

RECOVERIES, RECAPTURES AND RESIGHTINGS OF AUSTRALASIAN GANNETS *Morus serrator* BANDED AT LAWRENCE ROCKS, VICTORIA

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Banding of Australasian gannets *Morus serrator* (mainly of pre-fledging young) at Lawrence Rocks, off western Victoria, was initiated in 1960 and continued in most years until the 1971–1972 breeding period; a second series of banding began in 1986–1987 and occurred annually until 1996–1997. A total of 9 640 young and 374 adults was banded during these visits. Recoveries, recaptures and resightings of these banded birds are summarised here. To June 2002, some 203 (2.1%) of birds banded as young have been recovered both locally and at considerable distances. Dispersal tended to be westwards and included numerous records around Western Australia; younger (<48 months) birds were often recovered at greater distances. For younger birds, recoveries were more numerous in months immediately following fledging whereas older birds (>48 months) were usually found within the breeding period. Between 1960 and 1997, 86 birds marked as chicks were recaptured at Lawrence Rocks, usually four or more years post banding and breeding was increasingly reported in birds over three years old. Two birds from Lawrence Rocks were found dead during development of the Wedge Light colony in Port Phillip Bay, and 12 others have subsequently entered breeding populations there although only three from Port Phillip sites have been recorded at Lawrence Rocks. Several birds banded as chicks have been recovered (or resighted) at the newly-established mainland colony at nearby Point Danger and it is suggested that this colony was founded by young breeders from Lawrence Rocks.

Banding began at Lawrence Rocks as the colony was expanding and continued until the site was fully occupied. The recorded intrusion of birds from other sites has been low and it is considered that the colony developed essentially from the return of birds to the natal colony (apart from the inclusion of a small number of Cape gannets *M. capensis* now breeding there). Since Australasian gannets may move extensively, particularly when young and not breeding, conservation measures must take account of its temporal distribution and requisite resources.

INTRODUCTION

Colonies of Australasian gannets *Morus serrator* (gannets below) have increased recently, both in size and number, in New Zealand and in Australia (Waghorn 1983; Hawkins 1988; Norman *et al.* 1998; Bunce *et al.* 2002). For example, colonies in Port Phillip Bay have expanded from one site first occupied in 1966 (Wedge Light, 38°16'S, 144°42'E), to eight in 2002. This growth has occurred mainly as a result of internal recruitment, although some birds from Lawrence Rocks (38°25'S, 141°40'E), until recently the only other breeding location in Victoria, have intruded into the population breeding within the Bay (e.g. Norman 2001). The increases, at least at Victorian sites, have taken place in a period when local sea surface temperatures have risen and trawl fisheries have expanded, potentially generating food as a bycatch (Bunce *et al.* 2002). For much of the period of growth the commercial pilchard (*Sardinops sagax*) fishery also increased, particularly in Port Phillip Bay, although both total catch and catch per unit effort declined substantially following massive mortalities of pilchards in 1995 and 1998 (e.g. Neira *et al.* 1997; Coutin 2000; Gaughan 2002).

The colony at Lawrence Rocks has also expanded and a new breeding site was established at nearby Point Danger in 1995 (e.g. Norman *et al.* 1998; Bunce *et al.* 2002). In this note we examine some results obtained from banding activities conducted at Lawrence Rocks and consider them in relation to colony development there and in Victoria

generally. Locations of Victorian breeding sites were given in Norman (2001).

METHODS

Study site and colony development

Lawrence Rocks consist of two small, low-lying volcanic islands of approximately 6.8 and 1.5 hectares about 2 kilometres off Point Danger, near Portland in western Victoria (for the location of Lawrence Rocks, and other Victorian sites, see Norman 2001). The islands, separated by about 50 metres of open water, are about 90 metres and 10 metres above mean sea level respectively (Pescott 1980 provided some further details). Early records (Grant 1803; Bonwick 1858) implied that relatively small numbers of gannets bred on the larger island in the nineteenth century. In 1900 there were some 200 nests present (W. MacGillivray in North 1914) and in 1907 about 400 birds (but <200 nests) were 'attending their young' on the summit (Mattingley 1908, 1934). An aerial survey in March 1943 suggested that there were 190 nests; while there were other observations towards the end of, or outside, breeding periods, no estimates were made but Fowler and Serventy (n.d.) considered that the colony at that time was being limited by factors other than human interference. I. Watson (unpublished data, Department of Natural Resources and Environment (DNRE) file 86907) observed 603 nests in November 1958, McKean (1966) reported 406 breeding pairs in 1952, 605 pairs in 1960 and 639 in 1961, and Harris and Norman (1981) recorded 1 456 occupied nests in 1978. Somewhat later, Fisher and Cooper (n.d.) considered that there were 1 474 breeding birds in 1980–1981, 2 463 pairs in 1987 (E. J. Wingham in Marchant and Higgins 1990) and 5 490 ± 150 'adult birds' in December 1993. The colony expanded onto the smaller island in 1994–1995, and the nesting area was probably completely occupied in around 1996 (Norman *et al.* 1998). Some 6 200 birds were counted in December 1996, at a time when the colony at nearby Point Danger was developing (Norman *et al.* 1998). During the expansion of the Lawrence Rocks gannet colony,

Cape gannets *M. capensis* were first recorded in February 1992 (three birds), two were present in January 1993, four were seen in 1993–1994 (when one pair was nesting), seven in 1994 (Fisher and Cooper n.d.; chick banded January 1995), and four nests were found in 1995–1996 (two young banded).

Bandings, recaptures, resightings and recoveries

Banding of gannets at Lawrence Rocks was initiated by G. Bowker and J. McKean in 1960, and continued by a small group until the 1971–1972 breeding period. After a considerable break, E. Waghorn began the more recent series of bandings in the 1986–1987 breeding period, and this was continued until 1996–1997 by C. C. Aluminium bands were used in the first series of bandings, but stainless steel bands (all issued by the Australian Bird and Bat Banding Scheme, ABBBS) were used subsequently. In both periods, one or two visits were made to the colony in most breeding periods and large numbers of pre-fledging gannets banded; some adults were also marked. In later visits particularly, some attempts were made to capture previously banded adults, to replace worn bands and to obtain band numbers.

In this study, banding totals have been derived from microfiche records or electronic files held by the ABBBS; recapture, resighting and replacement details have in general been obtained from ABBBS and DNRE files. Records of banded birds found away from Lawrence Rocks were usually submitted directly to the ABBBS and this information has also been compiled together with associated details available on DNRE files. Here we include data received and processed by the ABBBS up to 30 June 2002.

For the purpose of analyses below, recoveries relate (except where otherwise indicated) to the reporting of birds found dead, either at the banding site or elsewhere. Recaptures here refer to the handling of birds previously banded at Lawrence Rocks, a time when the original band may also have been replaced. Occasional band numbers of some birds were obtained, particularly at sites away from Lawrence Rocks, as resightings by use of binoculars. It should be appreciated that totals given below may vary both as a result of differing levels of information provided (particularly relating to recoveries), and as a consequence of problems of reconciling given numbers with previous bandings. They are therefore minima. It should also be noted that recovery details have been taken as given (i.e. dates of recovery have been accepted as dates of death although they may have occurred some (perhaps considerable) time earlier) and information regarding the cause of death is rarely available. Distances and direction from the banding site used here are as provided by ABBBS and time elapsed since banding is given to the nearest month.

Using bill measurements of chicks at Lawrence Rocks, E. J. Wingham (= Waghorn) calculated that laying in 1986–1987 ranged from 20 September to 11 November, with the median date being 11 October (DNRE file 86907). Nevertheless, since information regarding most breeding events is unavailable for the Lawrence Rocks colony, generalized details for the Pope's Eye and Wedge Light colonies in Port Phillip Bay are used below as a proxy. Thus egg laying is assumed to commence in September and fledging in February (see Norman and Menkhurst 1995 for details), although it is realized that some interannual variation occurs (e.g. Gibbs *et al.* 2000; Bunce 2001).

RESULTS

Banding totals

Banding totals for breeding periods between 1960–1972 and 1986–1997 are summarized in Table 1. In this time, banding took place in 20 of the possible 23 breeding periods and 9 640 young and 374 adults were marked. A further 28 birds had bands replaced between 1986 and 1997. It is clear that more adults were banded between 1960 and 1972 than subsequently and that a higher rate of banding per breeding period (almost entirely of young birds) was achieved between 1986 and 1997.

Recaptures and resightings

Between 1960 and 1997, 86 recaptures of birds previously banded as young were made at Lawrence Rocks. The recapture total includes 22 birds (1.2% of the 1 867 banded as chicks) from the first banding period which were recaptured in the second (no birds banded in the 1966–1967 breeding period were recaptured). While small numbers ($n = 6$, 7%) were present when two or three years old, representation tended to increase substantially four years after banding (12, 13.9%) and subsequently (Table 2). More precise timing of return to the natal colony was precluded by the almost annual nature of visits to the Rocks.

Birds banded as adults were also recaptured or resighted at Lawrence Rocks, between 11 and 312 months later, and others have also been recaptured elsewhere. Thus one was caught and released off Western Australia during tuna fishing operations, two were caught (one 'exhausted') and released and another died while being rehabilitated. In addition, two birds (banded as chicks in the 1965–1966 and 1966–1967 breeding periods) were shot at Wedge Light in Port Phillip Bay in February 1972. Subsequently 12 other birds have joined the breeding populations in Port Phillip Bay (10 at Pope's Eye, and one each at Point Wilson and a South Channel marker), being recovered (1), recaptured and/or resighted (11) there. This immigration from Lawrence Rocks occurred at low but similar rates for both banding periods (i.e. 0.1%), involving two birds banded between 1960 and 1972 and 12 of those banded between 1986 and 1997. The average time between banding (as young) and recovery, first resighting or recapture at Port

TABLE 1
Banding of Australasian gannets *Morus serrator* at Lawrence Rocks, Victoria, 1960–1997.

Banding period	Young	Adults	Totals	Banding period	Young	Adults	Replacements	Totals
1960–1961	279	62	341	1986–1987	512			512
1961–1962	329	3	332	1987–1988	383	6		389
1964–1965	20		20	1988–1989	640			640
1965–1966	211	8	219	1989–1990	978		7	985
1966–1967	288	102	390	1990–1991	1 014		8	1 022
1967–1968	369	67	436	1991–1992	765		8	773
1968–1969	39	6	45	1992–1993	980		1	981
1969–1970	204	26	230	1993–1994	994		4	998
1971–1972	128	94	222	1994–1995	519*			519
				1995–1996	488**			488
				1996–1997	500			500
Totals	1 867	368	2 235		7 773	6	28	7 807

* or ** = includes 1 or 2 young Cape gannets.

TABLE 2
Recaptures of Australasian gannets *Morus serrator* at Lawrence Rocks, Victoria, previously banded there as young.

Banding period	Months to recapture																		Total		
	22-25	35-37	48-49	59-61	71-73	83-84	92-96	108-110	120-122	132-134	180-182	216-218	228-230	240-241	252-253	264-265	288-289	300-302		325-327	348-350
1960-1961					1	4		1		3										1	10
1961-1962				2	2		2		6												12
1964-1965		1																			1
1965-1966					1												1	1	1		4
1967-1968												2			1		1				4
1969-1970													1	5	1						7
1971-1972										2	1		2	1	1						7
1986-1987	1		1			7															9
1987-1988		1	2	1	3	3															10
1988-1989	1		2	5	2																10
1989-1990		1	5	2																	8
1990-1991	1		2	1																	4
Totals	3	3	12	11	9	14	2	1	6	3	2	1	2	3	6	3	2	1	1	1	86

Phillip Bay colonies for these 12 birds was 89.8 (\pm 51.69, 23-178) months although they may have occurred there earlier.

On occasion, and particularly during the second series of visits, some note was taken of the breeding status of individual recaptures, but again the distribution of such records reflects the timing of visits to Lawrence Rocks. Nevertheless, one bird was first reported as breeding when three years old, nine (17.6% of the 51 records) when four, and others subsequently (Table 3).

TABLE 3

Ages at first recorded breeding of Australasian gannets *Morus serrator* banded as young at Lawrence Rocks, Victoria.

Banding period	Number breeding in years post banding							Total	
	3	4	5	6	7	8	9		11+
1960-1971				1		2	1	18	22
1985-1997	1	9	7	5	7				29
Total	1	9	7	6	7	2	1	18	51

Recoveries

To the end of June 2002, there have been 203 recoveries of Australasian gannets banded as young (i.e. 2.1% of 9 640) at Lawrence Rocks; the recovery rate for birds banded as adults (374) was somewhat higher (12, 3.2%). Rates varied for the two banding periods, with 57 (3.0%) of those chicks banded in the early period being recovered compared with 146 (1.9%) for the later group, presumably reflecting the shorter time available for recovery of birds banded in the second period.

The locations of recoveries of gannets away from Lawrence Rocks are summarized in Figure 1. Clearly many birds were found dead locally, around coastal areas of western Victoria and southern South Australia. However, others were more distant; recoveries in Western Australia were not uncommon and one was made in Mauritius

(8 126 km, 27 days after banding in January 1997). In addition, occasional birds have been recovered in Tasmanian waters and one moved north of Townsville (Queensland). Movement, as indicated by recoveries, while affected by coastline (and perhaps human distribution), tended to be westwards. Thus of 176 recoveries of young gannets, 99 (55.6%) were made between 270° and 0° and 77 (43.7%) between 0° and 135°.

Dispersal of young from Lawrence Rocks may be substantial (Table 4), with numerous recoveries being made in Western Australia (see also Fig. 1) but there were many at or near the natal colony. Thus, for the 175 birds banded as young and found at known distances (and time) away from the Rocks, 24 (13.7%) were recovered within 10 kilometres and 37 (21.1%) up to 50 kilometres. Movements (as indicated by recoveries) were most extensive in the younger age groups, particularly those less than 48 months old. Hence, of 89 recoveries involving this cohort, 21 (23.6%) were made within 50 kilometres of the natal colony, another 31 (34.8%) within 500 kilometres and 37 (41.6%) beyond. Although a similar proportion of the 86 recoveries made of older birds were within 50 kilometres of Lawrence Rocks (16, 18.6%), 62 (72.1%) were reported between 51 and 500 kilometres and only 8 (9.3%) were more distant. The difference between the groups was significant ($X^2 = 29.655$, $df = 2$, $p < 0.0001$).

There is some indication that recoveries are more frequent, for birds banded as young, in the months following fledging. Of 75 individuals recovered within 12 months after banding, 26 (34.7%) were reported between March and June (Table 5); others were found dead at Lawrence Rocks (25) during routine banding visits in the December-February period, or elsewhere throughout the year. For birds of breeding age (here taken to be ≥ 48 months old, e.g. Norman and Menkhorst 1995) the situation was significantly different, with more recoveries (including recaptures and resightings) being made in the breeding period. Thus of 88 recoveries (including 10 resightings or recaptures) only 19 (21.6%) were outside the assumed September-February breeding period ($X^2 = 28.409$, $df = 1$, $p < 0.0001$).

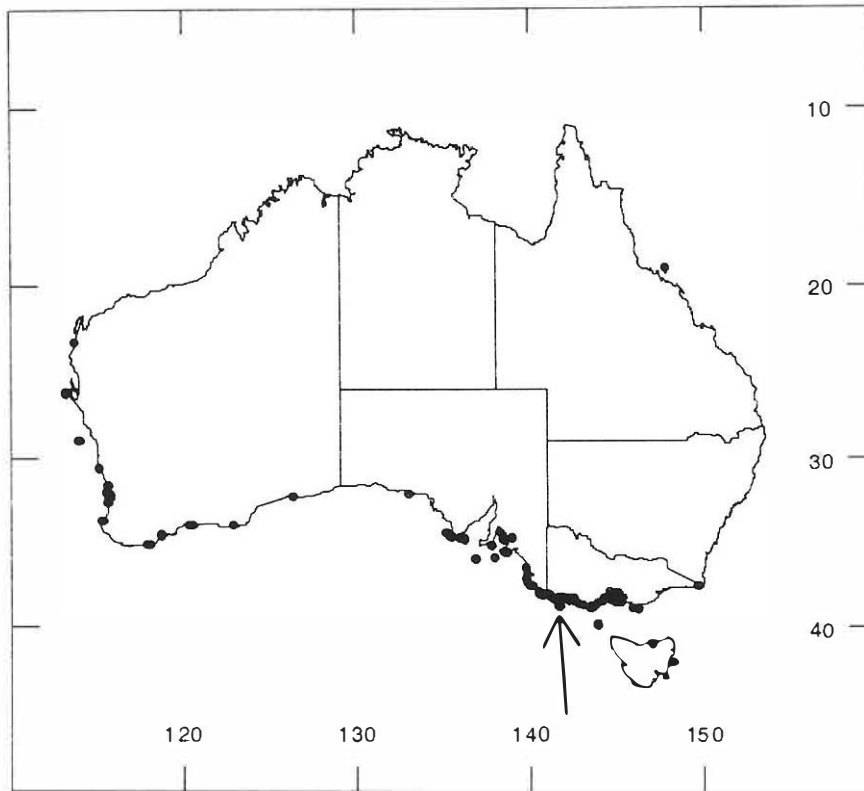


Figure 1. Locations where recoveries of Australasian gannets *Morus serrator* banded at Lawrence Rocks, Victoria were made around coastal Australia. (Position of Lawrence Rocks indicated by arrow and latitude °S and longitude °E shown. Multiple records at individual sites are not shown, nor is the one recovery in Mauritius).

Details for causes of death of recovered gannets are infrequently available (or determined). For the 203 recoveries considered here, the majority (187, 92.1%) were merely reported as dead, with no indication of the cause of, or time since, death. However, one bird was recovered from the stomach of a white-pointer shark, five were caught in fishing gear (one released), one was found near overhead wires, another was tangled in a tree (at Point Danger), two were shot (at Wedge Light), one speared by an arrow, one became caught in fencing (Pope's Eye) and

four were considered to have been killed by predators (three at the Point Danger colony). On some banding visits to Lawrence Rocks, young (not necessarily banded) were reportedly affected by 'fly strike'. Although its extent and importance is unknown, some 20 chicks were dead and a similar number infected in early 1987; another 22 were reported dead later that season. There were a 'lot' of dead chicks found in December 1967 and some 12 chicks were also found dead in February 1990, though causes were not determined. Based on recovery dates, there is no evidence

TABLE 4

Distances of recoveries (including recaptures and resightings) of Australasian gannets banded as young at Lawrence Rocks, Victoria. (Birds recaptured, resighted or found dead at Lawrence Rocks excluded).

Age at recovery (months)	Distance of recovery (km)										Total
	0	1-10	11-50	51-100	101-200	201-500	501-1 000	1 001-1 500	1 501-2 000	2 000+	
0-48	1	14	6	2	4	25	5	1	2	29	89
48-60			1	2	1	4			1		9
61-72		1		1	1	7	1				11
73-84		4		2		4					10
85-96		1	2	2	2	6	2				15
97-108		1	1	2	4						8
109-120		1	1	3	1						6
121-132		1		1		1			1		4
133-144					1						1
145-156				1	1	3					5
157-168			2	1			1			1	5
169-180				2		3					5
181-192				1							1
193-204						1					1
205-216				1							1
>217				1		2				1	4
Totals	1	23	13	22	15	56	9	1	4	31	175

TABLE 5

Month of recovery and time elapsed since banding for Australasian gannets *Morus serrator* banded as young at Lawrence Rocks, Victoria. (Numbers in parentheses reflect resightings or recaptures).

Months since banding	Month of recovery												Total
	J	A	S	O	N	D	J	F	M	A	M	J	
0-12	1	3	4	1	2	9	21	8	8	9	6	3	75
13-24		1		2		4 (1)	3	1	1	1		2	15
25-36		1		4		1		4	1	1			12
37-48			1 (1)	1	3		1	1			1		8
49-60					3	2	2 (1)		1	1			9
61-72			2 (1)	2 (1)	3	1		3 (1)					11
73-84	2				4	1		1 (1)			1		9
85-96	1		2 (1)	2 (1)	4		3		1	2			15
97-108	1			1		2		2	1				7
109-120					5	1	1						7
121-132								1	1	1	1		4
133-144				1									1
145-156		1 (1)			1	1	1			1			5
157-168				2			3						5
169-180		1 (1)		1	1 (1)			2					5
181-192			1		1								2
193-204											1		1
205-216						1							1
>217	1				1	2	2						6
Totals	6	7 (2)	10 (3)	17 (2)	28 (1)	25 (1)	37 (1)	23 (2)	14	16	10 (1)	5	198

that the mortalities of pilchards that occurred in 1995 and 1998 resulted in increased gannet deaths at those times.

Gannets were recovered along the coastline near Point Danger throughout the study period and, since the colony developed there in 1995, five banded as chicks at Lawrence Rocks have been found dead in and around it. Two of these recoveries were made 24 and 25 months respectively after banding while the others were 77, or more, months old. A bird was also resighted in the colony 68 months post-banding.

DISCUSSION

The gannet colony at Lawrence Rocks remained small and at about the same size from well before 1900 to the 1940s, but it had doubled by 1952 and increased substantially by the 1960s. When banding was initiated at Lawrence Rocks in 1960 there were some 600 breeding pairs (McKean 1966), a population which had expanded to over 2 400 pairs by 1987 (and more later) when the second banding period was underway. Some birds banded as chicks in the earlier period were recaptured in the second period, indicating a return to the natal colony and a philopatry similar to that previously reported in this and closely related species (e.g. Nelson 1978; Norman 2001). While the rate of this return to the natal colony is unknown at Lawrence Rocks, elsewhere it can be extensive and, when the colony is completely occupied, lead to nesting at other local sites (Norman 2001). Further, although there has been a low level of interchange between local colonies, with three birds from Wedge Light (Port Phillip Bay) being found at Lawrence Rocks, there is no evidence that any substantial immigration from other sites has supported the colony expansion there. Similarly, at Port Phillip Bay colonies the intrusion of birds from Lawrence Rocks has involved about 0.1 per cent of chicks banded there; while

representing about six per cent of resightings of banded birds, it was considered that colony growth essentially resulted from internal productivity (Norman 2001). Indeed, the representation of birds from Lawrence Rocks at Port Phillip Bay sites decreased as the colonies there grew. It is of note that the colony at Wedge Light in Port Phillip Bay was begun (in 1966) at a time when that at Lawrence Rocks was expanding, the Pope's Eye colony was also established (about 1985) well before the Rocks colony was complete. At Lawrence Rocks, as at Port Phillip Bay sites (Norman 2001), return of previously banded birds was increasingly recorded from their fourth year onwards although younger birds were occasionally seen. Such birds were presumably responsible for colony development at all sites (see also Wodzicki 1967 who considered that most returned when five years old). The resighting and recovery of birds from Lawrence Rocks at nearby Point Danger (which developed from 1995 onwards, about the time when Lawrence Rocks were fully occupied; Norman *et al.* 1998; Bunce *et al.* 2002) indicates the importance of the Lawrence Rocks colony as a source of breeding birds. At Point Danger too, although some birds were seen or recovered there when about two years old, others were older when resighted or recovered. As the colony at Lawrence Rocks filled, opportunities for younger birds to breed presumably decreased whereas they had been enhanced (as at Point Danger) while the colony was growing (Norman 2001). Prospective and new breeding sites are often initiated by young birds, particularly as populations are expanding (e.g. Nelson 1981).

Recoveries of gannets have been made well away from Lawrence Rocks, with birds tending to move westward into areas off South Australia and Western Australia (and in one case to Mauritius); few have occurred to the east of Port Phillip Bay or Tasmania. In contrast, the smaller number

of recoveries from Port Phillip Bay sites (also often shortly after fledging) have occurred in a more restricted area although in a usually western direction as far as Kangaroo Island in South Australia (Norman 2001). To some extent, for young banded at Lawrence Rocks, the distance to recovery site decreased with age post banding; recoveries of those of breeding age were more numerous in the breeding period. The breeding status of recoveries was, however, unknown and may include both breeders and non-breeders. Nevertheless, dispersal tends to be within the range of the pilchard, a prey species whose range itself is within the 9–21°C sea surface isohyet (e.g. Kailola *et al.* 1993).

Wingham (1985) considered that while the gannets' foraging range in the breeding period may extend to about 270 kilometres, most occurred within 60 kilometres of the colony. However, Bunce (2001) found that average foraging distances while adults were incubating were about 150 kilometres whereas those during chick rearing were about 90 kilometres: throughout the breeding period foraging trips averaged about 100 kilometres but were quite variable. Recoveries in this study during the nominal breeding period (September–February) ranged widely, but were less extensive than those outside it. At this time too, there is some admixture of birds from other populations. Although most recoveries of New Zealand-banded gannets occur along the eastern coast of Australia, some birds do disperse to Western Australia and intervening waters. Young from Lawrence Rocks also appear to disperse westwards, often to Western Australian waters but those from Port Phillip Bay have (to date) not shown such extensive movements, being made mainly near banding sites or in South Australian waters. Recoveries of birds banded in Tasmania also indicate some movement to southern Australia and, infrequently, Western Australia (see Wodzicki 1967; Marchant and Higgins 1990; Norman 2001 for further details). Further, movement over extensive distances can be apparently rapid (e.g. more than 8 000 km in less than 30 days) but is substantially less than predicted from body mass and wing structure (see Pennycook 1997).

The Cape gannet has now invaded two colonies in Victoria, those at Wedge Light (1981) and Lawrence Rocks (1993), and bred successfully either with another Cape gannet (Lawrence Rocks) or with the Australasian gannet (Wedge Light, Venn 1982; Norman *et al.* 1998; this study). This species has also been seen or recorded offshore (e.g. Ross 1988). However, at about the same time the Australasian gannet has expanded its breeding distribution. Lequette *et al.* (1995), for example, reported on the breeding of Australasian gannets (and the presence of Cape gannets) at Saint Paul Island (38°43'S, 77°30'E) in the southern Indian Ocean, well outside previously accepted breeding ranges. Two gannets were first seen there in early 1987, although their breeding status was not determined. Australasian gannets have also been recorded at Crozet and Marion Islands, in South African waters (see Lequette *et al.* 1995 for details) and within South African colonies (e.g. Dyer *et al.* 2001). Perhaps, as with the recovery made in Mauritius, some young gannets disperse beyond normal non-breeding habitat (southern Australia, including Western

Australia) and were subsequently attracted to, and occupied breeding sites within, colonies of Cape gannets. Certainly Australasian gannet populations and breeding sites have increased substantially in recent years, an expansion which has resulted in complete occupation of most previous sites and the development of others, often with younger aged birds from a presumed pool of potential breeders (Norman *et al.* 1998; Norman 2001; Bunce *et al.* 2002).

This study has shown that gannets from the Lawrence Rocks colony disperse extensively into the coastal waters off South Australia and Western Australia for considerable periods, particularly when young and not breeding. Conservation of this population therefore depends, at least during non-breeding periods, on activities and processes beyond single state-based fauna authorities. Management of the species and its required resources therefore should take account of variations in temporal distributions.

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