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## SEASONAL ABUNDANCE AND MARINE HABITAT OF STORM-PETRELS (OCEANITIDAE) OFF CENTRAL NEW SOUTH WALES

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During monthly oceanic cruises off central New South Wales between April 1985 and March 1987, a total of 153 storm-petrels was observed. Wilson's Storm-Petrel *Oceanites oceanicus* and White-faced Storm-Petrels *Pelagodroma marina* comprised 70 and 25 per cent of the Oceanitidae population respectively. Only two Grey-backed Storm-Petrels *Oceanites nereis* and six White-bellied *Fregetta grallaria* and/or Black-bellied *Fregetta tropica* Storm-Petrels were seen. All Oceanitidae were mostly pelagic and silent at sea. They occupied the air stratum within a few metres of the surface. The behaviour and seasonal abundance of Wilson's Storm-Petrels suggested that they purely migrated through the study area. White-faced Storm-Petrels were absent in autumn and most numerous in late winter. This pattern of abundance is evident elsewhere off New South Wales, suggesting a large-scale movement from (or through) the region in summer and a return in late winter.

### INTRODUCTION

The relative abundance and preferred marine habitat of storm-petrels off New South Wales is far from clear. Between May 1973 and April 1974, Milledge (1977) found that all species were absent from Sydney's coastal waters (<20 km from shore) but recorded 15 Wilson's Storm-Petrels *Oceanites oceanicus* and two White-faced Storm-Petrels *Pelagodroma marina* during his only cruise to 40 km from the mainland. Between 1977 and 1981, Blakers *et al.* (1984) reported only a small number of sightings of these two species (and no others) off central New South Wales. They were not aware of any measure of abundance of Wilson's Storm-Petrel in Australia. Morris *et al.* (1981) however, considered that both Wilson's

and White-faced Storm-Petrels were moderately common in offshore and pelagic waters off New South Wales while the Grey-backed *Oceanites nereis*, Black-bellied *Fregetta tropica* and White-bellied Storm-Petrel *Fregetta grallaria* were rare.

This paper analyses abundance and distribution of Oceanitidae off Wollongong (34°25'S, 150°54'E) using a standard census technique. Monthly data were obtained over a two year period during return ocean cruises to well beyond the continental shelf. The average cruise distance from the shore to the turning point was 66 km (depth >2 500 m) whereas the shelf-break itself (depth 200 m) is about 34 km east of Wollongong.

TABLE 1

Sightings of storm-petrels off Wollongong, New South Wales, between April 1985 and March 1987.

Cruise date	Number of 20-min. census periods	Numbers seen during 20-minute censuses (zeros not listed)			
		Wilson's Storm-Petrel	Grey-backed Storm-Petrel	White-faced Storm-Petrel	Black-bellied and White-bellied Storm-Petrel
20 Apr. 85	26	1 2 2 3 2 3 3 4 7 6 2 2			
26 May 85	33	1 1			1
29 Jun. 85	30				
27 July 85	30		1 1	2 1	
24 Aug. 85	32			1 2 1	
21 Sep. 85	24			2	1 1 1 1
27 Oct. 85	27	1 3 2 15 1 2			
3 Nov. 85	26	1 1 1 1			
23 Nov. 85	26	1 1 1		1 1 1	1
14 Dec. 85	30	1 2 1 3		2 1 2 2	
25 Jan. 86	29				
15 Feb. 86	29				
22 Mar. 86	29	1 1			
26 Apr. 86	26	1			
24 May 86	27	1 1 1			
28 Jun. 86	27				
26 July 86	27			1 1 1	
24 Aug. 86	29			2 1 1 1 1 1 1	
25 Oct. 86	26				
23 Nov. 86	29	1 2 1		1 1 1 1	
13 Dec. 86	28				
25 Jan. 87	29	1		1 1 1 1 1	
21 Mar. 87	29	1 2 2 1 2 7 3			
Total for each species		106	2	39	6

## STUDY AREA AND METHODS

The study area, methods and definition of terms have been described elsewhere (Wood 1989, 1990a,b). Briefly, I undertook 23 return ocean transects from Wollongong aboard a 14-metre chartered vessel on dates shown in Table 1. Chopped fish and animal fat were cast from the stern of the *Sandra K* throughout the duration of each cruise. I watched seabirds continuously from the lower deck and conducted 360° scans at about eight minute intervals. Storm-petrels within a radius of c. 100 m were counted using 8 × 40 binoculars.

## RESULTS AND DISCUSSION

Data in Table 1 and Figures 1 and 2 are presented as the number of discrete individuals counted within 20-minute (nominal) census periods. Although recounted storm-petrels were few (if any), choice of this census duration allowed comparisons of relative abundance to be made with other Procellariiformes counted similarly during the 23 cruises (e.g., petrels, shearwaters, Wood, 1990a,b). The number of census periods shown in Figure 2 applies only to cruises during which the particular species was observed. A total of 153 individuals was recorded (Table 1). Observation details of three rare species appear in Table 4.

### Wilson's Storm-Petrel *Oceanites oceanicus*

Wilson's Storm-Petrels made transient visits (<6 mins) occasionally dip-pattering for natural food and minute offal. They were usually viewed at more than 30 m. Altogether 106 individuals were counted, almost three times the number of White-faced Storm-Petrels. Seventy-five per cent were present on three cruises; 37 on 20 April 1985, 24 on 27 October 1985 and 18 on 21 March 1987. Usually only one, two or three birds were counted. Indeed, only once did a census produce more than seven birds (15 in October 1985 between 1154 h and 1215 h, sea depth 400–600 m). All but eight were present in autumn or spring and of these eight, seven were counted on 14 December 1985. This temporal distribution is not surprising because *O. oceanicus* is well known to migrate northwards and southwards past the Australian continent in autumn and spring respectively (Serventy 1952; Serventy *et al.* 1971). Serventy (1952) listed few records for the month of April, although that of W. Goddard has significance. In April 1939, Goddard sighted 'hundreds in loose flocks' feeding on offal discarded from a fishing trawler off Palm Beach (33°35'S, 151°20'E). More recently, in April 1975 and 1976 Rogers (1976, 1977) reported 'hundreds passing north' off Coffs Harbour, New South Wales and 'hundreds near North Solitary Island . . . and at the edge of the continental shelf off Coffs Harbour'. Migration in April 1985 was conspicuous off east and west Australian coasts. On 17 April 1985, Cooper (1989) reported '100's widely

distributed and all travelling N' off Sydney. On 20 and 21 April 1985, 117 birds were seen off Wollongong (Table 2) while on 20 April 1985, RAOU members 'counted hundreds' west of Rottneest Island, Western Australia (32°00'S, 115°30'E) (Harris 1985). Large-scale movement was also noticed off Wollongong in April 1988 but not in April 1984, 1986 or 1987 (Table 2).

I was expecting to find Wilson's Storm-Petrels inside the shelf-break (Serventy *et al.* 1971; Morris *et al.* 1981; Harrison 1983; Roselaar 1983) but 89 per cent were sighted in the pelagic zone (Fig. 2). Zonal distribution peaked at 47 individuals (44%) in the 50–60 km deep-water zone. No birds were observed less than 20 km from Wollongong. Between August 1984 and March 1989, D. H. Fischer (in litt.) attended 71 similar cruises from Wollongong on the *Sandra K*, when the author was absent. About 200 Wilson's Storm-Petrels were observed during these cruises, 80 and 40 of which were present in April 1985 and 1988 respectively (Table 2). Distribution from shore was not quantified but >90 per cent of sightings were thought to be in the pelagic zone. Goddard's sighting (above) was about 100 km north of Wollongong, presumably in neritic waters, but it is doubtful if adjacent pelagic waters were concurrently surveyed. Indeed, much of the habitat data in Australia are from cruises which exclusively traversed the neritic or pelagic zone (Serventy 1952), the neritic zone only (Rogers 1976, 1977; Blakers *et al.* 1984; Harris 1985; Cooper 1989), but not both zones, as did the *Sandra K*. Data to

TABLE 2

April counts of Wilson's Storm-Petrels at sea off Sydney and Wollongong between 1985 and 1988.

Date	Cruise terminus*	Maximum depth	Number counted†	Observer
28 Apr. 1984	km off Sydney	200 m	1	Author
20 Apr. 1985	65 km off Wollongong	2 700 m	37	Author (see Table 1)
21 Apr. 1985	60 km off Wollongong	2 400 m	c. 80	D. H. Fischer
26 Apr. 1986	63 km off Wollongong	2 500 m	1	Author (see Table 1)
27 Apr. 1986	58 km off Wollongong	2 100 m	3	D. H. Fischer
25 Apr. 1987	68 km off Wollongong	2 900 m	5	Author
17 Apr. 1988	65 km off Wollongong	2 700 m	40+	D. H. Fischer

\*Outgoing courses were within the compass segment ENE–SE.

†Author's counts are cumulative 20-minute censuses within a viewing range of c. 100 m. D. H. Fischer's counts are estimated daily totals.

enable comparisons in abundance between neritic and pelagic zones during particular voyages are, therefore, lacking and more information is required to determine accurately whether the species is generally pelagic or neritic. Although most Australian records may 'come from the edge of the continental shelf' (Blakers *et al.* 1984), a lack of sightings beyond the shelf-break might reflect a paucity of data rather than an absence of individuals.

This species is generally regarded as an inveterate or habitual follower of ships and fishing boats (Serventy *et al.* 1971; Fullagar 1976; Harrison 1983; Roselaar 1983). In the study area, boat-following was not apparent despite encouragement by continuously tossing offal. Furthermore, although *O. oceanicus* sometimes settles on water (Roselaar 1983) all my records were of birds flying within a few metres of the surface. The lack of interest in offal and all birds being seen in flight, mainly in waters beyond the shelf-break, suggest a seasonal migration well off the coast of central New South Wales. Behaviour in this area parallels that in New Zealand waters where 'birds feed mainly in the open sea, but also close to the edge of continental shelves, particularly on migration' (Imber 1985). A purely seasonal migration past east and west Australian coasts in spring and autumn and a preference for pelagic habitat may explain why so few specimens are found beach-washed (Serventy 1971).

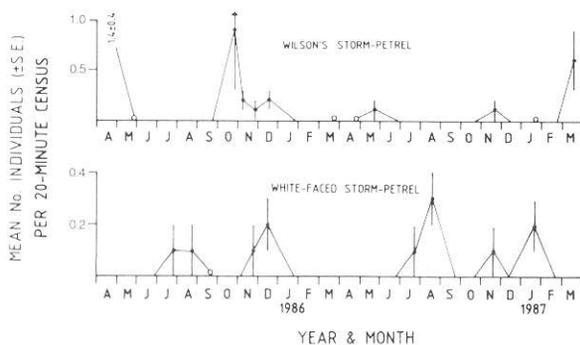


Figure 1. Relative abundance and distribution of Wilson's and White-faced Storm-Petrels off Wollongong, NSW between April 1985 and March 1987. Open circles represent a total of one or two individuals.

### Grey-backed Storm-Petrel *Oceanites nereis*

Two Grey-backed Storm-Petrels were observed, each at 48 km from shore. One was present on the outgoing and the other on the return voyage of the same cruise (Table 4). In company with the first bird were 37 albatrosses, four gadfly petrels, ten prions and two White-faced Storm-Petrels. The second occurred with a similar number of tubinares (excluding White-faced Storm-Petrels). Klapste (1981) reported that *O. nereis* often occurs at sea with White-faced Storm-Petrels.

Both Grey-backed Storm-Petrels were seen at c. 25 m for a few minutes. Their blackish heads and ashy-grey backs were clearly visible. They were silent and did not forage for offal cast astern. I am aware of only three other published records of this species from New South Wales (Morris *et al.* 1981).

### White-faced Storm-Petrel *Pelagodroma marina*

White-faced and Wilson's Storm-Petrels were observed at similar heights above the water and in similar circumstances. If anything, *P. marina* made shorter visits than *O. oceanicus* and paid less attention to either the vessel or the tossed offal. Little is known about vocalizations of storm-petrels at sea (Roselaar 1983) but both these species were silent. *P. marina* was absent in autumn with a peak of abundance during July and August. The total number observed in each season over the two-year study period was summer 12, autumn nil, winter 18, spring nine. This seasonal pattern of abundance is not unlike that reported in New South Wales by other authors. For example, Morris *et al.* (1981) stated that the species was 'recorded May-February (found beach-washed mainly October-February)'. Holmes (1977) found in 1972, 1974 and 1975 that most birds were present on Muttonbird Island between August and September, presumably while prospecting for nest-sites. Moreover, during 52 other pelagic cruises off Wollongong between 1985-1988, 48 individuals (62%) were sighted in late winter (July and August) and only one in

autumn (Table 3). By far the largest number seen during any of these cruises was 25 on 25 August 1985, when 15 birds were in a loose flock near the shelf-break. Off New South Wales I am aware of only three other reports of flocks of more than 15 birds: 60 at sea off Eden in August 1976, 30–50 at sea off Coffs Harbour in July 1976 (Rogers 1977) and 15+ off Cape Solander in July 1984 (Lindsey 1986). All the above observations suggest an autumn absence followed by an abundance peak in late winter.

I did not focus attention on the colour of the rump and therefore was not able to assess the age or race of the individuals observed (Imber 1984). Presumably, all birds were of the Australian race *P. m. dulciae*. Large numbers of this race breed on islands off south-eastern Australia between September and March (Blakers *et al.* 1984; Fullagar 1976). About 10 700 pairs breed off New South Wales of which 65 per cent are concentrated at the Tollgate Islands (35°45'S, 150°16'E) (Lane 1979). Close to the study area, Battam (1976a and b) estimated that some 30 pairs were breeding on the Five Island group (34°30'S,

150°56'E). This colony however is thought to have declined considerably in recent years because no evidence of the species presence has been found during bi-annual banding excursions in summer (A. J. Leishman, pers. comm.). It is therefore unlikely that the proximity of this small colony has biased the statistical results of the study.

Although the breeding biology and post-breeding dispersal of *P. m. dulciae* are somewhat unclear (Serventy *et al.* 1971; Harrison 1983; Imber 1984; Menkhorst *et al.* 1984) all the seasonal abundance data presented here suggest a regular large-scale movement away from (or through) New South Wales coastal waters soon after breeding. These data also suggest a rather synchronous return to (or through) the same area at least a month before egg-laying commences. Numerous sightings in the south Fiji oceanic basin in July (Imber 1984) and a flock of 33 birds in the Western Coral Sea in May 1981 (Stokes and Corben 1985) are consistent with the seasonal pattern of movement suggested.

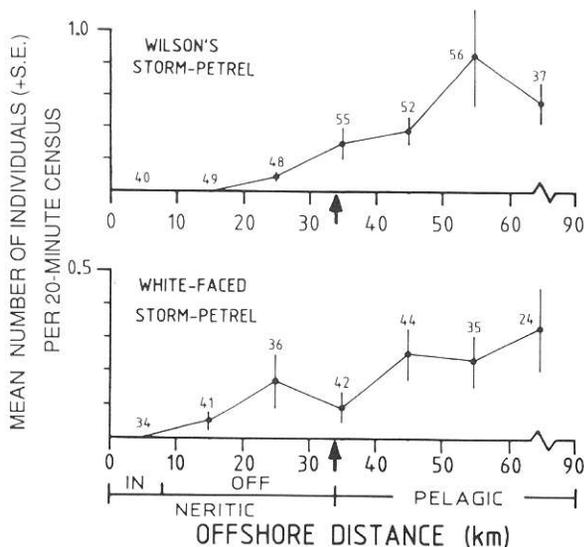


Figure 2. Zonation of Wilson's and White-faced Storm-Petrels off Wollongong, NSW between April 1985 and March 1987. Arrows indicate the approximate position of 200 m depth contour. The number of 20-minute census periods is shown above each incremental zone.

TABLE 3

Seasonal counts of White-faced Storm-Petrels at sea off Wollongong between January 1985 and December 1988\*.

Season	No. of cruises	No. of birds	No. of birds per cruise
Summer	14	17	1.2
Dec.–Feb.			
Autumn	16	1	0.06
Mar.–May			
Winter	12	48†	4
June–Aug.			
Spring	10	11	1.1
Sept.–Nov.			
TOTAL	52	77	1.5

\*Data kindly supplied by D. H. Fischer from monthly cruises which were not attended by the author. Outgoing cruise tracks on the *Sandra K* were within the compass segment ENE–SE of Wollongong. The maximum sea depths during cruises were between 1 500 and 3 500 m.

†None of these 48 were seen in June cruises; all were present in either July or August.

Of the 39 White-faced Storm-Petrels recorded, 29 (74%) were located beyond the 200 m isobath (Fig. 2). Depth details are not available from Fischer's records (Table 3 and in litt.) but more than 90 per cent of his sightings were from pelagic waters. These data suggest that White-faced Storm-Petrels prefer to forage in the pelagic zone off Wollongong. The possibility of nocturnal feeding in the neritic zone is low because closely-related Oceanitidae were recently observed feeding exclusively by day in the Southern Ocean (Harper 1987).

As for Wilson's Storm-Petrel, further matched neritic-pelagic abundance data are needed to determine if White-faced Storm-Petrels are widely pelagic. Rogers' (1977) reports of 60 and 30-50 off Eden and Coffs Harbour respectively were daily counts of birds seen from fishing vessels at the shelf-edge itself (M. J. Carter, pers. comm.; G. Holmes in litt.). Fishing operations from both these vessels were largely confined to waters less than 200 m deep. Most beach-washed birds are found in New South Wales between October and February (Morris *et al.* 1981); a period which coincides with breeding activity of these birds and peak recreational use of beaches by people. As breeding islands are inshore or just offshore, the species is considerably exposed to

near-shore waters when visiting breeding colonies at night; even if it feeds diurnally in the pelagic zone. It is to be expected, therefore, that most beach-washed specimens will be found during the breeding season. Serventy *et al.* (1971) considered that White-faced Storm-Petrels were markedly pelagic in habit, despite an observation in March 1961 by one author of thousands in small parties (<30) in Bass Strait which is almost entirely neritic. Conclusions as to whether the species is pelagic or neritic should be treated with caution if they depend on isolated sightings or beach-washed reports.

#### White-bellied and Black-bellied Storm-Petrels *Fregatta grallara* and *Fregatta tropica*

All *Fregatta* spp. made passes of one to two minutes at a viewing range of c. 60 m. Specific identification was not confirmed as I could not determine the presence or absence of the black mid-ventral belly stripe. Other workers (Bourne 1969; Beck and Brown 1971; Cheshire 1986) have also found this feature difficult to observe. Even if its presence or absence was confirmed, specific identification could still not be assured because a number of researchers (Serventy *et al.* 1971; Beck and Brown 1971; Fullagar 1976; Harper and

TABLE 4

Details of observations of Grey-backed, White-bellied and Black-bellied Storm-Petrels off Wollongong, New South Wales between April 1985 and March 1987.

Species of Storm-Petrel	Date	Time	Numbers	Distance from shore (km)	Depth (m)	Beaufort wind speed and direction	Surface water temp. (°C)
Grey-backed	27 July 1985	10:12	1	48	900	Force 5 SW	16.5
Grey-backed	27 July 1985	11:31	1	48	900	Force 5 SW	16.5
Possibly Black-bellied	26 May 1985	12:30	1	61	1 700	Force 3 SSE	20.7
Probably Black-bellied	21 Sept. 1985	11:43	1	38	460	Force 6 S	19.3
Possibly White-bellied	21 Sept. 1985	12:10	1	32	240	Force 6 S	19
Possibly Black-bellied	21 Sept. 1985	12:45	1	25	160	Force 6 S	18.8
Possibly White-bellied	21 Sept. 1985	13:43	1	16	130	Force 6 S	18.5
White-bellied or Black-bellied	23 Nov. 1985	09:20	1	72	2 250	Force 4 SW	21

Kinsky 1978; Harrison 1983) recognize that these sibling species exhibit marked chromatic polymorphism (particularly in the Pacific Ocean).

I clearly observed surface feeding by a bird seen at 1210 h on 21 September 1985. It dip-pattered at about 5 m intervals in zig-zag flight typical of storm-petrels. Four of the six records were beyond the edge of the continental shelf (Table 4).

As with other published records for eastern Australia (Norris 1967; Holmes 1977; Roberts 1979; Morris *et al.* 1981; Stokes and Corben 1985) all *Fregatta* sightings were between May and November when these congeners are not breeding. Confirmation of observations of *F. tropica* in the study area would reinforce the concept of an annual pelagic migration of some populations from their more southerly breeding grounds into the tropical Pacific Ocean (Fullagar 1976; Harper and Kinsky 1978; Imber 1985). Lord Howe Island, approximately 850 km ENE of the study area, supports a summer breeding population of about 1 000 pairs of *F. grallaria* (Fullagar *et al.* 1974). Holmes (1977) proposed that some of this breeding population winters regularly off northern New South Wales. If observations of *F. grallaria* off Wollongong are confirmed, the ambit of some wintering individuals from the Lord Howe Island colony may extend southwards to at least 34°25'S.

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