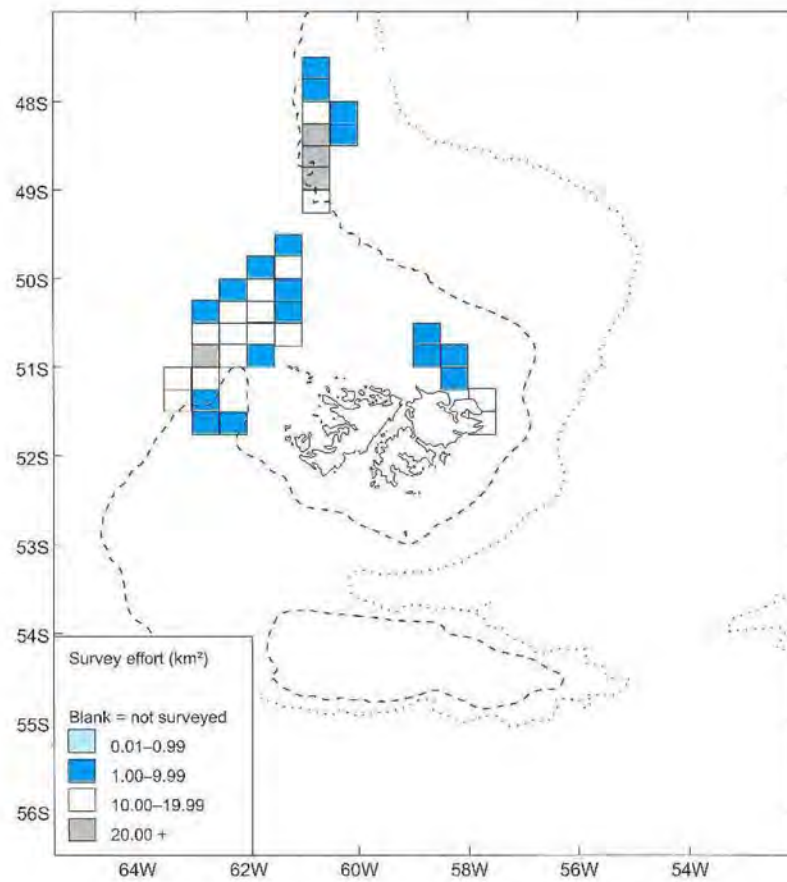


Figure 7 Distribution of survey effort, April 1998

Seabird and marine mammal dispersion in the waters around the Falkland Islands

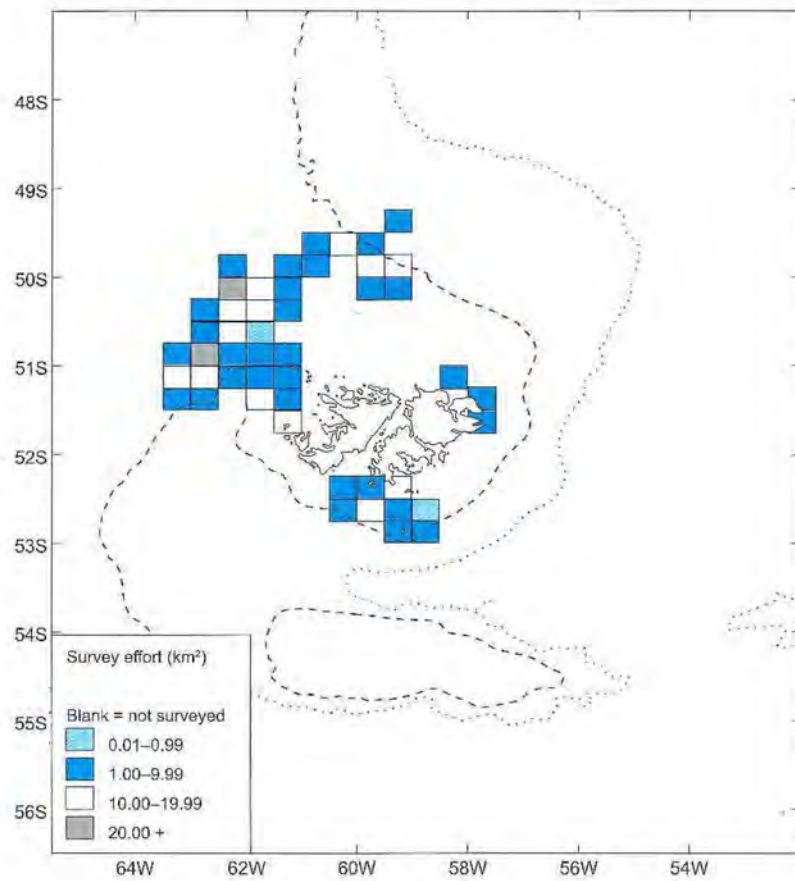


Figure 8 Distribution of survey effort, May 1998

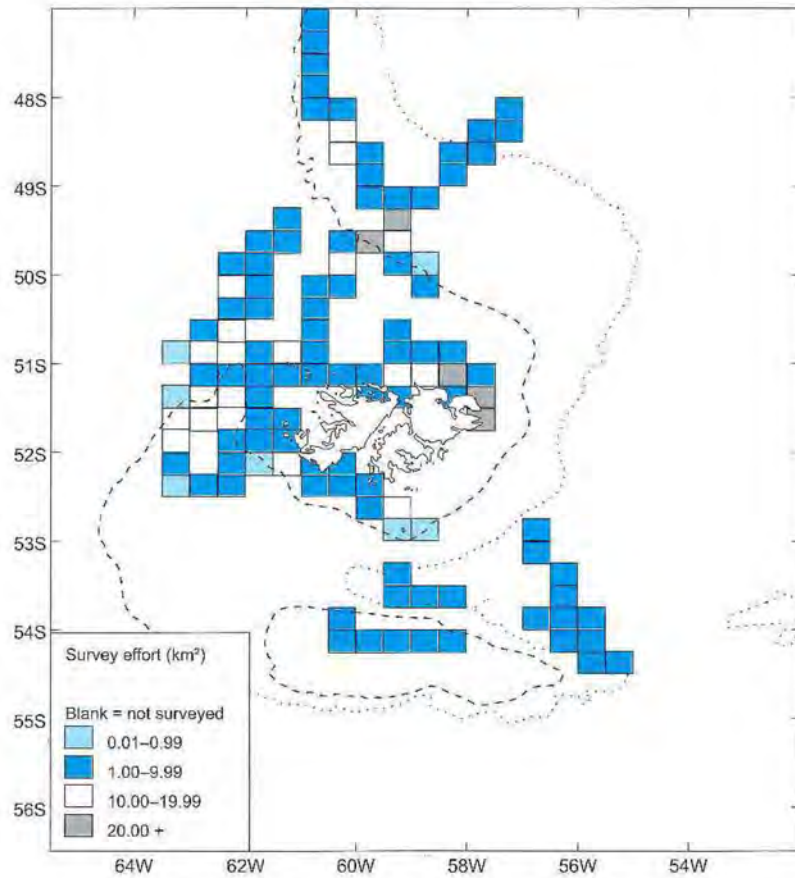


Figure 9 Distribution of survey effort, June 1998

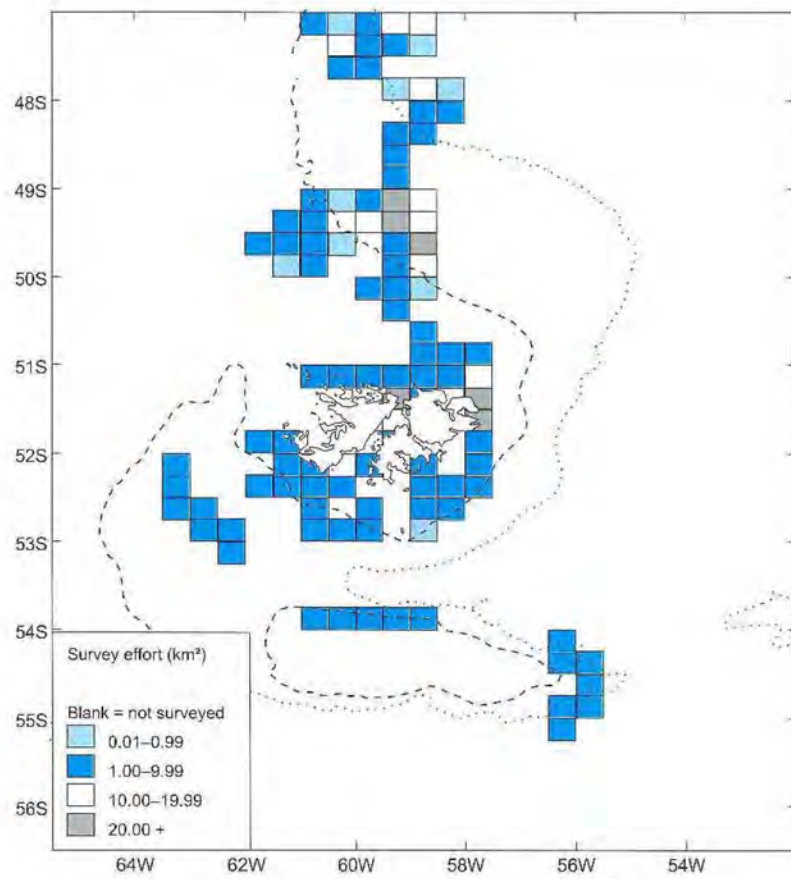


Figure 10 Distribution of survey effort, July 1998

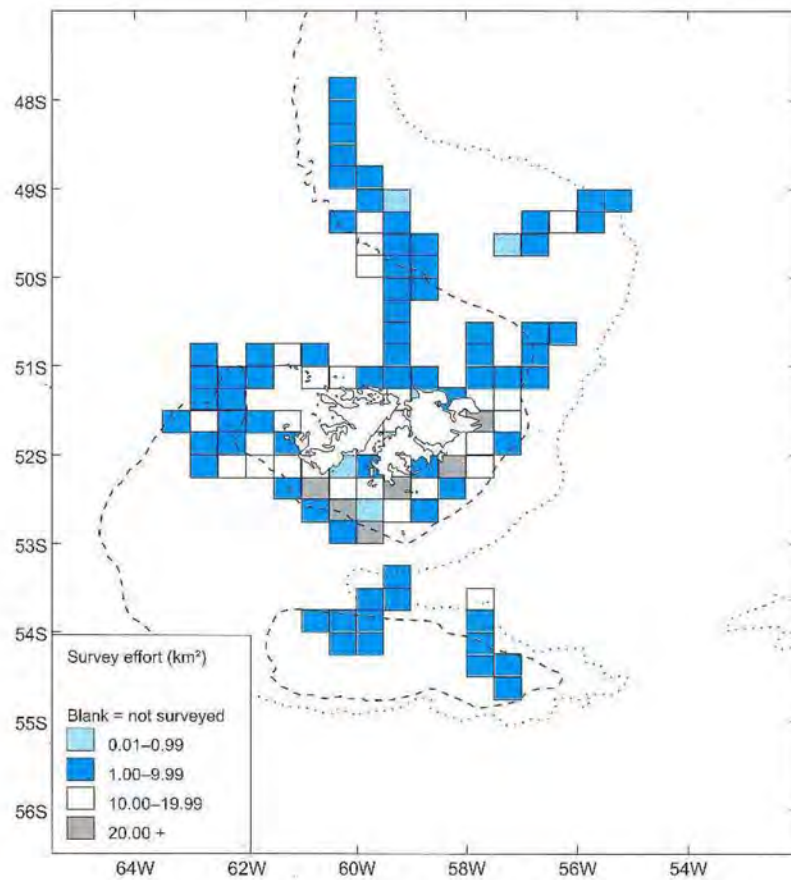


Figure 11 Distribution of survey effort, August 1998

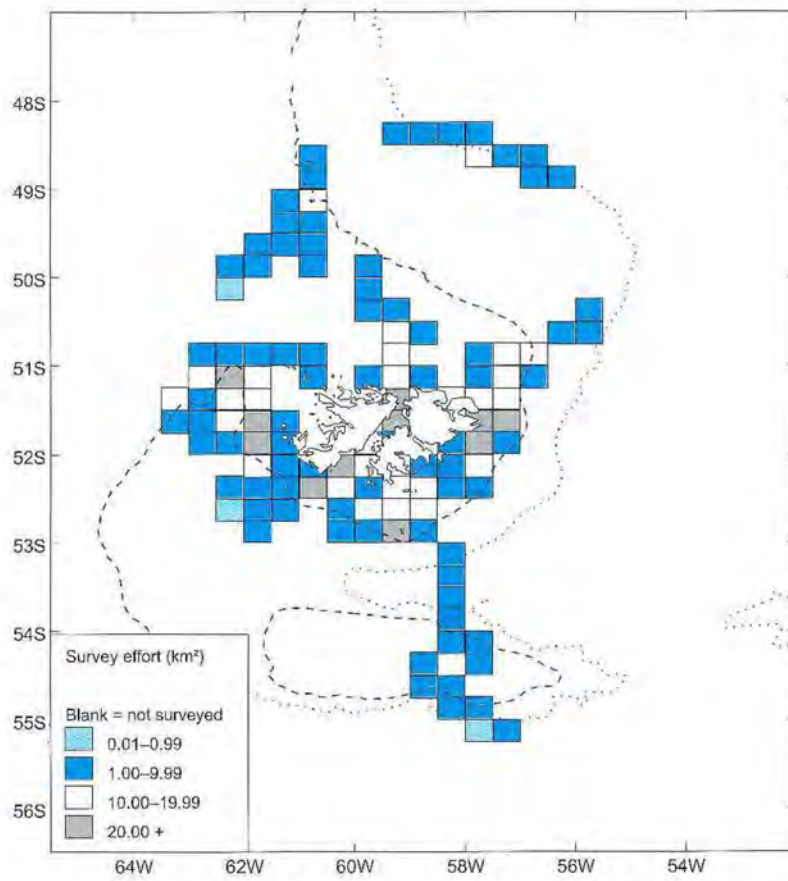


Figure 12 Distribution of survey effort, September 1998

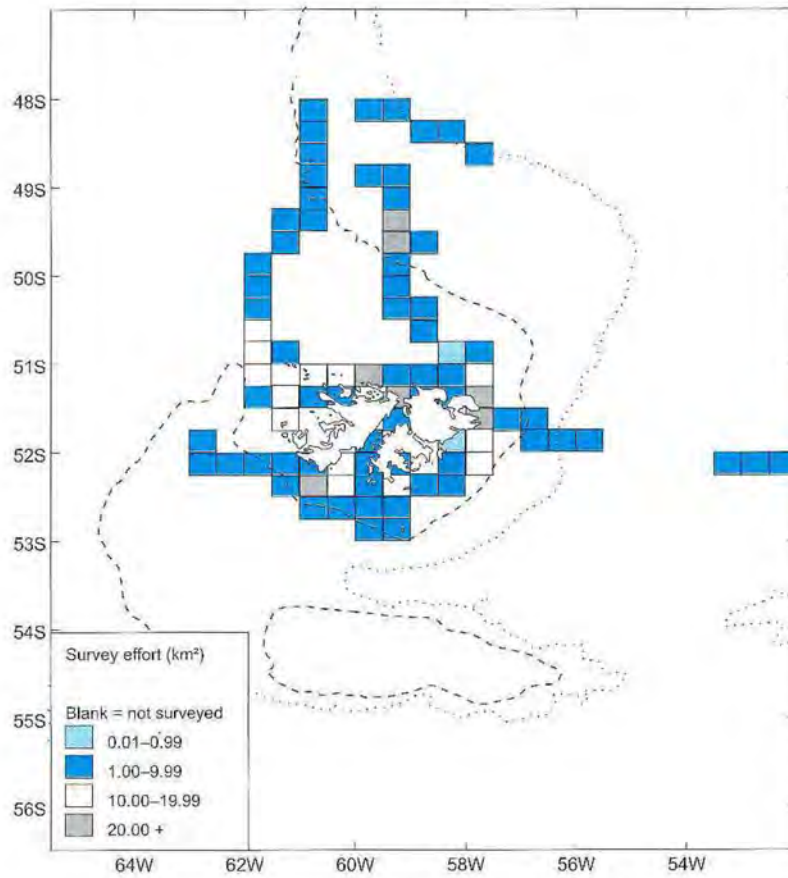


Figure 13 Distribution of survey effort, October 1998

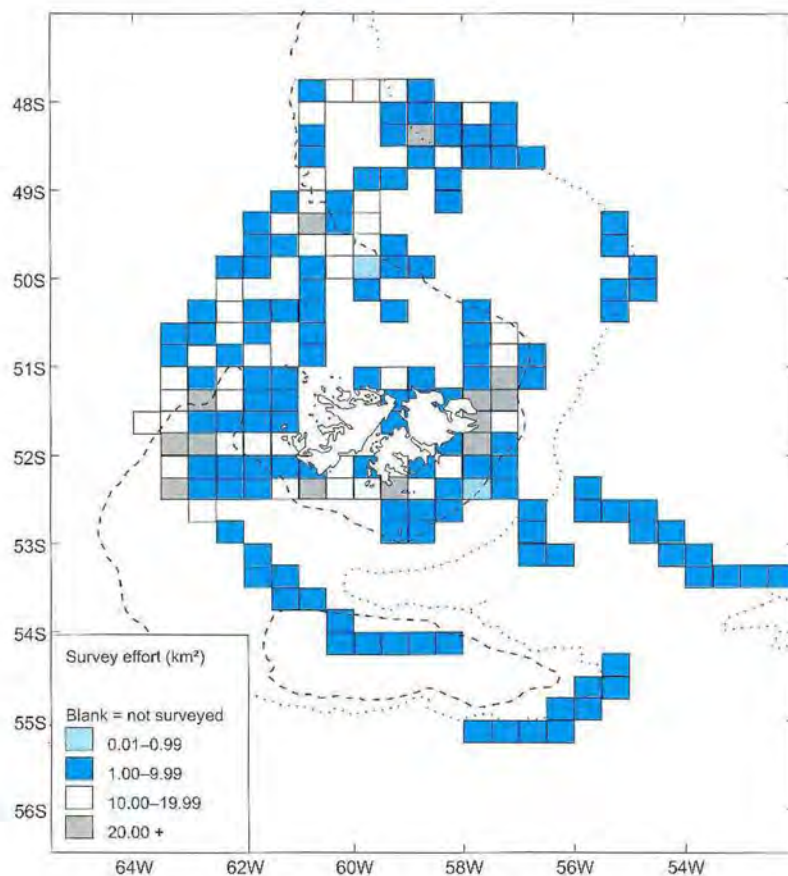


Figure 14 Distribution of survey effort, November 1998

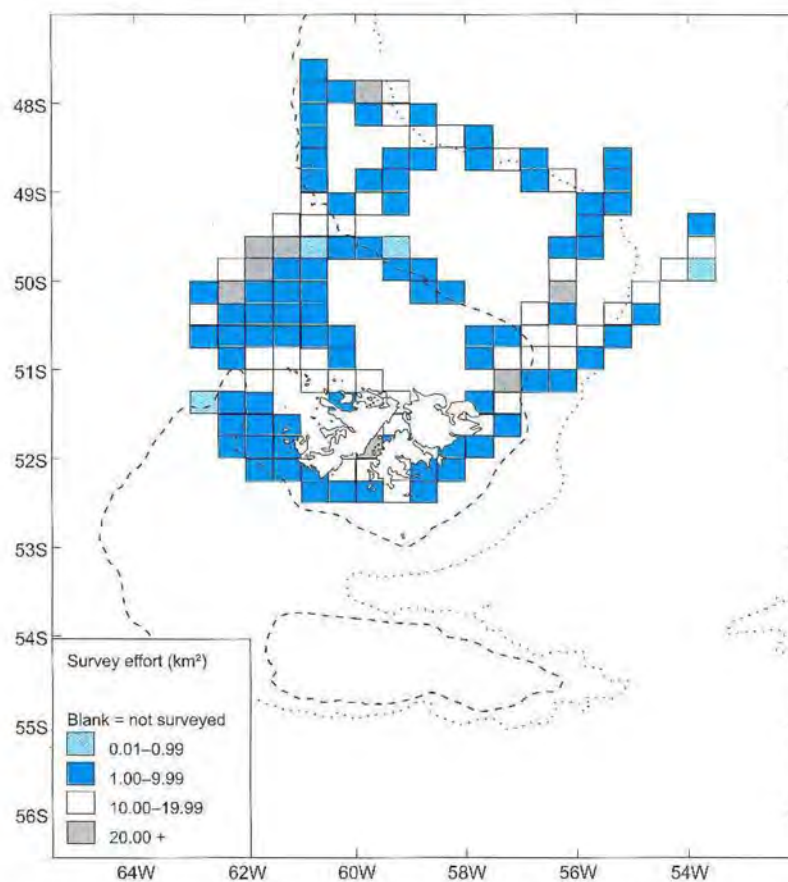


Figure 15 Distribution of survey effort, December 1998

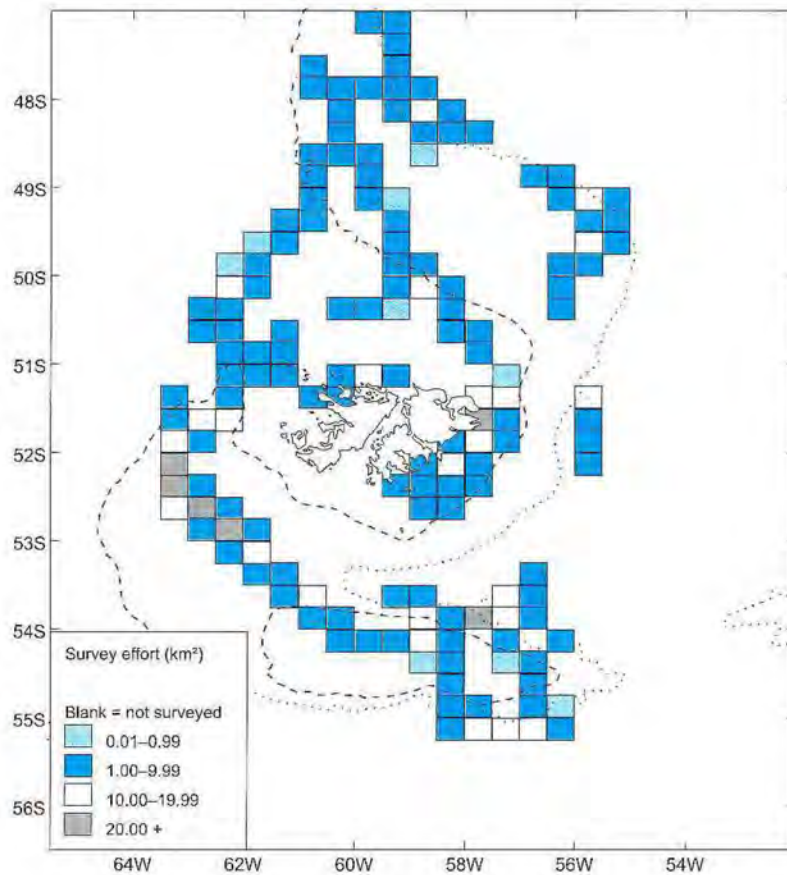


Figure 16 Distribution of survey effort, January 1999

5.2 Survey conditions

Figure 17 shows the average wind strength recorded during surveys. The windier months were from July to February, when average wind speeds of Beaufort force 4 or greater prevailed. Wind strength generally mirrored recorded sea states (Figure 18), except in March and August, when relatively higher sea states than might have

been expected based on wind strength were recorded. This was probably due to periods of prolonged strong winds in those months.

Figure 19 shows the predominance of winds from the westerly quadrant. During the study period, the wind blew from the westerly quadrant for 76.4% of survey time.

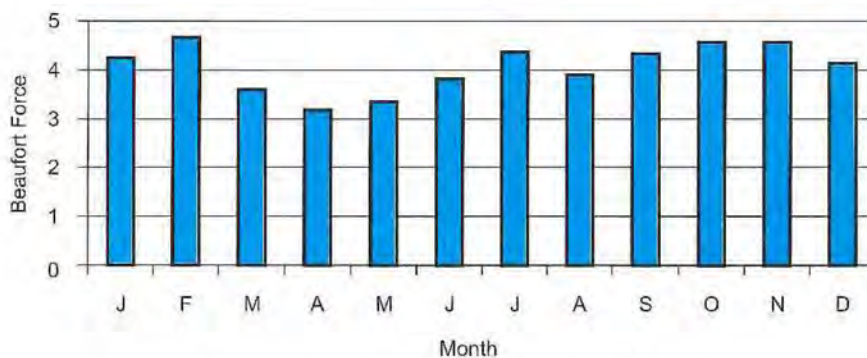


Figure 17 Seasonal variation in average wind strength during surveys

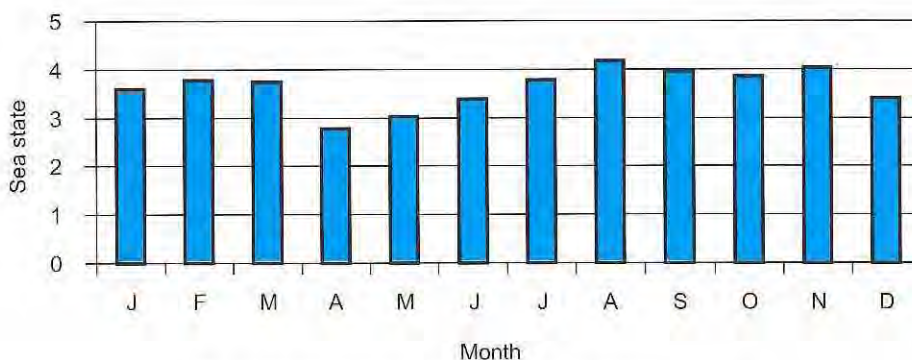


Figure 18 Seasonal variation in sea state during surveys

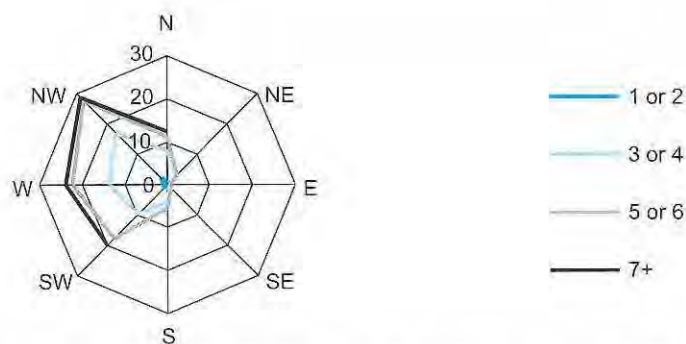


Figure 19 Wind rose showing wind direction and strength (Beaufort force) during surveys. The scale is the percentage of time for a given wind speed and direction. For example, the wind blew from the north-west for roughly 28% of the time, of which 1 or 2% was force 1 or 2, about 15% was force 3 or 4, about 13% 5 or 6 and less than 1% was force 7 or greater.

5.3 Data presentation

As with the effort maps, the species dispersion maps that follow use the '¼ ICES rectangle' as the mapping resolution—the same resolution as that used in most northern hemisphere studies (e.g. Begg *et al.* 1997, Stone *et al.* 1995), which provide the model for the present study. Within '¼ ICES rectangles', seabird distribution and abundance are depicted differently depending on each species' frequency of recording. The dispersion of 'common' species—those with more than ten records of more than 500 birds during the year—is depicted by bird density per km² of area surveyed (survey effort). 'Regular' species have more than ten records of between 100 and 500 individuals and are mapped as number of individuals recorded per km travelled, while 'rare' species (those recorded on more than ten occasions, but comprised less than 100 birds) are depicted using dots whose size is scaled to the frequency of recording. 'Very rare' (vagrant) species of seabird are not mapped at all, but are listed at the end of the species accounts. Vagrant species are those with fewer than ten records during the year.

The densities shown in the species maps are observed densities of seabirds. However, true densities will be

different, because the ability to detect seabirds and marine mammals depends on the conditions under which observations are made. For example, detectability declines with increasing sea state. Species such as penguins and diving-petrels are certainly less likely to be seen in rough conditions. While surveying is usually carried out in wind speeds less than Beaufort force 6, sea conditions between a Beaufort force 1 and force 6 vary considerably. Consequently, results obtained under different observation conditions may not strictly be comparable. Usually, they are rendered comparable by applying correction factors to account for the effective differences in survey effort that observing in different conditions impose. For example, Stone *et al.* (1995) applied species-specific correction factors to observed seabird densities to account for variation in detectability of birds on the water in transect bands at different distances from the observation platform. Using modelling techniques, Bravington *et al.* (1999) computed calibration factors to account for sea state in assessing cetacean sightings rates. However, such calibrations and corrections have not been applied in the present study.

This is mainly because the dataset is relatively small—more than 12 months' data are required to compute reliable correction factors. Therefore, the relative abundance data presented for each species must be treated with caution, and comparisons between months and/or species should be made prudently and conservatively, especially with smaller, less conspicuous species.

The distributions of regularly recorded marine mammals are shown as the number of animals recorded per km travelled, again within ¼ ICES rectangles. The

occurrence of rarely recorded marine mammals is presented in dot distribution maps showing the locations of sightings, but not the number of animals seen. Very rarely recorded marine mammals are listed at the end of the species accounts.

As previously noted, and in the species accounts that follow, the dispersion maps should be interpreted cautiously, always taking into account the degree and spatial distribution of survey coverage at different times of year.

5.4 Seabirds

5.4.1 Penguins *Spheniscidae*

During the survey period, all five species of penguin that breed in the Falkland Islands were recorded. Woods (1988), however, noted a further five species as vagrants, but none of these was recorded during our surveys.

5.4.1.1 King penguin *Aptenodytes patagonicus*

King penguins are resident in the Falkland Islands. They attend their colonies in all months of the year as chick rearing takes 12 months to complete (Williams 1995). The Falkland Islands population of king penguins is the most northerly in the world and numbers about 300 pairs

(Ingham 1998). The world population is in excess of 1 million pairs (Woehler 1993). The Falkland Islands population of king penguins is therefore important in terms of the species' geographical range, but the size of the population is only of local importance.

King penguins were only rarely recorded during surveys. This is partly a reflection on their scarcity as a breeding species in the Falkland Islands. There were 12 records of king penguin involving 43 birds, all in the period June to November. Most records were from the waters to the north of the islands with several records from within the licence blocks (Figure 20). On one occasion a king penguin was seen from a rig supply vessel

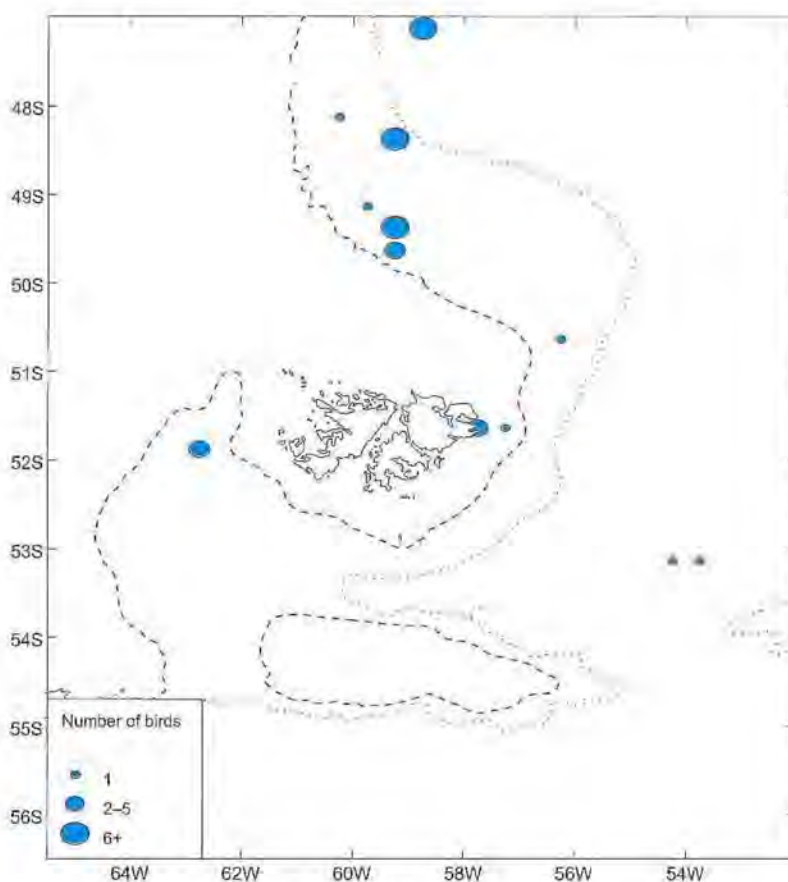


Figure 20 King penguin distribution, June–November

while alongside the drilling rig (A. Black pers. comm.). The records in deep waters to the south-east of the Falkland Islands were in November.

The observed distribution pattern may primarily reflect the pattern of survey coverage, but it is nevertheless similar to the pattern of king penguin distribution obtained from satellite tracked king penguins from Volunteer Point (K. Pütz pers. comm.). Pütz showed that in the austral winter, king penguins from Volunteer Point forage in waters to the north of the Falkland Islands, but to the south and east of the islands at other times in the year.

Whether king penguins from the considerably larger South Georgia population (>400,000 pairs; Ellis *et al.* 1998) regularly visit the waters of the Falkland Islands is not known. However, a king penguin in the Volunteer Point colony was originally ringed at South Georgia (K. Pütz pers. comm.).

5.4.1.2 Gentoo penguin *Pygoscelis papua*

Gentoo penguins are resident in the Falkland Islands and may be present onshore at colonies all year, although breeding is restricted to the summer months (pers. obs.). The Falkland Islands are of international importance for their populations of gentoo penguin, although estimates of the size of the population vary. Woehler (1993) lists the Falkland Islands as the most important location in the world for gentoo penguins, with 108,000 pairs repre-

senting 36% of the world population of 314,000 pairs. A more recent estimate puts the Falkland Islands population at about 65,000 pairs (Bingham 1998), which would render the Falkland Islands the second most important location for this species after South Georgia (Ellis *et al.* 1998).

Some 1,603 Gentoo penguins were recorded during surveys, with records in all months. Numbers were higher between June and November (1,281), although distribution patterns in June to November (Figure 21) and December to May (Figure 22) were similar. These higher densities probably result from birds spending more time at the colonies during the summer months. The highest densities of gentoo penguins were generally recorded in inshore waters, particularly around the north and south ends of Falkland Sound, and off the south coast of West Falkland in the winter. Very few gentoo penguins were recorded north of 49°S, but they were frequently recorded at low densities in the north-west of the survey area, out to the boundary with the Argentine EEZ, particularly during June to November.

Gentoo penguins are recorded only rarely in mainland South America, and it is not known how far birds from the Falkland Islands regularly swim into Argentine waters. The species has been recorded as a vagrant on Argentine shores (Harris 1998), although there is a small colony on Isla de los Estados (Staten Island, 54° 40' S, 64° 00' W; J. Croxall, pers. comm.).

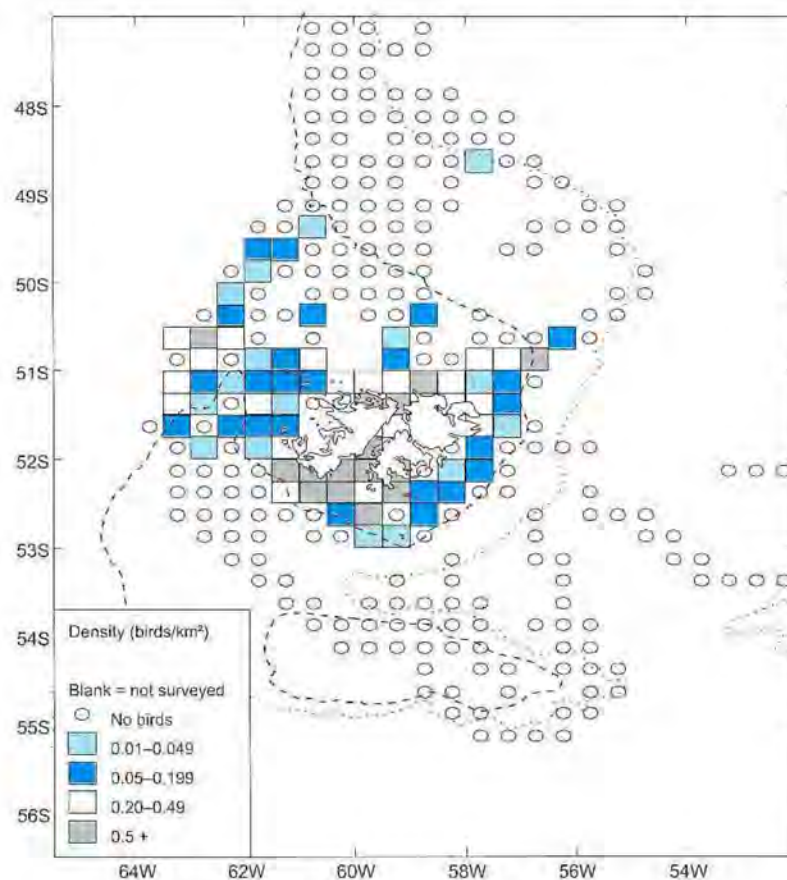


Figure 21 Gentoo penguin dispersion, June–November

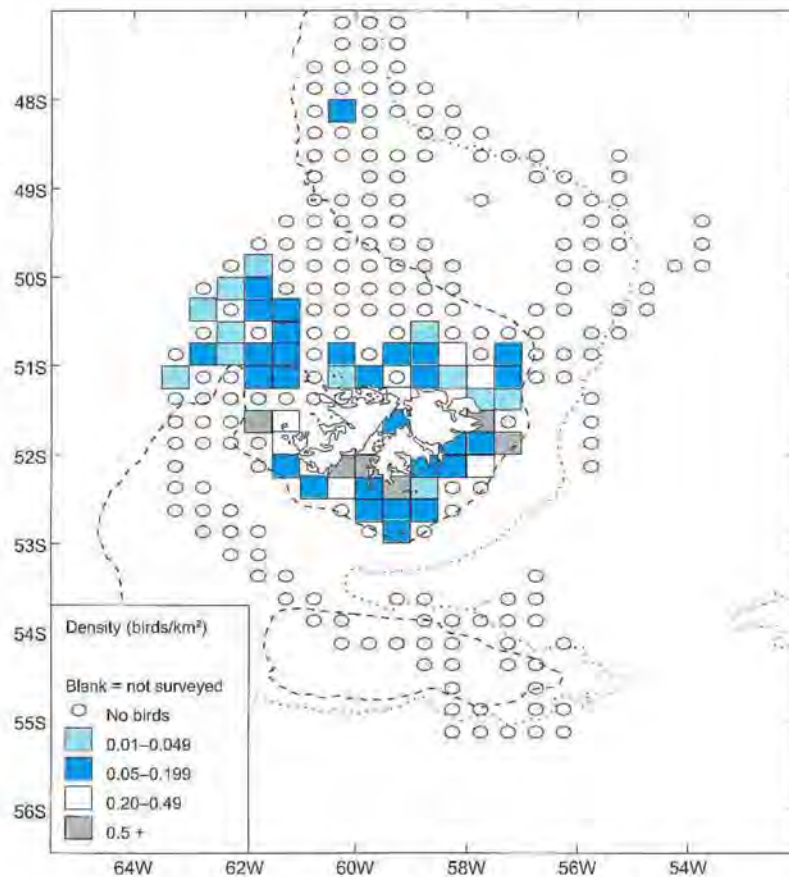


Figure 22 Gentoo penguin dispersion, December–May

Gentoo penguins were usually observed singly or in small groups, the largest group comprising 25 birds. Birds were significantly more likely to be recorded in groups in winter and singly in summer ($\chi^2 = 25.4613$, $df = 8$, $p = 0.0013$).

5.4.1.3 Rockhopper penguin *Eudyptes chrysocome* and macaroni penguin *E. chrysolophus*

When surveying *Eudyptes* penguins at sea it was not always possible to be certain of the specific identification of all birds seen. Consequently, most *Eudyptes* penguins were recorded as rockhopper or macaroni penguin. Only one sighting of *Eudyptes* penguins during the year was positively identified as macaroni penguin. The great majority of sightings are thought to refer to rockhopper penguins, which is the commoner breeding species in the Falkland Islands by a factor of about 10,000 pairs to one (Woods and Woods 1997).

The estimated 300,000 pairs of southern rockhopper penguin *E. c. chrysocome* breeding in the Falkland Islands is of international importance, as it comprises about 63% of the world population of this subspecies (Bingham 1998).

The rockhopper penguin is primarily a summer visitor to the waters of the Falkland Islands, although some birds are present year round. The survey recorded a total of

1,013 (presumed) rockhopper penguins, with records in all months. Although numerically the commonest penguin species breeding in the Falkland Islands, it was only the third most commonly recorded penguin during surveys. Why rockhopper penguins should be under sampled during at-sea surveys is unclear, but it could be due to a geographical bias in survey coverage. Being migratory, their abundance may perforce be lower than other, resident species of penguin. Compared with Magellanic penguins, for example, the distribution of rockhopper breeding areas is very patchy, and this may be reflected in their at-sea distribution, leading to a reduced likelihood of survey areas (which were mainly away from the main centres of rockhopper breeding) coinciding. Alternatively, the rockhopper penguin might be more difficult to detect at sea, or it may avoid vessels to a greater degree than other species.

The highest densities of rockhopper penguins were recorded between October and March, which coincides with the breeding season of this species. During this period, rockhopper penguins were recorded at locally high densities throughout the survey area, in both Patagonian Shelf and oceanic waters (Figure 23). In this respect the rockhopper penguin was perhaps the most widespread of the three species of penguin commonly recorded during surveys, although it was not as abundant as gentoo or Magellanic penguins. The rockhopper

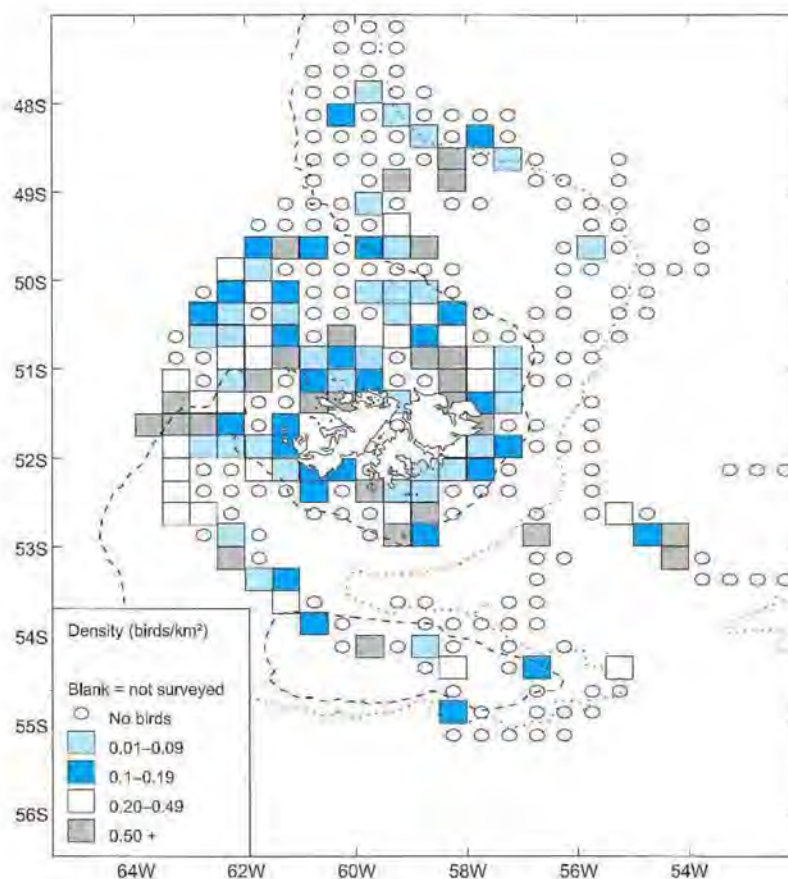


Figure 23 Rockhopper penguin dispersion, October–March

penguin is also unusual in that it was more typical for high densities to occur away from inshore waters, whereas high densities of the other two species exhibited a more inshore distribution.

In the months from April to September rockhopper penguins were recorded at low or moderate densities, mostly to the north and west of the Falkland Islands (Figure 24). This decrease in the numbers of rockhopper penguins recorded in the winter months was not as marked as the decrease in the numbers of Magellanic penguins from summer to winter—an observation supported by the results of satellite tracking of rockhopper penguins. Rockhopper penguins did move out of Falkland Islands waters to the north-west in winter, but did not swim much farther north than 46°S, and several birds returned to Falkland Islands waters during the course of the winter (Pütz *et al.* 1998).

Few other seabird species associated with rockhopper penguins at sea; only small groups of prions and black-browed albatrosses did so.

5.4.1.4 Magellanic penguin *Spheniscus magellanicus*

The Magellanic penguin population in the Falkland Islands is estimated to be between 76,000 and 142,000 pairs (Woods and Woods 1997). This represents about

10% of the world population, the majority of which is in South America (Bingham 1998).

Mainly a summer visitor to the waters of the Falkland Islands some Magellanic penguins may be present in all months. It was the commonest species of penguin recorded during surveys: a total of 5,388 birds were recorded in all months except June.

Magellanic penguins were commonest between November and February, coinciding with the breeding season. During this time highest densities were recorded throughout inshore waters, and in some offshore waters to the north of the islands, including some in deep water (Figure 25). Very few were recorded south of Beauchêne Island. In March and April, numbers of Magellanic penguins decreased significantly (Figure 26), but the small amount of survey effort achieved in inshore waters, and the lack of survey coverage to the south of the islands, renders recorded distribution patterns of Magellanic penguins in these months difficult to interpret.

By May most Magellanic penguins had left the waters of the Falkland Islands; there were just a few birds in inshore waters, notably off the north coast of West Falkland (Figure 27; see also brown-hooded gull *Larus maculipennis*, sooty shearwater *Puffinus griseus*, South American tern *Sterna hirundinacea* below). This is also

Seabird and marine mammal dispersion in the waters around the Falkland Islands

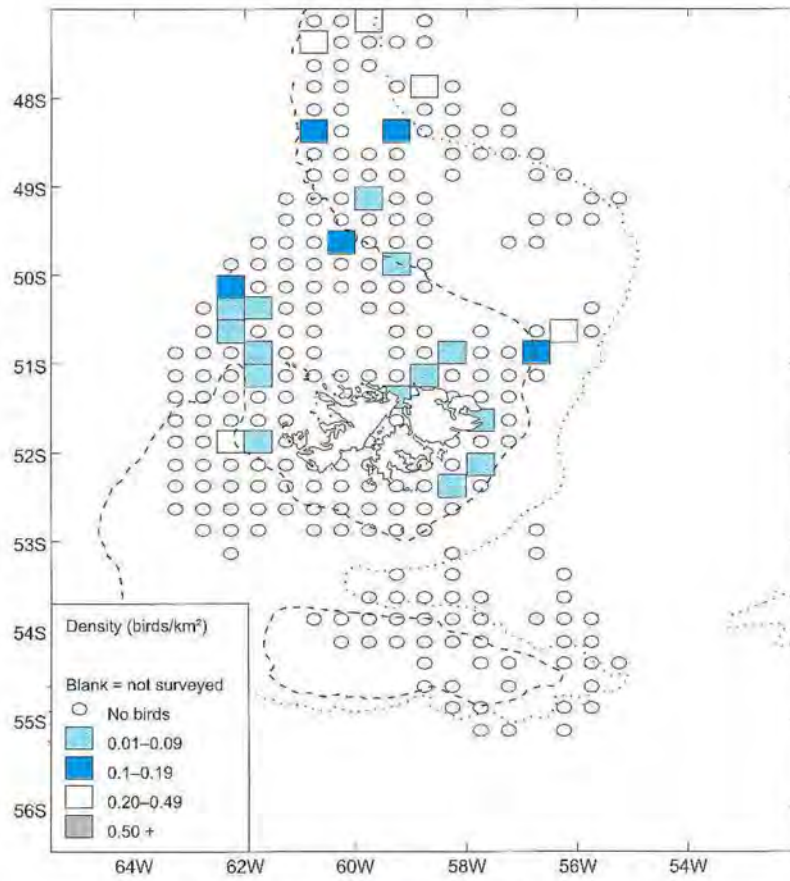


Figure 24 Rockhopper penguin dispersion, April-September

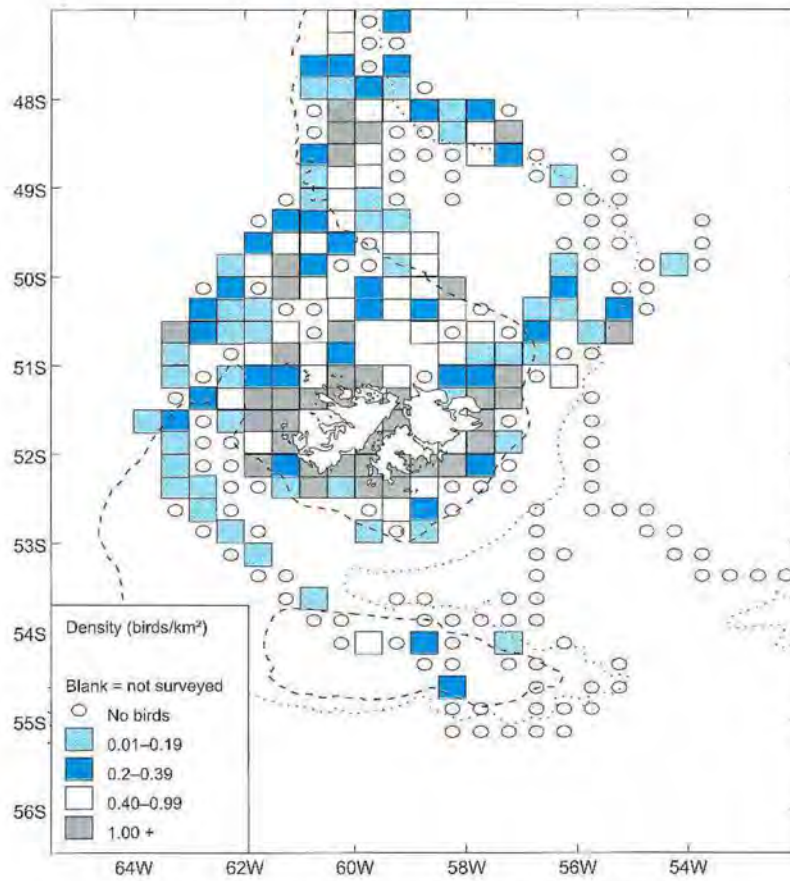


Figure 25 Magellanic penguin dispersion, November-February

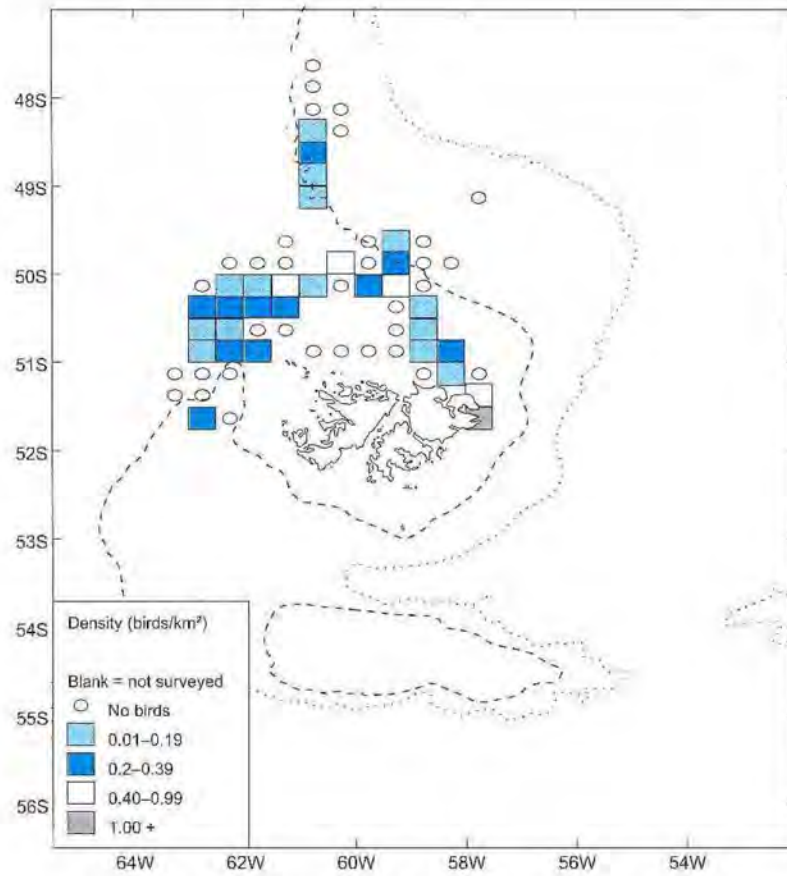


Figure 26 Magellanic penguin dispersion, March–April

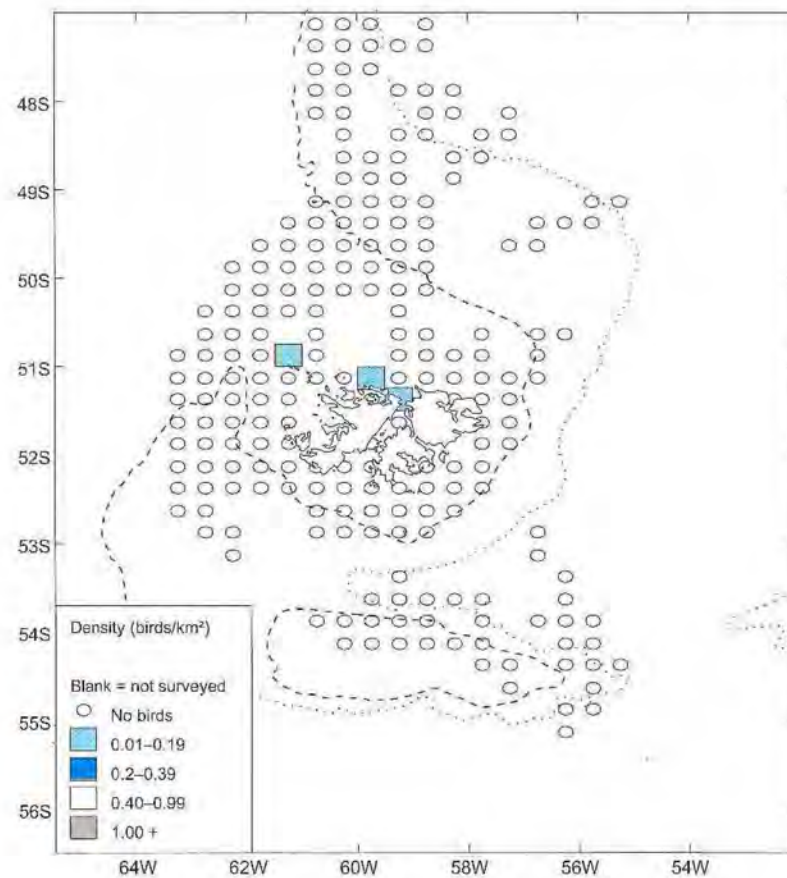


Figure 27 Magellanic penguin dispersion, May–August

mirrored in the results from satellite tagging, which show that birds leave Falkland Islands waters by the second week of April and swim north along the Patagonian Shelf as far as 35° S (Pütz *et al.* in press).

Magellanic penguins were observed returning to the waters of the Falkland Islands from early September onwards. Their arrival was characterised by the appearance of birds in inshore waters, with few noted in offshore waters at this time (Figure 28) indicating that, when returning from wintering areas, Magellanic penguins do not linger in offshore waters but go directly to the colonies. This is in contrast to the Magellanic penguins that linger in offshore areas in autumn (Figure 26).

Some of the Magellanic penguins recorded in summer in the north-west of the survey area were probably from the South American populations rather than from the Falkland Islands. The Falkland Islands and South American populations do mix on the wintering grounds (Pütz *et al.* in press), but to what extent South American birds visit Falkland Islands waters (or vice versa) in the summer is not known.

Immature (first summer) Magellanic penguins were noted returning to Falkland Islands waters from November onwards, and accounted for up to 24% of Magellanic penguins whose age was determined.

Magellanic penguins were observed in feeding associations with sooty shearwater and black-browed

albatrosses in inshore waters, brown-hooded gulls and South American terns in enclosed inshore waters, and Wilson's storm-petrel *Oceanites oceanicus* in deep-water areas. Occasionally, Magellanic penguins were observed with other penguin species (gentoo and/or rockhopper).

5.4.2 Albatrosses *Diomedidae*

Albatross taxonomy here follows Gales (1998).

At least ten species of albatross have been recorded in the seas around the Falkland Islands, of which one, the black-browed albatross, breeds (Woods 1988, Woods and Woods 1997). Eight species were recorded during surveys, five of them regularly and three others occasionally.

5.4.2.1 Wandering albatross *spp.* *Diomedea exulans spp.*

The wandering albatross is a non-breeding visitor to the waters of the Falkland Islands. Recently classified into four species (Gales 1998), it was not possible in this study to identify with certainty which of the four occurred around the Falkland Islands.

Evidence from satellite tracking of wandering albatrosses suggests that most birds seen in the south-west Atlantic are from the South Georgia population, the nominate wandering albatross *D. exulans*. Observations made from longliners operating in Falkland Islands waters support this view and indicate that this is an

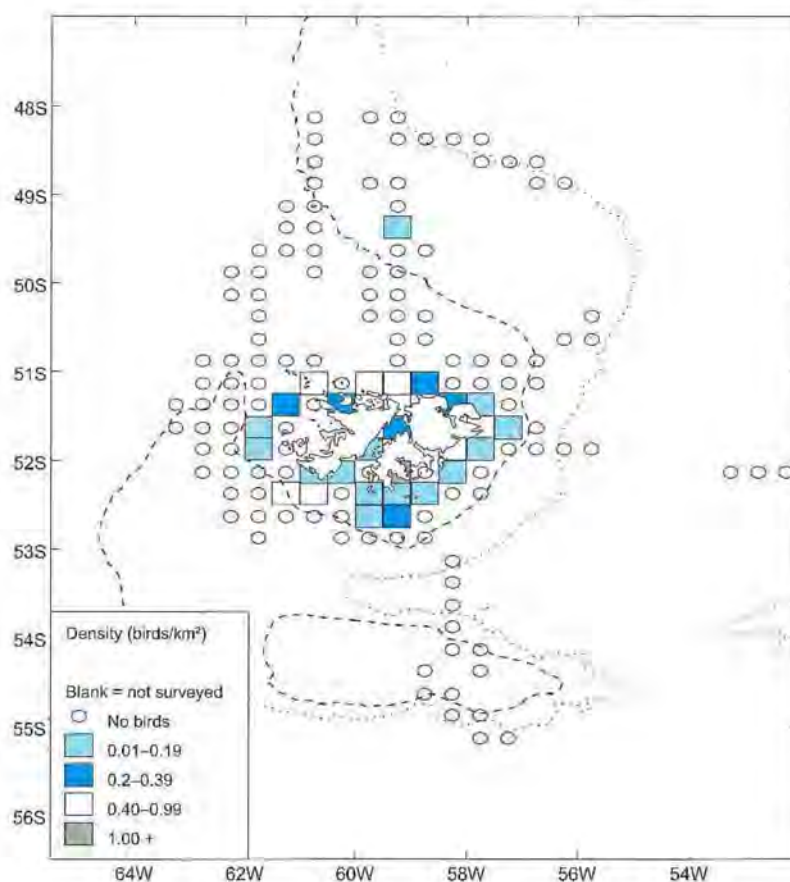


Figure 28 Magellanic penguin dispersion, September–October

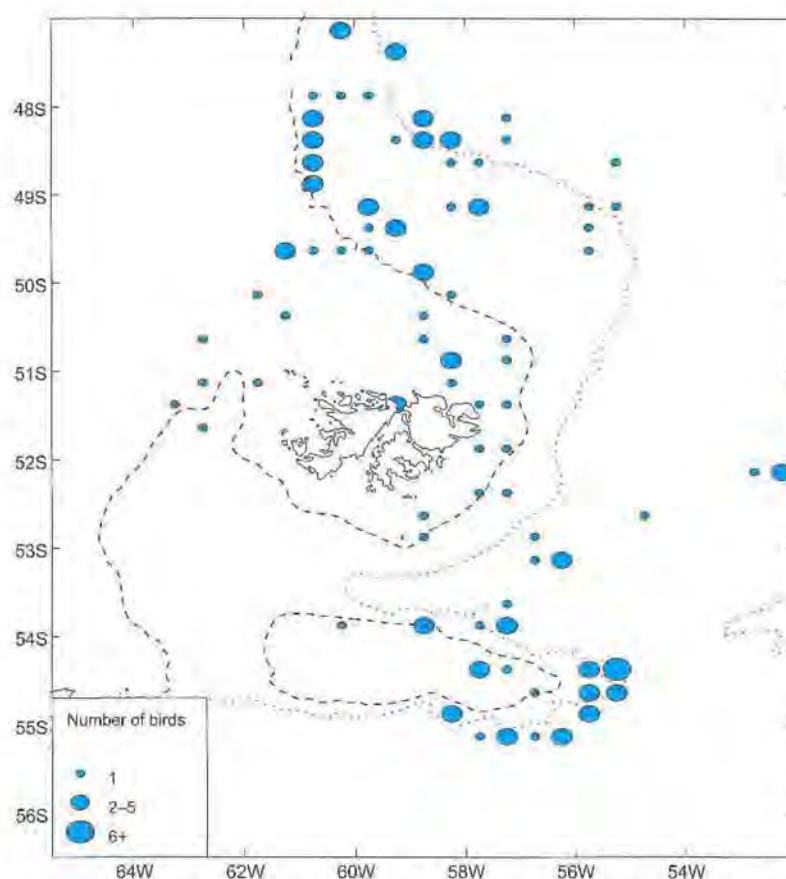


Figure 29 Wandering albatross distribution, all months

important area for South Georgia albatrosses (Croxall *et al.* 1999). In addition, during SAST surveys several colour-dyed wandering albatrosses were recorded near the Burdwood Bank in January 1999. These birds were dyed by BAS at Bird Island, South Georgia (C. Hill pers. comm.; see northern giant petrel *Macronectes halli*)

The total of 131 wandering albatrosses recorded throughout the year conforms to no apparent seasonal pattern. Wandering albatrosses were recorded throughout the survey area with more records in the waters over the continental shelf slope and in oceanic areas (Figure 29). This contrasts with the royal albatrosses *D. epomophora* and *D. sanfordi*, which were typically recorded in the shallower waters of the Patagonian Shelf (see below).

Wandering albatrosses were obligate ship associates (one bird was observed to remain with the survey base for at least 26 hr) and consequently were often not recorded using SAST methodology, which ignores survey base associates.

5.4.2.2 Northern royal albatross *Diomedea sanfordi* and southern royal albatross *D. epomophora*

Royal albatrosses breed only in New Zealand. The northern royal albatross has an annual breeding pop-

ulation of about 5,200 pairs (Gales 1998) and is classified by IUCN as Endangered (Croxall and Gales 1998). The southern royal albatross has an annual breeding population of 7,870 pairs (Gales 1998) and is classified as Vulnerable by the IUCN (Croxall and Gales 1998). Outside the breeding season, royal albatrosses range across the southern Pacific Ocean and into the south-west Atlantic Ocean. The importance of the south-west Atlantic for non-breeding royal albatrosses has long been recognised (Robertson and Kinsky 1972, Enticott 1986).

Both the northern royal albatross and the southern royal albatross were recorded during surveys; when possible, royal albatrosses were specifically identified. Of a total of 1,889 royal albatrosses recorded, 1,427 (75.5%) were identified as southern royal albatross and 157 (8.4%) as northern royal albatross, while 305 (16.1%) were not specifically identified. Of those birds specifically identified, southern royal albatrosses outnumbered northern royal albatrosses by a ratio of about 9:1. The proportions of *sanfordi* to *epomophora* royal albatrosses recorded previously have varied from "mostly *sanfordi*" in February to "mostly *epomophora*" in winter (Wolsey 1987).

All royal albatross records were combined in the distribution analysis here. Northern and southern royal albatrosses numbers peaked in the same months (March

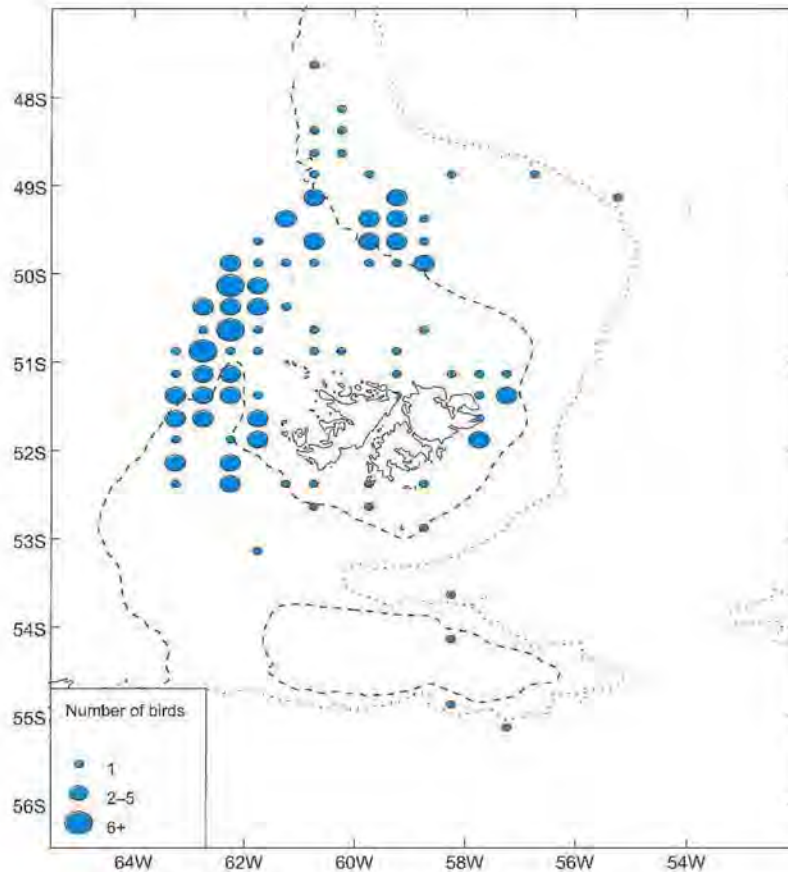


Figure 30 Northern royal albatross distribution, all months

to June) and there was no evidence of any large-scale spatial variation in their respective distributions. Generally, peak numbers of *sanfordi* occurred in the same areas as large numbers of *epomophora*; that is primarily over the Patagonian Shelf to the north-west of the Falkland Islands. The only exception to this was in the vicinity of the 200-m contour to the north of the Falkland Islands (Figure 30), an area where relatively high numbers of *sanfordi* but low numbers of *epomophora* were recorded.

The highest densities of royal albatrosses were recorded between March and June in the Patagonian Shelf waters to the north-west of the Falkland Islands (Figure 31), an area which is used at this time by a large fishing fleet of jiggers and trawlers. Royal albatrosses were frequently observed scavenging in the wake of trawlers, with at least 120 birds behind one vessel in March (pers. obs.). In other parts of the study area, royal albatrosses were recorded at low densities, and a similar pattern was observed between July and February (Figure 32). In all months, the species was more frequently observed over Patagonian Shelf in waters less than 200 m deep. This was in direct contrast to wandering albatrosses, which were more frequently recorded in waters more than 200 m deep (Figure 29).

5.4.2.3 Black-browed albatross *Thalassarche melanophris*

The Falkland Islands supports 86% of the world population of 682,000 pairs of black-browed albatross (Gales 1998).

A total of 35,801 black-browed albatrosses was recorded during surveys, rendering this the second most abundant species recorded. Black-browed albatrosses were recorded all year and were observed throughout the survey area, although they were uncommon in oceanic regions.

In common with royal albatrosses and grey-headed albatrosses and several of the smaller petrels, black-browed albatrosses were commoner over the shallower waters of the Patagonian Shelf to the north-west of the islands between February and June (Figure 33). High densities of black-browed albatrosses were also recorded during surveys in Falkland Sound during these months.

Between July and January, highest densities also were recorded to the west of the islands, but closer inshore than between February and June (Figure 34). Most black-browed albatrosses breed on the islands in the north-west of the Falklands but there is also a large colony on Beauchêne Island, near which high densities were also

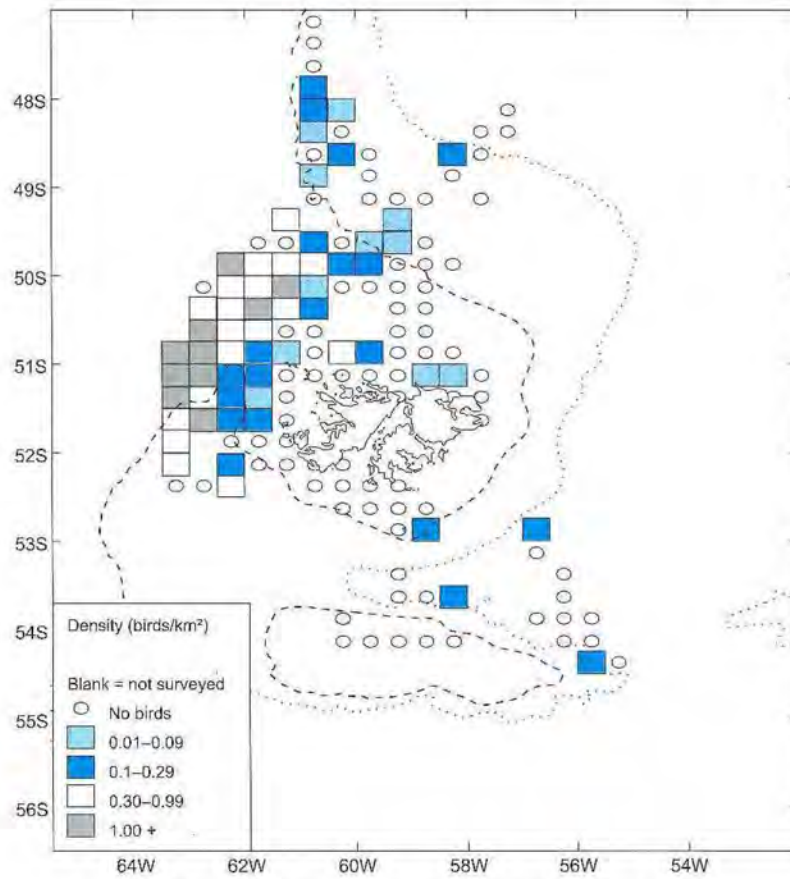


Figure 31 Royal albatross dispersion, March–June

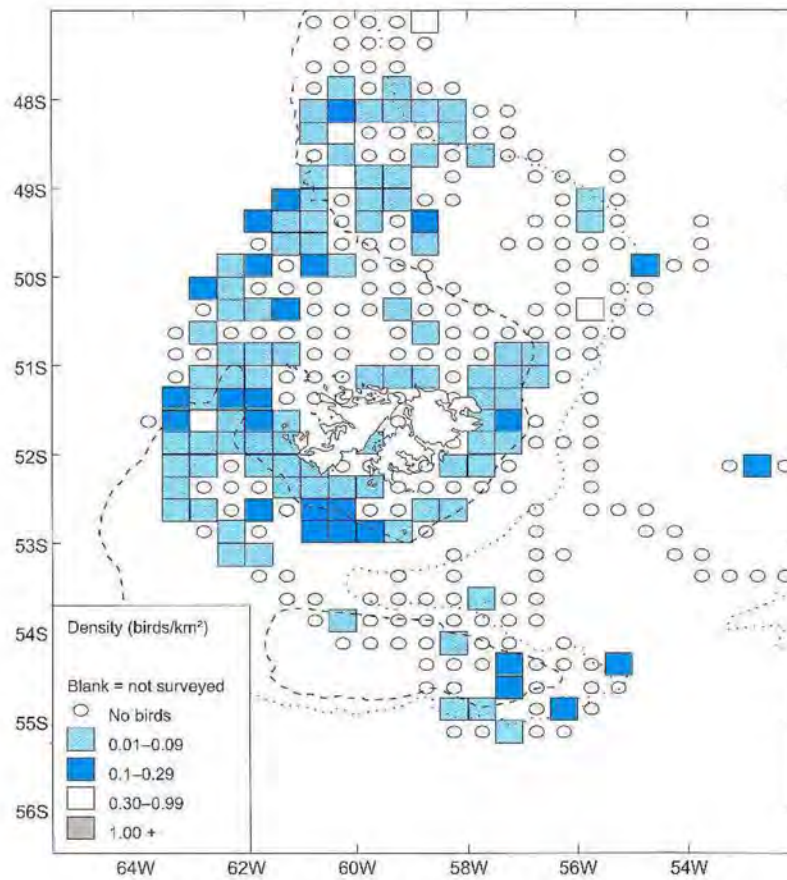


Figure 32 Royal albatross dispersion, July–February

Seabird and marine mammal dispersion in the waters around the Falkland Islands

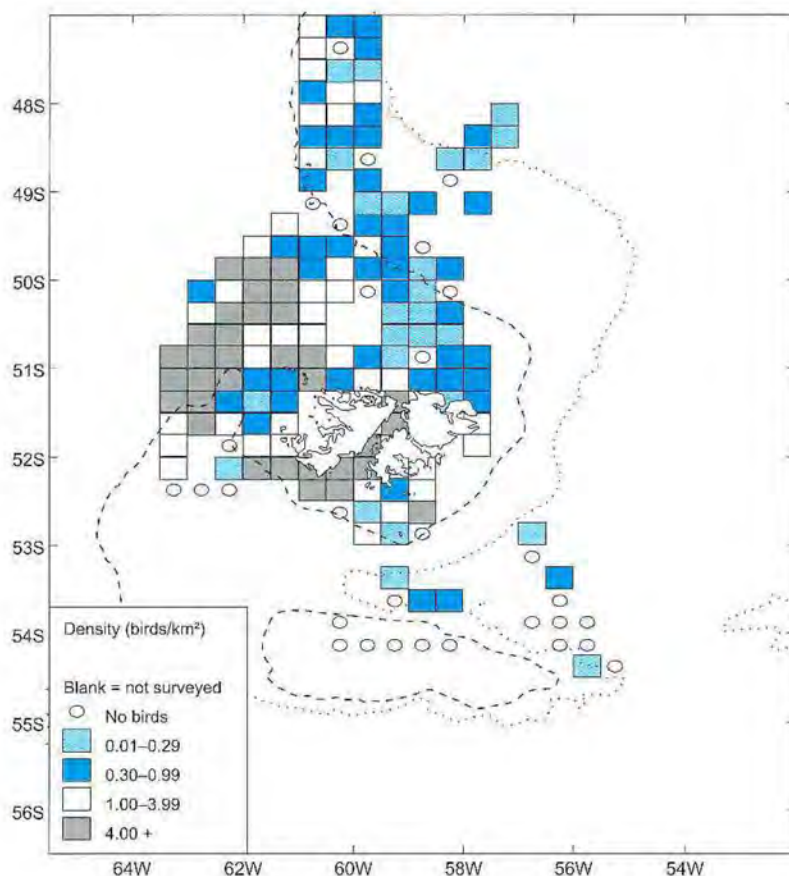


Figure 33 Black-browed albatross dispersion, February–June

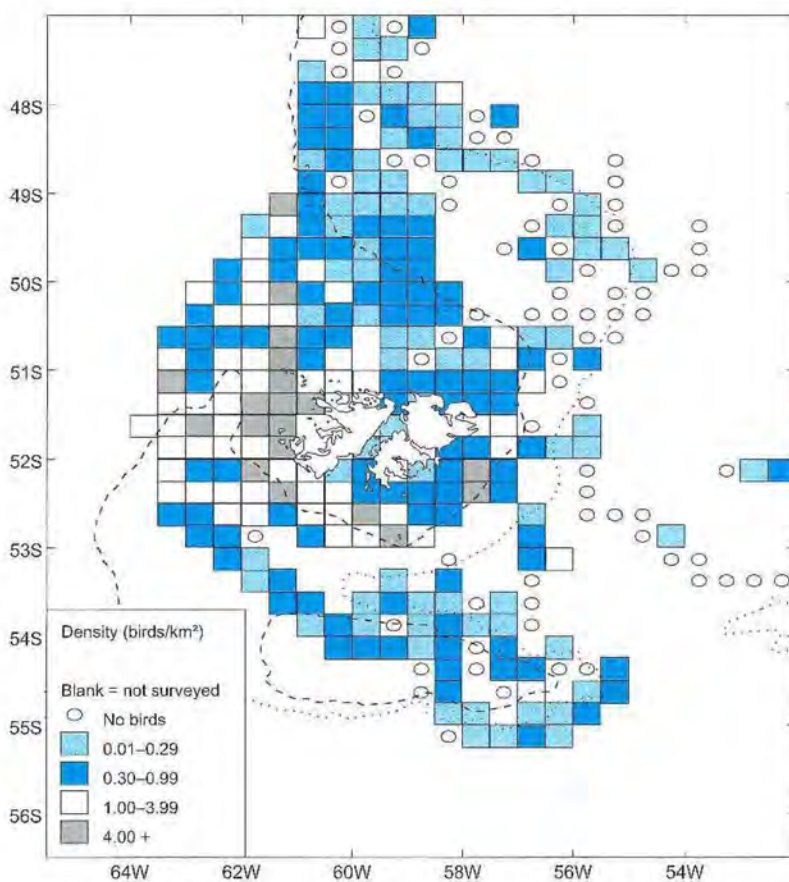


Figure 34 Black-browed albatross dispersion, July–January

recorded. Surveys in Falkland Sound between July and January did not record high densities of black-browed albatrosses.

In all months, only low to moderate densities of black-browed albatrosses were recorded in continental shelf slope and oceanic areas to the north, east and south of the islands (Figures 33 and 34).

Large numbers of black-browed albatrosses were often observed scavenging for discards around fishing vessels. Thompson (1989) concluded that the black-browed albatross was the only Falkland Islands breeding species likely to be competing with fishing vessels for commercially fished species. She estimated that scavenging around *Loligo* trawlers may provide the black-browed albatrosses breeding on Beauchêne Island with 10–15% of their food requirements during February–April (Thompson 1992) while overall, the population may get 4.4% of its energy requirement from fisheries discards (Thompson and Riddy 1995). Although scavenging may be beneficial to the albatrosses in the short term, both the *Loligo* and finfish fisheries take a greater mass of finfish than does the black-browed albatross population, so the long-term effect may be detrimental (Thompson 1992, Thompson and Riddy 1995).

Black-browed albatrosses appear to be the most frequently drowned bird during longline fishing in Falkland Islands waters (A. Black pers. comm.).

5.4.2.4 Grey-headed albatross *Thalassarche chrysostoma*

The world population of grey-headed albatross is about 92,000 pairs (Gales 1998). Grey-headed albatrosses nest on South Georgia, where over half the world population breeds, and on Diego Ramirez off the southern coast of Chile. It is not clear whether grey-headed albatrosses recorded in the waters of the Falkland Islands originate from South Georgia or South America.

A total of 444 grey-headed albatrosses was recorded during surveys in all months but February.

There was a distinct seasonal pattern to grey-headed albatross records. Between March and June, most birds were recorded in the waters to the north-west of the Falkland Islands (Figure 35). This coincides with the presence of the large fishing fleet in this area and the resultant large amount of survey effort in this area (see above). Between July and September, fewer grey-headed albatrosses were recorded in this area, with more records from Patagonian Shelf waters to the south and east of the islands, and also from deep waters to the north, east and south of the islands (Figure 36). Between October and February, there were very few records from Patagonian Shelf waters; most grey-headed albatrosses recorded in these months were from waters to the south-east of the islands (Figure 37). Satellite tracking of South Georgia

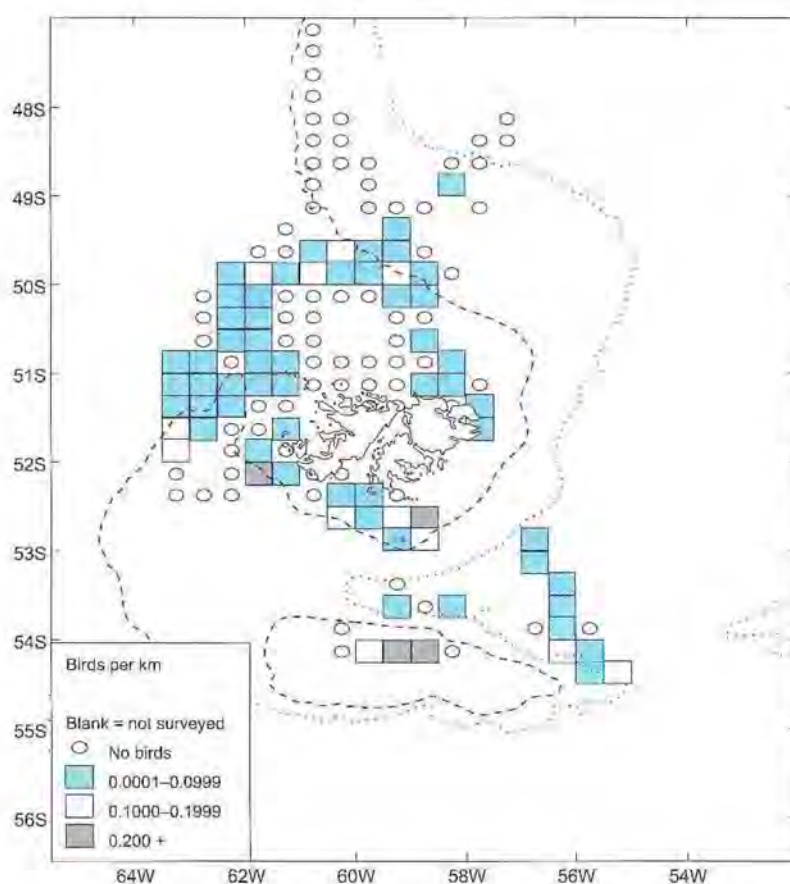


Figure 35 Grey-headed albatross dispersion, March–June

Seabird and marine mammal dispersion in the waters around the Falkland Islands

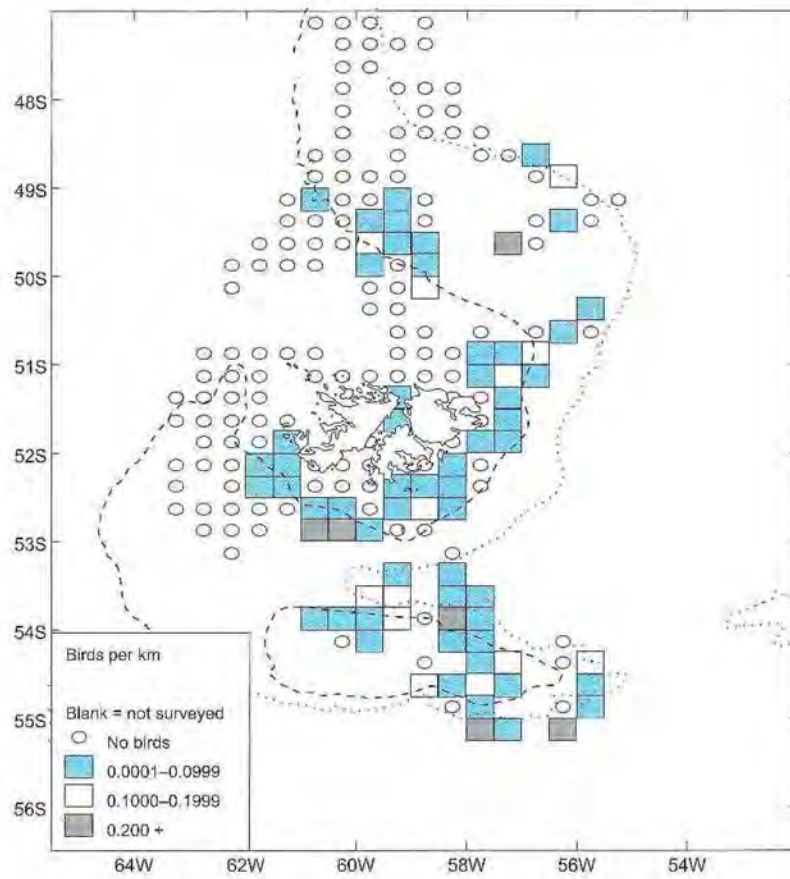


Figure 36 Grey-headed albatross dispersion, July–September

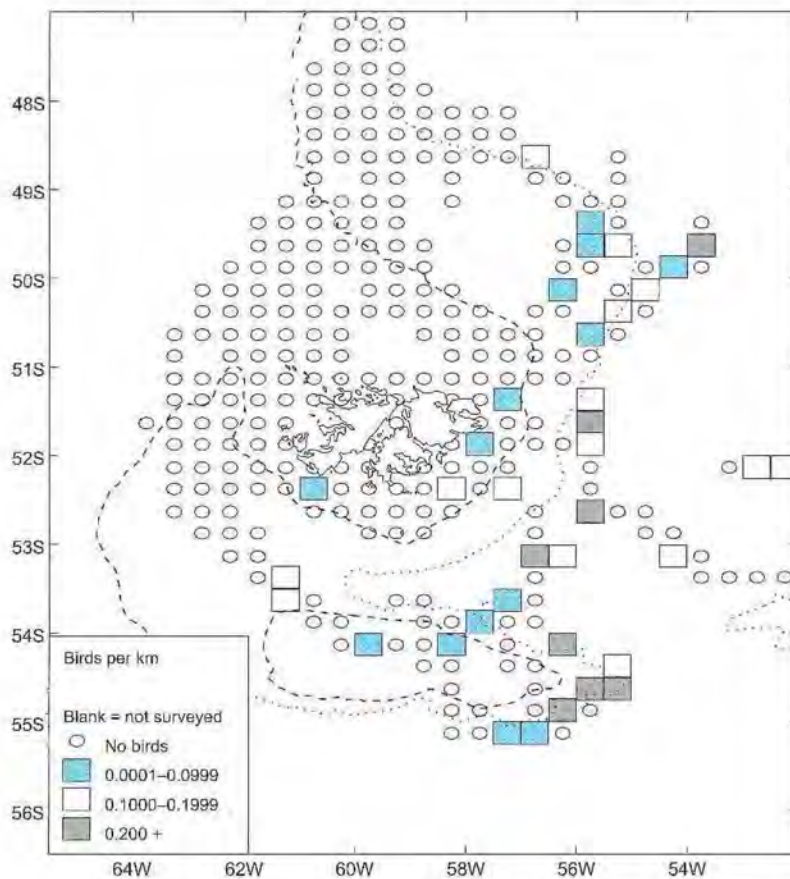


Figure 37 Grey-headed albatross dispersion, October–February

grey-headed albatrosses indicates that birds seen in the breeding season (October to April) around the Falkland Islands are unlikely to have come from South Georgia (Prince *et al.* 1998).

5.4.3 Petrels and shearwaters *Procellariidae*

Of the 24 species of *Procellariidae* that have been recorded in the waters of the Falkland Islands (Woods 1988), six breed in the islands (Woods and Woods 1997). In our study, 19 species were recorded, 13 of them regularly and six species occasionally.

5.4.3.1 Northern giant petrel *Macronectes halli* and southern giant petrel *giganteus*

There are two species of giant petrel—the northern giant petrel and southern giant petrel (Bourne and Warham 1966). Giant petrels have a circumpolar distribution in the southern hemisphere and both species were recorded during surveys. The two species are very similar in appearance, and their separation in the field was not always possible. Of a total 3,564 giant petrels recorded, 1,565 were identified as southern giant petrel (43.9%), 348 as northern giant petrel (9.8%) and 1,651 were not specifically identified (46.3%). Most unidentified giant petrels were probably southern giant petrels.

Of the two species, only the southern giant petrel breeds in the Falkland Islands where the population is

estimated to be between 5,000 and 10,000 pairs; all are dark-phase birds (Woods and Woods 1997). The local population is supplemented by immigration of southern giant petrels in the winter months, a small proportion of these being white-phase birds.

For the purposes of mapping, all giant petrel records were combined (Figures 38 and 39), although the dispersion patterns of northern giant petrels and white-phase southern giant petrels are also presented (Figures 40 and 41).

Giant petrels were noted in every month. Highest densities were recorded between February and June in the north-west of the study area (Figure 38), an area where large numbers of other petrels were also present (see Cape petrel, black-browed albatross, white-chinned petrel).

Between July and January, giant petrels were generally at low densities throughout the survey area, (Figure 39). High densities were recorded in the north of the survey area in these months, with moderate or high densities inshore off the south and west coasts of West Falkland. Very few giant petrels were recorded in the deep waters to the north-east of the Falkland Islands.

Giant petrels were habitual ship followers and, as a result, were often not recorded using the survey method. Being scavengers they were most numerous in areas where fishing vessels were present.

Most southern giant petrel surveyed were dark-phase birds. However, 45 white-phase birds were recorded. As

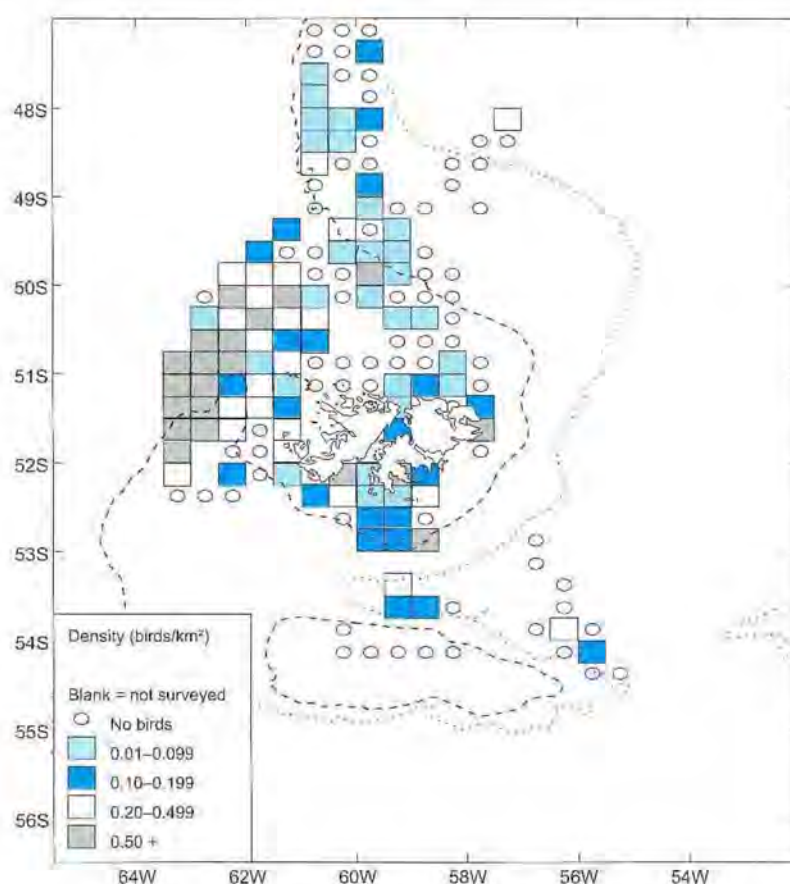


Figure 38 Giant petrel dispersion, February–June

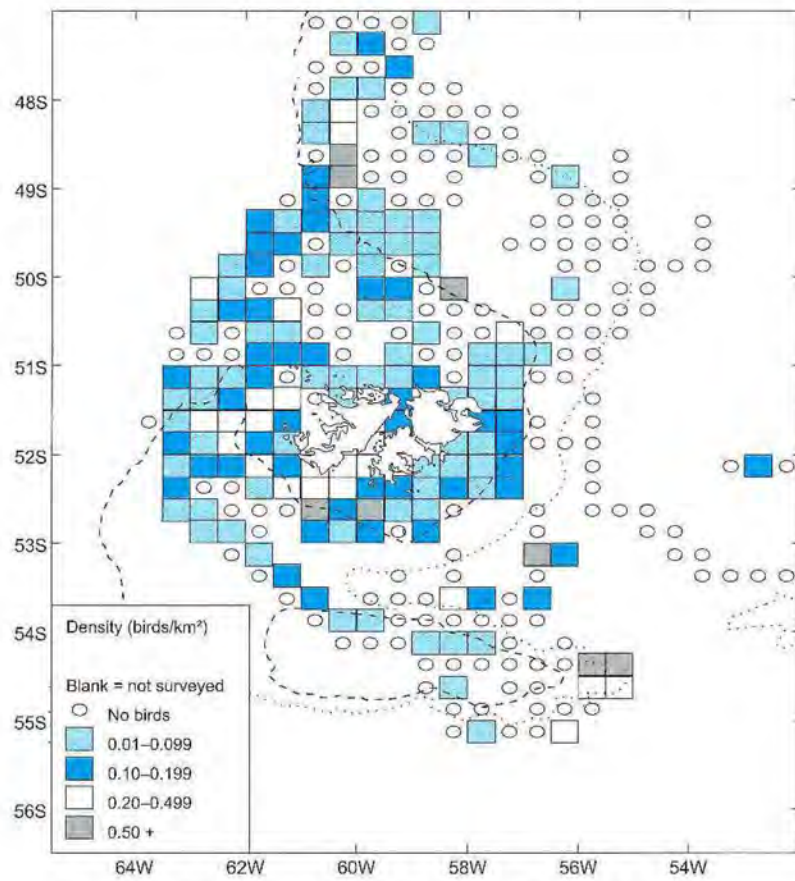


Figure 39 Giant petrel dispersion, July–January

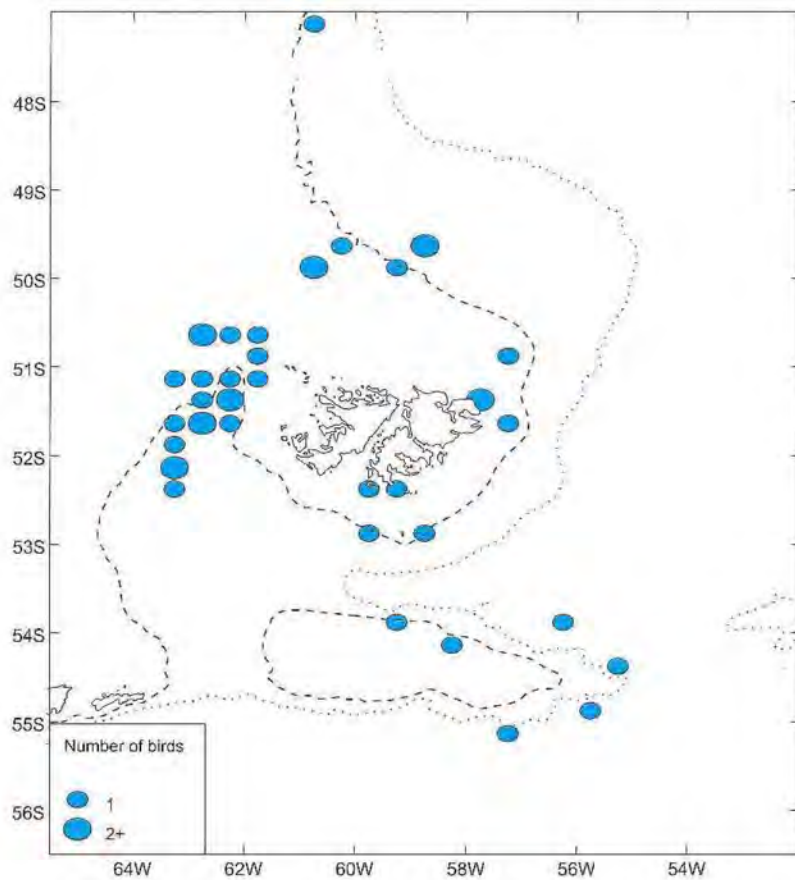


Figure 40 White phase southern giant petrel distribution, all months

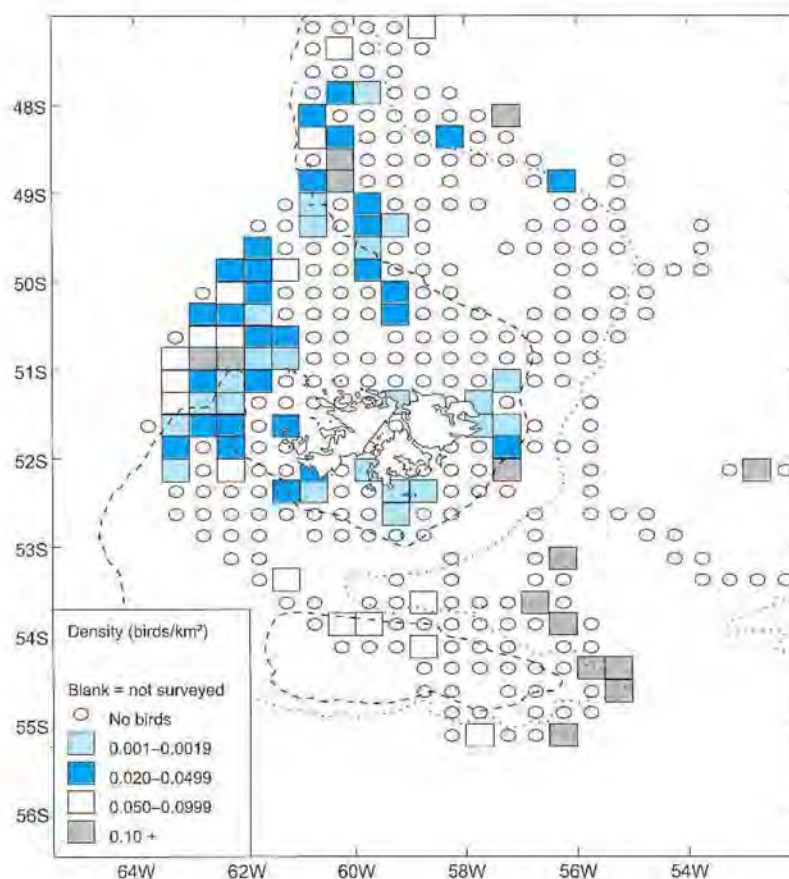


Figure 41 Northern giant petrel dispersion, all months

the northern giant petrel has no white phase, it is possible to be certain of the specific identification of white-phase birds. White-phase birds accounted for a maximum of 2.9% of southern giant petrels recorded, and a minimum of 1.4% (if all unidentified giant petrels proved to be southern giant petrels). The true figure is more likely to be about 1.6%, assuming that a proportion of the unidentified giant petrels was southern giant petrels, and no white-phase southern giant petrels went unidentified. Of the white-phase birds recorded, 40 occurred between May and September; the remaining five were in November and December. Most records were from similar areas to other southern giant petrel records (Figure 40).

Northern giant petrels are non-breeding visitors to the waters of the Falkland Islands. Low numbers were identified and recorded in all months, there being slightly more in the winter months. In October and December, single northern giant petrels were observed that had been colour-dyed as breeding adults on Bird Island, South Georgia (C. Hill pers. comm.). The results of satellite tracking also indicate that South Georgia females (of both northern and southern giant petrels) reach the Falkland Islands during the November incubation period (J. Croxall pers. comm.).

There was a tendency for more northern giant petrels than southern giant petrels to be recorded in deeper

waters (Figure 41). Many of the records of giant petrels in the vicinity of the Burdwood Bank were of northern giant petrels rather than southern giant petrels, although both species were recorded there.

5.4.3.2 Cape petrel *Daption capense*

Cape petrels breed in the Antarctic and also in South Georgia; they are common non-breeding visitors to the waters of the Falkland Islands during the austral winter.

A total of 7,098 Cape petrels was recorded during the year, with records in all months except February. Cape petrels were rare in the survey area between December and the end of April, with relatively few recorded (mostly in March and April) to the north-west of the islands (Figure 42). A total of 6,178 (87%) of all Cape petrels was recorded during surveys between May and September. The highest densities were in the waters to the west of the islands, with locally high densities elsewhere in the survey area, particularly in the north (Figure 43). Numbers decreased slowly over the spring, with birds spread widely at low and locally moderate or high densities in October and November (Figure 44). There were very few records of Cape petrels after the end of November.

In common with the giant petrels, Cape petrels were noted as frequent ship associates and, as a result, may

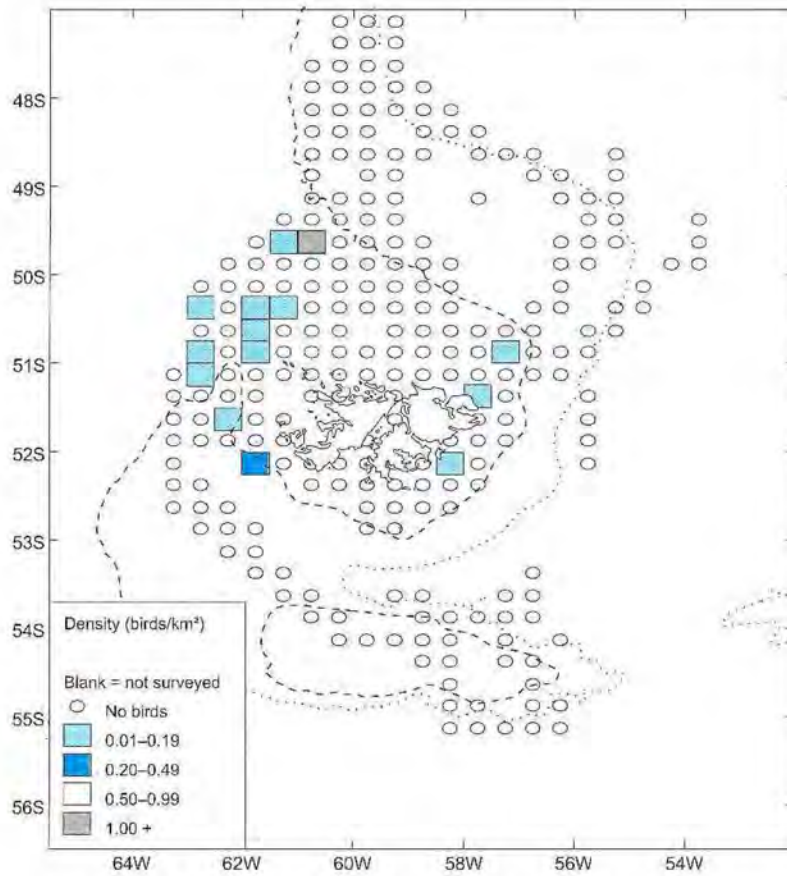


Figure 42 Cape petrel dispersion, December–April

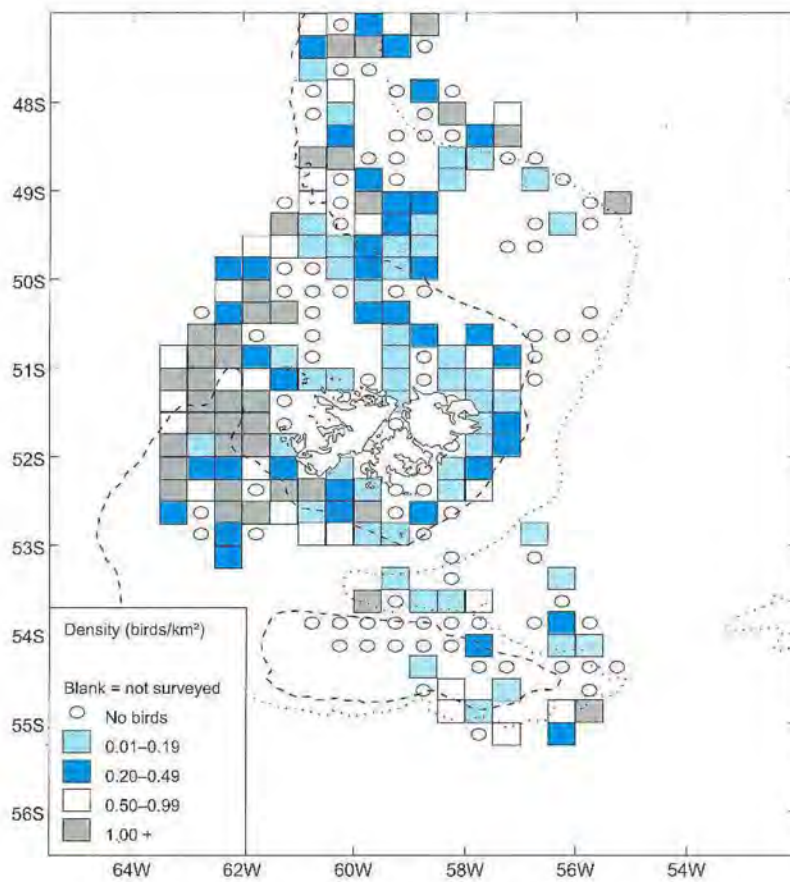


Figure 43 Cape petrel dispersion, May–September

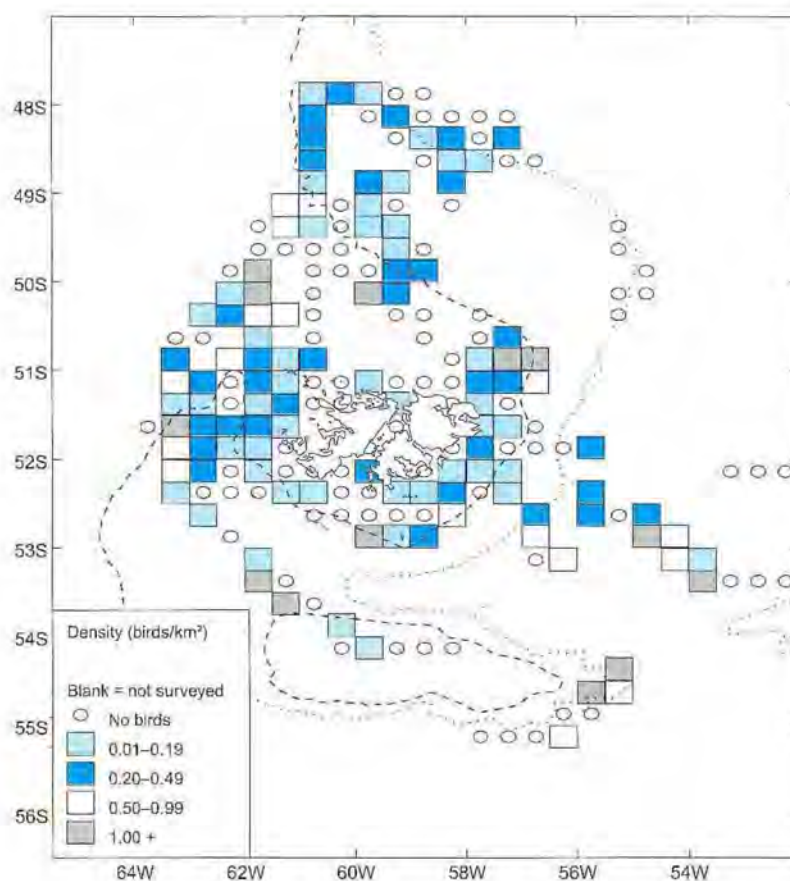


Figure 44 Cape petrel dispersion, October and November

have been under-recorded. They are also scavengers and were observed (but not recorded) in large flocks around fishing vessels.

5.4.3.3 Antarctic fulmar *Fulmarus glacialisoides*

In common with the Cape petrel, the Antarctic fulmar breeds in Antarctica and is a common non-breeding visitor to Falkland Islands waters.

A total of 6,480 Antarctic fulmars was recorded. All records were from between April and December. In April and May, numbers increased slowly with highest densities to the north-west of the islands (Figure 45), although there was little survey coverage outwith this area in these months. Antarctic fulmars were widespread in the study area from June to September, and density was highest in the Patagonian Shelf waters to the south-west of West Falkland (Figure 46). Numbers decreased slowly through the spring with low or moderate densities recorded throughout the survey area (Figure 47).

Antarctic fulmars arrived in the survey area shortly before Cape petrels, and numbers peaked earlier: Antarctic fulmars in June and July, whereas Cape petrel numbers remained high from June until September.

Antarctic fulmars were less likely to associate with the survey base than, for example, Cape petrels, and very few were observed scavenging around fishing vessels.

5.4.3.4 Blue petrel *Halobaena caerulea*

The blue petrel has a circumpolar distribution in the Southern Ocean. Its nearest breeding locations to the Falkland Islands are South Georgia and Diego Ramirez, Chile. The blue petrel nests early in the summer, returning to the breeding grounds in September (Watson 1975). A relatively rare visitor to the waters of the Falkland Islands, Woods (1988) describes it as widespread in offshore waters east of the islands, apparently more numerous in the winter.

A total of 119 blue petrels was recorded between June and November (see Kerguelen petrel, below). There were no records outside this period. The species was most frequently recorded in deep-water areas (Figure 48), so the lack of records between February and May could be due to poor survey effort in deep-water areas in those months. However, extensive survey coverage in deep-water areas in December and January did not record any blue petrels, indicating that they were absent from Falkland Islands waters for at least part of the summer.

5.4.3.5 Kerguelen petrel *Pterodroma brevirostris*

Kerguelen petrels nest at Tristan da Cunha and Gough Island, where they are an early summer breeder (see blue petrel, above). Bourne and Curtis (1985) recorded

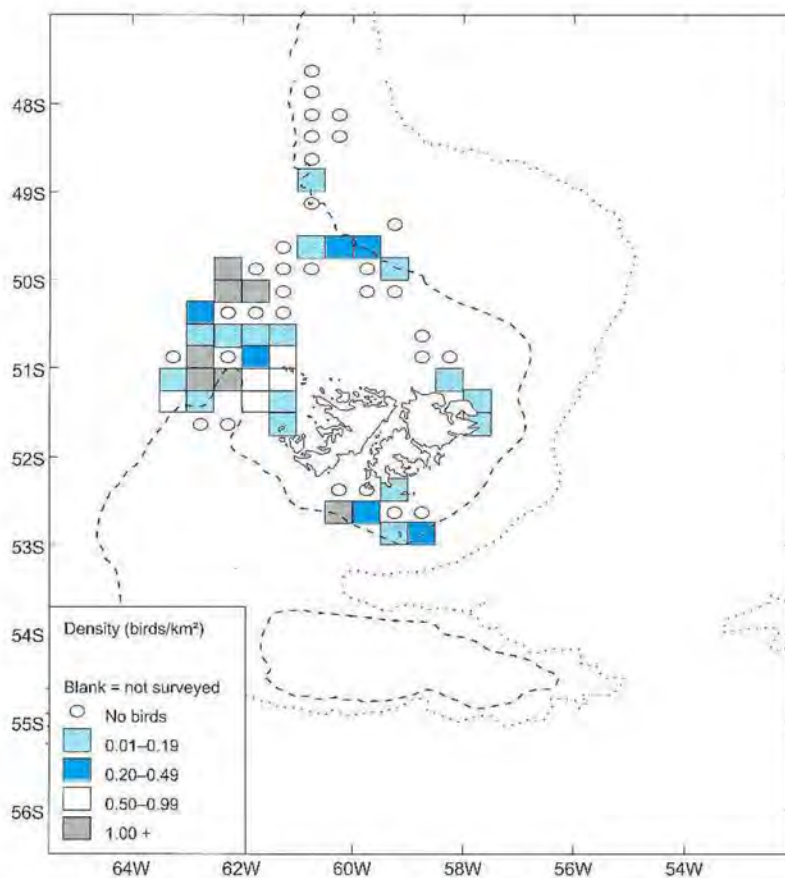


Figure 45 Antarctic fulmar dispersion, April and May

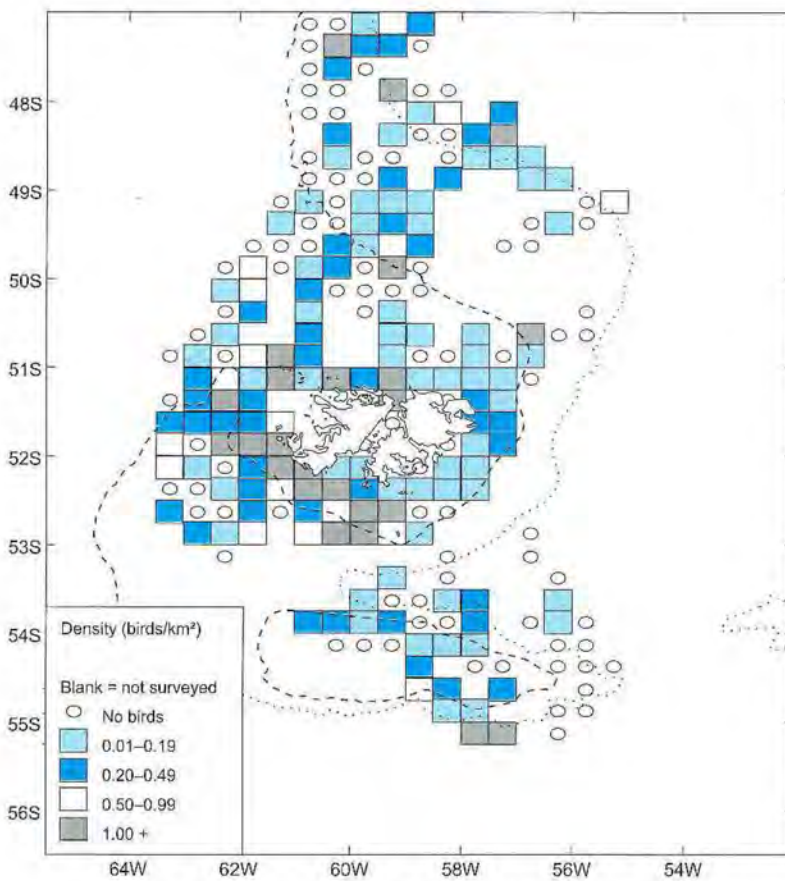


Figure 46 Antarctic fulmar dispersion, June-September

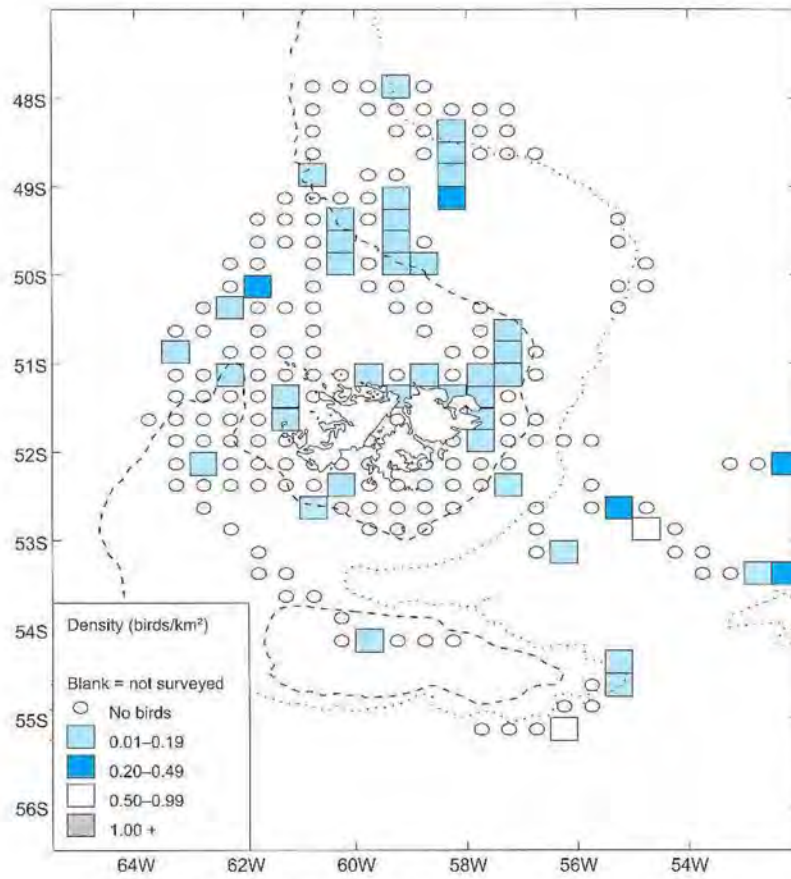


Figure 47 Antarctic fulmar dispersion, October and November

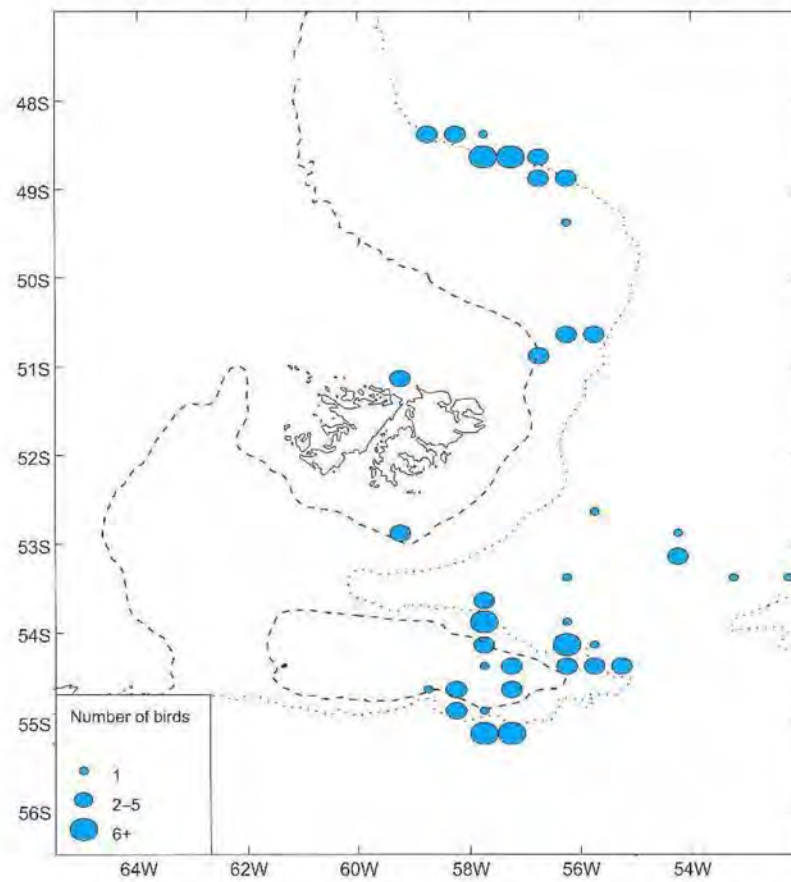


Figure 48 Blue petrel distribution, June–November

Kerguelen petrels as widespread at sea throughout the year.

Kerguelen petrels were encountered in both deep and shallow water, unlike the other *Pterodroma* species and also blue petrel, which were generally only found in deep waters to the north, east and south of the islands.

During surveys 33 Kerguelen petrels were recorded; they were all noted between June and November (see blue petrel, above) in contrast to the year-round presence noted by Bourne and Curtis (1985). Unlike blue petrel, records of Kerguelen petrel occurred as frequently over Patagonian Shelf waters as in deep water areas (Figure 49), so the similar seasonal distribution patterns of these species cannot be due to bias in survey coverage.

5.4.3.6 Soft-plumaged petrel *Pterodroma mollis*

Soft-plumaged petrels nest on Tristan da Cunha and Gough Island in the summer. Bourne and Curtis (1985) describe the species as a late summer visitor to the waters of the Falkland Islands, and Woods (1988) recorded small numbers regularly between December and April.

Between November and April 383 soft-plumaged petrels were recorded on surveys. There were no records outside this period, which accords with Woods' (1988) observations. Most records were from deep waters to the north and east of the islands, particularly in the vicinity of the 1,000-m depth contour. Occasional birds were

seen inshore off the north and south coasts, and in deep water to the south around the Burdwood Bank (Figure 50).

5.4.3.7 Atlantic petrel *Pterodroma incerta*

Atlantic petrels are winter breeders on Tristan da Cunha and Gough Island. Bourne and Curtis (1985) noted this species in the waters of the Falkland Islands in "early summer".

Thirty-seven Atlantic petrels were recorded in all seasons during the year, peaking with 27 in November. This peak coincides with the timing of the observations by Bourne and Curtis (1985). The majority of records were from deep-water areas to the north and east of the islands (Figure 51).

5.4.3.8 Prion spp. *Pachyptila* spp.

Prion taxonomy here follows Harper (1980).

The prions are a notoriously difficult group of species to identify at sea. Two species—the thin-billed prion *P. belcheri* and the fairy prion *P. turtur*—are known to breed in the Falkland Islands, and a further two species—the Antarctic prion *P. desolata* and broad-billed prion *P. vittata*—also occur. The status of the latter two species is not clear; the former is probably regular in small numbers while the latter is probably a vagrant.

The thin-billed prion is perhaps the most abundant breeding seabird species in the Falkland Islands. The size of the population is not known—estimates range from

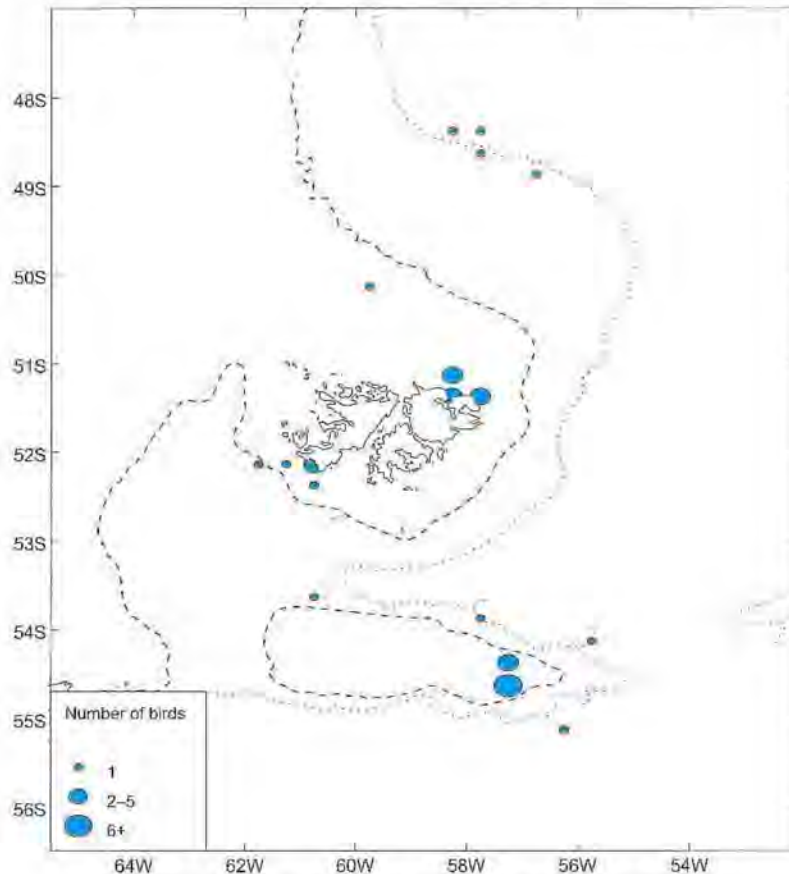


Figure 49 Kerguelen petrel distribution, June–November

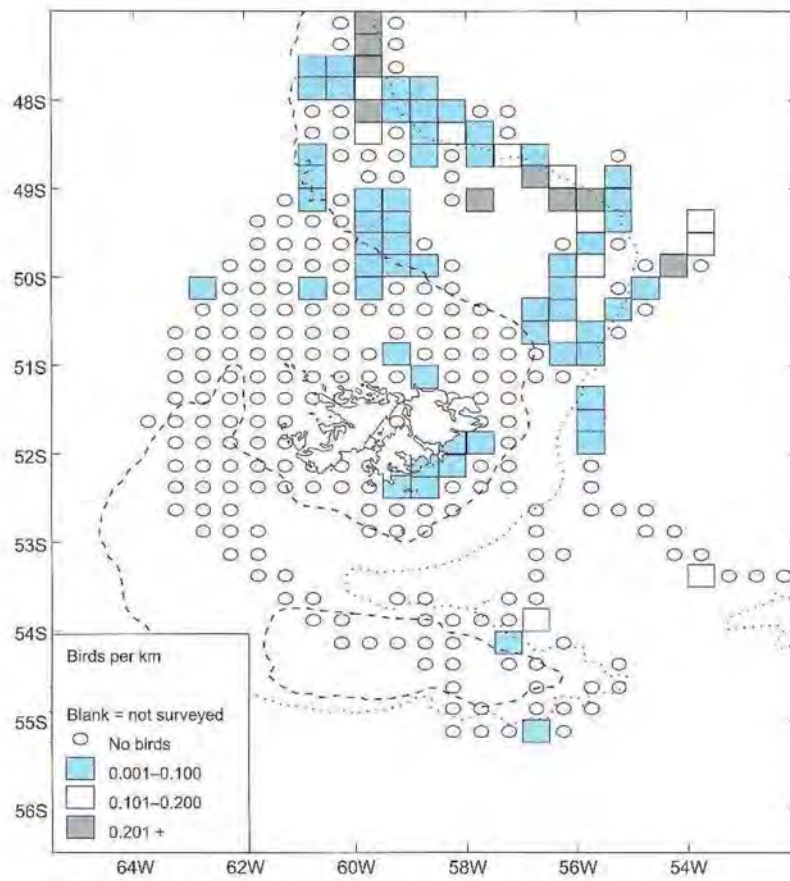


Figure 50 Soft-plumaged petrel dispersion, November–April

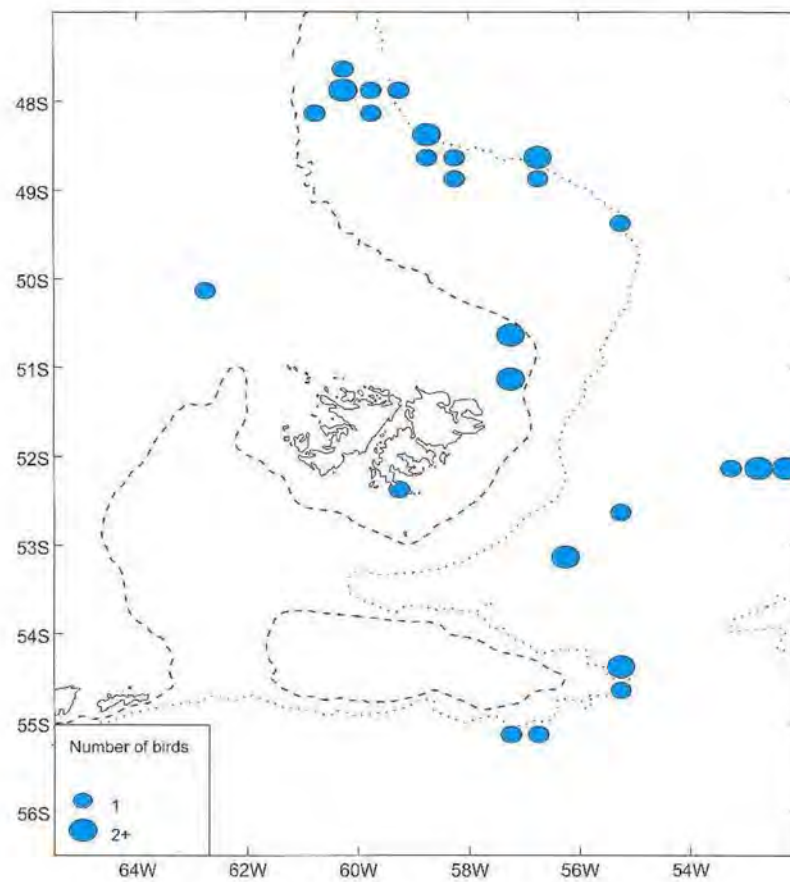


Figure 51 Atlantic petrel distribution, all months

100,000 pairs (Woods and Woods 1997) to one million pairs (Croxall *et al.* 1984). The fairy prion is much less numerous as a breeding species than the thin-billed prion. With a population estimated at perhaps as many as 10,000 pairs, its only known breeding location is on Beauchêne Island (Woods and Woods 1997).

The abundance of the thin-billed prion as a breeding species is reflected in the large numbers of prions recorded during surveys. Prions were the most abundant seabird recorded during surveys, totalling around 62,000 birds. The majority was not specifically identified, but most were probably thin-billed prions.

The greater numbers of prions were recorded on surveys between June and February. Typically, they occurred in patches of locally high density. The locations of these patches were not always constant and predictable between months, but several areas were regularly observed to support high densities of birds (Figure 52). These were:

- ◆ the 200-m depth contour to the north of the Falkland Islands and the south-west of West Falkland;
- ◆ the inshore areas off the north coast of West Falkland and the offshore islands in the north-west;
- ◆ the SAC; and
- ◆ Patagonian Shelf waters to the west and north-west of West Falkland.

Prions were notably present at only low densities in the vicinity of the 200-m depth contour to the south-east of East Falkland, and the shallower Patagonian Shelf waters to the south-west of the 200-m contour to the north of the islands.

In contrast, only 370 prions were recorded between March and May (Figure 53). In these months, they were widespread at low densities in the areas surveyed. Why prion numbers decreased so markedly in these months is not clear, and it will be interesting to see if the same pattern is repeated in future years.

5.4.3.9 White-chinned petrel *Procellaria aequinoctialis*

White-chinned petrels have a circumpolar breeding distribution that includes the Falkland Islands and South Georgia. The size of the Falkland Islands population in the summer is estimated at between 1,000 and 5,000 pairs (Woods and Woods 1997). Woods (1988) described white-chinned petrels as resident in the waters of the Falkland Islands, although less common in the winter months.

A total of 2,622 white-chinned petrels was recorded in all months during surveys. Highest numbers were during the summer, with a marked decrease in numbers between July and September. A substantial proportion of records may have been of South Georgia birds since satellite tracking has shown that breeders from South

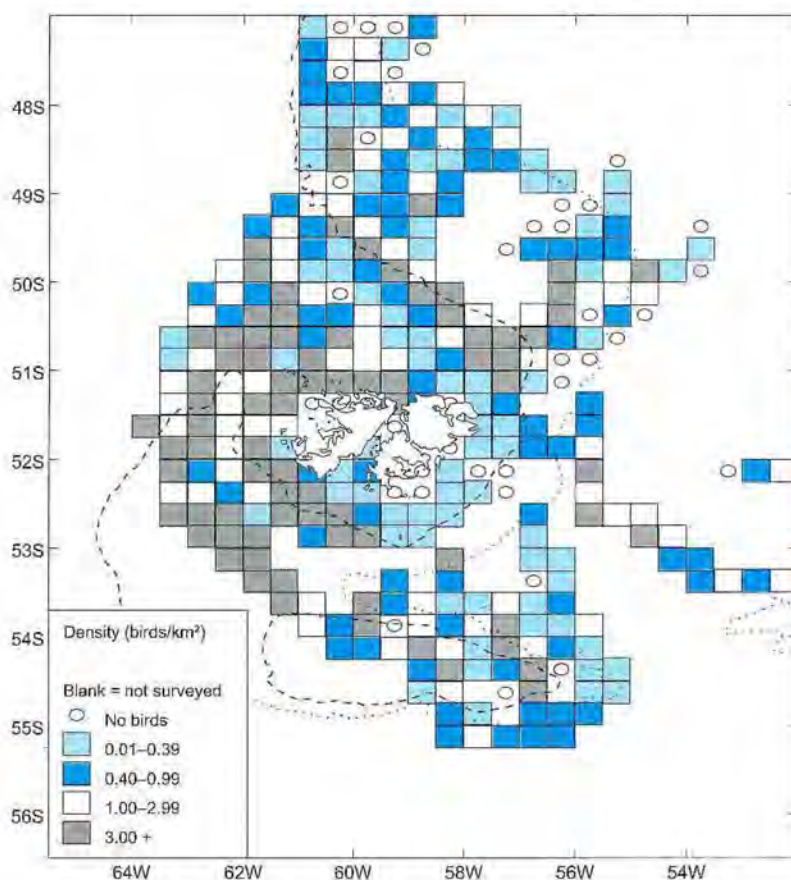


Figure 52 Prion dispersion, June–February

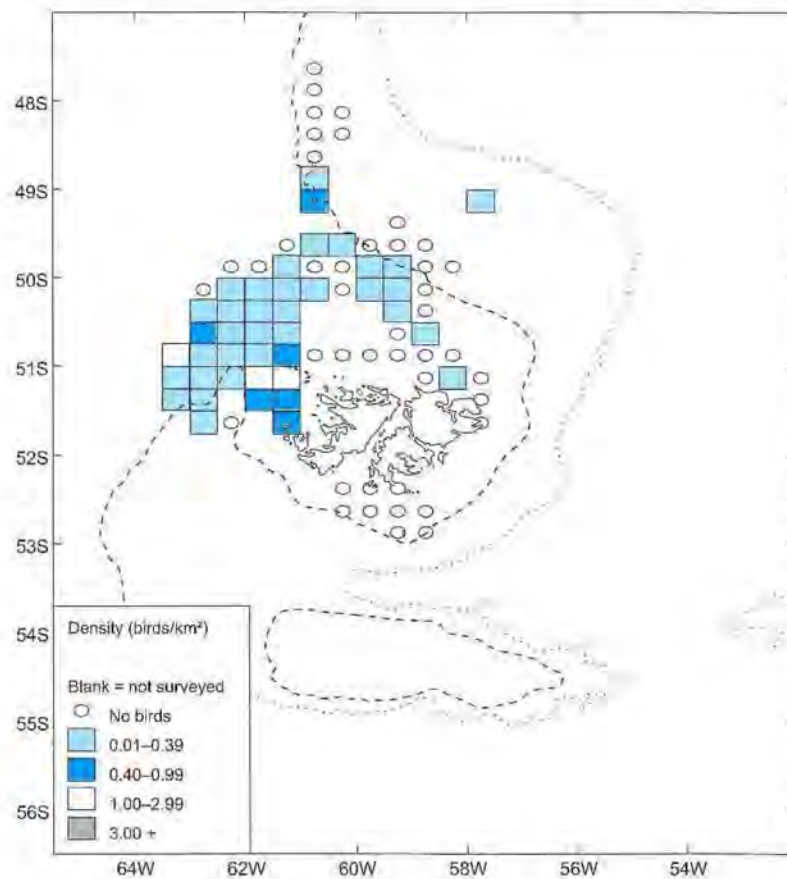


Figure 53 Prion dispersion, March–May

Georgia regularly reach Falkland Islands waters, and also as far north as Brazil (Weimerskirch *et al.* 1999, Berrow *et al.* in press).

In May and June, high densities of white-chinned petrels were recorded in Patagonian Shelf waters to the north-west of the Falkland Islands (Figure 54). Numbers decreased between July and September and the distribution of birds shifted slightly to the south (Figure 55). Between May and September there were no records of white-chinned petrels in the Patagonian Shelf waters to the east or south of the Falkland Islands. Between October and April white-chinned petrels were widespread at low densities throughout the waters of the survey area, including inshore waters to the south and east of the islands (Figure 56).

5.4.3.10 Great shearwater *Puffinus gravis*

Great shearwaters breed in the Falkland Islands in small numbers in summer. The population is estimated to be between 50 and 100 pairs (Woods and Woods 1997). Bourne and Curtis (1985) recorded highest numbers of great shearwaters around the Falkland Islands in April.

A total of 1,394 great shearwaters was recorded between September and April. There were no records outside these months. Highest numbers were generally observed over the shelf slope, whereas large numbers of sooty shearwaters *P. griseus* remained closer inshore.

Between September and November, there were very few records of great shearwaters (Figure 57), reflecting the very small size of the breeding population of this species in the Falkland Islands. However, from December to April large numbers were observed in Falkland Islands waters; the highest densities were over the 200-m depth contour, and also in deeper waters to the north of the islands (Figure 58). These birds were probably immature or non-breeders from the very large Tristan da Cunha and Gough Island populations. The immature status is supported by observations of great shearwaters in wing moult, particularly in March (pers. obs.). Watson (1970) also noted great shearwaters in moult in the south-west Atlantic in January 1966, while Stresemann and Stresemann (1970) concluded that these birds were immature, moulting several months before adults; adults moult in June and July when they have reached the North Atlantic.

Great shearwaters frequently formed feeding associations with cetaceans in deep-water areas, notably with long-finned pilot whales *Globicephala melas* and hourglass dolphins *Lagenorhynchus cruciger*.

5.4.3.11 Sooty shearwater *Puffinus griseus*

The sooty shearwater is a summer resident that breeds in the Falkland Islands. The size of the population is not known, but it is believed to be in the order of 10,000 to 20,000 pairs (Woods and Woods 1997).

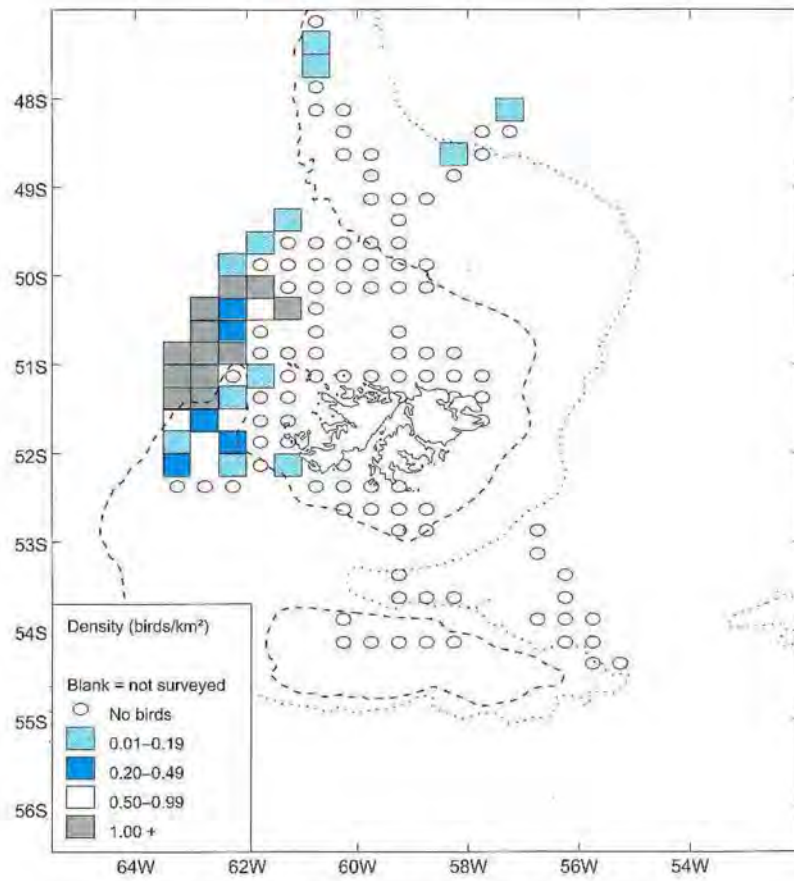


Figure 54 White-chinned petrel dispersion, May and June

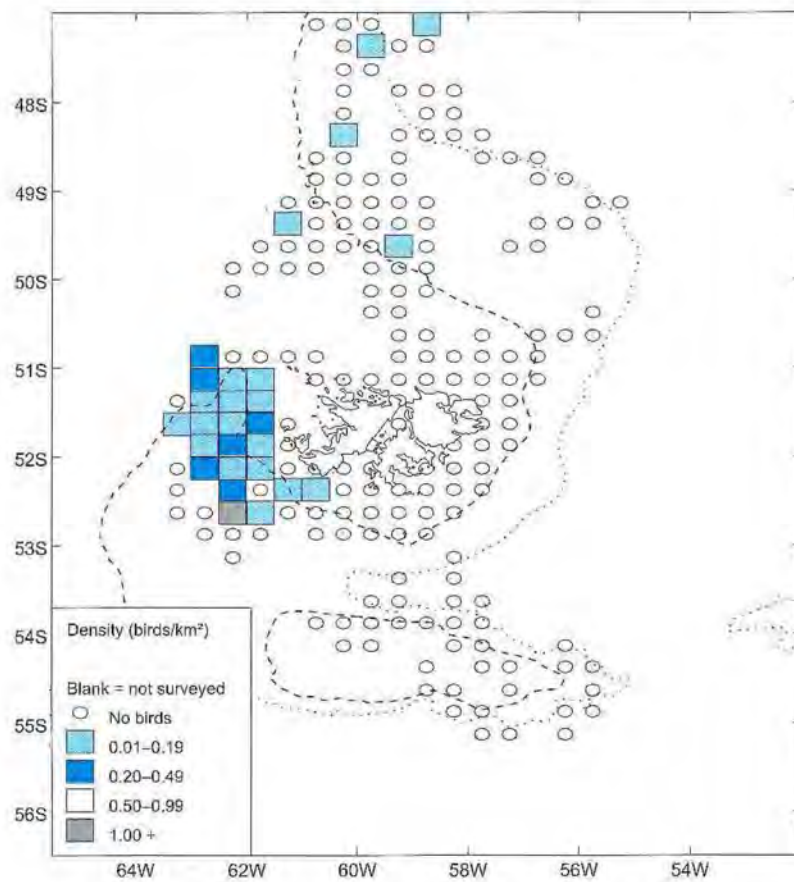


Figure 55 White-chinned petrel dispersion, July-September

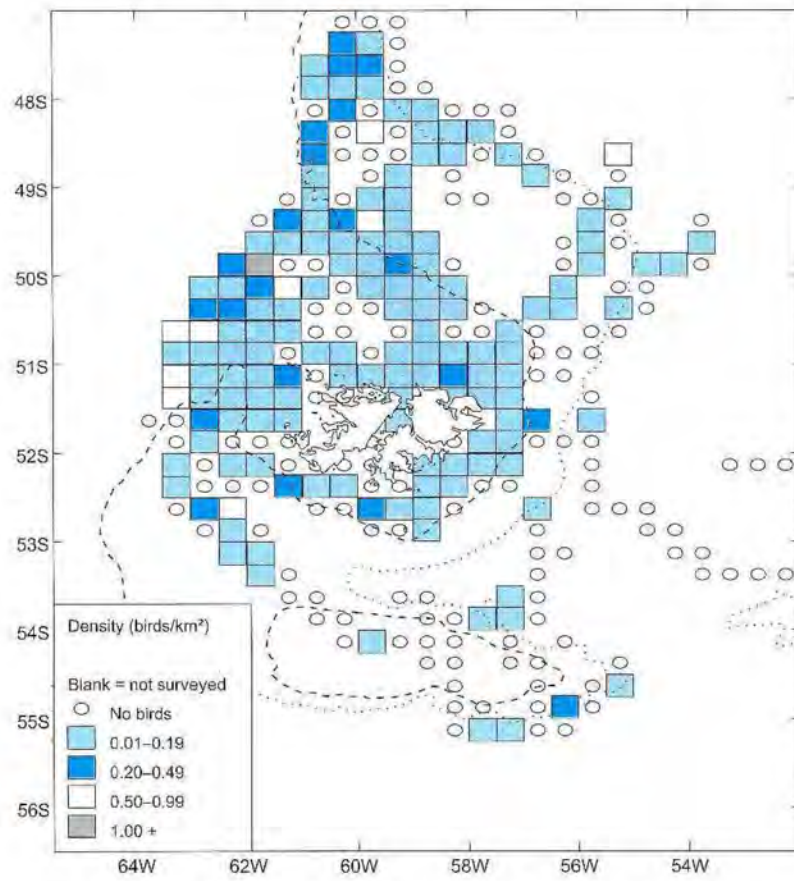


Figure 56 White-chinned petrel dispersion, October–April

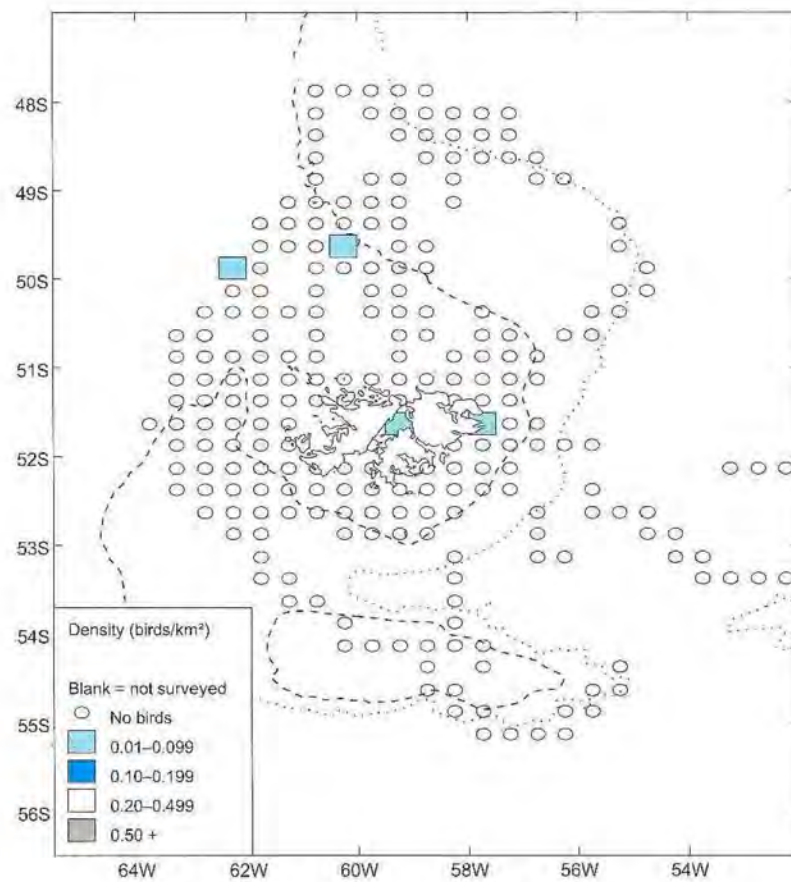


Figure 57 Great shearwater dispersion, September–November

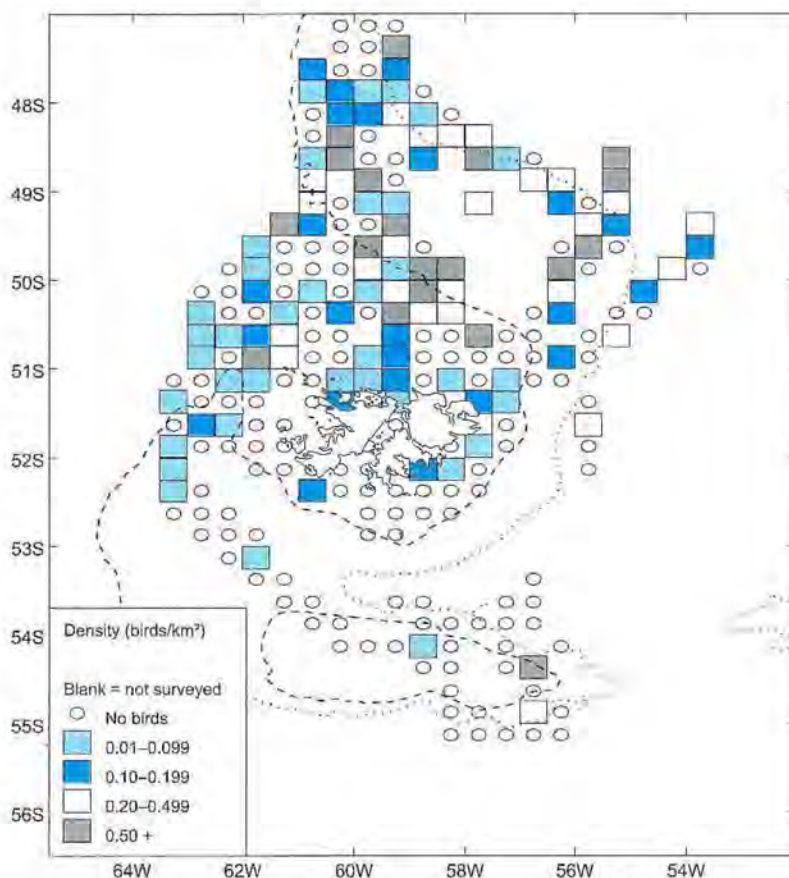


Figure 58 Great shearwater dispersion, December–April

A total of 18,700 sooty shearwaters was recorded in all months. Numbers recorded in the winter months were very low in comparison with the summer. Sooty shearwaters returned to the waters of the Falkland Islands from August onwards, and most had left again by the end of April. Highest densities were recorded in inshore waters, with records off all coasts (Figure 59). Between May and July, a locally high concentration of sooty shearwaters was recorded in inshore waters off the north coast of the islands. Elsewhere, sooty shearwaters were rare in these months (Figure 60). Several other species were observed in apparently unseasonal concentrations in the same area, notably South American terns, brown-hooded gulls and Magellanic penguins.

5.4.3.12 *Wilson's storm-petrel Oceanites oceanicus*

Wilson's storm-petrels breed in the Falkland Islands, having an estimated population in excess of 5,000 pairs (Woods and Woods 1997). The species is a trans-equatorial migrant, the majority of the population spending the winter months in temperate and subtropical seas in the northern hemisphere (Warham 1996).

The total recorded of Wilson's storm-petrels during surveys was 12,070 but, although there were records in all months, there were distinctly fewer during the winter. Wilson's storm-petrels were observed throughout the

survey area; the largest concentrations were found on the Patagonian Shelf, with fewer records in deep-water areas.

Between July and September, most Wilson's storm-petrel records were from waters to the north and west of the Falkland Islands (Figure 61), where they occurred at low or very locally high densities. Between October and June, there was a north-east to west split in the distribution (Figure 62); the species was abundant in waters to the west of the islands, and also along the 200-m depth contour to the north-east of the islands. Wilson's storm-petrels were notably scarce between these two areas in waters north of the islands, but they were recorded in high densities south of the islands near Beauchêne Island.

Wilson's storm-petrels were observed being kleptoparasitised by a long-tailed skua *Stercorarius longicaudus*, as noted also by Brady (1994).

5.4.3.13 *Black-bellied storm-petrel Fregetta tropica*

The black-bellied storm-petrel is listed as a possible breeder in the Falkland Islands by Woods and Woods (1997), but there is little evidence to support claims that it does in fact breed in the islands. The closest breeding sites are on South Georgia, Tristan da Cunha and Gough Island. Bourne and Curtis (1985) only rarely recorded black-bellied storm-petrels at sea off the Falkland Islands.

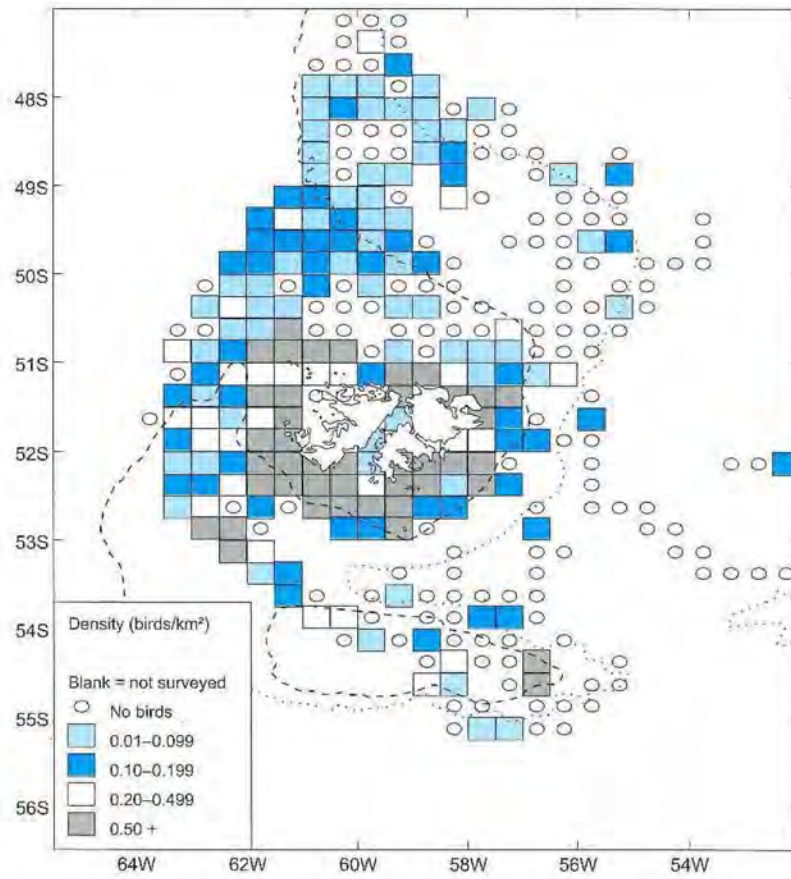


Figure 59 Sooty shearwater dispersion, August–April

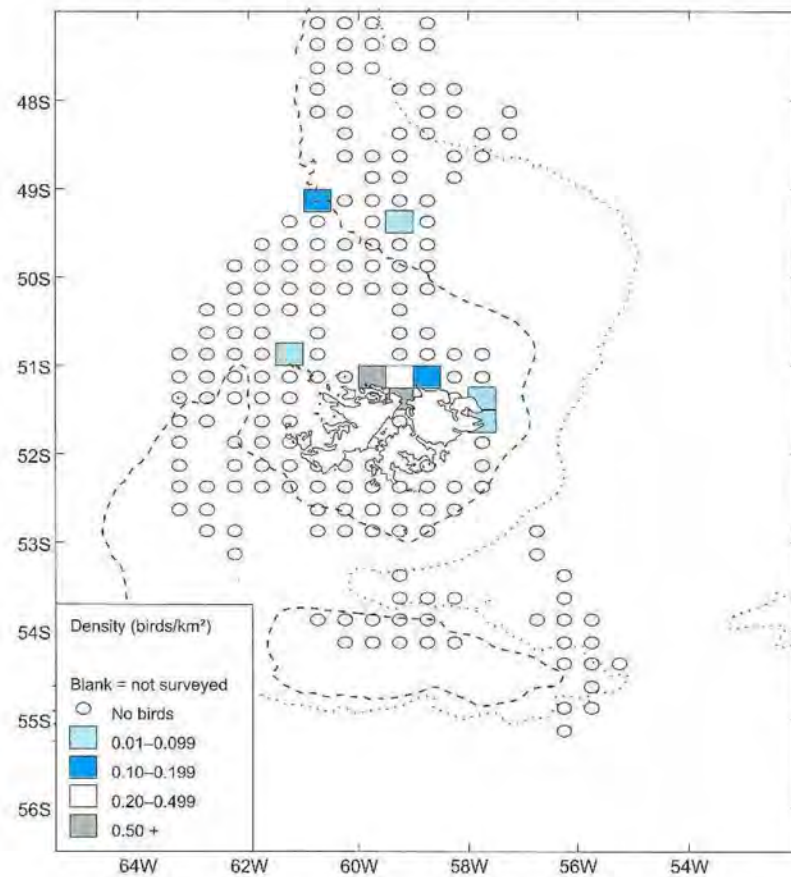


Figure 60 Sooty shearwater dispersion, May–July

Seabird and marine mammal dispersion in the waters around the Falkland Islands

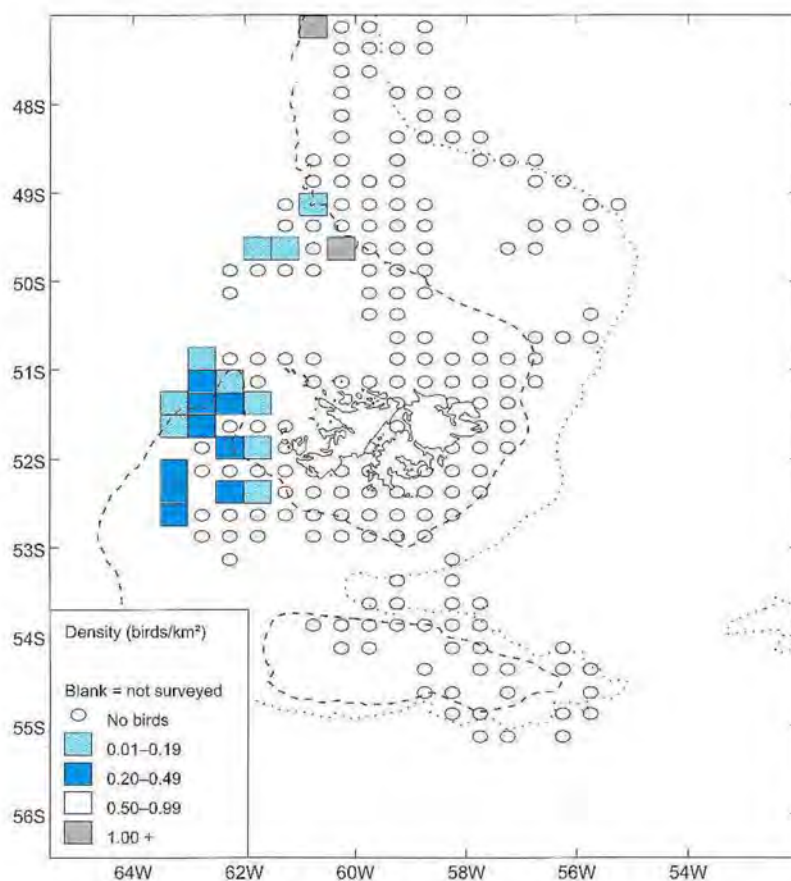


Figure 61 Wilson's storm-petrel dispersion, July–September

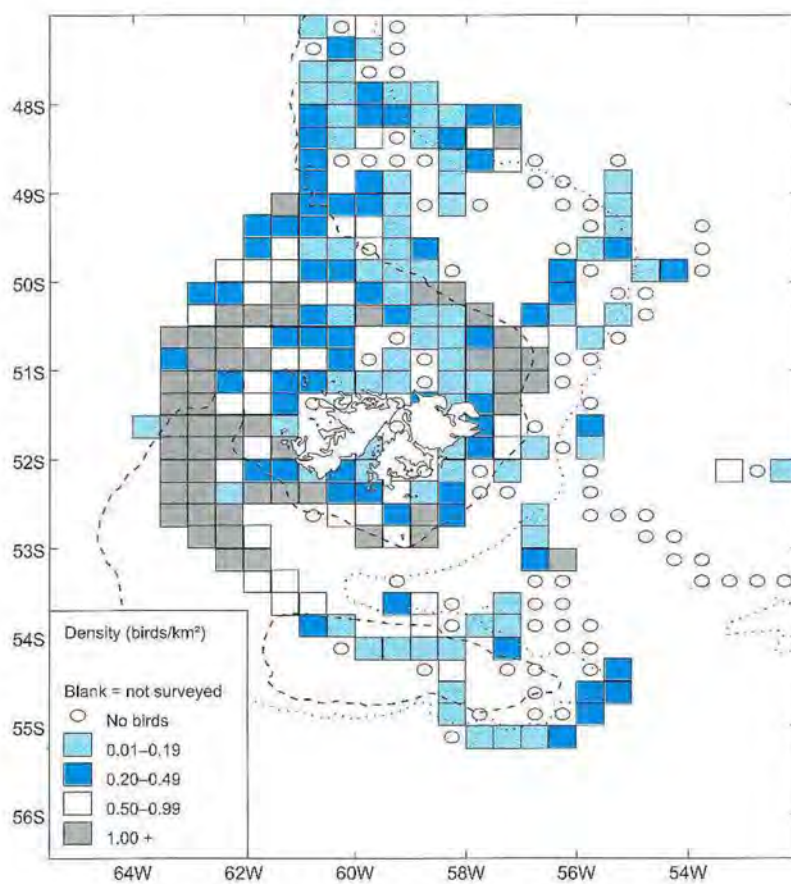


Figure 62 Wilson's storm-petrel dispersion, October–June

Records of black-bellied storm-petrel were restricted to November to January, and April. Most records are from deep-water areas to the north and east of the islands, with a few from the deep waters around the Burdwood Bank (Figure 63).

The provenance of black-bellied storm-petrels recorded in the waters of the Falkland Islands is not known, but there is some evidence to suggest that the birds are from Tristan da Cunha and Gough Island, rather than from South Georgia. The time when highest numbers of black-bellied storm-petrels were recorded around the Falkland Islands coincided with the occurrence of high numbers of other species (great shearwater, soft-plumaged petrel). These species nest on Tristan da Cunha and Gough Island, indicating that this is the possible origin for the black-bellied storm-petrels.

5.4.3.14 White-bellied storm-petrel *Fregetta grallaria*

The status of white-bellied storm-petrels is uncertain in the waters of the Falkland Islands. Woods (1988) published one record in waters north of the islands.

In December and January, 14 storm-petrels were recorded showing characteristics of white-bellied storm-petrel. These birds were all in deep-water areas to the north and north-east of the islands (Figure 64). Although a population of black-bellied storm-petrels exists in Tristan da Cunha and Gough Island that have white

bellies (Bourne 1960), it is unclear whether the petrels observed during surveys were white-bellied storm-petrels or birds belonging to this white-bellied form of black-bellied storm-petrel.

5.4.3.15 Grey-backed storm-petrel *Garrodia nereis*

Grey-backed storm-petrels breed in the Falkland Islands, with a population estimated to be between 1,000 and 5,000 pairs (Woods and Woods 1997). Bourne and Curtis (1985) reported grey-backed storm-petrels to be present in the waters of the Falkland Islands between September and May.

During the surveys around the Falkland Islands, grey-backed storm-petrels were recorded in all months; they totalled 1,207. The highest numbers were recorded between November and March, with the greatest densities to the north-east of the Falkland Islands along the 200-m depth contour, and in deep waters to the north and east of the islands (Figure 65). At other times of the year (April to October), the species was recorded in low densities throughout the survey area (Figure 66). Relatively more birds occurred over the Patagonian Shelf to the north-west of the islands than in the same area between November and March.

Grey-backed storm-petrels were frequently seen feeding near free-floating patches of kelp. The diet of this species in the Falkland Islands has not been studied, but

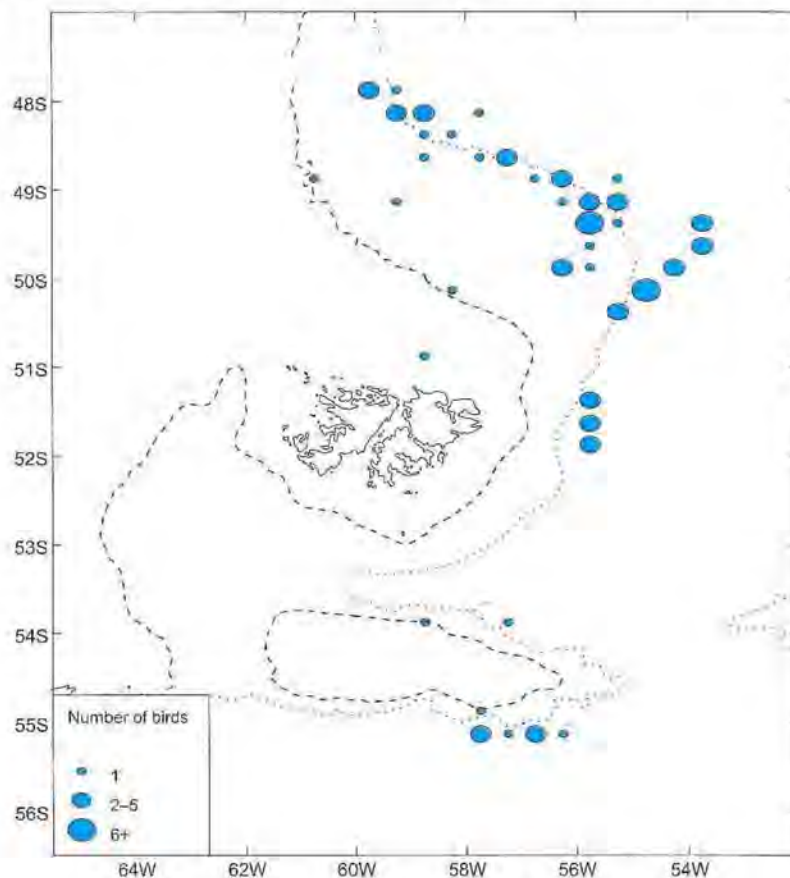


Figure 63 Black-bellied storm-petrel distribution, all months

Seabird and marine mammal dispersion in the waters around the Falkland Islands

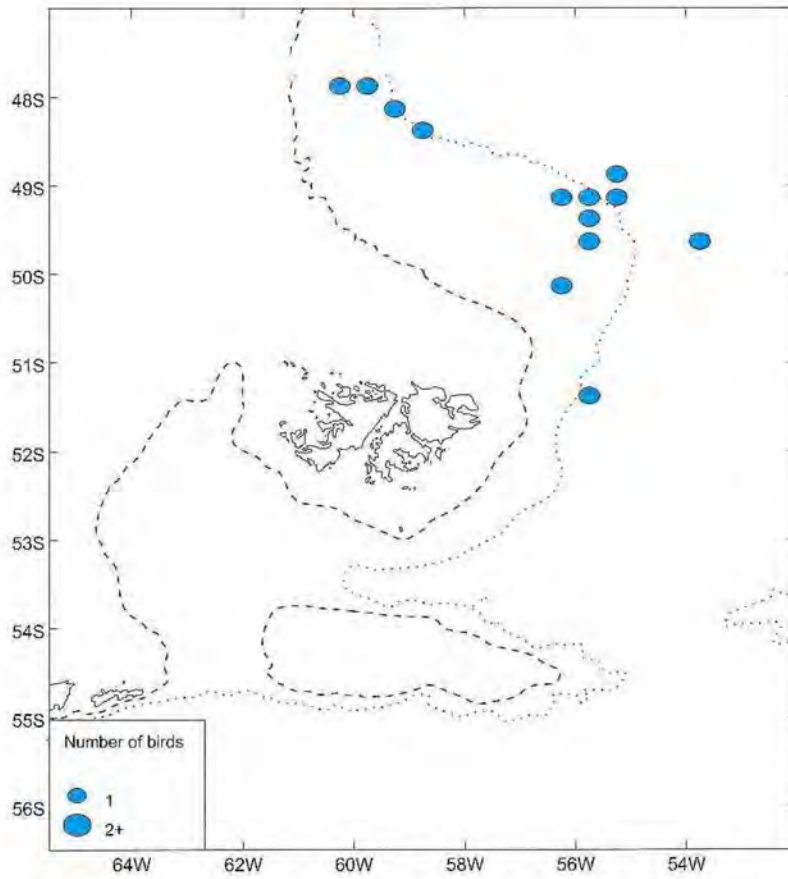


Figure 64 White-bellied storm-petrel distribution, December and January

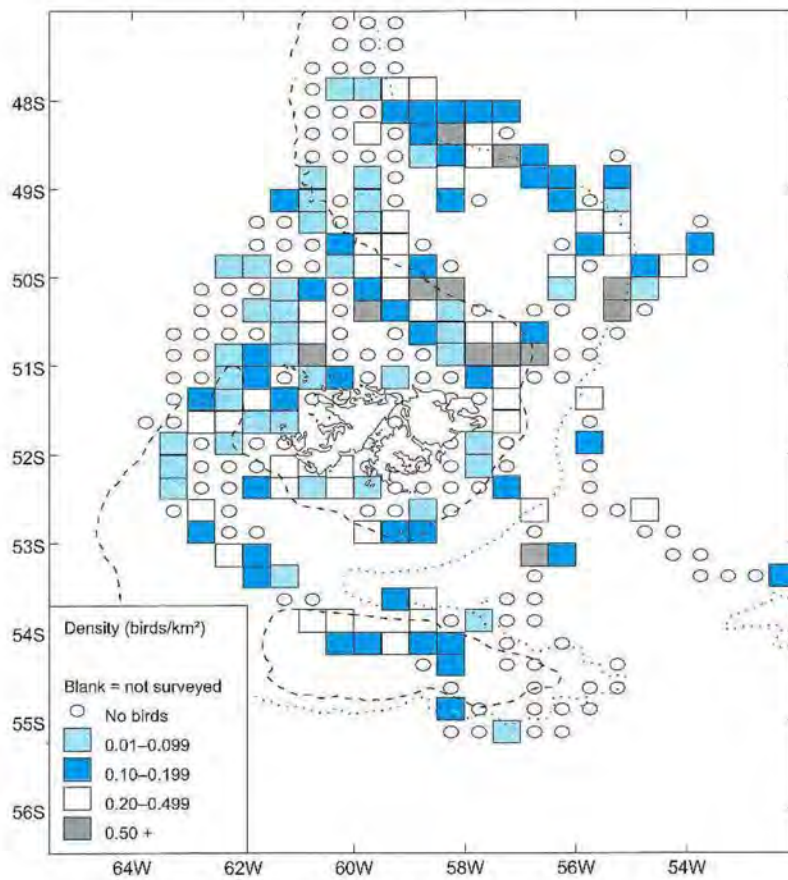


Figure 65 Grey-backed storm-petrel dispersion, November–March

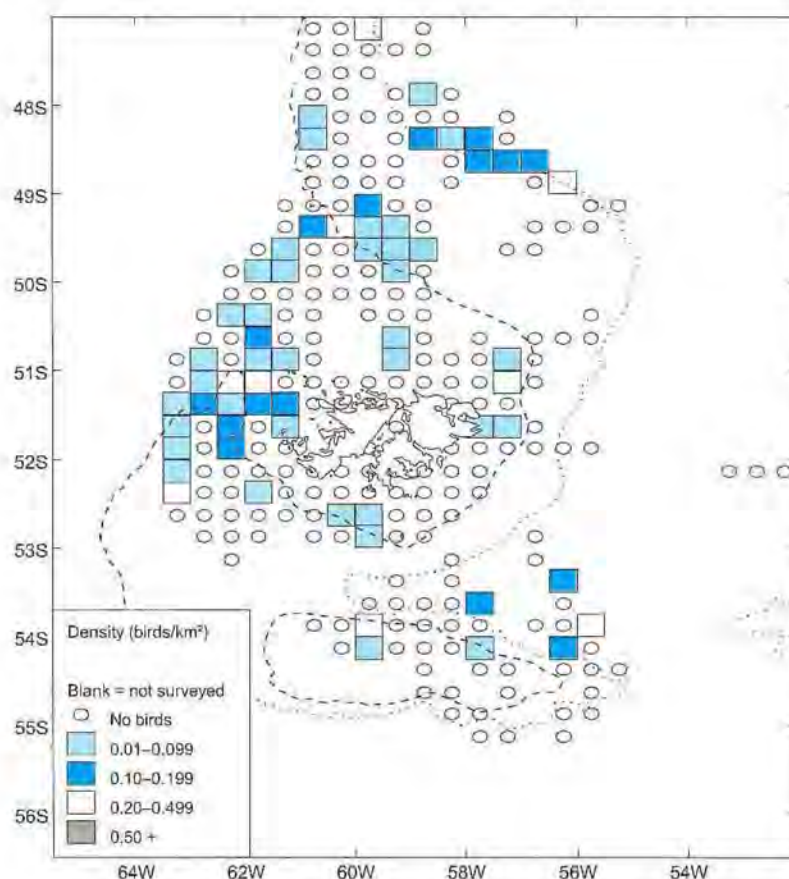


Figure 66 Grey-backed storm-petrel dispersion, April–October

research elsewhere suggests that grey-backed storm-petrels specialise on a pelagic form of the goose-barnacle *Lepas australis* (Imber 1985). The grey-backed storm-petrels observed in association with free-floating patches of kelp in this study were probably searching for pelagic goose-barnacles.

5.4.3.16 Common diving-petrel *Pelecanoides urinatrix* and Magellan diving-petrel *P. magellani*

Two species of diving-petrel occur regularly in the waters of the Falkland Islands. Between 5,000 and 10,000 pairs of an endemic subspecies of the common diving-petrel *P. urinatrix berardi* breed in the islands (Woods and Woods 1997). The Magellan diving-petrel *P. magellani* breeds in South America and its status in the Falkland Islands is uncertain. It has not been shown to breed, but it may do so in small numbers that have remained undetected.

Most diving-petrels recorded during surveys were not specifically identified. Of the 3,163 recorded, 671 (21.2%) were identified as common diving-petrel and 94 (3.0%) as Magellan diving-petrel, while 2,398 (75.8%) were not specifically identified. Common diving-petrels most probably made up a large proportion of unidentified diving-petrels, and Magellan diving-petrels were relatively over-recorded.

The identification of Magellan diving-petrel was based largely on the contrasting 'black-and-white' appearance

of the species, coupled with the pronounced white crescent at the rear of the ear coverts, if adequate views were obtained (Harrison 1983). Dusky birds showing little contrast between the upperparts and underparts were identified as common diving-petrels. The identification of diving-petrels at sea is not straightforward and all records should be interpreted with care, particularly given the probability that Georgian diving-petrel *P. georgicus* also regularly occurs in Falkland Islands waters.

Distribution maps are presented for common (Figure 67) and Magellan (Figure 68) diving-petrels in all months, and for all diving-petrels in September to February (Figure 69) and March to August (Figure 70). Highest concentrations of common diving-petrels were recorded in the waters to the west of the Falkland Islands. High densities occurred around Beauchêne Island, and some locally high densities were also recorded in offshore areas.

Numbers of Magellan diving-petrels were highest between June and September, and there were no records in February, October and December. They were most numerous in the west of the survey area, closest to their South American breeding grounds. However, there were also records of Magellan diving-petrels in enclosed inshore waters such as Falkland Sound and Port William (Figure 68).

Seabird and marine mammal dispersion in the waters around the Falkland Islands

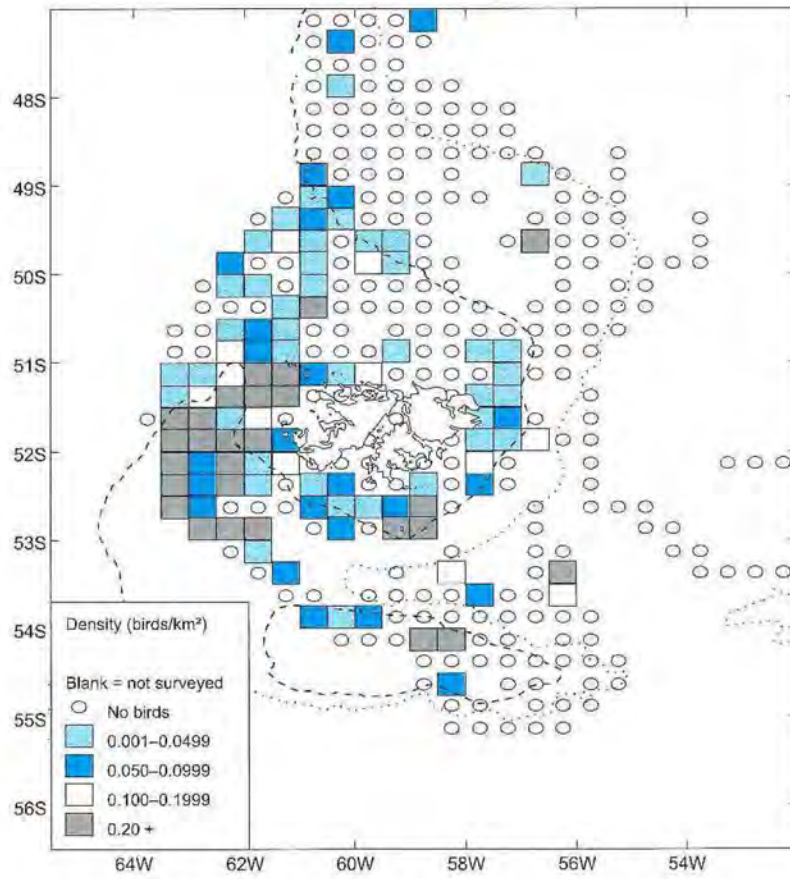


Figure 67 Common diving-petrel dispersion, all months

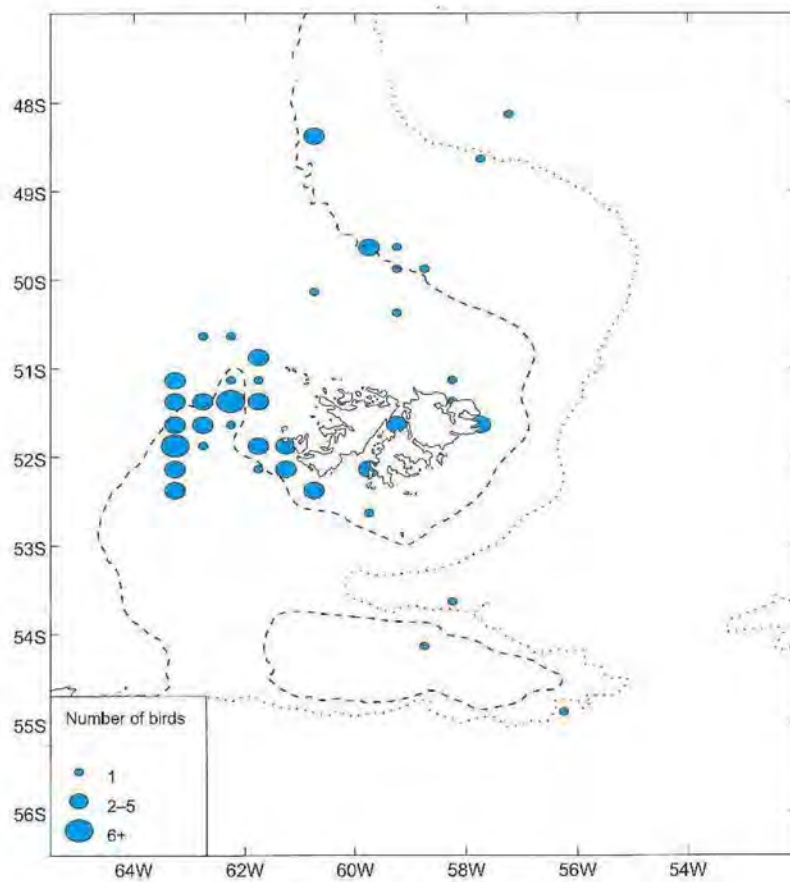


Figure 68 Magellan diving petrel distribution, all months

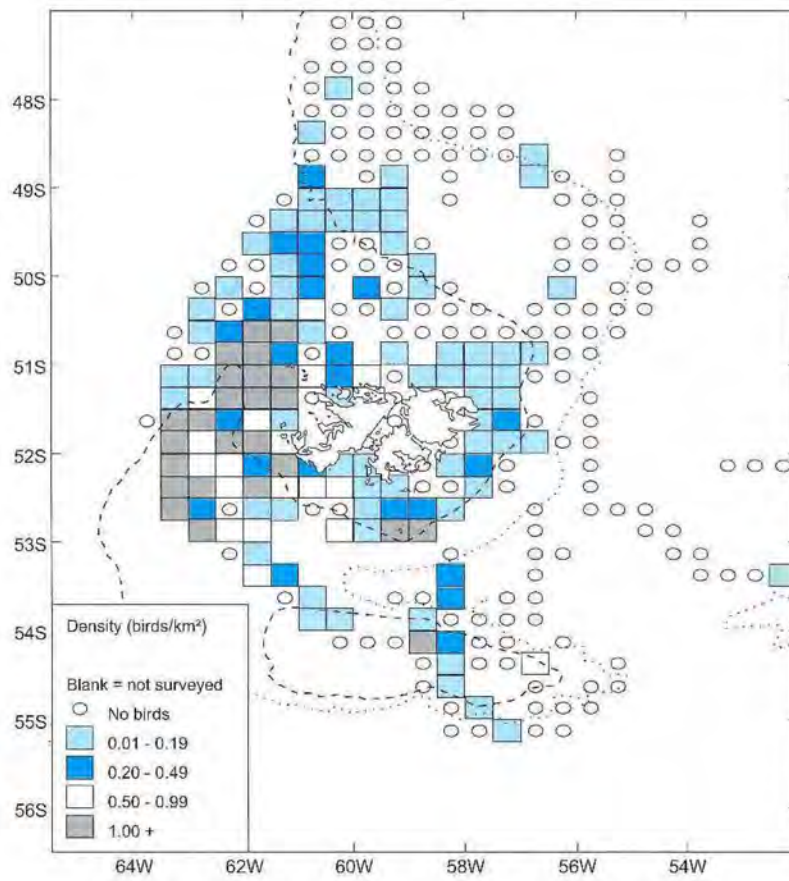


Figure 69 Diving-petrel dispersion, September–February

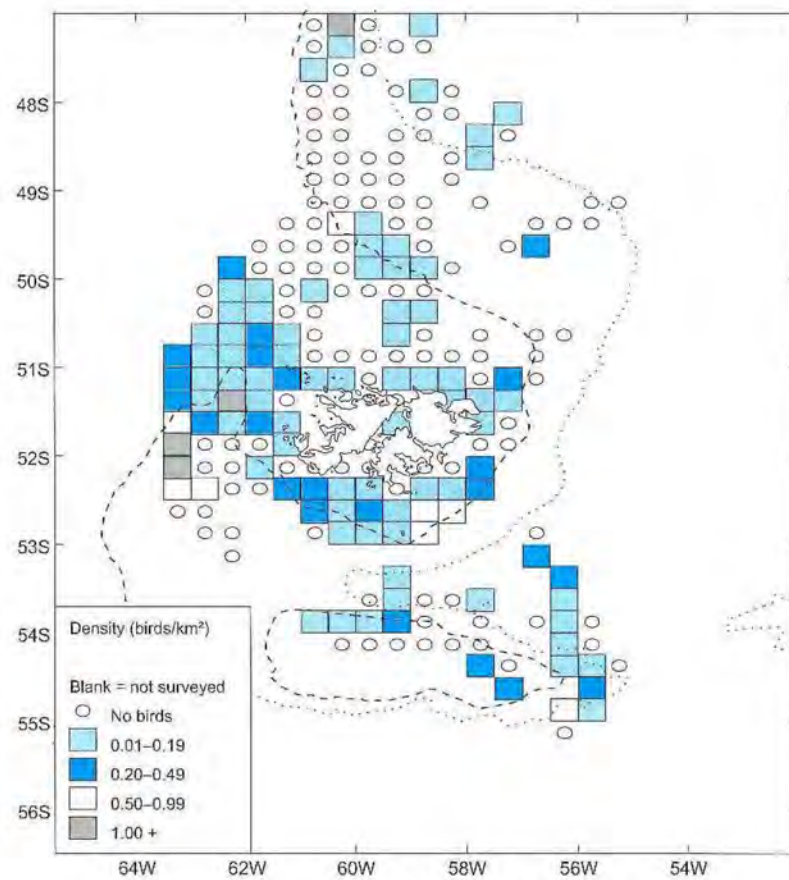


Figure 70 Diving-petrel dispersion, March–August

Highest densities of all diving-petrels were recorded to the west of the islands between September and February (Figure 69). These concentrations coincided with large numbers of prions and Wilson's storm-petrels in the same area in the same months. Between March and August (Figure 70), locally high densities of diving-petrels occurred to the west of the islands and also, to a lesser extent, to the north. Diving-petrels were generally commonest over Patagonian Shelf waters and were distinctly less common in deeper continental shelf slope or oceanic waters.

5.4.4 Shags *Phalacrocoracidae*

Three species of shag have been found in the waters of the Falkland Islands (Woods 1988). Two of these are resident breeding species and were commonly recorded during our surveys. The third, the red-legged shag *Phalacrocorax gaimardi* is a vagrant and was not recorded during surveys.

5.4.4.1 Imperial shag *Phalacrocorax atriceps*

The imperial shag is a resident breeder in the Falkland Islands. The Falkland Islands race, *P. a. albiventer* is endemic to the islands, the population numbering between 45,000 and 84,000 pairs (Woods and Woods 1997).

One of the most numerous species recorded during surveys, imperial shags were noted in all months.

Densities were highest during the winter and spring (Figures 71 and 72), the species occurring in larger feeding flocks during the winter months than in summer, although survey coverage in the inshore waters preferred by imperial shags was highest during the winter.

Imperial shags were recorded considerably farther offshore than rock shags *P. magellanicus*, but usually not more than 30 km from the coast. Occasionally they occurred as far as 70 km from the coast.

Typically, imperial shags formed single-species flocks, but they were observed in mixed-species flocks with rock shags. Occasionally, kelp gulls associated with imperial shag flocks, presumably to scavenge or steal food items.

5.4.4.2 Rock shag *Phalacrocorax magellanicus*

The rock shag is a resident breeder in the Falkland Islands, having an estimated population of between 32,000 and 59,000 pairs (Woods and Woods 1997).

A total of 444 rock shags was recorded during surveys in all months except March—a month when there was little inshore survey coverage. The species occurred only in inshore waters. Highest numbers of rock shags were recorded in winter, probably reflecting the greater survey effort in inshore waters in the winter months. Falkland Sound hosted the highest numbers of rock shags (Figure 73).

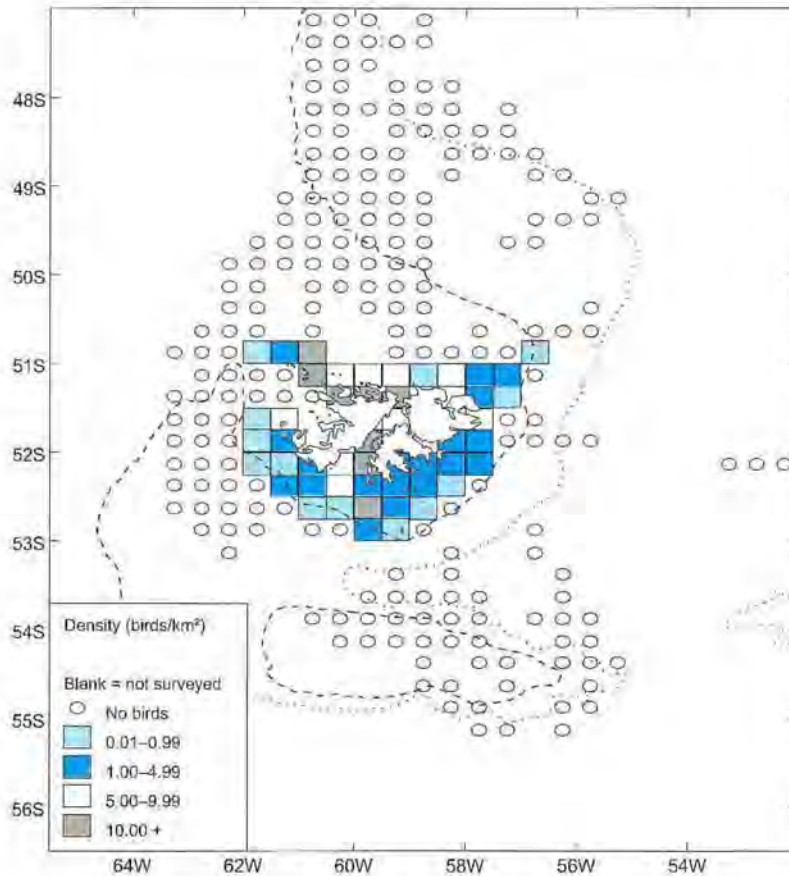


Figure 71 Imperial shag dispersion, June–October

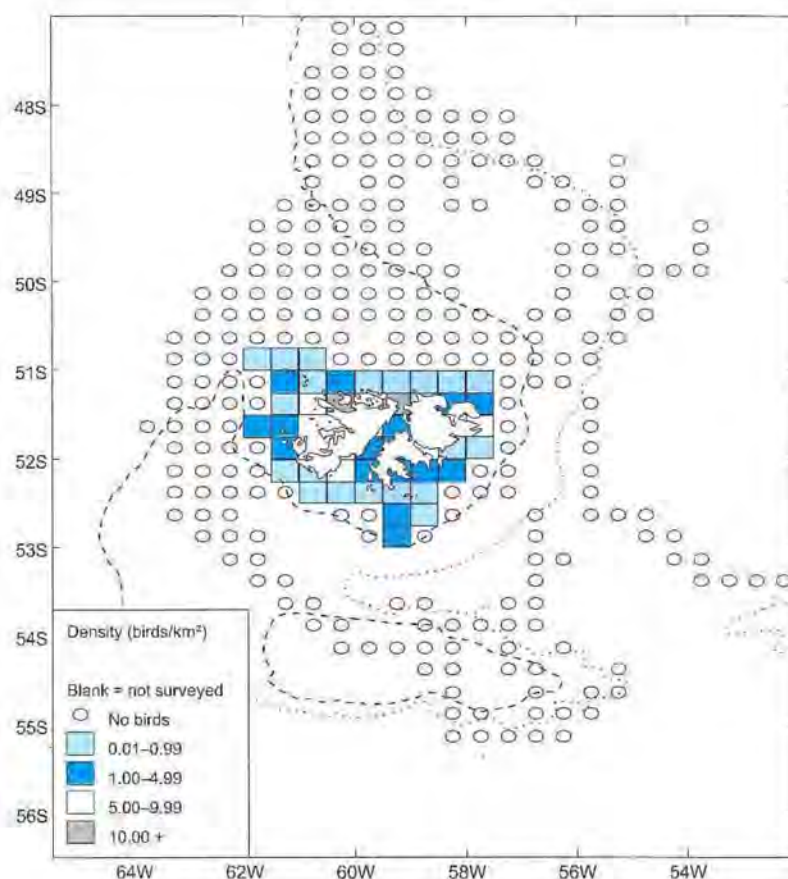


Figure 72 Imperial shag dispersion, November–May

5.4.5 Ducks *Anatidae*

One species of the *Anatidae*, the ducks and geese, was recorded during surveys. There are several other species of *Anatidae* present in the Falkland Islands that are primarily coastal in their distribution, but they are unlikely to venture far enough from the shore to occur within the areas surveyed.

5.4.5.1 Falkland steamer duck *Tachyeres brachydactyla*

The Falkland steamer duck is endemic to the Falkland Islands and has a population of between 9,000 and 16,000 pairs (Woods and Woods 1997).

A total of 309 Falkland steamer ducks was recorded during surveys, all from coastal waters or partially enclosed waters such as Falkland Sound (Figure 74).

5.4.6 Skuas *Stercorariidae*

Of the five species of skua that have been recorded in the waters of the Falkland Islands (Woods 1988) just one breeds in the islands (Woods and Woods 1997). Four species of skua were noted during our surveys—two were recorded regularly and two were considered vagrants.

5.4.6.1 Antarctic skua *Catharacta antarctica*

The Antarctic skua is circumpolar in the Southern Ocean; there are three distinct subspecies. A population of between 5,000 and 9,000 pairs of Antarctic skuas of the race *Catharacta a. antarctica* breeds in the Falkland Islands (Woods and Woods 1997). This race also occurs in mainland South America (Harrison 1983).

A summer visitor to the Falkland Islands, the Antarctic skua was recorded during surveys between November and April, and also in June. A total of 207 birds was recorded between November and April. In addition, a further 82 *Catharacta* skuas were recorded but not specifically identified. Many of these birds were probably Antarctic skuas, so these records have been included with Antarctic skua records in the map showing *Catharacta* skua distribution (Figure 75). Low numbers of *Catharacta* skuas were recorded in offshore areas, with higher numbers recorded in inshore waters in Falkland Sound, around New Island and off the south coast of East Falkland (Figure 75).

Where Antarctic skuas from the Falkland Islands spend the winter is unknown, but the paucity of midwinter records suggests that they leave Falkland Islands waters. However, five midwinter records of *Catharacta* skuas north of the islands (and several more records beyond the

Seabird and marine mammal dispersion in the waters around the Falkland Islands

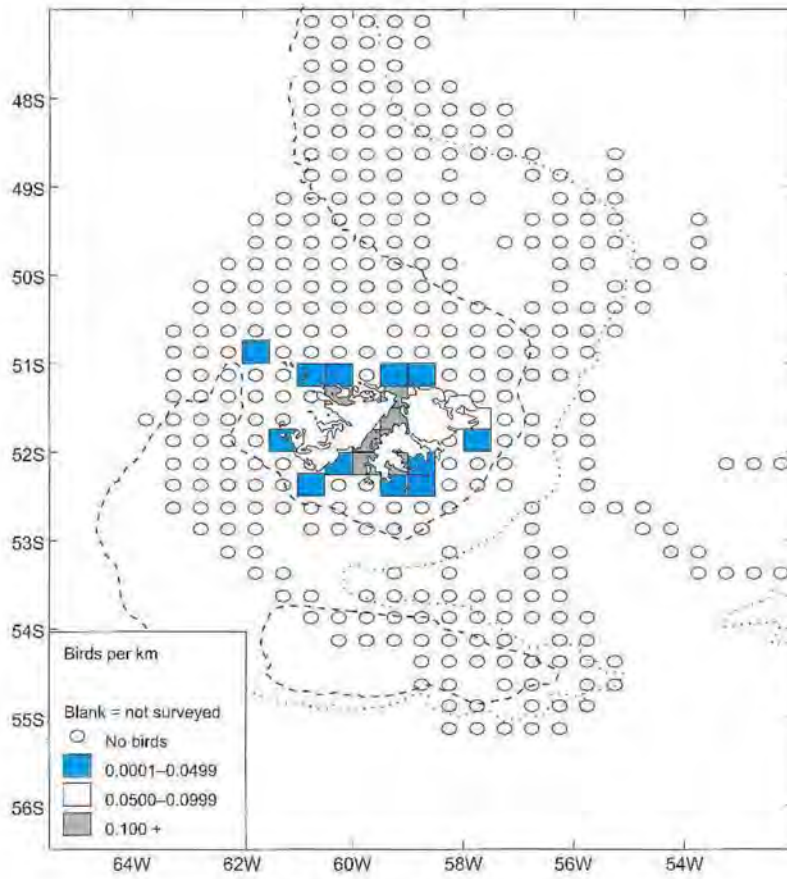


Figure 73 Rock shag dispersion, all months



Figure 74 Falkland steamer duck dispersion, all months

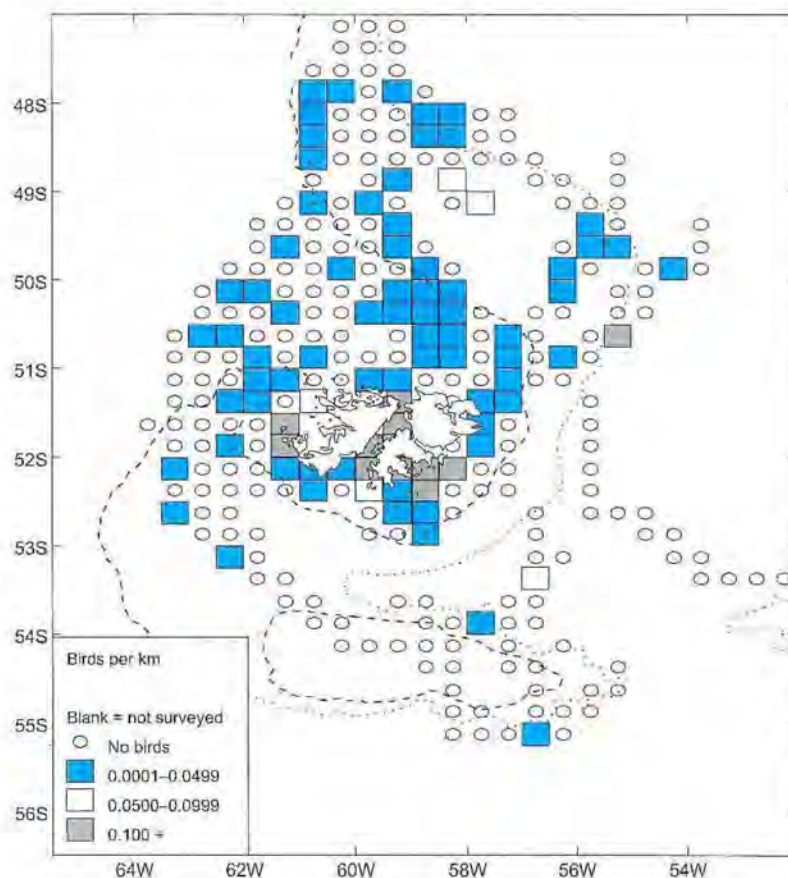


Figure 75 *Catharacta skua* dispersion, November–April

survey area farther north) indicates that *C. a. antarctica* might not move too far to the north in winter.

Antarctic skuas were observed kleptoparasitising imperial shags, rock shags, Magellanic penguins and sooty shearwaters.

5.4.6.2 Long-tailed skua *Stercorarius longicaudus*

Long-tailed skuas breed in the high Arctic, spending the boreal winter in the South Atlantic and South Pacific Oceans (Olsen and Larsson 1997).

A total of 126 long-tailed skuas was recorded in all months between November and April; there were no records outside these months. The majority of records were from offshore waters to the north and north-east of the Falkland Islands, with the highest densities in deep waters in the north of the survey area (Figure 76). There were no records from the seas south of the islands, only one record to the south-west and one record from Falkland Sound.

The Falkland Islands appear to be at the southerly limit of this species' non-breeding range. Veit (1985) recorded large numbers of long-tailed skuas on the Falkland Current between 39° S and 45° S.

A long-tailed skua was observed kleptoparasitising Wilson's storm-petrels on one occasion, behaviour also noted by Brady (1994).

5.4.7 Gulls *Laridae*

Seven species of gull have been recorded in the Falkland Islands (Falklands Conservation 1998), three of which breed (Woods and Woods 1997). The three breeding species, dolphin gull *Larus scoresbii*, kelp gull *L. dominicanus*, and brown-hooded gull *L. maculipennis*, were all recorded regularly during surveys. All three were found year round, but brown-hooded gulls appeared to decrease in numbers in the winter months, whereas kelp gull numbers increased at this time.

5.4.7.1 Brown-hooded gull *Larus maculipennis*

Brown-hooded gulls are mainly summer visitors to the Falkland Islands although some birds remain year round. The breeding population of the Falkland Islands is estimated to be between 1,400 and 2,600 pairs (Woods and Woods 1997).

A total of 48 brown-hooded gulls was recorded in inshore waters (Figure 77) with highest numbers in the summer months. Despite high levels of inshore survey coverage in the winter months, very few brown-hooded gulls were recorded in winter. In June and July, brown-hooded gulls were observed off the north coast of West Falkland. This is an area where South American terns,

Seabird and marine mammal dispersion in the waters around the Falkland Islands

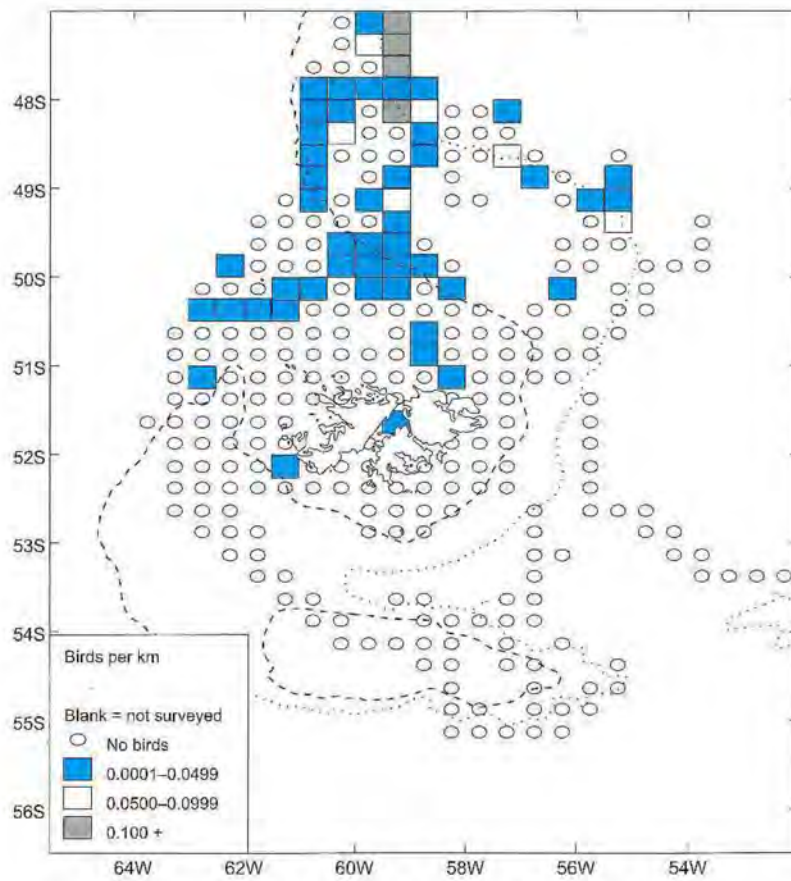


Figure 76 Long-tailed skua dispersion, November–April

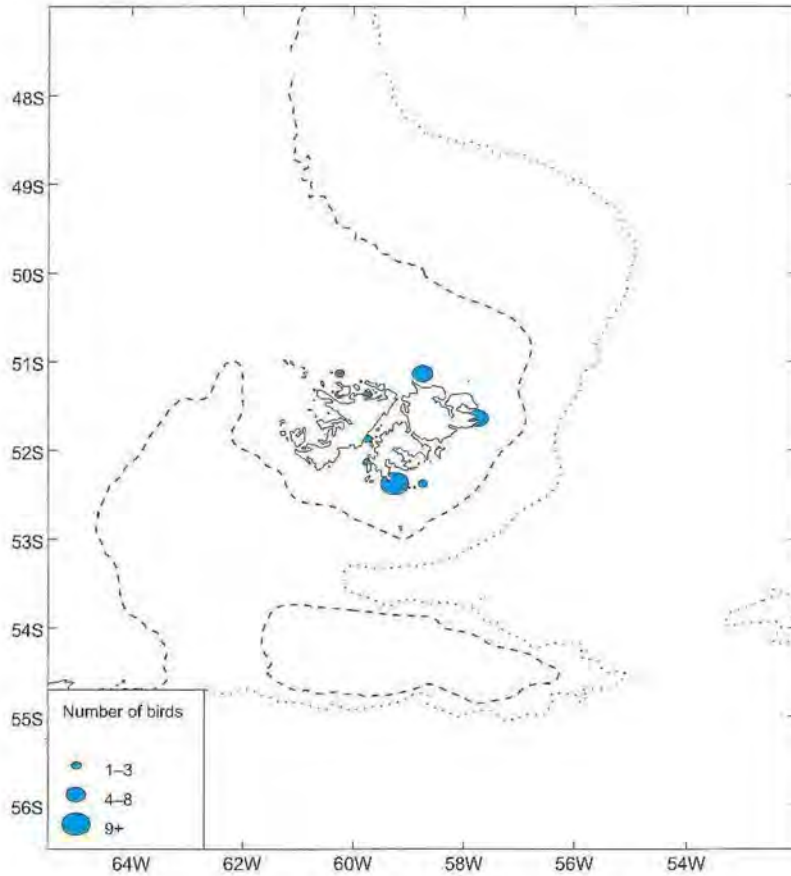


Figure 77 Brown-hooded gull distribution, all months

sooty shearwaters and Magellanic penguins were also observed in the winter months, a time when most individuals of these species had left the waters of the Falkland Islands.

5.4.7.2 Dolphin gull *Larus scoresbii*

Year-round residents in the Falkland Islands, dolphin gulls have an estimated breeding population of between 3,000 and 6,000 pairs (Woods and Woods 1997).

Dolphin gulls were infrequently recorded throughout the year during surveys. All 65 records were from coastal waters (Figure 78); there were no records of these gulls out of sight of land. The species exhibited no notable seasonality, although there were slightly more records between August and October.

5.4.7.3 Kelp gull *Larus dominicanus*

Kelp gulls are resident all year in the Falkland Islands with a breeding population estimated to be between 24,000 and 44,000 pairs (Woods and Woods 1997).

A total of 1,281 kelp gulls was recorded during surveys. They were recorded in all months, having an inshore distribution during the summer, and a distinct increase in both absolute numbers and the number of offshore records during the winter (Figures 79 and 80). This winter increase may be due to immigration of birds from Antarctica, or to an increase in the number of birds spending time at sea when not attending colonies.

Kelp gulls were frequently observed associating with, and presumably scavenging from, flocks of imperial shags in the winter months.

5.4.8 Terns *Sternidae*

Of the six species of tern that have been recorded in Falkland Islands waters (Falklands Conservation 1998), just one, the South American tern *Sterna hirundinacea*, breeds in the islands (Woods and Woods 1997). During our surveys two species of tern were recorded: the South American tern and the Arctic tern *Sterna paradisaea*. Although the Arctic tern was recorded only as a vagrant, it may be a regular migrant in the waters of the Falkland Islands. In addition, several terns that were recorded could not be specifically identified due to poor views. These birds were recorded as unidentified *Sterna* terns.

5.4.8.1 South American tern *Sterna hirundinacea*

The South American tern breeds in the Falkland Islands and has a population estimated to be between 6,000 and 12,000 pairs (Woods and Woods 1997). South American terns are present in the waters of the Falkland Islands in all months, although numbers were considerably lower in the winter months (see also brown-hooded gull).

A clear seasonal pattern emerged in tern observations during 1998/99. Terns were present all year in Falkland

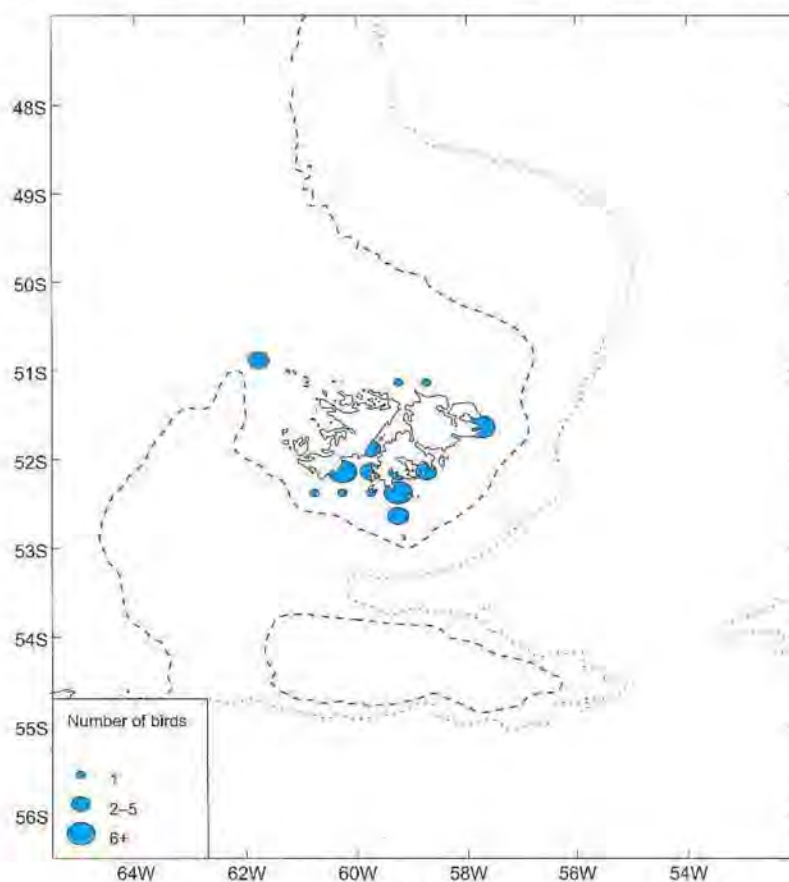


Figure 78 Dolphin gull distribution, all months

Seabird and marine mammal dispersion in the waters around the Falkland Islands

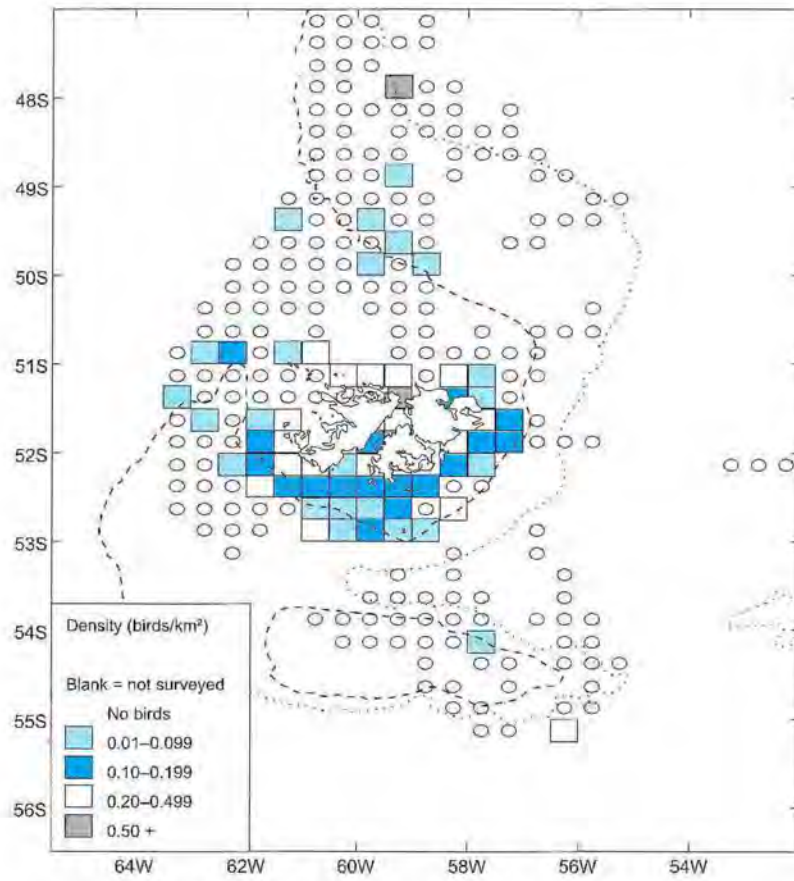


Figure 79 Kelp gull dispersion, May–October

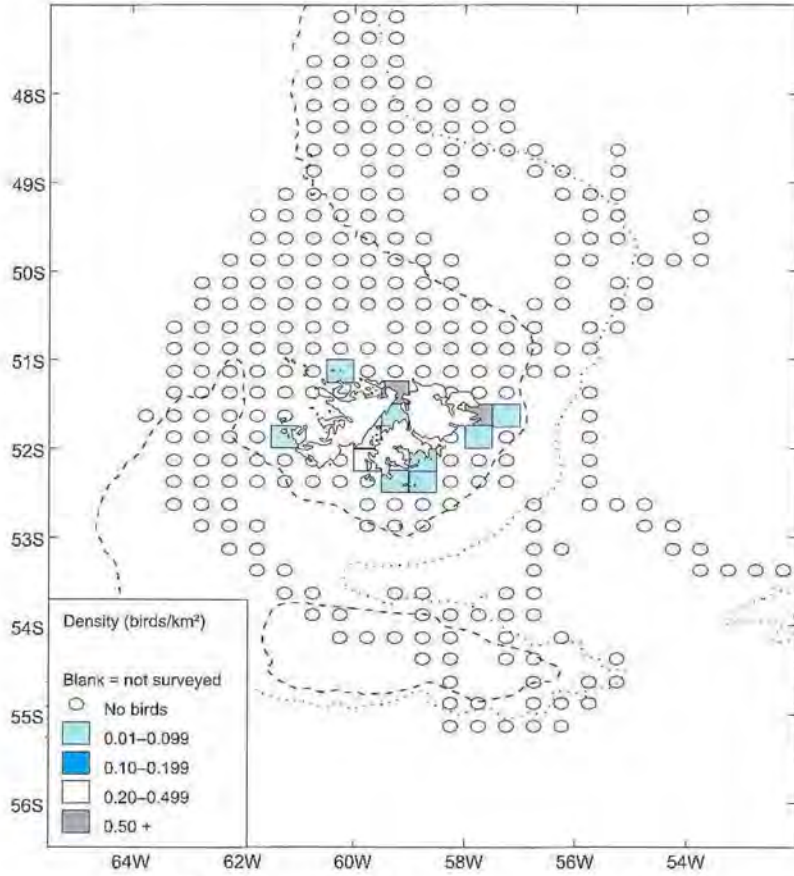


Figure 80 Kelp gull dispersion, November–April

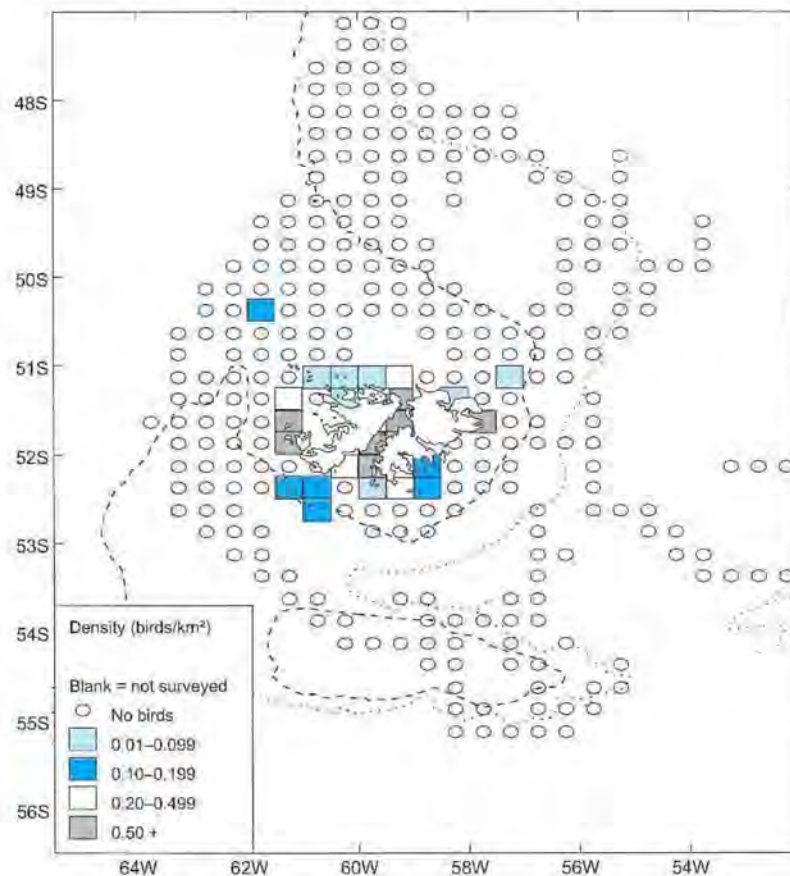


Figure 81 South American tern dispersion, October–February

Islands waters, but they were distinctly less common in the winter months than in the summer. A total of 611 South American terns was recorded in inshore waters between October and February, which roughly coincides with the breeding season of the species in the Falkland Islands. Highest numbers of South American terns were recorded at the south end of Falkland Sound in the summer months (Figure 81).

There were noticeably fewer tern records from March to May and August to September (Figure 82), with only 25 recorded at these times. This should be interpreted with care, as the pattern may be a result of biased survey coverage.

Winter records of terns (probably South American terns) peaked at 92 in June and July (Figure 83). Many of these birds were observed in inshore waters off the north coast of West Falkland and Pebble Island. Large numbers of fur seals and imperial shags were also recorded here, as well as high numbers of seabirds—such as brown-hooded gull, sooty shearwater and Magellanic penguin—which, typically, were not recorded elsewhere in winter in Falkland Islands waters.

In October and November, there was a significant increase in the number of unidentified terns, with 55 birds recorded compared with only 21 at other times. Many of these records were from waters deeper than 200 m (Figure 84), whereas all unidentified terns observed between December and September were over Patagonian Shelf waters (Figure 85). Some of the unidentified terns

in October and November, in particular the coastal records, were probably South American terns. However, the only positively identified Arctic tern record was in November, so it is possible that a number of the unidentified terns seen in deep waters in October and November were Arctic terns on their post-breeding migration from the northern hemisphere to the Antarctic.

5.4.9 Rare seabirds

There were fewer than ten records of the following species:

Macaroni penguin Eudyptes chrysolophus

Two macaroni penguins were identified in July in deep water to the north-east of the islands at 47°50'S, 58°47'W.

Shy albatross spp. Thalassarche cauta spp.

A single shy albatross, probably a white-capped albatross *T. cauta* was recorded in March with a further four in April. In addition, two birds in April were thought to have been Salvin's albatross *T. salvini*. All records involved birds on the Patagonian Shelf to the north-west of the islands.

Sooty albatross Phoebastria fusca

Two sooty albatrosses were recorded in January 1999 in deep water to the north-east of the islands at 49°06'S, 56°04'W and 49°11'S, 55°51'W.

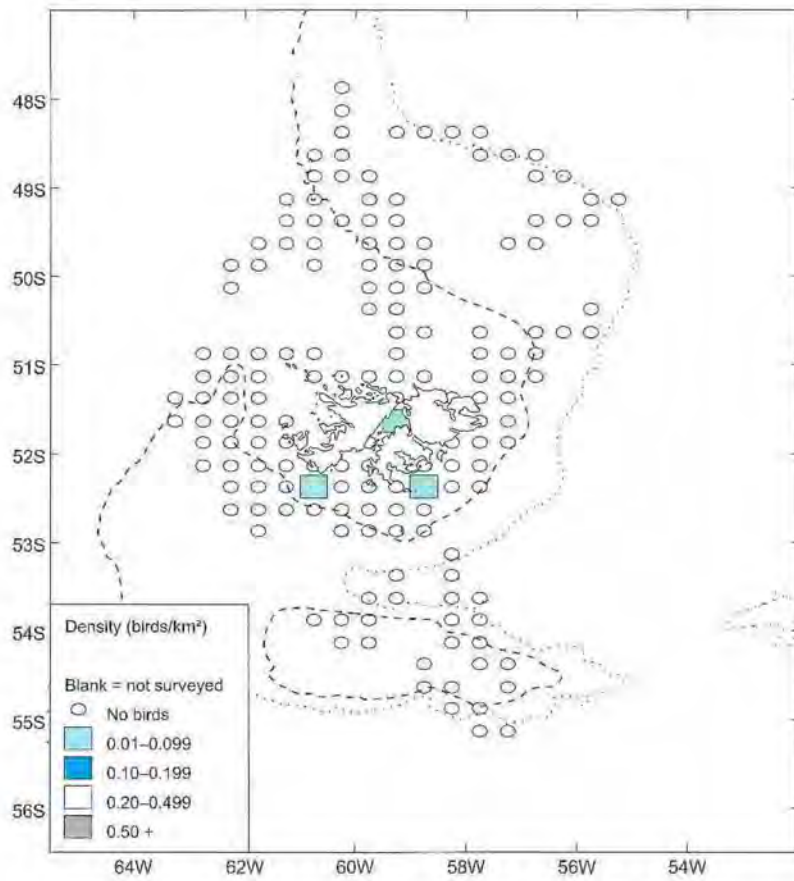


Figure 82 South American tern dispersion, August–September

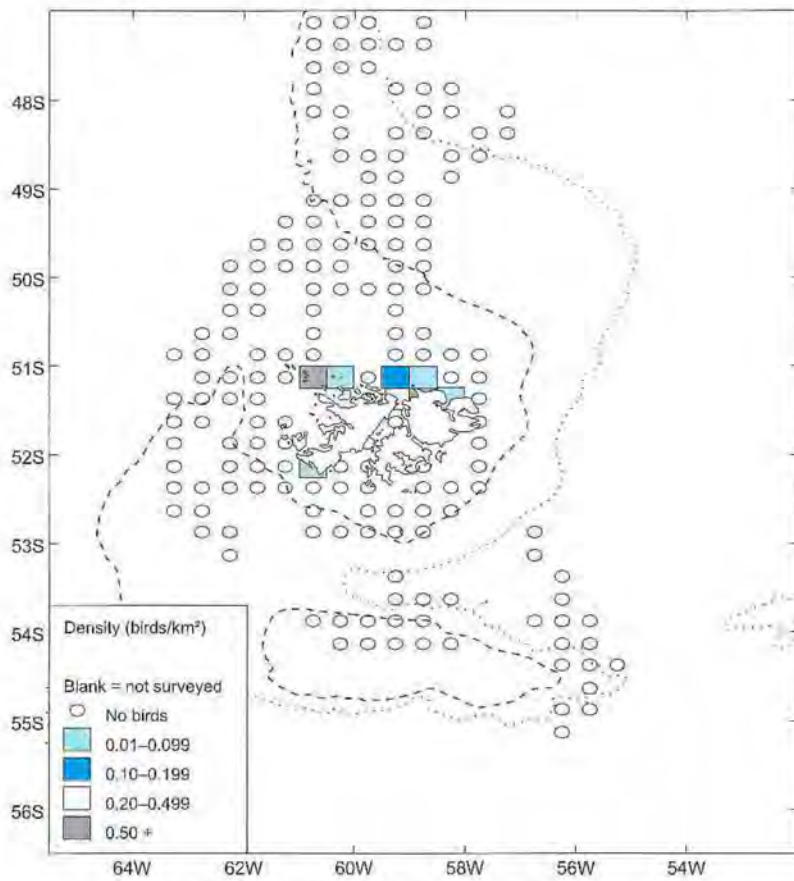


Figure 83 South American tern dispersion, June and July

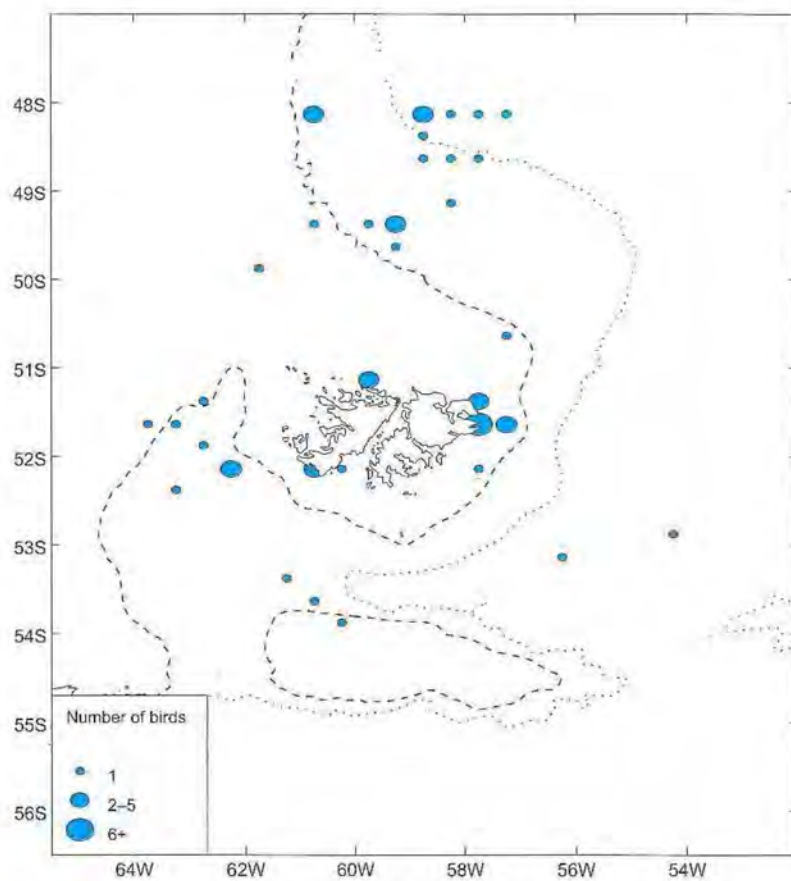


Figure 84 Unidentified tern distribution, October and November

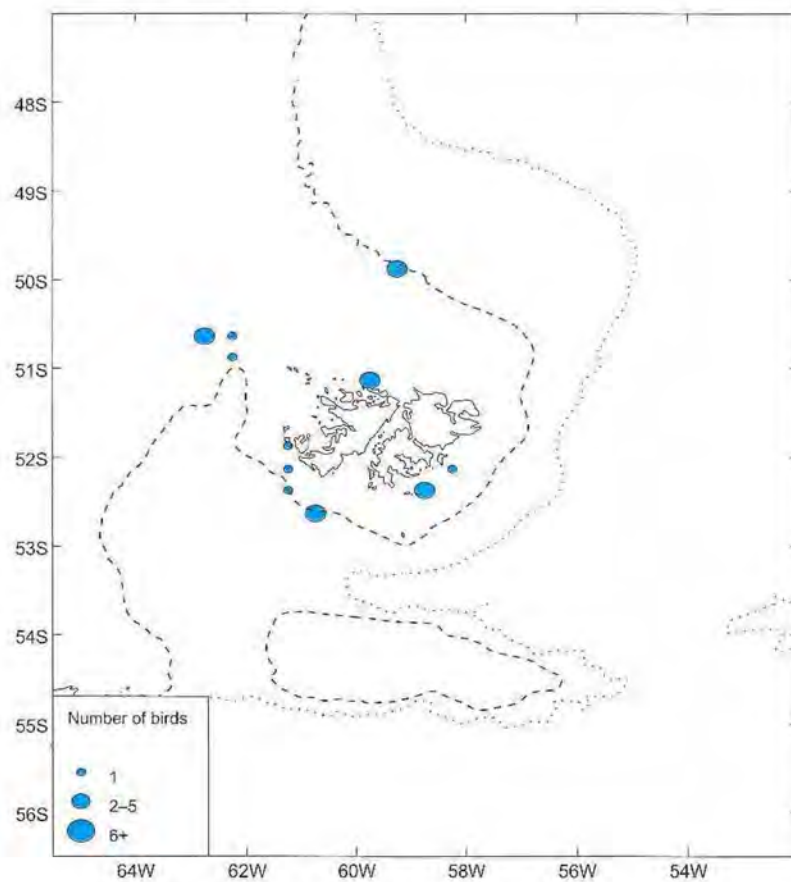


Figure 85 Unidentified tern distribution, December–September

Light-mantled albatross *Phoebetria palpebrata*

Six individuals were seen—one in January, one in February, two in August and two in November.

Antarctic petrel *Thalassoica antarctica*

There was a single record of an Antarctic petrel, in August on the south side of the Burdwood Bank at 54°43'S, 57°17'W.

Fairy prion *Pachyptila turtur*

Few prions were identified specifically but, of those that were, only four were identified as fairy prions—two in January, one in May and one in September.

Broad-billed prion *Pachyptila vittata*

A single broad-billed prion was identified in November at 52°46'S, 62°29'W.

White-headed petrel *Pterodroma lessonii*

A single white-headed petrel was recorded in January 1999, in deep water to the north-east of the islands at 49°01'S, 56°17'W.

Grey petrel *Procellaria cinerea*

Four grey petrels were recorded—two in January and two in October. All records were of birds in deep water to the north-east of the islands.

Little shearwater *Puffinus assimilis*

Five little shearwaters were recorded—three in January and singles in March and December. All records were from waters to the north of the islands.

Manx shearwater *Puffinus puffinus*

Two Manx shearwaters were recorded—one in January at 47°60'S, 60°28'W and one in November at 50°36'S, 57°21'W.

Grey phalarope *Phalaropus fulicarius*

Grey phalaropes were recorded on two occasions in December at 48°29'S, 57°53'W and 51°28'S, 57°21'W.

Chilean skua *Catharacta chilensis*

Two Chilean skuas were recorded in November 1998 and January 1999 at 52°00'S, 62°22'W and 49°04'S, 55°47'W respectively.

Arctic skua *Stercorarius parasiticus*

A single Arctic skua was identified to the north of the islands in January 1999 at 48°50'S, 59°49'W.

Arctic tern *Sterna paradisaea*

A single Arctic tern was recorded in November at 48°52'S, 59°26'W.

5.5 Marine mammals

In addition to seabirds, all marine mammals observed during surveys were recorded; they totalled 2,982 marine mammals of 17 species (Table 5).

Of 2,303 cetaceans recorded, 2,141 (of 12 species) were specifically identified. A further two cetacean 'types' were observed but not specifically identified, due to their similarity to other closely related species (Table 5). Unidentified cetaceans included 20 unidentified large whales, probably fin, sei or sperm whales, and 132 unidentified dolphins.

During the surveys 679 pinnipeds were recorded; 632 (of three species) were specifically identified (Table 5). All three species of pinniped positively identified during surveys breed in the Falkland Islands.

5.5.1 Cetaceans

5.5.1.1 Fin whale *Balaenoptera physalus*

Fin whales are widespread throughout the oceanic waters of both hemispheres, only rarely being recorded in shallower inshore waters (Jefferson *et al.* 1993).

Thirteen sightings of 32 fin whales were recorded, with eight animals in the largest group. Fin whales were noted only between November and January, most records being from waters over 200 m deep (Figure 86). Fin whales do

have a deep-water distribution, but the apparent seasonal pattern to the observations may be due to survey coverage bias towards deep-water areas. However, deep-water surveys in July and August failed to record any fin whales, although unidentified large whales

Table 5. Total number of marine mammals recorded during surveys.

Species	Total
Southern right whale	4
Fin whale	32
Sei whale	15
Minke whale	31
Humpback whale	2
Sperm whale	15
Ziphiid whale sp. ¹	9
Beaked whale sp. ²	5
Killer whale	7
Long-finned pilot whale	77
Hourglass dolphin	480
Peale's dolphin	1,181
Southern rightwhale dolphin	120
Commerson's dolphin	163
South American sea lion	32
South American fur seal	596
Southern elephant seal	4

¹one of the small beaked whale species, generally considered inseparable at sea

²either southern bottlenose whale *Hyperoodon planifrons* or Arnoux's beaked whale *Berardius arnuxii*

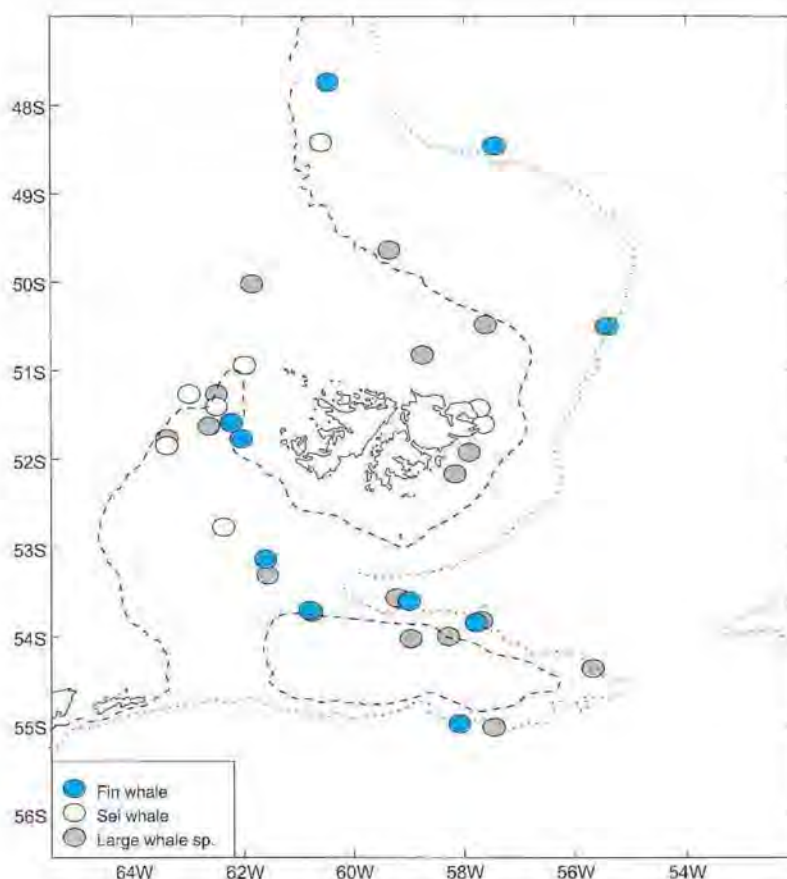


Figure 86 Fin whale, sei whale and unidentified large whale distribution

(fin, sei, blue or sperm whale) were recorded in these months.

Many of the records of unidentified large whales around the Burdwood Bank may have been of fin whales.

5.5.1.2 Minke whale *Balaenoptera acutorostrata*

Minke whales are the commonest of the baleen whales and are found throughout the world's oceans (Jefferson *et al.* 1993).

Minke whale was the most frequently recorded species of baleen whale. They were observed throughout the survey area in both Patagonian Shelf and oceanic waters (Figure 87). A total of 24 sightings of 31 animals was recorded. Apart from a record of eight animals in April, all records were of single whales. There were no records in March, May, July or August.

One minke whale was recorded in association with a group of hourglass dolphins and, on one occasion, a very small minke whale was seen that may have been a form known as pygmy minke whale.

5.5.1.3 Sperm whale *Physeter macrocephalus*

Sperm whales are widespread throughout the world's oceans, usually in deep waters. They tend to winter in temperate and tropical waters with movements towards the poles in summer (Jefferson *et al.* 1993).

A total of 15 sperm whales was recorded during July, November, December and January. All records were from deep waters near the 1,000-m depth contour (Figure 88). On several occasions sperm whales were recorded near longliners fishing for Patagonian toothfish, an association also noted by fisheries observers on longliners in Falkland Islands' waters (A. Black pers. comm.) and in the waters around South Georgia (Ashford *et al.* 1996).

5.5.1.4 Hourglass dolphin *Lagenorhynchus cruciger*

Hourglass dolphins are circumpolar in the higher latitudes of the Southern Ocean, predominantly between 45°S and 65°S. The species is oceanic, and is seen only rarely in continental shelf waters (Jefferson *et al.* 1993).

A total of 480 hourglass dolphins was recorded during surveys between September and February only. Again, this apparent seasonal pattern may be due to biased survey effort in deep waters, although the species was not recorded in deep water surveys in July and August. Records during SAST surveys to date have been over the continental shelf slope, or in deep oceanic waters to the north, east and south of the Falkland Islands (Figure 89). Hourglass dolphins were relatively more abundant than Peale's dolphin.

Hourglass dolphins have been recorded in the company of long-finned pilot and minke whales and, on

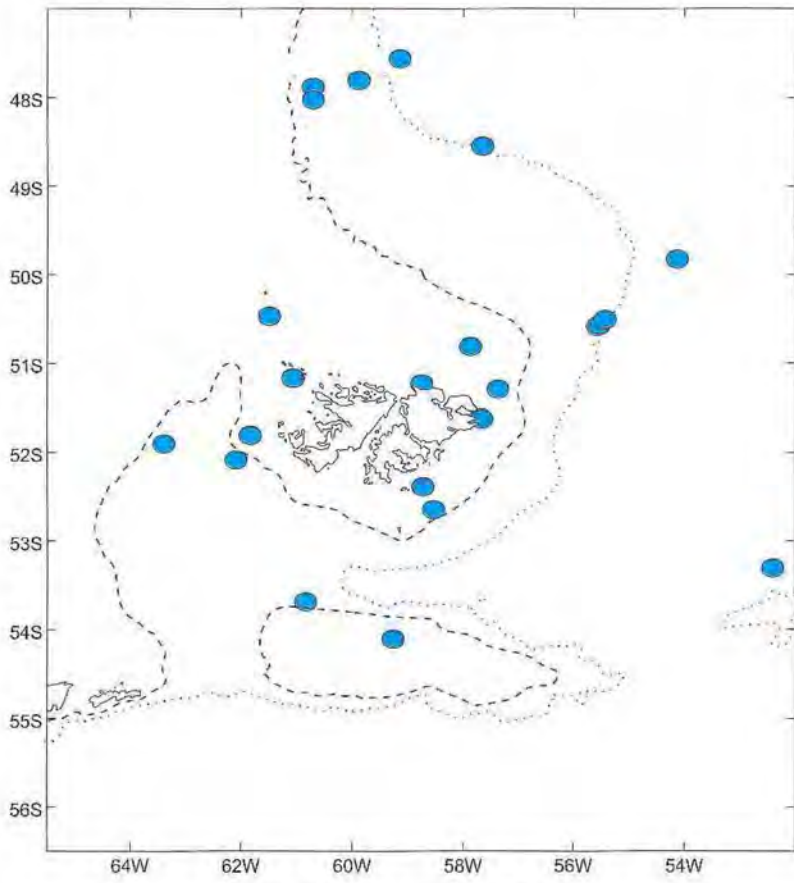


Figure 87 Minke whale distribution

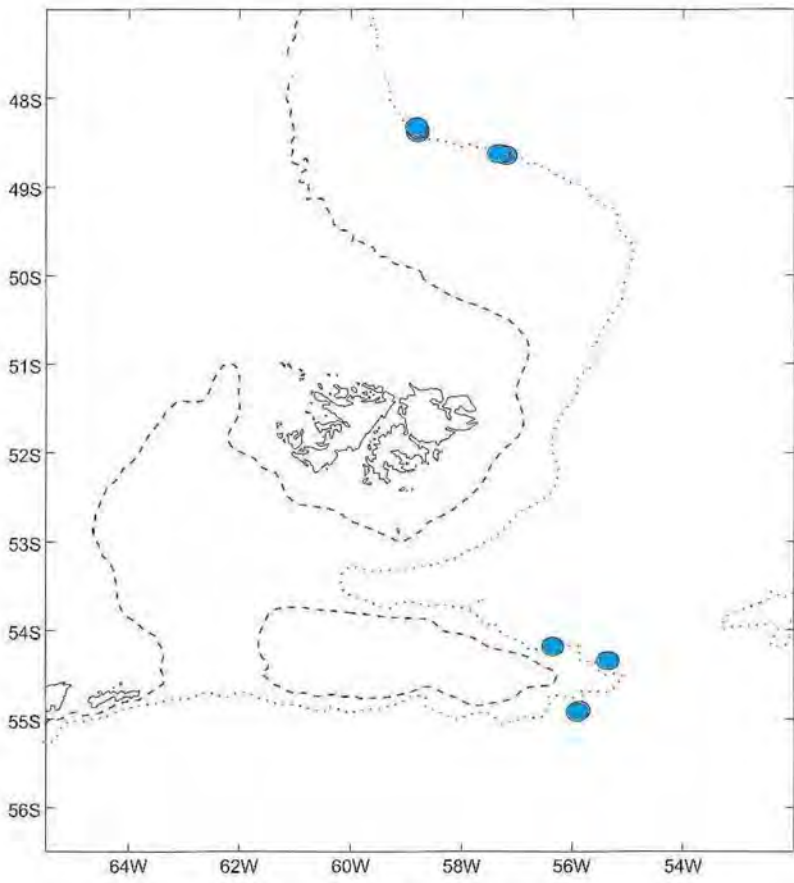


Figure 88 Sperm whale distribution

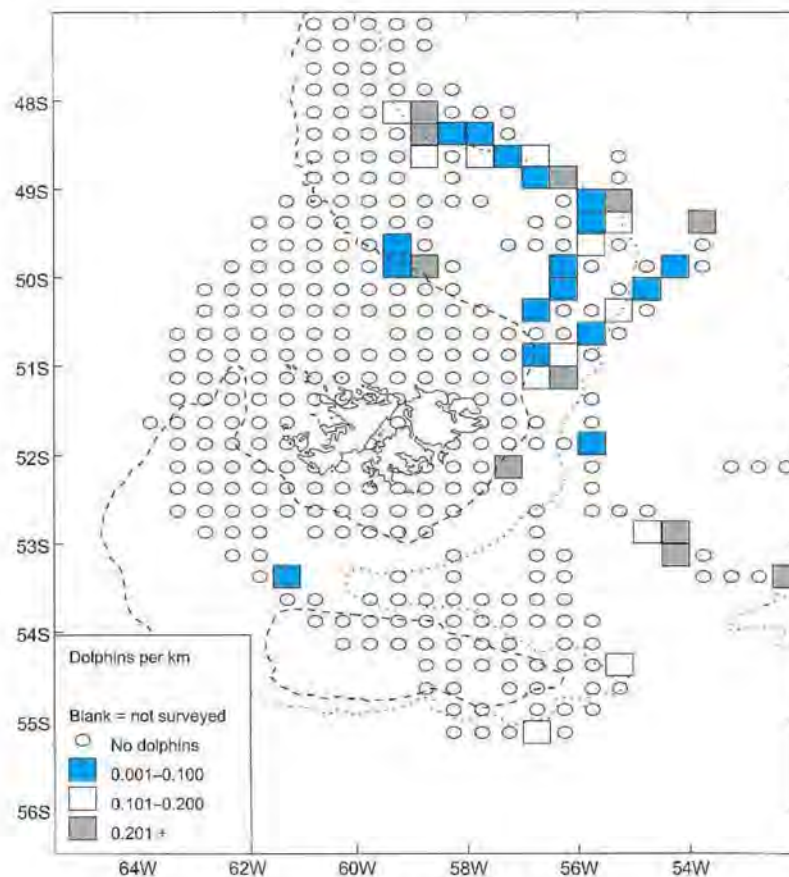


Figure 89 Hourglass dolphin distribution

several occasions, seabirds (notably great shearwaters and black-browed albatrosses) were observed feeding in association with hourglass dolphins. The diet of hourglass dolphin is poorly known, but probably comprises fish and squid (Goodall and Galeazzi 1985).

5.5.1.5 Peale's dolphin *Lagenorhynchus australis*

The world distribution of Peale's dolphin is restricted to the waters around South America. Peale's dolphins occur in the seas off southern Argentina, around the tip of South America to central Chile and around the Falkland Islands (Jefferson *et al.* 1993).

Most Peale's dolphin records were from the relatively shallow waters of the Patagonian Shelf (Figure 90). The only area where the species was frequently recorded in waters deeper than 200 m was to the west of the Falkland Islands, i.e. between the Falkland Islands and South America. Given this observation, and the observations of Peale's dolphin at the north-western boundary of Falkland Islands waters and the Argentine EEZ, these dolphins seem to have a continuous distribution between the Falkland Islands and South America. There were also records of Peale's dolphins over the Burdwood Bank in January 1999.

Peale's dolphin sightings were most frequent in the waters over the Patagonian Shelf to the south and east of

the Falkland Islands (Figure 90). This is probably due to high prey densities in this area, which overlaps with part of the *Loligo* fishery. Although little is known of the diet of Peale's dolphin, the available evidence suggests that they are generalist feeders, taking a mixture of fish and cephalopods (Goodall and Galeazzi 1985).

5.5.1.6 Commerson's dolphin *Cephalorhynchus commersonii*

Commerson's dolphins are restricted to the waters of South America (southern Chile and Argentina) except for an isolated population in the waters around Kerguelen Island (Jefferson *et al.* 1993).

A total of 163 Commerson's dolphins was recorded from SAST surveys during the year (Figure 91). There were no records in March, April and May, but this paucity probably reflects survey effort and coverage rather than seasonality, as the species is probably resident in the survey area.

Frost and Best (1976) suggest that Commerson's dolphins may have a habitat preference for well-indented coastlines with sheltered bays. All observations during surveys certainly accord with this. There were many records from coasts near Falkland Sound, and the species was not recorded more than a few miles from shore during SAST surveys (Figure 91). Only two published records of Commerson's dolphin around the

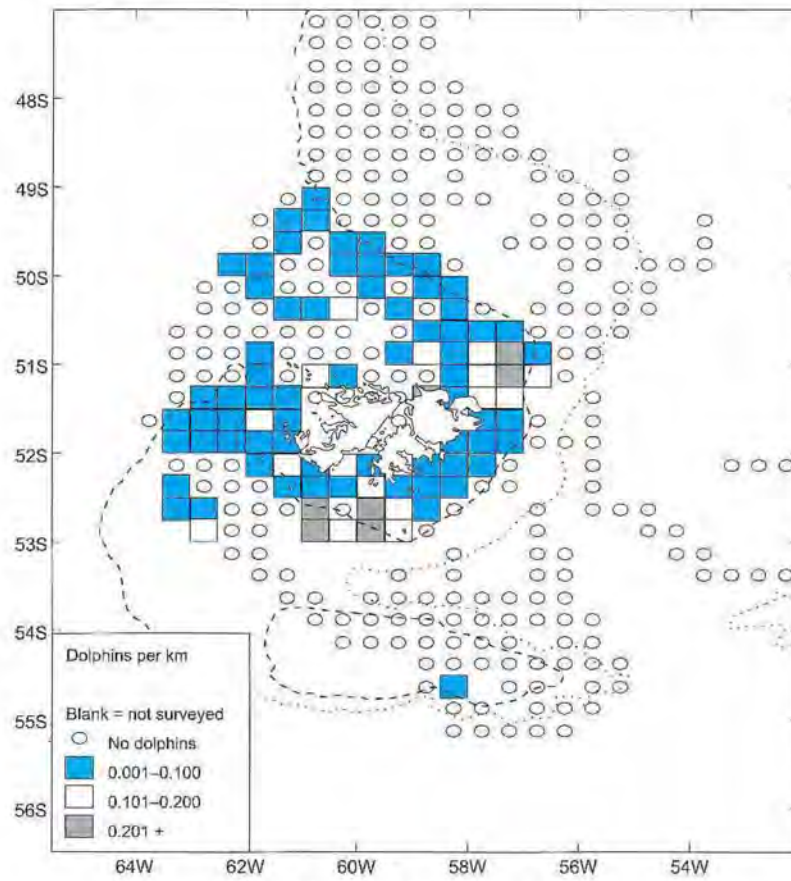


Figure 90 Peale's dolphin distribution



Figure 91 Commerson's dolphin distribution

Falkland Islands (to the south-east of the islands) indicate that the species occurs in waters deeper than 200 m (Goodall *et al.* 1988).

As the species is rarely seen in offshore areas, the Commerson's dolphin populations in the Falkland Islands and South America are most probably distinct and do not mix.

Stomach contents analyses of animals caught accidentally in fishing gear off Tierra del Fuego indicate that this species is a generalist feeder. Their diet comprised mysid shrimps, schooling fish, and *Loligo* squid (Bastida *et al.* 1988).

5.5.2 Pinnipeds

5.5.2.1 South American sea lion *Otaria byronia*

The South American sea lion is widely distributed around the coasts of southern South America and the Falkland Islands. The population in Patagonia is estimated to be about 60,000 animals (Harris 1998), with 3,385 in the Falkland Islands (Strange 1990).

A total of 32 South American sea lions was recorded throughout the year but not in all months. Most records were from the shallow waters of the Patagonian Shelf (Figure 92), with one over the Burdwood Bank, and several records in the north of the survey area which may

have been of animals from South America rather than the Falkland Islands.

5.5.2.2 South American fur seal *Arctocephalus australis*

South American fur seals are widely distributed around the coasts of southern South America and the Falkland Islands. The population of fur seals in the Falkland Islands is between 18,000 and 20,000 animals (Strange 1992), whereas in Patagonia this species is less common than the South American sea lion (Harris 1998).

South American fur seals were recorded in all months except February and April. They were more widespread and were recorded in higher numbers in the winter months (Figures 93 and 94). They occurred in all areas surveyed, and their distribution appeared not to be constrained by water depth or proximity of land. The largest concentrations of fur seals were recorded close inshore, with particularly high numbers recorded off the north coast of West Falkland, off Pebble Island, and to the west of the Falkland Islands. There was also a notable concentration in deep waters to the north of the survey area during winter.

5.5.3 Rare marine mammals

The following marine mammal species were recorded on ten or fewer occasions.

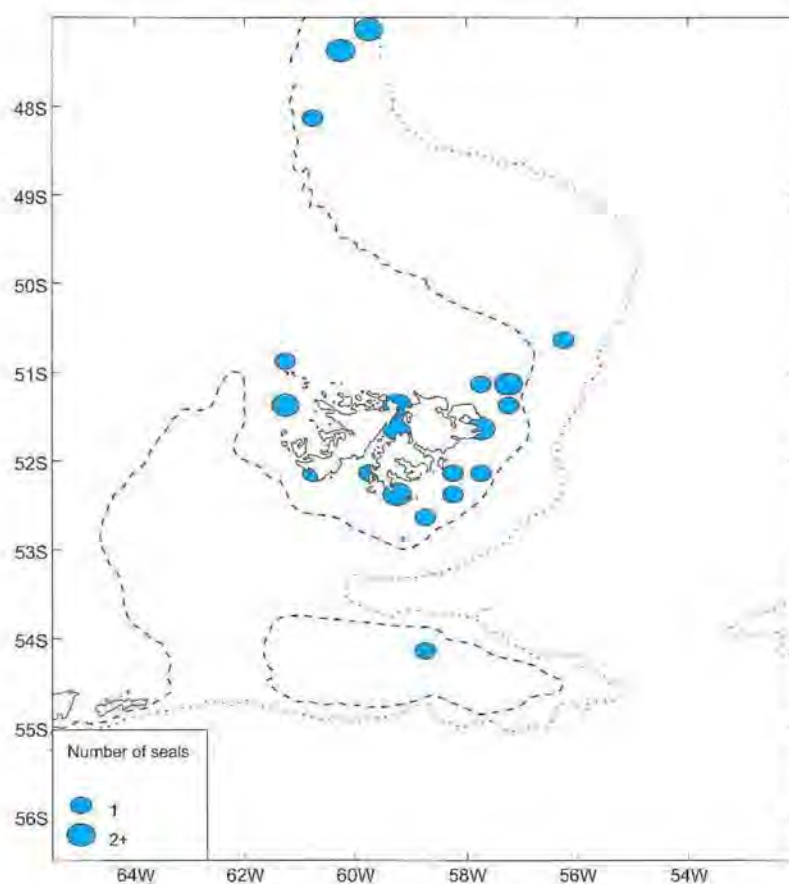


Figure 92 South American sea lion distribution

Seabird and marine mammal dispersion in the waters around the Falkland Islands

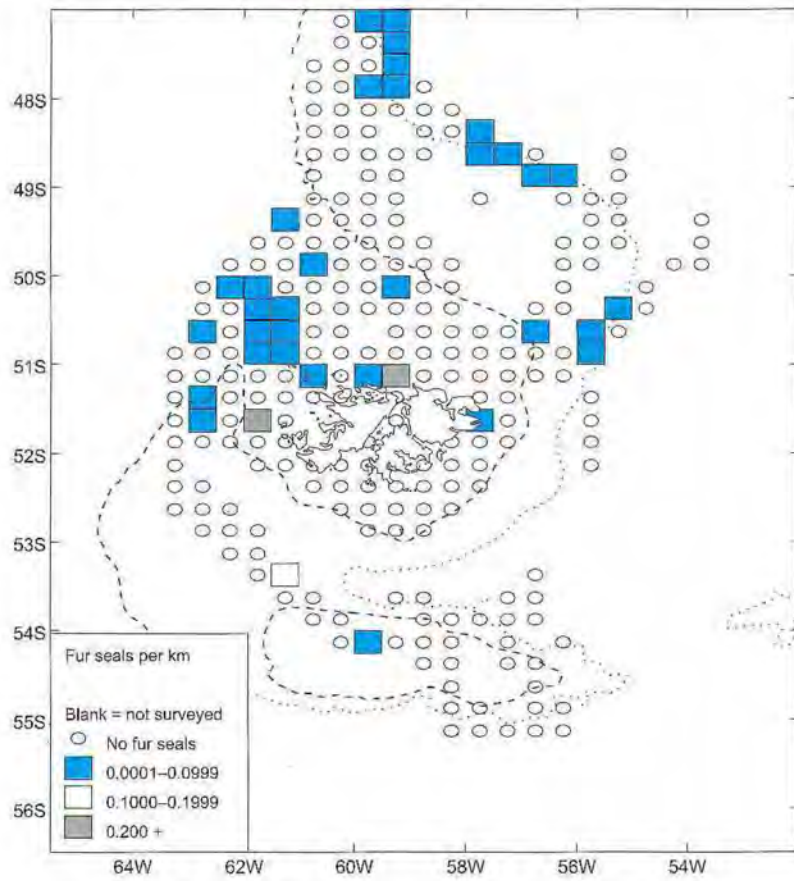


Figure 93 South American fur seal dispersion, December–May

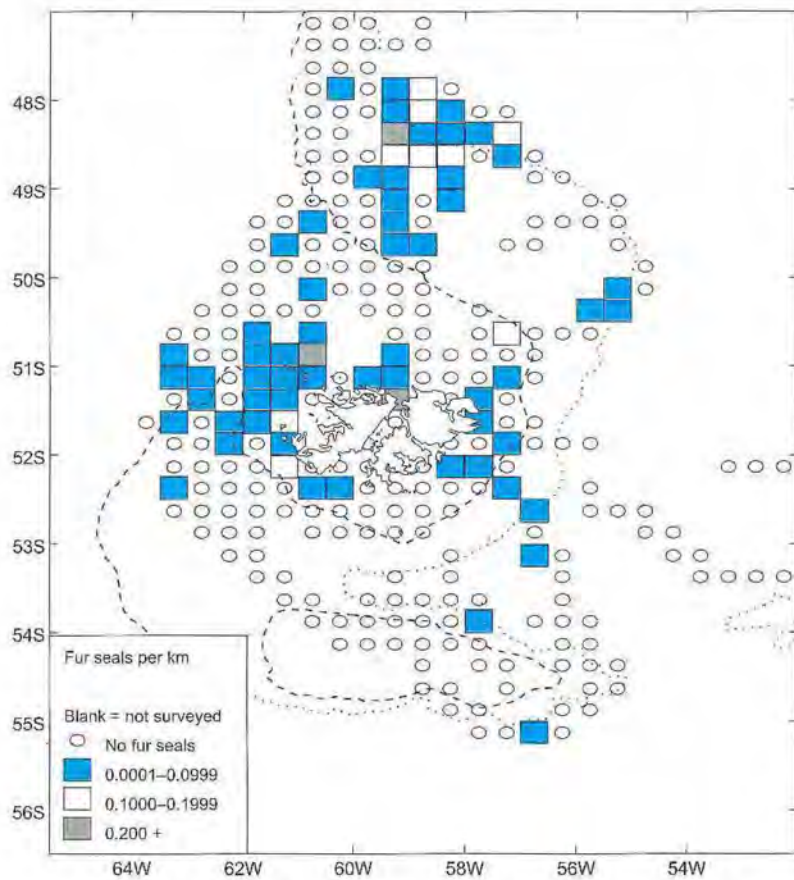


Figure 94 South American fur seal dispersion, June–November

Southern right whale Eubalaena australis

There were two records of southern right whales during surveys—in November, two animals were observed at 48°36'S, 56°57'W, and in December, two were recorded at 50°00'S, 62°06'W.

Sei whale Balaenoptera borealis

There were eight records of 15 sei whales during surveys in January, March, April and November (Figure 83). Most records were in March, both to the west of the islands and off Berkeley Sound.

Humpback whale Megaptera novaeangliae

In December, two humpback whales were observed at 51°29'S, 57°33'W.

Unidentified beaked whales

There were three sightings of 14 unidentified beaked whales during surveys. These records were from two November surveys, both in deep waters to the south and east of the Falkland Islands. One of the records was of either southern bottlenose whale *Hyperoodon planifrons* or Arnoux's beaked whale *Berardius arnuxii* (five animals) at 53°00'S, 54°16'W. The other two records were of ziphiid whales—six animals were observed at 53°26'S, 54°35'W, and three animals at 54°18'S, 55°24'W.

These could be the first documented sightings of live beaked whales at sea in waters off the Falkland Islands (Strange 1992).

Killer whale Orcinus orca

There were two records of killer whales during surveys. In January, four animals were recorded at 48°09'S, 58°41'W, and in September, three animals were seen at 52°04'S, 58°14'W.

Long-finned pilot whale Globicephala melas

Between September and December long-finned pilot whales were recorded four times, giving a total of 77 animals. In September, 30 animals were seen at 48°40'S, 57°12'W; in November, ten animals were observed at 51°32'S, 57°21'W and two at 52°06'S, 61°47'W; while in December, there were 35 animals at 50°17'S, 55°00'W.

Southern right whale dolphin Lissodelphis peronii

In September, a group of 120 southern right whale dolphins was seen in company with long-finned pilot whales in deep waters to the north-east of the islands at 48°40'S, 57°12'W.

Southern elephant seal Mirounga leonina

Five southern elephant seals were recorded during our surveys. One was seen in January at 48°40'S, 57°12'W; one in April at 49°02'S, 60°40'W; one in October at 52°25'S, 50°32'W; and two single animals were observed in November at 51°04'S, 61°01'W and 51°30'S, 62°52'W.

6 Discussion and conclusions

This survey is the first of its kind in the waters of the Falkland Islands. The results depict for the first time a broad picture of the dispersion patterns of all seabird species and marine mammals encountered here. This study also represents the successful transfer of survey methods developed in the northern hemisphere to work in the southern hemisphere.

Care must be exercised in interpreting the results. The observations are based only on 12 months of observation, and there is considerable seasonal and geographical variation in survey effort within this period.

6.1 Seabird dispersion

High densities of a wide range of seabird species are supported by Falkland Islands waters, the size and species composition of this seabird community varying both seasonally and geographically. Broadly, the recorded patterns of seabird dispersion agree well with those that might have been predicted from the relatively few previous observations in this part of the South Atlantic Ocean (e.g. Bourne and Curtis 1985, Woods 1988). No species was recorded during the first year of surveys that had not previously been reported, although several species were found to be more common than might have been expected, and new information on the seasonal occurrence of others was revealed.

Before the present investigation, little information was available on the relative abundance of non-breeding visitors to the waters of the Falkland Islands. This is the first survey to quantify the relative abundance of species such as Cape petrel, Antarctic fulmar and the royal albatrosses. Before this survey, there had been only infrequent records of Magellan diving-petrels—a species whose status in the Falkland Islands is uncertain. During surveys, however, they were often observed throughout the survey area and were, on several occasions, recorded within partially enclosed inshore waters. The abundance of most other species matched the expected abundance based on the size of the Falkland Islands breeding population. For example, prions and black-browed albatrosses, the commonest breeding species, featured prominently among the most abundant species recorded on at-sea surveys. In contrast however, the imperial shag

The availability only of fishery patrol and oil-rig supply vessels may also introduce biases in survey coverage that must temper any conclusions made. Furthermore, how representative this 12-month period might be of the typical year in these waters is unknown—only continued study will allow comparisons of inter-annual variation in dispersion patterns. Nevertheless, it is possible to draw some tentative conclusions about the seasonal and spatial distribution and abundance of seabirds and marine mammals in the waters around the Falkland Islands.

was perhaps over-recorded in relation to the size of the breeding population in the Falkland Islands.

Based on previous information, rockhopper penguins were expected to be recorded in greater numbers during the austral summer than in the winter. Since rockhoppers are the commonest breeding penguin in the islands (Woods and Woods 1997), it might also have been expected that they would be the commonest species of penguin recorded during the summer. During the surveys rockhopper penguins were indeed recorded more frequently in the austral summer than the winter, but it was not the commonest species of penguin recorded in the summer—Magellanic penguins were found to be more common. It is not clear why this should be the case. Possibly the areas of highest rockhopper penguin densities were not surveyed, or perhaps rockhopper penguins are more difficult to detect at sea than Magellanic penguins.

The observed distributions of some species of seabird concurred with previous reports. For example, Thompson (1989) recorded imperial shags feeding farther offshore than rock shags, an observation confirmed by the results of the present survey. In contrast, several species were found to have unexpected distributions. For example, gentoo penguins were thought to remain inshore close to their colonies throughout the year. During surveys, however, gentoo penguins were found throughout the area of the shallower Patagonian Shelf waters around the Falkland Islands, and were frequently observed as far offshore as the extreme west of the survey area close to the border

with the Argentine EEZ. The observed seasonality of some species was also unexpected. For example, grey-backed storm-petrels were thought to be austral summer visitors to the waters of the Falkland Islands (Woods 1988), but they were recorded during surveys in all months, albeit in reduced numbers during the austral winter months. Bourne and Curtis (1985) described Kerguelen petrels as being widespread in all months, but in the present study they were recorded only between June and November. The little shearwater, thought to be a rare vagrant to Falkland Islands waters with only one recorded by Woods (1988), was recorded on five occasions during at-sea surveys, suggesting that the species occurs regularly in low numbers.

6.2 Marine mammal dispersion

The waters of the Falkland Islands supported a diverse range of marine mammal species.

A high diversity of cetacean species was recorded during at-sea surveys, the highest diversity occurring in deep water areas in the summer months. It is not clear how much of this apparent seasonality may be due to the increased survey coverage of deep-water areas in the summer months, and better sea conditions for detecting cetaceans.

The importance of the Falkland Islands for cetaceans cannot be readily quantified, largely due to a lack of information on population sizes and species distributions. However, the seas around the Falkland Islands are important for their populations of Peale's and Commerson's dolphins, both of which have a restricted world distribution. In addition, both species are threatened by exploitation in South America where both are caught and used as bait in crab pots (Jefferson *et al.* 1993). Peale's dolphin was the most frequently recorded cetacean in Falkland Islands waters, with all records

The results of at-sea surveys will allow for comparison between the distributions of a number of seabird species to be linked to oceanographic features. For example, Curtis (1994) recorded the preference of wandering albatrosses for deeper waters, and royal albatrosses for shallower Patagonian Shelf waters. This pattern has been confirmed by satellite tracking of these species (Nicholls *et al.* 1998) and also the present study: most royal albatross records are from the shallower Patagonian Shelf waters, while the wandering albatross was found to have a complementary distribution in the deeper continental shelf slope and deep oceanic waters.

coming from the shallower waters of the Patagonian Shelf. Commerson's dolphins were frequently recorded in inshore waters, particularly partially enclosed waters.

The complementary distribution of the three most commonly recorded dolphin species is notable. Commerson's dolphins are restricted to inshore waters, and were never observed out of sight of land. The distribution of Peale's dolphin is almost exclusively confined to the shallower waters of the Patagonian Shelf, and hourglass dolphins were found almost exclusively in waters deeper than 200 m. Clearly, the virtually non-overlapping distributions of these three species indicate a degree of habitat segregation which should ensure reduction in competition for food.

All species of pinniped recorded during at-sea surveys are known to breed in the Falkland Islands. Only the South American fur seal was found to be widespread and numerous at sea, with a concentration of animals near the 1,000-m isobath to the north of the islands.

6.3 Importance of sea areas

A number of sea areas around the islands support important concentrations of seabirds during part, or all, of the year.

Inshore waters were found to be important in all months, largely due to the dependence on them by resident populations of several seabird species, such as the Falkland steamer duck and imperial shag. The presence of penguins also enhances their importance, with gentoo and king penguins present year round and rockhopper and Magellanic penguins present during the breeding season.

The shallower waters of the Patagonian Shelf were also found to be important for seabirds throughout the year, but there was some seasonal and spatial variation in the distribution of the most important areas. The waters in

the vicinity of the 200-m isobath were generally found to be important throughout the year for species such as prions and storm-petrels. However, not all areas were of equal importance; the 200-m isobath to the south-east of the islands and around the Burdwood Bank was of least importance. The Patagonian Shelf to the north-west of the islands was important for a range of seabird species such as black-browed albatross and white-chinned petrel in late summer and winter—the same time of year as the large *Illex* squid fishery operates in this area.

The deeper continental shelf slope and oceanic waters around the Falkland Islands were generally of least importance for seabirds.

The vicinity of the hydrocarbon exploration licence blocks to the north of the islands encompasses both

Patagonian Shelf waters (to the south-west) and continental shelf slope waters (to the north-east). These areas occasionally supported moderate or high concentrations of several seabird species, such as great shearwater, rockhopper penguin and prions. However, the area did

not consistently support seabird concentrations as large as those found either in inshore waters or in Patagonian Shelf waters to the west of the Falkland Islands.

6.4 Vulnerability of Falkland Islands waters and seabirds to surface pollution

The genesis of the present study was prompted by the perceived threat of hydrocarbon exploration and potential production in the FICZ and FOCZ, and also in the Special Area of Co-operation. Assessing the vulnerability of sea areas in north-west Europe to the potential effects of surface pollution is aided by application of Oil and Area Vulnerability Indices (Williams *et al.* 1995). The Oil Vulnerability Index (OVI) is computed for all seabird species; it takes account of several factors that include the biogeographic population size of the species, reproductive rate, the amount of time spent in flight compared with on the sea surface, and others. Combined with known densities of each species, the OVIs for all species that occur in $\frac{1}{4}$ ICES rectangles are computed and summed to give an Area Vulnerability Score (AVS) for each rectangle in each month of the year. Conservation advice is offered to the hydrocarbon industry based on AVSs and atlases that depict their distribution (Carter *et al.* 1993, Webb *et al.* 1995).

As a model for the present study, this method will be applied to the waters around the Falkland Islands when sufficient data have been collected, although some modification might be necessary. For example, some Procellariiformes, which have a greater representation in the South Atlantic than in north-west European waters, may be at less risk from surface pollution than flightless seabirds, or those that spend a large proportion of their time on the sea surface, such as penguins or shags.

The species dispersion patterns identified in this study allow some preliminary conclusions to be drawn about the vulnerability of seabird concentrations and sea areas to potential contamination by surface pollutants. Those species that spend the greater proportion of their lives in contact with the sea surface, e.g. penguins, are most vulnerable to inimical effects of surface pollution, and therefore greatest attention is paid to concentrations of these species when discussing vulnerability.

The inshore waters of the Falkland Islands support highly vulnerable concentrations of internationally important seabird species throughout the year. The highest densities of several resident species for which the Falkland Islands are internationally important were found here. Many of these species are either flightless or spend much of their time on the surface of the sea and are vulnerable at any time of year:

- ◆ High densities of imperial shags were recorded around the coasts of the Falkland Islands. Imperial shags were rarely observed more than 20 km from the coast. The Falkland Islands support an endemic race of the imperial shag. Imperial shags spend much of their time on the sea surface and are one of the species that would be particularly vulnerable to the effects of surface pollution;
- ◆ Gentoo penguins were found in highest densities in inshore waters. The Falkland Islands support the second largest gentoo penguin population in the world. Gentoo penguins are flightless and would be particularly susceptible to the effects of surface pollution;
- ◆ The flightless steamer duck was found to be widespread around the coast throughout the year. Flightless steamer ducks were under-recorded due to a low level of survey effort in partially enclosed waters. This species is endemic to the Falkland Islands and is flightless, and therefore highly vulnerable to the effects of surface pollution.

The importance of the inshore waters of the Falkland Islands increases markedly during the breeding season (approximately October to March) when, in addition to the resident species listed above, several internationally important species visit the Falkland Islands to breed:

- ◆ southern rockhopper penguins were recorded at locally high densities in inshore waters between October and March. The Falkland Islands support most of the world population of the southern rockhopper penguin;
- ◆ Magellanic penguins were recorded at high densities in inshore waters between November and February. The Falkland Islands support an internationally important population of this species.

In addition to these species, large numbers of a wide range of other seabird species were recorded in inshore waters in all months, rendering the inshore waters of the Falkland Islands the most important habitat for seabirds in the survey area.

The offshore waters of the Patagonian Shelf support important concentrations of seabirds throughout the

year. However, in contrast to the inshore waters, many of these concentrations are not considered to be as highly vulnerable to the effects of surface pollution.

The Procellariiformes were widespread at high densities in offshore areas of the Patagonian Shelf. This group of birds has a highly developed olfactory sense. They are also primarily aerial species except, notably, the diving-petrels—they spend much more of their time on the surface of the sea and are poor flyers. Given their excellent sense of smell, the Procellariiformes are perhaps better equipped to avoid surface pollution than other families, and therefore may be less at risk from relatively localised surface pollution than other families of seabird.

Some of the highest concentrations of Procellariiformes were observed over the offshore waters of the Patagonian Shelf and where the Patagonian Shelf meets the continental shelf slope:

- ◆ black-browed albatrosses were recorded in greatest densities over the Patagonian Shelf to the north-west of the islands between March and June, and also to the west of the islands in the austral summer months where they were closer inshore. The Falkland Islands host most of the world population of black-browed albatross;
 - ◆ highest densities of prions were recorded over the Patagonian Shelf. High densities of these species were recorded between June and February near the 200-m isobath to the north-east, west and south-west of the islands and also off the north coast of West Falkland. The Falkland Islands support an internationally important population of thin-billed prion and, although most prions were not specifically identified, many of these birds would have been locally breeding thin-billed prions;
 - ◆ Southern royal albatrosses were recorded in high densities over the Patagonian Shelf to the north-west of the islands between March and June. In these months it is likely that a significant proportion of the world population of this species occurs in the survey area;
 - ◆ Magellanic and rockhopper penguins both migrate north-west over the Patagonian Shelf towards the coast of Argentina in autumn (Pütz *et al.* 1998) and return in spring. Such dispersal was not detected during our surveys, but the importance of the Patagonian Shelf in the north-west of the survey area at these times of year will be higher than in other seasons;
 - ◆ to the west and south-west of the islands, in addition to the very high densities of prions, high densities of diving-petrels and Wilson's storm-petrels were observed during the austral summer months, although no survey effort was achieved here at other times of the year. Highest densities were associated with the edge of the Patagonian Shelf near the 200-m isobath;
 - ◆ to the north-east of the islands, in addition to high densities of prions, high densities of Wilson's storm-petrel and grey-backed storm-petrel were observed in the austral summer months over the 200-m isobath. The Falkland Islands population of grey-backed storm-petrel is of international importance, and the species' habit of searching for prey in kelp patches could increase its vulnerability to the effects of surface pollution.
- The seabird communities found over the continental shelf slope, and in the oceanic areas, were mostly Procellariiformes, and were present to a greater extent than over the Patagonian Shelf waters. The numbers of seabirds recorded in these areas were generally very low, and there were very few high densities of seabirds recorded:
- ◆ the waters to the north-east of the Falkland Islands close to the 1,000-m isobath held relatively high numbers of great shearwater, soft-plumaged petrel and grey-backed storm-petrel between November and April. It is unlikely that these species were present in internationally important concentrations, and all are probably of low vulnerability to the effects of surface pollution;
 - ◆ several seabird species that were commonest in continental shelf slope and oceanic waters, only rarely ventured over the Patagonian Shelf or into inshore waters. Many of these species were not present at high densities, and have a low vulnerability to the impact of surface pollution, but the presence of wandering albatrosses, a species classified as Vulnerable (Croxall and Gales 1998) is noteworthy;
 - ◆ Magellanic penguins were recorded at locally high densities in the deep waters to the north of the islands between November and February. Rockhopper penguins could be encountered at locally high densities in deep waters anywhere in the survey area between October and March. Neither intermediate nor high densities of gentoo penguins were recorded in deep water areas.
- Several sea areas were host to consistently low seabird abundance:
- ◆ inshore waters to the south-east of East Falkland had relatively low numbers of seabirds compared with other inshore areas. Farther offshore to the south-east of the islands, the area near the 200-m isobath did not support high densities of prions and storm-petrels;
 - ◆ there was an area of consistently low seabird density approximately due north of Falkland Sound on the

Patagonian Shelf. This area rarely held high densities of any seabird species;

- ◆ the continental shelf slope and oceanic waters of the south-west Atlantic generally supported low densities of seabirds compared with the Patagonian Shelf and inshore waters of the Falkland Islands;
- ◆ the shallower waters of the Burdwood Bank, and the continental shelf slope and oceanic waters around the Burdwood Bank, typically supported very few seabirds.

The licence blocks to the north of the islands were found to have moderate to low concentrations of seabirds throughout the year. Locally high concentrations of prions, storm-petrels and great shearwaters were recorded during the austral summer, particularly near the 200-m isobath. Locally high densities of Magellanic and rockhopper penguins were also recorded in the licence blocks during the austral summer months. During the austral winter, there were few notable concentrations of seabirds in the area, but it was important for king penguins at this time.

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Appendix I

Scientific names of species mentioned in text

English and scientific names of birds

English	Scientific
King penguin	<i>Aptenodytes patagonicus</i>
Gentoo penguin	<i>Pygoscelis papua</i>
Rockhopper penguin	<i>Eudyptes chrysocome</i>
Macaroni penguin	<i>E. chrysolophus</i>
Magellanic penguin	<i>Spheniscus magellanicus</i>
Wandering albatross spp.	<i>Diomedea exulans</i> spp.
Southern royal albatross	<i>D. epomophora</i>
Northern royal albatross	<i>D. sanfordi</i>
Black-browed albatross	<i>Thalassarche melanophris</i>
Shy albatross spp.	<i>T. cauta</i> spp.
Salvin's albatross	<i>T. salvini</i>
Grey-headed albatross	<i>T. chrysostoma</i>
Sooty albatross	<i>Phoebastria fusca</i>
Light-mantled albatross	<i>P. palpebrata</i>
Southern giant petrel	<i>Macronectes giganteus</i>
Northern giant petrel	<i>M. halli</i>
Antarctic petrel	<i>Thalassoica antarctica</i>
Cape petrel	<i>Daption capense</i>
Antarctic fulmar	<i>Fulmarus glacialisoides</i>
Blue petrel	<i>Halobaena caerulea</i>
Broad-billed prion	<i>Pachyptila vittata</i>
Antarctic prion	<i>P. desolata</i>
Fairy prion	<i>P. turtur</i>
Thin-billed prion	<i>P. belcheri</i>
Kerguelen petrel	<i>Pterodroma brevirostris</i>
Soft-plumaged petrel	<i>P. mollis</i>
White-headed petrel	<i>P. lessonii</i>
Atlantic petrel	<i>P. incerta</i>

English	Scientific
Grey petrel	<i>Procellaria cinerea</i>
White-chinned petrel	<i>P. aequinoctialis</i>
Great shearwater	<i>Puffinus gravis</i>
Sooty shearwater	<i>P. griseus</i>
Manx shearwater	<i>P. puffinus</i>
Little shearwater	<i>P. assimilis</i>
Wilson's storm-petrel	<i>Oceanites oceanicus</i>
Black-bellied storm-petrel	<i>Fregatta tropica</i>
White-bellied storm-petrel	<i>F. grallaria</i>
Grey-backed storm-petrel	<i>Garrodia nereis</i>
Georgian diving-petrel	<i>Pelecanoides georgicus</i>
Common diving-petrel	<i>P. winatrix</i>
Magellan diving-petrel	<i>P. magellani</i>
Imperial shag	<i>Phalacrocorax atriceps</i>
Rock shag	<i>P. magellanicus</i>
Red-legged shag	<i>P. gaimardi</i>
Falkland steamer duck	<i>Tachyeres brachydactyla</i>
Grey phalarope	<i>Phalaropus fulicarius</i>
Antarctic skua	<i>Catharacta antarctica</i>
Chilean skua	<i>C. chilensis</i>
Arctic skua	<i>Stercorarius parasiticus</i>
Long-tailed skua	<i>S. longicaudus</i>
Brown-hooded gull	<i>Larus maculipennis</i>
Kelp gull	<i>L. dominicanus</i>
Dolphin gull	<i>L. scoresbii</i>
Arctic Tern	<i>Sterna paradisaea</i>
South American tern	<i>S. hirundinacea</i>

English and scientific names of marine mammals

<i>English</i>	<i>Scientific</i>
Southern right whale	<i>Eubalaena australis</i>
Fin whale	<i>Balaenoptera physalus</i>
Sei whale	<i>B. borealis</i>
Minke whale	<i>B. acutorostrata</i>
Humpback whale	<i>Megaptera novaeangliae</i>
Sperm whale	<i>Physeter macrocephalus</i>
Arnoux's beaked whale	<i>Berardius arnuxii</i>
Southern bottlenose whale	<i>Hyperoodon planifrons</i>
Killer whale	<i>Orcinus orca</i>

<i>English</i>	<i>Scientific</i>
Long-finned pilot whale	<i>Globicephala melas</i>
Hourglass dolphin	<i>Lagenorhynchus cruciger</i>
Peale's dolphin	<i>L. australis</i>
Southern rightwhale dolphin	<i>Lissodelphis peronii</i>
Commerson's dolphin	<i>Cephalorhynchus commersonii</i>
South American sea-lion	<i>Otaria byronia</i>
South American fur seal	<i>Arctocephalus australis</i>
Southern elephant seal	<i>Mirounga leonina</i>
Leopard seal	<i>Hydrurga leptonyx</i>

English and scientific names of fish

<i>English</i>	<i>Scientific</i>
Southern blue whiting	<i>Micromesistius australis</i>
Hake spp.	<i>Merluccius</i> spp.
Patagonian toothfish	<i>Dissostichus eleginoides</i>
Hoki	<i>Macruronus magellanicus</i>
Kingclip	<i>Genypterus blacodes</i>
Red cod	<i>Salilota australis</i>
Skate	<i>Bathyraja</i> spp. and <i>Raja</i> spp.

English and scientific names of marine invertebrates

<i>English</i>	<i>Scientific</i>
Goose-barnacle	<i>Lepas australis</i>
Argentine shortfin squid	<i>Illex argentinus</i>
Patagonian squid	<i>Loligo gahi</i>

Joint Nature Conservation Committee

SEABIRDS AT SEA TEAM RECORD SHEET

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Appendix III

List of survey cruises, February 1998–January 1999

<i>Vessel</i>	<i>Dates</i>	<i>Effort in survey area (km²)</i>
MV <i>Cordella</i>	06.02–17.02.98	321
MV <i>L'Espoir</i>	21.02–04.03.98	67
MV <i>Cordella</i>	20.03–01.03.98	420
MV <i>Dorada</i>	12.04–22.04.98	401
MV <i>Mærsk Mariner</i>	30.04–02.05.98	20
MV <i>Dorada</i>	10.05–13.05.98	60
MV <i>Criscilla</i>	14.05–25.05.98	359
MV <i>Criscilla</i>	02.06–09.06.98	196
MV <i>Mærsk Mariner</i>	10.06–12.06.98	25
MV <i>Criscilla</i>	10.06–23.06.98	292
MV <i>Dorada</i>	22.06–04.07.98	301
MV <i>Criscilla</i>	24.06–07.07.98	205
MV <i>Dorada</i>	05.07–15.07.98	146
MV <i>Criscilla</i>	08.07–21.07.98	225
MV <i>Dorada</i>	19.07–01.08.98	164
MV <i>Mærsk Puncher</i>	22.07–24.07.98	34
MV <i>Mærsk Mariner</i>	25.07–27.07.98	29
MV <i>Dorada</i>	03.08–15.08.98	484
MV <i>Criscilla</i>	19.08–01.09.98	359
MV <i>Mærsk Puncher</i>	26.08–29.08.98	38
MV <i>Dorada</i>	30.08–11.09.98	313
MV <i>Criscilla</i>	02.09–15.09.98	218
MV <i>Criscilla</i>	16.09–29.09.98	465
MV <i>Dorada</i>	27.09–11.10.98	380
MV <i>Criscilla</i>	15.10–27.10.98	296
MV <i>Mærsk Puncher</i>	19.10–21.10.98	59
MV <i>Criscilla</i>	28.10–10.11.98	453
MV <i>Dorada</i>	28.10–08.11.98	112
MV <i>Criscilla</i>	11.11–24.11.98	451
MV <i>Dorada</i>	11.11–21.11.98	434
MV <i>Dorada</i>	22.11–05.12.98	423
MV <i>Criscilla</i>	09.12–23.12.98	598
MV <i>Dorada</i>	27.12.98–09.01.99	872
MV <i>Dorada</i>	10.01–15.01.99	312
MV <i>Criscilla</i>	20.01–02.02.99	441

The Joint Nature Conservation Committee is the forum through which the three country nature conservation agencies – the Countryside Council for Wales (CCW), English Nature (EN), and Scottish Natural Heritage (SNH) – deliver their statutory responsibilities for Great Britain as a whole and internationally. These responsibilities, known as the special functions, contribute to sustaining and enriching biological diversity, enhancing geological features and sustaining natural systems. The special functions are principally;

- to advise ministers on the development of policies for, or affecting nature conservation in Great Britain and internationally;
- to provide advice and knowledge to anyone on nature conservation issues affecting Great Britain and internationally;
- to establish common standards throughout Great Britain for the monitoring of nature conservation and for research into nature conservation and the analysis of the results;
- to commission or support research which the Committee deems relevant to the special functions.

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