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The Distribution and Abundance of Seabirds at Sea and on Islands near the Mid- and North-Western Coasts of Australia

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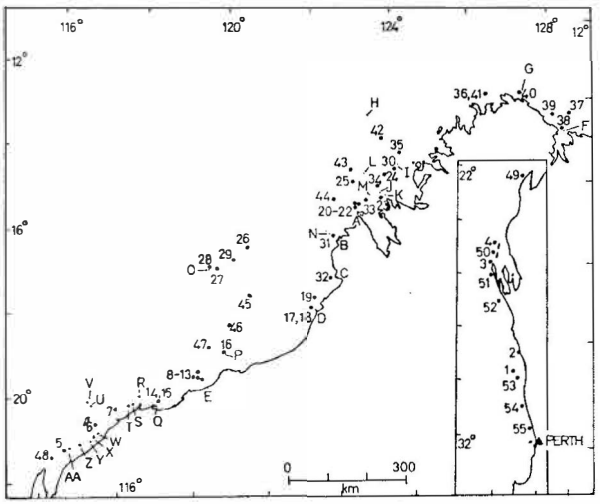
During a 47-day voyage along the mid- and north-western coasts of Australia I landed on five mainland sites and 22 islands, and spent 55 hours counting seabirds at sea. An annotated list of the 24 species of seabirds seen is provided. Previously unrecorded nesting sites of the Wedge-tailed Shearwater and Caspian, Bridled and Crested Terns were found. The distribution and relative abundance at sea of the four most frequently met species (Wilson's Storm-Petrel, Brown Booby, Silver Gull, Crested Tern) are mapped. Explanations of these distributions and abundances are considered in terms of distance from land, state of the sea, and surface temperature of the sea.

Introduction

Between 20 May and 5 July 1978 I was a passenger aboard the lighthouse tender M.V. *Cape Don* on a voyage to service the lights of north-western coast of Australia. The total distance covered, from Fremantle to Fremantle (Fig. 1), was 4 986 nautical miles (9 075 km). My main purpose was to investigate tropical island ecosystems, but so as to make use of much spare time spent voyaging I counted seabirds seen at sea during one-hour watches. A duration of one hour was chosen to conform with previous seabird watches at sea (e.g. Bailey 1966, Johnstone and Kerry 1976). As the vessel's speed averaged only 11.5 knots (21 km/h), I further decided to restrict my counts to three times a day, namely 08:00-09:00, 12:00-13:00 and 16:00-17:00 hours. Sometimes these times varied slightly. On days when I was ashore no watches were carried out. Thirteen of the watches were taken while at anchor, either near a lightbuoy or near land (island or mainland coast). Birds seen with (7 x 50 binoculars) within one kilometre of the ship were counted. From the bridge, 10 metres above sea level, the horizon on a calm day is approximately seven nautical miles (13 km) distant. Opportunistic recordings of seabirds at other times were also made, and when I was ashore I attempted to count nesting and other seabirds.

The substance of this paper is therefore: an annotated list of seabirds seen; maps of the distribution and relative abundance at sea of the four most often met species; and an attempt to account for any patterns of distribution and abundance of these species in terms of distance from land, state of the sea, and noon surface temperature of the sea.



● Figure 1. *Map showing mid and north-western Australia.* A—E *are places visited on mainland coast,* F—AA *(labelled from north to south) are islands visited, and numbers* 1—55 *code the locations at sea of the one hour seawatches of seabirds.*

Key: A *Cape Lévèque,* B *Red Bluff,* C *Gantheaume Point,* D *Cape Bossut,* E *Port Hedland,* F *Lacrosse I.,* G *Lesueur I.,* H *Browse I.,* I *Degérando I.,* J *Tanner I.,* K *Cockatoo I.,* L *Adèle I.,* M *Caffarelli I.,* N *East Lacépède I.,* O Cunningham *I., Impérieuse Reef,* P *Bedout I.,* Q *Jarman I.,* R *Legendre I.,* S *Rosemary I.,* T *East Goodwyn I.,* U *Trimouille I.,* V *Northwest I.,* W *North Sandy I.,* X *Beagle I.,* Y *Maryanne Reef,* Z *Anchor I.,* AA *Airlie I.*

ANNOTATED LIST

The records of seabirds on land are listed approximately from north to south (see Figure 1). Eash case of nesting is specifically indicated, C/= clutch, B/= brood. The position of counts of seabirds at sea (termed 'watches') is indicated broadly in Figure 1 and in more detail in the Appendix.

Black-browed Albatross *Diomedea melanophris*
At sea: Watch 50 (1). This record, well north of this species' usual distribution in Western Australia, requires confirmation.

Yellow-nosed Albatross *D. chlororhynchos*
At sea: Watches 1 (2 birds), 51 (1), 52 (1), 53 (2), 54 (1). One seen NE of Red Bluff near Cape Cuvier on 22 May.

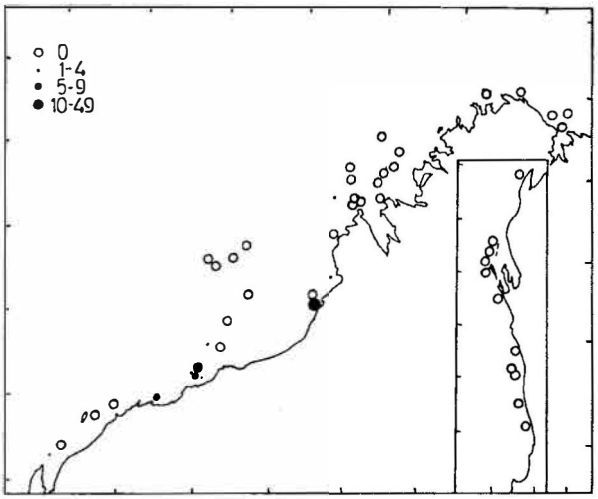
Giant-Petrel *Macronectes* sp.
At sea: Watch 50 (6).

Cape Petrel *Daption capense*
At sea: Watches 48 (2), 49 (2), 50 (3).

Wedge-tailed Shearwater *Puffinus pacificus*
At sea: All records are probably of this species. Watches 3 (1), 50 (3), 53 (1).

On land: Colonies found on East Goodwyn I. (new record); North Sandy I., E slopes from light tower; Beagle I., mainly N of light tower (new record); Airlie I., Anchor I. The colony on Beagle I. is bigger than that on North Sandy I. Virtually the whole of Anchor I. is a dense colony.

Wilson's Storm-Petrel *Oceanites oceanicus*
At sea: see Figure 2.



● Figure 2. *Distribution and relative abundance, at sea, of Wilson's Storm-Petrel.*

Australian Pelican *Pelecanus conspicillatus*
On land: Adèle I., 18 + 1 corpse; Cape Bossut creek, 1; Jarman I., 26; Northwest I., 2.

Australasian Gannet *Morus serrator*
At sea: Watch 55 (3).

Masked Booby *Sula dactylatra*
At sea: Watch 16 (6), 47 (1).

On land: Adèle I. Many large white chicks present. About three-quarters of the perimeter of the island was visited and I counted 177 nests, all above high water mark but just below the vegetated edge of the island. Bedout I. 235 birds counted. Many of these were on eggs, some of which hatched during my visit. An easily recognizable bare area just south of the light tower had 47 birds, of which seven were on nests (C/1 (4), C/2 (2), B/1 (1)).

Brown Booby *Sula leucogaster*

At sea: see Figure 3. All 10 light buoys near Port Walcott and Port Hedland had deposits of booby guano on them. Medusa Bank buoy, north of the Ord River, did not. Two birds were perched on the leading lights, Broome Harbour (14 June) and seven were perched on buoy C1 near Port Hedland (25 May). On night of 9 June, one flew aboard ship when it was between Adèle I. and Impérieuse Reef.

On land: Adèle I. The majority of nests had large white young. From the top of the light tower I counted, through binoculars, 185 nests with a bird sitting. When I walked around the edge of three quarters of the island I noted an average of 20-30 nests per 100 metres. East Lacépède I., one corpse. Between Broome new jetty and Riddell Point, one corpse. Bedout I. over 1 300 adults were counted. Numerous nests with eggs and hatchlings were present. Eight nests, each with large white edge of the vegetated zone as well as thinly chicks, were found. Nest scrapes were on the scattered throughout the island.

Pied Cormorant *Phalacrocorax varius*

At sea: Watch 2 (22), 47 (9).

On land: Adèle I., colony of 400 nests toward SW corner. Eggs, small chicks and chicks to 60 centimetres long were present. Degérando I., six; Red Bluff, six; Bedout I., four; on negroheads at high tide; Jarman I., one; rock near Rosemary I., one; Northwest I., one; North Sandy I., two; Maryanne Reef, 474 nests counted. The contents of a sample of 18 nests were as follows: C/1 (3), C/2 (1), C/3 (7), C/1 + B/1 (1), C/1 + B/2 (2), C/1 + B/3 (3).

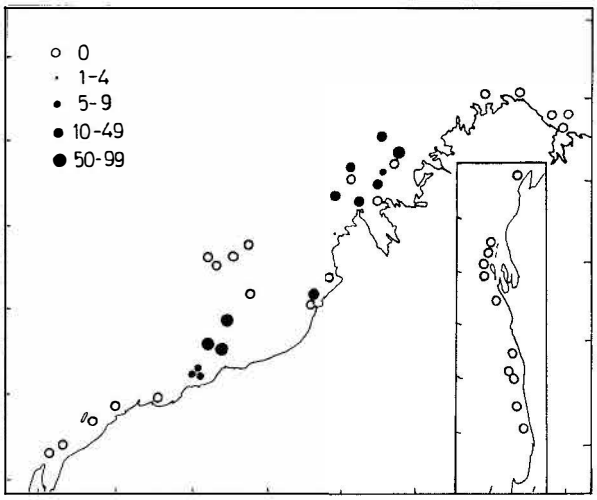


Figure 3. *Distribution and relative abundance, at sea, of the Brown Booby.*

Least Frigatebird *Fregata ariel*

At sea: Watch 16 (4), 24 (1 ♂,1 ♀), 42 (1), 44 (2). Also, one high overhead at sunrise on 24 June about 100 kilometres NE of Adèle I.

On land: Browse I., two over island at 1 700 hr on 3 June; Caffarelli I., one nearby; Adèle I., large breeding colony, in which 2 045 nests were counted. However, time did not allow me to reach a large colony in the SE corner of the island. Nests were grouped in 10 colonies, which did not seem to be synchronized in breeding stage. Hence in one colony there were mainly eggs or small chicks, but in another many large chicks with brown heads. Cape Bossut, one flew past light tower out to sea; Red Bluff, one noted high over light tower; Bedout I. 300 nests counted. Most nests were empty or had eggs chipping. Only a few large chicks were seen. Contents of a sample of 20 nests were as follows: one; nest with no eggs, C/1 (16), three; with small white chick. The sex of incubating birds was noted on a random sample of 37 nests: 23 nests had females sitting and 14 males.

Red-tailed Tropicbird *Phaethon rubricauda*

North Sandy I. One of the NAVAIDS staff described a bird, flying south at 10:00, the description of which agreed well with this species.

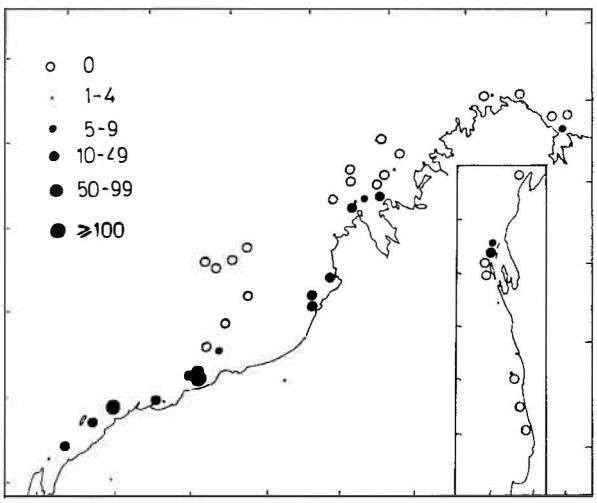
Great Skua *Stercorarius skua*

At sea: Watches 16 (1), 50 (2), 55 (1).

Silver Gull *Larus novaehollandiae*

At sea: see Figure 4. Also noted at anchorage between East Lacépède I. and Red Bluff, seven birds; at anchorage at Point Samson, 18; Legendre I. anchorage, 40; Rosemary I. anchorage, 20; Airlie I. anchorage, 50.

On land: Lacrosse I., three; Lesueur I., four; Adèle I., 30, preying on Brown Booby eggs; Degérando I., 20; Cockatoo I., 80 at settlement bay and another 30 on dolphins near ore deposit jetty; Cape Lévêque, 10; East Lacépède I., 26; Broome Harbour, particularly rocks between new jetty and Entrance Point, 140; Bedout I., 35; preying on Brown Booby eggs; Cape Bossut, 50; Jarman I., 42 including several immatures; Rosemary I., eight; Trimouille I., five; North Sandy I., five + dead fledglings near helipad; Beagle I., four; Maryanne Reef, 31, preying on cormorant eggs; Airlie I., 30; Anchor I., 10. Indirect evidence of past nesting was found only at Jarman and North Sandy Is.



● Figure 4. *Distribution and relative abundance, at sea, of the Silver Gull.*

Pacific Gull *Larus pacificus*

At sea: Watch 2 (22).

Gull-billed Tern *Gelochelidon nilotica*

On land: Near new jetty, Broome on 16 June, one doubtful.

Caspian Tern *Hydroprogne caspia*

On land: Adèle I. 60 counted. On the west coast I found 19 scrapes with either eggs, egg + chick, or just one large (15 cm) chick. Six such chicks were present. Many others scrapes were empty. East Lacépède I., one; Bedout I., two; Jarman I., one of the largest breeding colonies yet found off the Western Australian coast was discovered on the SW point. Ninety birds were counted and 52 nests were found as well as many empty scrapes. Contents of all nests were as follows: C/1 (15), C/2 (24), one with dead small chick, 12 with one large chick. Rosemary I., two; Northwest I., two; North Sandy I., one; Beagle I., two; Maryanne Reef, two; Anchor I., one.

Roseate Tern *Sterna dougallii*

At sea: Watch 22 (78), 33 (213); three at Cape Lévêque anchorage on 1 June.

On land: Maryanne Reef, about 200.

Bridled Tern *S. anaethetus*

On land: Lesueur I. No live birds were seen, but many corpses were found around the base of Osprey nests and near feeding roosts of other raptors. 50-100 old nests, recognized by thick guano and feather deposits, were found under bushes of *Capparis* sp. in the central-eastern sector of the island. One dead small chick was found (new breeding record).

Fairy Tern *S. nereis*

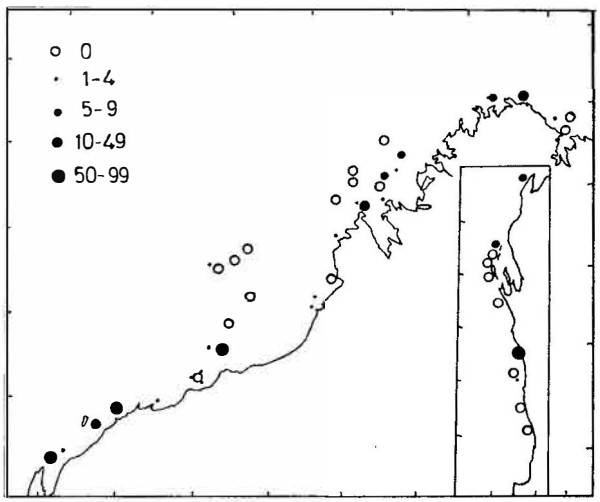
At sea: Watch 48 (115).

On land: Rosemary I., two; North Sandy I., 10; Beagle I., three; Airlie I., four.

Crested Tern *S. bergii*

At sea: see Figure 5; also noted as we passed Jones I., north coast.

On land: Lacrosse I., one; Lesueur I., 18, also several corpses; Browse I., about 300 birds nesting on NE edge of island. There were 400 eggs in an area 16 m x 5 m. About 30 eggs had been broken by a turtle (new breeding record). Adèle I., present; East Lacépède I., one corpse; Cunningham I., eight; Jarman I., two; Legendre I., 30; Rosemary I., 10; Trimouille I., five; Northwest I., two; North Sandy I., 180 and a few corpses around light tower; Beagle I., 40; Maryanne Reef, 10; Airlie I., 60.



● Figure 5. *Distribution and relative abundance, at sea, of the Crested Tern.*

Lesser Crested Tern *S. bengalensis*

At sea: Watch 16 (2).

On land: Adèle I., two separate flocks of 15 and 25; East Lacépède I., three; North Sandy I., eight amongst Crested Terns; Beagle I., one; Airlie I., one. Smith *et al.* (1978) found this species to be commoner than the Crested Tern by about 30:1. The reverse applied during my voyage. Whether this difference is due to differences in the route followed or to a real change is not known.

Common Noddy *Anous stolidus*

On land: East Lacépède I., 14; Bedout I., 120 perched on vegetation near shoreline west of light tower.

In summary, previously unrecorded nesting islands of four species were found: Wedge-tailed Shearwater (East Goodwyn, Beagle), Caspian Tern (Adèle, Jarman), Bridled Tern (Lesueur) and Crested Tern (Browse). The number of breeding species found on each island was as follows: five (Adèle), three (Bedout), two (Jarman, North Sandy), one (Browse, Lesueur, East Goodwyn, Beagle, Maryanne Reef, Airlie, Anchor).

Several of these islands have previously been visited. Although Serventy's visits were the most comprehensive, they took place mainly in October (Serventy 1952) and so cannot be fairly compared with the visits by others, including myself (Bush and Lodge 1977, Kolichis 1977, Smith *et al.* 1978). These took place in May or June. Further, although the seabirds of Adèle I. were surveyed on 2 May 1891 (Walker 1892) and those on Bedout I. on 19-30 May 1901 (Tunney 1902) neither worker recorded the number of nests or birds. Hence their information is of no help in making quantitative comparisons.

Interesting comparisons can be made among May/June visits in 1972, 1975 and 1978 (Table 1). Allowing for the fact that census methods differed, it seems clear that on Adèle I. the numbers of nesting Masked Boobies, Brown Boobies and Least Frigatebirds have changed little. It is difficult to evaluate the significance of the change in numbers of the Pied Cormorant because this species elsewhere can breed at other times of the year, although it has not yet been recorded breeding in spring on Adèle I. (Serventy 1952). A similar remark applies to the Crested Tern colony on Browse I. The data for Bedout I. are more extensive and may be more safely interpreted. Each of the four most common nesting species of seabird shows a marked decline in numbers since 1972 (Table 1). Kolichis (1977) attributed this to a cyclone that passed close to Bedout I. in February 1975. However, cyclones occur regularly near Port Hedland and their frequency seems to be increasing (Lourensz 1977); the decline may instead be related to changes in the productivity of the waters around Bedout I. Bedout I., being small and close to a major town, would be a suitable island to monitor regularly in May/June, provided that census methods can be standardized.

Analysis of Distribution and Relative Abundance at Sea of Four Species of Seabirds

Several physical factors are important in determining the kinds and density of seabirds found in a particular region of ocean (e.g. Bailey 1966, Serventy *et al.* 1971), particularly distance from land and temperature of surface and sub-surface sea water. As well as these factors, I have also examined the influence of wind speed. Unfortunately I have no date on the distribution and abundance of the preferred food of any of the seabird species. This last factor has usually been taken into account only when an ornithologist was present on an oceanographic survey vessel (e.g. Bailey 1966, 1968).

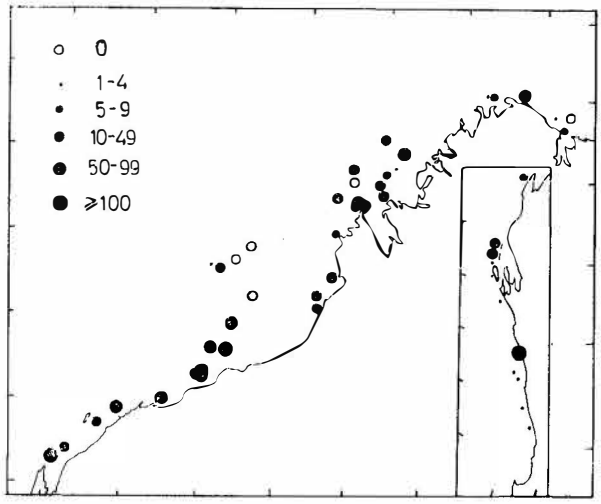
TABLE 1

Comparison of numbers of breeding seabirds on various islands for the same month but in different years.

Island and species	Dates, reference, and approximate number of breeding pairs		
Adèle I.	18 June 1972 (Smith *et. al.* 1978)		4 June 1978 (this paper)
Masked Booby	100		177
Brown Booby	1 000-1 500		400-700
Pied Cormorant	0		400
Least Frigatebird	2 000-4 000		2 000+
Browse I.	17 June 1972 (Smith *et. al.* 1978)		3 June 1978 (this paper)
Crested Tern	0		300
Bedout I.	14-15 May 1972 (Bush & Lodge 1977)	11 May 1975 (Kolichis 1977)	28 May 1978 (this paper)
Masked Booby	400	270	c.120
Brown Booby	5 000	1 000	600-700
Least Frigatebird	2 000	900	300
Crested Tern	300	200	0
Lesser Crested Tern	1	2	0
Common Noddy	Several thousand probably about to breed	0	60 probably about to breed

Concerning the area covered during the cruise of the *Cape Don,* Serventy *et al.* (1971:10) have stated (based on their own unpublished data) that seabird densities are greatest between Shark Bay and Cape Lévèque whereas those off south-western Australia and the north Kimberley coast are very low. This situation was, however, only partially confirmed during the present voyage (Fig. 6). Seabird watch 40, made adjacent to the northern Kimberley coast, yielded a density as high as that found along the Pilbara coast. Very few of the watches south of North-west Cape yielded densities as high as that found north of the Cape, in agreement with Serventy *et al.* (1971).

The results of several oceanographic cruises along the eastern Indian Ocean have shown that the concentration of inorganic phosphate is highest off the north-west coast north of about Port Hedland, due to upwelling, and lowest off the central western coast (Rochford 1962). The biomass of zooplankton in the upper 200 m of the sea is over 100 mg m^{-3} from Shark Bay northward, whereas biomass ranges from only 25-50 mg m^{-3} from Shark Bay south to Cape Naturaliste during the period July to October (Tranter 1962). These factors presumably help explain the pattern obtained in Figure 6.



● Figure 6. *Distribution and relative abundance, at sea, of all species of seabirds combined.*

TABLE 2

Relation between distance from land and relative abundance and frequency of four species of seabird seen at sea.

Species		Distance from land (Nautical miles) 0-10 (0-18 km)	10-20 (18-36 km)	>20 (>36 km)
Silver Gull	Median No. h^{-1}	3	2	0
	Frequency %	68	54	13
	No. 1-h counts	34	13	8
Crested Tern	Median No. h^{-1}	2	0.5	0
	Frequency %	68	54	0
	No. 1-h counts	34	13	8
Brown Booby	Median No. h^{-1}	0	1	0
	Frequency %	41	56	38
	No. 1-h counts	17	9	8
Wilson's Storm-Petrel	Median No. h^{-1}	0	0.5	0
	Frequency %	24	50	13
	No. 1-h counts	21	10	8

However, more transient factors could modify the availability of food for seabirds, even off the north-western coast. These factors, distance from land, wind speed, and surface sea temperature, will now be considered in some detail. In Tables 2 to 4, only the median number of seabirds of the various species is given. This is because in all cases the mean number was less than the median number, indicating frequency distributions skewed to the right. For such distributions the median is a more meaningful statistic than the mean. Frequency is the percentage of one hour counts in which a species was seen.

Distance from nearest land

This factor is of established importance, as it serves to segregate ecologically seabird species at sea (Ashmole 1971). The literature dealing with seabirds classifies their foraging zones as coastal, offshore (within sight of land) and pelagic. Three arbitrary categories are used here (Table 2). The Silver Gull and Crested Tern were most abundant and most frequently met with within 10 nautical miles of land. The other two species, Brown Booby and Wilson's Storm-Petrel, seem to be more pelagic as they were most abundant and frequent 10-20 nautical miles from land.

Wind speed

Because waves obtain their energy from the wind, wind speed largely determines the state of the sea, as summarized in the well-known Beaufort Scale. The numbers of this scale can be grouped according to their similar effect on wave action (Table 3). Beaufort numbers 0 and 1 indicate a calm sea or one with ripples without foam crests. Numbers 2 and 3 indicate formation of wavelets (about 2 m high), just beginning to break. Beaufort numbers 4 to 7 signify the presence of 'white horses', with spray present at numbers 6 and 7. Wave heights may reach 6 m. Beaufort number 7, a moderate or near gale with winds to 60 km/h, was reached only twice on the voyage. All Beaufort numbers were extracted from the ship's log.

Both the Silver Gull and Wilson's Storm-Petrel within 10 nautical miles of land were most abundant and frequent when Beaufort numbers were 0 or 1. The Crested Tern and Brown Booby within 10 nautical miles of land were most abundant and frequent at Beaufort numbers 2-3. The probable explanation of these differences follows from considering the foraging behaviour of these species. Silver Gulls and Wilson's Storm-Petrels are surface feeders, rarely diving for food; therefore both species should most successfully feed (other factors being equal) when the sea is calm or nearly so. On the other hand, the Crested Tern and Brown Booby feed by diving from above water. A calm sea should make them easily seen by their prey (fish) under the surface. Hence the foraging success of both species should be less in calm conditions. At Beaufort numbers 2 and 3 the surface of the ocean is sufficiently disturbed presumably to pre-

TABLE 3

Effect of wind speed on the relative abundance and frequency of four species of seabirds seen at sea, within 10 nautical miles (18 km) of land.

Species		Wind speed (Beaufort Scale) 0-1	2-3	4-7
Silver Gull	Median No. h^{-1}	11	1	0.5
	Frequency %	100	56	56
	No. 1-h counts	9	9	16
Crested Tern	Median No. h^{-1}	1	3	1.5
	Frequency %	56	78	68
	No. 1-h counts	9	9	16
Brown Booby	Median No. h^{-1}	0	16	1
	Frequency %	14	67	50
	No. 1-h counts	7	6	4
Wilson's Storm-Petrel	Median No. h^{-1}	0+	0	0
	Frequency %	38	17	14
	No. 1-h counts	8	6	7

vent fish seeing a bird above, but not disturbed enough to hinder the bird seeing the fish below. At higher Beaufort numbers, the surface is so disturbed that the birds cannot locate prey easily. The data in Table 3 are consistent with this explanation. The importance of a clear layer of surface water for visual predators has previously been noted by Robertson (1978).

Surface temperature of sea

I have divided the data into two similarly sized groups by arbitrarily classing sea temperatures according to whether they were above or below 25.5°C (Table 4). Sea temperatures were taken from the ship's log. The Silver Gull and Crested Tern within 10 nautical miles of land were more abundant and frequent where surface temperatures were 25.5°C or more. The opposite was found for the Brown Booby. The data for abundance of Wilson's Storm-Petrel are inadequate to draw conclusions from; however this species was slightly more frequent at higher surface temperatures.

TABLE 4

Effect of sea temperature on the relative abundance and frequency of four species of seabirds seen at sea, within 10 nautical miles (18 km) of land.

Species		Sea temperature (° C) at surface < 25.5	≧ 25.5
Silver Gull	Median No. h^{-1}	**1**	**10**
	Frequency %	53	76
	No. 1-h counts	19	17
Crested Tern	Median No. h^{-1}	0.5	2
	Frequency %	**50**	**82**
	No. 1-h counts	18	**17**
Brown Booby	Median No. h^{-1}	15	0
	Frequency %	67	25
	No. 1-h counts	6	**12**
Wilson's Storm-Petrel	Median No. h^{-1}	0+	0
	Frequency %	14	20
	No. 1-h counts	14	15

Correlation coefficients were calculated between surface sea temperature and wind speed, and between surface sea temperature and distance from land, but none was significant. The three variables may thus be taken to be independent of one another.

There is only one study known to me that attempts to relate distance from land, state of the sea or surface sea temperature with the distribution and abundance of several of these four species of seabird. Bailey (1966, 1968) made extensive traverses in June to November 1963 and March to July 1964 of the western Indian Ocean. The abundance of seabirds at sea was related to distance from land and surface sea temperature, but only two of the species studied by him were also studied by me. These were Wilson's Storm-Petrel and Crested Tern. Although Bailey's studies were done mainly at different times of year from mine, and of course in different years, it seems worthwhile to compare (with some caution) our relevant findings.

In the western Indian Ocean, Wilson's Storm-Petrels are most abundant and frequent within 10 nautical miles of land, whereas near north-western Australia they were more abundant and frequent 10-20 nautical miles from land. Wilson's Storm-Petrels in the western Indian Ocean were more abundant and frequent at surface temperatures lower than 24°C, but the reverse applied in my study for birds within 10 nautical miles of the coast. A difference in method of study between Bailey and myself may be responsible for the first difference, but not for the second. Bailey's range of distances was to 90 nautical miles and over, in contrast to mine which was to 20 nautical miles and over. The spread of sea surface temperatures was about the same in both studies (18°-30°C, Bailey; 19°-29°C, this study).

Frequency, but not abundance, of the Crested Tern was recorded near the Arabian coast (Bailey 1966). This species was most frequent within 10 nautical miles of land, agreeing with the result of my survey, and was most frequent where surface temperatures were 24°C or less, the reverse of the situation near north-western Australia within 10 nautical miles of land.

It needs to be pointed out that these comparisons are further complicated by large oceanographic differences between the two regions. Upwelling occurs in the Arabian Seas, so that sea surface temperature is inversely correlated with zooplankton density. A high temperature is a good indicator of a poor food supply for seabirds. In contrast there is little indication of a correlation between these factors in north-western Australian waters (Tranter 1962, Rochford 1962) and inconclusive evidence of upwelling (Rochford 1977).

Future research in north-western Australian waters should attempt to extend my study to other periods of the year, and establish whether my conclusions about seabird distribution and abundance hold for periods other than winter and for different years. It would also be valuable if students of seabirds elsewhere in Australian waters were to test the generality of these conclusions.

In conclusion, it is relevant to note that ornithologists interested in the biology of seabirds seem to have focused on nesting populations for several reasons. They can be easily counted, their reproductive success can be easily established, and although adults must feed at sea they have to return to land to feed their young. On the other hand, studies of the ecology of seabirds at sea have been neglected, largely because of logistic difficulties. It is expensive to charter boats so as to watch birds at sea. It is often difficult to find the birds, still more to record their foraging, (many feed at night) and it is not easy to interpret data gathered without knowledge of the distribution and abundance of their prey (fish, plankton, etc.). Despite these limitations, it seems desirable that more emphasis be placed on studying the ecology and behaviour of seabirds at sea, and co-ordinating such studies with land-based research on seabirds (cf. Brown 1976).

Acknowledgments

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APPENDIX

Positions of seawatches. The locality mentioned is that at the start of the watch.

1. SW of Dongara 29°30′, 114°36′ (21 May)
2. Approach to Geraldton Harbour (21 May)
3. 6 nautical miles (11 km) off Cape Inscription 25°33′, 112°52′ (22 May)
4. Off Cape Ronsard 24°50′, 113°2′ (22 May)
5. Off Thevenard I. 21°20′, 114°55′ (23 May)
6. Near North Sandy I. 21°3′, 115°40′ (23 May)
7. SW of Enderby I. 20°40′, 116°10′ (23 May)
8. At anchor at buoy C3 near Port Hedland, 20°4′, 117°25′ (24 May)
9. ditto (24 May)
10. At anchor at buoy C2, 20°2′, 117°25′ (24 May)
11. Heading for buoy C4 (25 May)
12. At anchor at buoy C3 (26 May)
13. Leaving buoy C3 (26 May)
14. At anchor at buoy 3, Port Walcott 20°27′, 117°23′ (27 May)
15. Approaching buoy 4 .(27 May)
16. At anchor, Bedout I. (28 May)
17. At anchor. Cape Bossut (30 May)
18. ditto (30 May)
19. 10 nautical miles (19 km) N of C. Bossut (31 May)
20. At anchor, Cape Lévêque (1 June)
21. Halfway between C. Lévêque and Caffarelli I. (2 June)
22. Leaving C. Lévêque (5 June)
23. At anchor, Tanner I. (6 June)
24. 26 nautical miles (48 km) NNE of Cockatoo I. (8 June)
25. 17 nautical miles (32 km) SW of Adèle I. (8 June)
26. 13 nautical miles (24 km) E of Mermaid Reef (9 June)
27. Halfway between Impérieuse and Clerke Reefs (9 June)
28. At anchor, 0.2 nautical miles (0.4 km) E of Impérieuse Reef (10 June)
29. 13 nautical miles (23 km) S of Mermaid Reef (10 June)
30. At anchor, Degérando I. (12 June)
31. At anchor, East Lacépède I. (13 June)
32. Leaving Roebuck Bay (16 June)
33. Leaving Cape Lévêque (17 June)
34. 9 nautical miles (16 km) N of Bathurst I. (17 June)
35. 9 nautical miles (16 km) NE of Degérando I. (17 June)
36. 9 nautical miles (16 km) NE of Jones I. (18 June)
37. At anchor, Medusa Bank Buoy (19 June)
38. At anchor, Lacrosse I. (20 June)
39. 13 nautical miles (24 km) E of Reveley I. (21 June)
40. At anchor, Lesueur I. (22 June)
41. 6 nautical miles (11 km) NE of Jones I. (23 June)
42. 35 nautical miles (64 km) NE of Adèle I. (24 June)
43. 13 nautical miles (24 km) WNW of Adèle I. (24 June)
44. 36 nautical miles (67 km) NW of Cape Lévêque (24 June)
45. 65 nautical miles (120 km) SE of Impérieuse Reef (25 June)
46. 39 nautical miles (72 km) NE of Bedout I. (25 June)
47. 16 nautical miles (30 km) NW of Bedout I. (25 June)
48. 2 nautical miles (4 km) NE of North Muiron I. (3 July)
49. 4 nautical miles (8 km) NW of Low Point (3 July)
50. 4 nautical miles (8 km) W of Dorre I. (4 July)
51. 4 nautical miles (8 km) WNW of Herald Heights, Dirk Hartog I. (4 July)
52. 17 nautical miles (32 km) SE of Point Zuytdorp, 7 nautical miles off coast (4 July)
53. 9 nautical miles (16 km) NW of Beagle Islets (5 July)
54. 5 nautical miles (9 km) SW of Grey (5 July)
55. 9 nautical miles (16 km) W of Yanchep (5 July)