THE DISTRIBUTION OF SPECTACLED PETRELS *PROCELLARIA CONSPICILLATA* IN THE SOUTH-EASTERN ATLANTIC

KEES (C.J.) CAMPHUYSEN[1,2]

Camphuysen C.J. 2001. The distribution of Spectacled Petrels *Procellaria conspicillata* in the south-eastern Atlantic. Atlantic Seabirds 3(3): 113-124. *At least 215 Spectacled Petrels* Procellaria conspicillata *were observed during systematic seabird surveys in the south-east Atlantic in January-March 2000 and 2001. These sightings provide a clearer picture of the pelagic distribution, relative abundance, habitat preferences, behaviour, and tendency to join vessels at sea of this rare seabird off Southern Africa. Spectacled Petrels were among the species that most readily associated with the research vessel, both during steaming and while the ship was stationary. Flocks of up to 18 individuals joined the ship. Nearby long-lining fishing vessels were also followed by this species. Most Spectacled Petrels occurred in an area where frontal edges of so-called Agulhas Rings provided enhanced feeding opportunities for a variety of seabirds. However, Spectacled Petrels were not seen to directly benefit from these conditions, which may have been caused by their predominantly nocturnal foraging habits.*

[1]Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg, Texel; [2]CSR *Consultancy*, Ankerstraat 20, 1794 BJ Oosterend, Texel, kees.camphuysen@wxs.nl

INTRODUCTION

Spectacled Petrels *Procellaria conspicillata* are among the rarer seabirds in the world, only breeding at Inaccessible Island in the Tristan da Cunha group (37°18'S, 12°41'W; central South Atlantic), with an estimated population of 3000-4000 breeding pairs (Stattersfield & Capper 2000; Ryan & Moloney 2000). Murphy (1936) considered the *conspicillata* type "merely a phase that crops out from time to time in the Shoemaker [White-chinned Petrel *P. aequinoctialis*] population, and not a rare or dwindling species", but the Spectacled Petrel was described as a separate species in the late 1990s (Ryan 1998; Ryan 1999).

Very little information has so far been published on their pelagic distribution. Enticott & O'Connell (1985) summarised the available information and listed sightings of 80 individuals, suggesting that Spectacled Petrels dispersed throughout the South Atlantic between 25°S and 40°S latitude. Many birds have been recorded in Brazilian waters, where interactions with long-line fisheries are frequent (Olmos 1997; Neves & Olmos 1998; Ryan 1999). Camphuysen & Van der Meer (2000) reported sightings of 30 individuals off

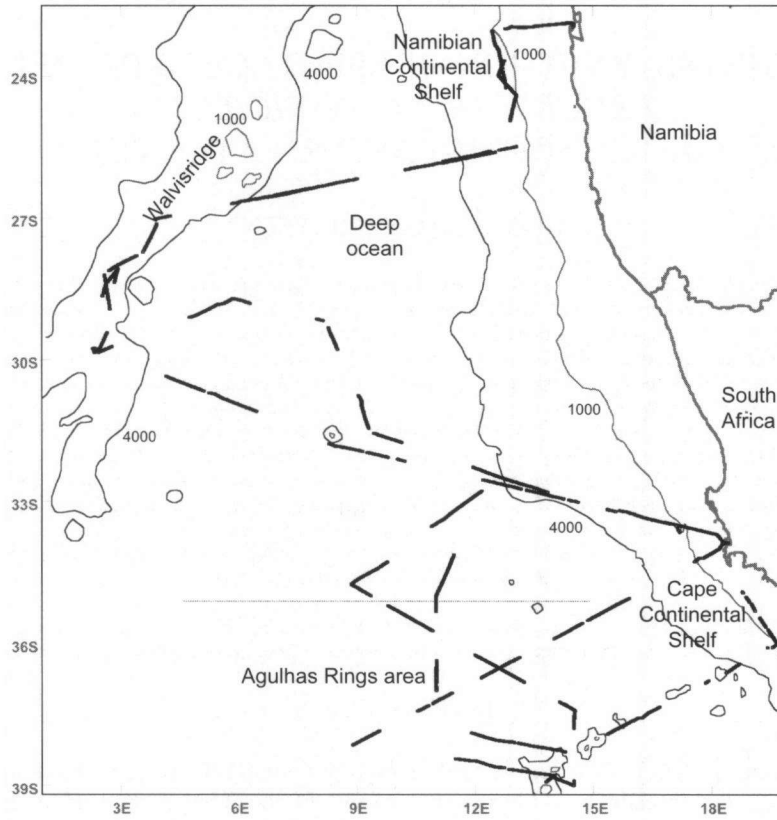

Figure 1. Study area and routes followed in 2000 and 2001. Solid lines represent transects. Subregions mentioned in this paper are indicated, as well as the 4000 and 1000m depth contours indicating Walvis Ridge, the continental shelf and various seamounts off Southern Africa.

Figuur 1. Onderzoeksgebied en afgelegde transecten in 2000 en 2001 (dikke lijnen) De in dit artikel genoemde deelgebieden zijn afgebeeld met daarnaast de 4000m en 1000m dieptelijnen, waarmee de Walvis Ridge, de shelfrand en verschillende onderzeese bergen zichtbaar worden gemaakt.

Southern Africa in February 2000, suggesting that the (summer) at sea distribution of Spectacled and White-chinned Petrels was dissimilar, with the former being confined to deep ocean waters and the latter mainly to the shelf and shelf edge.

This paper reports the results of systematic seabird surveys between late January and mid February 2001 off Southern Africa between Walvis Bay and Cape Town, covering the same area and therefore combined with data collected by Camphuysen & Van der Meer (2000) in the previous year. In addition to this, results are provided of systematic surveys within an adjacent sea area further to the south during mid-February-early March 2001. Additional notes include information on moult stage, (foraging) behaviour, habitat preferences and the tendency of Spectacled Petrels to associate with vessels.

MATERIAL AND METHODS

Systematic seabird surveys were conducted from 15 to 26 February 2000 and from 29 January to 11 February 2001 from Walvis Bay (Namibia) to Cape Town (South Africa) via Walvis Ridge (Fig. 1). Between 13 February and 3 March 2001, an area SW of Cape Town was worked in, between 32° and 39° S latitude and 18° and 8° E longitude.

Methods of observation were similar to those standardised for NW Europe, using a 300m wide transect, 10-minute periods of observation, and a snap-shot for flying birds (*cf.* Tasker *et al.* 1984). In 43 days, a total of 5771 km was surveyed, covering approximately 1700 km². Seabirds associating with the vessel while stationary at Conductivity-Temperature-Depth (CTD) recording stations were counted one hour after arrival and listed separately ('additional birds on station'). Those that followed the ship during steaming were recorded as 'ship-associated during transects'.

Seabird counts were attached to the Netherlands Institute for Sea Research (NIOZ) Mixing of Agulhas Rings Experiment programme (MARE). This project was meant to determine the proportion of Agulhas current leakage that contributes to the northward branch of the oceans thermohaline circulation (THC). As part of that study, a selected Agulhas Ring (an eddy, a roughly circular water mass originating from the Indian Ocean travelling through the South Atlantic) was examined at different stages of its non-linear decay over a period of one year. The oceanographic research under MARE enabled studies of marine wildlife to investigate and interpret interactions with physical processes simultaneously. Agulhas Rings were characterised by relatively high surface salinity, their anti-clockwise rotating velocity, and could be traced down and followed best by altimetry from a satellite (Sea Surface Height Anomaly analysis from the Colorado Center for Astrodynamics Research). These data, in combination with continuous recordings of surface salinity (‰), surface temperature (°C), and water depth (m; analysed at 500m depth intervals), measured at 1-minute intervals and automatically recorded on board, were used to describe and classify habitats at sea in broad terms. Shifts in surface salinity

within 10-minute counts of over 0.099‰ were categorised as steep gradients (5.6%, n = 550 10-minute counts), shifts between 0.049 and 0.099‰ as medium gradients (10.9%) and shifts <0.049‰ as (near-) stable situations (83.5%). Similarly, surface temperature shifts within 10-minute periods over more than 0.2°C were considered strong gradients (10.2%), between 0.1 and 0.2°C as medium gradients (22.7%), and shifts of less than 0.1°C as (near-) stable situations (67.1%). Observed numbers of petrels in each situation were compared with expectation based on the frequency of encountered gradients (G-test).

Foraging behaviour, feeding success and certain types of non-foraging behaviour (e.g. resting/sleeping, preening, courtship display) were recorded as standard practice during transect counts (Camphuysen & Garthe 2001). Specific differences in attraction of the research vessel were compared for the most numerous Procellariiform species and for the Spectacled Petrel, by calculating the total number of individuals seen, the proportion seen during steaming (not visibly attracted by the ship), the proportion recorded as ship-followers and the proportion assembling at stations only (excluding shelf and shelf edge data; 2001 only). Because Spectacled Petrels were so heavily attracted to the research vessel, it proved to be unwise to calculate densities. Results are therefore presented as numbers observed per km steamed (n km^{-1}).

On the basis of moult stage and individually characteristic head patterns, double counts could be avoided in 2000. In late February 2001, Spectacled Petrels became so numerous that this method did not work, so that only 'best professional judgement' could be used to separate newcomers from persistent or repeated attendants. In all cases, presented figures are either precise counts or estimates of a 'minimum number present'. Moult stages were recorded as 'not moulting' (entire primary series intact) or 'moulting' (primary series interrupted by growing or missing feathers; no further details), whenever possible by an indication of the moult stage in three groups: start of moult (inner primaries missing or growing; P1-P4), progressed moult (central primaries missing or growing; P5-P7), or end of moult (outer primaries missing or growing; P8-10).

RESULTS

During transect counts in February 2000, 30 Spectacled Petrels were observed, 13 of which were recorded as 'ship-associates'. The first three individuals were encountered in the Walvis Ridge area, at 29°50'S, 02°25'E, the others while the ship was on transit between Walvis Ridge and the Continental shelf off Cape Town. Most individuals (16) were encountered at approx. 31°S, 9°E. In 2001, 96 Spectacled Petrels were recorded during transect counts, 61 of which as

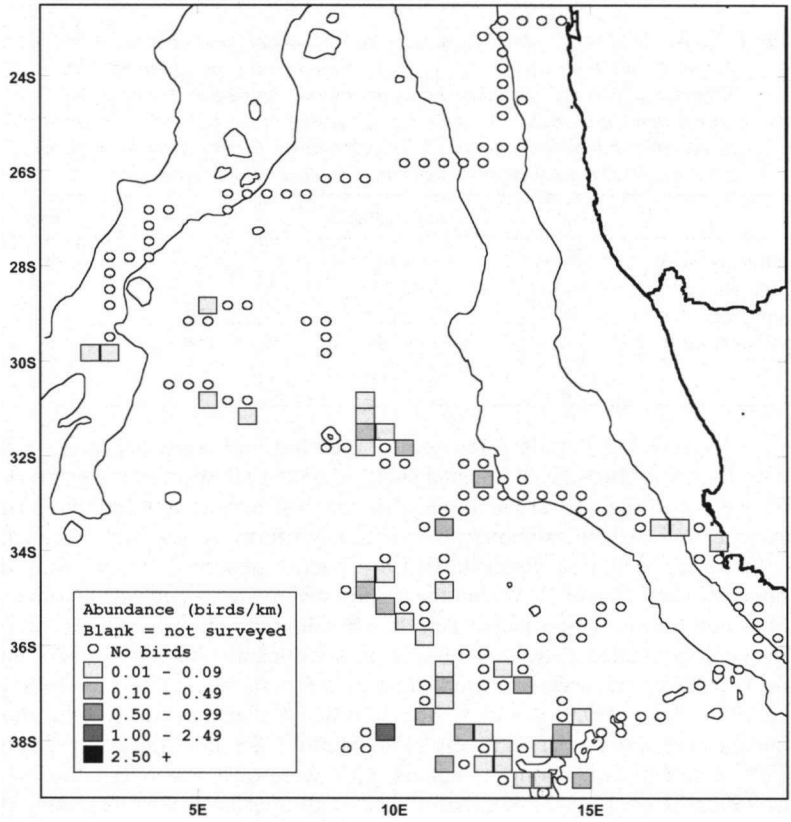

*Figure 2. Distribution of Spectacled Petrels (*n*km^{-1}) based on systematic surveys off Southern Africa, January-March 2000 en 2001.*
*Figuur 2. Verspreiding van Gebrilde Stormvogels (*n *km^{-1}) gebaseerd op systematische tellingen ten zuidwesten van Zuidelijk Afrika, januari-maart 2000 en 2001.*

'ship-associates', 5 as 'associated with nearby fishing vessel'. Additionally, 89 birds were recorded on stations, not following on subsequent transects. Of the grand total, 215 individuals, most birds were seen either during transects, or assembling around the ship at stations, in the 'Agulhas Ring area' (35-39°S), well beyond the continental shelf (Table 1, Fig. 2).

Of 75 individuals that could be checked and recorded, 24 (32%) were actively moulting primaries, 51 were not moulting. Moult stages included nine individuals that had just commenced, six with progressed moult and five with nearly completed primary moult.

Table 1. Spectacled Petrels observed during transect counts and at stations in differen parts of the study area (Fig. 1) in February 2000 and January-March 200 Expectation was based on differences in observer effort (km steamed).

Tabel 1. Aantallen Gebrilde Stormvogels (Obs) tijdens transecttellingen en op stations in verschillende delen van het onderzoeksgebied. De verwachtingen (Exp) zijn gebaseerd op verschillen in waarnemingsinspanning (km steamed).

	km steamed	Obs	Exp
Continental shelf	1015	6	38
Walvis Ridge	529	5	20
Deep Ocean	2439	38	91
Agulhas Ring area	1788	166	67
	5771	215	215

Spectacled Petrels often joined the ship and were persistent ship-followers. Away from the continental shelf, 85.5% of all Spectacled Petrels (n = 197) were recorded in association with the research vessel (either during transect counts or while stationary), or with any nearby vessel, higher than any of the other common Procellariiform species observed away from the continental shelf (Table 2). Within the Agulhas Ring area, there was no obvious habitat preference of Spectacled Petrels when looking at surface temperature. However, Spectacled Petrels were seen in significantly higher numbers than expected during transects with moderate or steep surface salinity drops (G_{adj} 11.2, df = 2, $P < 0.01$), with a non-significant tendency to become more abundant over water with relatively high salinity (>35.8‰). Of all Spectacled Petrels recorded during transect counts, 80% were observed over water of at least 4500m depth (Fig. 3). Similarly, 92% of all Spectacled Petrels joining the ship on CTD-stations occurred in waters of at least 4500m depth (expected 65% based on number of stations per depth category). As in 2000, Spectacled Petrels were rather rare over the continental shelf in 2001 in comparison with the closely related and abundant White-chinned Petrels (Table 3). In areas defined as Open Ocean and 'influenced by' Agulhas Rings, both species occurred in appreciable numbers, with the latter at best being twice as numerous.

DISCUSSION

The tendency to associate with a vessel was higher in Spectacled Petrels than in any of the other common Procellariiform species observed away from the continental shelf (Table 2), comparable only with notorious ship-followers as the White-chinned Petrel *Procellaria aequinoctialis*(79.7%, n = 232), Black-browed Albatross *Thalassarche melanophrys* (70.5%, n= 362), and Yellow-

Table 2. Tendency to associate with a vessel for the most numerous Procellariiform species observed over deep ocean waters beyond the continental shelf in 2001. Shown are total number observed, proportion seen during transect counts that did not follow the ship (% transect), proportion that followed the ship during transect counts (% assoc.), proportion seen in association with nearby fishing vessels (%trawler) and proportion seen assembling around the ship on stations (% station). Sorted by the apparent species-specific 'readiness' to join the ship.

Tabel 2. Soortspecifieke neiging tot associatie met schepen voor de meest talrijke stormvogelachtigen op open zee in 2001. Gegeven zijn het totaal aantal individuen en het percentage daarvan tijdens transecttellingen (niet volgend), achter het schip tijdens transecttellingen, bij een vissersschip, en tijdens het stilliggen op station. Aflopend gesorteerd naar het aandeel met schepen geassocieerde individuen.

	% transect	% assoc.	% trawler	% station	Total
Spectacled Petrel *Procellaria conspicillata*	14.5	33.0	2.8	49.7	179
White-chinned Petrel *Procellaria aequinoctialis*	20.3	34.9	8.6	36.2	232
Black-browed Mollymawk *Thalassarche melanophris*	29.6	30.4	15.2	24.9	362
Atlantic Yellow-nosed Mollymawk *Thalassarche chlororhynchos*	30.0	24.0	18.0	28.0	50
Great Shearwater *Puffinus gravis*	42.7	37.3	20.0	0	75
Wandering Albatross *Diomedea exulans*	43.5	39.1	0	17.4	23
Tasmanian Mollymawk *Thalassarche cauta*	52.2	14.2	6.2	27.4	113
Yellow-nosed Mollymawk *Thalassarche chlor./carteri*	61.2	28.6	0	10.2	49
Scopoli's/Cory's Shearwater *Calonectris spp.*	62.3	0.8	12.5	24.5	257
Indian Ocean Yellow-n Mollymawk *Thalassarche carteri*	69.0	17.2	0	13.8	29
Wilson's Storm-petrel *Oceanites oceanicus*	71.9	21.9	6.3	0	32
Cory's Shearwater *Calonectris borealis*	73.3	24.2	0	2.5	120
Great-winged Petrel *Pterodroma macroptera*	84.0	10.7	0.6	4.7	852
Scopoli's Shearwater *Calonectris diomedea*	88.5	11.5	0	0	26
Leach's Storm-petrel *Oceanodroma leucorhoa*	97.8	2.2	0	0	723
White-bellied Storm-petrel *Fregetta grallaria*	100	0	0	0	14

Table 3. Relative abundance of closely related White-chinned Petrels and Spectacled Petrels in different sea areas (Fig. 1) in 2000 and 2001 expressed as number of birds per km steamed and surveyed. Recorded water depth during surveys in either area is shown in parentheses.

Tabel 3. Verschillen in relatieve talrijkheid tussen de nauw verwante Witkinstormvogel en de Gebrilde Stormvogel in verschillende delen van het studiegebied (Fig. 1) in 2000 en 2001. Tussen haakjes is de tijdens tellingen geregistreerde waterdiepte in elk van de gebieden weergegeven.

		km steamed	White-chinned Petrel	n km^{-1}	Spectacled Petrel	n km^{-1}
Namibian Shelf	2000	347	959	2.77	0	0
(5 - 2000m)	2001	192	9	0.05	0	0
Walvis Ridge	2000	168	2	0.01	4	0.02
(1875 - 3675m)	2001	361	0	0	1	0.00
Deep Ocean	2000	1174	69	0.06	26	0.02
(500 - 5200m)	2001	1422	20	0.01	18	0.01
Agulhas Ring area (900 - 5500)	2001	1630	128	0.08	71	0.04
Cape Shelf	2000	81	20	0.25	0	0
(25 - 1980m)	2001	395	968	2.45	6	0.02

nosed Albatross *Thalassarche chlororhynchos* subsp. (70%, n = 50). This tendency would bring them automatically in contact and potentially in conflict with long-line fisheries (Neves & Olmos 1998), even if such boats would not be overabundant in some of their preferred areas.

Off Southern Africa, White-chinned Petrel is one of the commonest seabirds throughout the year (Summerhayes *et al.* 1974; Ryan 1997), perhaps outnumbered only by the Sooty Shearwater *Puffinus griseus*. White-chinned Petrels regularly occur close inshore and are abundant at fishing vessels off Southern Africa's south and west coasts (Ryan & Moloney 1988). Sinclair (1978) reported three individuals visiting a deep-sea trawler in August 1977 in the midst of the 'common, aggressive and noisy' White-chinned Petrels, but otherwise, the Spectacled Petrel has been described as a scarce visitor to the west coast, primarily in winter (Ryan 1997). This picture is apparently changing as a result of recent pelagic trips off Southern Africa (P.G. Ryan *in litt.*). The data presented previously (Camphuysen & Van der Meer 2000), and certainly the sightings described in the present paper, confirm that just off the continental shelf of Southern Africa, Spectacled Petrels are relatively common summer visitors, occasionally visiting the shelf in that time of the year. The results point at spatial segregation of the two closely related species, White-chinned and Spectacled Petrels, with the former being comparatively numerous in inshore

Spectacled Petrel in flight Vliegende Brilstormvogel (photo C.J. Camphuysen)

Resting Spectacled Petrels near stationary vessel Rustende Brilstormvogels op een station van het schip (photo C.J. Camphuysen)

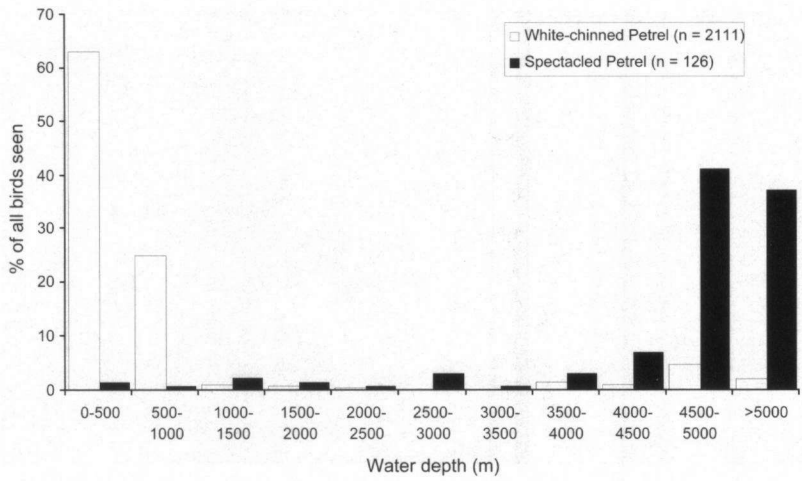

Figure 3. Fraction (%) of all recorded White-chinned and Spectacled Petrels durin transect counts off Southern Africa in 2000 and 2001 in relation to water depth (m).

Figuur 3. Percentage (%) van geregistreerde Witkinstormvogels en Gebrilde Stormvogels tijdens transecttellingen voor de Zuid-Afrikaanse kust in 2000 en 2001 in relatie tot de waterdiepte (m).

waters, which is best illustrated by plotting the fraction observed of either species in different zones of water depth within the study area (Fig. 3).

The only other study that could be traced in which substantial numbers of Spectacled Petrels have been observed away from the breeding colony was conducted off Brazil and involved birds attending commercial bottom long-line fishing vessels (Olmos 1997). Spectacled Petrels were the commonest species in flocks of seabirds attending long-line fishing operations on the coastal shelf off southeastern Brazil during summer (Nov-Mar). In winter, the White-chinned Petrel (jointly with Yellow-nosed and Black-browed Albatrosses) were the commonest species, replacing Spectacled Petrels and suggesting a temporal segregation between the two taxa. More recent studies suggested that Spectacled Petrels are abundant off the shelf in winter (F. Olmos *in litt.*), indicating spatial segregation just as off southern Africa. Clearly, waters off southeastern Brazil are important feeding areas for some seabird populations nesting in the Tristan da Cunha and Gough group, including non-breeding Spectacled Petrels.

Very few Spectacled Petrels were actively foraging or feeding and in fact, most of the birds attracted to the stationary research vessel would

immediately alight and start preening or fall asleep. This suggests nocturnal foraging activities, or, as Fabio Olmos (*in litt.*) suggests, the associated birds simply wait for the ship to start fishing. In any case, a detailed analysis of hydrographical characteristics explaining their daytime distribution at sea is not likely to result into clear patterns for a bird so heavily attracted to any nearby vessel. Nevertheless, the relatively high numbers around the Agulhas Rings could be indicative of enriched foraging opportunities (albeit perhaps at night) for Spectacled Petrels in the general area of the rings. Most of the foraging activities of (mainly planktivorous) seabirds near Agulhas Rings was focussed at ring-edges, where the abrupt change in surface salinity and strong currents seemed to be attractive.

Ryan (1991) described Spectacled Petrels as highly localised ship-followers even in the Tristan archipelago itself (present at fishing vessels off their breeding station Inaccessible Island, absent off Nightingale island). It is therefore most likely that the Spectacled Petrels observed off Southern Africa in summer are non-breeders or immatures. If so, it is remarkable that the only two locations in the South Atlantic presently known to hold substantial numbers of Spectacled Petrels during the summer months are so wide apart: the coastal shelf off southeastern Brazil (Olmos 1997) and deep waters off the continental shelf of South Africa (this study).

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DE VERSPREIDING VAN GEBRILDE STORMVOGELS IN DE ZUIDOOST-ATLANTISCHE OCEAAN

In totaal tenminste 215 Gebrilde Stormvogels Procellaria conspicillata *werden gezien tijdens systematische tellingen in het Zuidoost-Atlantische gebied in de maanden januari-maart, 2000 en 2001. Deze nieuwe waarnemingen geven een veel completer beeld van het voorkomen en de gebiedsvoorkeuren van deze zeldzame zeevogel in de zomer voor de kust van Zuidelijk Afrika, waar zij tot op heden als een schaarse wintergast te boek stond. Gebrilde Stormvogels werden enorm aangetrokken door het onderzoeksschip en daarom is het niet zinvol om verspreidingspatronen op basis van dichtheden (n per km^2) uit te rekenen. In plaats daarvan is het aantal vogels per strekkende kilometer gegeven (figuur 2). Groepen Gebrilde Stormvogels verzamelden zich soms rond het stilliggende schip en er was geen andere zeevogel waarvan een zo groot aandeel werd genoteerd als 'schipvolger' (tabel 2). Ook een dichtbij langsvarende lijnenvisser bleek door enkele Gebrilde Stormvogels te worden gevolgd. De meeste Gebrilde Stormvogels werden aangetroffen in een gebied waar de front-achtige randen van zogenaamde Agulhas-ringen (bellen warm, zout water*

uit de Indische Oceaan die in de Atlantische Oceaan terechtkomen en daar langzaam afkoelen op hun weg naar het noordwesten) kennelijk attractief zijn voor veel foeragerende zeevogels. Van de nacht-actieve Gebrilde Stormvogels werden overigens geen activiteiten waargenomen waaruit bleek dat zij inderdaad van deze situatie gebruik maakten. In vergelijking met de nauw verwante Witkinstormvogel Procellaria aequinoctialis *was het voorkomen van Gebrilde Stormvogels veel meer beperkt tot de diepere delen van de oceaan. Op en langs de rand van het Continentale Plat was de Witkinstormvogel veel beter vertegenwoordigd (figuur 3, tabel 3). De gepresenteerde gegevens laten zien dat de diepere delen voor de kust van Zuid-Afrika na Brazilië vermoedelijk de meeste overzomerende Gebrilde Stormvogel huisvesten.*

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