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SEABIRDS FOUND DEAD ON NEW ZEALAND BEACHES IN 1991, AND A REVIEW OF *Morus* AND *Sula* SPECIES RECOVERIES, 1943 TO 1991

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ABSTRACT

In 1991, 4780 km of coast of New Zealand were patrolled and 6955 dead seabirds were found as part of the Beach Patrol Scheme. An unusual find was a Red-tailed Tropicbird (*Phaethon rubricauda*), and more than usual were found of the Antarctic Petrel (*Thalassoica antarctica*), White-headed Petrel (*Pterodroma lessonii*), Little Black Shag (*Phalacrocorax sulcirostris*) and Brown Skua (*Catharacta skua lonnbergi*). A summary is given of the coastal and monthly distributions of *Morus* and *Sula* species found during the 1943-1991 period. Overall, 5637 Australasian Gannets (*Morus serrator*) were found, mainly on beaches of the northern half of the North Island. The peak period of adult recoveries was in December-February, but that of juveniles was in February-May. Both the Brown Booby (*Sula leucogaster*) and the Masked Booby (*Sula dactylatra*) are vagrants to the New Zealand mainland, with four and one individuals respectively having been found by patrollers.

INTRODUCTION

This paper records the results of the Ornithological Society of New Zealand's Beach Patrol Scheme for 1991 and reviews *Morus* species recovered since 1943, when the results of patrols were first recorded on Beach Patrol Cards. All sections of coast, except Fiordland, were patrolled (see Powlesland & Imber 1988). Some patrols on Chatham Island and South East Island, Chathams Group, were made, the results being given under the heading "Outlying Islands". In total, 766 Beach Patrol Cards and 7 Specimen Record Cards were submitted.

Kilometres "travelled" are the total distances travelled during patrols, whereas kilometres "covered" are the lengths of coast patrolled monthly. Hence, if the same 1 km stretch of beach is patrolled twice in one month, 2 km have been travelled but only 1 km covered per month. For a detailed description of methods for beach patrolling and of the Beach Patrol Scheme

TABLE 1 — Numbers of dead seabirds recovered and kilometres covered on each coast of New Zealand in 1991

COAST	CODE		MONTH												TOTAL KM	TOTAL BIRDS	BIRDS/KM OF COAST
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
AUCKLAND EAST	AE	KM	20	76	43	64	34	32	29	10	62	64	55	55	544	678	1.25
		BIRDS	142	94	32	97	9	9	15	13	73	50	56	88			
AUCKLAND WEST	AW	KM	110	134	182	163	115	159	155	188	163	161	194	136	1863	2987	1.60
		BIRDS	83	101	64	101	107	100	150	879	319	397	458	228			
BAY OF PLENTY	BP	KM	22	7	23	5	5	3	11	7	4	3	12	28	130	295	2.27
		BIRDS	152	7	28	3	3	2	10	9	10	1	8	62			
CANTERBURY NORTH	CN	KM	15	17	7	14	8	6	7	4	18	11	18	20	145	299	2.06
		BIRDS	58	28	19	14	9	7	2	3	18	54	23	64			
CANTERBURY SOUTH	CS	KM	6	9	5	5	9	9	5	5	13	5	8	2	81	152	1.88
		BIRDS	27	42	4	7	19	7	0	0	6	9	17	14			
EAST COAST NI	EC	KM	7	7	5	9	13	5	12	10	13	19	6	1	107	75	0.70
		BIRDS	5	14	9	10	5	2	11	3	8	3	2	3			
NORTH COAST SI	NC	KM	1	0	0	0	0	0	2	0	7	6	0	0	16	31	1.94
		BIRDS	23	0	0	0	0	0	0	0	7	1	0	0			
OUTLYING ISLANDS	OI	KM	0	0	0	0	0	0	0	1	0	0	2	0	3	8	2.67
		BIRDS	1	0	0	0	0	0	0	0	1	0	0	6	0		
OTAGO	OT	KM	12	6	6	8	8	6	10	6	6	4	8	9	89	30	0.34
		BIRDS	5	7	4	1	0	0	2	0	0	6	3	2			
SOUTHLAND	SD	KM	11	19	12	13	13	10	3	2	13	11	34	32	173	492	2.84
		BIRDS	68	16	11	3	6	4	3	1	15	89	157	119			
TARANAKI	TA	KM	6	5	4	10	6	0	2	35	18	5	2	0	93	194	2.09
		BIRDS	2	6	1	4	5	0	1	99	64	8	4	0			
WAIRARAPA	WA	KM	1	5	1	16	0	0	0	0	0	16	0	0	39	32	0.82
		BIRDS	1	5	23	2	0	0	0	0	0	1	0	0			
WESTLAND	WD	KM	4	0	20	2	0	113	113	114	113	0	0	0	479	27	0.06
		BIRDS	11	0	3	1	0	0	4	6	2	0	0	0			
WELLINGTON SOUTH	WS	KM	9	5	7	14	14	9	4	11	5	11	9	14	112	180	1.61
		BIRDS	5	6	17	20	13	17	52	10	4	2	14	20			
WELLINGTON WEST	WW	KM	36	24	13	18	5	19	21	76	38	67	27	17	361	1475	4.09
		BIRDS	78	164	4	13	0	17	32	697	115	278	68	9			
TOTAL KILOMETRES TRAVELLED			315	333	373	369	234	383	394	574	501	463	502	339	4780		
TOTAL KILOMETRES COVERED			260	314	329	341	230	372	374	470	473	383	375	314	4235		
TOTAL BIRDS RECOVERED			661	490	219	276	176	165	282	1721	641	899	815	609	6955		
BIRDS/KM COVERED			2.54	1.56	0.67	0.81	0.77	0.44	0.75	3.66	1.36	2.35	2.18	1.94		1.64	

TABLE 2 — Coastal and monthly distribution of seabird species for which 1 to 11 specimens only were found in 1991

SPECIES OR SUBSPECIES	NUMBER FOUND	COAST (S)	MONTH (S)
<i>Diomedea melanophrys</i>	3	AW (2), AE	JAN, APR, JUN
<i>exulans</i>	5	AW (5)	JUN, SEP, OCT (2), NOV
<i>epomophora</i>	1	AW	FEB
<i>cauta</i> subsp.**	7	AW (6), TA	JUN (2), JUL, AUG (3), NOV
<i>cauta salvini</i>	1	TA	AUG
<i>chlororhynchos</i>	1	AE	SEP
<i>bulleri</i>	5	AW (2), SD (2), WW	MAY, JUN, JUL, OCT, NOV
<i>Phoebastria palpebrata</i>	8	AW (7), WW	JAN, JUN, AUG, SEP, OCT, NOV (2), DEC
<i>Puffinus gavia/huttoni</i>	4	CN (2), CS (2)	JAN (2), NOV, DEC
<i>Procellaria</i> spp.**	2	AW, SD	FEB, DEC
<i>cinerea</i>	2	AW (2)	SEP, DEC
<i>parkinsoni</i>	7	AW, AE (5), WW	JAN, FEB, APR (2), MAY, JUN, OCT
<i>westlandica</i>	3	AW, SD, WD	JAN (2), JUN
<i>sequinoctialis</i>	2	AW (2)	SEP, OCT
<i>Pachyptila crassirostris</i>	2	AW (2)	JUL, AUG
<i>Pterodroma pycrofti</i>	1	BP	MAR
<i>nigripennis</i>	2	AW (2)	APR, DEC
<i>Oceanites nereis</i>	1	SD	NOV
<i>Megadyptes antipodes</i>	5	CS (3), OT, SD	FEB (2), APR, SEP (2)
<i>Eudyptes pachyrhynchus</i>	2	SD, WD	MAR, NOV
<i>Phaethon rubricauda</i>	1	AW	APR
<i>Phalacrocorax</i> spp.**	5	AE, EC, OT, SD, WS	JUN, JUL (2), NOV, DEC
<i>sulcirostris</i>	8	AW, AE, EC (3), WS (3)	JAN, APR (2), JUL (2), SEP, OCT, NOV
<i>melanoleucos</i>	6	AW, AE (3), TA (2)	FEB (2), MAY, AUG, NOV (2)
<i>Stercorarius parasiticus</i>	2	AW, CS	APR, DEC
<i>Larus</i> spp.**	1	WW	NOV
<i>Sterna</i> spp.**	1	WW	OCT
<i>caspia</i>	11	AW (8), BP, CN, WD	JUN, JUL (2), AUG (6), OCT, NOV
<i>fuscata</i>	2	AW, WW	AUG (2)
TOTALS	101		

**Species/subspecies was not identified by the patroller

TABLE 3 — Coastal distribution of the seabirds species more commonly found dead (> 11 specimens) in 1991

SPECIES OR SUBSPECIES	COAST														TOTAL BIRDS		
	W	AH	BP	TA	WM	NC	WA	WS	NC	WD	CN	CS	OT	SD		OI	FD
<i>Diomedea</i> spp."	7	0	0	0	3	0	1	0	0	0	1	0	0	4	0	0	16
<i>cauta stendi</i>	11	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	14
<i>chrysostrama</i>	19	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	20
<i>Puffinus</i> spp."	5	4	0	4	0	0	0	0	0	0	1	2	0	0	0	0	20
<i>carneipes</i>	22	63	9	0	0	0	0	0	0	0	0	0	0	0	0	0	94
<i>bulleri</i>	76	29	6	0	13	1	1	0	0	2	3	0	0	0	0	0	131
<i>griseus</i>	254	80	49	2	16	1	0	11	3	3	37	40	3	45	2	0	546
<i>tenuirostris</i>	102	4	0	4	14	0	0	0	0	2	8	1	0	95	2	0	232
<i>gavia</i>	145	88	27	2	31	1	1	6	7	0	6	0	0	0	0	0	314
<i>huttoni</i>	6	1	0	1	21	6	2	1	0	1	21	3	1	0	0	0	64
<i>essimilis</i>	9	8	0	0	3	0	0	0	0	0	1	0	0	0	0	0	21
<i>Pelecanoides urinatrix</i>	31	41	11	3	55	0	0	2	1	0	2	0	0	43	0	0	189
<i>Lagenus brevirostris</i>	16	1	2	0	13	0	0	0	0	1	0	1	0	0	0	0	34
<i>Deption capense</i>	18	0	0	1	3	0	0	1	0	2	1	2	0	6	0	0	34
<i>Thalassidroma antarctica</i>	6	0	0	0	4	0	0	0	0	0	0	0	0	8	0	0	18
<i>Fulmarus glacialis</i>	29	1	0	0	14	0	0	0	1	0	0	0	0	20	0	0	65
<i>Macronectes</i> spp."	24	2	1	0	2	0	0	0	1	0	1	1	0	2	0	0	34
<i>Pachyptila</i> spp."	143	3	2	25	260	0	0	2	4	2	4	5	0	5	0	0	455
<i>torquatus</i>	445	30	51	48	410	1	4	5	5	2	5	2	0	57	1	0	1066
<i>belcheri</i>	419	2	5	34	321	0	0	0	2	1	0	0	0	1	1	0	786
<i>desolata</i>	38	0	0	6	10	0	0	0	0	0	0	0	0	0	0	0	54
<i>salvini</i>	27	0	0	4	9	0	0	0	0	0	0	0	0	0	0	0	40
<i>vittata</i>	67	0	0	8	68	0	3	0	0	0	14	23	0	56	0	0	239
<i>Halobaena caerulea</i>	233	8	3	10	100	0	0	0	0	1	0	0	0	17	0	0	372
<i>Pterodroma</i> spp."	9	0	1	1	0	0	0	0	0	0	0	0	0	8	0	0	19
<i>cockii</i>	9	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	12
<i>inexpectata</i>	21	0	0	1	0	0	0	0	0	0	0	0	0	11	0	0	33
<i>macroptera</i>	20	19	11	0	0	0	1	0	0	0	0	0	0	0	0	0	51
<i>lessonii</i>	175	3	0	5	18	0	0	0	1	0	1	1	0	1	0	0	205
<i>Palagodroma marina</i>	8	8	2	0	1	0	0	0	0	0	0	0	0	1	1	0	21
<i>Rudyptula minor</i>	124	152	76	3	28	2	13	6	2	2	16	5	3	25	1	0	459
<i>Morus serrator</i>	270	51	5	13	5	12	3	1	1	0	3	1	0	1	0	0	366
<i>Phalacrocorax carbo</i>	3	0	0	1	0	7	0	0	0	0	1	0	0	1	0	0	13
<i>varius</i>	10	14	5	0	0	0	0	0	0	0	8	0	0	1	0	0	38
<i>Laucocorbo chalconotus</i>	0	0	0	0	0	0	0	0	0	0	0	6	3	12	0	0	21
<i>Stictocorbo punctatus</i>	1	1	0	0	2	0	0	0	1	2	35	27	2	9	0	0	80
<i>Catharacta skua lonnbergi</i>	9	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	22
<i>Larus dominicanus</i>	74	37	10	12	28	28	2	129	1	2	73	22	10	39	0	0	467
<i>novaezelandiae</i>	28	9	12	0	4	2	0	11	1	1	40	1	6	11	0	0	126
<i>bulleri</i>	0	0	0	0	1	7	0	0	0	0	5	2	0	2	0	0	17
<i>Sterna caspia</i>	8	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	11
<i>striata</i>	27	4	5	0	4	3	1	1	0	0	9	1	0	1	0	0	56
TOTALS	2948	666	294	190	1469	71	32	176	31	25	297	146	28	484	8	0	6865

*Species was not identified by the patroller

TABLE 4 — Monthly distribution of the seabird species more commonly found dead (≥ 11 specimens) in 1991

SPECIES OR SUBSPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL BIRDS
<i>Diomedea</i> spp.**	0	1	1	0	1	1	1	3	1	3	1	3	16
<i>cauta</i> <i>steadi</i>	0	0	1	0	2	1	1	1	2	3	1	1	14
<i>chrysostrama</i>	0	1	0	0	0	2	1	2	3	5	6	0	20
<i>Puffinus</i> spp.**	2	1	2	0	1	2	2	5	2	1	1	1	20
<i>carneipes</i>	16	17	6	33	0	0	0	0	0	1	13	8	94
<i>bulleri</i>	22	13	6	18	6	5	5	0	1	10	22	23	131
<i>griseus</i>	128	41	16	17	54	13	2	2	3	47	128	95	546
<i>tenuirostris</i>	9	6	0	1	6	4	1	0	1	66	128	10	232
<i>gavia</i>	55	23	9	31	7	5	11	36	22	42	54	19	314
<i>huttoni</i>	6	6	12	1	1	0	3	1	0	16	14	4	64
<i>assimilis</i>	3	0	0	0	1	2	0	1	2	2	7	3	21
<i>Pelecanoides</i> <i>urinator</i>	24	2	0	1	3	4	12	40	24	36	24	19	189
<i>Lugensa</i> <i>brevirostris</i>	0	1	0	0	0	0	0	12	5	9	6	1	34
<i>Deption</i> <i>capense</i>	6	1	1	1	1	0	1	12	6	3	2	1	34
<i>Thalassoica</i> <i>antarctica</i>	0	0	0	0	0	0	0	0	0	11	5	1	18
<i>Fulmarus</i> <i>glacialoides</i>	0	0	0	0	0	0	0	2	3	26	25	9	65
<i>Macronectes</i> spp.**	22	61	2	1	7	19	12	129	80	93	22	7	455
<i>Pachyptila</i> spp.**	96	105	5	10	3	12	40	440	189	86	47	33	1066
<i>turtur</i>	4	1	0	0	1	0	31	666	61	17	2	3	786
<i>belcheri</i>	0	0	0	0	0	1	2	33	17	1	0	0	54
<i>desolata</i>	1	0	0	0	0	0	5	24	7	1	1	1	40
<i>salvini</i>	33	4	4	1	2	0	5	99	24	7	3	57	239
<i>vittata</i>	0	0	0	0	0	0	0	63	26	176	87	11	372
<i>Halobaena</i> <i>caerulea</i>	0	0	0	0	0	0	0	0	0	1	0	12	5
<i>Pterodroma</i> spp.**	0	2	0	0	6	0	0	0	0	1	0	2	12
<i>cookii</i>	3	5	1	3	2	0	0	0	0	0	5	14	33
<i>inexpectata</i>	14	2	1	0	0	3	0	8	5	5	5	8	51
<i>macroptera</i>	4	2	0	1	2	13	6	9	16	99	37	16	205
<i>lessoni</i>	4	1	0	2	0	0	0	0	6	3	4	1	21
<i>Pelagodroma</i> <i>marina</i>	63	47	47	55	16	4	8	23	35	24	28	109	459
<i>Eudyptula</i> <i>minor</i>	26	40	29	19	19	14	29	61	29	31	46	23	366
<i>Morus</i> <i>serriator</i>	1	0	1	2	1	0	2	2	2	0	1	1	13
<i>Phalacrocorax</i> <i>carbo</i>	3	6	2	2	9	1	0	1	1	4	4	5	38
<i>varius</i>	3	5	1	0	0	4	0	0	1	4	2	1	21
<i>Leucocarbo</i> <i>chalconotus</i>	15	9	3	1	2	7	3	3	1	6	9	21	80
<i>Stictocarbo</i> <i>punctatus</i>	47	54	54	43	18	27	59	21	29	36	31	48	467
<i>Catharacta</i> <i>skua</i> <i>lonnbergi</i>	15	14	11	13	7	3	5	3	15	4	8	28	126
<i>Larus</i> <i>dominicanus</i>	1	3	0	1	0	1	0	0	3	2	3	3	17
<i>novae-hollandiae</i>	0	0	0	0	0	1	2	6	0	1	1	0	11
<i>bulleri</i>	23	9	2	3	1	2	0	2	3	3	2	6	56
<i>Sterna</i> <i>caspia</i>													
<i>striata</i>	653	483	217	267	173	156	275	1712	633	851	803	602	6865

**Species was not identified by the patroller

see Powlesland & Imber (1988). The taxonomic nomenclature and sequence are as in Turbott (1990). For the meaning of the abbreviations of each section of coast (e.g. AE = Auckland East), see Table 1.

RECOVERIES IN 1991

In 1991, the total length of coast travelled was 4780 km, along which 6955 seabirds were found by 150 members of the Ornithological Society of New Zealand and their friends. The average number of birds recovered per kilometre of coast covered was 1.64 (Table 1). The total distance travelled was 16% greater than the average of 4105 km per year recorded over the past 20 years (1971-1990). However, the number of seabirds found in 1991 was only 67% of the average of 10 349 birds for the same 20 year period. This period is used for comparison because the distance travelled annually was fairly constant; whereas from 1943 to 1970 the distance travelled increased gradually (Powlesland 1990). Table 1 gives the kilometres covered and the number of seabirds found per month and in total for the various coasts, plus the number of birds found per kilometre covered for each coast. Coastal and monthly totals for uncommon species (11 or fewer specimens) are given in Table 2, while for more common species (more than 11 specimens) coastal totals are presented in Table 3 and monthly totals in Table 4.

Unusual finds

A Red-tailed Tropicbird found on Ninety Mile Beach (AW) in April (Table 2) is the eighth record for the Scheme. The previous records are 1963, AW, October; 1984, AW, April; 1987, AW, February; 1988, AE, October; 1988, Macauley Island of the Kermadec Group (OI), September; and 1990 (2), AW (2), May (2). For a brief review of the biology of this species and of Red-tailed Tropicbirds found or seen in New Zealand previously see Powlesland *et al.* (1992).

Four species were found in greater numbers than usual in 1991. The 1991 total of Antarctic Petrels was 18. This is the second highest annual total for the species, but is much less than the 77 found in 1978. Usually 0-5 specimens of Antarctic Petrel are found annually. The 1991 birds were found on Auckland West (6), Wellington West (4) and Southland (8) beaches (Table 3), mainly in October (11) and November (5) (Table 4). While the 1978 wreck of this species also occurred mainly on North Island west coast and Southland beaches, most specimens were found in August and September (Veitch 1980). Generally, Antarctic Petrels do not venture north beyond 50°S. The 1991 birds were picked up at a time of year when adults return to their nesting sites about the Antarctic continent and nearby islands (Serventy *et al.* 1971).

In 1991, 205 White-headed Petrels were found compared with the previous highest annual total of 288 in 1985. Generally, 50-100 have been found in most years since 1970. Most (85%) of the White-headed Petrels were picked up from Auckland West beaches (Table 3) in October and November (66%) 1991 (Table 4). The birds found in 1991 were possibly non-breeders because breeders tend to remain near their subantarctic nesting islands for most of the year (Warham 1985), with courtship and egg-laying occurring in October and November (Warham 1967).

The 1991 tally of Little Black Shags was eight, the highest annual total. Usually five or fewer are found each year. In keeping with the finding that Little Black Shags are rarely seen south of Cook Strait (Bull *et al.* 1985), all eight 1991 specimens were found on North Island beaches (Table 3). As the shags were picked up during an 11-month period (Table 4), their deaths were not associated with a seasonal event.

There were 12 Brown Skuas picked up in 1991, the highest annual total. The previous highest annual total was five in both 1973 and 1988; patrollers usually find 1-3 each year. Nine of the 1991 skuas were found on Auckland West beaches (Table 3). Similarly, of the 37 Brown Skuas found during 1943 to 1990, 22 (59%) of them were on Auckland West beaches. Fifty-eight percent of the 1991 skuas were picked up in August (3) and September (4) (Table 4). By comparison, although at least one Brown Skua from the 1943-1990 sample was found in each month, 57% were picked up during June to September. In the New Zealand region the species breeds on Auckland, Antipodes, Campbell, Chatham, Macquarie, Snares, Solander and Stewart Islands and their outliers (Turbott 1990). Most territorial adults on The Snares and Chatham Islands remain resident year round (Horning & Horning 1974, Hemmings 1989). However, adult Brown Skuas from more southern islands disperse northwards to about 33°S (just north of the Three Kings Group) during autumn and winter (Moors 1980). As Brown Skuas on South East and Antipodes Islands lay eggs from mid-September to late October (Young 1978, Moors 1980), those found on New Zealand beaches in 1991 may have been non-breeders.

Miscellaneous birds

Birds other than seabirds recovered in 1991 totalled 139. There were 34 Australian Magpies, 10 Rock Pigeons, nine Mallards, eight Black Swans, six New Zealand Pigeons, five each of South Island Pied Oystercatchers and Starlings, four each of Cattle Egrets, Paradise Shelducks, Variable Oystercatchers, Blackbirds and unknown species, three each of Reef Herons, domestic geese, Grey Ducks, Western Wekas, Pukekos, Song Thrushes and Goldfinches, two each of White-faced Herons, Pied Stilts, and Cockatiels, and one each of Brown Kiwi, New Zealand Dabchick, heron species, Canada Goose, Australasian Harrier, Ring-necked Pheasant, Wild Turkey, domestic fowl, Spur-winged Plover, Eastern Bar-tailed Godwit, North Island Kaka, Shining Cuckoo, Sacred Kingfisher, Tui and Chaffinch.

RECOVERIES 1943-1991 of *MORUS* and *SULA*

AUSTRALASIAN GANNET (*Morus serrator*)

The Australasian Gannet breeds on islets off Tasmania and southeastern Australia, Philip Island of the Norfolk Group, and about New Zealand (Turbott 1990). Twenty-eight gannetries are presently used about New Zealand (Wodzicki *et al.* 1984, Hawkins 1988). The northernmost gannetries are the five at the Three Kings Islands, and the southernmost is on Little Solander Island near Foveaux Strait (Wodzicki *et al.* 1984). Although gannets are seen throughout New Zealand's coastal waters, the species is most plentiful north of Cook Strait. The results of national censuses carried out

in 1946-47 (21 115 pairs), 1969-70 (37 774 pairs) and 1980-81 (46 004 pairs) indicate a mean annual rate of increase for the population over the 34 years of 2.3% (Wodzicki *et al.* 1984). Of note is that 99% of gannets in 1980-81 nested in gannetries about the northern half of the North Island.

Most gannetries are deserted outside the breeding season (Robertson 1985). Generally the breeding season of the Australasian Gannet about New Zealand extends from July to February, but it can vary between years for a particular gannetry (Wingham 1984), and between gannetries within a year depending on latitude and availability of food (Marchant & Higgins 1990). Incubation takes about 44 days and chicks depart when 93-115 days old (Robertson 1985, Marchant & Higgins 1990). Chicks leave gannetries in the Hauraki Gulf from late December (Stein 1961, Waghorn 1983) and leave Cape Kidnapper and Farewell Spit gannetries from early February (Wodzicki 1967, Hawkins 1988). The last chicks leave the gannetries in May. Most fledglings cross the Tasman Sea soon after leaving the gannetries and arrive in Australian waters from January onwards (Wodzicki 1967). The majority remain in Australian waters for 1-4 years, mainly off the east coast south of the Tropic of Capricorn and in Bass Strait (Wodzicki 1967). Although a few return to their natal gannetries when 1-2 years old, most do so when 3-7 years old (Wodzicki 1967, Robertson 1985). Most breeders remain in New Zealand's coastal waters during the non-breeding season, but at least one has been recorded back in Australian waters (Wodzicki 1967).

Generally, 100-300 Australasian Gannets have been found annually during the past 22 years of beach patrolling (1970-1991). The number of gannets found each year has varied from 58 in 1970 to 500 in 1985. In total, 5637 gannets were found during 1943-1991, at an average rate of 6.49 birds per 100 km of coast covered. Patrollers indicated that of the 5637 gannets found, 1358 (24.1%) were in adult plumage, 302 (5.4%) were in juvenile plumage, and the remaining 70.5% were of unknown age or their age was not given on the cards.

Of the coastal regions, Auckland East had the greatest rate of gannet recovery (10.01 birds/100 km of coast covered), followed by Auckland West (9.39), East Coast North Island (6.07) and Bay of Plenty (5.62). Except for North Coast South Island (3.20), the recovery rates for South Island coasts (0.08-1.23) were much lower than for North Island coasts (1.43-10.01). These results were as expected from the distribution and size of the gannetries about New Zealand (Wodzicki *et al.* 1984).

To test whether the annual pattern of recovery for the Australasian Gannet depicted in Figure 1 differs from the theoretical situation whereby an equal number of birds per 100 km of beach covered was found each month, we used the Kolmogorov-Smirnov one-sample test (Siegel 1956, p. 47). Overall, the monthly rate of recovery of Australasian Gannets of unknown age was greatest in November-February and least in May-June ($p < 0.01$); similarly, the peak period of adult mortality was December-February ($p < 0.01$) (Figure 1). This period coincides mainly with the rearing of nestlings by most breeders and probably with the moult of non-breeders and some unsuccessful breeders. The data suggest that finding and capturing sufficient prey to meet the demands of rearing a nestling or of moulting may

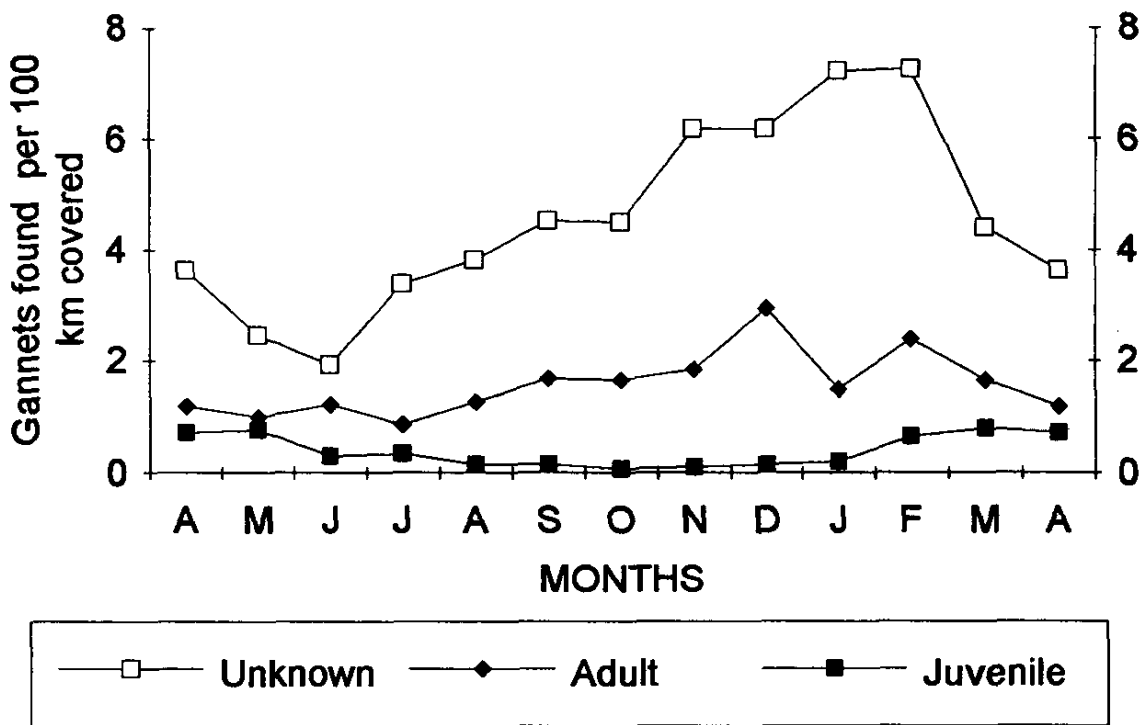


FIGURE 1 — Monthly rate of recovery of Australasian Gannets during 1943-1991

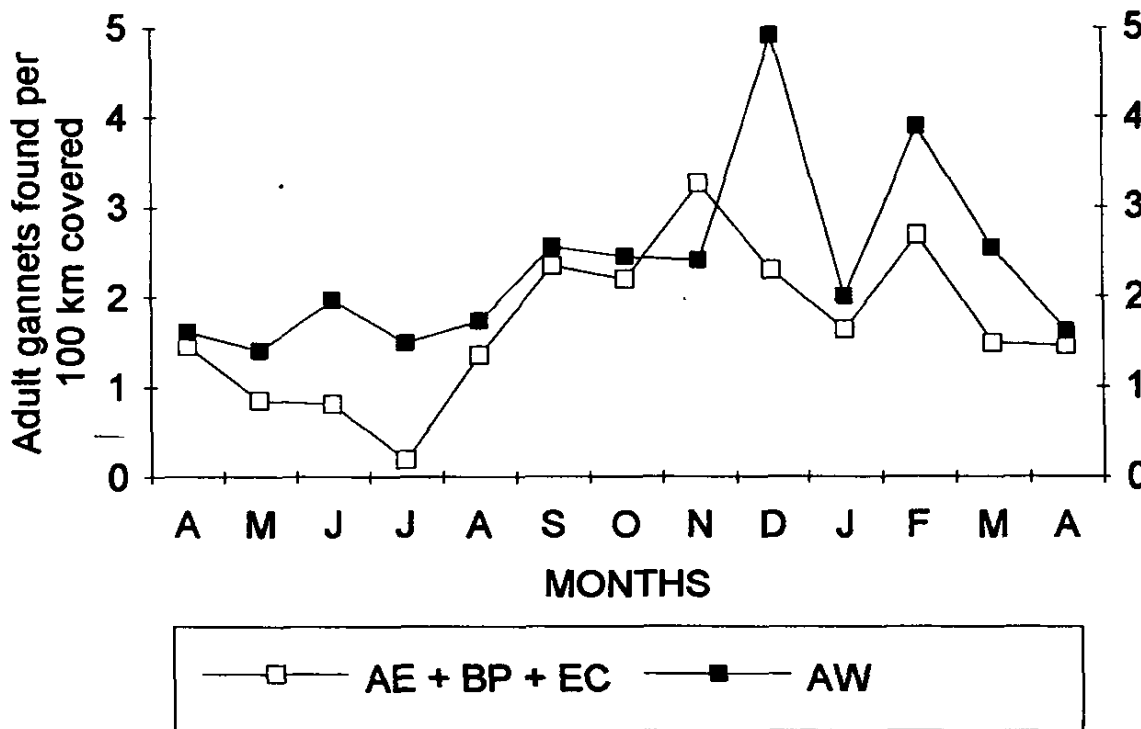


FIGURE 2 — Monthly rate of recovery of adult Australasian Gannets during 1943-1991 on northeastern North Island beaches (Auckland East, Bay of Plenty and East Coast North Island beaches) and Auckland West beaches

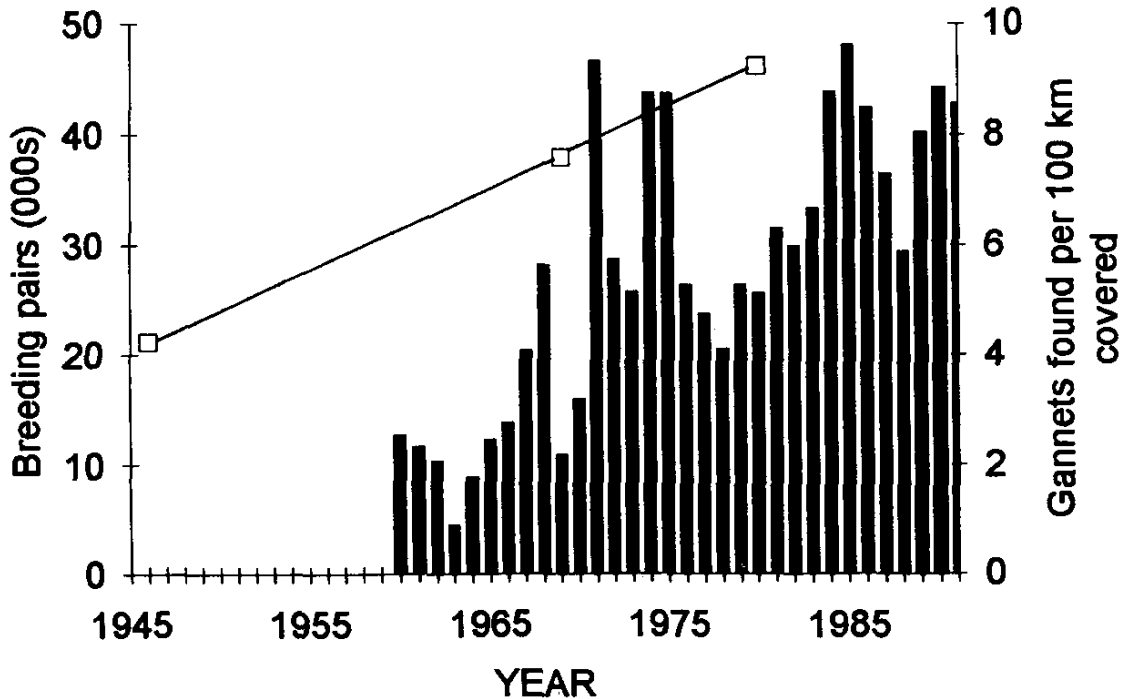


FIGURE 3 — Annual rate of recovery of Australasian Gannets during 1960-1991 (vertical bars), and the number of pairs of nesting gannets about New Zealand in 1946-47, 1969-70 and 1980-81 (Wodzicki *et al.* 1984)

result in greater mortality of adults than does meeting maintenance requirements outside the breeding season.

Figure 2 shows the monthly rate of recovery of adults found on northeastern North Island beaches (Auckland East, Bay of Plenty and East Coast North Island beaches) compared with that of adults found on Auckland West beaches. One difference is the greater rate of finding dead adults in May-July on Auckland West beaches than east coast beaches, which possibly relates to two factors. First, the gannet population in the non-breeding season is more dispersed. (Of nesting gannets about the North Island in 1980/81, only 25% were in gannetries along the Auckland West coast — Wodzicki *et al.* 1984). Second, onshore storms are more frequent on the west coast in winter than on the east coast. The other feature is the greater mortality of adults in December on Auckland West beaches than northeastern North Island beaches. During December-January adolescent gannets, whose plumage is largely indistinguishable from that of breeders, arrive at Cape Kidnappers gannetries (C.J.R. Robertson, pers. comm.) with more northern colonies being accordingly earlier. Thus, the increased rate at which adult-plumaged gannets are found on Auckland West beaches may indicate the arrival of migrating adolescent gannets from Australian back to New Zealand coastal waters.

In contrast to that of adults, the monthly recovery rate of juveniles was greatest in February-May, and least in September-November ($p < 0.01$) (Figure 1). This period of greatest mortality of juveniles coincides with when many leave the gannetries (Wodzicki 1967, Robertson 1985). That

juvenile gannets continue to be found by patrollers on New Zealand beaches after May, when the majority have flown to Australian coastal waters, relates to at least two factors. First, it is known that a small proportion of juvenile gannets overwinter about New Zealand (Stein 1961, 1962). Second, some dead birds are found months after they have died and been washed ashore because either the beach they are cast up on is patrolled infrequently or the corpse has been covered by sand and then exposed by wind and tide weeks later (Powlesland & Pickard 1992).

Other than rare species or those of very limited distribution, the Australasian Gannet is the only New Zealand seabird species whose entire breeding population has been counted accurately more than once (Wodzicki *et al.* 1984). The difference in the total number of pairs counted between 1946-47 and 1980-81 indicates a 118% increase over the 34-year period. Such an increase in the population might be expected to be reflected in the annual rate at which gannets have been found by patrollers over the same period. Figure 3 shows the gannet census figures for 1946-47, 1969-70 and 1980-81 (Wodzicki *et al.* 1984) and the annual recovery rate of gannets (numbers found per 100 km of beach covered) from 1960 to 1991. The annual recovery rate of gannets before 1960 is not shown because usually less than 500 km were patrolled and fewer than 10 gannets found. By smoothing the annual recovery rate data using the LOWESS algorithm with tension 0.5 (Cleveland 1981, Wilkinson *et al.* 1992), the annual percentage change in recovery rate for the 1969-80 period is +3.42%, and for 1970-81 it is +3.23%. For the period 1969-81, the census figures give an annual percentage change in numbers of breeding pairs of +1.81%. Thus, the increase in the annual rate at which gannets have been found by patrollers during 1969-81 has a similar magnitude to the increase in the number of breeding pairs.

BROWN BOOBY (*Sula leucogaster*)

This species occurs through all tropical oceans, mostly between latitudes 30°N and 30°S (Marchant & Higgins 1990). The nearest breeding sites of the species to New Zealand are many islands and cays off the Queensland coast (Marchant & Higgins 1990). Breeding of Brown Boobies has been recorded in all months. Adults leave the nesting islands after the breeding season, but the extent of their movements and those of juveniles is unknown. The subspecies *S. l. plotus*, of the western and central Pacific Ocean, is considered to reach New Zealand waters in most summers, where it often associates with Australasian Gannets (Turbott 1990). During 1943-1991, patrollers found four Brown Boobies. The results for these birds are 1971, AE, January; 1980, AW, April; 1987, CS, July; and 1989, WW, March. On a further 31 occasions Brown Boobies have been seen alive or found dead about New Zealand (Heather & Sheehan 1990, Marchant & Higgins 1990, Hawkins *et al.* 1992).

MASKED BOOBY (*Sula dactylatra*)

The Masked Booby has a widespread distribution through the tropics, both in terms of its non-breeding season movements and its breeding sites (Marchant & Higgins 1990). It wanders widely in search of food, with nesting birds foraging far from land (Marchant & Higgins 1990). In the New Zealand

region the Masked Booby breeds at the Kermadec Group on Meyer, Dayrell, South Chanter, Macauley, Haszard and Curtis Islands (Nelson 1985). At these islands eggs are laid mainly from late August to November (Oliver 1955), and most chicks leave their nests between January and July (G. Taylor, pers. comm.). It is a vagrant to New Zealand, with just one having been found by patrollers on mainland beaches: 1988, AW, May. There are six other records of the Masked Booby having reached New Zealand. One was found on Gannet Island (AW) in 1883, and one was seen west of North Cape in 1964 (Turbott 1990). Two birds were seen on each of three occasions in the Firth of Thames (AW); 19 and 30 October 1977 and 5 March 1978 (Brown & Lawrie 1979). The sixth record is of a booby found alive in Hamilton in July 1983 (C.R. Veitch, pers. comm.). Since the species ranges widely and large numbers inhabit the tropical Pacific Ocean, it is noteworthy that few Masked Boobies have been found on or seen about the New Zealand mainland.

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