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*Antarctic Marine Living Resources Program*

# Surveys of Breeding Penguins and Other Seabirds in the South Shetland Islands, Antarctica, January-February 1987

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National Oceanic and Atmospheric Administration
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NOAA Technical Memorandum NMFS-F/NEC-59

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*Antarctic Marine Living Resources Program*

# Surveys of Breeding Penguins and Other Seabirds in the South Shetland Islands, Antarctica, January-February 1987

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Abstract: Surveys conducted as part of the Antarctic Marine Living Resources Program in 1987 provided data on the number, size, and location of penguin and Antarctic Blue-eyed Shag colonies and the breeding status of other seabirds in the South Shetland Islands, Antarctica. Several species were encountered at many more sites than previously reported, thus increasing the known breeding localities of American Sheathbills and skuas by threefold, Chinstrap Penguins by twofold, and Cape Petrels and Antarctic Blue-eyed Shags by 50%. The minimum estimate of 1,620,000 breeding Chinstrap Penguins, the most abundant penguin in the study area, is about 2.5 times greater than previous estimates. Although there appears to have been about a 40% overall increase in the Chinstrap Penguin population in the last 20-30 years, about three-fourths of the difference between these counts and previous ones is due to more complete coverage of available nesting habitat in 1987. For the same reason, at least in part, other species of breeding seabirds



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were also found to be more abundant than previously reported.

## PROGRAM STATEMENT

The U.S. Antarctic Marine Living Resources (AMLR) Program supports U.S. policy regarding the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). The CCAMLR is an international agreement that supports an ecosystem approach to the conservation and management of living resources found in ocean areas surrounding the continent of Antarctica. The Convention mandates a management regime committed to applying measures to ensure that harvesting of Antarctic marine living resources, such as finfish and krill, is conducted in a manner that considers ecological relationships among dependent and related species. Member countries of CCAMLR are: Argentina; Australia; Belgium; Brazil; Chile; European Economic Community; France; German Democratic Republic; Germany, Federal Republic of; India; Japan; Korea; New Zealand; Norway; Poland; South Africa; Spain; Union of Soviet Socialist Republics; United Kingdom; and United States.

U.S. objectives for CCAMLR were established with the signing into law of the Antarctic Marine Living Resources Convention Act of 1984 (P.L. 98-623). The legislation charges the Secretary of Commerce with the design, conduct and implementation of directed scientific research in support of U.S. objectives in the CCAMLR. Responsibility for these activities has been delegated to the National Marine Fisheries Service (NMFS) of NOAA.

The U.S. AMLR Program supports the CCAMLR need for information through analysis of commercial fisheries data and directed research on key species groups in the Antarctic marine ecosystem. This information, along with research done by other member countries, is used by the CCAMLR to detect and record significant changes in critical components of the Antarctic ecosystem. The Scientific Committee of the CCAMLR then makes conservation recommendations to the Commission, which establishes required conservation measures.

The U.S. AMLR Program focuses its field research activities in the southwest Atlantic Ocean, Scotia Arc, and Antarctic Peninsula. Special attention is directed to the vicinity of Bransfield Strait, South Shetland Islands, and the Palmer Archipelago. In addition, the AMLR Program conducts field work in other areas, as needed, to provide comparative data.

## ABSTRACT

Surveys conducted as part of the Antarctic Marine Living Resources Program in 1987 provided data on the number, size, and location of penguin and Antarctic Blue-eyed Shag colonies and the breeding status of other seabirds in the South Shetland Islands, Antarctica. We encountered several species at many more sites than previously reported, thus increasing the known breeding localities of American Sheathbills and skuas by threefold, Chinstrap Penguins by twofold, and Cape Petrels and Antarctic Blue-eyed Shags by 50%.

Our minimum estimate of 1,620,000 breeding Chinstrap Penguins, the most abundant penguin in the study area, is about 2.5 times greater than previous estimates. Although there appears to have been about a 40% overall increase in the Chinstrap Penguin population in the last 20-30 years, about three-fourths of the difference between our counts and previous ones is due to more complete coverage of available nesting habitat in 1987. For the same reason, at least in part, other species of breeding seabirds were also found to be more abundant than previously reported.

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## INTRODUCTION

Data on the distribution and abundance of breeding penguins and other seabirds of the Antarctic Peninsula and the islands of the Scotia Sea have been summarized recently but information is incomplete (Watson et al., 1971; Croxall and Kirkwood, 1979; Wilson, 1983; Croxall et al., 1984). To fill data gaps, we censused breeding birds along most of the ice-free shoreline of the South Shetland Islands from 29 January to 12 February 1987. This work highlighted the need for careful regional census work to assess population trends accurately (see Jehl and Todd, 1985).

## STUDY AREA AND METHODS

Censuses. Our work in the South Shetland Islands (Fig. 1) was conducted in conjunction with the AMLR Program surveys of seals, primarily Antarctic fur seals (*Arctocephalus gazella*) and southern elephant seals (*Mirounga leonina*). We surveyed the ice-free shorelines of King George, Nelson, Robert, Greenwich, Livingston, Deception, Snow, Smith and Low Islands, and other small offshore islands in their vicinity (Figs. 2-5). Locations not censused include offshore islands on the north coast of King George Island from Cape Melville to False Round Point and from Stigant Point to Fildes Strait (Fig. 2), the inside of Admiralty Bay, King George Island from Sphinx Hill on the west to Chabrier Rock on the east (Fig. 2), and offshore islands on the north coast of Nelson and Robert Islands as far west as Dee Island off the northeast corner of Greenwich Island (Fig. 3).

Information for some of these areas was obtained from observers who were principally engaged in the censusing of seals. In the Elephant Island group the only sites we surveyed for breeding seabirds were the Seal Islands and Cape Lindsey, Elephant Island (Fig. 4). So as not to bias our censuses, we refrained from consulting previous penguin colony-size estimates for this region (Croxall and Kirkwood, 1979; Jablonski, 1984) until after the completion of our work.

Surveys were conducted primarily from two inflatable boats deployed from the Polish research ship, *Professor Siedlecki*. Seabirds were viewed through 8-10X binoculars from the stationary boats or while we cruised at approximately 1-3 knots, usually 50-300 m from shore. We occasionally went ashore to census seals and to obtain overviews of very large penguin colonies which were not completely visible from the water.

At all Chinstrap Penguin (*Pygoscelis antarctica*) colonies, and the one Macaroni Penguin (*Eudyptes chrysolophus*) colony, we counted adults associated directly with nests or young only, excluding peripheral birds such as those roosting nearby, loafing on beaches, or walking to and from the colonies. At the time of our censuses, Chinstrap and Macaroni adults and chicks were still closely associated with their nest sites. At most Gentoo Penguin (*Pygoscelis papua*) colonies, we censused adults by the above method, but, because Gentoos breed earlier than Chinstraps, we sometimes estimated adult numbers by counting chicks, a method recommended by Croxall and Kirkwood (1979) when many adults are absent from the colony. Our censuses of penguins were dependent on

the schedule and priorities of the seal investigators, and thus we were able to obtain careful counts at only a few sites. Because of the short time available for most censuses, the distant looks at some colonies, and sub-optimal viewing conditions when looking up to cliffs from a moving boat, we probably missed some small colonies of Gentoo or Macaroni Penguins amidst large Chinstrap colonies.

Accuracy of censuses. We report estimates of breeding penguins and Antarctic Blue-eyed Shags as the total number of adults. Because we could not estimate other breeding species adequately, we report their suspected or confirmed breeding status only. Among-site differences existed in censusing conditions (e.g., diverse topography, boat versus land vantage points, and time available for censusing) and, thus, the accuracy of our censuses varied considerably. Accordingly, we assigned each penguin estimate to one of four categories of accuracy:

1) Detailed counts of individuals in small colonies (<500 birds) or estimates of individuals by blocks of 10, 50, or 100 in larger colonies -- these were made from the land by walking along colony boundaries; we guess accuracy to be ±5-10% (see Jehl and Todd, 1985).

2) Rough estimates by blocks of 100's or 1,000's, from a moving boat, or by walking around major portions of extensive colonies to make partial counts and mental extrapolations from these -- the accuracy of estimates under 5,000 is probably ±10-20%, between 5,000 and 25,000 ±20-30% and over 25,000 ±30-50%.

3) Gross estimates were guesses based on mental comparison with detailed counts of other penguin colonies or prior experience with known-sized colonies of other seabirds. These were made for very large and expansive colonies when time or vantage points were limited, and were the least reliable of all; accuracy likely ±50-100%.

4) Casual observations were verbal descriptions from observers concerned with other work, or our own for localities where it was not possible to see a substantial proportion of the colony due to time and vantage point limitations.

## RESULTS AND DISCUSSION

The following species accounts summarize the results of our surveys on the distribution and abundance of all breeding species encountered. To facilitate direct comparisons with the numbers of breeding sites and individuals in the South Shetlands reported by Croxall et al. (1984), the number of sites from our surveys reported below does not include those in the Elephant Island area.

### Adélie Penguin (*Pygoscelis adeliae*)

Because this species had finished breeding before our effort began, we gathered no information on breeding distribution.

Chinstrap Penguin (Pygoscelis antarctica)

We recorded 91 chinstrap colonies (Table 1, Fig. 6). Although this species occurred throughout the study area, most of the breeding sites and population were located on the northern or western sides of the islands (Table 1). Taking into account the margin of error in our estimates, breeding failure before our arrival, and the lack of quantitative population estimates for several large colonies, a conservative estimate of the minimum population of chinstraps breeding in the study area is 1,620,000. This is about 2.5 times Croxall et al.'s (1984) estimate of about 660,000 birds nesting at 45 sites in the South Shetlands.

Although conditions for conducting the census were not optimal, our estimate of 480,250-641,300 Chinstraps on King George Island compares well with a more detailed 1980/81 estimate of 604,874 (Jablonski, 1984). A comparison of estimates at 23 sites in the South Shetlands with reliable data for both 1987 (Table 1, sites with *) and for prior counts at these sites reported by Croxall and Kirkwood (1979) gives totals of 376,740 and 270,900 Chinstraps, respectively. This suggests that Chinstrap populations in the South Shetlands have increased roughly 40% in about the last 20-30 years. However, since the total estimate of breeding Chinstraps on these islands in 1987 is about 2.5 times the previous estimate, it appears that about 110% of this recent 250% increase in the population estimate is due to our more complete coverage of available nesting habitat in 1987 compared with prior surveys. On the other hand, it is likely that the size of many of the previously uncensused colonies has also increased over time.

Areas where we encountered large populations unreported by Croxall and Kirkwood (1979) were on the north shore of King George Island (also reported by Jablonski 1984), on Low Island, and to a lesser extent, on Livingston, Snow, and Smith Islands (Table 1). In particular, the populations on Low Island added most substantially to the increase. We estimated 760,000 chinstraps there compared to about 40,000 estimated from cursory surveys as reported by Croxall and Kirkwood (1979).

Gentoo Penguin (Pygoscelis papua)

We encountered 21 Gentoo colonies, primarily on the southern sides of the islands (Table 1, Fig. 7). Our data indicate a minimum nesting population of 18,000 Gentoos in the study area. This figure is probably low because: no correction was possible to take breeding failure, which occurred before our arrival, into account; we probably missed some Gentoo colonies in areas we could not survey, and in areas where they were not visible due to their location within large Chinstrap colonies censused from a distance (e.g., Harmony Point, Nelson Island). Croxall et al. (1984) estimated that about 40,000 Gentoo's nested at 24 sites in the South Shetlands. We found Gentoo Penguins at 10 sites not reported by Croxall and Kirkwood (1979). However, the significance of this is unclear because Gentoo colony locations frequently change from year to year (W. Trivelpiece, pers. commun.).

Macaroni Penguin (Eudyptes chrysolophus)

Seal Island was the only site where breeding Macaroni Penguins were observed. One colony of 40 adults and 12 chicks and a second of 85 adults and

13 chicks were found on the east and north sides of the island, respectively. As noted above, we could have missed small numbers of birds nesting within Chinstrap colonies, especially since we could not thoroughly investigate the few sites where the species has been reported co-occurring with Chinstraps south of the Elephant Island group (Croxall and Kirkwood, 1979).

Southern Giant Fulmar (Macronectes giganteus)

We recorded Southern Giant Fulmars at 37 sites scattered throughout the study area (Table 1, Fig. 8). Croxall et al. (1984) estimated that about 630 birds bred at 43 sites. Because these fulmars breed in loose colonies on flat or gently sloping terrain atop coastal bluffs and offshore islands or rocks, our observations made primarily from boats are inadequate for making population estimates due to the limited visibility available to us from boats. For example, at Penguin Island (off King George), we counted about 65 fulmars from a boat while Jablonski (1980) reported 1,012 birds, based on nest counts on land. Croxall et al. (1984) report an association of this species with penguin colonies but the fulmar's apparent absence as a breeder in some areas where very large numbers of penguins nest (e.g., north-central King George Island) suggests that other factors may be important for nest site selection. Perhaps the availability of bluffs or cliffs from which birds can launch themselves into the wind is also a factor.

Cape Petrel (Daption capense)

We recorded Cape Petrels at 18 apparent nesting sites (Table 1, Fig. 9). Since this species nests in crevices primarily on steep cliffs and bluffs, boat surveys are adequate for detecting only the presence or absence of breeding birds. Croxall et al. (1984) estimated 2,000 to 20,000 birds at more than 10 sites in these islands. Although time limitations prevented us from conducting a more thorough census, we suspect that the present breeding population size is on the low end of the range reported by Croxall et al. (1984).

Wilson's Storm-Petrel (Oceanites oceanicus)

We recorded Wilson's Storm-Petrels flying around suitable breeding habitat of cliffs and scree slopes at only seven sites in the study area (Table 1), and so were unable to estimate population size reliably. Since storm-petrels are primarily nocturnal at colonies, surveys from boats are inadequate for censusing this species. Croxall et al. (1984) estimated that two million birds bred at more than 57 sites. More land-based work is needed to clarify population status in the region, particularly because no satisfactory estimates of storm-petrel populations in the Antarctic have been made to date.

Antarctic Blue-eyed Shag (Phalacrocorax atriceps)

We recorded 1,221 Blue-eyed Shags at 34 potential or confirmed breeding sites, primarily on the northern sides of the islands (Table 1, Fig. 10). Croxall et al. (1984) estimated that 1,400 birds bred at 21 sites.

American Sheathbill (Chionis alba)

We recorded sheathbills at 64 sites scattered throughout the study area (Table 1, Fig. 11), primarily at penguin colonies. Although our counts were not accurate for estimating total population size, the bulk of the population apparently occurs on the northern sides of the islands in association with Chinstrap penguins. Croxall et al. (1984) estimated that 1,300 birds nested at 26 sites in the South Shetlands.

Skua spp. (Brown Skua Catharacta lonnbergi and South Polar Skua C. maccormicki)

We recorded skuas at 76 sites (Table 1, Fig. 12). Most birds appeared to be C. lonnbergi, but many were not identified to species. Identification to species, made difficult by our often distant views, was amplified by hybridization of the two species in the South Shetlands. Because Brown Skuas have feeding territories in penguin rookeries, whereas South Polar Skuas do not (Trivelpiece and Volkman, 1982), we were more likely to overlook the latter species. Croxall et al. (1984) estimated that 840 C. lonnbergi bred at more than 20 sites and 20 C. maccormicki bred at six sites in the South Shetlands. Although our counts were not adequate for estimating population size, occurrence of skua at 76 sites suggests a much larger breeding population in this region than has been reported. Indeed, at Point Thomas, King George Island, where both species breed, the 44 C. maccormicki nesting there in 1987 (W. & S. Trivelpiece, pers. commun.) is twice the Croxall et al. (1984) estimate for the whole region. South Polar Skua numbers have increased in recent decades at King George Island (W. & S. Trivelpiece, pers. commun.), as well as in the South Orkneys (Hemmings, 1984).

Kelp Gull (Larus dominicanus)

We recorded Kelp Gulls at 80 sites scattered throughout the study area (Table 1, Fig. 13), but our counts were inadequate for determining population size. Croxall et al. (1984) estimated that 4,200 birds bred at more than 80 sites.

Antarctic Tern (Sterna vittata)

We recorded Antarctic Terns at 45 sites (Table 1), primarily on the northern shores of the islands (Fig. 14). Our counts were inadequate for determining population size. Croxall et al. (1984) estimated that 70,000 birds bred at 44 sites.

## OVERVIEW

The adequacy of regional coverage and accuracy of population estimates for breeding penguins of the South Shetland Islands was previously considered "good" relative to other areas in the Antarctic (Croxall et al., 1984). However, it is clear from the number of "new" colonies we encountered and other recent surveys (i.e., Jabłoński, 1984) that regional population estimates are inadequate even for species heretofore considered well-censused (e.g., Chinstrap Penguin). For example, Low Island, which supports roughly one-third of the South Shetland Chinstrap population (Table 1), has had minimal prior coverage and Smith and Snow islands, to our knowledge, have

never been censused before (Croxall and Kirkwood, 1979). Our extensive but rough survey indicates that the South Shetland Chinstrap population is, at minimum, two to three times larger than previously thought (Croxall et al., 1984). Because our work was conducted within a short time period, during one year, by one team of observers, which has rarely been the case in other regional assessments, we also have a basis on which to appreciate the relative sizes of the various penguin colonies.

Regional survey coverage of seabirds nesting in crevices and cliffs, and seabirds breeding in more dispersed aggregations (gulls, terns, skuas) has been considered inadequate and patchy, respectively (Croxall et al., 1984). It is, therefore, not surprising that we encountered higher numbers of suspected or confirmed breeding sites for Cape Peterels, American Sheathbills, and skuas than were previously reported. This further suggests that prior regional population estimates for most species of seabirds besides penguins (Croxall et al., 1984) have been rough at best or that populations have been on the increase in recent years. As a result of the survey reported here, we now have a good indication of the number of breeding sites currently existing for most species.

Much attention has been focused on the apparent increase in numbers of Antarctic and sub-Antarctic penguins and other species during this century. This change is thought to be due to increased availability of krill resulting from intense harvesting of baleen whales (Sladen, 1964; Emison, 1968; Conroy and White, 1973; Conroy, 1975; Croxall and Kirkwood, 1979; Smith and Tallowin, 1979; Croxall et al., 1981; Croxall et al., 1984). For the South Shetlands, it has also been suggested that Chinstraps have increased in the last 20 years due to the exposure of suitable nest sites by the retreat of glacial ice cliffs (Jabłoński, 1984). However, population changes have been well-documented with census data at only one penguin colony (Croxall et al., 1981), and no adequate data exist for a broad region. Recently, penguin population monitoring programs have gained more attention in the scientific community in response to increased commerical harvest of krill for human use (BIOMASS, 1983, 1984). Much of this work is focused on reproductive success and diet studies. If changes in the size of penguin populations are to be documented, there is still a need for accurate census work in coordination with ecological studies. While it is beyond the scope of this report to suggest methods for future penguin censuses, it is clear that much more detailed work than that reported here will be needed if penguin data are to provide a sensitive tool for monitoring the health of the Antarctic ecosystem.

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Table 1. Censuses of breeding penguins and shags and assessment of the breeding status of other seabirds on the South Shetland Islands, Antarctica (Figs. 1-5). Penguin colony size expressed as total adults. Most censuses were of breeding adults, but a few of gentoo penguins were based on chick counts (c). Accuracy of penguin colony estimates: 1 = detailed counts; 2 = rough estimate; 3 = gross estimate; 4 = casual observations (see Methods). * = sites where chinstrap data is compared in the text with that reported by Croxall and Kirkwood (1979). FUSG = Southern giant fulmar (Macronectes giganteus), PETC = Cape petrel (Daption capense), STWI = Wilson's storm-petrel (Oceanites oceanicus), SHBE = Antarctic blue-eyed shag (Phalacrocorax atriceps), SHAM = American sheathbill (Chionis alba), SKUA = Brown and South Polar skuas (Catharacta lonnbergi and C. maccormicki), GUKE = kelp gull (Larus dominicanus), and TEAN = Antarctic Tern (Sterna vittata). Breeding status codes: P = possible breeder, ie. occurring in "appropriate" breeding habitat; PR = probable breeder, ie. exhibiting territorial behavior; @ = confirmed breeder, ie. nest(s) with eggs or pre-fledged young.

| | | Penguins | | Other Seabirds | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| # Location | Date | Chinstrap | Gentoo | FUSG | PETC | STWI | SHBE | SHAM | SKUA | GUKE | TEAN |
| Elephant Island | | | | | | | | | | | |
| 1. Seal Islands | 1/30 | 20,000 & 125 Macaroni[2][1] | - | @ | @ | PR | 6 | @ | P | P | PR |
| 2. Cape Lindsey | 1/30 | 120[2] | - | - | P | P | 3 | P | - | P | - |
| King George Island | | | | | | | | | | | |
| 3. 4-5 km West Cape Melville near Melville Peak | 1/31 | - | - | - | - | - | - | - | - | @ | PR |
| *4. Cape Melville | 1/31 | 8000-9000[2] | - | P | PR | P | 200-300 | P | P | P | P |
| 5. Spit opposite Trowbridge Is. | 1/31 | - | - | - | - | - | - | P | P | @ | P |
| 6. Trowbridge Is. | 1/31 | 2000[2] | - | - | - | - | - | - | - | - | - |
| 7. Taylor Point & one offshore rock | 1/31 | - | - | @ | - | - | 100 | P | P | P | P |
| 8. Carolyn Bluff & hillside to North | 1/31 | 5000-6000[2] | - | - | - | - | - | - | - | - | - |
| *9. Southeast corner North Foreland | 1/31 | 10,000[2] | - | @ | - | - | - | - | @ | - | - |
| *10. North Foreland proper | 1/31 | 50,000[3] | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| 11. Hole Rock | 1/31 | - | - | - | - | - | 30 | - | - | - | - |
| 12. Emerald Cove | 1/31 | 200[2] | - | PR | - | - | 1 | P | - | @ | - |
| 13. Brimstone Peak | 1/31 | 10,000[4] | - | P | - | - | - | P | P | P | P |
| 14. Brimstone Peak to next point to West | 1/31 | 5000-7000[2] | - | - | - | - | - | - | - | - | - |
| 15. Gam Point | 1/31 | - | - | - | - | - | - | - | - | - | P |
| *16. False Round Pt. | 1/31 | 100,000-175,000[3] | - | P | - | - | - | - | @ | P | - |
| 17. Small point just East of Pottinger Point | 1/31 | 500-600[2] | - | - | - | - | - | P | P | P | - |
| 18. Pottinger Point | 1/31 | 150,000-200,000[3] | - | - | - | - | - | @ | @ | P | - |
| 19. Kellick Island | 1/31 | 30,000-50,000[3] | - | - | - | - | - | P | P | P | - |
| 20. Owen Island | 1/29 | 25,000+[2] | - | - | - | - | - | P | P | P | P |
| *21. Tartar Island/Round Pt. | 1/29 | 30,000-40,000[2] | - | - | - | P | - | P | P | P | P |
| 22. Vicinity of Davey Pt. | 1/29 | 25,000[2] (10,000 & 15,000) | - | - | - | - | 15@ | - | P | @ | PR |
| 23. Stigant Point | 1/29 | 13,550[1] | - | - | - | P | - | P | P | PR | - |
| 24. Offshore rocks, Bell Point | 2/1 | 3000-5000[2] (3 groups) | - | - | - | P | 20@ | P | P | PR | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25. Northwest side of Fildes Peninsula | 2/1 | 150[2] | - | PR | PR | - | 15 | P | P | P | P |
| 26. Nebles Point | 2/11 | - | 2500[2] | - | - | - | - | - | P | P | - |
| *27. Barton Peninsula | 2/12 | 3500[2] | - | @ | - | - | - | P | P | - | - |
| 28. Stranger Pt. | 2/12 | 150-200[2] | 1500-2000(c)[2] | - | - | - | - | P | P | - | - |
| 29. Northwest Telefon Rocks | 2/12 | 2000[2] | 10[2] | - | - | - | - | P | P | - | - |
| 30. Demay Pt. | 2/12 | 3000[2] | - | - | - | - | - | - | - | - | - |
| 31. Chabrier Rock | 2/12 | 2500[2] | - | P | - | - | 75@ | - | - | - | - |
| 32. Rocks near Low Head | 2/12 | - | 75 (c)[2] | - | - | - | - | P | P | P | - |
| *33. Lions Rump | 2/12 | 400[2] | 3000 (c)[2] | - | - | - | - | - | P | P | - |
| 34. Penguin Island | 2/12 | >1000[4] | - | @ | P | - | - | P | P | P | P |
| *35. Turret Point | 2/12 | 300[2] | - | @ | - | - | 100@ | P | P | PR | PR |
| Nelson Island | | | | | | | | | | | |
| 36. Vicinity of Rip Pt. | 2/1 | a 500-1000[2]<br>b 100[2]<br>c 15,000-20,000[2] | - | @ | PR | - | 14 | P | P | P | P |
| 37. Nancy Rock | 2/1 | "covered with penguins"[4] | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| 38. Withen Island | 2/1 | "covered with penguins"[4] | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| 39. Pt. 3-4 km East of Harmony Point | 2/1 | 1500-2000[2] | - | P | P | - | 4 | P | P | P | - |
| 40. From site 39 to Harmony Pt. | 2/1 | - | - | P | P | - | 1 | - | P | P | P |
| 41. Harmony Point | 2/1 | > 300,000[3] | - | @ | - | - | 1 | - | @ | P | - |
| 42. The Toe | 2/11 | 20,000-25,000[2] | - | - | - | - | - | P | P | P | - |
| 43. Duthoit Point | 2/11 | - | 700-800[2] | - | - | - | 100@ | P | P | P | - |
| 44. Pt. 2-3 km North of Duthoit Pt. | 2/11 | - | 900[2] | P | - | - | - | - | P | P | - |
| Robert Island | | | | | | | | | | | |
| 45. Newell Point | 2/1 | 15,000-20,000[2] | - | P | P | P | 35@ | P | @ | P | P |
| 46. Pt. 4-5 km West of Newell Point | 2/1 | - | - | @ | - | - | 1 | - | PR | P | - |
| 47. Next pt. to West of site 46 | 2/1 | - | - | @ | - | - | - | - | P | @ | - |
| 48. Heywood Is. | 2/1 | "almost as many as Harmony Pt., Nelson Is." | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| 49. Long pt. Northwest corner of island | 2/1 | - | - | @ | PR | - | 8 | - | P | @ | P |
| *50. Edwards Point | 2/11 | 40[2] | - | - | - | - | - | - | - | - | - |
| 51. Robert Point | 2/11 | 5000[2] | - | @ | - | - | - | P | @ | - | - |
| 52. Kitchen Point | 2/11 | 2500[2] | - | @ | - | - | 45@ | - | - | P | PR |
| 53. Salient Point | 2/11 | - | - | - | - | - | - | - | - | PR | P |
| Greenwich Island | | | | | | | | | | | |
| 54. Canto Point | 2/1 | - | - | P | - | - | - | - | P | - | - |
| 55. Large is. North of Dee Island | 2/1 | "large colony"[4] | ? | ? | ? | ? | ? | ? | ? | ? | ? |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 56. Mt.Plymouth to Duff Pt. | 2/2 | - | - | P | - | - | 9 | - | P | PR | - |
| 57. Romeo Island | 2/2 | 500[2] | - | - | - | - | - | - | P | - | - |
| 58. Unnamed Island | 2/2 | - | - | - | - | - | - | - | - | PR | P |
| 59. Rock East of Cave Is. | 2/2 | - | - | - | - | - | 40@ | P | - | - | - |
| 60. East Cave Is. | 2/2 | - | - | - | - | - | - | - | - | PR | - |
| 61. Triangle Pt. | 2/10 | - | 1000[2] | - | - | - | 15@ | P | - | - | - |
| 62. Spit Pt. | 2/10 | - | 4000-5000[2] | - | - | - | - | P | P | P | - |
| 63. Fort Point | 2/10 | 3500[2] | 250[2] | - | - | - | - | P | P | - | - |
| 64. Hardy Cove | 2/11 | - | - | - | - | - | - | - | P | @ | - |
| <u>Livingston Island</u> | | | | | | | | | | | |
| 65. Zed Island | 2/2 | 8000[2] | - | - | - | - | - | P | P | P | P |
| 66. Williams Pt. & Dunbar Is. | 2/2 | - | - | P | - | - | 17 | - | P | P | PR |
| 67. Desolation Is. | 2/2 | 18,000[2] | - | - | - | - | - | P | P | P | P |
| 68. Wood Island | 2/2 | 5000-6000[2] | - | - | - | - | - | - | - | - | - |
| 69. Siddons Pt. | 2/2 | - | - | - | - | - | 1 | - | - | P | P |
| 70. Black Pt. | 2/2 | - | - | P | - | - | - | P | P | P | P |
| *71. Cape Shirreff | 2/2 | 20,800[1] | 750[1] | P | - | - | 3 | - | P | P | P |
| 72. Telmo Island | 2/3 | - | - | - | - | - | - | P | P | PR | - |
| 73. Mercury Bluff | 2/3 | - | - | - | - | - | - | - | P | - | P |
| 74. Rowe Pt. to Lair Pt. | 2/3 | - | - | - | - | - | 35@ | - | P | P | PR |
| *75. Lair Point | 2/3 | 50[1] | 200[1] | - | - | - | - | - | @ | PR | - |
| *76. Robbery Beach | 2/3 | - | - | - | - | - | - | - | - | PR | PR |
| 77. Window Island | 2/3 | 50-100[2] | - | - | PR | - | - | P | - | P | PR |
| 78. North Byers Pen. | 2/3 | - | - | - | - | - | - | - | - | PR | @ |
| 79. Kermone Is. | 2/3 | - | - | - | - | - | - | P | P | P | - |
| *80. Start Pt. to Devils Pt. | 2/4 | 5000-6000[a,2] | 2000[b,2] | @ | P | - | 120@[a] | P | P | @ | P |
| [a = rock off Devils Pt.; b = 1 km NE Devils Pt] | | | | | | | | | | | |
| 81. Rugged Is. | 2/4 | - | - | - | - | - | - | P | - | PR | PR |
| 82. Long Rock | 2/9 | - | - | - | - | - | - | - | - | PR | - |
| 83. Pt. just East of Devils Point | 2/9 | - | - | @ | P | - | - | P | P | PR | PR |
| 84. Vietor Rock | 2/9 | 200[2] | - | - | - | - | - | - | - | - | - |
| 85. Pt Northwest of Vietor Rock | 2/9 | 100[2] | - | - | - | - | - | - | - | - | P |
| *86. Elephant Point | 2/9 | 1500[2] | 500[2] | P | - | - | - | - | P | P | P |
| 87. Island just off Elephant Pt. | 2/9 | 500[2] | 50[2] | - | - | - | - | - | - | - | - |
| *88. Hannah Pt. West | 2/9 | 2500[2] | 50[2] | - | - | - | - | - | - | - | - |
| 89. Hannah Pt. East | 2/9 | - | 150-200[2] | PR | PR | - | 20@ | - | - | PR | PR |
| 90. 1-2 km Northwest Miers Bluff | 2/9 | 80[2] | 20[2] | - | - | - | - | - | - | - | - |
| 91. Miers Bluff | 2/9 | 5000[2] | - | - | - | - | - | P | - | P | P |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 92. Cove 3-4 km Northeast Miers Bluff | 2/9 | 200[2] | - | - | - | - | - | - | - | - | - |
| 93. East side False Bay | 2/10 | - | 50[2] | - | - | - | - | - | P | - | - |
| 94. Barnard Pt. West | 2/10 | 750 (2 groups)[2] | - | - | - | - | - | P | P | - | - |
| 95. Barnard Pt. East | 2/10 | several thousand[4] | ? | ? | ? | ? | ? | ? | ? | ? | ? |
| 96. Rugged Rocks off Renier Pt. | 2/10 | 3000[2] | - | - | - | - | 40@ | P | - | - | - |
| *97. Half Moon Is. | 2/10 | 6000[2] | - | - | - | - | - | - | - | P | P |
| Deception Island | | | | | | | | | | | |
| *98. Bailey Head | 2/8 | 100,000-150,000[3] | - | - | - | - | - | P | - | - | - |
| 99. Macaroni Point | 2/8 | >1000[4] | - | - | - | - | - | - | - | - | - |
| *100. Bluff West of site 99 | 2/8 | 400[1] | - | - | - | - | - | P | - | PR | - |
| 101. Shoreline 2-3 km West of Macaroni Pt. | 2/8 | - | - | - | P | - | - | P | P | P | - |
| 102. Stretch of shoreline 2-3 km North of site 103 | 2/8 | - | - | - | P | - | - | - | - | PR | - |
| 103. Unnamed point | 2/8 | - | - | - | P | - | - | - | - | P | - |
| *104. Mainland pt. Northeast of New Rock | 2/8 | 15,000[2] | - | - | - | - | - | - | - | PR | - |
| *105. Pt. 5-6 km Northwest of South Point | 2/8 | 15,000[2] | - | - | - | - | - | - | - | - | - |
| *106. First bluff West of South Point | 2/8 | 4000-5000[2] | - | - | - | - | - | P | P | - | - |
| *107. Entrance Point | 2/8 | 4000[2] (5 groups) | - | - | - | - | - | - | - | - | - |
| *108. Pt. Northwest of Entrance Point | 2/8 | 250[2] | - | - | - | - | - | - | - | - | - |
| Snow Island | | | | | | | | | | | |
| 109. Cape Timblon | 2/4 | - | - | P | - | P | 15 | - | P | P | PR |
| 110. Byewater Pt. | 2/4 | 700[2] (4 groups) | - | - | - | - | 6@ | - | P | - | P |
| 111. Pt. 2-3 km South of Byewater Pt. | 2/4 | 2350-2850[2] (3 groups) | - | @ | - | - | 5 | - | P | P | PR |
| 112. Castle Rock | 2/4 | 5000[2] | - | - | PR | - | - | P | - | - | - |
| 113. Monroe Point | 2/4 | 2000[2] | - | - | - | - | - | P | P | P | - |
| 114. Cape Conway | 2/8 | 400[2] | - | - | - | - | - | P | - | PR | - |
| 115. Tooth Rocks | 2/8 | - | - | - | P | - | - | - | - | P | - |
| 116. Pt. 1-2 km East of Cape Conway | 2/8 | 2000-2500[2] | 200-300[2] | - | - | - | - | P | - | P | - |
| 117. Hall Pen. West/South pt. | 2/8 | 2000[2] | - | - | - | - | - | P | P | - | - |
| 118. Hall Pen. East/North pt. | 2/8 | 3000[2] | - | P | - | - | - | - | - | - | - |
| 119. Presidents Head | 2/8 | 100[2] | - | @ | P | P | - | - | P | @ | PR |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Smith Island | | | | | | | | | | | | |
| 120. Cape Smith | 2/4 | 4500[1] | - | - | - | - | - | - | P | - | - |
| 121. Cape James | 2/5 | 10,000[2] | - | - | - | - | - | P | P | P | - |
| Low Island | | | | | | | | | | | | |
| 122. Large is. off Northeast pt. of Cape Wallace | 2/5 | 50,000[3] | - | - | - | - | 60@ | P | - | - | - |
| 123. Other offshore rocks/ islands Cape Wallace | 2/5 | 8100[2] (8000 & 100) | - | - | - | - | - | P | P | P | PR |
| 124. Cape Wallace | 2/5 | 150,000-300,000 | 5-600[2] | @ | - | - | - | P | P | P | - |
| 125. First bluff South of Cape Wallace | 2/5 | 50,000-100,000[3] | - | P | - | - | - | P | P | P | - |
| 126. Vicinity Jameson Pt. | 2/5 | 40,000-70,000[3] | - | P | - | - | - | P | P | P | - |
| 127. Pt. South of Jameson Pt. | 2/5 | 1500[2] | - | - | - | - | - | P | P | PR | - |
| 128. Islands, Jameson Pt. to Cape Gary | 2/5 | 2750[2] (5 groups) | - | - | - | - | 50@ | P | P | P | - |
| 129. Cape Gary | 2/5 | 200,000[3] | - | - | - | - | 20@ | @ | P | - | - |
| 130. Pt. 2-3 km East of Cape Gary | 2/5 | 6000[2] (2 groups) | - | P | - | - | - | P | - | - | - |
| 131. Rock 1 km South of Cape Hooker | 2/5 | 4500[2] | - | - | - | - | - | P | P | - | P |
| 132. Cape Hooker | 2/5 | 15,000-20,000[2] | - | - | - | - | - | P | P | - | - |
| 133. Two pts. North of Cape Hooker | 2/5 | 100[2] | - | - | - | - | - | P | P | - | - |
| 134. Promontories on North-central coast | 2/5 | 100[2] | - | - | - | - | - | P | - | P | PR |

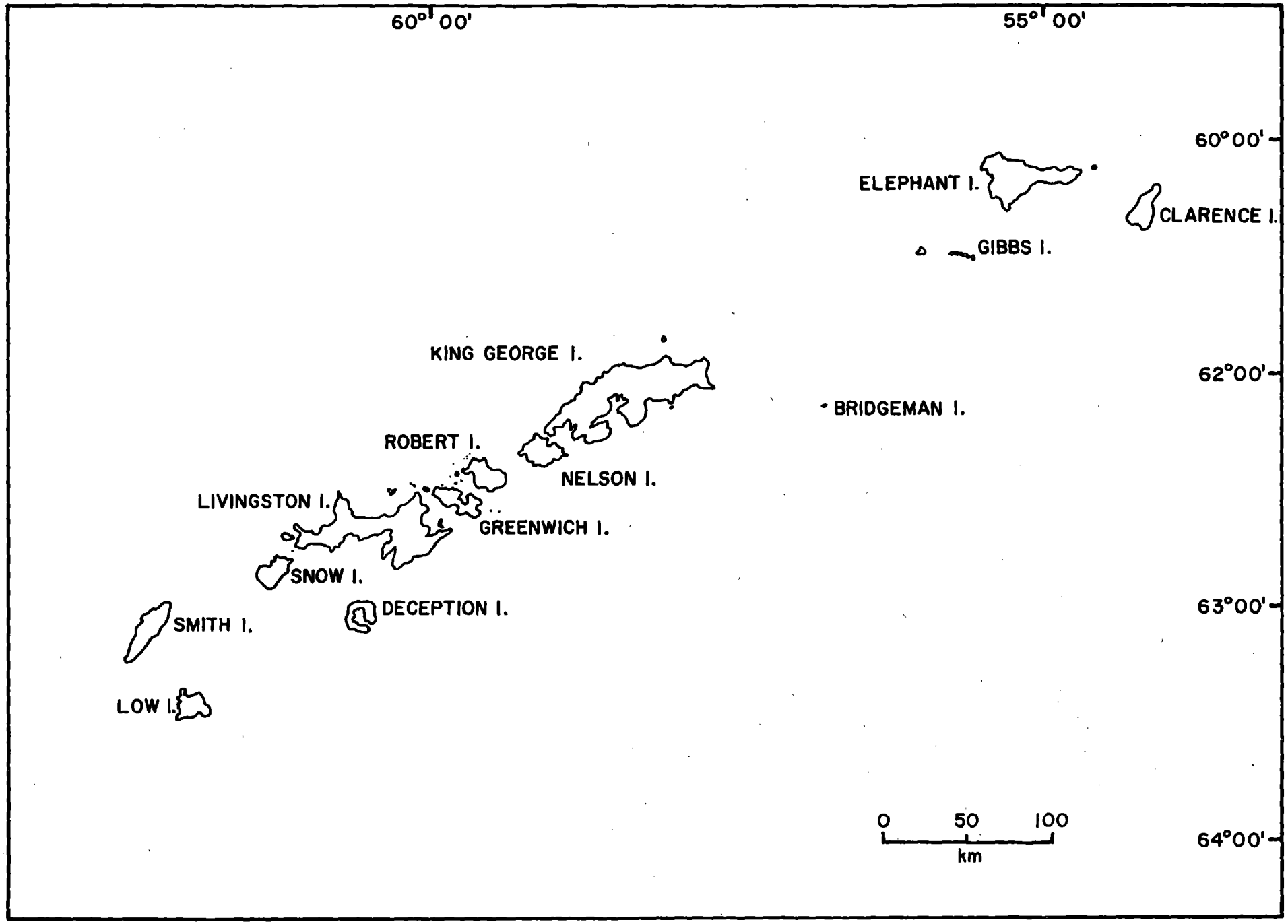


Figure 1. South Shetland Islands, Antarctica study area.

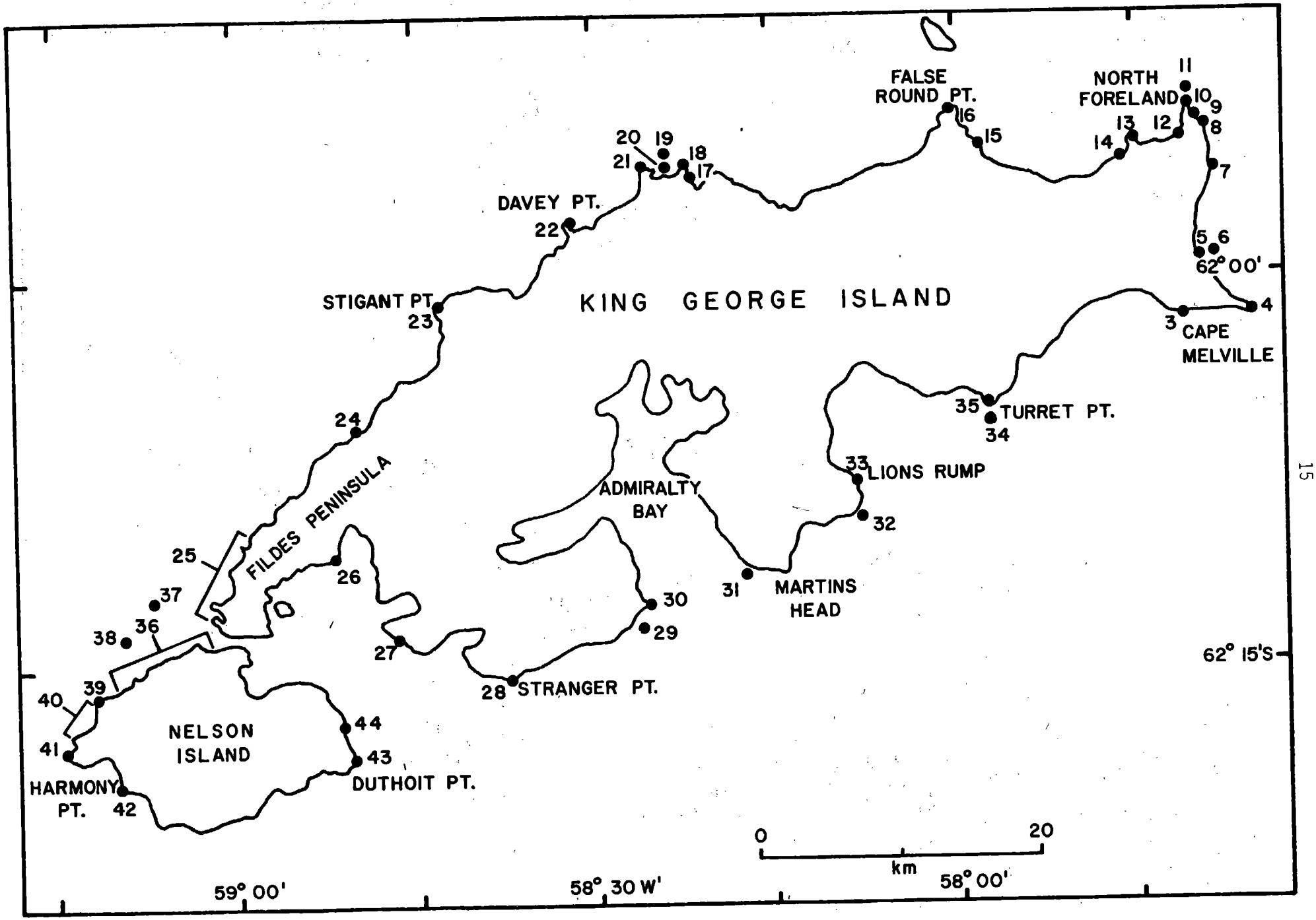


Figure 2. King George and Nelson Islands, South Shetland Islands; survey sites (Table 1) indicated by numbered dots and bracketed stretches of coastline.

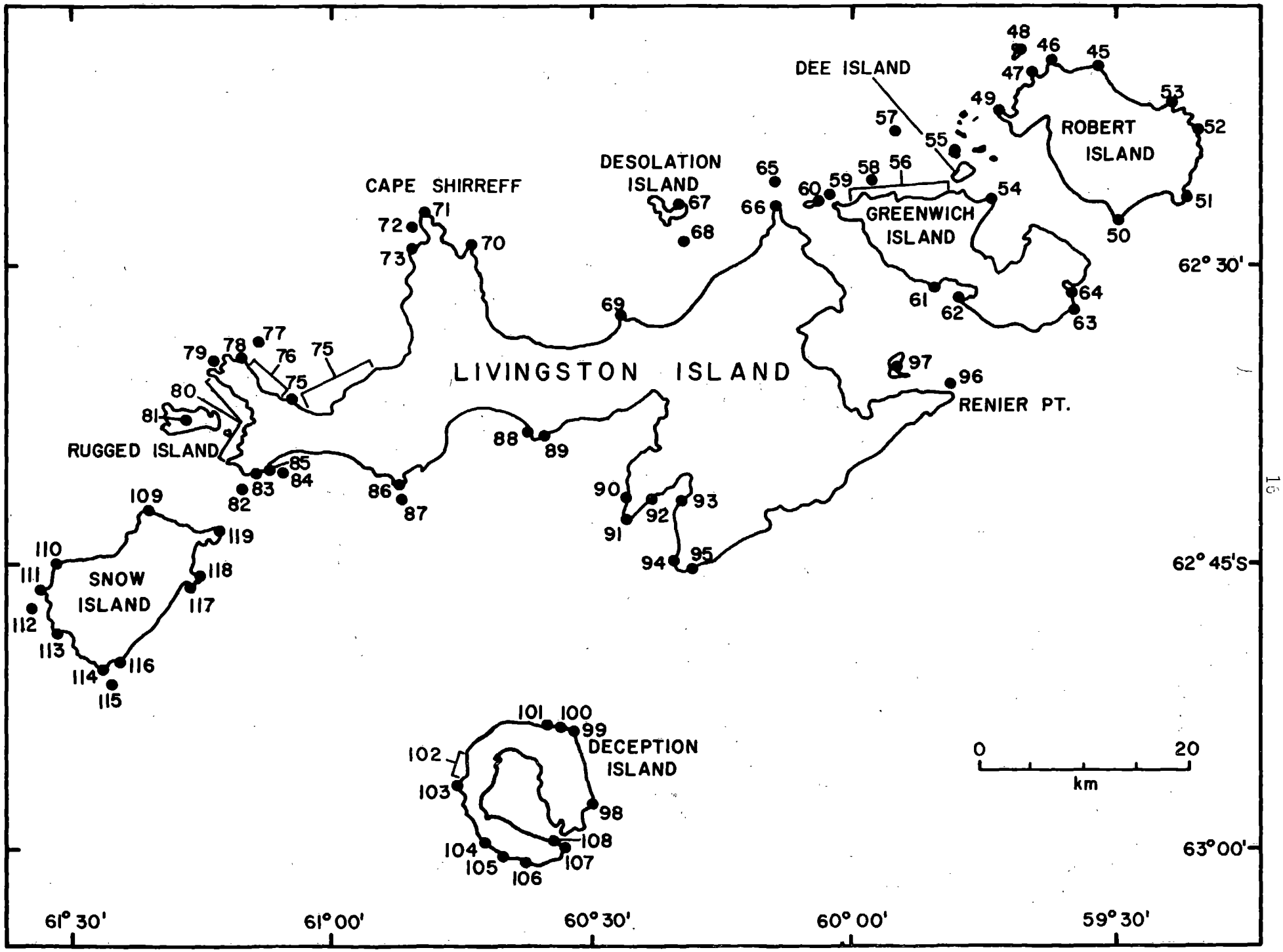


Figure 3. Robert, Greenwich, Livingston, Deception, and Snow Islands, South Shetland Islands; survey sites (Table 1) indicated by numbered dots and bracketed stretches of coastline.

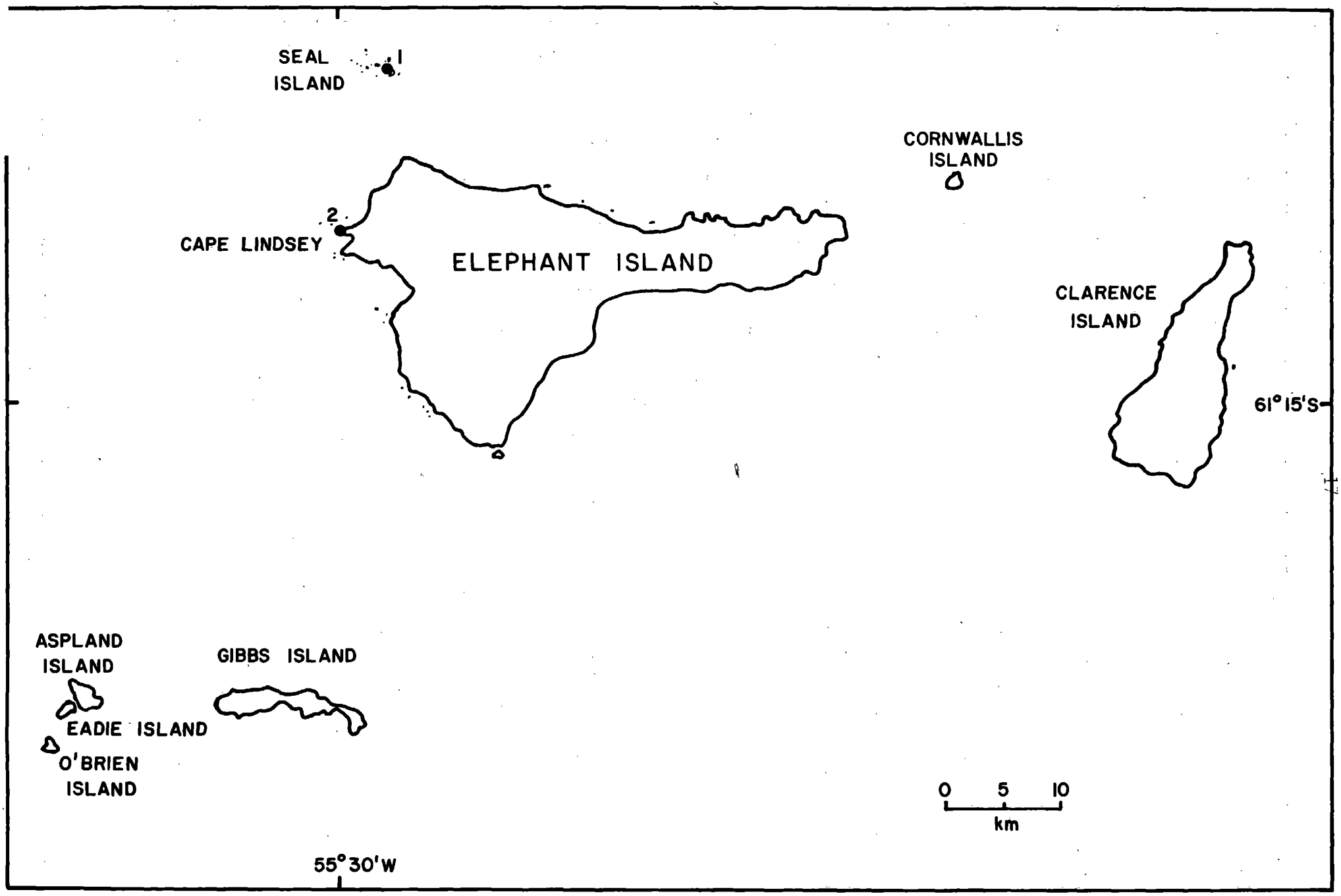


Figure 4. Elephant Island group of the South Shetland Islands; survey sites (Table 1) indicated by numbered dots.

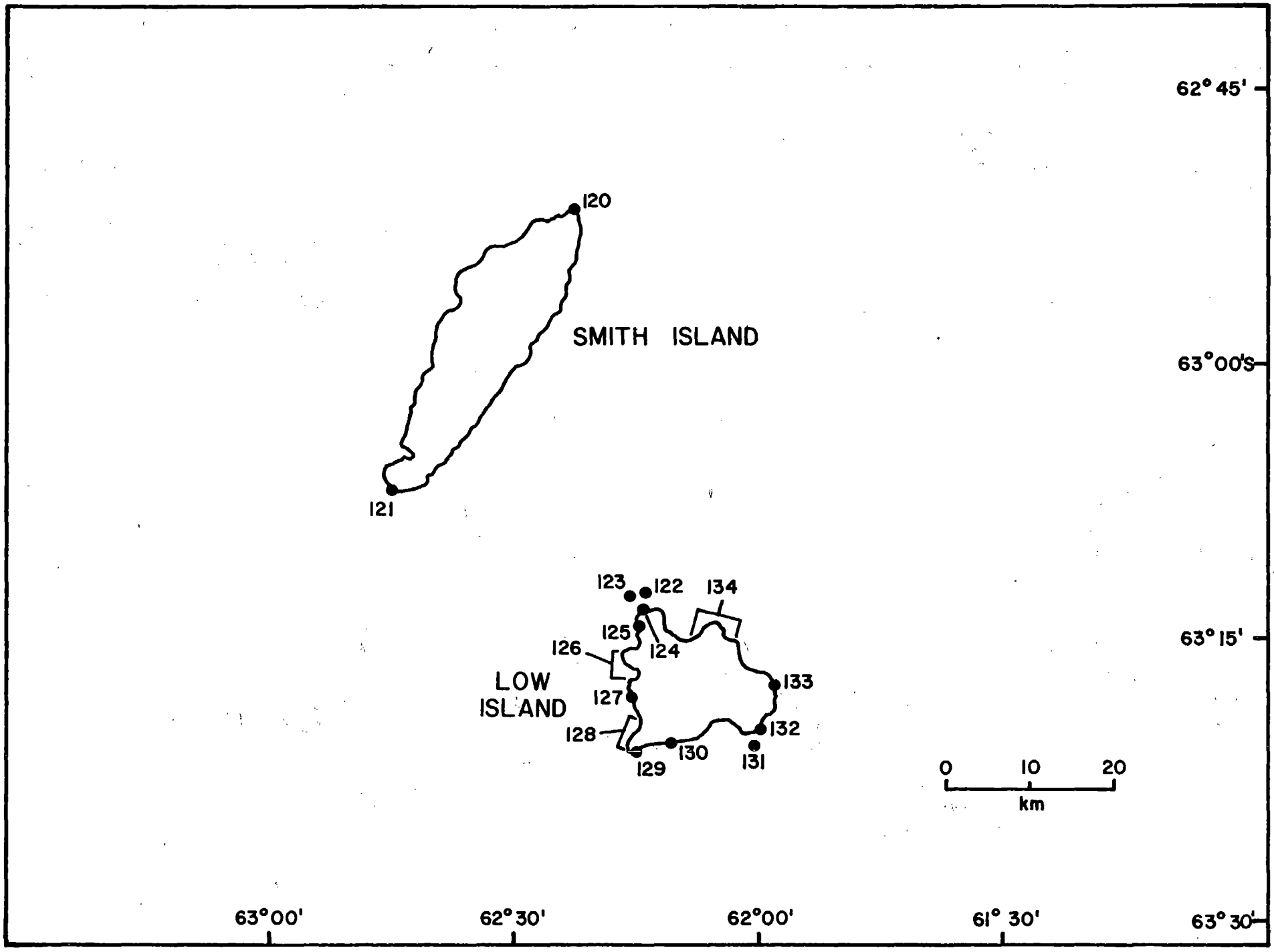


Figure 5. Smith and Low Islands, South Shetland Islands; survey sites (Table 1) indicated by numbered dots and bracketed stretches of coastline.

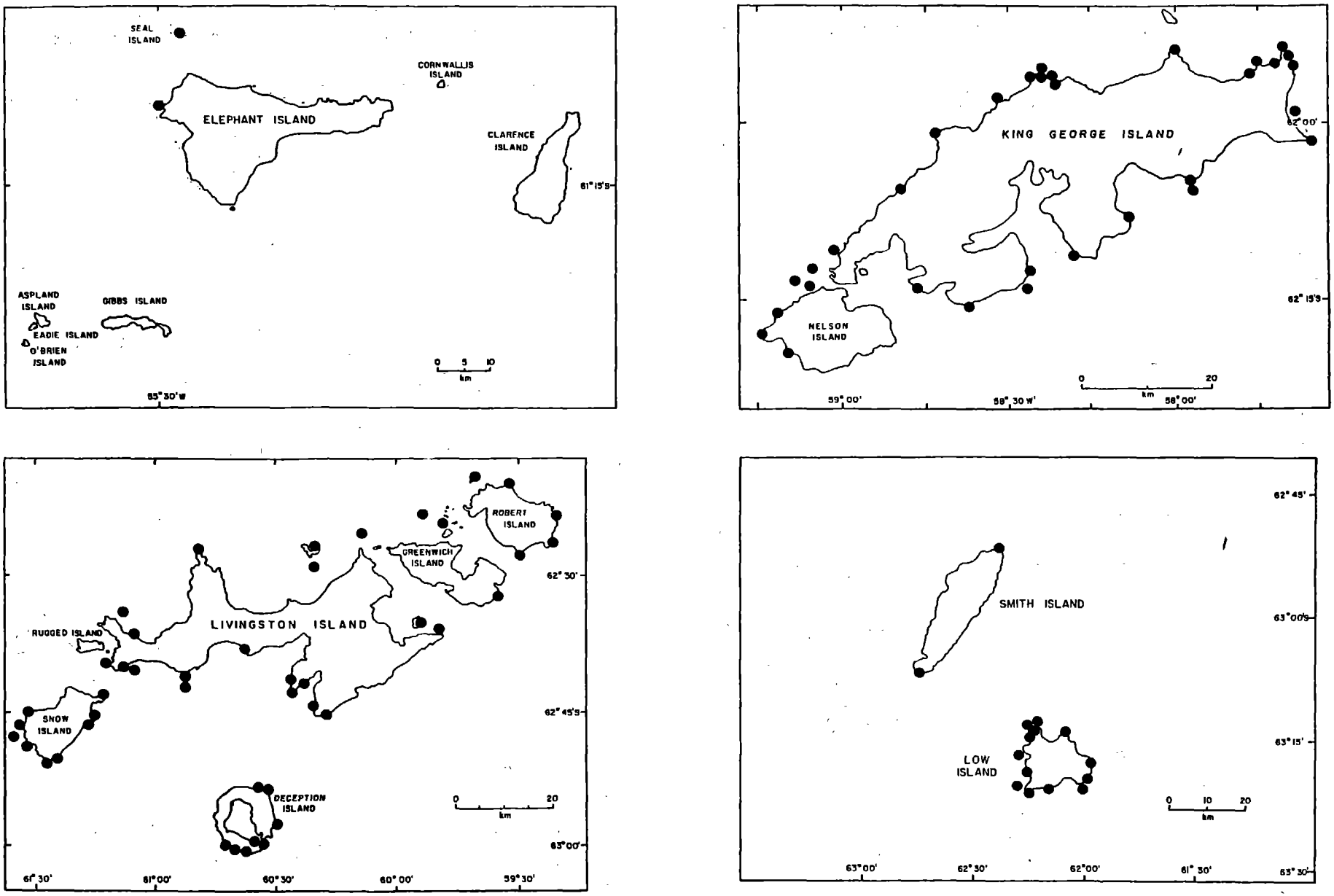


Figure 6. Breeding distribution of Chinstrap Penguins in the South Shetland Islands during Jan-Feb 1987; colony sites indicated by dots (Table 1).

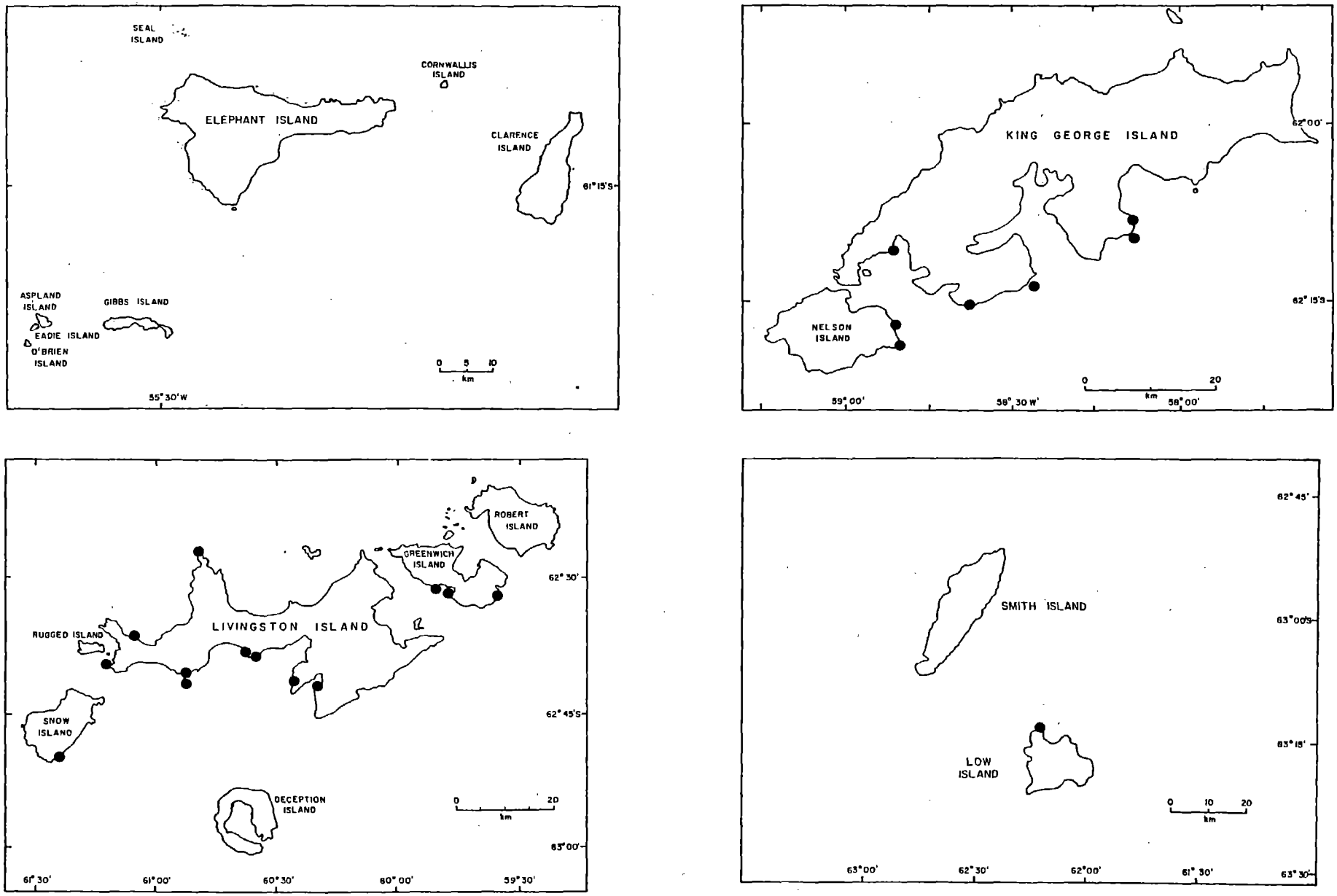


Figure 7. Breeding distribution of Gentoo Penguins in the South Shetland Islands during Jan-Feb 1987; colony sites indicated by dots (Table 1).

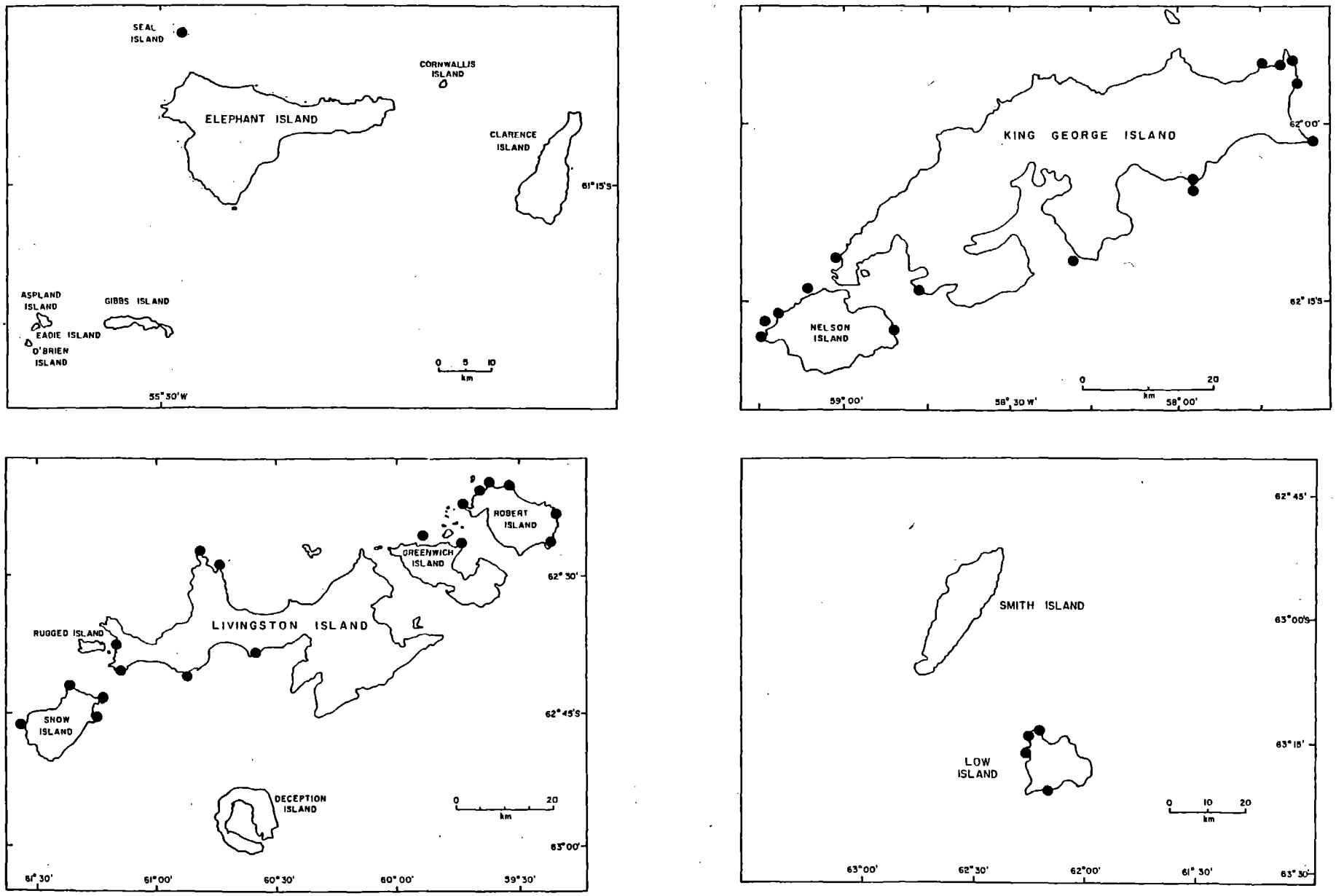


Figure 8. Breeding distribution of Southern Giant Fulmars in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

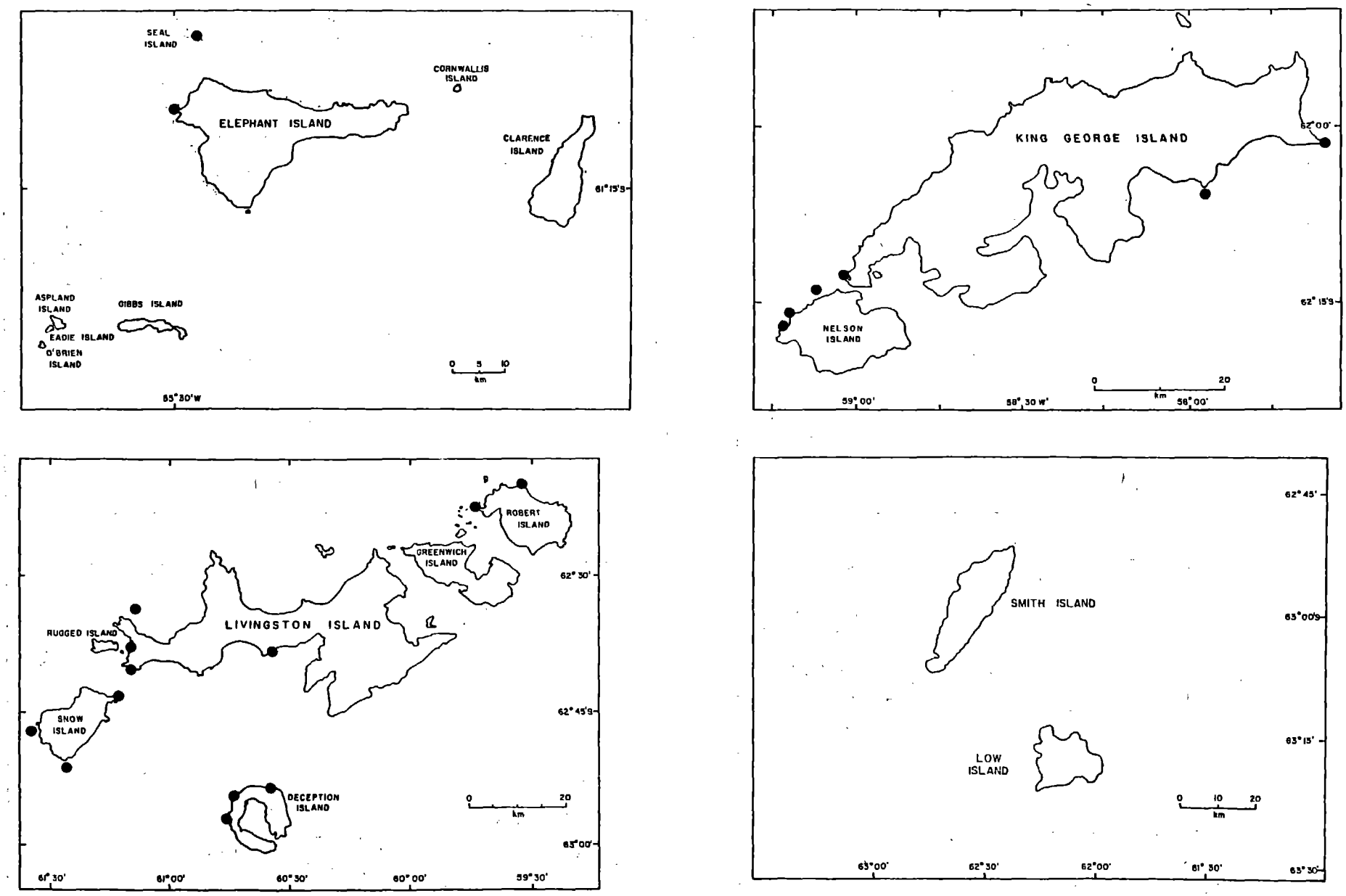


Figure 9. Breeding distribution of Cape Petrels in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

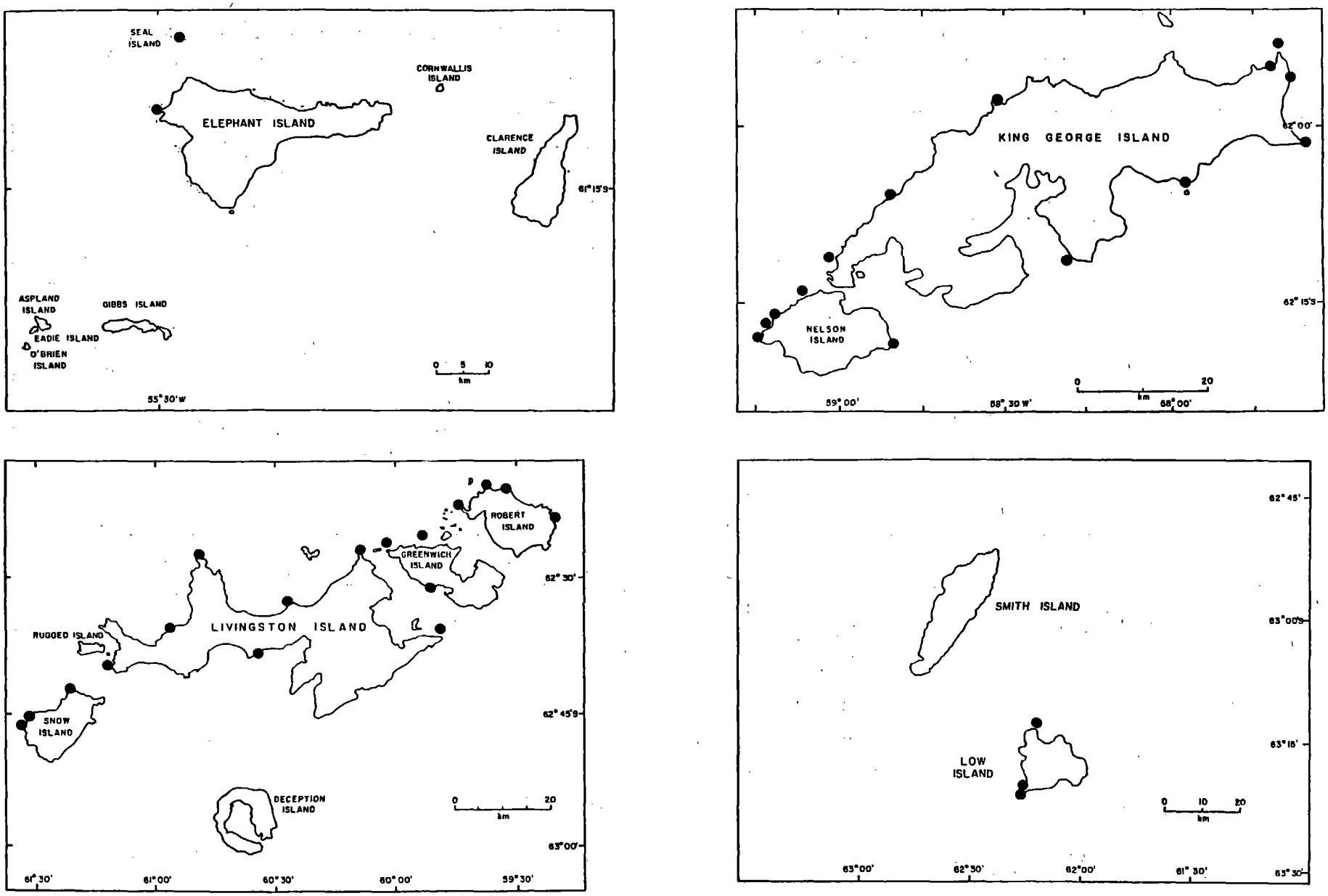


Figure 10. Breeding distribution of Antarctic Blue-eyed Shags in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

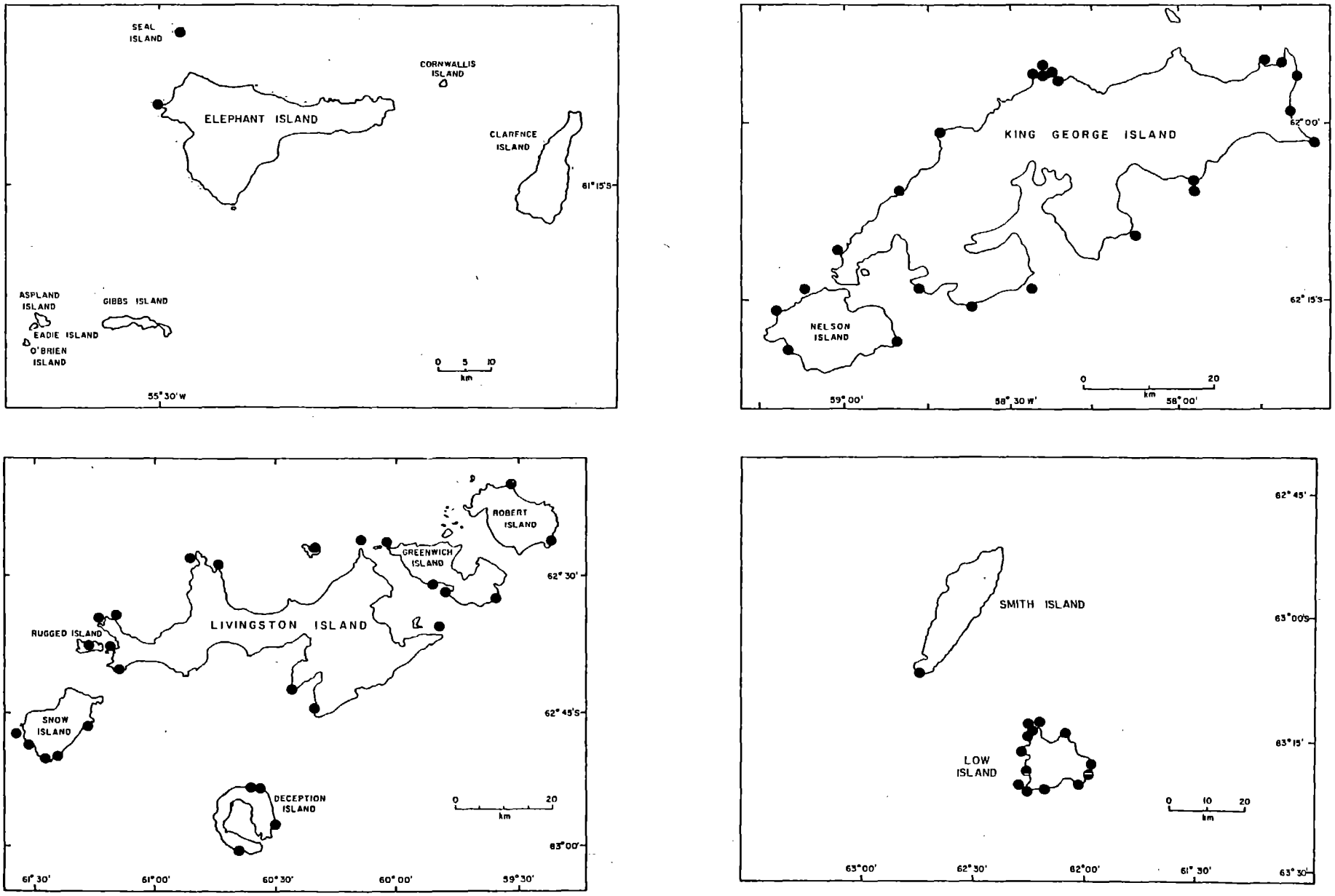


Figure 11. Breeding distribution of American Sheathbills in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

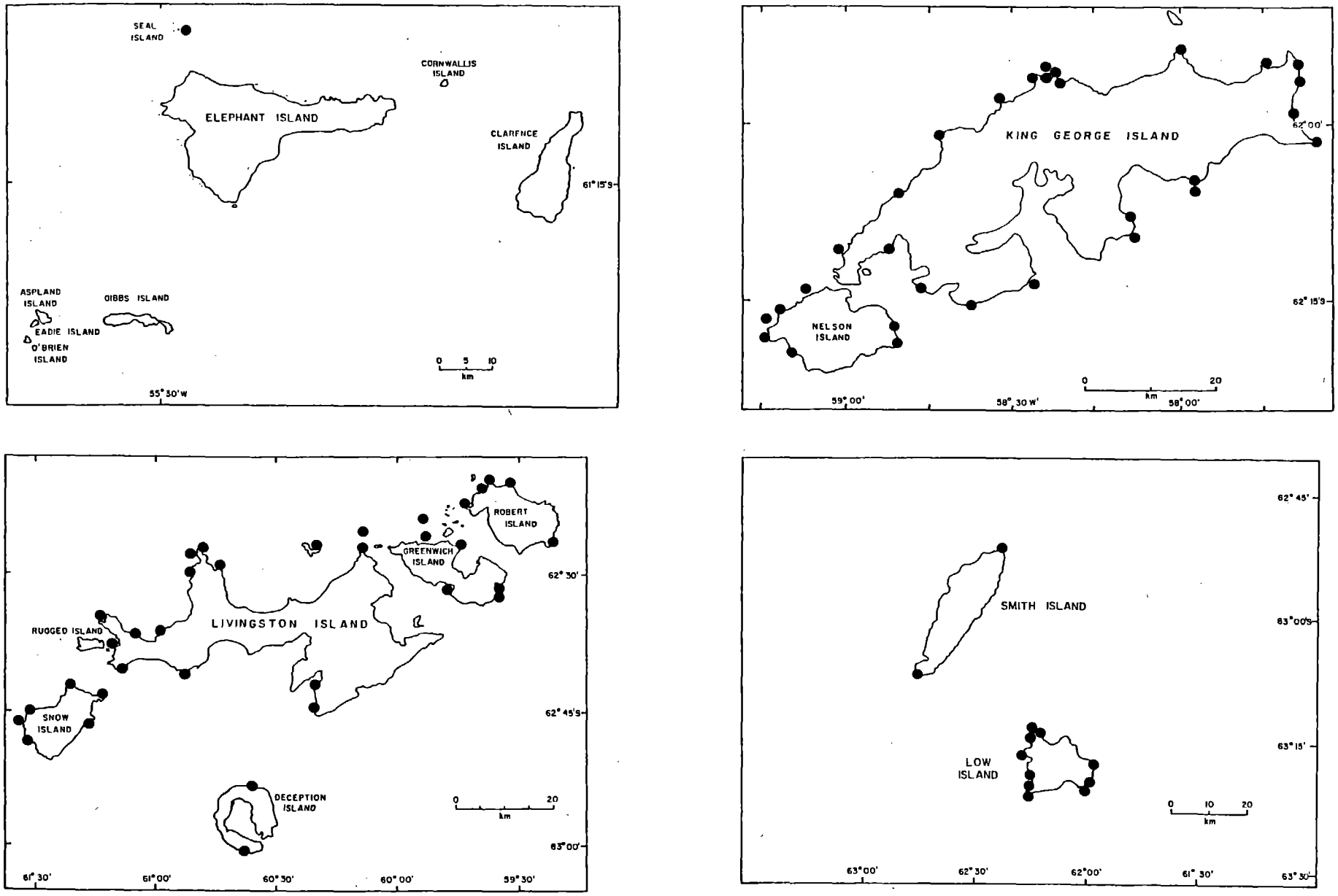


Figure 12. Breeding distribution of skuas (primarily Brown Skuas) in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

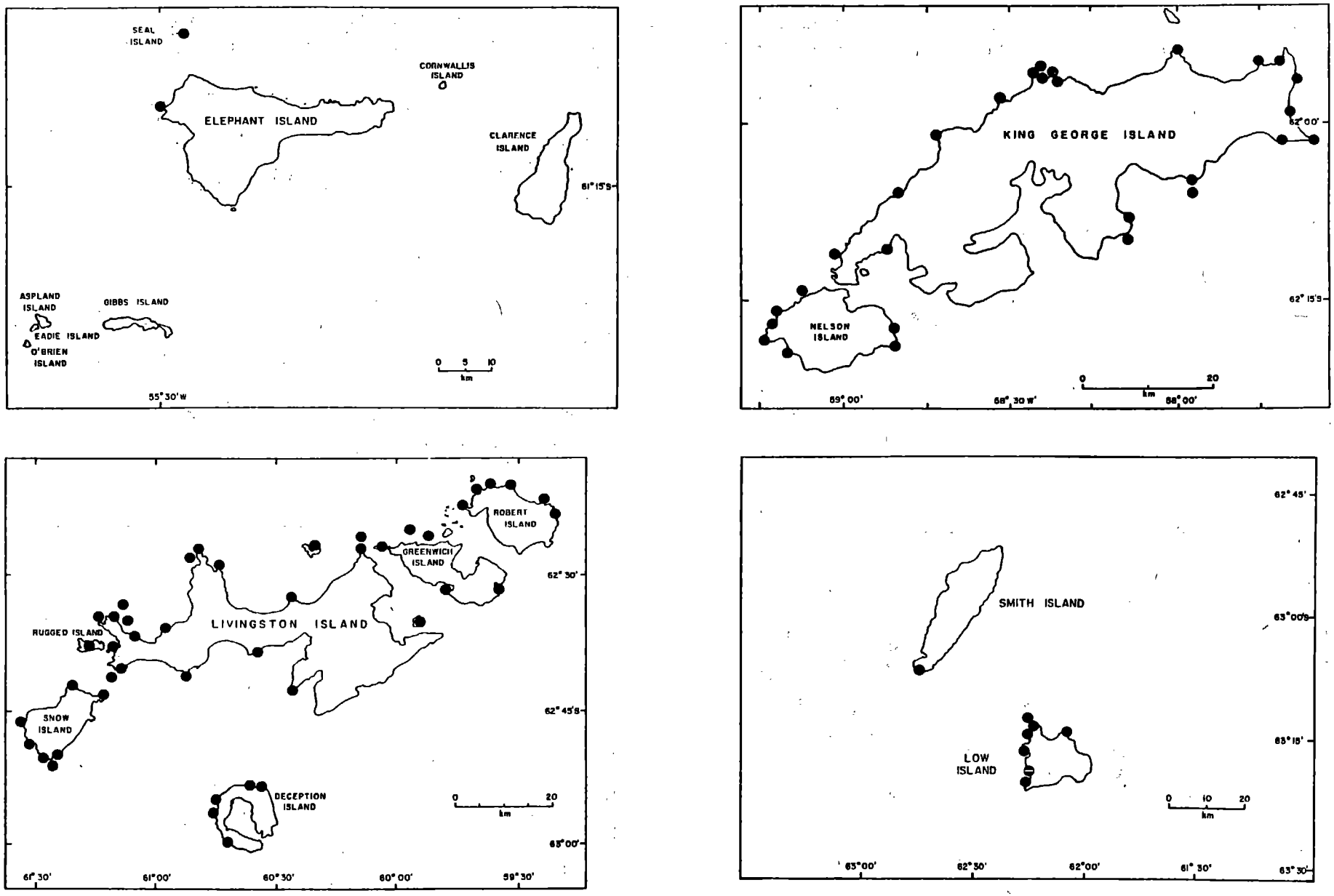


Figure 13. Breeding distribution of Kelp Gulls in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).

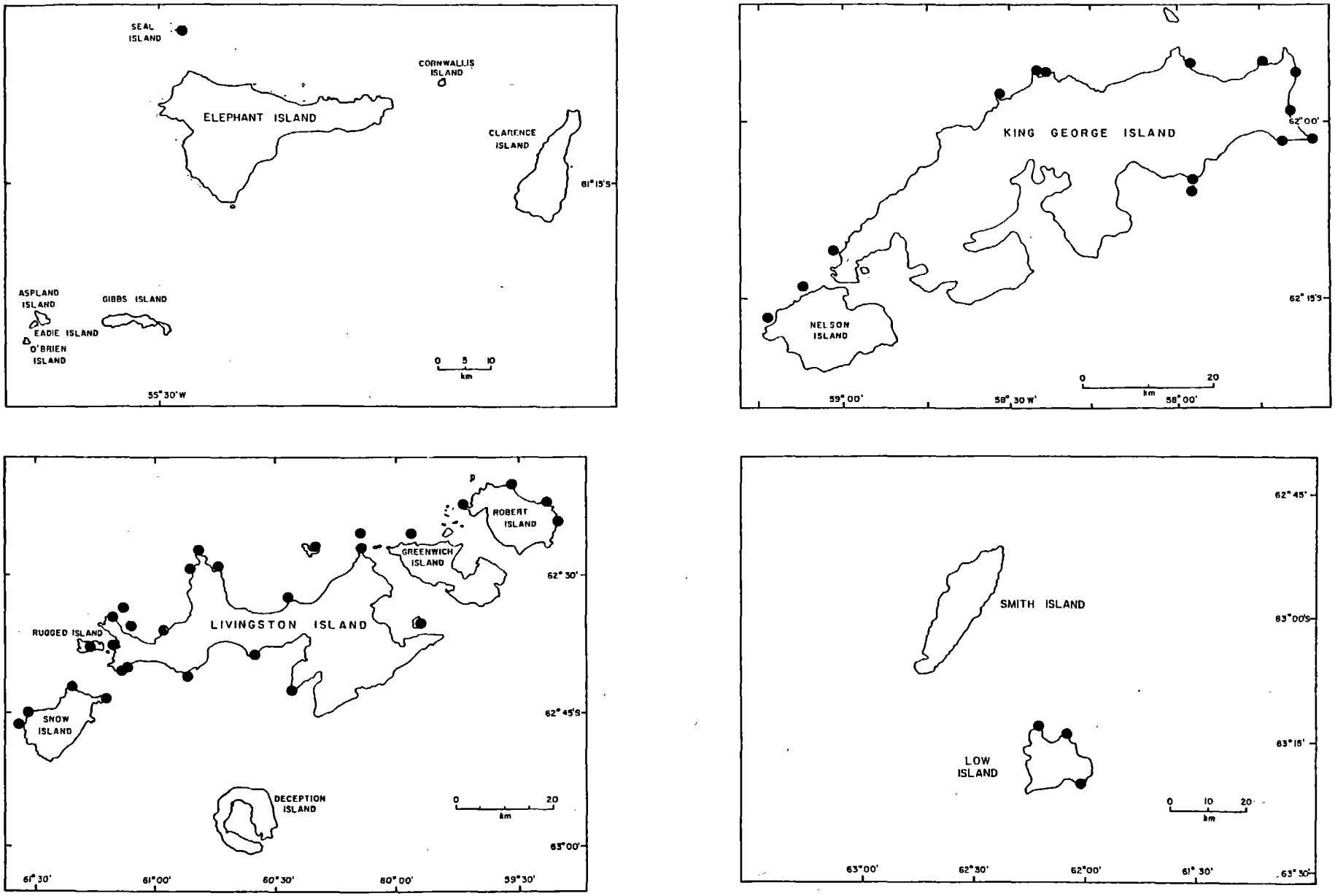


Figure 14. Breeding distribution of Antarctic Terns in the South Shetland Islands during Jan-Feb 1987; dots indicate sites of suspected or confirmed breeding (Table 1).



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*(continued from inside front cover)*

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