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## BREEDING SEABIRDS OF THE HOUTMAN ABROLHOS, WESTERN AUSTRALIA: 1991-1993

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All islands in the Houtman Abrolhos were searched for seabird breeding colonies during the last week of November and first week of December 1991 (Easter Group), 1992 (Wallabi Group) and 1993 (Pelsaert Group). The number of pairs in colonies located was counted or estimated, large colonies being estimated by point or quadrat sampling. Nineteen species, totalling over 1.6 million pairs, were recorded breeding on 122 islands, islets and rocks. The Houtman Abrolhos are particularly important for the conservation of Wedge-tailed Shearwaters (1 117 800 pairs on 12 islands), Little Shearwater (30 500 pairs on 26 islands), Roseate Tern (3 450 pairs on 20 islands), Sooty Tern (260 000 pairs on nine islands), Fairy Tern (480 pairs on 14 islands), Common Noddy (132 000 pairs on one island) and Lesser Noddy (48 800 pairs on three islands). These are the first comprehensive data on the numbers of breeding seabirds in the archipelago. Future regular counts or accurate estimates will enable trends to be documented and allow evaluation of the effects of environmental and human-induced changes, such as changes in sea temperatures and sea level, increased fishing effort and increased human visitation.

### INTRODUCTION

The Houtman Abrolhos are a shelf edge reef complex located about 70 km off the Western Australian coast near Geraldton. The emergent parts of the reef complex are in three island groups; channels reaching depths of approximately 40 m separate the central Easter Group from the northern Wallabi Group and the southern Pelsaert Group. The Abrolhos is located in a transitional zone between the high latitude cold water carbonate sediments of southern Australia, which are dominated by limestone reefs, and more tropical environments to the north, where coral reefs prevail. Its latitudinal position (28°18' to 29°00'S) places it at the generally accepted limit of existence for significant coral reef development. The Leeuwin Current, a southward flowing, offshore, warm water stream (Pearce and

Walker 1991) appears to have been critical in the development of these reefs, which are underlain by about 900 m of Tertiary and Cretaceous limestone, siltstone and marl. Recent coring in Easter Group reefs supported by high precision dating (Collins *et al.* 1993) has shown vigorous coral growth with reefs over 26 m thick in the Holocene and over 15 m thick in the last Interglacial. The growth history of the Abrolhos reefs over the last few thousand years is closely linked to global sea-level variations.

Each of the three Abrolhos groups consists of a central platform composed of last Interglacial reefs about which windward and leeward Holocene reefs developed asymmetrically. The wave exposed-windward reefs consist of a slow growing association of coralline algal bindstones and coral framestones, whereas fast growing coral

framestones dominate the more protected leeward reefs. These commenced growth 10 000 years ago and grew to present sea level by 6 500 years ago, generating a Holocene structural topography consisting of 'blue-hole' terrain in the leeward parts of the platforms.

The Abrolhos region has a Mediterranean climate and a microtidal environment dominated by southerly wind flows and swell waves. The islands are generally low in elevation, often being little more than coral cays or tabular platforms, rising some 3–5 m above present sea level. Exceptions to this generalisation occur in the Wallabi Group, where Late Quaternary eolianites reach elevations of 15 m above mean sea level. The larger islands — East and West Wallabi Islands and North Island — have areas of low alluvial dunes of white sand overlying the limestone. Well developed lagoon sand sheets are prominent elements of the Pelsaert and Easter Groups and coral shingle storm ridges are distinctive features of many of the islands.

Most islands are small and sparsely vegetated. Most of the coral rock is bare, some has very low perennial and annual herbs and grasses and prostrate shrubs such as *Atriplex cinerea* var. *brachytheca*, *Threlkeldia diffusa*, *Frankenia pauciflora*, *Enchylaena tomentosa*, *Scaevola crassifolia* and *Carpobrotus virescens*. Limestone areas support low shrubs and scrambling plants including *Myoporum insulare*, *Scaevola crassifolia*, *Eremophila glabra* and *Sarcostemma australe*, while extensive areas of sand have a low shrubland of *Nitraria billardierei* and *Atriplex cinerea* var. *brachytheca*, with *Spinifex longifolius* near beaches. Samphire (*Sarcocornia* and *Halosarcia*) is found in salt marsh areas, while the White Mangrove (*Avicennia marina*) forms usually small, dense low forests along sheltered coasts, and sometimes within enclosed lagoons, of many islands. The Wallabi Islands and North Island have a more diverse vegetation which has been described by Storr (1960, 1965). The introduced ice plant (*Mesembryanthemum crystallinum*) is widespread while the African Boxthorn (*Lycium ferocissimum*), which has established on many islands, is being controlled on an opportunistic basis.

All islands in the Houtman Abrolhos are reserved under the Western Australian Land Act as Class A Reserve No. 20253 for 'Conservation of Flora and Fauna, Tourism and Purposes Associated with the Fishing Industry'. The reserve

is vested in the Western Australian Minister for Fisheries. Under the Abrolhos Islands Planning Strategy many of the islands will become the Abrolhos National Park (Abrolhos Islands Task Force 1988).

The Abrolhos is renowned for its rich and abundant seabird fauna, which includes some species not normally found at such high latitudes. Although there are accounts of the seabirds of individual islands, some dating back over 100 years (e.g. Stokes 1846), and although a summary of the avifauna of the Houtman Abrolhos has been published (Storr *et al.* 1986), there have been few systematic counts of seabird numbers; counts that are available are limited to particular islands or particular species (e.g. Burbidge and Fuller 1981; Storr *et al.* 1986; Fuller and Burbidge 1992; Johnstone 1992a and b). Only regular counts or accurate estimates will enable trends to be documented and allow evaluation of the effects of environmental and human-induced changes, such as changes in sea temperatures and in sea level, increased fishing effort, and increased human visitation.

In this paper we have adopted a broad definition of 'seabird', including not only species such as shearwaters, storm-petrels, gulls, terns and noddies (see Ross *et al.* in press), but also species that nest on islands and utilise the ocean for food, such as Eastern Reef Egret, Pied and Sooty Oystercatchers, Osprey, White-bellied Sea-Eagle (which utilizes other seabirds for food) and Little Pied Cormorant.

## METHODS

All counts and estimates reported here were carried out between 23 November and 7 December 1991 inclusive (all islands in Easter Group), 1 and 8 December 1992 inclusive (all islands in Wallabi Group and North Island) and 25 November and 2 December 1993 (all islands in Pelsaert Group). Transport to islands was by the Fisheries Department 'jet-boat' Piper. On each island, one to four people traversed the whole of the island searching for colonies or individual nests. Counts or estimates were made as follows:

- (i) The nests of non-colonial species, such as Eastern Reef Egret, Osprey, White-bellied Sea-Eagle, Oystercatchers, Pacific Gull, Caspian Tern (colonial on Leo Island), and Bridled Tern were located by searching. Only current breeding season nests are reported here.
- (ii) For species that nest in relatively small compact colonies, such as Little Pied Cormorant, Pied Cormorant (except Wooded Island), Caspian (Leo Island) Crested, Roseate and Fairy Terns and Silver Gulls, where eggs and/or small

chicks were present, all nests were counted while walking slowly through the colony. Occasionally, if large chicks were present, we did not disturb the colony and made a rough estimate of its size.

- (iii) For species that nest in very large colonies on the surface (Sooty Tern, Common Noddy) or in burrows (Wedge-tailed Shearwater, Little Shearwater and White-faced Storm-Petrel), the total number of occupied or recently occupied nests was calculated by carefully mapping the area of active nests on to aerial photographs of known scale and using Ward's (1991) triangular tessellation method to calculate the number of nests per hectare. Estimating the number of pairs of the Wedge-tailed Shearwaters on the 600 ha West Wallabi Island took three persons three days. The Pied Cormorant colony on Wooded Island was at an advanced stage during our visit and its size was estimated by examining it through binoculars, to avoid causing disturbance to the chicks.
- (iv) For the Lesser Noddy, which nests mostly in trees, we counted nests in a series of quadrats along fixed transects (Fuller and Burbidge 1992) after calculating the area of occupied mangroves from aerial photographs.
- (v) Nest burrows on smaller islands were counted in entirety, or estimated by extending counts of small areas to that part of the island with currently occupied burrows.

Wherever possible, figures resulting from complete counts of colonies are given in Tables 2 and 3 and Appendix 1. However, time did not permit accurate counts or mathematical estimates for some species on many of the smaller islands and on these we used our experience to estimate the number of breeding pairs. For Bridled Terns we first confirmed breeding by locating a nest with an egg or chick and then counted or estimated the number of pairs flushed from nests. When nesting burrows were encountered, we ascertained the species by carefully examining several burrows before counting or estimating the number of active burrow entrances. Wedge-tailed Shearwater burrows could be easily identified because of their size and the presence of a sitting bird and/or the large, single egg during early December. White-faced Storm-Petrels have much smaller diameter burrows and a small egg or, if chicks were present, they were at an early stage of development. Little Shearwaters, however, which have a burrow with a diameter only a little larger than that of a Storm-Petrel, had finished or nearly finished breeding at the time of our visits, and while large chicks were present in some burrows, most had been abandoned. Where all burrows on an island were of one or the other species this presented few problems, but where the colonies were mixed (e.g. on Beacon Island), we were sometimes unable to provide a figure for the number of pairs of either or both species.

When calculating the total breeding population for the whole Houtman Abrolhos, we have used conservative figures from our estimates. Where our estimate was, e.g. 200 to 300, we have used the figure at the lower end of that estimate. For those islands in Pelsaert Group which were examined in both 1991 and 1993, we have used the 1993 data, being the more recent.

Information presented on breeding biology is derived from our own observations augmented by Storr *et al.* (1986).

## RESULTS

Appendix 1 lists by group, all islands on which we recorded breeding, together with numbers of active nests of each species located on each island. Appendix 2 lists breeding islands for each species, Appendix 3 is a map of the region showing the principal islands, and Table 4 summarizes the data for all Houtman Abrolhos Islands. We found seabirds breeding on a total of 122 islands, islets and rocks within the archipelago. The following is a summary of our breeding data set in the context of other available information, including our own earlier visits.

**Wedge-tailed Shearwater *Puffinus pacificus*.** Total breeding population about 1 117 816 pairs. Breeding recorded on 12 islands. Nests colonially. Nests are in substantial burrows or, sometimes, under low spreading vegetation or under rock ledges. Breeding colonies varied in size from eight on Gregory Island to an estimated 1 022 250 on West Wallabi. Birds arrive at the colonies during the latter half of August to renovate the burrows, egg laying takes place in late November and chicks leave the islands during May. The Houtman Abrolhos populations are by far the largest in the eastern Indian Ocean. The Department of Conservation and Land Management Seabird Breeding Island Database (CALM-SBID; Burbidge and Fuller in press) lists 82 other islands for this species from Carnac Island, near Perth north to the Ashmore Reef. The largest populations known outside the Abrolhos are Rottneest with 5 865 nests (Sims, C. V. *et al.* 1993, in CALM-SBID) and Serrurier with approximately 6 000 (Western Mining Corp. Ltd. 1990).

**Little Shearwater *Puffinus assimilis*.** Total breeding population about 30 555 pairs. Breeding recorded on 26 islands. Nests colonially. Colonies located varied in size from 20 pairs on Hall Island and Shag Rock to about 9 000 on West Wallabi. Nests in burrows or, sometimes, in scrapes under low spreading vegetation and, rarely, in rock crevices or under rock ledges. Birds arrive to clean out burrows in April, egg laying takes place in July and August and most young have departed by early December. In the eastern Indian Ocean, the Abrolhos is the northern limit of the breeding range for this species. The CALM-SBID lists 28 islands where this species breeds outside the Abrolhos.

**White-faced Storm-Petrel** *Pelagodroma marina*. Total breeding population about 4 227 pairs. Breeding recorded on 14 islands. Nests colonially. Colony size varied from 10 on an islet to the north of First Sister Island to between 1 000 and 1 500 on Dry Island and between 1 200 and 1 500 on Bynoe Island. Adults arrive in August, egg laying takes place in October and chicks leave the islands in February or March. Burrows found among those of Little Shearwaters on Bynoe, Beacon, Eastern, Seal and Stick Islands. The Abrolhos is the northern limit of the breeding range for this species in the eastern Indian Ocean. The CALM-SBID lists 31 islands where this species breeds outside the Abrolhos.

**Red-tailed Tropic-bird** *Phaethon rubricauda*. Not recorded breeding during our visits. Breeding recorded on Pelsaert Island in the 1940s and 1950s (Tarr 1949; Storr *et al.* 1986) (five nests were found in 1949), but no nests were observed between 1954, when Warham (1956) found eight nests, and December 1988 when R. Goodale and K. Coate found one bird incubating (CALM-SBID). Serventy *et al.* (1971) reported breeding on Rat Island, but provided no additional information.

**Pied Cormorant** *Phalacrocorax varius*. Total breeding population about 1 176 pairs. Breeding recorded on 9 islands. Nests colonially. Colony size varied from nine on an islet adjacent to Seven Island to about 1 000 on Wooded Island. Substantial nest constructed from sticks, stems, grasses and seaweed on plateaux of small islands on limestone or low shrubs. In 1991, the Wooded Island colony was in mangroves but in 1993 had been relocated to shrubs and on the ground. In the Abrolhos, breeding can occur from autumn to spring and into summer; however, most of our records were of old nests. On Sweet Island, we found egg laying commencing on 28 November 1993 and on Wooded on 2 December 1991, breeding was at all stages from eggs to near flying young.

**Little Pied Cormorant** *Phalacrocorax melanoleucos*. Not recorded breeding by us during the surveys reported above. However, on 5 December 1993 we found a colony comprising eleven nests, most with eggs but a few with small chicks, located in mangroves in the lagoon on Wooded Island. There is only one previous breeding record for

the Abrolhos: Wooded Island, 10 pairs, August 1980 (Storr *et al.* 1986). Nests constructed of sticks and built on mangrove branches or on rock ledges (Storr *et al.* 1986). Based on the two records above, egg laying can be during spring or early summer.

**Eastern Reef Egret** *Egretta sacra*. Breeding recorded on 11 islands. Eastern Reef Egret nests, although bulky structures of sticks, are difficult to locate, being hidden in mangroves or under rock ledges, and our total of 12 pairs is probably an under-estimate. Egg-laying occurs in spring to early summer. All birds sighted were of the grey phase.

**Osprey** *Pandion haliaetus*. Total breeding population 47 pairs. Breeding recorded on 41 islands. Osprey nests are substantial nests of sticks, coral shingle and flotsam. Nests may be on the ground, but are more commonly placed on shrubs. Occasionally they are placed on derelict crappots, buildings or on poles erected for nesting by lobster fishers. One occupied nest on Wooded Island was 1.7 m high. Egg laying usually occurs in late winter, but some birds lay later. Most chicks are flying by November or early December. Old nests can be found on almost every island in the archipelago. We have never observed Ospreys preying on seabirds or reptiles, only fish; seabird remains may be found in nests, but appear to have been dead when incorporated into nests as building material.

**White-bellied Sea-Eagle** *Haliaeetus leucogaster*. Total breeding population 15 pairs. Breeding recorded on 14 islands. Nests are constructed from sticks and lined with leaves, usually on the ground, but sometimes in mangroves, on low hills or promontories or on a disused Osprey nest. Egg laying occurs in late winter and chicks are flying by November or early December. While on West Wallabi Island on 5 December 1992, we counted 18 Sea-Eagles soaring over the island at the one time. In the Wallabi Group, inspection of nests showed that Sea-Eagles prey predominantly on Little and Wedge-tailed Shearwaters, although the remains of Tamar Wallabies (*Macropus eugenii*) are sometimes found at feeding roosts on and near the Wallabi Islands. On Pelsaert Island remains of shearwaters and noddies were recorded at nests and feeding roosts.



**Pied Oystercatcher** *Haematopus longirostris*. Not recorded breeding during our visits; however, it is moderately common throughout the archipelago. Breeds singly; nest is a scrape in sand or shingle near high water mark. Breeding data from the CALM-SBID are: East Wallabi, West Wallabi, Turnstone and Pelsaert Islands (no counts, no dates, Storr *et al.* 1986); Jackson (1 pair, 25 November 1989, K. Coate); North (1 pair, 15 June 1984, J. and B. Fitzhardinge) and Pelsaert (1 pair, October 1981, Fuller and Burbidge; 1 pair, 26 November 1989, K. Coate).

**Sooty Oystercatcher** *Haematopus fuliginosus*. Fairly common throughout the Abrolhos. Our only breeding record was of a runner on Leo Island (5 December 1991). Nest is a scrape in sand or shingle a short distance above the strand line. Egg laying occurs in late winter and chicks were either flying or hiding in vegetation at the time of our visits. Many more pairs breed in the Abrolhos than indicated by our data. Other breeding records are: West Wallabi 5 August 1976, 1 pair (Johnstone in press), and Wooded Island 1 December 1991, 1 pair and 6 December 1992, 1 pair (K. Coate in CALM-SBID) (see also Johnstone 1992a).

**Silver Gull** *Larus novaehollandiae*. Breeding recorded on 17 islands. Nests on ground in colonies, however nests are often several metres apart. The nest is constructed from grass and usually adjacent to or under low vegetation. At the Abrolhos, most breeding is in autumn and spring; spring breeding was nearly finished at the time of our visits and our record of 162 pairs is an under-estimate. There are insufficient historical data to judge whether numbers are increasing as is the case near settlements elsewhere in Australia.

**Pacific Gull** *Larus pacificus*. Total breeding population 51 pairs. Breeding recorded on 39 islands. Nests on ground; not colonial. Nest a substantial bowlshaped constructed from seaweed and grasses. Most eggs are laid in September and most young have flown by mid-December. The Abrolhos population belongs to subspecies *georgii*, which is restricted to Western Australia and western South Australia and is not numerous. The Abrolhos population is the largest on the west coast.

**Caspian Tern** *Hydroprogne caspia*. Total breeding population 81 pairs. Breeding recorded on nine islands. Nest is a scrape in sand or shingle. Usually nests singly, but occasionally in colonies. The Leo Island colony (70 pairs in 1991 and 40 pairs in 1993) is the largest known on an offshore island in Western Australia. Formerly nested colonially on West Wallabi and Wooded Islands (Storr *et al.* 1986). Eggs may be laid from September to December.

**Roseate Tern** *Sterna dougallii*. Total breeding population 3 441 pairs. Breeding recorded on 19 islands. Nests colonially. Nest is a scrape in shingle or sand, occasionally with a sparse lining of grass. Colonies located varied from two pairs on an islet near Traitors Island to 552 on Little North Island. Colonies may change significantly in size from year to year. For example, on 24 November 1991 the Square Island colony contained 874 nests, on 5 December 1992, between 800 and 900 nests (K. Coate in CALM-SBID) and on 26 November 1993 it contained 497 nests. Serventy and White (1951) reported a colony of 2 656 pairs on Pelsaert Island in December 1946. During our visits between 1986 and 1993, we found between 365 and 785 pairs. Egg laying usually occurs in summer, commencing in late November. However, some autumn breeding occurs — on 9 May 1993 a colony of 250 nests with eggs was found on Post Office Island. Colonies may be in the same place in consecutive years, or may shift from island to island. Outside the Abrolhos, Roseate Terns have been reported nesting on 20 islands as far south as Warnbro Sound (32°20'S), but the Abrolhos is its stronghold in Western Australia (CALM-SBID). Fairy Terns may be found breeding within Roseate Tern colonies.

**Sooty Tern** *Sterna fuscata*. Total breeding population 260 320 pairs. Breeding recorded on nine islands, all in Easter and Pelsaert Groups. Nests colonially. Nest is a scrape in sand or shingle under low vegetation. Colonies located varied from 20 on Leo Island in 1991 (this colony had increased to 12 000 to 15 000 in 1993) to 246 000 on Pelsaert Island in 1991. The 1993 estimate is based on the nest density of 2 November 1990, when all nests in the colony contained eggs. Using the triangular tessellation method of Ward (1991), an estimate of about 233 000 nests was obtained. At the time the colony covered an area of 16.18 ha giving a density of 14 400 nests ha<sup>-1</sup>. On 26 November

1991 the colony covered 17.08 ha and, assuming the same nest density as in 1990, it contained about 246 000 nests. In December 1986 the colony covered 12.89 ha (186 000), in December 1989 it covered 12.43 ha (179 000) and in November 1993 it encompassed 14.50 ha (209 000). Colony size can vary considerably from year to year; in November 1982 the colony extended north almost to the old guano jetty and there was another colony further south, to the west of the lighthouse. In the eastern Indian Ocean, outside the Abrolhos, the Sooty Tern currently nests only on two islands at Ashmore Reef, where the total number of pairs nesting between 1983–88 was estimated at 10 000 to 50 000 (ANPWS 1989). A colony formerly occurred on Bedout Island (19°45'S, 119°06'E), but the species has not been reported breeding there since 1901 (Tunney 1901) and may have been eliminated by the introduction of the Black Rat *Rattus rattus* (now eradicated, Morris 1989).

**Bridled Tern** *Sterna anaethetus*. Total breeding population about 7 046 pairs. Breeding recorded on 66 islands. Particularly widespread in Easter Group, where Rat was the only substantial vegetated island with no breeding birds. Nests singly, although nests may be close together on some islands leading to large concentrated populations, e.g. about 1 000 pairs on Gun Island. Nest is usually a scrape in shingle or sand under a shrub, under a coral or limestone slab or under a building; however, sometimes the egg is laid on bare rock or without any scrape being made.

**Fairy Tern** *Sterna nereis*. Total breeding population 481 pairs. Breeding recorded on 14 islands. Nests colonially. Nests sometimes intermingled with those of Roseate Terns. Colony size varied from three to 128 nests. Nest is a scrape in sand or coral shingle. Egg laying usually commences in late November. During our late November–early December visits, egg laying was usually incomplete and our counts would often have been an underestimate of the total breeding population. Breeding sites often change from year to year, although it is not unusual to find the same sites being used again and again. The total population of Fairy Terns in Western Australia is thought to be only a few thousand pairs (Burbidge *et al.* in press) and the population at the Abrolhos is a significant one.

**Crested Tern** *Sterna bergii*. Total breeding population 2 159 pairs. Breeding recorded on nine islands. Nests colonially. Colony size varied from four to 1 013 nests; however, on 26 November 1991 the Pelsaert Island colony contained 1 159 nests. Nest is a scrape in sand, often lined with grasses, often among *Spinifex* or low shrubs. Egg laying can occur in both autumn and spring; in the latter case laying has been recorded as early as August but most laying occurs in November, with some extending into December. Most chicks are on the wing by late January. Breeding sites may change from year to year; however, on Pelsaert Island we have often found the same sites being re-used.

**Common Noddy** *Anous stolidus*. Total breeding population 132 000. Breeds only on Pelsaert Island. Previously a very large colony occurred on Rat Island (see Changes in Abundance, below). Previously recorded breeding on Wooded Island (no count, 1913, Alexander 1922). The number of pairs in the colony at the southern end of Pelsaert Island has increased in recent years, although its extent has varied (Table 1). Nests are built from twigs, grasses and seaweed, some being decorated with small shells and pieces of coral. Others are placed on soil with little or no added material; most are on vegetation, including *Sarcocornia blackiana*, *Atriplex cinerea* and *Nitraria billardierei*. Nest density is highest in *Sarcocornia* around salt-pans where densities as high as 25 400 ha<sup>-1</sup> were noted in 1986. Breeding is not synchronised; in December 1986, December 1989, November 1991 and November 1993, some birds were constructing nests, some had the usual single egg, and young were at all stages to flying. In late October 1990 nests were either being constructed or contained an egg. Previous observations show that egg laying can commence in early August. In the eastern Indian Ocean, outside the Abrolhos, Common Noddies breed on two islands

TABLE 1

Colony area and estimated number of pairs, Common Noddy, Pelsaert Island.

Date of estimate	Colony area (ha)	Estimated number of pairs
12 December 1986	13.35	79 200
11 December 1989	17.90	116 500
26 November 1991	14.40	129 960
30 November 1993	13.21	132 000

TABLE 2

Lesser Noddy estimates — Pelsaert Island (for location of colonies see Burbidge and Fuller 1989; S1 refers to the southern colony among Common Noddies).

Colony	1986	1989	1991	1993
1	13 994	30 057	26 422	20 107
2	8 941	22 480	14 016	14 763
3	20	0	0	0
4	110	0	16	0
5	7 736	3 617	1 220	0
6	597	115	86	0
7	30	0	0	0
S1	0	0	0	25
Total	31 428	56 269	41 760	34 895

at Ashmore Reef (estimated 13 000 to 35 000 breeding pairs, 1983–88, ANPWS 1989), Sandy Island, Scott Reef (70 pairs, November 1984, Berry 1986), Middle and West Lacepede Islands near Broome (maximum counts 36 and 20 pairs 1987–88 (Fuller in CALM–SBID) and Lancelin Island (31°00'S, 115°19'E), 10 pairs, November 1992, Fuller and Burbidge in CALM–SBID). It formerly nested on Bedout Island (Tunney 1901). The Lacepede Islands' colonies may also have been affected by Black Rats (now eradicated).

**Lesser Noddy** *Anous tenuirostris*. Total breeding population 48 885 pairs. Breeds colonially on Wooded, Morley and Pelsaert Islands. Since 1989, estimates have been carried out on all islands every two years and an estimate was also made at Pelsaert in 1986. Numbers have fluctuated considerably (Tables 2 and 3). The nests, which are large for a seabird of this size, are placed on White Mangrove *Avicennia marina* branches and are built from seaweed (various green and brown algae, especially *Ulva* and *Cystophora* spp.), copiously cemented with white excreta. In 1993, we located about 25 Lesser Noddy nests on steep-sided, large *Nitraria* bushes near the southern end of the island. These nests were among those of Common Noddies. In 1986, on Pelsaert Island, nest density was as high as 43 in a 20 m<sup>2</sup> quadrat (noting that the nests were at different heights) and in 1989, 75 nests were counted in one 20 m<sup>2</sup> quadrat (Burbidge and Fuller 1989; Fuller and Burbidge 1992). In 1991, 108 nests were counted in one 20 m<sup>2</sup> quadrat on Morley Island (in 1993 this quadrat had only 14 nests). Fuller and Burbidge (1992) provide a description of the historical changes in abundance of this species in the

TABLE 3

Lesser Noddy estimates — all islands.

	Pelsaert	Wooded	Morley	Total
1986	31 430	—	—	—
1989	56 300	6 875	16 375	79 550
1991	41 760	5 325	11 745	58 830
1993	34 895	6 325	7 665	48 885

Abrolhos. There are two subspecies. The nominate subspecies breeds in the western Indian Ocean on the following islands: Latham, Gloriosa, the Aldabras, Providence, Amirantes, Agalegas, the Seychelles, the Mascarenes, St Brandon, the Maldives and Chagos (Feare 1984). Subspecies *melanops* nests only at the Houtman Abrolhos, although a noddy reported breeding in small numbers on two islands at the Ashmore Reef may be of this taxon (Stokes and Hinchey 1990).

A study of the reproductive biology of the Lesser Noddy in 1991–92 (Surman 1992) showed that egg laying began around 27 August and continued for 102 days, peaking on 30 September. Incubation lasted 34 days. Hatching success averaged 60 per cent, and varied through the season and within colonies depending on nest location. Those pairs breeding early in the season and/or in protected sites were more successful in hatching eggs and raising young. Age at first powered flight was 37 to 45 days. Fledging success varied from 73 per cent and 74 per cent (mid and late season layers) to 93 per cent (early season layers) with overall success being 79 per cent. Foraging range appeared to be 5–20 km from the colony.

## DISCUSSION

### *Numbers of seabirds*

These are the first data that provide reasonably accurate numbers of breeding pairs of seabirds at the Houtman Abrolhos, at least for the late spring early summer peak of breeding. Their value is increased because the data were collected over a short period of time.

TABLE 4

Summary of breeding seabirds recorded at the Houtman Abrolhos, November–December 1991–1993.

Species	Total number pairs	Number of islands
Wedge-tailed Shearwater <i>Puffinus pacificus</i>	c 1 117 800	12
Little Shearwater <i>Puffinus assimilis</i>	c 30 600	26
White-faced Storm-Petrel <i>Pelagodroma marina</i>	c 4 230	14
Pied Cormorant <i>Phalacrocorax varius</i>	c 1 180	9
Little Pied Cormorant <i>Phalacrocorax melanoleucos</i>	11	1
Eastern Reef Egret <i>Egretta sacra</i>	12	11
Osprey <i>Pandion haliaetus</i>	47	41
White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	15	14
Sooty Oystercatcher <i>Haematopus fuliginosus</i>	1	1
Silver Gull <i>Larus novaehollandiae</i>	162	17
Pacific Gull <i>Larus pacificus</i>	51	39
Caspian Tern <i>Hydroprogne caspia</i>	81	9
Roseate Tern <i>Sterna dougallii</i>	3 441	19
Sooty Tern <i>Sterna fuscata</i>	c 260 300	9
Bridled Tern <i>Sterna anaethetus</i>	c 7 050	66
Fairy Tern <i>Sterna nereis</i>	481	14
Crested Tern <i>Sterna bergii</i>	2 159	9
Common Noddy <i>Anous stolidus</i>	c 132 000	1
Lesser Noddy <i>Anous tenuirostris</i>	c 48 900	3
TOTAL	c 1 608 500	

All islands within a group were examined within a few days. The different groups were visited over three consecutive breeding seasons, however, since the island groups are well separated, we believe that there is little likelihood of birds being counted twice, even in the case of species that shift breeding sites from year to year (e.g. Pied Cormorant, Roseate Tern, Fairy Tern, Crested Tern).

For some species, our totals are under-estimates. On the Abrolhos, Silver Gulls breed mainly in the autumn and the number of breeding pairs at that time of year would be much larger than the 160 pairs with large young we observed in early summer. Some spring-breeding species, such as Pied and Sooty Oystercatchers, had largely finished breeding by the time of our visits and, since their nests are little more than temporary shallow scrapes, they would not have been located. On the other hand, Roseate and Fairy Terns were sometimes located when commencing egg-laying, and again our totals may be conservative. Roseate Terns are known to breed in the autumn (Post Office Island, 250 pairs, May 1993, R. Owens in CALM–SBID); it is not known

whether autumn breeding birds are from the same population as summer breeding ones. Autumn breeding is not common in the Abrolhos; one of us (RO) visits the islands frequently in autumn and has found little autumn breeding. Thus our counts for this species may be slight under-estimates.

For most species we believe our totals to be complete. These are: Wedge-tailed Shearwater, Little Shearwater, White-faced Storm-Petrel, Pied Cormorant, Little Pied Cormorant, Osprey, White-bellied Sea-Eagle, Pacific Gull, Caspian Tern, Roseate Tern, Sooty Tern, Bridled Tern, Fairy Tern, Crested Tern, Common Noddy and Lesser Noddy.

Our counts and estimates show that the Houtman Abrolhos are among the most important seabird breeding islands in Australia and support very significant breeding colonies of some species of seabirds. For some species they support the largest breeding colonies or aggregations in the eastern Indian Ocean: Wedge-tailed Shearwater, Little Shearwater, White-bellied Sea-Eagle, Osprey, Pacific Gull, Roseate Tern, Sooty Tern, Fairy Tern, Common Noddy and Lesser Noddy.



### Biogeography

The seabird fauna of the Houtman Abrolhos is a mixture of tropical and warm temperate species. The four tropical species are the most numerous in the archipelago: Wedge-tailed Shearwater, Sooty Tern, Common Noddy and Lesser Noddy. The presence and abundance of these species is probably due to the warm Leeuwin Current and the abundance of prey species in adjacent waters. Most Abrolhos seabird species have distributions encompassing both tropical and warm temperate seas: Pied Cormorant, Little Pied Cormorant, Eastern Reef Egret, White-breasted Sea-Eagle, Pied Oystercatcher, Sooty Oystercatcher, Osprey, Silver Gull, Caspian Tern, Crested Tern, Roseate Tern, Bridled Tern and Fairy Tern. Two species breed no further northward: Little Shearwater and White-faced Storm-Petrel; both these species are abundant in the Abrolhos and have warm temperate distributions. The Pacific Gull, another warm temperate species, continues its breeding distribution northwards only as far as Shark Bay.

### Changes in abundance

There are few previous counts of breeding seabirds on the Abrolhos islands and it is not possible to establish clear longterm trends in abundance of any species. Recent changes in abundance of Sooty Terns, Common Noddies and Lesser Noddies, reported above, were recorded over too short a time for a long term trend to be apparent. However, in the case of Rat Island, there has clearly been an extinction of the formerly very large colonies of Wedge-tailed Shearwater, Sooty Tern and Common Noddy due to the combined effects of guano mining and the introduction of cats (*Felis catus*) (Burbidge *et al.* in press). It seems unlikely that numbers of Shearwaters or Noddies have increased elsewhere in the Archipelago, however, numbers of Sooty Terns now seem to be increasing in Easter Group, with colonies on Alexander (40 000–60 000 pairs), Keru (2 000–3 000), Leo (20), Little North (200), Stokes (1 000–1 500), White (5 000–6 000), Wooded (400–600) and Suomi (3 000–5 000) Islands. On 5 December 1993, the Leo Island colony was estimated to contain 12 000 to 15 000 pairs, but other islands in the group were not examined.

### Threats

There are few significant threats to Houtman Abrolhos seabird populations at present. The islands are reserved and managed to minimize disturbance of the seabird breeding areas. As tourism increases, however, more intensive management will be needed to ensure that disturbance or damage does not occur. The reservation of the important seabird breeding islands as national park, as recommended in 1988, would enhance their conservation status. Management resources will be required to ensure that the national park is adequately protected. Major oil spills are of concern here, as elsewhere where seabirds congregate to breed.

Threats could arise in the medium to long term. For example, the over-exploitation of marine resources on which the birds depend for food, as has happened elsewhere in the world (e.g. Monaghan *et al.* 1991), could lead to reductions in seabird abundance. Any proposals to harvest these resources require evaluation before being approved. Additionally, even slight sea level rises could have a profound effect on the seabird colonies, because the islands rise such a short distance above high water mark. The establishment of mammalian predators, such as feral cats or black rats, could be devastating. Monitoring is required to ensure that any introductions are detected and eradication should be conducted as soon as possible.

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## APPENDIX 1

Islands in the Houtman Abrolhos, and seabirds recorded breeding on them.

<b>Wallabi Group — 1992</b>			Seal	Little Shearwater	c 250
Akerstrom	Little Shearwater	c 40		White-faced Storm-Petrel	c 70
	White-bellied Sea-Eagle	1		Pacific Gull	1
	Bridled Tern	c 40	Second Sister	Osprey	1
Alcatraz	Bridled Tern	c 8	(= Lagoon)	Crested Tern	4
(= Lumley)			Shag Rock	Little Shearwater	20
Beacon	Little Shearwater	c 5 000		Pied Cormorant	12
	White-faced Storm-Petrel	no estimate		Bridled Tern	5
	Osprey	1	Tattler	Little Shearwater	c 50
	Bridled Tern	c 700		White-bellied Sea-Eagle	1
Dakin	Little Shearwater	c 700		Bridled Tern	2
	Pacific Gull	1	Third Sister	Roseate Tern	139
Dicks	White-faced Storm-Petrel	c 400	Traitors	White-faced Storm-Petrel	c 20
	Osprey	1		Pacific Gull	1
	Bridled Tern	c 300		Roseate Tern	81
East Wallabi	Osprey	1		Bridled Tern	c 5
	Caspian Tern	1	Traitors	Pied Cormorant	23
	Fairy Tern	58	(Islet 1)	Bridled Tern	1
Eastern	Little Shearwater	c 70	Traitors	Bridled Tern	2
	White-faced Storm-Petrel	c 100	(Islet 2)		
	Bridled Tern	c 5	Traitors	Pied Cormorant	28
Far	Roseate Tern	297	(Islet 3)		
First Sister	White-faced Storm-Petrel	c 300	Traitors	Pacific Gull	1
First Sister	White-faced Storm-Petrel	17	(Islet 5)	Roseate Tern	2
(islet 2 to N)				Bridled Tern	2
First Sister	Pied Cormorant	11	Wann	White-faced Storm-Petrel	25
(islet 3 to N)	Osprey	1		Eastern Reef Egret	1
	Pacific Gull	1		Osprey	1
Hall	Little Shearwater	c 20		Bridled Tern	2
Little Pigeon	Eastern Reef Egret	1	West Wallabi	Wedge-tailed Shearwater	1 022 250
	Bridled Tern	c 50		Little Shearwater	c 9 000
Long	Little Shearwater	c 700		Osprey	1
	Eastern Reef Egret	1			
	White-bellied Sea-Eagle	1			
	Pacific Gull	1			
	Bridled Tern	c 700	<b>Easter Group — 1991</b>		
	Crested Tern	c 60	Alexander	Wedge-tailed Shearwater	c 700
Long	Osprey	1		Sooty Tern	c 50 000
(islet to NE)			Alexander	Bridled Tern	4
Marinula	Little Shearwater	c 40	(islet to S)		
	Roseate Tern	10	Bushby	Pacific Gull	1
	Bridled Tern	c 20	Bynoe	Little Shearwater	1 200–1 500
Marinula	Roseate Tern	490		White-faced Storm-Petrel	1 200–1 500
(islet to NE)				Eastern Reef Egret	1
North	Osprey	3		Bridled Tern	c 200
	Crested Tern	343		Fairy Tern	25
Oystercatcher	White-bellied Sea-Eagle	1	Campbell	Little Shearwater	c 200
Pelican	White-bellied Sea-Eagle	1		Bridled Tern	c 40
	Bridled Tern	c 30	Campbell	Roseate Tern	386
Pigeon	Osprey	1	(islet to S)		
	Bridled Tern	c 300	Crake	Little Shearwater	c 40
Plover	Osprey	1		Bridled Tern	c 3
	Silver Gull	2	Dry	White-faced Storm-Petrel	1 000–1 500
	Pacific Gull	1		Silver Gull	c 7
	Bridled Tern	4		Bridled Tern	c 10
Saville-Kent	White-faced Storm-Petrel	c 300	Gibson	Silver Gull	2
	Osprey	1		Roseate Tern	c 20
	Pacific Gull	1		Bridled Tern	1

## Appendix 1 — continued

<b>Easter Group — 1991 (continued)</b>					
Gilbert	White-bellied Sea-Eagle	1	Sandy (= Graveyard)	White-faced Storm-Petrel	c 300
	Silver Gull	c 8	Serventy	White-bellied Sea-Eagle	1
	Pacific Gull	1		Eastern Reef Egret	1
	Bridled Tern	c 10		Osprey	1
Gilbert	Roseate Tern	98		Silver Gull	4
(islet to NW)	Pacific Gull	1		Roseate Tern	3
	Bridled Tern	1	Serventy	Bridled Tern	c 40
Helms	White-faced Storm-Petrel	c 100	(islet to N)	Osprey	1
	Pacific Gull	1	Shearwater	Little Shearwater	c 100
	Bridled Tern	8		Osprey	1
	Fairy Tern	c 8		Silver Gull	c 5
Helms	Bridled Tern	6		Caspian Tern	1
(islet 1 to SE)				Crested Tern	c 35
Helms	Eastern Reef Egret	1	Shearwater	Little Shearwater	c 40
(islet 2 to SE)	Pacific Gull	1	(islet to S)	Bridled Tern	10
	Bridled Tern	2	Stokes	Sooty Tern	1 000–1 500
Helms	Bridled Tern	2		Bridled Tern	c 40
(islet 3 to SE)			Suomi	Little Shearwater	c 1 500
Helms	Osprey	1		Eastern Reef Egret	1
(islet 4 to SE)				Osprey	1
Joe Smith	Silver Gull	8		White-bellied Sea-Eagle	1
	Pacific Gull	1		Pacific Gull	2
	Bridled Tern	3		Sooty Tern	3 000–5 000
Keru	Little Shearwater	c 700		Bridled Tern	c 1 000
	Pacific Gull	1	Tapani	Pacific Gull	1
	Caspian Tern	1		Bridled Tern	5
	Sooty Tern	2 000–3 000		Fairy Tern	32
	Bridled Tern	c 250	White	Little Shearwater	c 500
Leo	Little Shearwater	c 3 000		Sooty Tern	5 000–6 000
	Osprey	1		Bridled Tern	c 10
	Sooty Oystercatcher	1	White	Pacific Gull	1
	Caspian Tern	70	(islet to S)	Roseate Tern	42
	Sooty Tern	c 20	Wooded	Little Shearwater	c 2 000
	Bridled Tern	c 200		Pied Cormorant	c 1 000
	Crested Tern	600		Little Pied Cormorant	11
Leo	Bridled Tern	1		Pacific Gull	2
(islet to N)				Sooty Tern	c 500
Little North	White-faced Storm-Petrel	c 200		Bridled Tern	c 500
	Pacific Gull	1		Lesser Noddy	5 325
	Roseate Tern	552			
	Sooty Tern	c 200	<b>Pelsaert Group — 1993</b>		
	Bridled Tern	c 300	Arthur	Osprey	1
	Fairy Tern	128		Bridled Tern	2
Little Rat	Eastern Reef Egret	1	Basile	Bridled Tern	c 4
	Osprey	1	Burnett	Bridled Tern	c 6
	Bridled Tern	c 25	(=Fin)		
Little Roma	White-faced Storm-Petrel	c 50	Burnett	Bridled Tern	1
	Bridled Tern	2	(islet to N)		
Morley	Little Shearwater	c 3 000	Coronation	Bridled Tern	c 4
	Pacific Gull	1	Coronation	Caspian Tern	1
	Bridled Tern	c 50	(2nd islet NE)		
	Lesser Noddy	11 745	Davis	White-bellied Sea-Eagle	1
Rat	Osprey	2		Bridled Tern	c 20
Rat	White-faced Storm-Petrel	c 35	Diver	Pacific Gull	1
(islet to N)	Osprey	1		Bridled Tern	c 3
	Crested Tern	4	Eight	Pied Cormorant	35
Robertson	Bridled Tern	1		Pacific Gull	1
Roma	Bridled Tern	c 5		Bridled Tern	c 70



Appendix 1 — *continued*

<b>Pelsaert Group — 1993 (continued)</b>			Pelsaert	Caspian Tern	2
Fairbridge	Osprey	1		Roseate Tern	365
(=Jackson)	Silver Gull	4		Bridled Tern	c 1 000
	Pacific Gull	1		Sooty Tern	246 000
	Fairy Tern	9		Fairy Tern	38
Gaze.	Osprey	1		Crested Tern	1 013
(islet to S)				Common Noddy	130 000
Gregory	Eastern Reef Egret	1		Lesser Noddy	34 870
	Roseate Tern	30	Post Office	Bridled Tern	c 15
	Fairy Tern	10		Fairy Tern	5
Gun	Wedge-tailed Shearwater	c 5 000	Seven	Osprey	1
	Bridled Tern	c 1 000		Pacific Gull	1
Gun	Osprey	1		Bridled Tern	4
(islet adjacent)			Seven	Pied Cormorant	9
Hummock	Little Shearwater	c 400	(islet adjacent)		
	White-bellied Sea-Eagle	1	Ship Rock	Silver Gull	1
Iris Refuge	Little Shearwater	35		Pacific Gull	1
	Pacific Gull	1	Six	Osprey	1
Jackson	Silver Gull	4	Square	White-bellied Sea-Eagle	1
Jon Jim	Osprey	1		Pacific Gull	1
	Silver Gull	4		Roseate Tern	497
	Roseate Tern	105	Stick	Little Shearwater	c 1 000
Lagoon	Osprey	1		White-faced Storm-Petrel	c 500
Murray	Wedge-tailed Shearwater	c 2 000		Osprey	1
	Silver Gull	4		Pacific Gull	1
	Pacific Gull	1		Bridled Tern	c 50
	Fairy Tern	57	Sweet	Wedge-tailed Shearwater	c 200
Newbold	Osprey	1		Pied Cormorant	33
Newman	Silver Gull	c 15		Osprey	2
	Fairy Tern	20		Silver Gull	4
One	Wedge-tailed Shearwater	c 30		Roseate Tern	11
	Pied Cormorant	25		Bridled Tern	c 15
	Eastern Reef Egret	1	The Coral	Osprey	1
	Osprey	1	Patches	Pacific Gull	1
	Pacific Gull	1		Roseate Tern	311
	Bridled Tern	c 50		Fairy Tern	12
Pelsaert	Wedge-tailed Shearwater	75 460		Crested Tern	95
	Little Shearwater	c 50	Three	Pacific Gull	2
	White-faced Storm-Petrel	12		Bridled Tern	4
	Eastern Reef Egret	1	Two	Wedge-tailed Shearwater	20
	Osprey	3		Bridled Tern	5
	White-bellied Sea-Eagle	2	Uncle Margie	Pacific Gull	1
	Silver Gull	80	(=Mangrove)	Bridled Tern	c 6
	Pacific Gull	8		Fairy Tern	3

## APPENDIX 2

Counts and estimates of breeding pairs by species

<b>Wedge-tailed Shearwater</b> <i>Puffinus pacificus</i>		<b>Pied Cormorant</b> <i>Phalacrocorax varius</i>	
Alexander	700	Eight	35
Davis	c 50	First Sister (islet 3 to north)	11
Gregory	8	One	25
Gun	c 5 000	Seven (islet adjacent)	9
Middle	120	Shag Rock	12
Murray	2 000	Sweet	33
One	c 30	Traitors (islet 1)	23
Pelsaert	75 460	Traitors (islet 3)	28
Sweet	c 200	Wooded	c 1 000
Two	20	TOTAL	c 1 176
West Wallabi	1 022 250		
TOTAL	c 1 117 816	<b>Little Pied Cormorant</b> <i>Phalacrocorax melanoleucos</i>	
<b>Little Shearwater</b> <i>Puffinus assimilis</i>		Wooded	11
Akerstrom	40	TOTAL	11
Beacon	5 000	<b>Eastern Reef Egret</b> <i>Egretta sacra</i>	
Bynoe	1 200	Bynoe	1
Campbell	200	Gregory	1
Crake	30	Helms (islet 2 to south-east)	1
Dakin	700	Little Pigeon	1
Eastern	70	Little Rat	2
Hall	20	Long	1
Hummock	c 400	One	1
Iris Refuge	35	Pelsaert	1
Keru	700	Serventy	1
Leo	c 3 000	Suomi	1
Long	c 700	Wann	1
Marinula	c 40	TOTAL	12
Morley	c 3 000	<b>Osprey</b> <i>Pandion haliaetus</i>	
Pelsaert	c 50	Arthur	1
Seal	c 200	Beacon	1
Shag Rock	20	Burnett	1
Shearwater	100	Dick	1
Shearwater (islet to South)	40	East Wallabi	1
Stick	c 1 000	Eastern	1
Suomi	c 1 500	Fairbridge	1
Tattler	c 50	Far	1
West Wallabi	c 9 000	First Sister (islet 3 to north)	1
White	c 500	Gaze (islet to south)	1
Wooded	c 3 000	Gregory	1
TOTAL	c 30 555	Gun (islet adjacent)	1
<b>White-faced Storm-Petrel</b> <i>Pelagodroma marina</i>		Helms (islet 4 to south-east)	1
Beacon	no estimate	Jon Jim	1
Bynoe	c 1 000	Lagoon	1
Dick	c 400	Leo	1
Dry	c 1 000	Little Rat	1
Eastern	c 300	Long (islet to north)	1
First Sister	c 300	Newbold	1
First Sister (islet to North)	10	North	3
Pelsaert	12	One	1
Sandy	c 300	Pelsaert	3
Saville-Kent	c 300	Pigeon	1
Seal	c 60	Plover	1
Stick	c 500	Rat	2
Traitors	20	Rat (islet to north)	1
Wann	25	Saville-Kent	1
TOTAL	c 4 227	Second Sister (lagoon)	1
		Serventy	1

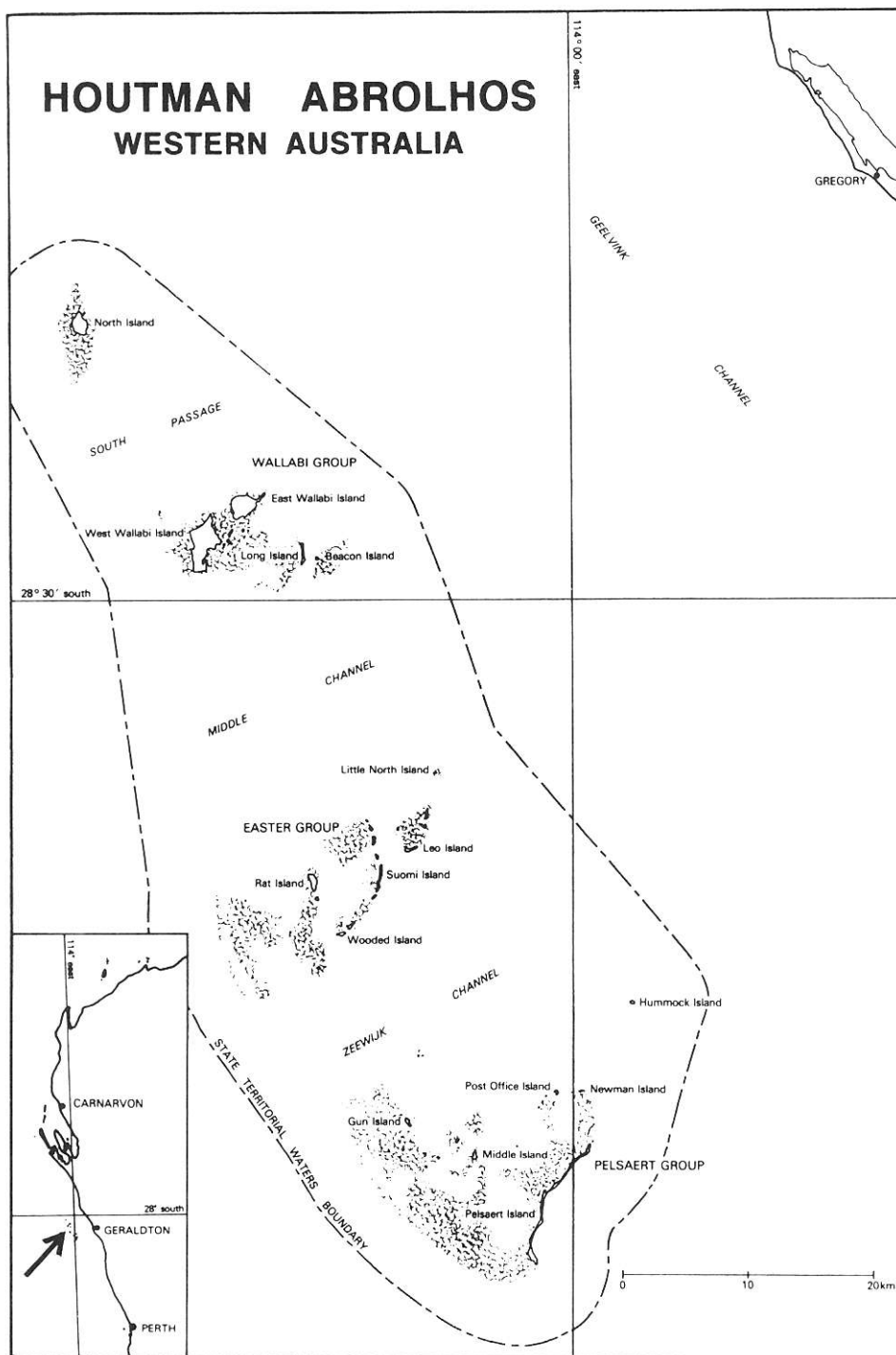
Appendix 2 — *continued*

<b>Osprey</b> (continued)					
Serventy (islet to north)	1	Gilbert	1		
Seven	1	Gilbert (islet to south-west)	1		
Shearwater	1	Gregory	1		
Six	1	Gun	1		
Square	1	Helms	1		
Stick	1	Helms (islet 2 to south-east)	1		
Suomi	1	Iris Refuge	1		
Sweet	1	Joe Smith	1		
The Coral Patches	2	Keru	1		
Three	1	Little North	1		
Wann	1	Long	1		
West Wallabi	1	Morley	1		
TOTAL	47	Murray	1		
		One	1		
<b>White-bellied Sea-Eagle</b> <i>Haliaeetus leucogaster</i>		Pelsaert	8		
Akerstrom	1	Plover	1		
Arthur	1	Saville-Kent	1		
Davis	1	Seal	1		
Gilbert	1	Seven	1		
Hummock	1	Ship Rock	1		
Long	1	Square	1		
Middle	1	Stick	1		
Oystercatcher	1	Suomi	2		
Pelican	1	Tapani	1		
Pelsaert	2	The Coral Patches	1		
Sandy	1	Three	2		
Square	1	Traitors	1		
Suomi	1	Traitors (islet 5)	1		
Tattler	1	Traitors (islet to south)	1		
TOTAL	15	Uncle Margie (= Mangrove)	1		
<b>Sooty Oystercatcher</b> <i>Haematopus fuliginosus</i>		White (islet to south)	1		
Leo	1	Wooded	4		
TOTAL	1	TOTAL	51		
<b>Silver Gull</b> <i>Larus novaehollandiae</i>		<b>Caspian Tern</b> <i>Hydroprogne caspia</i>			
Dry	4	Coronation (2nd islet NE)	1		
Fairbridge	4	Foale	1		
Gibson	2	Keru	1		
Gilbert	4	Leo	70		
Gun	4	North	3		
Jackson	4	Pelsaert	2		
Joe Smith	8	Shearwater	1		
Jon Jim	4	Stick	1		
Middle	4	Sweet	1		
Murray	4	TOTAL	81		
Newman	c 15	<b>Roseate Tern</b> <i>Sterna dougallii</i>			
Pelsaert	c 90	Campbell (islet to south)	386		
Plover	2	Fairbridge	12		
Serventy	4	Far	297		
Shearwater	4	Gibson	10		
Ship Rock	1	Gibson (islet to north)	98		
Sweet	4	Gregory	30		
TOTAL	c 162	Jon Jim	105		
<b>Pacific Gull</b> <i>Larus pacificus</i>		Little North	552		
Bushby	1	Marinula	10		
Bynoe	1	Marinula (islet to north-east)	490		
Dakin	1	Pelsaert	365		
Diver	1	Serventy	3		
Eight	1	Square	497		
Fairbridge	1	Sweet	11		
First Sister (islet 3 to north)	1	The Coral Patches	311		

## Appendix 2 — continued

<b>Roscate Tern (continued)</b>			
Third Sister	139	Robertson	1
Traitors	81	Roma	4
Traitors (islet to south)	2	Serventy	50
White	42	Seven	4
TOTAL	3 441	Shag Rock	5
		Shearwater (islet to south)	10
<b>Sooty Tern <i>Sterna fuscata</i></b>		Square	4
Alexander	c 40 000	Stick	50
Keru	c 2 000	Stokes	50
Leo	c 20	Suomi	c 1 000
Little North	c 200	Sweet	c 15
Pelsaert	208 700	Tapani	5
Stokes	c 1 000	Tattler	2
White	c 5 000	Three	5
Wooded	c 400	Traitors	4
Suomi	c 3 000	Traitors (islet 1)	1
TOTAL	c 260 320	Traitors (islet 2)	2
		Traitors (islet 5)	2
<b>Bridled Tern <i>Sterna anaethetus</i></b>		Two	5
Akerstrom	c 50	Uncle Margie (= Mangrove)	c 6
Alcatraz	1	Wann	2
Alexander (islet to south)	4	White	4
Arthur	2	Wooded	c 300
Basile	4	TOTAL	c 7 046
Beacon	c 700		
Burnett	6	<b>Fairy Tern <i>Sterna nereis</i></b>	
Burnett (islet to N)	1	Bynoe	11
Bynoe	c 200	East Wallabi	58
Campbell	50	Fairbridge	9
Coronation	4	Gregory	10
Crake	1	Gun	94
Davis	20	Helms	4
Dick	c 300	Little North	128
Diver	3	Murray	57
Dry	4	Newman	20
Eastern	4	Pelsaert	38
Eight	c 50	Post Office	5
Fairbridge	4	Tapani	32
Gibson	1	The Coral Patches	12
Gilbert	c 40	Uncle Margie (= Mangrove)	3
Gilbert (islet to south-west)	1	TOTAL	481
Gun	c 1 000		
Helms	8	<b>Crested Tern <i>Sterna bergii</i></b>	
Helms (islet 2 to south east)	2	Leo	600
Helms (islet 3 to south east)	2	Long	60
Joe Smith	3	North	343
Keru	300	Pelsaert	1 013
Leo	200	Rat (islet to north)	4
Leo (islet to north)	1	Second Sister	4
Little North	300	Shearwater	35
Little Pigeon	50	Sweet	5
Little Rat	50	The Coral Patches	95
Little Roma	2	TOTAL	2 159
Long	c 700		
Marinula	20	<b>Common Noddy <i>Anous stolidus</i></b>	
Morley	50	Pelsaert	132 000
One	c 50	TOTAL	132 000
Pelican	10		
Pelsaert	c 1 000	<b>Lesser Noddy <i>Anous tenuirostris</i></b>	
Pigeon	c 300	Morley	7 665
Plover	4	Pelsaert	34 895
Post Office	c 15	Wooded	6 325
		TOTAL	48 885





## APPENDIX 3

Map of Houtman Abrolhos, showing principal islands and reefs within which the minor islands are found.