

LAND-BASED OBSERVATIONS OF SEABIRDS OFF SUB-ANTARCTIC MACQUARIE ISLAND DURING 2002 AND 2003

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SUMMARY

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A total of 391 hours of land-based observations of seabirds visible at sea was conducted over a 59-week period from sub-Antarctic Macquarie Island during 2002 and 2003. We detected 43 species. The results provide an indication of species occurrence in inshore waters off the island and reveal seasonal trends for breeding species such as Light-mantled Sooty *Phoebastria palpebrata*, Black-browed *Thalassarche melanophrys* and Grey-headed *T. chrysostoma* Albatrosses, Northern *Macronectes halli* and Southern *M. giganteus* Giant Petrels, White-headed *Pterodroma lessonii*, Blue *Halobaena caerulea* and Grey *Procellaria cinerea* Petrels, Macquarie Island Cormorant *Phalacrocorax atriceps purpurascens*, Subantarctic Skua *Catharacta antarctica*, Kelp Gull *Larus dominicanus* and Antarctic Tern *Sterna vittata*. This study also provides the first quantitative assessment of abundance of non-breeding species around Macquarie Island. Counts reveal the timing of passage movements and arrival and departure dates for visiting species such as Antarctic Fulmar *Fulmarus glacialis*, Pintado or Cape *Daption capense* and Mottled *Pterodroma inexpectata* Petrels, Short-tailed Shearwater *Puffinus tenuirostris* and Wilson's Storm Petrel *Oceanites oceanicus*. Species rarely reported from Macquarie Island that were detected during these surveys include Northern Royal *Diomedea sanfordi*, Southern Royal *D. epomophora*, Salvin's *T. salvini*, Buller's *T. bulleri* and Sooty *Phoebastria fusca* Albatrosses, Snow *Pagodroma nivea*, Antarctic *Thalassoica antarctica* and White-chinned *Procellaria aequinoctialis* Petrels and Little Shearwater *Puffinus assimilis*.

Key words: sub-Antarctic seabirds, petrel, albatross, prion, sea watch, Macquarie Island

INTRODUCTION

Macquarie Island (54°30'S, 158°55'E), an Australian possession, is the most southerly of the sub-Antarctic islands in the Pacific sector of the Southern Ocean. Situated on the Macquarie Ridge, approximately 1100 km south-southwest of New Zealand, the island lies just to the north of the Antarctic Polar Front in the Polar Frontal Zone.

Macquarie Island covers an area of approximately 127 km² and is an important breeding site for large numbers of land-breeding marine predators, including 86 000 seals and more than three million seabirds. Of the seabirds, two or three endemic breeding taxa are present. Several small islands in close proximity to Macquarie Island provide additional roosting and breeding sites for seabirds. Judge and Clerk Islets, which can be wave-washed in storms, are located 11 km to the north; Bishop and Clerk Islets, which support some breeding seabirds, are located 37 km to the south.

At present, only one commercial fishery operates in the region: it was developed in 1994 and targets Patagonian Toothfish *Dissostichus eleginoides*. Current management of the fishery by Australian agencies restricts fishing to trawling by a single licensed vessel; the discharge of factory waste that may attract and provision seabirds is prohibited. Fishing is permitted year-round, with most activity occurring between October and February. To date, no illegal or unreported fishing has been noted around the island

Australian Fisheries Management Authority (AFMA) 1999]. A study by Goldsworthy *et al.* (2001) indicated weak trophic linkages around the island between key breeding seabirds and seals (selected by biomass), Patagonian Toothfish and its fishery. The ecologic impacts of the current fishery on key breeding seabirds and seals were thus considered minimal, but it was recognized that future novel fisheries might compete more directly with these seabirds and seals (Goldsworthy *et al.* 2001). In contrast to the information available for breeding seabirds with a large total biomass, the impacts of current and future fisheries on both breeding seabirds with small populations and non-breeding seabirds that visit waters around Macquarie Island are unknown.

The Australian National Antarctic Research Expeditions (ANARE) established a permanent research station on Macquarie Island in 1948. Subsequently, populations of various breeding seabirds have been the focus of intensive studies. There has been an emphasis on studies of the larger summer-breeding species that breed above ground (e.g. penguins—Hindell 1988a, 1988b, 1989; Robertson *et al.* 1988; Hull & Wilson 1996; Hull 1999; albatrosses—Copson 1988, de la Mare & Kerry 1994, Weimerskirch & Robertson 1994; giant petrels *Macronectes* spp.—Johnstone 1977, Woehler & Johnstone 1988; and the Macquarie Island Cormorant *Phalacrocorax atriceps purpureascens*—Brothers 1985; Kato *et al.* 1996a, 1996b). Few studies have been conducted on the smaller, mostly burrow-nesting, species (e.g. Warham 1967, Brothers 1984, M. Schulz unpubl. data, S. Robinson & R. Gales unpubl. data).

However, non-breeding seabirds that visit the waters around Macquarie Island have not been the focus of any studies—with the exception of occasional incidental observations. Little is therefore known about the composition and seasonal variation of seabirds in the waters around Macquarie Island.

The objective of the present study was to provide an understanding of the year-round seasonal trends of seabirds that visit inshore waters of Macquarie Island. Such information would be of value in assessing the potential impact of current and novel trawl and long-line fisheries on seabirds visiting inshore waters.

METHODS

Sea watches for seabirds were conducted from headlands on Macquarie Island from 25 October 2002 until 5 December 2003 (Fig. 1). Observation periods were opportunistic, and the location

of observations was dictated by our primary work schedule. Effort varied between the various headlands, with most surveys being undertaken from locations on North Head or in the vicinity of Hurd Point (Fig. 1). We conducted at least one hour of observation each day during the 59-week period. Each observation period was undertaken by a single experienced observer seated on an elevated headland (>15 m above sea level [asl]). Observations were undertaken in all weather conditions, except when persistent rain, sea fog or storm-force onshore wind hampered visibility. We used a 20× telescope to scan continuously for seabirds over or on the water, identifying individuals (species-dependent) up to several kilometres offshore. During an observation period, the cumulative maximum number of individuals of each species observed was recorded. The sea watches provided a measure of relative abundance of all species.

In an effort to avoid double-counting, we applied the following criteria: i) where individuals of a species were frequently changing direction or many individuals were travelling in multiple directions, the maximum number of individuals visible at any one time during the observation period was recorded; ii) in circumstances where birds were not changing direction and most or all individuals were travelling in the same direction, a count of all individuals passing the observation point was recorded; and iii) for some low-density species (e.g. the great albatrosses *Diomedea* spp.), regardless of activity, a more accurate count was made where possible by noting the plumage characteristics of individuals.

Because of the variability of count location, time of day and weather conditions, daily observations were combined into one-week periods. Results are presented as mean hourly rates of observation in a given week. Most daily surveys were conducted for a one-hour period ($n = 360$). The results of shorter (range: 30–50 min.; $n = 42$) or longer (2–2.5 h, $n = 4$) surveys were converted to sightings per hour. Surveys that lasted fewer than 30 minutes were excluded. Seasons are defined as follows: spring, September to November; summer, December to February; autumn, March to May; and winter, June to July.

RESULTS AND DISCUSSION

We recorded 43 species of seabirds during 391 sea-watch hours over a 59-week period. Because of variable weather conditions and availability of the observers, these surveys were conducted on an average of 25 days each month (range: 11–29 days; complete months only; Table 1). Most surveys were conducted from North Head or the Australian Antarctic Division research station at the northern tip of the island, or from Hurd Point at the southern end of the island (Fig. 1). All other locations ($n = 19$) were used opportunistically.

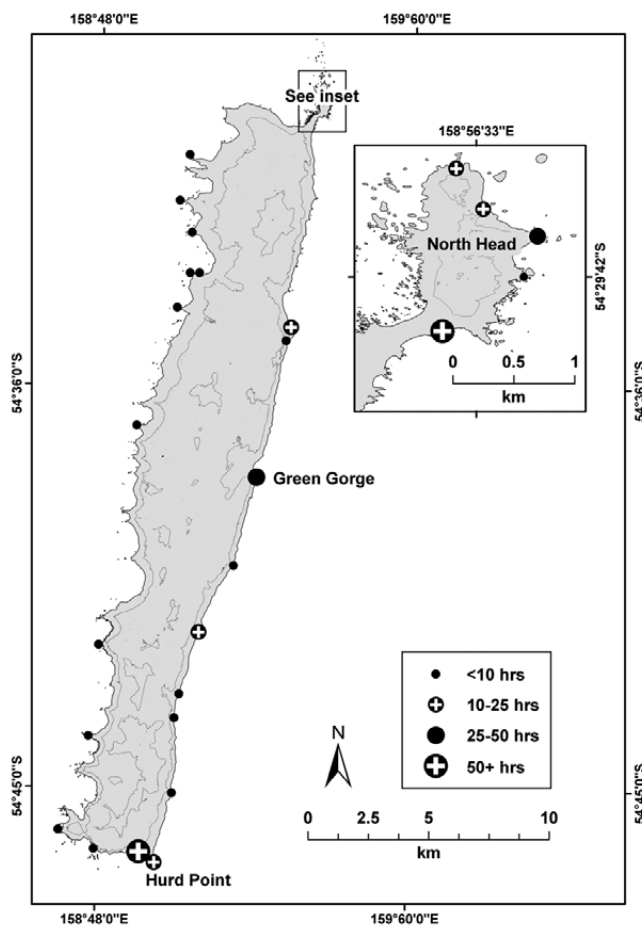


Fig. 1. Macquarie Island, showing seabird observer effort (in hours) for each observation point. The whole-island map shows 100- and 300-m contours. The inset map shows North Head with 50- and 100-m contours.

TABLE 1
Number of days and total hours of sea watches by month^a from headlands around Macquarie Island

	2002			2003												Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Days of observation (n)	6	11	11	21	22	23	27	28	25	26	27	29	25	25	5	311
Total hours	6.8	17.9	21.7	28.8	37.8	32.5	30.5	33.0	28.5	29.5	29.5	34.0	29.0	27.0	5.0	391.67

^aSurveys commenced 25 October 2002 and ceased 5 December 2003.

King Penguin *Aptenodytes patagonicus*

King Penguin *Aptenodytes patagonicus* is a locally abundant breeding species present throughout the year. Hourly rates of encounter were lowest for the months of May to September, although birds were still recorded in all months and during most weeks (Fig. 2). Numbers peaked in mid- to late November in both years (33–43 birds per hour) and in late February to March (33–82 birds per hour).

Gentoo Penguin *Pygoscelis papua*

Gentoo Penguin *Pygoscelis papua* is a locally common summer breeder. As a year-round resident, small numbers were recorded throughout the year, with no clear seasonal trends (Fig. 3). Lowest counts were obtained in the periods November to March and July to August. Low counts in the first of these periods may be attributable to the location of the sea watches, because most were conducted in areas away from known breeding colonies.

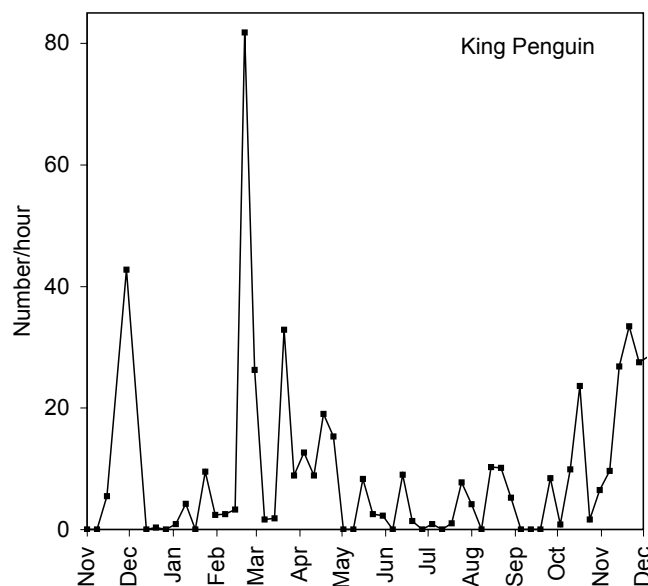


Fig. 2. Average hourly counts per week of the King Penguin *Aptenodytes patagonicus* offshore from Macquarie Island, October 2002 to December 2003.

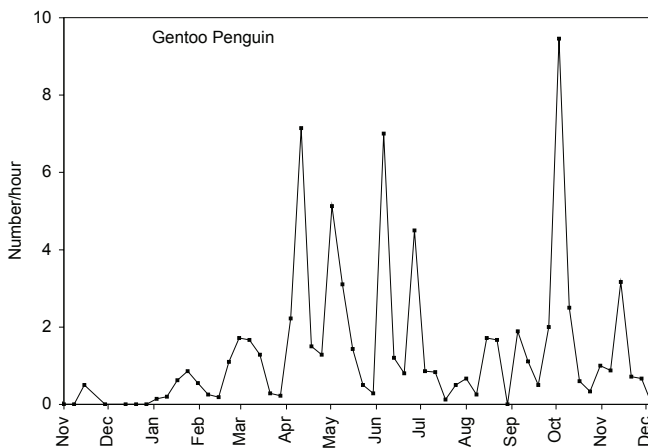


Fig. 3. Average hourly counts per week of the Gentoo Penguins *Pygoscelis papua* offshore from Macquarie Island, October 2002 to December 2003.

Rockhopper Penguin *Eudyptes chrysocome*

Rockhopper Penguin *Eudyptes chrysocome* is a locally very common summer breeder. Hourly counts were generally low (< four individuals), although a peak occurred in the last week of April, when an average of 16 birds per hour was detected (Fig. 4). The species was absent from inshore waters from May to mid-October. The species was again recorded in the last week of October when an average of 14 birds per hour was detected. In mid-November numbers peaked at a weekly average of 44 birds per hour. This pattern of presence and absence is consistent with the presence of the species ashore at Macquarie Island, except that the birds typically leave colonies in late February to early March (Marchant & Higgins 1990), yet remain in nearby waters for another two months.

Royal Penguin *Eudyptes chrysolophus*

Royal Penguin *Eudyptes chrysolophus* is a locally abundant summer breeder. The species was absent from inshore waters from the last week of March to the end of September (Fig. 5). During the remaining period, numbers fluctuated markedly largely as a result of observer location. In particular, observations around Hurd Point detected large numbers of birds because those observations were made in the vicinity of the largest Royal Penguin colony on the island (ca. 500 000 pairs; Copson & Rounsevell 1987). The observed pattern of presence and absence is largely consistent with that of the species ashore at Macquarie Island, although small numbers are typically recorded ashore until mid-April, and returning birds are usually first detected by mid-September (Marchant & Higgins 1990).

Wandering Albatross *Diomedea exulans*

Wandering Albatross *Diomedea exulans* is a rare breeding species present throughout the year. There were 60 sightings of between one and four individuals per hour across all months of the year, with increased observations from January through March. It is often not possible to separate the various forms of the Wandering Albatross complex, but most individuals observed had attained a plumage that fell within the range observed in the local adult breeding population (i.e. Stages 3–6, see Harrison 1983 for definitions). Exceptions included a stage 1 juvenile on 8 January 2003 and stage 2 birds on 31 January, 1 and 13 February, and

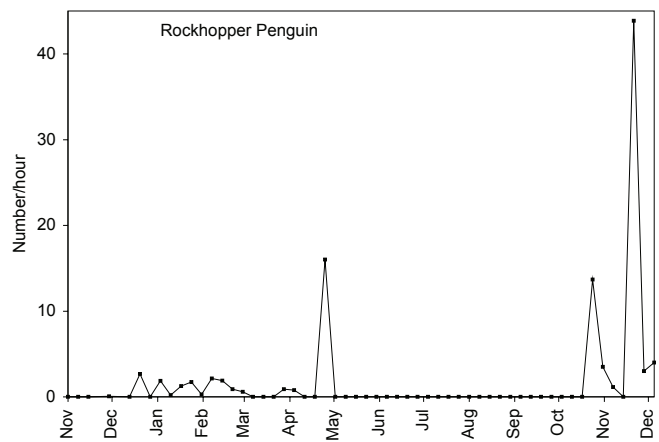


Fig. 4. Average hourly counts per week of the Rockhopper Penguin *Eudyptes chrysocome* offshore from Macquarie Island, October 2002 to December 2003.

11 March 2003. Note that stage 1 (juvenile) and stages 5 and 6 (old individuals in any population in which such a plumage state is attained) provide some relative measure of age, but that both the specific identity and the ages of stages 2, 3 and 4 are unknown.

Northern Royal Albatross *Diomedea sanfordi*

Northern Royal Albatross *Diomedea sanfordi* is a vagrant. Single individuals observed on 31 December 2002 and 5 January 2003 were possibly the same bird, judging by plumage characteristics.

Southern Royal Albatross *Diomedea epomophora*

Southern Royal Albatross *Diomedea epomophora* is a rare summer and autumn non-breeding visitor. The only sightings were of single individuals on 15 November 2002, 1 and 24 January and 2, 13 and 17 March 2003.

Black-browed Albatross *Thalassarche melanophrys*

Black-browed Albatross *Thalassarche melanophrys* is an uncommon summer breeder. This species was absent from Macquarie Island waters during the winter period, with the last sighting made on 8 April 2003 and the first returning individuals recorded on 20 August 2003, when three birds were observed (Fig. 6). The species was continuously present around Macquarie Island from mid-September to late March. Maximum numbers were recorded in the last week of November in both 2002 and 2003. The Campbell Albatross *Thalassarche impavida* was not recorded, although more distant individuals may have been overlooked.

Grey-headed Albatross *Thalassarche chrysostoma*

Grey-headed Albatross *Thalassarche chrysostoma* is an uncommon summer breeder. This species was present around Macquarie Island from mid-September to late April, with the last sighting on 25 April 2003 and the first returning individual observed on 20 September (Fig. 6). Maximum numbers were recorded in the last week of November in both 2002 and 2003. Seasonal fluctuations were similar to those seen with the preceding species, an exception being that first returns and last departures of Grey-headed Albatross were later than those of the Black-browed Albatross. This difference is probably as a result of the later breeding cycle of the Grey-headed Albatross at Macquarie Island (Copson 1988).

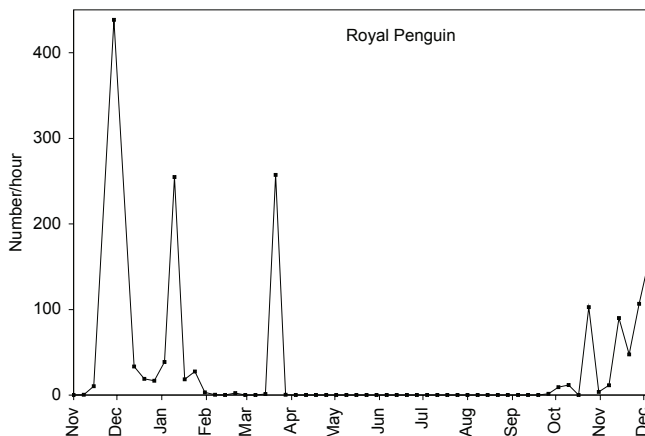


Fig. 5. Average hourly counts per week of the Royal Penguin *Eudyptes schlegeli* offshore from Macquarie Island, October 2002 to December 2003.

Shy Albatross *Thalassarche cauta*

Shy Albatross *Thalassarche cauta* is an uncommon summer and autumn non-breeding visitor. This species was observed on 28 days ($n = 88$ birds) between 30 November 2002 and 29 March 2003. Average hourly sighting rates by week during this period ranged from 0 to 2.3 birds per hour. Sightings of multiple individuals were clustered and tended to occur within four- to six-day periods.

Salvin's Albatross *Thalassarche salvini*

Salvin's Albatross *Thalassarche salvini* is a vagrant. The only sighting was of a single adult seen off North Head on 9 January 2003.

Buller's Albatross *Thalassarche bulleri*

Buller's Albatross *Thalassarche bulleri* is a rare summer and autumn non-breeding visitor. Singletons were recorded on 17 and 25 February and 10, 22 and 25 March, with two individuals seen in one-hour counts on 20 and 24 March 2003.

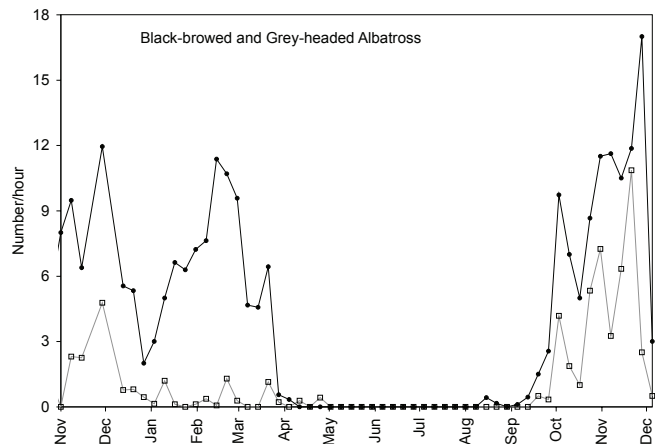


Fig. 6. Average hourly counts per week of two species of small albatrosses offshore from Macquarie Island, October 2002 to December 2003. The solid black line depicts the Black-browed Albatross *Thalassarche melanophrys* and the grey line depicts the Grey-headed Albatross *Thalassarche chrysostoma*.

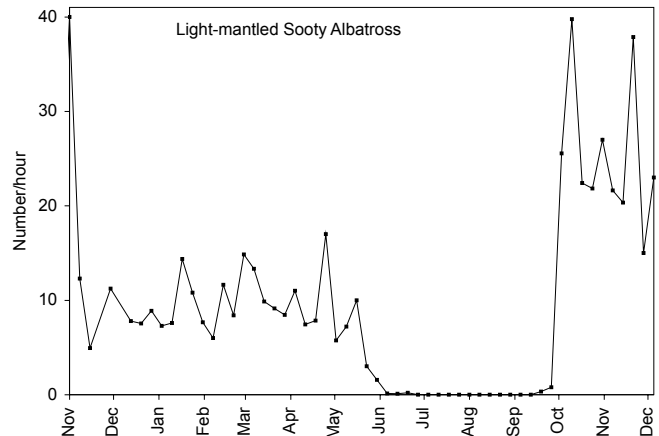


Fig. 7. Average hourly counts per week of the Light-mantled Sooty Albatross *Phoebastria palpebrata* offshore from Macquarie Island, October 2002 to December 2003.

Dark-mantled Sooty Albatross *Phoebastria fusca*

Dark-mantled Sooty Albatross *Phoebastria fusca* is a vagrant. The only sighting was of a single bird off Hurd Point on 30 November 2002. It or another individual was observed on the following day flying over steep grassy slopes supporting breeding Light-mantled Sooty Albatrosses.

Light-mantled Sooty Albatross *Phoebastria palpebrata*

Light-mantled Sooty Albatross *Phoebastria palpebrata* is a locally common summer breeder. This species returned to the island during the first week of October and was observed in varying numbers to late May (Fig. 7). Counts peaked from October through November with maximum counts of up to 40 individuals per hour during this time, a period of courtship display and nest building. The higher numbers of individuals than other albatrosses observed in sea watches reflects that the Light-mantled Sooty Albatross is the most abundant breeding albatross on Macquarie Island (Rounsevell & Brothers 1984).

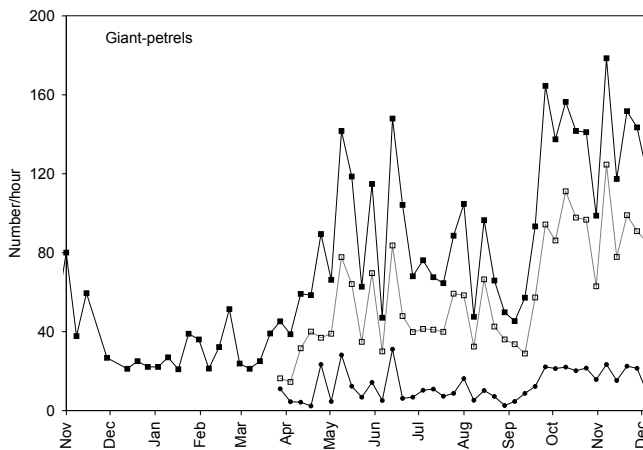


Fig. 8. Average hourly counts per week of giant petrels offshore from Macquarie Island, October 2002 to December 2003. The continuous black line denotes unidentified giant petrels; the grey line that commences in late March 2003 denotes Northern Giant Petrels *M. halli*, while the black line that commences in late March 2003 denotes Southern Giant Petrels *Macronectes giganteus*.

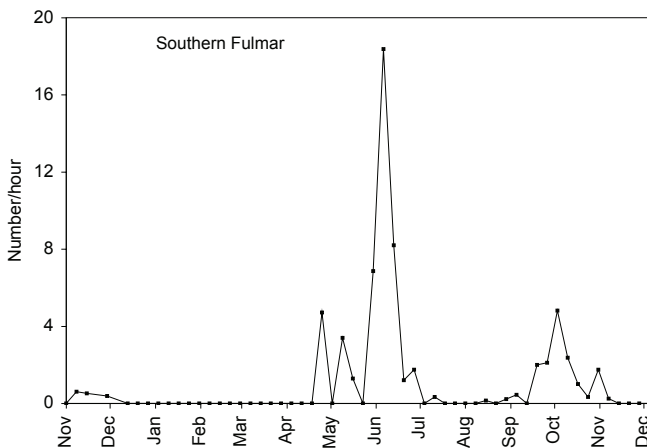


Fig. 9. Average hourly counts per week of the Antarctic Fulmar *Fulmarus glacialisoides* offshore from Macquarie Island, October 2002 to December 2003.

Southern and Northern Giant Petrels *Macronectes giganteus* and *M. halli*

Southern and Northern Giant Petrels *Macronectes giganteus* and *M. halli* are locally common summer breeders. Giant petrel numbers at sea fluctuated through the year with peak counts occurring May to June and late September to December. Until April 2003 no effort was made to identify individuals to species, and counts were combined. Subsequently, when possible, individuals were identified to species, and unidentified individuals were tallied as giant petrels (Fig. 8). Throughout this more intensive period of observation, Northern Giant Petrels ($n = 14\,566$) were sighted four times more frequently than Southern Giant Petrels ($n = 3\,277$). That population estimates for Macquarie Island show Southern Giant Petrel pairs outnumbering Northern Giant Petrel pairs breeding on the island (Southern Giant Petrel: 2000–2200 annual breeding pairs; Northern Giant Petrels: 1200 annual breeding pairs; Baker *et al.* 2002) suggests that the two species occupy different marine niches. Indeed, this trend is consistent, with Northern Giant Petrels foraging frequently in inshore waters, and Southern Giant Petrels foraging more frequently over deeper pelagic waters, as has been reported in southeastern Australia (Reid *et al.* 2002).

Antarctic Fulmar *Fulmarus glacialisoides*

Antarctic Fulmar *Fulmarus glacialisoides* is a common late autumn and spring non-breeding visitor (Fig. 9). Absent from December to mid-April. Regularly recorded during late April to mid-June, with maximum numbers recorded in the second week of June, when an average of 18.4 birds (maximum count: 64 in a single hour on 9 June) was detected per hour. The species was not recorded through much of July and August, with all sightings being of single individuals, before larger numbers reappeared in the first week of September. Fulmars continued to be recorded in low numbers until the second week of November. The two observed peaks in abundance might reflect a northerly movement through the region to winter foraging grounds and a southerly movement during late spring as birds return to their breeding grounds on the Antarctic Continent.

Antarctic Petrel *Thalassoica antarctica*

Observations indicated Antarctic Petrel *Thalassoica antarctica* to be a rare non-breeding visitor in spring. Two individuals were recorded on 7 September, three on 2 October, two on 4 October

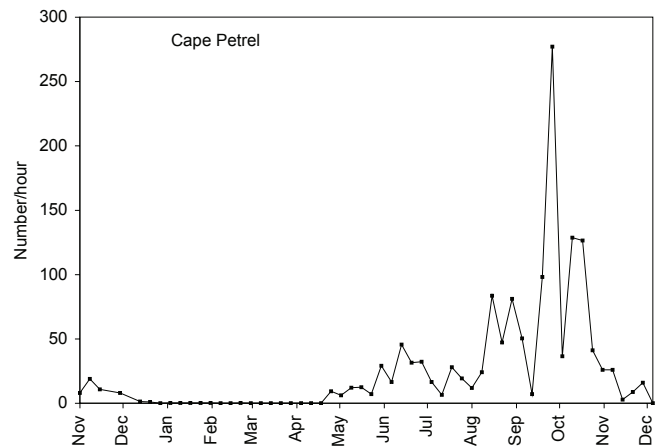


Fig. 10. Average hourly counts per week of the Cape or Pintado Petrel *Daption capense* offshore from Macquarie Island, October 2002 to December 2003.

and singletons on 5, 8 and 13 October. However, five fresh beach-washed specimens were located on west and south coast beaches in mid-July, suggesting that this species is also present offshore during winter months (Schulz & Lynn 2003b). Macquarie Island is likely to be at the northern edge of this species' usual range (e.g. Woehler *et al.* 1990).

Cape or Pintado Petrel *Daption capense*

Pintado Petrel *Daption capense* is primarily a common late autumn, winter and spring visitor, with a small breeding population present. A pronounced movement into the area was seen during May, and by the second week of June, an average of 45.5 birds was detected per hour (Fig. 10). Following a slight decrease during July, numbers subsequently increased markedly. In the last week of September, an average of 277 birds per hour was detected. On 22 September 2003, 468 Pintado (or Cape) Petrels were observed in a single hour, with most flying south in an almost continuous stream of birds. Similar movements were observed over the following two weeks, with a peak hourly count of 812 birds on 1 October 2003. During this time, the Pintado Petrel, along with giant petrels, was the most common species observed around Killer Whale *Orcinus orca* kills. Numbers decreased sharply after early October, so that by mid-November, a weekly average of fewer than 16 birds per hour was detected. Small numbers (1–10 birds per hour) from December to mid-April may be attributed to birds breeding around the island. Six nests were located on North Head during November 2003, and at least one nest was suspected on a stack off the west coast (Schulz & Lynn 2003b). Small numbers in flight off Hurd Point during this same period suggested that additional pairs may breed on Bishop and Clerk Islets or on rock stacks off the south coast. Large numbers of Pintado Petrels winter off southern Australia and New Zealand (Marchant & Higgins 1990). The peak in late September is consistent with a significant southerly passage of birds returning to breeding grounds around Antarctica.

Snow Petrel *Pagodroma nivea*

Snow Petrel *Pagodroma nivea* is a rare winter non-breeding visitor. The only record was of a single bird observed approximately 200 m off Hurd Point on 18 August 2003. During the study period, non-sea-watch records indicated that occasional individuals visit the island between March and September: a single bird flew over the

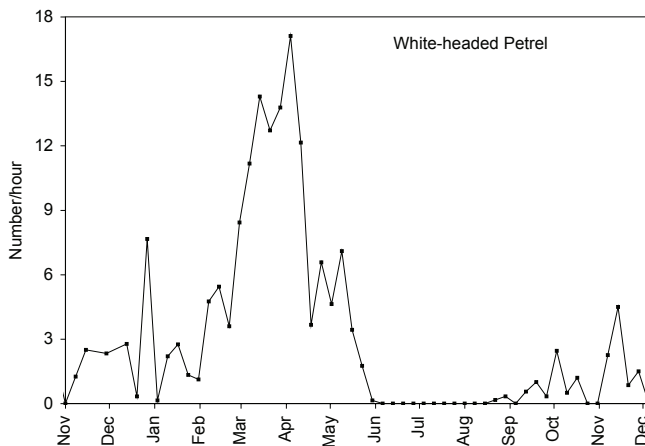


Fig. 11. Average hourly counts per week of the White-headed Petrel *Pterodroma lessonii* offshore from Macquarie Island, October 2002 to December 2003.

base on 27 March, a freshly dead specimen was located in a gully on the south end of the island on 16 August, and fresh remains were detected in a Subantarctic Skua *Catharacta antarctica* territory on 30 September (Schulz & Lynn 2003a, 2003b). Scofield & Wiltshire (2004) previously reported two specimens of the Snow Petrel from Macquarie Island that were collected in the mid-1990s.

Kerguelen Petrel *Aphrodroma brevirostris*

Kerguelen Petrel *Aphrodroma brevirostris* is a rare winter and spring non-breeding visitor. Seven records of single birds were noted on 27 October 2002 and on 26 June; 6, 8, 11 and 12 October; and 9 November 2003. The seasonal timing of records is consistent with the majority of sightings in Australia and New Zealand (June–October; Marchant & Higgins 1990). The species is a highly irregular visitor to these waters, with periods of abundance evidenced by mass wrecks of birds, followed by years of apparent rarity before the next irruptive event (Marchant & Higgins 1990). Because the study period did not coincide with one of these irruptive events (RHC pers. obs.), the species is likely to be more abundant around Macquarie Island in such years.

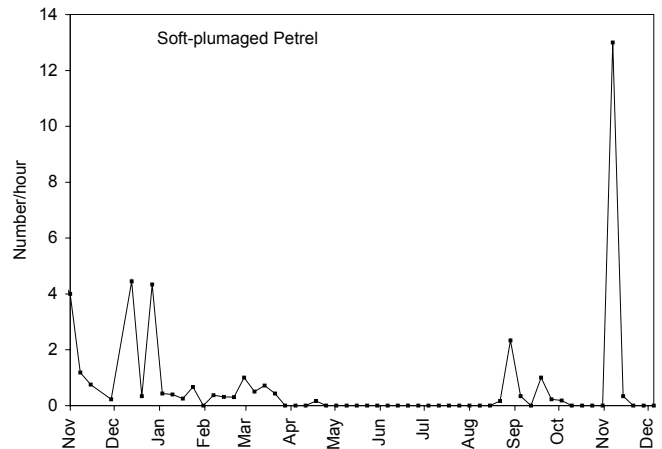


Fig. 12. Average hourly counts per week of the Soft-plumaged Petrel *Pterodroma mollis* offshore from Macquarie Island, October 2002 to December 2003.

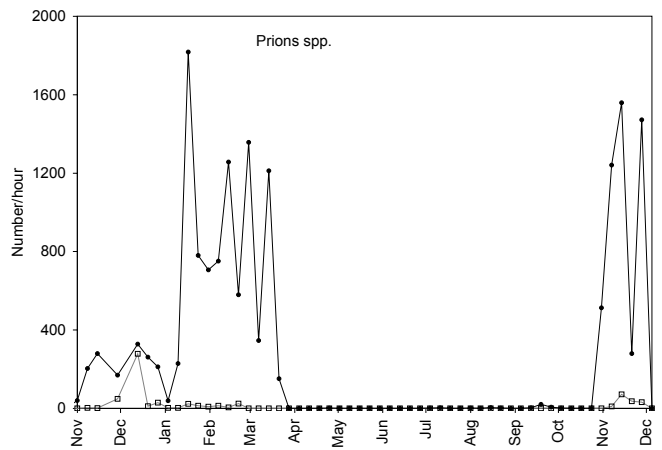


Fig. 13. Average hourly counts per week of prions offshore from Macquarie Island, October 2002 to December 2003. The solid black line depicts all prions combined, whereas the grey line depicts counts of the Antarctic Prion *Pachyptila desolata*.

Great-winged Petrel *Pterodroma macroptera*

Great-winged Petrel *Pterodroma macroptera* is an uncommon summer and autumn non-breeding visitor. Birds were observed on 12 days in the months of February (n = 7 birds), March (n = 7 birds) and May 2003 (n = 8 birds). The May observations were clustered over a seven-day period and suggest a local movement into or through the area at this time.

White-headed Petrel *Pterodroma lessonii*

Locally common summer breeder. Following the first observed birds in late August, small numbers were detected through spring and summer before a pronounced increase during the period February to April (Fig. 11). By the first week in April, an average of 17.1 birds was detected per hour of observation. This peak coincided with the period when nests contained older (2 months+) chicks (Brothers 1984). Numbers then steadily declined during May. The species was absent during June to August. Although counts provide an indication of seasonal trends, it is unlikely that they reflect the actual abundance of this species on Macquarie Island, because an estimated 7850 active burrows were present in the late 1970s (Brothers 1984). It is likely that most breeding individuals approach the island only at or after dark, as indicated by rafting behaviour at dusk more than one kilometre offshore in late March (MS pers. obs.).

Soft-plumaged Petrel *Pterodroma mollis*

Soft-plumaged Petrel *Pterodroma mollis* is an uncommon but increasing summer breeder. With the exception of a single sighting on 20 April, birds were absent from sea watches from late March to late August (Fig. 12). Calling birds were regularly heard and spotlighted over sections of the island from 21 July (Schulz & Lynn 2003b). Small numbers were generally recorded from late August to late March. However, a marked peak occurred in the first week of November. This species is apparently in the early stages of colonizing Macquarie Island, with breeding yet to be confirmed (Schulz & Lynn 2003b). The small number of individuals detected (weekly average of less than four per hour of observation) probably reflects both the rarity of the species on the island and their behaviour of coming inshore after dusk.

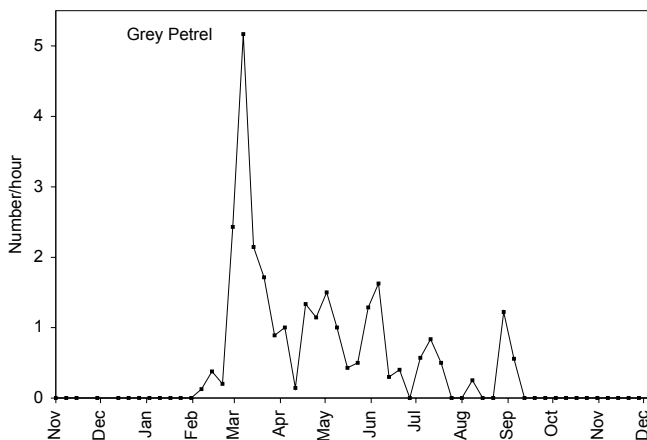


Fig. 14. Average hourly counts per week of the Grey Petrel *Procellaria cinerea* offshore from Macquarie Island, October 2002 to December 2003.

Mottled Petrel *Pterodroma inexpectata*

Mottled Petrel *Pterodroma inexpectata* is a regular summer non-breeding visitor. Birds (n = 106) were observed on 18 days in all months from November 2002 to March 2003. Single birds were observed in November 2003 on two days. Typical counts ranged from one to six birds per hour. High hourly counts were 24 on 1 January, 19 on 22 January and eight on 12 March 2003. Notably, all of these higher counts occurred during 20- to 30-knot southeasterly winds.

Blue Petrel *Halobaena caerulea*

Blue Petrel *Halobaena caerulea* is an increasing summer breeder, visiting colonies at night throughout the year (Baker *et al.* 2002, Schulz & Lynn 2003b). Blue Petrels (n = 62) were observed on 22 different days in November 2002 and in April to June, August, October and November 2003. The largest number observed in an hour was 10 birds on 29 June 2003. However, most sightings involved just of one or two individuals per hour. Blue Petrels may be mistaken for prions *Pachyptila* spp. at a distance (Marchant & Higgins 1990). However, their distinctive flight and white tail tip suggested that few individuals were misidentified. Similar to other burrowing petrels, the paucity of records indicates that the species approaches the island mainly after dark.

Prions *Pachyptila* spp.

The identification of prions at sea is difficult (e.g. Marchant & Higgins 1990). The Antarctic Prion *Pachyptila desolata* is a locally abundant breeder, with smaller breeding populations of the Fairy Prion *Pachyptila turtur* and possibly the Slender-billed Prion *Pachyptila belcheri* and Fulmar Prion *Pachyptila crassirostris* recorded (Brothers 1984, Marchant & Higgins 1990, Baker *et al.* 2002, Schulz & Lynn 2003b). Where low numbers of individuals were present close to shore, we were usually able to identify individuals to species level. However, more typically, individuals and large flocks observed a kilometre or more out to sea were identified only to genus. Prions were present in large numbers off the island from late October to March, with a high count of 1818 per hour in the second week of January (Fig. 13). Numbers abruptly decreased in April and prions remained largely absent until the third week in October when they returned. Where species

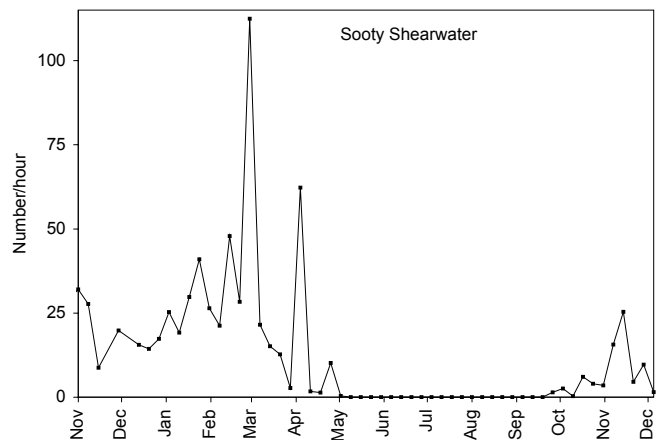


Fig. 15. Average hourly counts per week of the Sooty Shearwater *Puffinus griseus* offshore from Macquarie Island, October 2002 to December 2003.

composition was determined, Antarctic Prions outnumbered all other species combined, accounting for more than 95% of all prions observed through the summer months. (There are no confirmed records of Salvin's Prion *Pachyptila salvini* from Macquarie Island [RHC & MS unpubl. data].) The exceptions were single Slender-billed Prions on 1 February 2003 and 23 March 2003 and small numbers of Fairy/Fulmar Prions throughout the year. Fairy/Fulmar Prions ($n = 45$) were observed on 18 days spanning all months except April to June, with a maximum count of 10 on 10 November 2002. It is noteworthy that Fairy/Fulmar Prions were the only prions identified during the months of July to September, conforming to the pattern elsewhere of some individuals remaining in the vicinity of breeding colonies throughout the year (Marchant & Higgins 1990).

White-chinned Petrel *Procellaria aequinoctialis*

White-chinned Petrel *Procellaria aequinoctialis* is a rare spring, summer and autumn non-breeding visitor. Nine records of 20 individuals: two on 1 January, singletons on 9 and 16 January, nine on 12 February, singletons on 20 and 30 March and 30 May, three on 19 September and a singleton on 3 October 2003. Records were insufficient to show a pattern of occurrence, except to suggest that this species was absent in the winter months.

Grey Petrel *Procellaria cinerea*

Grey Petrel *Procellaria cinerea* is a rare but increasing winter breeder. No sea-watch records from mid-September to January (Fig. 14), although chicks did not fledge until mid-October (M. Schulz, S. Robinson & R. Gales unpubl. data). The first returning individuals were detected on 10 February 2003. A month later, numbers peaked at five individuals per hour in the first week of March. Small numbers were then present around the island until the second week of September. This species is in the process of recolonizing Macquarie Island following the successful eradication of feral cats *Felis catus* in 2000 (M. Schulz, S. Robinson & R. Gales unpubl. data). Given that this species is active around breeding colonies during daylight hours, the present low counts are indicative of a small population.

Sooty Shearwater *Puffinus griseus*

Sooty Shearwater *Puffinus griseus* is a locally common summer breeder. Birds were absent from the island from May through

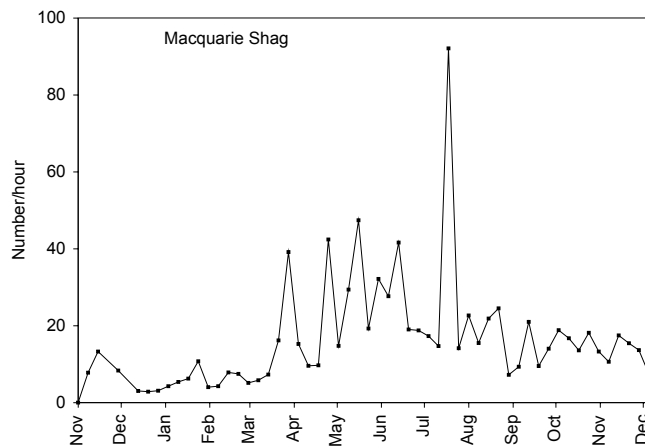


Fig. 16. Average hourly counts per week of the Macquarie Island Cormorant *Phalacrocorax atriceps purpurascens* offshore from Macquarie Island, October 2002 to December 2003.

September (Fig. 15). The first returning individuals were detected in the last week of September. Subsequently, the species was regularly recorded through to mid-April. Weekly averages generally fluctuated between 15 and 50 birds per hour. A high count of 112 per hour during the first week of March coincided with a southerly movement of Short-tailed Shearwaters *Puffinus tenuirostris* past the island. Many Sooty Shearwaters appeared to be involved in this movement and thus these high counts may have included individuals on passage from populations elsewhere.

Short-tailed Shearwater *Puffinus tenuirostris*

Short-tailed Shearwater *Puffinus tenuirostris* is a common late summer and early autumn passage non-breeding migrant. Intermittent passages of Short-tailed Shearwaters were observed on four occasions. The first event extended from 1 to 3 February 2003, with between 60 and 925 birds ($n = 5$ h; mean: 366 per hour) recorded travelling south per hour. No further birds were recorded until 14 February 2003 when 68 birds passed southwards in a single hour of observation. The species was infrequently seen until a third southerly passage occurred on 19 to 21 February 2003 ($n = 5$ h; mean: 794.4 per hour). A maximum of 3768 Short-tailed Shearwaters was counted in an hour on 20 February 2003. The last passage recorded was on 4 and 5 March 2003 with between 80 and 460 birds moving south per hour ($n = 4$ h; mean: 275 per hour). No northerly movements were observed. Correspondingly, flight tracks of Short-tailed Shearwaters fitted with satellite transmitters showing individuals travelling southwards from their breeding grounds in southeastern Australia past Macquarie Island to the pack ice edge. Returning birds moved along the pack ice before travelling north, far to the west of Macquarie Island (Nicholls *et al.* 1998, Klomp & Schultz 2000), accounting for the observed absence of birds flying northwards.

Little Shearwater *Puffinus assimilis*

Little Shearwater *Puffinus assimilis* is a vagrant. The only observation was of a single bird flying south off Green Gorge on 18 March 2003.

Wilson's Storm Petrel *Oceanites oceanicus*

Wilson's Storm Petrel *Oceanites oceanicus* is an uncommon summer and autumn non-breeding visitor, although the species has been recorded breeding on Bishop and Clerk Islets 37 km to

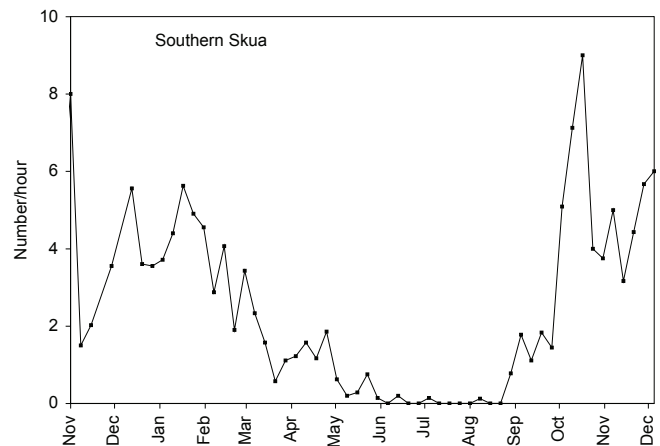


Fig. 17. Average hourly counts per week of the Subantarctic Skua *Catharacta antarctica* offshore from Macquarie Island, October 2002 to December 2003.

the south (Brothers 1993). Birds ($n = 54$) were sighted on 11 days from December to March, predominantly comprising between one and six individuals. The maximum number of individuals recorded was 23 birds observed foraging over a slick on the sea surface around feeding Killer Whales on 20 March 2003. This observation coincides with a period when birds are on northward passage (Marchant & Higgins 1990).

Grey-backed Storm Petrel *Garrodia nereis*

Grey-backed Storm Petrel *Garrodia nereis* is a rare visitor that may breed. Single individuals were observed on 9 February and 20 March 2003. Observations of individuals ashore at night (Brothers 1984, Schulz & Lynn 2003b) suggested that this species is either prospecting for breeding sites or that it currently breeds on offshore rock stacks in small numbers.

Black-bellied Storm Petrel *Fregetta tropica*

Black-bellied Storm Petrel *Fregetta tropica* is a rare autumn and spring visitor to inshore waters. The only observations were of one individual on 12 March 2003, three on 25 April 2003 and one on 6 October 2003. This species was common in waters more than 10 km off the island on 6 December 2003 (MS unpubl. data).

Diving petrels *Pelecanoides* spp.

Diving petrels are rare summer breeders (e.g. Brothers 1984). Both the Common *Pelecanoides urinatrix* and South Georgian *Pelecanoides georgicus* Diving Petrels have been recorded from Macquarie Island (Jones 1980, Bourne 1981, Brothers 1984). Because we were unable to separate these two species at sea, observations were combined. Diving petrels were recorded on eight days with singletons on 9 and 29 January; 1, 13 and 20 February; and 15 and 25 March 2003. Two individuals were observed on 30 July 2003. It is likely that diving petrels were under-recorded, because of the difficulty of detecting floating individuals at a distance in choppy to rough sea conditions. This contention is supported by the finding of six sets of diving petrel wings in Subantarctic Skua territories on the south and west coasts in late spring 2003 (Schulz & Lynn 2003a).

Macquarie Island Cormorant *Phalacrocorax atriceps purpurascens*

The Macquarie Island Cormorant *Phalacrocorax atriceps purpurascens* is a locally common endemic taxon that is a year-

round resident. Small numbers were detected from August to March with average hourly rates per week typically between five and 20 individuals (Fig. 16). Average hourly rates fluctuated more markedly from March to July. Because this species is a resident, these pronounced fluctuations may be explained by flock formation during the non-breeding months. For example, on 31 March 2003, a flock of 250 birds was observed flying west off North Head, while on 21 July 2003, multiple flocks totalling 312 individuals were counted in the same area. Such large aggregations away from breeding colonies were not observed during summer months.

Subantarctic Skua *Catharacta antarctica*

Subantarctic Skua is a common summer breeder with small numbers over-wintering. Birds were largely absent offshore after May. Sightings of single individuals on 13 and 15 June, 5 July and 10 August 2003 were consistent with a greatly reduced over-wintering population on the island (Schulz & Gales 2004b). Sightings increased in the last week of August, with average hourly rates per week fluctuating at between one and two birds during September before a pronounced increase in October (Fig. 17).

Kelp Gull *Larus dominicanus*

Kelp Gull *Larus dominicanus* is a common summer breeding resident. Kelp Gull numbers offshore fluctuated throughout the year (Fig. 18). Four peaks in average hourly counts per week in November, December and July were the result of large aggregations totalling between 80 and 114 individuals observed over one or two days during these periods. Most flocks were formed during gale- to storm-force conditions, when gulls were sheltering on protected waters close inshore. With the exception of these high counts, Kelp Gull numbers appear constant over the seasons.

Arctic Tern *Sterna paradisaea*

Arctic Tern *Sterna paradisaea* is a rare autumn and spring non-breeding visitor. Single individuals were seen on 13 April and 14 and 20 November, and four on 16 November 2003. Unidentified terns that may have been this species were observed more than one kilometre offshore on 15 August (12 birds in a one-hour count) and 6 and 7 September 2003 (one and three birds, respectively).

Antarctic Tern *Sterna vittata*

Antarctic Tern *Sterna vittata* is a resident, with a small breeding population (Schulz & Gales 2004a). This species was detected

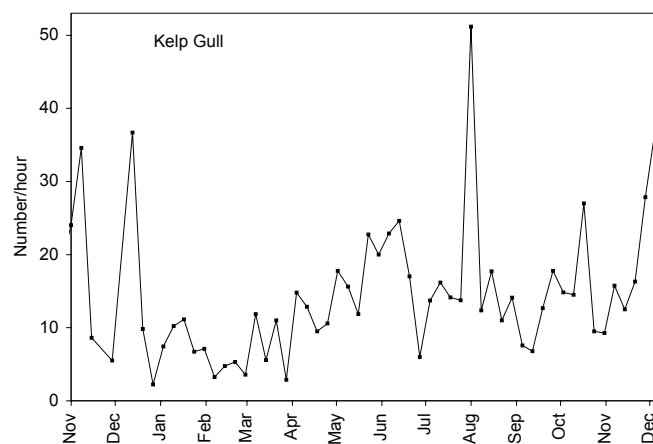


Fig. 18. Average hourly counts per week of the Kelp Gull *Larus dominicanus* offshore from Macquarie Island, October 2002 to December 2003.

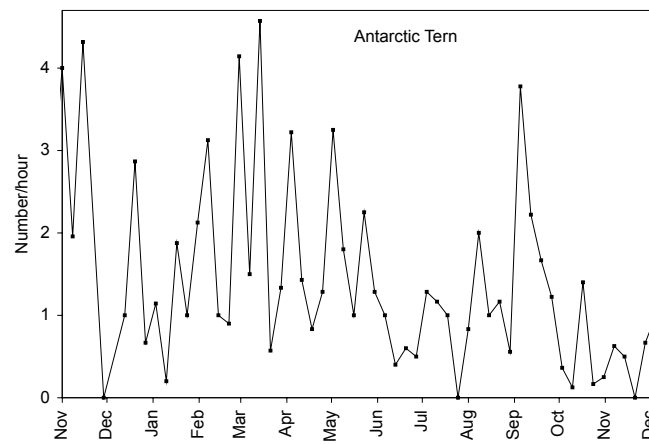


Fig. 19. Average hourly counts per week of the Antarctic Tern *Sterna vittata* offshore from Macquarie Island, October 2002 to December 2003.

during most weeks of the survey ($n = 56$ of 59 weeks), with maximum average weekly counts of four individuals per hour in the third week of March (Fig. 19). At this time many adults were attending free-flying young and family parties of three to four individuals were regularly encountered. Counts indicated that at least a proportion of the island's population is resident throughout the year.

GENERAL CONCLUSIONS

These surveys for the first time provide information about the seasonal occurrence of breeding and non-breeding seabirds in the close-inshore waters around Macquarie Island. The application of hourly counts routinely conducted over a 59-week period provides a good indication of arrival and departure dates. Counts also provide some baseline data for re-establishing seabird populations such as those of Soft-plumaged and Grey Petrels, following the successful eradication of feral cats from the island in 2000.

Two additional seabird species were recorded at Macquarie Island during the study period, but were not detected during seabird surveys presented here. A single Chinstrap Penguin *Pygoscelis antarctica* was observed ashore on 21 January 2003, and single Erect-crested Penguins *Eudyptes sclateri* ashore on 25 November 2002 and 25 February 2003. The fact that we missed just two vagrant species recorded during all other fieldwork suggests that land-based observations of seabirds are an effective method for determining the composition of seabird communities over inshore waters. However, one should be cautious not to over-interpret the trends in our data.

For example, for many breeding visitors, the average hourly counts per week peaked in the first month or two after arrival at Macquarie Island (e.g. Soft-plumaged Petrel, Grey Petrel, Black-browed Albatross and Light-mantled Sooty Albatross). This pattern is almost certainly the result of i) breeding individuals being more active and prominent at this time of year, and ii) the additional presence of prospecting non-breeders. In contrast, similar peaks observed in other species may simply be artefacts of chance events or related to environmental events such as atypical weather or changes in availability and abundance of food resources nearby. These possibilities hold particularly true for species that were generally recorded in low numbers (e.g. Grey Petrel, Grey-headed Albatross, Subantarctic Skua and Antarctic Tern), because high counts during a single hour can lead to pronounced weekly peaks.

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