



# Falkland Islands Seabird Monitoring Programme

## Annual Report 2016/2017 (SMP24)

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## Summary

The Falkland Islands support seabird populations that are of global importance; both numerically, and in terms of conservation status. Accordingly, fluctuations in local populations may substantially affect the global conservation status of these species.

Falkland Islands Seabird Monitoring Programme (FISMP) monitors Gentoo Penguin (*Pygoscelis papua*) at 11 sites (16 colonies), Magellanic Penguin (*Spheniscus magellanicus*) at one site (one colony), and Southern Rockhopper Penguin (*Eudyptes c. chrysocome*) at five sites (13 colonies). Imperial Shag (*Phalacrocorax atriceps*) is monitored at three sites. King Penguin (*Aptenodytes patagonicus*) and Black-browed Albatross (*Thalassarche melanophris*) are monitored at single, but key, sites, in terms of population numbers. Southern Giant Petrel (*Macronectes giganteus*) is monitored at one site (three colonies) and Brown Skua (*Catharacta antarctica*) at one site (four colonies).

**Overall** the 2016/17 FISMP detected notable decreases in overall breeding pair numbers of Gentoo Penguin, Southern Rockhopper Penguin and Black-browed Albatross at nearly all the monitoring sites. The only notable increase in breeding pair numbers during 2016 was at one Southern Giant Petrel site. Numbers of pre-fledged King Penguin chicks at Volunteer Point decreased significantly compared with 2014. Mixed breeding success was reported across species and locations but on the whole was below yearly averages. A number of factors may have influenced the decreases in breeding numbers between 2015 and 2016, including deferred (abstained) breeding in adult birds and adult mortality (particularly in Southern Rockhopper Penguin). FISMP monitoring in and after 2017/18 will be critical to understanding better the nature and longevity of the recent decreases across the monitored species and sites.

**Gentoo Penguin** pair numbers at monitored sites decreased significantly in 2016 with a reduction of 35 % or 10,518 pairs overall from 2015. All sites, excluding Steeple Jason, showed a downward turn in breeding pair numbers, with the largest reduction in terms of numbers at Sea Lion Island accounting for 2,445 pairs. Overall breeding success remained well below the yearly average with the lowest value recorded in the last 14 years. The breeding success regional trends shows substantial temporal variations; however at Steeple Jason a continuing decreasing trend is apparent.

**Southern Rockhopper Penguin** pair numbers at monitored sites decreased significantly in 2016 with an overall decline of 31 % or 2,142 pairs from 2015. All sites showed decreases in breeding pair numbers with a range from 77 % at Fanning Head to 10 % at Steeple Jason North-west colony. The largest reductions in terms of breeding pair numbers were at Stephen's Peak and Fanning Head colonies, with an estimated reduction of 1,252 pairs and 1,184 pairs, respectively. At Fanning Head and Stephen's Peak breeding pair numbers were the lowest recorded by FISMP (i.e. since 1997 and 2010 respectively). As expected, breeding success in 2016 was highly variable between locations. The overall breeding success in 2016 remained below the yearly average.

**Macaroni Penguin** (*Eudyptes chrysolophus*) and Southern Rockhopper Penguin pairs were observed at Berkeley Sound and Sea Lion Island.

**Magellanic Penguins** at Gypsy Cove remained broadly in three groupings, which appear to be associated with the extent of tussock habitat at the monitoring site. In 2016 the occupancy rate of 43.9 % was above the yearly average and a similar value to 2015.

**King Penguin** numbers of pre-fledged chicks at Volunteer Point was reduced by 47 % from 2014 (no count was obtained during 2015). The long-term monitoring at the site shows periodic fluctuations with an overall upward trend.

**Black-browed Albatross** reductions in breeding pair numbers were evident at all the monitored sites with an overall decrease of 31 % from 2015. Despite annual fluctuations, the overall trend since 2005 suggests a stable population. Breeding success at Steeple Jason fell from 2015 taking it to below the yearly average and the third lowest figure observed over the course of the monitoring period.

**Southern Giant Petrel** numbers at Steeple Jason increased by 31 % but still remained below the count for 2014. Breeding success at both the Neck and Northwest colonies was lower than 2015, and was close to near-failure at the Northwest colony with only a 4 % success rate. Numbers of chicks counted at Bleaker Island fell by 10 %, the second year in succession of reductions at this location. Six nests were recorded at the Northwest Albatross colony, Steeple Jason, and four at Lagoon Sands Gentoo colony; none were successful.

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## Introduction

The Falkland Islands support seabird populations that are of global importance, both numerically, and in terms of conservation status. An estimated 72 % of the global population of Black-browed Albatross (*Thalassarche melanophris*) breeds in the Falkland Islands (ACAP 2010, BirdLife International 2016). This species is currently listed as 'Near Threatened' on the IUCN Red List. The Falklands are also home to approximately 36 % of the world's population of Southern Rockhopper Penguin (*Eudyptes c. chrysocome*) (Red Listed as 'Vulnerable') and approximately 34 % of the world's population of Gentoo Penguin (*Pygoscelis papua*). The Gentoo Penguin was recently down listed from 'Near Threatened' on the IUCN Red List to Least Concern (IUCN 2017). Accordingly, fluctuations in local populations may substantially affect the global conservation status of these species.

Falklands Conservation initiated the Falkland Islands Seabird Monitoring Programme (FISMP) in 1989/90. Its initial purpose was to monitor the diet and population dynamics of Gentoo Penguin, Magellanic Penguin (*Spheniscus magellanicus*), Southern Rockhopper Penguin, and Black-browed Albatross. Diet sampling was discontinued in 2003. Since then, population monitoring has continued on an annual basis with some changes taking place to the original format, such as the addition and loss of some monitoring sites and the addition of other species.

Currently the FISMP monitors Gentoo Penguin at 11 sites (16 colonies), Magellanic Penguin at one site (one colony), and Southern Rockhopper Penguin at five sites (13 colonies). King Penguin (*Ap-tenodytes patagonicus*) and Black-browed Albatross are monitored at single, but key, sites in terms of population numbers. Since 2006, Southern Giant Petrel (*Macronectes giganteus*) has been monitored at one site (three colonies). Monitoring of Imperial Shag (*Phalacrocorax atriceps*) has three sites and more recently Brown Skua (*Catharacta antarctica*) at one site.

In 2010, monitored colonies made up approximately 18 % of the Falklands' breeding population of Gentoo Penguin (estimated at 132,000 breeding pairs) (Baylis et al. 2013a), approximately 2.6 % of the Falklands' breeding population of Southern Rockhopper Penguin (estimated to be 319,000 breeding pairs) (Baylis et al. 2013b) and approximately 0.5 % – 0.6 % of the total Falklands' breeding population of Black-browed Albatross (estimated to be between 475,500 and 535,000 breeding pairs) (Wolfaardt 2012). Based on 2015/16 figures (the last Island-wide census for Southern Giant Petrel), the monitoring site for Southern Giant Petrel made up approximately 8.6 %

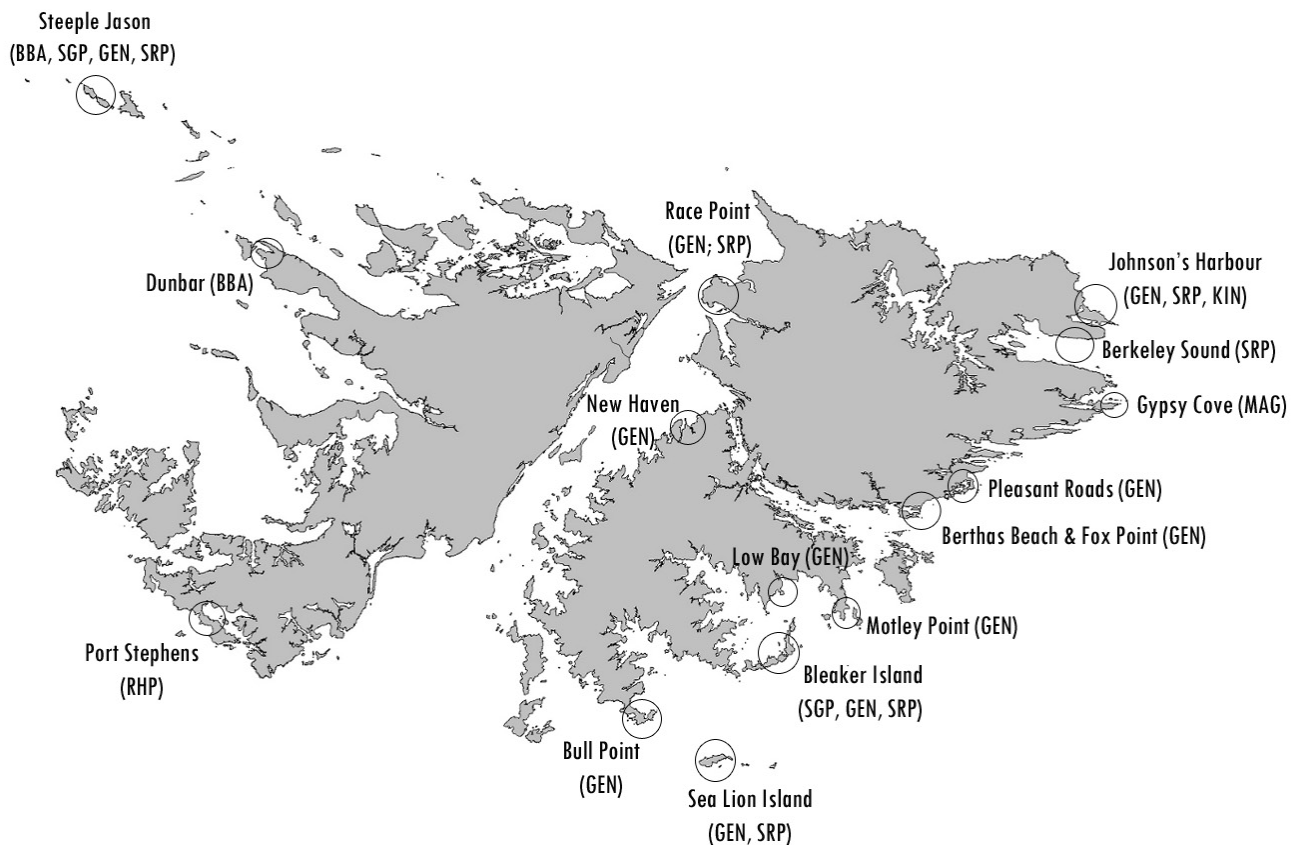
of the total Falklands' breeding population (Stanworth & Crofts 2017). The only population estimate for Magellanic Penguin in the Falkland Islands is for 76,000 to 142,000 pairs (Woods & Woods 1997). As a very rough estimate, the current monitoring site is likely to represent less than one percent of this. There are no other significant King Penguin colonies within the Falkland Islands and the small numbers of individuals at other locations are not systematically monitored. The current monitoring site is likely to represent over 95 % of the breeding population.

The information gathered as a result of the FISMP has contributed to the identification of local, regional and global conservation priorities and provides information necessary for IUCN Red Listing assessments. The FISMP provides an important long-term data set on population trends and breeding success, which further contributes to other areas of research.

This report details monitoring results from the 2016/2017 breeding season as well as contributed current and historic data collected by landowners at Dunbar and Bleaker Island settlements.

## Materials and methods

Within this report, breeding seasons are referred to by the year in which they commenced, for example; 2016 describes the 2016/2017 austral summer breeding season. 'Location' or 'site' refers to a named geographical area, such as a settlement or 'camp', and this may support more than one colony. For example, Johnson Harbour has Gentoo Penguin colonies at Volunteer Green, Lagoon Sands and at Cow Bay; Race Point has Gentoo Penguin colonies at Rookery Sands and Fanning Harbour. 'Colony' refers to a group or groups (sub-colonies) of birds in close proximity, typically within 50-100 m of each other and/or with the same or proximate access from the sea. Monitoring locations are shown in **Figure 1**, exact grid references are provided in **Appendices 2 to 5**.



**Figure 1:** Map of FISMP monitoring locations.

In addition to those counts undertaken by Falklands Conservation (below), counts have also been undertaken at Dunbar (Black-browed Albatross) and Bleaker Island (Southern Giant Petrel, Southern Rockhopper and Gentoo Penguin) by the landowners. Any variation from the standard methodology is reported in the text.



## **Gentoo Penguin**

Breeding pairs of Gentoo Penguins were counted during egg-laying, over the period 3-23 November 2016. The number of chicks was counted soon before fledging, during the period 5-18 January 2017, and used to estimate breeding success. The monitoring locations (colonies in brackets if more than one) were:

- Johnson Harbour (Volunteer Green, Cow Bay and Lagoon Sands);
- Race Point (Fanning Harbour and Rookery Sands);
- Sea Lion Island;
- New Haven;
- Bull Point (Bull Point and Bull Roads);
- Motley Point;
- Low Bay;
- Bertha's Beach;
- Fox Point;
- Pleasant Roads; and
- Steeple Jason (House and Neck).

## **Southern Rockhopper Penguin**

Southern Rockhopper Penguin breeding pair counts were performed from the commencement of egg-laying during the period 3 to 27 November 2016. Chick counts were carried out between 5 and 20 January 2017. The locations (colonies in brackets if more than one) were:

- Steeple Jason (Northwest Flat, Northwest Ridge, S5Tip and Southeast);
- Sea Lion Island (Rockhopper Point);
- Race Point (Fanning Head North and Fanning Head South);
- Berkeley Sound (Diamond Cove, Rugged Hill and Eagle Hill); and
- Port Stephens (Stephen's Peak).

## **Magellanic Penguin**

Transects were carried out every 100 m (approximately) from Engineer Point to the Car Park at Gypsy Cove on 10 December 2016. Transects were 4 m wide, starting from the shore line, and running perpendicular to it, for a distance 40 m further than the last burrow found. Using a pole

with torch attached, burrows within the transect were categorised as either 'occupied', 'unoccupied' or 'unknown', if it was not possible to determine occupancy. Burrow density was derived from each transect as number of burrows in the transect area from the start of the transect to as far as the last recorded burrow.

### **King Penguin**

The only significant population of King Penguins within the Falkland Islands is found at Volunteer Point. This population has been monitored annually since the onset of the FISMP, with the first independent counts having been performed earlier, since 1980. A few individuals also breed at nearby Lagoon Sands. The breeding cycle of King Penguins extends over a year and consequently is not synchronised to summer breeding as with the other penguin species. The chosen unit of measure for King Penguin is pre-fledged chicks that have survived the winter. This is not a measure of the total number of chicks produced (as some will have perished over the winter), nor is it an exact indicator of the number of breeding pairs. The counts were conducted on the 21 November 2016.

### **Imperial Shag**

Counts of Imperial Shag were conducted at Motley Point (16 November 2016 and 17 January 2017), Berkeley Sound (5 January 2017) and Steeple Jason (18 January 2017). Due to the variable breeding times of Imperial Shag, numbers derived represent potential, rather than actual, breeding pairs.

### **Brown Skua**

Counts of Apparently Occupied Territory (AOT) were conducted at Steeple Jason between 16 and 20 January 2017. Due to the restricted monitoring window at Steeple Jason AOTs were classified by a territory with egg/s and or chick/s observed or an adult sitting tightly on a nest and assumed to be incubating/brooding. All territories were recorded with a GPS position.

### **Black-browed Albatross and Southern Giant Petrel**

Counts of Black-browed Albatross and Southern Giant Petrel breeding pairs at Steeple Jason were performed between 3 and 8 November 2016, and in order to estimate breeding success, chicks from these colonies were counted between 13 and 15 March 2017. Three colonies of Southern Giant Petrel and five sub-colonies (distinct nodes from the main colony, or groups of breeding birds that are discrete from the main colony) of Black-browed Albatross are monitored.

Counts of Black-browed Albatross breeding pairs were made at Penguin Point South in November 2016 and of chicks in February 2017 by the landowner. Counts were made at Bleaker Island by the landowner for Gentoo Penguin (13 November 2016), Southern Rockhopper Penguin (24 November 2016) and Southern Giant Petrel chicks on 13 and 26 March 2017.

## **Count methods**

Whenever possible the total counts were made of all breeding pairs/chicks at individual locations, whilst in the field, by paired observers (**Appendix 1**). The count units for estimated breeding pairs and estimated breeding success were 'apparently occupied nest' and 'pre-fledged chick', respectively. The decision to utilise photo counting was made on an individual colony/sub-colony basis, where it was felt that a paired tally count in the field would not provide a reliable estimate. This was generally due to the size of some colonies (e.g. Steeple Jason Neck). In some instances, for chick counting, large numbers of highly mobile chicks had merged sub-colonies over large areas. Here again, it was felt, that reliable estimates could not be derived and the decision was made to count the other sub-colonies that had remained distinct. These counts still related to individual breeding pair numbers from the counts earlier in the season, and from this breeding success could be derived; in essence a sub-sampling technique. The various methods, or combination of methods, employed for each location/colony are presented in **Appendices 2 to 5**.

Grid references of individual colonies (due south of the approximate centres, 5m from the colony edge) were taken where possible and are provided in **Appendices 2 to 5**.

## **Field counts**

Whenever possible, the number of 'apparently occupied nests' and 'pre-fledged chicks' were counted at least three times by two or more observers using tally counters in accordance with standard methods (Thompson & Riddy 1993). These counts (and those few of reduced replication) were subsequently averaged to give estimates of breeding pair and chick numbers. These counts are referred to as 'Tally repeated'. Counts at Penguin Point South, Dunbar and Bleaker Island were single counts by a single observer. In some instances, groups or count unit numbers were so small that it was felt the number of count units could confidently be counted without error on a single occasion. These counts are referred to as 'Tally agreed'. Breeding success is expressed on graphs as the number of chicks per breeding pair for species with two or more chicks and as a percentage for

those with one chick.

### **Photo counts**

The majority of photographs were taken using a GoPro HD Hero. The camera was pole mounted and held aloft from a vantage point to a height of approximately 5 m whilst a minimum of three photos were taken in 1920x1080 resolution in jpeg format giving a 127° field of view. Where colonies were too large to fit into a single photograph, markers or natural features were used to subdivide the colonies into sections that could be photographed. There was no evidence of disturbance in the colonies from using this technique. A number of other photos were taken using digital SLR cameras using the highest possible resolution images.

Photographs were down-loaded and counted using ImageJ software. Counts were repeated a minimum of three times and the average taken. These are referred to in Tables as 'Photo counts'.

### **Drone counts**

DJI Phantom 3 & 4 drones were trialled in 2016 to capture aerial images of colonies under FIG Research Licence No: R13/2016. All operations were conducted at a minimum launch distance of 15 m from a colony and reaching a minimum flying altitude of 15 m when directly over colonies. Greater caution was used when operating the drone at Southern Giant Petrel or around other flying seabird colonies. Drone use is prohibited by the landowner at Volunteer Point and therefore were not used at this site. The inbuilt camera produces 4000x3000 resolution jpeg format images giving a 94° field of view. There was evidence that birds were aware of the drone but no evidence to suggest disturbance of breeding birds in the colonies using this method (Crofts 2017).

Photographs were down-loaded and counted using ImageJ software. Counts were repeated a minimum of three times and the average taken. These are referred to in Tables as 'Drone counts'.

### **Comparativeness of differing counting methods**

Multiple count data for the same colony using two or more of the methods were stored for future comparative work. For the purpose of this report, where multiple counting methods exist for the same colony the data were used in order of 1) Tally counts, 2) Photo counts, 3) Drone counts.

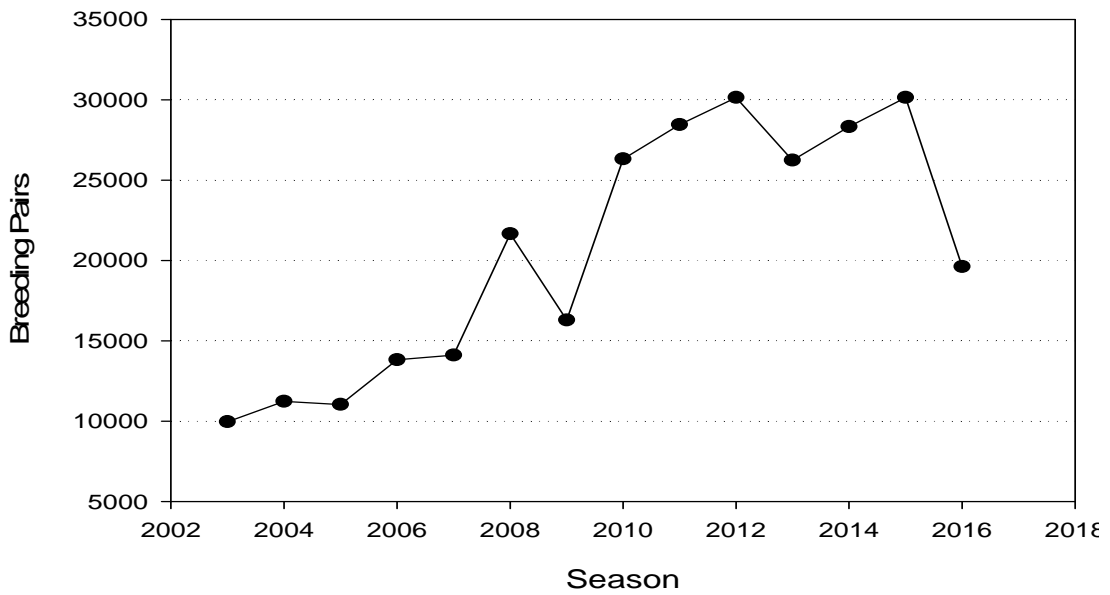
Where possible the same counting method was used to calculate breeding success for each colony.

# Results

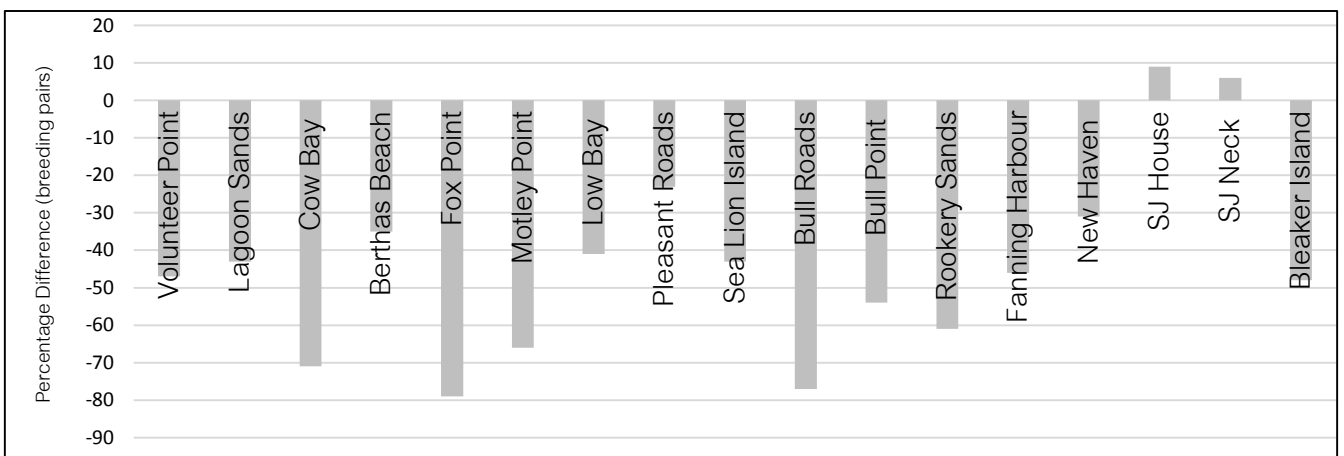
## Gentoo Penguin

### Breeding pairs

There is a complete data set for the current annually monitored locations (excluding Pleasant Roads) for the last 13 years. The combined total of estimated breeding pairs for all these locations is shown in **Figure 2**. At these monitored sites, the estimated total number of pairs decreased significantly from 30,139 in 2015 to 19,621 in 2016; a decline of 35 % or 10,518 pairs overall.



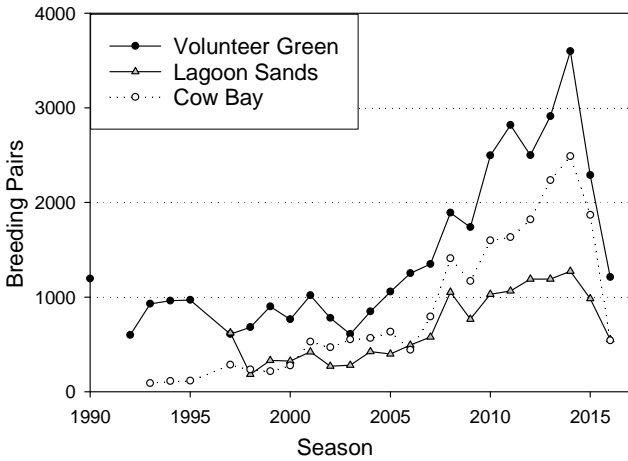
**Figure 2:** Gentoo Penguin breeding pairs at FISMP locations, 2003–2016.



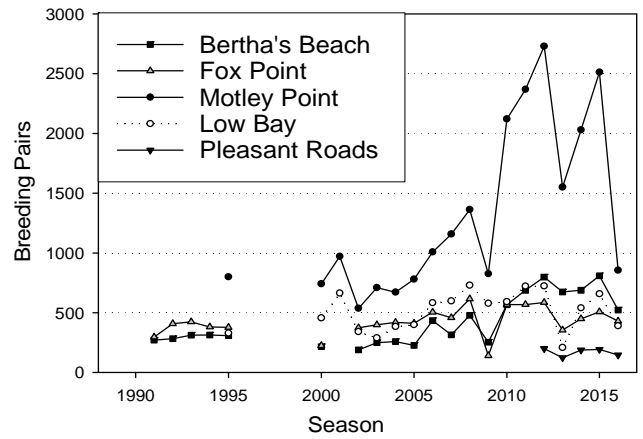
**Figure 3:** Percentage change of Gentoo Penguin breeding pair numbers between 2015 and 2016 at individual FISMP locations.

Number of Gentoo Penguin breeding pairs decreased at 15 of the 17 FISMP colonies between 2015 and 2016 (**Figures 3**). The only Gentoo Penguin colonies to show increases were at Steeple Jason

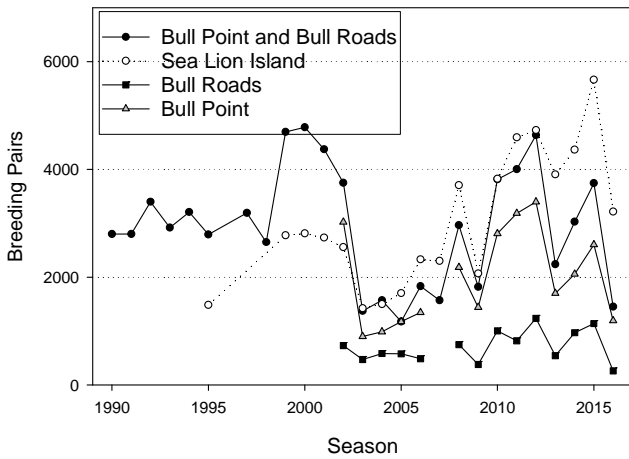
House and Neck colonies of 9 % and 6 % respectively.



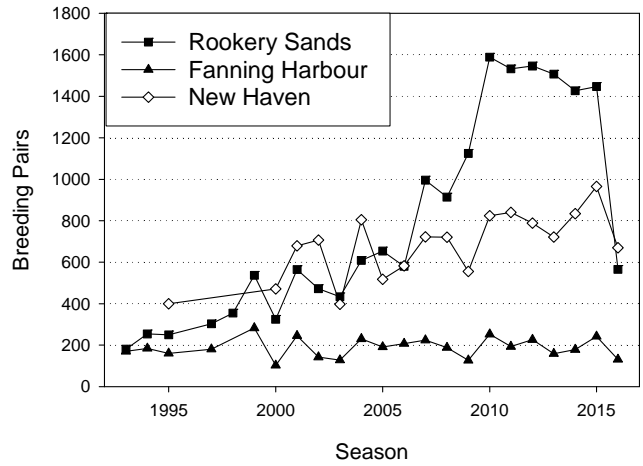
**Figure 4:** Gentoo Penguin breeding pairs for locations in Northeast Falkland.



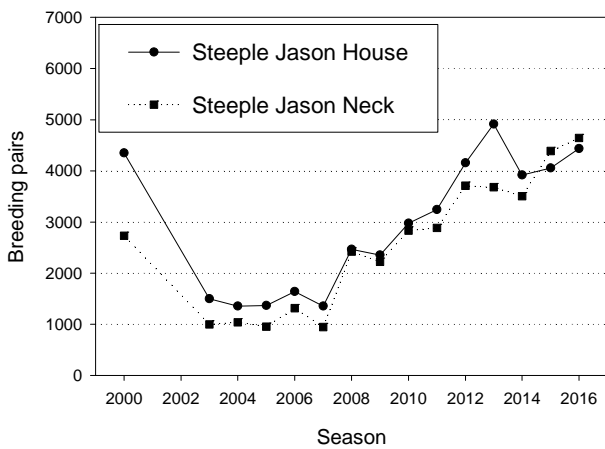
**Figure 5:** Gentoo Penguin breeding pairs for locations in Mideast Falkland.



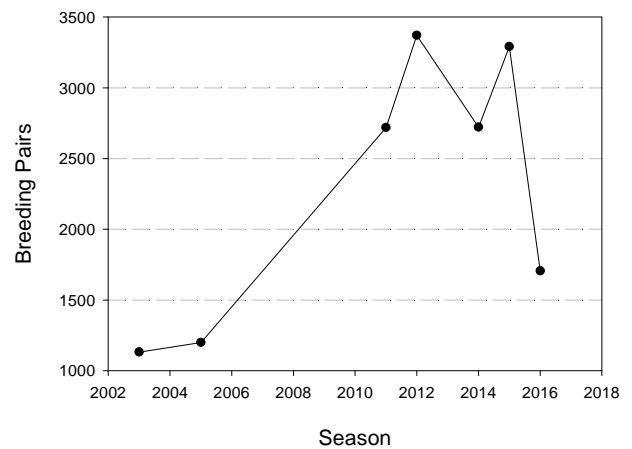
**Figure 6:** Gentoo Penguin breeding pairs for locations in Southeast Falkland.



**Figure 7:** Gentoo Penguin breeding pairs for locations on Falkland Sound.



**Figure 8:** Gentoo Penguin breeding pairs for locations on Steeple.



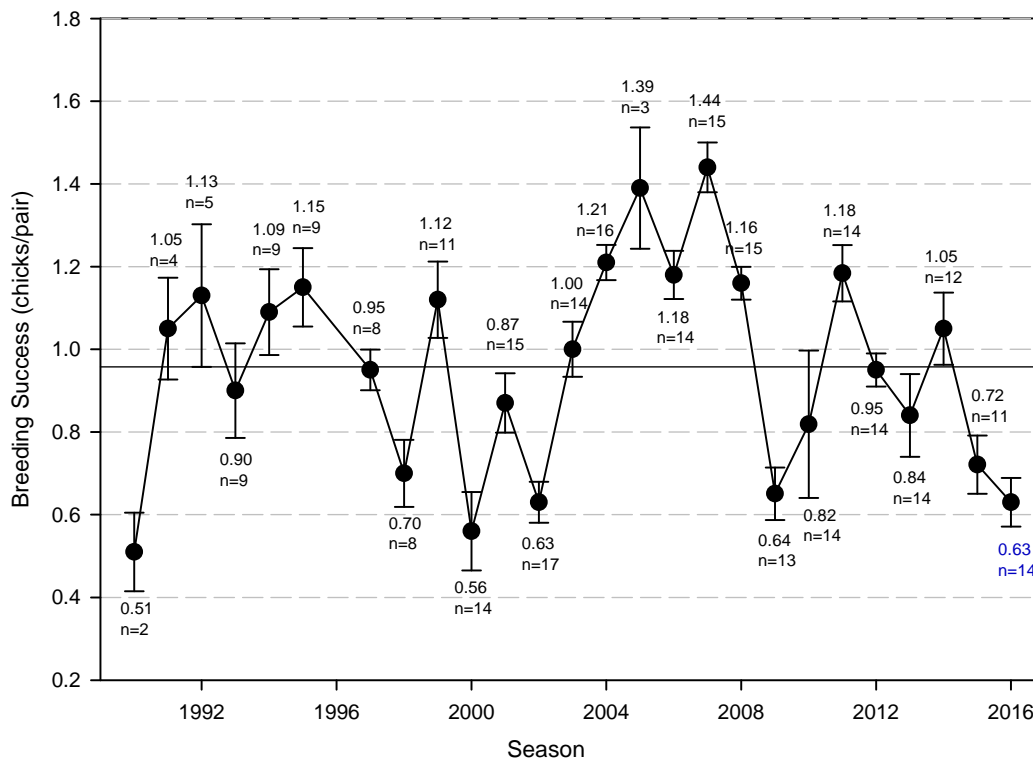
**Figure 9:** Gentoo Penguin breeding pairs for Bleaker Island.

All Gentoo Penguin colonies in the Northeast region showed decreased numbers of breeding pairs from 2015, with the largest decrease at Cow Bay (71 %), followed by Volunteer Green (47 %) and Lagoon Sands (44 %) (**Figure 4**). The largest decreases at colonies in the Mideast region were seen at Fox Point (79 %), followed by Motley Point (66 %), Low Bay (41 %) and Pleasant Roads (23 %) (**Figure 5**). Colonies at the Southeast (Sea Lion Island, Bull Point, Bull Roads and Bleaker Island) also showed marked decreases ranging from 77 % at Bull Roads to 43 % at Sea Lion Island (**Figure 6**). Similarly, at colonies in the Falkland Sound region decreases were also evident from Rookery Sands (61 %) to New Haven (31 %) (**Figure 7**).

The largest reductions in terms of numbers of breeding pair were seen at Sea Lion Island (2,445 pairs), Motley Point (1,658 pairs), Bleaker Island (1,585 pairs) and Bull Point (1,413 pairs).

### **Breeding success**

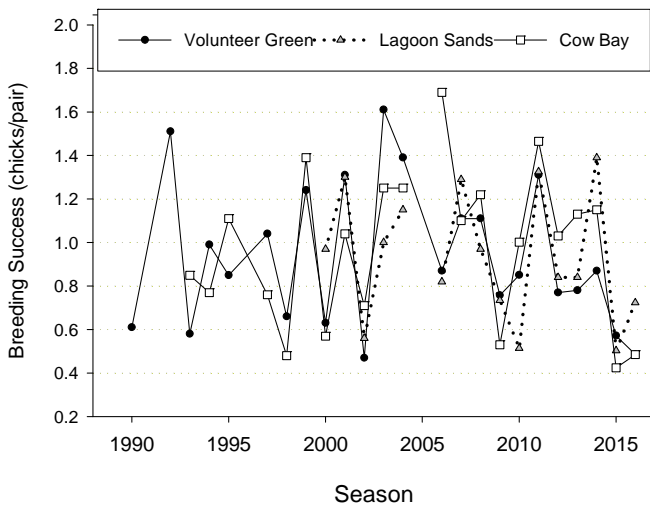
Average estimated breeding success fell from  $0.72 \pm 0.23$  chicks/pair in 2015 to  $0.63 \pm 0.22$  chicks/pair in 2016. This year's figure is well below the FISMP annual average for this species and the lowest value reached over the last 14 years (**Figure 10**).



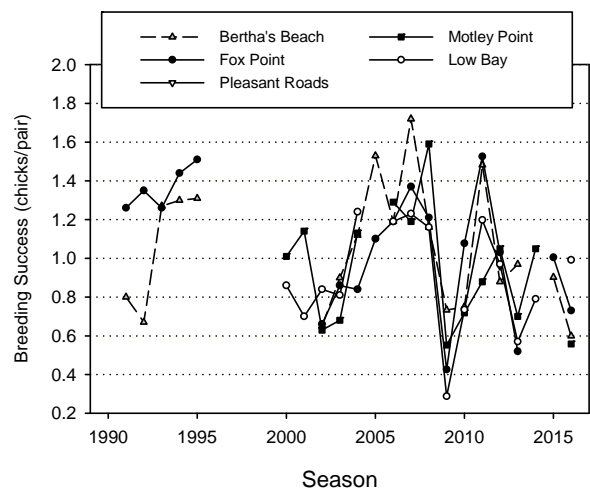
**Figure 10:** Gentoo Penguin breeding success at FISMP locations, 1990-2016.

(Solid line – annual average). Standard Error bars show error about the overall mean by site means, and do not incorporate error about individual sites.

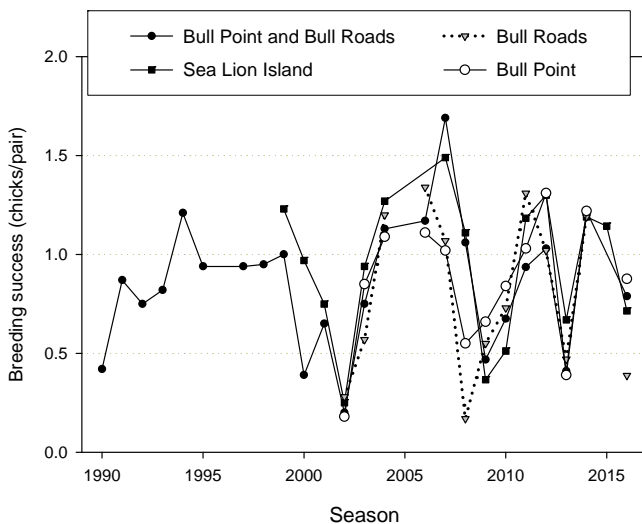
The range of breeding success between locations ( $n=14$ ) varied from a minimum of  $0.26 \pm 0.03$  chicks/pair at Rookery Sands to a maximum of  $1.02 \pm 0.02$  chicks/pair at New Haven (Figures 11 to 15). Of the colonies with chick counts obtained for both the 2015 and 2016 ( $n=12$ ) seven showed a decrease in breeding success (Volunteer Green, Rookery Sands, Fanning Harbour, Sea Lion Island, Berthas Beach, Fox Point, Pleasant Roads). The largest decreases were at Rookery Sands (71 %) and Fanning Harbour (50 %). Colonies showing increased breeding success ( $n=5$ ) ranged from 14 % at Cow Bay to 38 % at New Haven. Breeding success at Steeple Jason colonies remained similar to 2015 values.



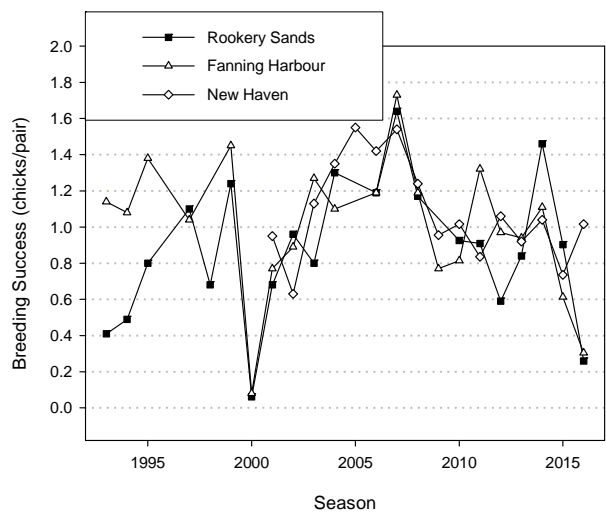
**Figure 11:** Gentoo Penguin breeding success for locations in Northeast Falkland.



**Figure 12:** Gentoo Penguin breeding success for locations in Mideast Falkland.

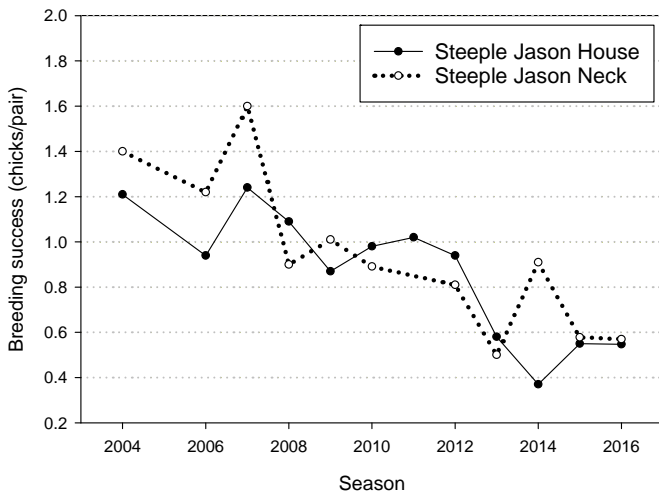


**Figure 13:** Gentoo Penguin breeding success for locations in Southeast Falkland.



**Figure 14:** Gentoo Penguin breeding success for locations on Falkland Sound.



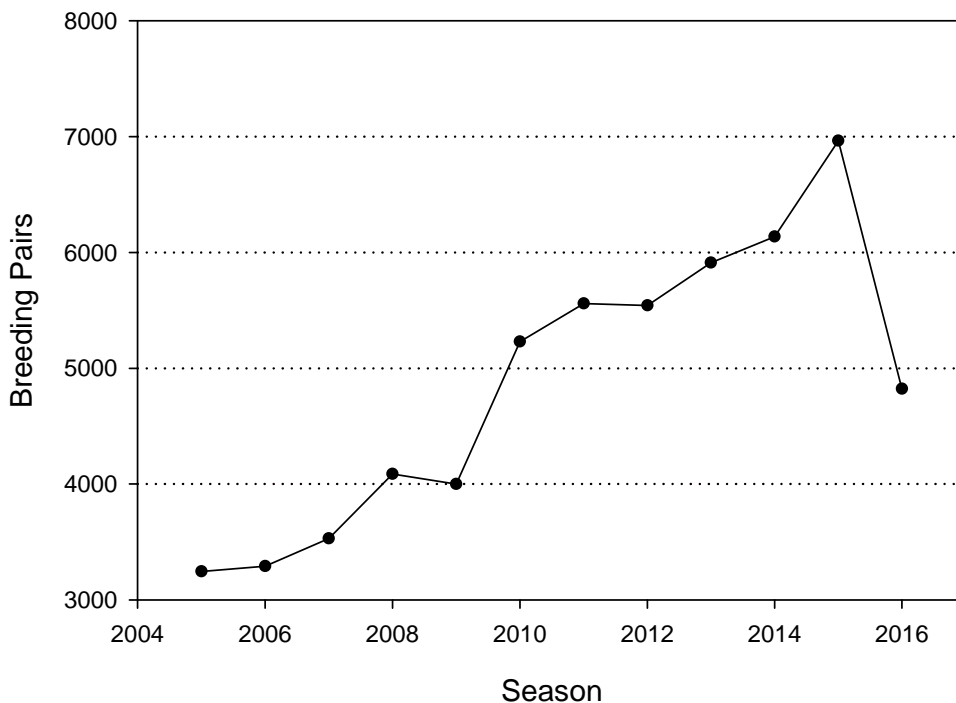


**Figure 15:** Gentoo Penguin breeding success for locations on Steeple Jason.

## Southern Rockhopper Penguin

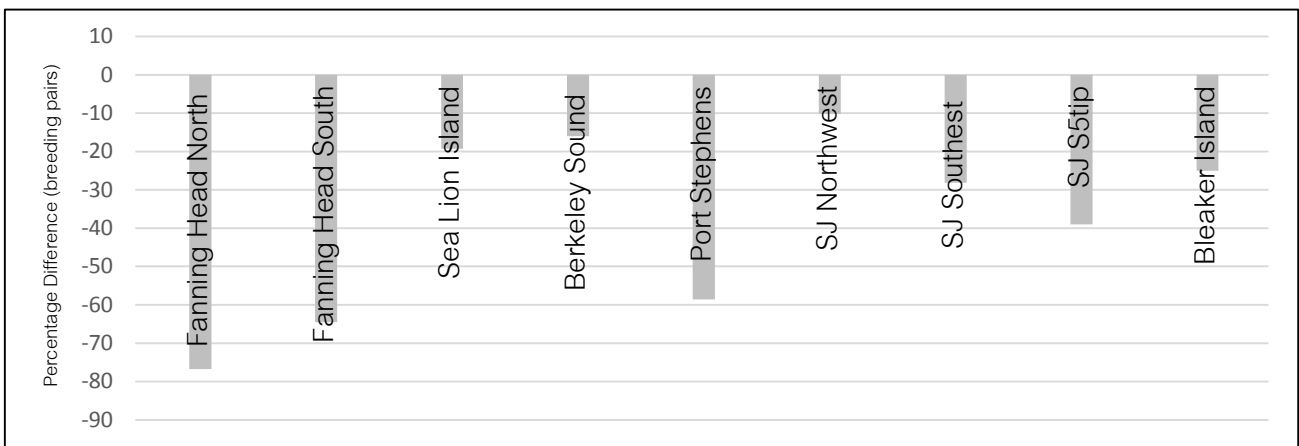
### *Breeding pairs*

Five locations have been monitored annually since 2005 (Race Point, Steeple Jason, Sea Lion Island and Berkeley Sound). At these sites, the combined total estimate of the number of breeding pairs decreased from 6,965 in 2015 to 4,823 in 2016, a decrease of 31 % or 2,142 pairs (**Figure 16**).

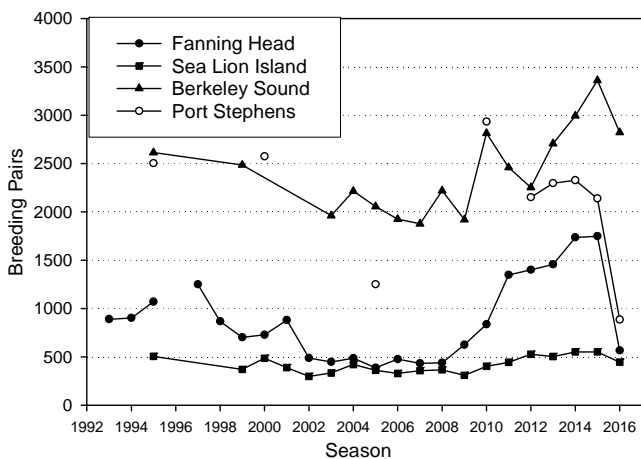


**Figure 16:** Southern Rockhopper Penguin breeding pairs at FISMP locations 2005-2016.

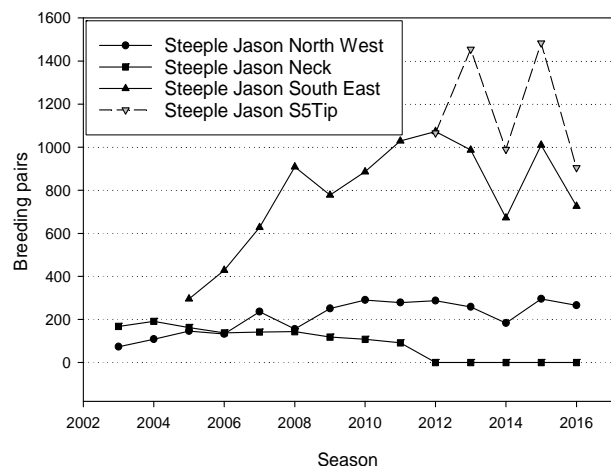
Decreases were recorded at all of the 9 FISMP sites in 2016 (**Figure 17**). The percentage decrease in breeding pair numbers ranged from 77 % at Fanning Head North to 10 % at Steeple Jason Northwest colonies. In terms of numbers of pairs, the largest declines were at Stephen’s Peak with an estimated reduction of 1,252 pairs, followed by Fanning Head colonies (1,184 pairs), Steeple Jason S5tip (579 pairs) and Berkeley Sound (538 pairs). At Fanning Head and Stephen’s Peak breeding pair numbers reached the lowest value recorded since 1997 and 2010 respectively (**Figure 18**).



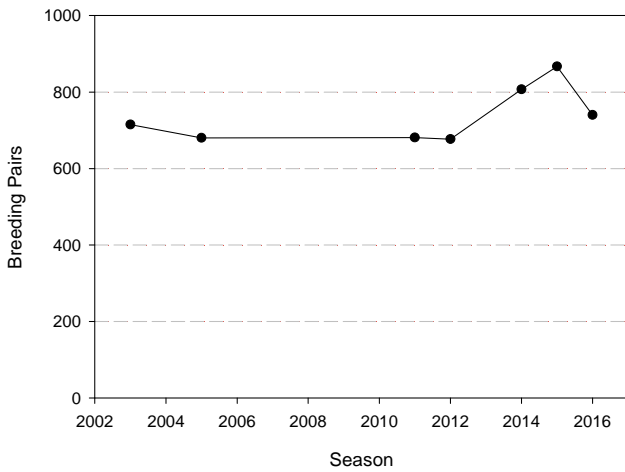
**Figure 17:** Percentage change of Southern Rockhopper Penguin breeding pair numbers between 2015 and 2016 at individual FISMP locations.



**Figure 18:** Southern Rockhopper Penguin breeding pairs for locations in mainland East and West Falkland.



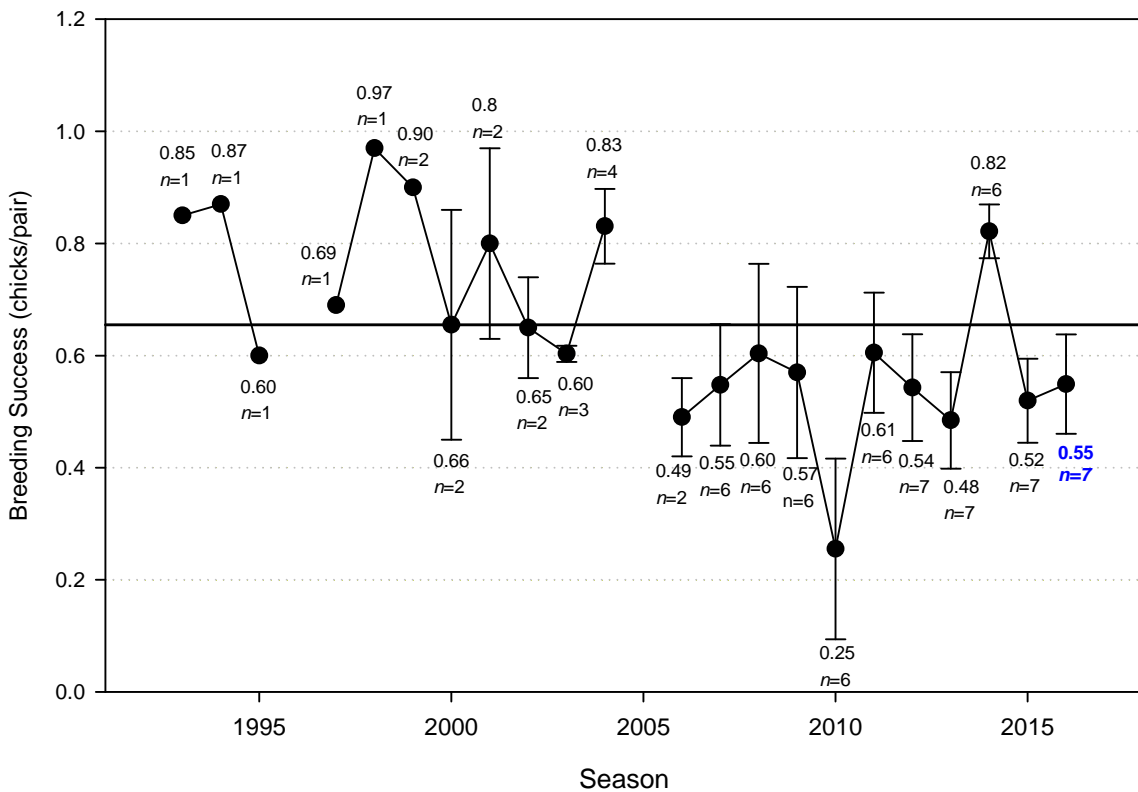
**Figure 19:** Southern Rockhopper Penguin breeding pairs for locations on Steeple Jason



**Figure 20:** Southern Rockhopper Penguin breeding pairs for Bleaker Island.

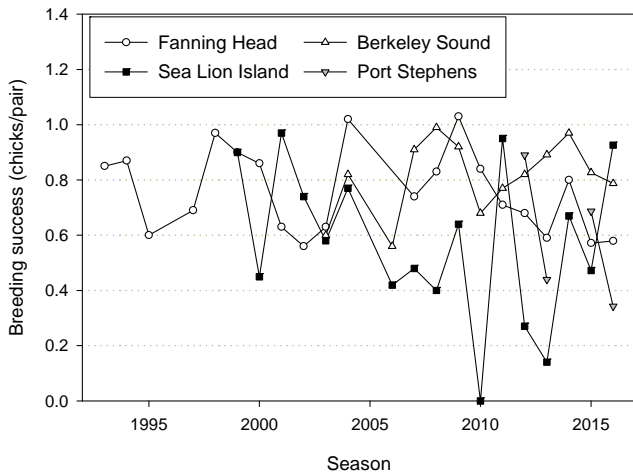
**Breeding success**

Average breeding success in Southern Rockhopper Penguin increased by a small fraction from  $0.52 \pm 0.19$  chicks/pair in 2015 to  $0.55 \pm 0.23$  chicks/pair in 2016. The figure remains below the annual average (Figure 21).

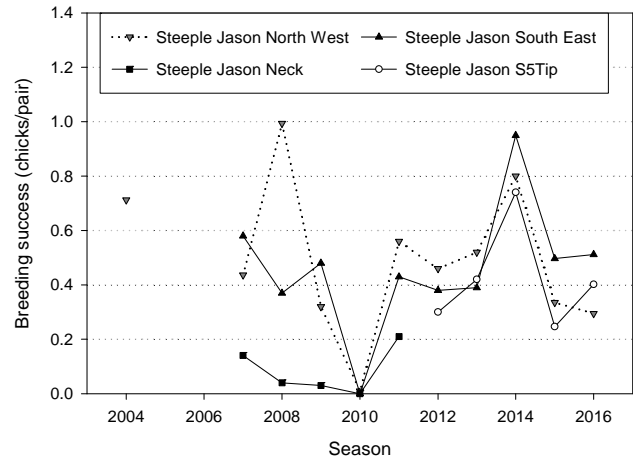


**Figure 21:** Southern Rockhopper Penguin breeding success at FISMP locations, 1993-2016. (Solid line - annual average). Standard Error bars show error about the overall mean by site means, and do not incorporate error about individual sites.

The range of breeding success varied between locations from a minimum of  $0.29 \pm 0$  chicks/pair at Steeple Jason Northwest colony to a maximum of  $0.93 \pm 0.01$  chicks/pair at Sea Lion Island. The most pronounced changes in breeding success between 2015 and 2016 were at Stephen's Peak with a 57.1 % decrease and at Sea Lion Island with a 96.1 % increase (**Figure 22**).



**Figure 22:** Southern Rockhopper Penguin breeding success for locations in mainland East and West Falkland and Sea Lion Island.



**Figure 23:** Southern Rockhopper Penguin breeding success for locations on Steeple Jason.

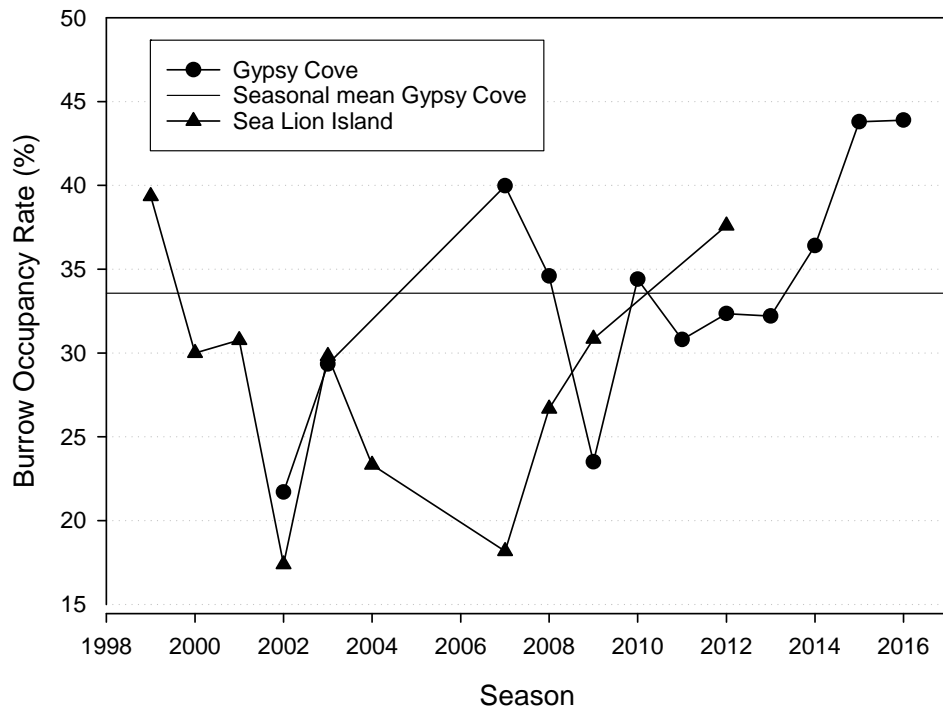
## Magellanic Penguin

The location and extents of transects and the estimated occupied burrow densities at Gypsy Cove are shown in **Figure 24**. Twenty-seven transects were carried out between Engineer Point and the Car Park at Gypsy Cove, of which, just under half ( $n=12$ ) contained occupied Magellanic Penguin burrows (yellow, orange, dark orange and red coloured bars on **Figure 24**).



**Figure 24:** Transect locations for the Magellanic Penguin survey at Gypsy Cove, 2016. Yellow ( $\geq 0$  and  $\leq 10,000$  breeding pairs/ $\text{km}^2$ ), light orange ( $> 10,000$  and  $\leq 20,000$  breeding pairs/ $\text{km}^2$ ), dark orange ( $> 20,000$  and  $\leq 30,000$  breeding pairs/ $\text{km}^2$ ) and red ( $> 30,000$  breeding pairs/ $\text{km}^2$ ) lines show burrow densities between the shore and the furthest burrow from the shore; grey lines show the extent of each transect where no burrows were present.

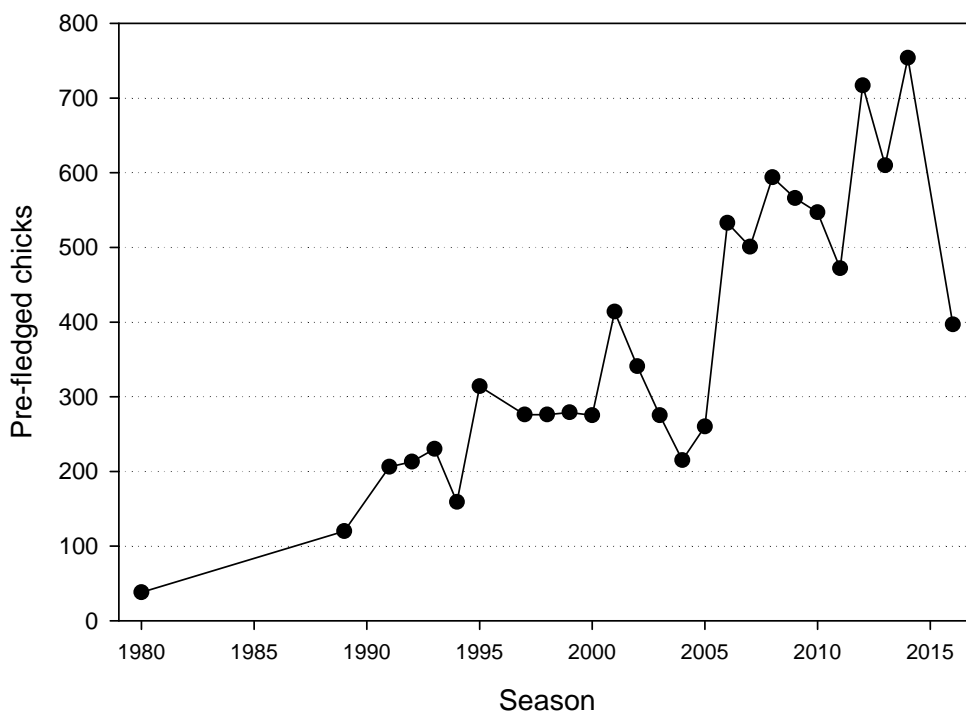
Where burrows occurred, estimated densities ranged from 8,000 to 38,461 occupied burrows / $\text{km}^2$ , with an average density of  $5,860 \pm 11,502$  / $\text{km}^2$ . Mean occupancy rate derived from transects using the current methodology for Gypsy Cove was  $41.9 \pm 10.3\%$  ( $n=12$ ). Taking all burrows where there was no uncertainty over occupancy status ( $n=41$ ), as per surveys prior to 2012, gave an occupancy rate of 43.9%, a similar value to the 2015 season and above the annual average for monitored sites (**Figure 25**).



**Figure 25:** Magellanic Penguin burrow occupancy rate at Gypsy Cove and Sea Lion Island, 1999-2016.

### King Penguin

The number of pre-fledged chicks at Volunteer Point in the 2016 season was  $397 \pm 4.6$ . This figure is a 47 % decrease from  $754 \pm 32.1$  chicks in the 2014 season (**Figure 26**). No count was conducted during 2015.



**Figure 26:** King Penguin pre-fledged chick numbers at Volunteer Point, 1980-2016.

## Imperial Shag

At Motley Point it was estimated that there were  $451 \pm 9$  Apparently Occupied Nests in 2016, an increase from  $175 \pm 2$  in 2015 and a breeding success of  $1.2 \pm 0.03$  chicks/pair (**Figure 27**).

	AON (Nov 2016)	AON (Jan 2017)	PFC (Jan 2017)	Breeding success
Motley Point	451		562	1.2
Rugged Hill	0	177		
SJ Northwest Flat	0	35		
SJ Northwest Ridge	0	45		

**Figure 27:** Imperial shag counts of Apparently Occupied Nests (AON) and Pre-Fledged Chicks (PFC), 2016.

## Brown Skua

Brown Skua counts were conducted systematically for the first time in 2016 at Steeple Jason at four locations. A total of 215 Apparently Occupied Territories (AOT) were counted (**Figure 28**).

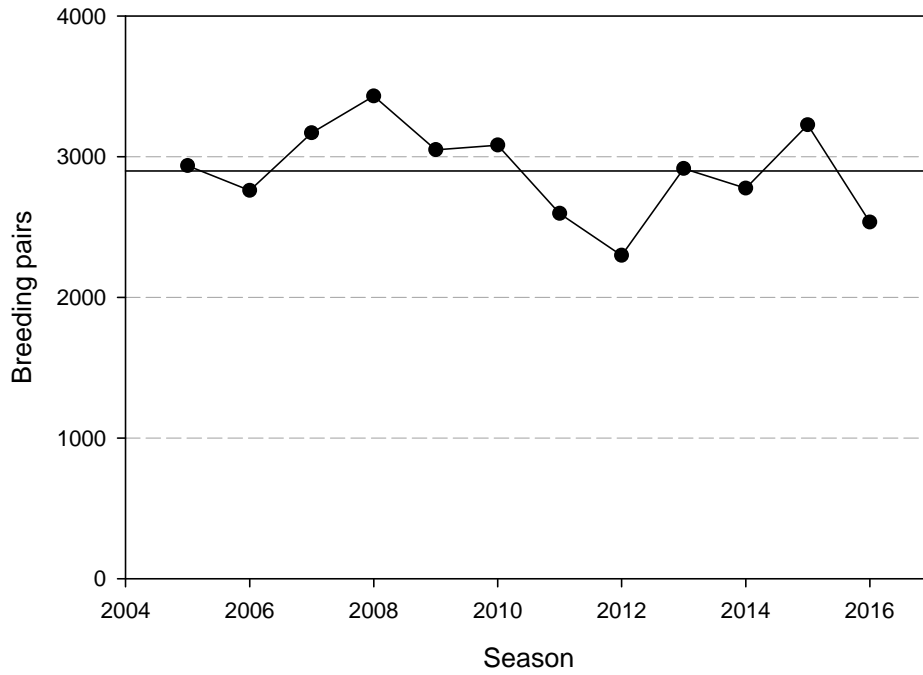
	(Adult sitting- no nest contents seen)	(Nest contents seen)		
	AOT	AOT	Number of eggs	Number of chicks
SJ Neck	1	61	21	72
SJ House	3	43	12	48
SJ North	4	90	40	96
SJ Neck_South	0	13	4	15
	<b>8</b>	<b>207</b>	<b>77</b>	<b>231</b>
	<b>Total AOT 215</b>		<b>Total nest contents 308</b>	

**Figure 28:** Brown Skua Apparently Occupied Territories (AOT) and nest content counts at Steeple Jason, 2016.

## Black-browed Albatross

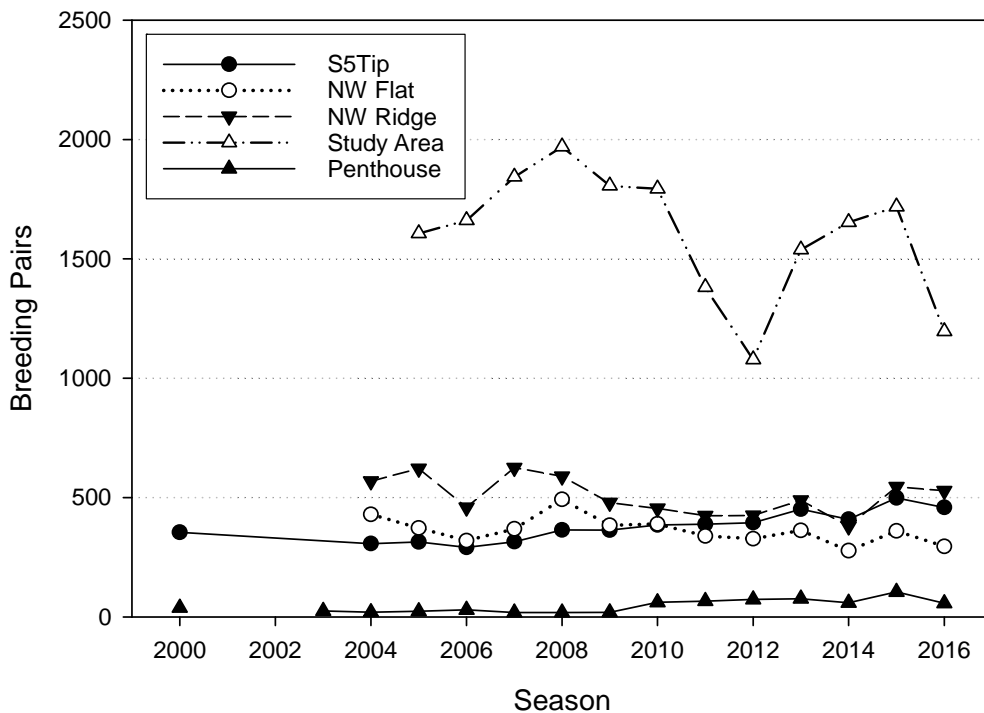
### *Breeding pairs*

The total estimated number of breeding pairs of Black-browed Albatross at Steeple Jason monitoring sites decreased from 3,227 pairs in 2015 to 2,535 pairs in 2016, taking the numbers below the annual average (**Figure 29**).



**Figure 29:** Black-browed Albatross breeding pairs at FIMSP sites, Steeple Jason, 2005-2016. (Solid line – annual average).

When compared to 2015, estimated breeding pair numbers decreased at all monitoring colonies at Steeple Jason (**Figure 30**), namely; Penthouse by 46 %, Study Area by 30 %, Northwest Flat by 18 %, S5Tip by 8 % and Northwest Ridge by 3 %.

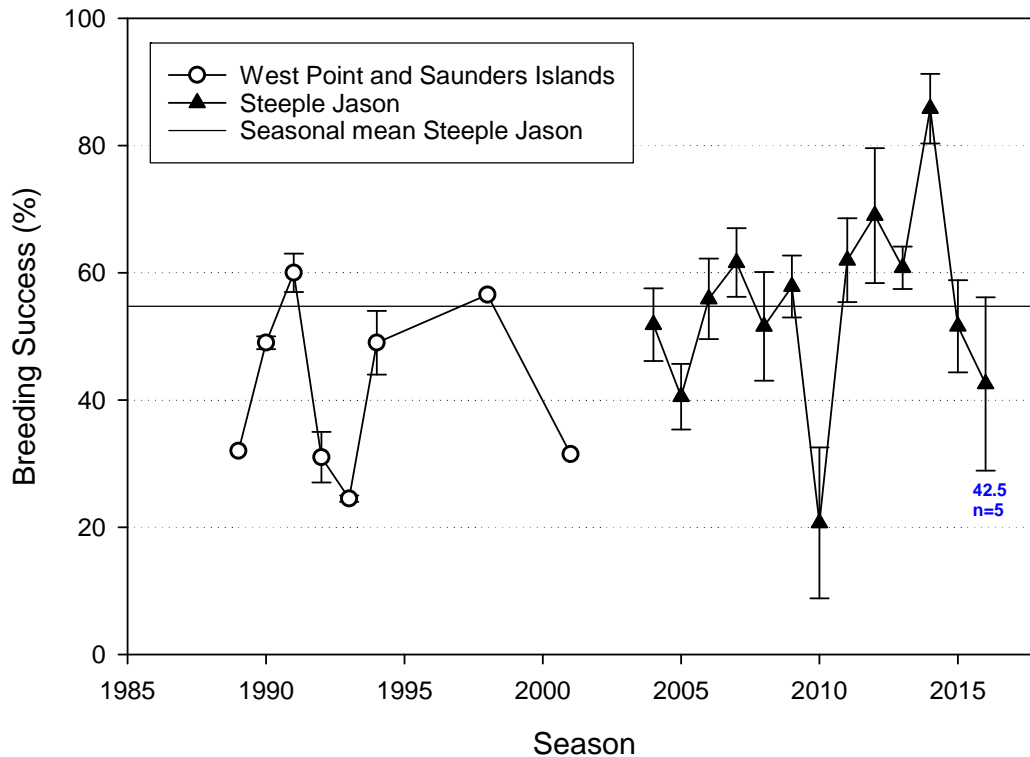


**Figure 30:** Black-browed Albatross breeding pairs at individual FIMSP sites on Steeple Jason, 2000-2016.



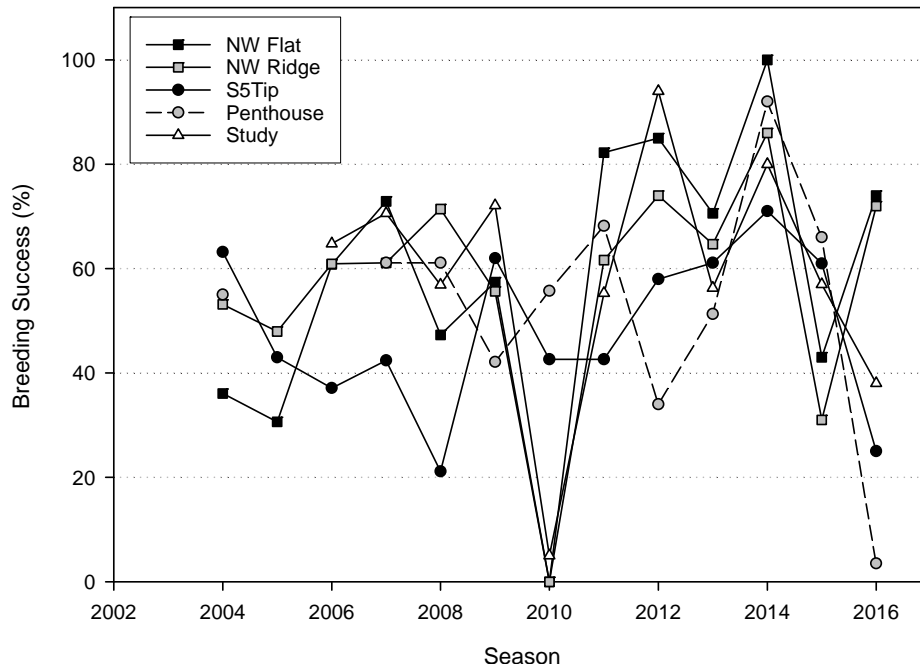
### Breeding success

Overall, mean breeding success for the monitored colonies on Steeple Jason decreased from  $52.0 \pm 16.2\%$  in 2015 to  $42.5 \pm 30.5\%$  in 2016 (Figure 31). This is the third lowest figure observed over the course of the monitoring period (2004 to 2016) and below the annual average for the second consecutive year.



**Figure 31:** Black-browed Albatross breeding success at FISMP sites on Steeple Jason, 2004-2016 and at West Point and Saunders Island, 1989-2001. Standard Error bars show error about the overall mean by colony means and do not incorporate error about individual sites.

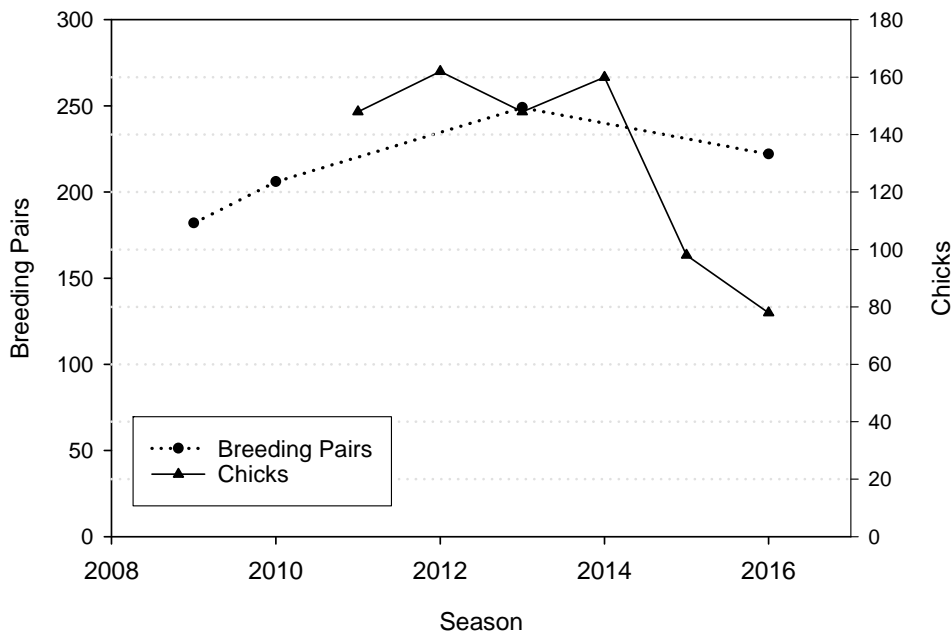
Breeding success varied highly between the individual colonies. When compared to the 2015 season, the largest decrease was at the Penthouse colony (95 %) and the largest increase at Northwest Ridge colony (132 %) (Figure 32).



**Figure 32:** Black-browed Albatross breeding success at FIMSP locations on Steeple Jason, 2004-2016.

***Penguin Point South, Dunbar***

The chick counts at Dunbar fell by 20 % from 98 in 2015 to 78 in 2016 (**Figure 33**), making it the second consecutive year with a decrease. Breeding success was 35 % which was lower than the average for other FIMSP sites at 42.5 %.

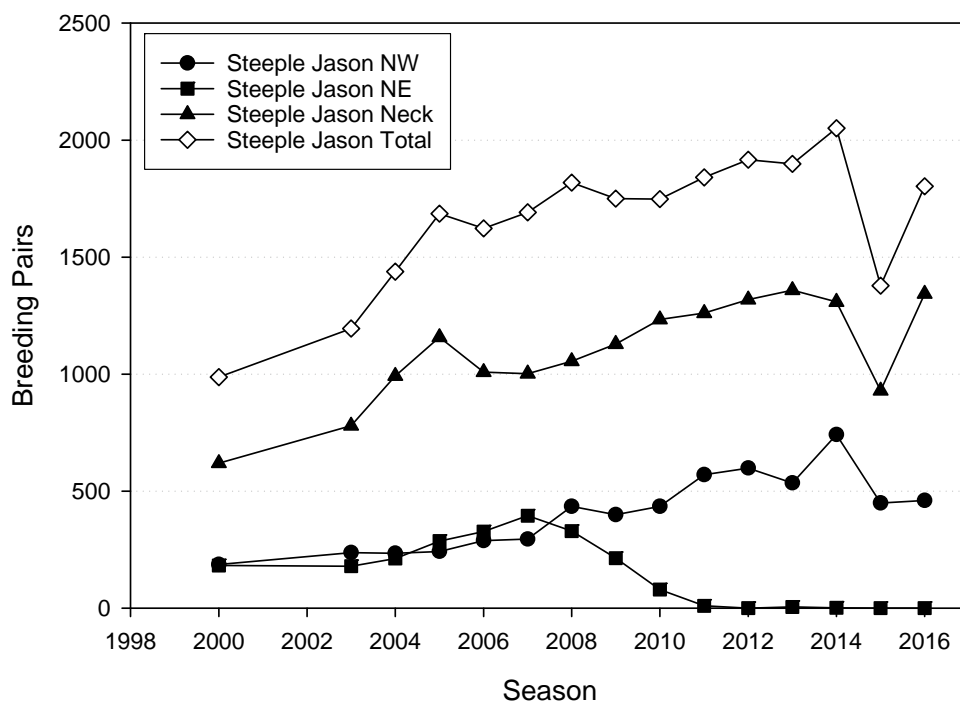


**Figure 33:** Black-browed Albatross breeding pair and chick numbers for Penguin Point South, Dunbar, 2009-2016.

## Southern Giant Petrel

### Breeding pairs

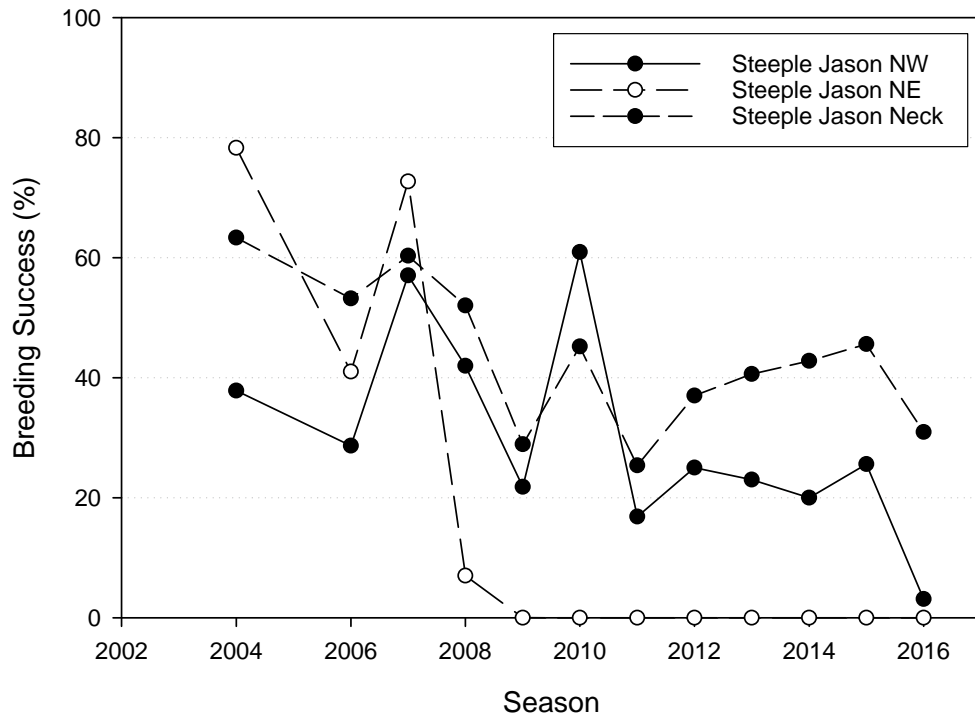
The number of breeding pairs of Southern Giant Petrel at monitored colonies on Steeple Jason increased by 31.0 % from an estimated 1,378 breeding pairs in 2015 to 1,803 pairs in 2016. A pronounced increase was observed at the Neck colony (45 %) compared with 2015, whilst the Northwest colony remained relatively stable (Figure 34). In 2016, six nests were observed near the Black-browed Albatross Northwest Flat colony at Steeple Jason and four nests near the Gentoo Penguin colonies at Lagoon Sands. None of these nests were successful in raising chicks.



**Figure 34:** Southern Giant Petrel breeding pair numbers at FISMP sites on Steeple Jason, 2000-2016.

### Breeding success

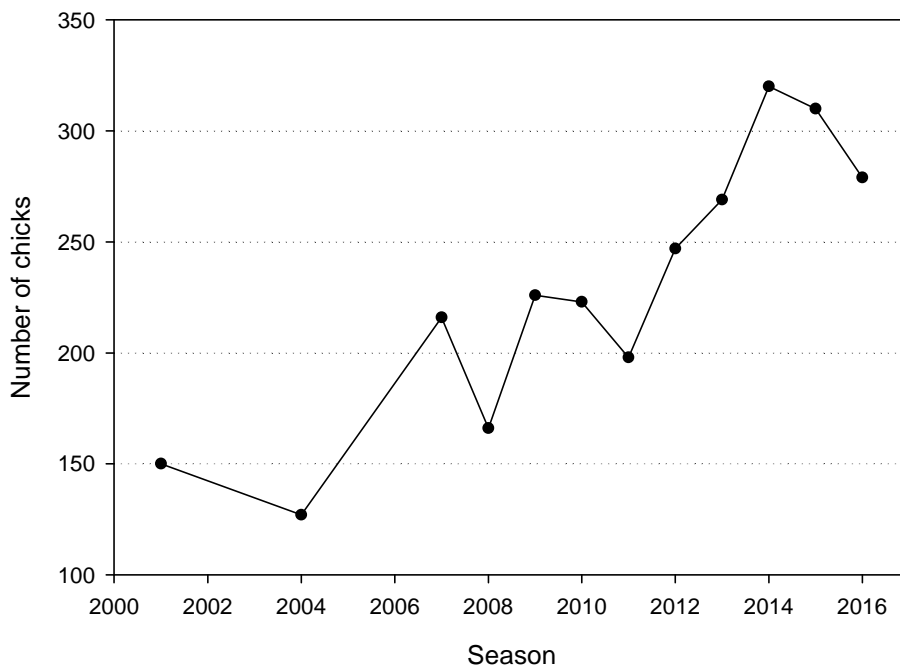
When compared with 2015 breeding success was down, namely; at the Neck colony (31 %) and at the Northwest colony (84 %). Breeding success at the Northwest colony was near to failure with the lowest value reached (4 %) over the lifespan of the monitoring (Figure 35).



**Figure 35:** Southern Giant Petrel breeding success at FISMP sites on Steeple Jason, 2004-2016.

***Bleaker Island chick count***

The number of Southern Giant Petrel chicks on Bleaker Island fell by 10 % from 310 in 2015 to 279 in 2016. This is the second year that numbers have fallen following an otherwise increasing trend despite several annual fluctuations (**Figure 36**).



**Figure 36:** Southern Giant Petrel chick counts at Bleaker Island, 2001-2016.

## Discussion

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### ***Gentoo Penguin: IUCN status: Least Concern (2017)***

*Falkland Islands breeding pair estimate: 132,321 ± 2,015 in 2010 (34 % of global population)*

*FISMP 2016 annual change in breeding pair numbers: Decrease (35 %)*

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The estimated number of pairs decreased significantly in 2016 with a reduction of 35 % or 10,518 pairs overall from 2015. All sites, excluding Steeple Jason, showed downward turns in breeding pair numbers. Bull Roads colony exhibited the most pronounced change with a drop of 77 %; however in terms of breeding pair numbers the largest decrease was at Sea Lion Island, of 2,445 pairs. The overall population trend indicates that the period of growth in breeding pair numbers between 2009 and 2015 now appears to have ceased, and decreases in breeding pair numbers in 2016 puts numbers roughly similar to those recorded by FISMP in 2009 and 2010.

As with previous years' breeding success, 2016 was highly variable between locations with overall breeding success the lowest value for the last 14 years, and well below the annual average. The overall trend in breeding success at FIMSP locations shows substantial temporal and regional variation; however, at Steeple Jason a continuing downward trend is apparent.

A number of factors may have affected temporal variability in breeding numbers between 2015 and 2016, including deferred (abstained, skipped) breeding in adult birds. Deferred breeding influenced, at least in part, by environmental variability that alters prey availability (Baylis et al. 2013a), could help explain site observations in 2016 of abandoned nests in the early incubation period and high proportions of loafing adult birds at some colonies. The proportion of deferred breeders or breeders that abandoned nests to known breeders in 2016 was unknown, making it difficult to assess the extent of birds deciding to defer breeding and its overall influence on the breeding population in 2016.

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***Southern Rockhopper Penguin: IUCN status: Vulnerable (2017)***

*Falkland Islands breeding pair estimate: 319,163 ± 24,820 in 2010 (36 % of global population)*

*FISMP 2016 annual change in breeding pair numbers: Decrease (31 %)*

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The estimated number of pairs decreased significantly in 2016 with an overall decrease of 31 % or 2,142 pairs from 2015. All sites showed downward turns in breeding pair numbers with a large variation of change. At two colonies (Fanning Head and Stephen's Peak) breeding pair numbers reached the lowest values recorded by FISMP for these sites (i.e. since 1997 and 2010 respectively). As expected, breeding success in 2016 was highly variable between locations and the overall breeding success remained below the annual average.

The overall trend at the FISMP sites showed a steady increase in breeding pair numbers from 2003 reaching a peak in 2015 and followed by a significant decrease in 2016. The 2016 breeding pair numbers are now roughly similar to the numbers recorded by FISMP in 2010. During the previous moult period (March to May 2016) mortality due to starvation in adult Southern Rockhopper Penguins was recorded at the Falklands (Crofts & Stanworth 2016). The extent of mortality was unknown and at this stage the level of impact of this adult mortality on the 2016 breeding population is unclear. Decreases in breeding numbers were clearly evident at the FISMP sites in 2016, but it is difficult to attribute these entirely to the mortality event during the previous moult. As with Gentoo Penguins, breeding deferral, which could help explain a decrease in breeding numbers and the temporal variation between 2015 and 2016, is reported in *Eudyptes* penguins (Crawford et al. 2006), however very little is known about this at the Falkland Islands.

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***Magellanic Penguin: IUCN status: Near Threatened (2017)***

*Falkland Islands breeding pair estimate: 76,000 – 142,000 (1997) (<10 % of globally population)*

*FISMP 2016 annual change in burrow occupancy rate: Stable*

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At Gypsy Cove, breeding birds remain broadly in three groupings, which appear to be associated with the extent of tussac habitat at the monitoring site. The occupancy rate of 43.9 % is above the annual average for the monitored site and a similar value to 2015.

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**King Penguin:** IUCN status: *Least Concern (2017)*

*Falkland Islands breeding pair estimate: 750 in 2012 (<1 % of global population)*

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In 2016 the number of pre-fledged chicks at Volunteer Point significantly decreased (47 %) from 2014. No count was obtained during 2015. The long-term monitoring at the site shows periodic fluctuations with an overall upward trend.

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**Black-browed Albatross:** IUCN status: *Near Threatened (2017)*

*Falkland Island breeding pair estimate: 475,000-535,000 in 2010 (70 % of global population)*

*FISMP 2016 annual change in breeding pair numbers: Decrease (31 %)*

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Black-browed Albatross breeding pairs at the monitoring sites at Steeple Jason showed an overall decrease of 31 % from 2015. Decreases were evident at all the monitored sites. Despite annual fluctuations, the overall FISMP trend since monitoring began in 2005 suggests a stable population, even though the 2016 count represents the second lowest breeding pair count. Breeding success at Steeple Jason fell from 2015 taking it to below the yearly average and the third lowest figure observed over the course of FISMP monitoring. Chick numbers at Dunbar fell by 20 % in 2016 compared to 2015, and makes 2016 the second consecutive year of decreases.

Breeding deferral is reported in Black-browed Albatross, and for females evidence suggests the decision to reproduce or defer breeding is associated with their relative fitness (i.e. body condition and hormonal traits) prior to arrival at breeding colonies (Crossin et al. 2012). Breeding deferral may help explain a decrease in breeding numbers in 2016 if feeding conditions were sub-optimal across their winter migration ranges.

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**Southern Giant Petrel:** IUCN status: *Least Concern (2017)*

*Falkland Island breeding pair estimate: 20,970 ± 180 pairs in 2015 (43 % of global population)*

*FISMP 2016 annual change in breeding pair numbers: Increase (31 %)*

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Compared to 2015, breeding pair numbers of Southern Giant Petrels increased by 31 %; however numbers in 2016 still remained below those counted in 2014. A pronounced increase was observed at the Neck colony whilst the numbers remained similar at the Northwest colony. Overall, the population has demonstrated an upward trend since 2000 despite periodic fluctuations (excluding

the House colony that failed in 2012). Breeding success at both the Neck and Northwest colonies decreased from 2015, and was near to failure at the Northwest colony with a value of only 4 %. For Bleaker Island, 2016 is the second consecutive year that numbers of pre-fledged chicks have fallen following an otherwise increasing trend. At new breeding locations, six nests were recorded at the Northwest Albatross colony, Steeple Jason, and four at Lagoon Sands Gentoo colony; none were successful.

## **Overall**

The FISMP in 2016 detected notable decreases in overall breeding pair numbers of Gentoo Penguin, Rockhopper Penguin and Black-browed Albatross and decreases were reported at nearly all the monitoring sites. Numbers of pre-fledged King Penguin chicks at Volunteer Point decreased significantly compared with 2014. The only notable increase in breeding pair numbers during 2016 was at one of the Southern Giant Petrel colonies. Variable breeding success across species and locations were recorded, however overall were below the annual averages. Productivity was near to complete failure at the Black-browed Albatross Penthouse colony and the Southern Giant Petrel Northwest colony at Steeple Jason.

This comparatively poor year has seen clear decreases in breeding numbers and in productivity (chicks raised), and is likely to be closely linked to associated environmental conditions. During the tail-end of the previous breeding season (February to April 2016) the temperature in the surrounding waters was much cooler than normal (<https://www.ncdc.noaa.gov/sotc/global/>) leading to low productivity and likely food shortages. Corresponding to this period an unknown number of mortalities, through starvation, in adult Southern Rockhopper Penguins, with lesser numbers of Gentoo Penguins, occurred during the moult at sites in the Falklands (Crofts & Stanworth 2016). The moult for penguins is a particularly sensitive period as birds must fast onshore for 3-4 weeks until their new feathers have completely regrown. Hence, if birds have not gained sufficient body condition before going into the moult, in the worst-cases are susceptible to starvation and death. Whilst food shortages were evident at the tail-end of the breeding season in 2015/16, the cooler sea temperatures persisted through to August, and probable food shortages continued, to some extent, into the late winter period resulting in a carryover effect influencing reproductive effort of seabirds in the summer of 2016/17. There is evidence that suggests long-lived migratory species, such as albatrosses and penguins, exhibit breeding deferral as a trade-off strategy between fitness and reproduction (Harrison et al. 2007; Crossin et al. 2012). It is highly



likely that an unknown proportion of breeding deferral occurred in 2016 across the FISMP species and sites and this mirrors on-site observations at colonies, most notably for Gentoo Penguins. Ocean surface temperatures over the summer of 2016/17 returned to near average (i.e. no significant departure from the yearly average 1981- 2010) although began to warm from January to April 2017 (<http://www.ncdc.noaa.gov/cag/>).

The potential impacts of the 2016 decrease in breeding pair numbers on the populations will variably depend on the levels of mortality and breeding deferral that occurred, but could bring about an immediate response of decline (i.e. driven by significant adult mortality), a short-lived response (i.e. decrease in pair numbers explained through breeding deferrals), a response with a time lag (i.e. reduced breeding success and reproductive rates and therefore reduced future recruitment) or a combination of all.

The long-term FISMP data shows a high degree of inter-annual variability in numbers of breeding pairs, for example between 2008 and 2009 the number of breeding pairs of Gentoo Penguins declined by 30 %, but then increased by 67 % in 2010, highlighting the importance of annual monitoring effort. FISMP monitoring in and after 2017/18 will be critical to understanding better the nature and longevity of the recent 2016 decreases across the species and sites.

### **IUCN re-assessment**

A re-assessment of the status of all bird species was undertaken by BirdLife International, on behalf of the International Union for Conservation of Nature (IUCN) during 2016 (IUCN 2017). In relation to FISMP species, Southern Rockhopper and Macaroni Penguins remain listed as Vulnerable, Magellanic Penguin and Black-browed Albatross remain listed as Near Threatened and King Penguin, Southern Giant Petrel, Imperial Shag and Brown Skua as Least Concern. Gentoo Penguin was moved from Near Threatened to Least Concern.

## **Acknowledgements**

The continuation of the FISMP is dependent on access to seabird colonies. Falklands Conservation would like to thank the many landowners/managers who have allowed us to conduct fieldwork on their land, including the Wildlife Conservation Society, Falkland Islands Government, Port Stephens, Fitzroy, Race Point, Johnson Harbour, Goose Green, Walker Creek, and North Arm. We thank Mike Clarke, Derek Pettersson and Rob McGill for logistical support and the many volunteers who participated in data collection, particularly Mike Morrison for his long-standing support. We would also like to thank the landowners at Dunbar (Hugues and Marie-Paul Delignieres) and Bleaker Island (Mike Rendell) for providing their survey data and allowing it to be included within the report. We also thank Denise Herrera (Falkland Islands Fisheries Department) for helping to provide environmental data.

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## Appendix 1: Count information

Location	Date of breeding pair count	Counters	Date of chick count	Counters
Volunteer Green	21/11/16	S. Crofts J. Fairclough	07/01/17	S. Crofts M. Taylor
Race Point	18/11/16	S. Crofts J. Fairclough	09/01/17	S. Crofts A. Howarth
Sea Lion Island	13/11/16	M. Morrison J. Peck	05/01/17	M. Morrison C. Morrison
New Haven	17/11/16	A. Stanworth J. Fairclough	18/01/17	A. Stanworth M. Taylor
Bull Roads	15/11/16	A. Stanworth J. Fairclough	15/01/17	A. Stanworth M. Taylor
Bull Point	16/11/16	A. Stanworth J. Fairclough	15/01/17	A. Stanworth M. Taylor
Cow Bay	22/11/16	S. Crofts J. Fairclough	06/01/17	S. Crofts M. Taylor C. Weir
Low Bay	15/11/16	A. Stanworth J. Fairclough	16/01/17	A. Stanworth M. Taylor
Motley Point	16/11/16	A. Stanworth J. Fairclough	17/01/17	A. Stanworth M. Taylor
Bertha's Beach	09/11/16	M. Morrison J. Peck	15/01/17	M. Morrison J. Peck
Fox Point	09/11/16	M. Morrison J. Peck	15/01/17	M. Morrison J. Peck
Pleasant Roads	06/11/16	M. Morrison J. Peck	08/01/17	M. Morrison J. Peck
Steeple Jason	Gentoo and Rockhopper 03-18/11/16. Black- browed and Giant Petrel 03-08/11/16.	S. Crofts J. Fairclough R. James	Gentoo and Rockhopper 15- 18/01/17. Black-browed and Giant Petrel 13- 15/03/17	S. Crofts S. Sanvito E. Bertram S. Cleminson A. Stanworth D. Robertson
Lagoon Sands	22/11/16	S. Crofts J. Fairclough	06/01/17	S. Crofts M. Taylor C. Weir
Diamond Cove	27/11/16	S. Crofts M. Taylor K. Lorimer	05/01/17	S. Crofts M. Taylor C. Weir
Rugged Hill/Eagle Hill	27/11/16	S. Crofts M. Taylor K. Lorimer	05/01/17	S. Crofts M. Taylor C. Weir
Port Stephens	26/11/16	A. Milston D. Towsey	20/01/17	A. Milston D. Towsey
Penguin Point South	Nov 2016	M. Delignieres	Feb 2017	M. Delignieres
Bleaker Island	Gentoo – Nov. 2016, Rockhopper - 23/11/16	M. Rendell	Giant Petrel 13- 26/03/17	M. Rendell

## Appendix 2: Gentoo Penguin count data

Location	Colony	Grid Ref.	Breeding Pairs (Mean±1SD)		Breeding Success (Mean±1SD)	
			Count	Count Type*	Count	Count Type*
Bertha's Beach	Bertha's Beach	-58.358916 -51.882233	523 ± 5	TR	0.60 ± 0.01	TR
Bull Point	Bull Roads	-59.398188 -52.309364	259 ± 12	TR	0.39 ± 0.07	TR
Bull Point	Bull Point	-59.321461 -52.342591	1192 ± 29	TR, Ph, D	0.88 ± 0.03	TR, Ph
Fox Point	Fox Point	-51.92 -58.45	430 ± 6	TR	0.73 ± 0.04	TR
Low Bay	Low Bay	-58.879630 -52.077608	390 ± 10	TR, TA	0.99 ± 0.04	TR
Motley Point	Motley Point	-58.643177 -52.108576	855 ± 11	TR	0.56 ± 0.02	TR
New Haven	New Haven	-59.222044 -51.742073	670 ± 10	TR	1.02 ± 0.02	TR
Pleasant Roads	Pleasant Roads	-51.83 -58.24	148 ± 3	TR	0.82 ± 0.02	TR
Race Point	Fanning Harbour	-59.087958 -51.464667	131 ± 1	Ph	0.30 ± 0.05	TR
Race Point	Rookery Sands	-59.106928 -51.434122	566 ± 12	TR	0.26 ± 0.03	TR
Sea Lion Island	Sea Lion Island	-59.072513 -52.426578	3218 ± 29	TR	0.71 ± 0.02	TR
Steeple Jason	House	-61.233113 -51.020186	4436 ± 21	D	0.55 ± 0.03	TR, Ph
Steeple Jason	Neck	-61.214888 -51.034787	4645 ± 73	TR, Ph, D	0.57 ± 0.02	TR, Ph
Johnson Harbour	Cow Bay	-57.879051 -51.428572	543 ± 5	TR, Ph	0.49 ± 0.02	TR
Johnson Harbour	Lagoon Sands	-57.77581 -51.513702	553 ± 5	TR	0.72 ± 0.02	TR
Johnson Harbour	Volunteer Green	-57.837858 -51.478494	1211 ± 26	TR	0.49 ± 0.02	TR

\* TR – Tally Repeated, TA – Tally Agreed, Ph – Photo count, D – Drone image count

### Appendix 3: Southern Rockhopper Penguin count data

Location	Colony/Sub-colony	Grid Ref.	Breeding Pairs (Mean $\pm$ 1 SD)	Breeding Success (Mean $\pm$ 1 SD)
Berkeley Sound	Diamond Cove	-57.923512 -51.538059	157 $\pm$ 0	0.84 $\pm$ 0.01
	Eagle Hill East	-57.785118 -51.544064	Not done	
	Eagle Hill	-57.802981 -51.544497	621 $\pm$ 24	0.70 $\pm$ 0.05
	Eagle Hill West	-57.810499 -51.545082	671 $\pm$ 10	1.00 $\pm$ 0.02
	Rugged Hill East	-57.845031 -51.543674	412 $\pm$ 9	1.13 $\pm$ 0.03
	Rugged Hill West	-57.851570 -51.543488	826 $\pm$ 18	0.53 $\pm$ 0.02
Port Stephens	Stephen's Peak	-60.859281 -52.133803	886 $\pm$ 9	0.34 $\pm$ 0.01
Race Point	Fanning Head North	-59.141540 -51.460831	175 $\pm$ 7	0.58 $\pm$ 0.04
	Fanning Head South	-59.137749 -51.469284	390 $\pm$ 17	Not done
Sea Lion Island	Rockhopper Point	-59.115501 -52.446667	444 $\pm$ 1	0.93 $\pm$ 0.06
Steeple Jason	Northwest Flat	-61.252682 -51.012810	150 $\pm$ 0	0.25 $\pm$ 0.0
	Northwest Ridge	-61.252884 -51.012939	115 $\pm$ 0	0.34 $\pm$ 0.0
	S5Tip	-61.220460 -51.037932	905 $\pm$ 0	0.40 $\pm$ 0.0
	Study Area	-61.206635 -51.046215	726 $\pm$ 2	0.51 $\pm$ 0.01

## Appendix 4: Magellanic Penguin survey data

Transect	Number of Burrows	Occupancy (%)	Distance to last burrow	Minimum Pair Density per Km <sup>2</sup>
1	0	-	0	0
2	0	-	0	0
3	0	-	0	0
4	2	0	36	0
5	2	100	15	33333
6	1	0	20	0
7	0	-	0	0
8	0	-	0	0
9	0	-	0	0
10	0	-	0	0
11	0	-	0	0
12	6	17	30	8333
13	1	100	25	10000
14	8	20	50	8000
15	0	-	0	0
16	8	60	41	29268
17	0	-	0	0
18	0	-	0	0
19	0	-	0	0
20	0	-	0	0
21	1	0	26	0
22	7	83	75	19444
23	10	40	26	38462
24	8	43	117	7326
25	2	100	15	33333
26	0	-	0	0
27	0	-	0	0

## Appendix 5: Black-browed Albatross and Southern Giant Petrel count data

### *Black-browed Albatross*

Sub-colony	Breeding Pairs (Mean $\pm$ 1 SD)	Breeding Success (chicks/pair) (Mean $\pm$ 1 SD)
Study Colony	1197 $\pm$ 21	0.38 $\pm$ 0.02
S5Tip	458 $\pm$ 24	0.25 $\pm$ 0.05
Penthouse	57 $\pm$ 0	0.04 $\pm$ 0
Northwest Flat	295 $\pm$ 12	0.74 $\pm$ 0.04
Northwest Ridge	528 $\pm$ 8	0.72 $\pm$ 0.02

### *Southern Giant Petrel*

Colony	Breeding Pairs (Mean $\pm$ 1 SD)	Breeding Success (chicks/pair) (Mean $\pm$ 1 SD)
Neck	1343 $\pm$ 37	0.31 $\pm$ 0.03
Northwest	460 $\pm$ 6	0.04 $\pm$ 0.01
House	0	0
Northwest Flat	6 $\pm$ 0	0
Lagoon Sands	4 $\pm$ 0	0