SEABIRDS FOUND DEAD ON NEW ZEALAND BEACHES IN 1988, AND A REVIEW OF *Puffinus* SPECIES RECOVERIES, 1943 TO 1988

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ABSTRACT

In 1988, 3603 kilometres of the coast of New Zealand were patrolled and 7545 dead seabirds were found as part of the Beach Patrol Scheme. Two new species were the Tahiti Petrel (*Pseudobulweria rostrata*) and the Masked Booby (*Sula dactylatra*). Unusual finds were a Black-bellied Storm Petrel (*Fregetta tropica*) and a White Tern (*Gygis alba*).

A summary is given of the coastal and monthly distributions for 10 species of *Puffinus* found between 1943 and 1988. Of these shearwaters, the Sooty Shearwater (*P. griseus*) was found most frequently overall, mainly in May and November-December. This review of beach-wrecked shearwaters indicates that the information derived from the Beach Patrol Scheme for common seabird species relates reasonably well to the movements of these species about New Zealand coasts.

INTRODUCTION

This paper records the results of the Ornithological Society of New Zealand's Beach Patrol Scheme for 1988, and reviews *Puffinus* species recovered from 1943, when the results of patrols were first recorded on Beach Patrol Cards, to 1988. All sections of coast were patrolled (see Powlesland & Imber 1988), except Fiordland. Some beaches on Chatham Island (21 km "travelled") and Macauley Island, Kermadec Group (5 km) were patrolled, the results being given under the heading "Outlying Islands". In total, 769 Beach Patrol Cards and 26 Specimen Record Cards were submitted.

Kilometres "travelled" are the total lengths of coast patrolled, 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 see Powlesland & Imber (1988). The taxonomic nomenclature used is that of Turbott (1990).

RECOVERIES IN 1988

In 1988, the total length of coast travelled was 3603 km along which 7545 seabirds were found by 207 members of the Ornithological Society of New Zealand and their friends. The average number of birds recovered per kilometre of coast covered was 2.28 (Table 1). Both the total distance travelled and the number of birds found were fewer than the respective averages of 4079 km and 10 694 birds per year recorded over the past 17 years (1971-1987). This period is used for the 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

TABLE 1 — Numbers of dead seabirds recovered and kilometres covered on each coast of New Zealand in 1988

COAST	CODE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL KM	TOTAL BIRDS	BIRDS/KM /COAST
AUCKLAND WEST	AW	KM	126	124	100	139	69	97	73	97	107	200	178	90	1400		
		BIRDS	139	101	62	128	101	107	297	389	95	287	977	282		2965	2.12
TARANAKI	TA	KM	17	15	7	3	9	2	14	10	7	21	43	3	151		
		BIRDS	54	6	13	4	26	1	35	13	8	23	482	7		672	4.45
WELLINGTON WEST	WW	KM	46	27	23	31	58	18	62	40	43	33	46	9	436		
		BIRDS	80	40	59	34	95	12	148	69	24	81	465	32		1139	2.61
AUCKLAND EAST	AE	KM	34	19	42	44	16	33	18	39	33	20	60	39	397		
		BIRDS	120	59	386	75	21	42	51	53	99	7	297	78		1288	3.24
BAY OF PLENTY	BP	KM	22	14	14	5	9	5	23	15	10	2	18	33	170		
		BIRDS	41	17	27	4	9	5	58	31	9	8	52	70		331	1.95
EAST COAST NI	EC	KM	8	8	16	22	24	17	17	9	17	17	16	16	187		
		BIRDS	14	3	12	11	12	8	3	8	4	1	4	3		83	0.44
WAIRARAPA	WA	KM	2	–	–	–	–	–	2	–	5	–	–	–	9		
		BIRDS	1	–	–	–	–	–	1	–	0	–	–	–		2	0.22
WELLINGTON SOUTH	WS	KM	3	4	9	11	3	8	9	–	8	4	4	–	63		
		BIRDS	8	4	23	15	3	6	8	–	5	6	2	–		80	1.27
NORTH COAST SI	NC	KM	3	7	2	1	25	4	–	–	–	–	11	1	54		
		BIRDS	16	20	0	0	14	9	–	–	–	–	4	2		65	1.20
WESTLAND	WD	KM	–	–	4	–	9	–	4	4	11	–	24	18	74		
		BIRDS	–	–	0	–	0	–	0	1	1	–	13	11		26	0.35
CANTERBURY NORTH	CN	KM	15	11	9	7	17	10	4	25	19	3	3	20	143		
		BIRDS	46	39	26	13	41	7	4	34	13	2	2	77		304	2.13
CANTERBURY SOUTH	CS	KM	6	4	7	9	11	11	4	3	3	2	3	–	63		
		BIRDS	10	8	21	48	34	27	1	4	0	4	5	–		162	2.57
OTAGO	OT	KM	8	15	10	6	11	7	10	6	8	13	6	23	123		
		BIRDS	5	36	5	4	6	2	3	2	3	5	3	108		182	1.48
SOUTHLAND	SD	KM	1	8	5	–	–	–	–	–	–	–	–	2	16		
		BIRDS	3	129	11	–	–	–	–	–	–	–	–	9		152	9.50
OUTLYING ISLANDS	OI	KM	–	6	4	–	–	–	–	–	5	11	–	–	26		
		BIRDS	–	18	1	–	–	–	–	–	67	8	–	–		94	3.62
TOTAL KILOMETRES TRAVELLED			304	281	280	294	286	223	270	266	288	366	466	271	3603		
TOTAL KILOMETRES COVERED			291	262	252	278	261	212	240	248	276	326	412	254	3312		
TOTAL SEABIRDS RECOVERED			537	480	646	336	362	226	609	604	328	432	2306	679		7545	
BIRDS/KM COVERED/MONTH			1.85	1.83	2.56	1.21	1.39	1.07	2.54	2.44	1.19	1.33	5.60	2.67			2.28

various coasts, plus the number of birds picked up per kilometre covered for each coast. Coastal and monthly totals for uncommon species (15 or fewer specimens) are given in Table 2, while for more common species (more than 15 specimens) coastal totals are presented in Table 3 and monthly totals in Table 4.

Unusual finds

A new species for the Beach Patrol Scheme, and first New Zealand record, is the Tahiti Petrel, a specimen of which was found on the section of beach between Dargaville and Tikinui (AW) in June 1988 (Table 2). The Tahiti Petrel's range is usually confined to the tropical Pacific Ocean, where it

TABLE 2 — Coastal and monthly distribution of seabird species for which 1 to 15 specimens only were found in 1988

SPECIES OR SUBSPECIES	NUMBER FOUND	COAST(S)	MONTH(S)
Diomedea exulans	6	AW(3), NC, WS, WW.	FEB(2), MAR, MAY, JUL, NOV.
epomophora	2	EC, OI.	FEB, NOV.
melanophrys	1	TA.	MAY.
bulleri	10	AW(3), CN, SO(4), WW, OI.	FEB(3), MAR(2), APR, MAY(2), JUL, NOV.
cauta subspp.*	13	AW(7), TA(2), WW(2), OT(2).	FEB, APR, MAY, JUN(2), JUL, AUG, OCT, NOV(4), DEC.
salvini	7	BP, TA(2), WW, NC, CS, OI.	JAN, MAR, APR, JUL, SEP, OCT, NOV.
Phoebetria palpebrata	15	AE, AW(10), WW(4).	JAN(2), JUN(2), AUG(2), OCT(5), NOV(4).
Puffinus gavia/huttoni	7	WW(3), NC, CN(2), CS.	JAN, APR(2), MAY, JUN, OCT(2).
Procellaria spp.*	2	AW, TA.	MAY, JUL.
parkinsoni	2	AE(2).	NOV(2).
westlandica	3	AW, WW(2).	MAY, JUL, NOV.
aequinoctialis	9	AW(6), EC, TA(2).	JAN, OCT, NOV(7).
Pseudobulweria rostrata	1	AW.	JUN.
Pterodroma spp.*	9	AW(2), BP(5), WW(2).	JAN, FEB(2), APR, MAY(2), JUL, SEP, DEC.
cervicalis	6	OI(6).	SEP(6).
cookii	12	AE(5), AW(6), WW.	FEB(2), MAR(3), APR(2), NOV(2), DEC(3).
Fregetta tropica	1	WW.	JAN.
Megadyptes antipodes	9	CN, OT(6), SO(2).	JAN, FEB(2), MAR(3), MAY, JUN, DEC.
Eudyptes pachyrhynchus	3	AW, CS, WO.	APR, NOV, DEC.
sclateri	1	OT.	OCT.
Phaethon rubricauda	1	OI.	SEP.
Sula dactylatra	2	AW, OI.	MAY, SEP.
Phalacrocorax spp.*	2	AW(2).	JAN, FEB.
carbo	13	AW, EC(7), WS, CN(2), OT, OI.	FEB, MAY(2) JUN, JUL(4), AUG(2), SEP, OCT, DEC.
sulcirostris	4	AE, BP(2), EC.	SEP, NOV, DEC(2).
melanoleucos	3	AW, WW, OT.	MAR, MAY, OCT.
Leucocarbo chalconotus	4	OI, SO(3).	FEB(3), DEC.
onslowi	1	OI.	FEB.
Stictocarbo featherstoni	1	OI.	FEB.
Catharacta skua lonnbergi	5	AW(4), CS.	MAY, JUN(2), AUG, SEP.
Stercorarius spp.*	1	WW.	APR.
longicaudus	2	AW, WW.	NOV, DEC.
Larus spp.*	4	CN(2), CS(2).	JUN, AUG(2), OCT.
Sterna spp.*	1	TA.	MAR.
albostriata	2	WW, CN.	JUL, DEC.
caspia	5	AW(3), BP, NC.	MAR, JUN, JUL, NOV, DEC.
Gygis alba	1	WW.	APR.
TOTAL	171		

* Species or subspecies was not identified by the patroller.

breeds on New Caledonia and the Marquesas and Society Islands (Harrison 1983). Tahiti Petrels occur in Fijian waters (Jenkins 1986), and two specimens have been found in Fiji, one on Taveuni and one on Gau Islands (Plant *et al.* 1989). The closest it usually gets to New Zealand is at the western extremity of its range about the outer fringes of the Australian Great Barrier Reef and about New Caledonia. It is of note that Tahiti Petrels were sighted at sea off the north-eastern coasts of the North Island once in July and twice in August 1988 (G.S. Clark, pers. comm.). The sightings were near White Island, near the Aldermen Islands and east of the Poor Knights Islands, all of which are off the Auckland East and Bay of Plenty coasts.

TABLE 3 — Coastal distribution of the seabird species more commonly found dead (> 15 specimens) in 1988

SPECIES OR SUBSPECIES	COASTS AW	TA	WW	AE	BP	EC	WA	WS	NC	WO	CN	CS	OT	SD	OI	TOTAL BIRDS
Diomedea spp.*	6	-	10	-	-	1	-	-	1	-	1	-	-	2	1	22
chrysostoma	13	1	5	-	-	-	-	-	-	-	-	-	-	-	-	19
cauta cauta	12	1	7	-	-	-	-	-	-	-	1	1	-	1	-	23
Puffinus spp.*	7	-	5	9	-	-	-	-	-	2	4	2	-	-		29
carneipes	10	-	1	50	4	-	-	-	-	-	-	-	-	-	-	65
pacificus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	17
bulleri	111	12	24	24	2	6	-	-	-	-	9	1	-	-	-	189
griseus	536	47	97	45	22	8	-	2	2	3	35	35	7	37	3	879
tenuirostris	397	123	204	14	-	-	-	-	-	12	-	2	1	-	-	753
gavia	307	37	69	140	37	5	-	1	4	-	6	4	-	-	-	610
huttoni	10	-	3	1	-	5	-	1	1	-	8	6	1	-	-	35
assimilis	24	2	3	19	16	-	-	1	-	-	-	-	-	-	2	67
Pelecanoides urinatrix	219	11	54	159	26	-	-	-	-	-	1	1	3	8	-	482
Lugensa brevirostris	10	1	-	6	-	-	-	-	-	-	-	-	-	-	-	17
Daption capense	21	6	10	4	6	-	-	-	2	-	2	-	1	-	-	52
Fulmarus glacialoides	19	-	1	-	-	-	-	-	-	-	-	-	-	-	-	20
Macronectes spp.*	11	-	1	1	-	-	-	-	-	-	1	-	1	3	-	18
Pachyptila spp.*	107	20	159	4	-	-	-	1	9	-	5	3	-	-	1	309
turtur	302	290	230	72	39	1	1	6	8	4	9	1	9	58	8	1038
belcheri	69	3	23	-	2	-	-	-	-	-	1	-	-	1	-	99
desolata	20	4	5	-	3	-	-	-	-	-	-	-	-	-	-	32
salvini	73	4	11	-	-	-	-	-	-	-	-	-	-	2	-	90
vittata	17	5	13	-	-	-	-	-	-	1	2	1	1	4	2	46
Halobaena caerulea	22	2	2	-	-	-	-	-	-	1	-	1	-	-	-	28
Pterodroma nigripennis	1	-	1	-	-	-	-	-	-	-	-	-	-	-	22	23
inexpectata	10	4	3	-	-	-	-	-	-	-	-	-	-	3	-	20
macroptera	13	2	2	81	18	-	-	-	-	-	-	-	-	-	-	116
lessonii	73	6	8	-	-	-	-	-	-	-	-	-	-	-	-	87
Pelagodroma marina	11	-	2	11	19	-	-	-	-	-	-	-	-	2	-	45
Eudyptula minor	228	27	49	509	89	6	1	10	16	-	19	9	10	12	4	989
Morus bassana	98	12	25	33	4	4	-	-	-	-	-	2	-	-	-	178
Phalacrocorax varius	2	-	-	29	12	-	-	1	-	-	1	-	-	-	-	45
Stictocarbo punctatus punctatus	-	-	1	4	-	1	-	1	4	-	40	48	11	-	-	110
Larus dominicanus	84	21	68	29	3	26	-	43	11	2	72	22	120	7	2	510
novaehollandiae	43	13	10	24	17	2	-	10	3	-	54	12	4	1	-	193
bulleri	-	-	4	-	-	5	-	-	-	-	12	6	1	1	-	29
Sterna striata	25	9	7	11	3	3	-	2	-	-	10	1	-	1	-	72
Procelsterna cerulea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	18
TOTALS	2911	663	1116	1279	322	73	2	78	61	25	293	158	170	143	80	7374

* Species or subspecies was not identified by the patroller.

Another new species for the Beach Patrol Scheme is the Masked Booby. One specimen was found on the beach between Dargaville and Tikinui (AW) in May, and another on a Macauley Island beach (OI) in September (Table 2). There are six other records of this species having reached New Zealand. One was found on Gannet Island (AW) in 1883, one was seen west of North Cape in 1964 (Kinsky 1970). Two birds were seen on each of three occasions in the Firth of Thames; 19 and 30 October 1977 and 5 March 1978 (Brown & Lawrie 1979). The sixth record is of a bird found alive in Hamilton in July 1983, but which later died (C.R. Veitch, pers. comm.).

TABLE 4 — Monthly distribution of the seabird species more commonly found dead (≥ 15 specimens) in 1988

SPECIES OR SUBSPECIES	MONTH												TOTAL BIRDS
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Diomedea spp.*	3	2	2	1	3	–	–	2	–	3	5	1	22
chrysostoma	–	–	–	–	–	–	7	2	3	5	2	–	19
cauta cauta	4	–	1	2	3	3	2	–	1	4	2	1	23
Puffinus spp.*	6	2	3	1	3	3	1	1	–	1	2	6	29
carneipes	10	1	2	7	3	5	–	–	–	–	18	19	65
pacificus	–	–	–	–	–	–	–	–	17	–	–	–	17
bulleri	18	17	20	8	18	7	6	1	5	24	45	20	189
griseus	51	56	14	24	33	6	6	5	–	32	517	135	879
tenuirostris	24	10	–	–	14	5	1	–	–	16	580	103	753
gavia	32	19	31	20	21	18	119	115	53	65	90	27	610
huttoni	1	1	10	4	1	1	1	4	3	2	3	4	35
assimilis	12	3	–	–	–	–	5	4	2	14	14	13	67
Pelecanoides urinatrix	18	16	1	1	49	37	53	140	37	16	93	21	482
Lugensa brevirostris	2	–	–	–	–	3	1	3	6	1	–	1	17
*Daption capense	4	2	–	–	1	2	9	4	5	9	13	3	52
Fulmarus glacialoides	1	–	–	–	17	–	–	–	–	1	1	–	20
Macronectes spp.*	–	4	1	1	1	–	2	–	2	4	2	1	18
Pachyptila spp.*	27	21	9	2	8	7	68	25	7	30	85	20	309
turtur	31	84	10	2	10	16	147	110	48	58	487	35	1038
belcheri	–	1	–	–	–	1	42	48	2	–	4	1	99
desolata	–	–	–	–	–	3	19	5	–	1	–	–	32
salvini	1	2	–	–	5	15	40	13	2	5	5	2	90
vittata	6	4	1	1	1	–	10	9	–	2	7	5	46
Halobaena caerulea	–	–	–	–	–	–	7	10	3	5	3	–	28
Pterodroma nigripennis	1	1	1	–	–	–	–	–	22	–	–	–	23
inexpectata	4	1	3	3	2	–	–	–	–	–	5	2	20
macroptera	7	2	1	–	2	–	3	5	3	4	75	14	116
lessonii	4	1	–	–	1	1	5	–	4	23	44	4	87
Pelagodroma marina	1	4	–	1	2	1	–	1	3	3	22	7	45
Eudyptula minor	135	62	400	109	29	10	8	43	31	49	75	38	989
Morus bassana	22	20	28	34	19	5	8	8	6	15	10	3	178
Phalacrocorax varius	8	6	6	2	1	2	–	1	4	–	4	11	45
Stictocarbo punctatus punctatus	4	12	10	21	28	10	–	3	2	2	4	14	110
Larus dominicanus	51	64	34	54	47	40	17	23	15	14	25	126	510
novaehollandiae	26	27	32	19	13	10	6	8	6	6	20	20	193
bulleri	8	7	2	1	6	1	–	1	–	2	1	–	29
Sterna striata	6	9	12	7	5	3	2	2	5	2	11	8	72
Procelsterna cerulea	–	–	–	–	–	–	–	–	18	–	–	–	18
TOTAL	528	460	633	325	346	215	595	596	315	418	2278	665	7374

* Species or subspecies was not identified by the patroller.

The Masked Booby has a widespread distribution through the tropics, both in terms of its non-breeding season movements and its breeding sites. It wanders widely in search of food, often foraging more than 1000 km from land (Nelson 1985). In the New Zealand region it breeds at the Kermadec Group on Meyer, Dayrell, South Chanter, North 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.). Since the species ranges widely and large numbers inhabit the tropical Pacific Ocean,

it is interesting that few Masked Boobies have been found on New Zealand mainland beaches.

A Black-bellied Storm Petrel that was found on Waikawa Beach (WW) in January (Table 2) is the sixth record for the Scheme. The previous records are 1963, Campbell Island, February; 1968, WS, May; 1975, WW, June; 1977, SD, November; and 1981, SD, January. The species has a widespread breeding distribution, nesting on islands in the South Pacific, South Atlantic and Indian Oceans. In the New Zealand region it nests on the Auckland and Antipodes Islands (Imber 1985b). The storm petrels return to these islands in September and lay their eggs between mid-October and the end of January. The young fledge between February and April (Imber 1985b). It is noteworthy that, although large numbers of Black-bellied Storm Petrels nest on the Auckland and Antipodes Islands and these birds migrate to tropical and subtropical waters in the non-breeding season (Imber 1985b), few have been found on New Zealand beaches. Perhaps their migration route is to the east of New Zealand so that the prevailing westerly winds blow weakened and dead birds away from our beaches.

A White Tern, which was found on Te Horo Beach (WW) in April 1988, is the second recorded for the Beach Patrol Scheme. The first was picked up in May 1986, also from a Wellington West beach (Otaki Beach). For a brief review of the biology of this tern and of White Terns seen or found in New Zealand previously see Powlesland (1989).

Some other unusual finds for the Beach Patrol Scheme resulted from a patrol along a Macauley Island beach, Kermadec Group, in September. Specimens found included six White-naped Petrels (*Pterodroma cervicalis*), 22 Black-winged Petrels (*P. nigripennis*), 17 Wedge-tailed Shearwaters (*Puffinus pacificus*), a Red-tailed Tropicbird (*Phaethon rubricauda*) and 18 Grey Ternlets (*Procelsterna cerulea*). All five species breed on Macauley Island (G. Taylor pers. comm.).

Two species were found in greater numbers than usual in 1988. The 1988 total of Grey-faced Petrels (*Pterodroma macroptera*) was 116, two fewer than the highest annual total in 1981. Usually 40-70 specimens of this species are found annually. Many of the 1988 birds were on Auckland East beaches (70%)(Table 3) and in November (65%)(Table 4). The distribution of the beached petrels relates to the species' main nesting colonies on islands to the east of the northern North Island (Imber 1985b). Why so many Grey-faced Petrels were found in November, when mainly breeders would have been about the colonies feeding well-grown young, is unknown.

In 1988, 753 Short-tailed Shearwaters (*Puffinus tenuirostris*) were found compared with the previous highest annual total of 864 in 1986. Generally, 100-300 have been found each year since 1970. Most (96%) of the Short-tailed Shearwaters were picked up from North Island west coast beaches (AW, TA, WW)(Table 3) in November and December (91%) 1988 (Table 4). The large number of Short-tailed Shearwaters found in 1988 coincided with the return of immatures to Australian waters from the wintering grounds (Warham 1985). Possibly weakened by the transequatorial migration, they succumbed to a storm forcing them across the Tasman Sea on to New Zealand beaches.

Miscellaneous birds

Birds other than seabirds recovered in 1988 totalled 243. There were 53 magpies, 28 Black Swans, 22 Mallards, 18 Rock Pigeons, 13 Canada Geese, nine each of domestic geese, Australasian Harriers and Starlings, eight each of duck species and Pukeko, seven Blackbirds, six each of Grey Ducks, Bar-tailed Godwits, and Song Thrushes, five Paradise Shelducks, four each of White-faced Herons, South Island Pied Oystercatchers, White-faced Herons, House Sparrows and Mynas, three Variable Oystercatchers, two each of New Zealand Shovelers, Spur-winged Plovers, New Zealand Pigeons, Moreporks and Yellowhammers, and one each of North Island Brown Kiwi, Australasian Bittern, Cattle Egret, Mute Swan, Grey Teal, Brown Teal, Californian Quail, quail species, North Island Weka, New Zealand Dotterel, Banded Dotterel, Marsh Crake, Kaka, Spine-tailed Swift, Skylark, Tui, Goldfinch, and Rook.

Puffinus RECOVERIES 1943-1988

The following is a summary of the coastal and monthly distributions of *Puffinus* species found by patrollers for the 1943-1988 period of the Beach Patrol Scheme. To test whether the annual pattern of recovery for each species depicted in Figures 1, 2 and 3 differed from the theoretical situation whereby an equal number of birds was found each month, we used the Kolmogorov-Smirnov one-sample test (Siegel 1956, p. 47).

In total, 57 800 *Puffinus* shearwaters were found between 1943 and 1988. Of these, only 480 (0.8%) were not identified to species, although patrollers determined that 86 were either *P. gavia* or *P. huttoni*. The remaining 57 320 birds comprised 10 *Puffinus* species (Table 5).

MANX SHEARWATER *P. puffinus*

Only two Manx Shearwaters have been found by patrollers. These birds were recorded in 1972, WW, June (Kinsky & Fowler 1973); and in 1985, WW, January (Tennyson 1986). Both specimens were identified as being of the nominate race, which breeds in the North Atlantic from April (egg-laying) to September (young fledge)(Harrison 1983). After the breeding season most migrate southwards to the main wintering area off eastern South America, but a few move east to the seas about the Cape of Good Hope, South Africa (Harrison 1983). Some apparently go far enough south in this region to be in the 'Roaring Forties' and this may explain the presence of birds as far east as New Zealand. Immature birds do not return to the North Atlantic colonies in their second year (Cramp & Simmons 1977) and therefore are more likely to wander widely in the southern oceans than adults and so end up outside their usual range. Both birds found on New Zealand beaches were immatures.

FLESH-FOOTED SHEARWATER *P. carneipes*

This shearwater nests on the Hen and Chickens (AE), the Mercury and Aldermen Islands (BP), Karewa Island (BP), the main Sugar Loaf Island (TA), on Trio and Titi Islands (NC), Lord Howe Island, on many islands off the south-western coast of Australia, and on Ile St-Paul (Imber 1985b). Shearwaters from south-west Pacific nesting sites move north of the subtropical convergence in the North Pacific Ocean to winter from near Japan

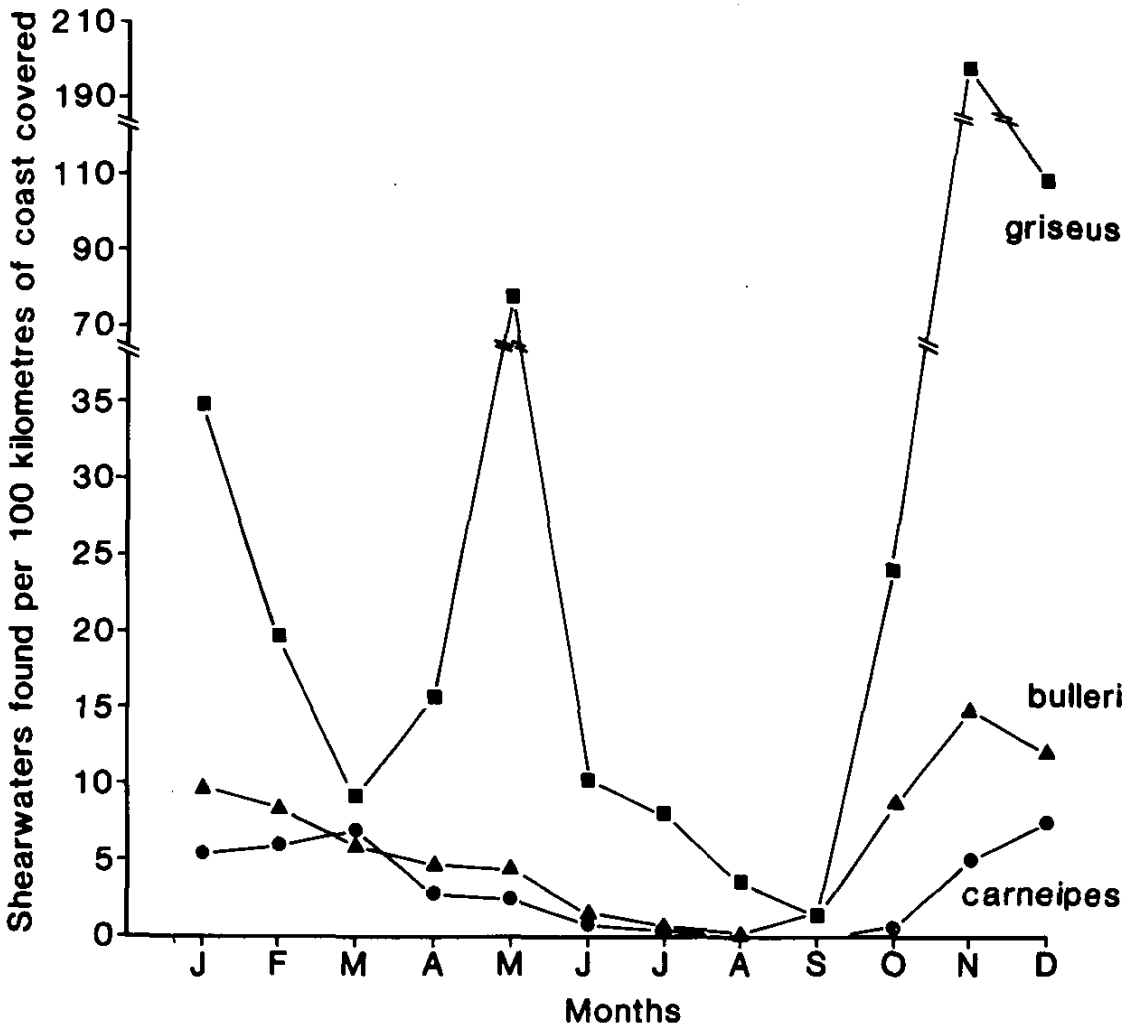

FIGURE 1 — Monthly rate of recovery (number of shearwaters found dead per 100 km of beach covered) of eight species of *Puffinus* on each coast of New Zealand during 1943-1988

and Korea to off the west coast of North America (Imber 1985b). After the breeding season, birds from Indian Ocean islands move north-west to winter in the Arabian Sea (Harrison 1983).

The Flesh-footed Shearwaters return to New Zealand waters in late September and lay eggs in mid-November to mid-December (Imber 1985b). Most chicks hatch in January and leave the burrows between late April and early May. During the breeding season this shearwater forages around the North Island, with some birds wandering as far south as Foveaux Strait.

During 1943-1988, patrollers found 2085 Flesh-footed Shearwaters. About 100 shearwaters have been found each year since 1970, the lowest and highest annual totals being 38 in 1972 and 181 in 1974. Overall, the average rate of recovery was 2.92 birds per 100 km of coast covered. Of the coastal regions, Auckland East had the highest rate of recovery (13.90 birds/100 km of coast covered), followed by Bay of Plenty (5.87) and Auckland West (1.61)(Table 5). This result reflects that most Flesh-footed Shearwaters nesting about New Zealand do so on islands mainly along the Auckland East and Bay of Plenty coastlines.

Figure 1 shows that the monthly rate of recovery changed significantly ($p<0.01$) during the year, being greatest in summer and early autumn, and least in winter. As the chicks do not leave the colonies until April-May (Imber 1985b), the shearwaters found beach-wrecked in summer were breeders and/or pre-breeders. Some of the summer mortality may result from shearwaters being drowned on longlines. Flesh-footed Shearwaters dive deeply to retrieve scraps about fishing boats and some are hooked and drowned trying to take baits from longlines being set, for example, in the Hauraki Gulf (Tennyson 1990). Recoveries have been least in winter because the species is absent from New Zealand waters then, having migrated to the North Pacific Ocean. The slight increase in recoveries of Flesh-footed Shearwaters in September and October (Figure 1) is in accord with observations that the species does not return to New Zealand waters until late September (Imber 1985b).

WEDGE-TAILED SHEARWATER *P. pacificus*

This shearwater breeds on islands off eastern and western Australia and on many islands and islets of the Indian and Pacific Oceans in the tropics and subtropics (Imber 1985b). In the New Zealand region it nests on the Kermadec Group. Wedge-tailed Shearwaters from the Kermadec Group spend June to September in the south-eastern North Pacific (Imber 1985b). They arrive back en masse about mid-October to Tongan waters and then disperse to their various breeding islands of Fiji, Samoa, Tonga, Norfolk and the Kermadec Group (Jenkins 1979). The digging and cleaning of burrows and pairing activities continue until about late November, after which the paired birds are absent from the islands for about three weeks (Crockett 1975). Eggs are laid in December and the chicks hatch in the first half of February (Imber 1985b). Adults desert their almost fully feathered young in April and the young leave the islands mainly in May. During the breeding season Wedge-tailed Shearwaters are regularly seen 160 km north-east of Cape Brett, Bay of Islands, particularly in February and March (Jenkins 1979).

Although 29 Wedge-tailed Shearwaters have been found by patrollers over the 45 years of the Beach Patrol Scheme, 17 of these were found in September 1988 on Macauley Island, Kermadec Group, where the species breeds. The rest were found on North Island west coast (AW, TA, WW) and Auckland East beaches (Table 5). Except for these September 1988 recoveries, most were found during the species' breeding season (November-April). Probably the few Wedge-tailed Shearwaters found on New Zealand mainland beaches were pre-breeders, which tend to disperse more widely than breeders from the nesting islands.

BULLER'S SHEARWATER *P. bulleri*

Buller's Shearwater, a distinctively plumaged species, nests only on the Poor Knights Islands. Harper (1983) estimated that the population numbered about 2.5 million birds. Most Buller's Shearwaters are absent from New Zealand waters from late May to early September (Jenkins 1988). The species winters in the North Pacific, reaching subarctic waters in June and then gradually expanding northward and eastward as far as the Gulf of Alaska

TABLE 5 — Rate of recovery (number of shearwaters found per 100 km of beach covered) of eight species of *Puffinus* on each coast during 1943-1988

SPECIES	AW	TA	WW	AE	BP	EC	WA	WS	NC	WD	CN	CS	OT	SD	OI
P. carneipes	1.61	0.14	0.22	13.90	5.87	0.51	-	0.48	0.35	-	0.14	-	0.05	-	-
P. pacificus	0.02	0.03	0.02	0.04	-	-	-	-	-	-	-	-	-	-	4.57
P. bulleri	7.25	2.63	3.55	10.16	6.83	3.56	2.86	4.43	0.23	0.45	1.00	1.10	0.16	0.19	1.34
P. griseus	59.26	16.58	22.27	20.13	32.38	25.32	6.87	30.43	11.91	5.06	31.20	21.86	19.87	258.93	20.43
P. tenuirostris	9.16	6.80	14.55	6.52	6.05	0.76	0.29	0.54	2.31	4.77	2.04	4.09	0.82	10.50	2.15
P. gavia	23.45	16.58	13.28	29.58	25.52	4.66	2.58	8.03	7.17	0.45	5.36	5.01	0.33	0.39	1.34
P. huttoni	0.95	0.23	2.88	0.26	0.37	0.59	-	0.45	1.04	0.89	8.01	1.95	0.11	-	-
P. assimilis	0.17	0.34	0.55	3.62	3.48	0.76	-	0.09	0.35	0.15	0.09	-	-	-	1.61

by August (Wahl 1985). Many shearwaters occur along the west coast of North America from British Columbia to southern California until early November (Wahl 1985). Presumably these birds are pre-breeders because large numbers arrive back at the Poor Knights in early September. Within a few nights of the first birds overflying the islands, many are ashore investigating and refurbishing burrows (Harper 1983). After mating in late October, the birds desert the breeding islands for about 30 days, the pre-laying exodus. Most eggs are laid during the short period 26-30 November (Harper 1983). Eggs hatch about mid-January, and most fledglings leave the islands in early May.

Until late November most Buller's Shearwaters forage between the Three Kings Islands and East Cape, but in December the distribution expands greatly, across the Tasman Sea into Australian coastal waters, south to Foveaux Strait and east to the Chathams (Jenkins 1988). In February, Jenkins (1988) recorded a decline in the number and distribution of shearwaters in the Tasman Sea and an increase around the New Zealand coast, especially north of the North Island and about the eastern approaches to Cook Strait. By April shearwater numbers in coastal waters have decreased noticeably and by early June almost all Buller's Shearwaters have left the region (Jenkins 1988).

Generally, 100-200 Buller's Shearwaters have been found annually during the past 18 years, 492 in 1978 being the most. In total, 4168 Buller's Shearwaters were found during 1943-1988 at an average rate of 5.84 birds per 100 km of coast covered. Of the coastal regions, Auckland East had the greatest rate of recovery (10.16 birds/100 km of coast covered), followed by Auckland West (7.25) and Bay of Plenty (6.83)(Table 5). These results were as expected from this shearwater's distribution and abundance patterns at sea during the breeding season (Jenkins 1988). That Buller's Shearwaters have been seen as far south as Foveaux Strait (SD) is reflected in the recoveries (Table 5). However, the rates of recovery of shearwaters from beaches of the two Canterbury regions were lower than expected because Jenkins (1988), during voyages in 1960-1987, saw large numbers off these coasts from January to May.

The monthly rate of recovery of Buller's Shearwaters increased rapidly from a low in August to a peak in November, and then gradually declined

(Figure 1)($p \leq 0.01$). During winter (June-August), Buller's Shearwaters are absent from New Zealand waters (Jenkins 1988) and so the few found on beaches during this period presumably had been washed ashore weeks and even months previously. The peak period of recoveries in November-December coincides with egg-laying (Harper 1983) and probably the later arrival of non-breeders back to New Zealand waters. In contrast to the results for the Sooty Shearwater (*Puffinus griseus*)(Figure 1), the departure of Buller's Shearwater chicks from the islands in May (Harper 1983) has not resulted in greater numbers of this shearwater being found on beaches in May-June than previously (Figure 1).

SOOTY SHEARWATER *P. griseus*

The Sooty Shearwater has a widespread breeding distribution; on Guafo Island off Chile; on islands near Cape Horn, the Falkland Islands; and on islands off Tasmania and New South Wales, and on Macquarie Island (Clark *et al.* 1984, Warham 1985). In the New Zealand region its breeding distribution extends from the Three Kings Islands south to Campbell Island. Whereas few breed at the extremities of the New Zealand breeding range, very large numbers, sometimes millions, nest on islands about Stewart Island and at The Snares (Warham & Wilson 1982). In addition, a few still attempt to breed on some headlands of mainland New Zealand.

This large aggressive shearwater is a transequatorial migrant, wintering in the cool offshore waters of the North Atlantic and North Pacific Oceans (Warham *et al.* 1982). The first birds return to The Snares on about 10 September each year, and 10 nights later start landing ashore for courtship and burrow refurbishing activities (Warham *et al.* 1982). After about a month, part of the population leaves on a pre-laying exodus for about a fortnight. Most eggs are laid over a two-week period centred on 22 November. The eggs hatch in January and after a nestling period of about 100 days, the fledglings leave the islands from mid-April to early May (Warham *et al.* 1982). Departing on migration before their young, most adults leave between the end of March and the third week of April. From observations at sea and from headlands the main migration route of southern New Zealand Sooty Shearwaters is along the east coast of the North and South Islands.

This was the most numerous shearwater found by patrollers, with 29 938 recovered during 1943-1988. The number found each year has varied markedly in the past 18 years, from 371 in 1987 to 7017 in 1978. During 1943-1988 the Sooty Shearwater was found at an average rate of 41.95 birds per 100 km of beach covered. As expected from the distribution of its populous nesting colonies south of the South Island, the highest rate of recovery of Sooty Shearwaters has been from Southland beaches (258.93 birds/100 km of coast covered). The coasts with the next highest rates of recovery were Auckland West (59.26) and Bay of Plenty (32.38)(Table 5). The common occurrence of dead Sooty Shearwaters on beaches of Outlying Islands (OI)(Table 5) is a reflection that most patrolling contributing to this category has been along Chatham Island beaches and that Sooty Shearwaters nest in reasonable numbers on several islands in the Chathams Group.

The monthly rate of recovery of Sooty Shearwaters increased markedly from a low in September to a peak in November-December, followed by a decline to March, and then a second peak in May ($p \leq 0.01$)(Figure 1). The breeders return to New Zealand waters in September (Warham *et al.* 1982) and so the peak rate of recovery in November probably relates to the death of pre-breeders which, for several migratory seabird species, return later to nesting colonies from their wintering grounds than birds that have bred before.

Analysis of beach-wrecked Sooty Shearwaters found in November-December for the years 1943-1988 showed that the coasts with the highest rates of recovery were Auckland West (250 birds/100 km of coast covered), Bay of Plenty (147) and Canterbury North (93). The May peak in recoveries of Sooty Shearwaters coincides with the departure of the fledglings (Warham *et al.* 1982).

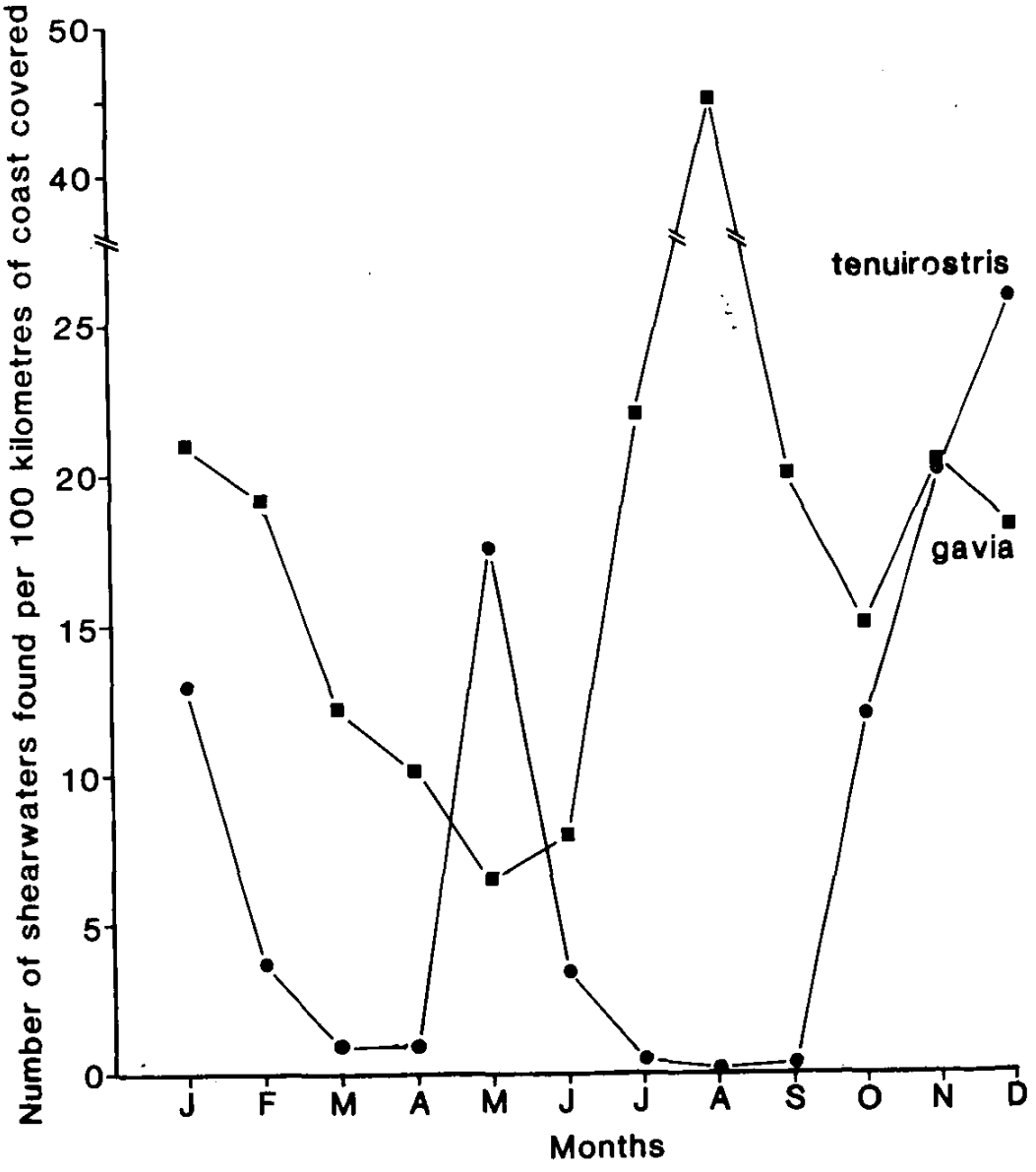

FIGURE 2 — Monthly rate of recovery (number found dead per 100 km of beach covered) of *puffinus tenuirostris* and *P. gavia* during 1943-1988

In contrast to the coastal distribution of Sooty Shearwaters in November-December, the coasts with the highest rates of recovery in May for the years 1943-1988 were Southland (1637 birds/ 100 km of coast covered) and Wellington South (163). The very high recovery rate for Southland beaches probably relates to the high proportion of Sooty Shearwaters fledging from the islands about Stewart Island and at The Snares. The prevailing southerly winds would force weak fledglings on to Southland beaches lying directly in their path.

Each year in May several dead fledglings are found with primary, secondary and tail feathers still developing. Presumably these fledglings are forced to start their migration before completing their feather development because their parents have provided inadequate food for them and/or they were abandoned too soon by their parents starting their own migration.

SHORT-TAILED SHEARWATER *P. tenuirostris*

This transequatorial migrant shearwater nests solely in the Australian region; on many islands about south-eastern Australia, in Bass Strait, and on and around Tasmania (Serventy *et al.* 1971). The breeders return to the breeding islands in late September from their wintering areas in the North Pacific, around the Aleutian Islands and in the Arctic Ocean (Warham 1985). Pre-breeders arrive later and do not appear ashore until late November. Unlike the Sooty Shearwater, the entire Short-tailed Shearwater population vacates the nesting islands for about three weeks before egg-laying. However, like other migrant shearwaters, this species has a short egg-laying period from about 19 November to 2 December. The eggs hatch in late January and after about 100 days in the nest the chicks leave from about mid-April to early May, their parents having left about a fortnight earlier (Serventy *et al.* 1971).

During 1943-1988, patrollers found 5762 Short-tailed Shearwaters. Between 100 and 300 shearwaters were found in most years during 1970-1988, the lowest and highest annual totals for this period being 53 in 1980 and 864 in 1986. Overall, the average rate of recovery was 8.07 birds per 100 km of coast covered. Of the coastal regions, Wellington West (14.55 birds/100 km of coast covered), Southland (10.50) and Auckland West (9.16) had the greatest rates of recovery (Table 5).

Figure 2 shows that the monthly rate of recovery changed significantly ($p<0.01$) during the year, with peaks in recoveries in November-December and again in May. As for the Sooty Shearwater, the first peak of recoveries coincides with the return of pre-breeders to the vicinity of the nesting islands in November (Warham 1985), and the second peak to the departure of fledglings in mid-April to early May (Serventy *et al.* 1971).

CHRISTMAS ISLAND SHEARWATER *P. nativitatis*

Just one Christmas Island Shearwater has been found by patrollers, in February 1976 on Dargaville Beach (AW)(Crockett 1977). The species breeds on islands of the tropical and subtropical central Pacific Ocean. In November 1989 a Christmas Island Shearwater was found on Curtis Island, Kermadec Group (G. Taylor, pers. comm.); thus a small number may occur there. Little is known of its breeding biology other than that eggs are present from April to July (Harrison 1983). Although it is absent from the seas about the breeding islands during the non-breeding season, the Christmas Island

Shearwater is assumed not to disperse far (Harrison 1983). If this is so, presumably the individual was carried south out of its usual range by a tropical storm.

FLUTTERING SHEARWATER *P. gavia*

The Fluttering Shearwater breeds on islands within 40 km of the New Zealand mainland and inside the 100 fathom line, except for colonies on islands of the Three Kings Group (Wragg 1985). It nests on many islands and islets along the north-eastern coast of the North Island from Simmonds Island, near Houhora (AE), south to Motuheka Island, near Tolaga Bay (EC). In September 1988 about 20 Fluttering Shearwaters were seen investigating burrows on a small stack, and a few burrows were found on the adjacent headland, near Urenui (TA)(D. Medway, pers. comm.). This is the only known colony of the species along the North Island west coast. In addition, Fluttering Shearwaters breed on many islands in the Marlborough Sounds (Wragg 1985). No detailed study has been published of the breeding biology of this shearwater. Incidental observations indicate that birds come ashore in August to dig or refurbish burrows. Unlike the migrant *Puffinus* species, the fluttering Shearwater has a long egg-laying period from early September to at least mid-October (Imber 1985b). Most chicks hatch in November and leave the burrows in late January - February (Imber 1985b, Wragg 1985). Most Fluttering Shearwaters forage inside the 100 fathom line and within 200 km of the breeding sites (Wragg 1985). However, the species has been seen as far south as Canterbury South in autumn and winter, and very rarely to near the Chatham Islands (Imber 1985b). Some, mainly young birds, migrate to the coastal waters of south-eastern Australia from Brisbane to Adelaide and the east coast of Tasmania in winter (Imber 1985b, Wragg 1985).

The Fluttering Shearwater and the Hutton's Shearwater (*Puffinus huttoni*) are very similar in size and colouration, with considerable overlap in most morphological characters (Kinsky & Fowler 1973, Tarburton 1981, Wragg 1985). Wragg (1985) took external measurements and recorded the plumage colouration of live birds from three populations of Fluttering Shearwaters [Poor Knights Islands (AE), Moturipa Island (EC) and Long Island (NC)] and from Hutton's Shearwaters at the Upper Kowhai River colony (CN) in August, November and February 1983. He found that no one character can be used to separate the two species and concluded that it was best to check several characters. The best characters to check are:

1. *Exposed undertail coverts:* Dark markings are on the lateral feathers of 90% of *huttoni*, but of only 5% of *gavia*.
2. *Underwing colouration:* Most *huttoni* are smudgy brown on underwing coverts, some being darkish all over but a few being pure white. Most *gavia* have white underwings, but a few show smudgy markings on the coverts.
3. *Long axillaries:* These are round ended and rarely white tipped on *huttoni*, square ended and usually white tipped in *gavia*.
4. *Bill length as a percentage of head plus bill length:* This is greater than 44% in *huttoni* and less than 43% in most *gavia*, but a few *huttoni* are less than 43% (Wragg 1985).

Because of this considerable overlap in the characters used to identify Fluttering Shearwaters from Hutton's Shearwaters a few specimens found beach-wrecked of both species have probably been misidentified. For this reason the results given in this paper for these species should be regarded as a guide only to their true geographical and monthly distribution on beaches.

The number of Fluttering Shearwaters found by patrollers varied markedly during the past 18 years, from 231 in 1980 to 2392 in 1985. During 1943-1988, 13 533 of these shearwaters were found at an average rate of 18.96 birds per 100 km of beach covered. As expected from the distribution of its breeding colonies, most Fluttering Shearwaters were found on Auckland East (29.58 birds/100 km of coast covered) and Bay of Plenty (25.52) beaches (Table 5).

The monthly rate of recovery, as shown in Figure 2, changed significantly ($p<0.01$) through the year. The rate of recovery of beach-wrecked Fluttering Shearwaters was lowest in May-June but increased rapidly to a peak in August. Afterwards the rate remained at about 20 birds per 100 km of beach covered from September to February (Figure 1). The peak in recoveries in August may reflect the return of the migrant portion of the population from south-eastern Australian waters at the start of the breeding season. However, this high rate of recoveries in winter, characteristic of resident petrels such as Common Diving Petrels (*Pelecanoides urinatrix*) and Fairy Prions (*Pachyptila turtur*), may also be due to the effects of minimum food availability concurrent with storms. In contrast to the results for *griseus* (Figure 1) and *tenuirostris* (Figure 2), there is no increase in the rate of recoveries of Fluttering Shearwaters coinciding with the

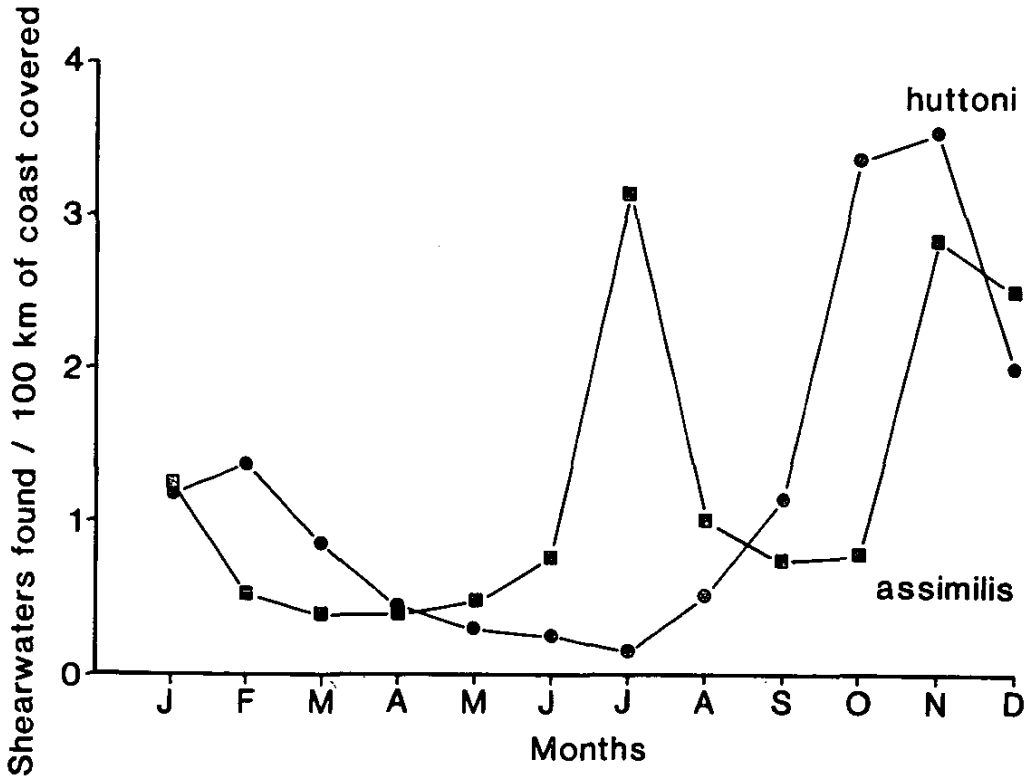

FIGURE 3 — Monthly rate of recovery (number found dead per 100 km of beach covered) of *Puffinus huttoni* and *P. assimilis* during 1943-1988

departure of the chicks in January-February (Figure 2). Probably this is because *gavia* fledglings remain close to the breeding colonies after leaving their burrows, whereas *griseus* and *tenuirostris* fledglings immediately begin a demanding transequatorial migration, passing New Zealand shores, for which runty or late hatching fledglings would be ill-prepared.

HUTTON'S SHEARWATER *P. huttoni*

The Hutton's Shearwater breeds only in the Seaward Kaikoura mountains of the South Island (Harrow 1976), although formerly it bred in the Inland Kaikoura mountains too (Wragg 1985). Recent surveys of Hutton's Shearwater colonies, which are on tussock-clad hillsides and ridges between 1200 and 1800 m a.s.l., 9-24 km from the sea (Harrow 1965), show that several colonies have become extinct and that the number of pairs breeding at the remaining colonies has declined significantly in the past 20 years (G. Sherley, pers. comm.). Hutton's Shearwaters return to the breeding grounds in late August (Harrow 1976). By mid-September large numbers are at the colonies. They clean out their burrows during September and until early October, but in a few years snow delays the birds' access to some burrows for up to a month (Harrow 1976). The pre-laying exodus is in mid-October, and the eggs are laid from late October to mid-November. However, egg-laying is occasionally delayed for up to a fortnight if snow lies thickly over entrances (Harrow 1976). The chicks hatch from late December to late January and most leave the colonies during March and April.

During the breeding season the range of Hutton's Shearwater extends from offshore of the Wellington West coast south to the Otago Peninsula (Harrow 1985), but the species is seen most frequently from Cook Strait to Banks Peninsula (Wragg 1985). The birds forage regularly from close inshore out to the subtropical convergence zone and irregularly up to 200 km east of Christchurch (Wragg 1985). Outside the breeding season few *huttoni* have been found beached-wrecked on New Zealand beaches (Imber & Crockett 1970, Wragg 1985). This result, plus the regular occurrence of immature birds in southern Australian waters, led Imber & Crockett (1970) to suggest that the entire population left New Zealand seas in autumn. Observations in 1978-1979 of large numbers of live *huttoni* off North West Cape and the finding of beach-wrecked specimens around Australia, particularly from North West Cape, Western Australia, south along the southern coastline and up the east coast to Brisbane from April to November (Halse 1981, Wragg 1985, Halse & Halse 1988) give further credence to this suggestion. Whether part of the *huttoni* population regularly circumnavigates Australia, as suggested by Warham (1981), is unproven as yet. Hutton's Shearwaters collected from Australian waters between September and March have been pre-breeders, indicating that they probably do not return to New Zealand in their first year (Halse 1981).

Generally, 20-40 Hutton's Shearwaters were found annually during the past 18 years, 11 being the lowest number in 1977 and 80 the greatest in 1985. From 1943 to 1988, 884 shearwaters were found at an average rate of 1.24 birds per 100 km of coast covered. Of the coastal regions, Canterbury North had the greatest rate of recovery (8.01 birds/100 km of coast covered), followed by Wellington West (2.88) and Canterbury South (1.95)(Table 5).

These results were to be expected from the position of the shearwater's nesting colonies in North Canterbury and its distribution at sea during the breeding season (Wragg 1985).

The monthly rate of recovery of Hutton's Shearwaters increased gradually, from a low in July to a peak in November (Figure 3, $p<0.01$). The few recoveries in late autumn-winter reflects the species' absence from New Zealand waters then, as it has migrated to Australian coastal waters. The first birds return to the breeding colonies in late August, which is reflected in the gradual increase in recoveries from August to November. As for the Fluttering Shearwater, recoveries of Hutton's Shearwaters did not increase in February-March, when fledglings leave the colonies.

LITTLE SHEARWATER *P. assimilis*

Individuals of at least four subspecies of the Little Shearwater have been beach-wrecked on New Zealand mainland beaches but usually patrollers did not determine the subspecies. The North Island Little Shearwater (*P. a. haurakiensis*) breeds in small to moderate numbers on the Hen and Chickens Islands, Stephenson Island, and Cavalli, Poor Knights, Mokohinau and Mercury Islands (Imber 1985b). Red Mercury Island has one of the largest colonies (> 1000 pairs)(G. Taylor, pers. comm.). No detailed study of its breeding biology has been made, but incidental observations show that this subspecies is a winter breeder, laying eggs from early July to mid-August and the fledglings departing in November and December (Imber 1985b). The North Island race ranges from North Cape to Bay of Plenty, rarely being found as far south as Hawke's Bay.

Recent fledglings of the Kermadec Little Shearwater (*P. a. kermadecensis*) are often found on west coast North Island beaches in November-December (Imber 1985b). This abundant subspecies (> 100 000 pairs) breeds on the Herald Islets and Macauley, Haszard, Curtis and Cheeseman Islands of the Kermadec Group. Eggs are laid from mid-June to the end of July, and the young leave for the sea between mid-October and late November (Imber 1985b, G. Taylor, pers. comm.). The Norfolk Island race (*P. a. assimilis*) breeds in winter on islets off Norfolk and Lord Howe Islands. Occasionally specimens of this race are found on Auckland West beaches (Imber 1985b). The other winter-breeding race, *P. a. tunneyi*, nests on several islands along the south-western coast of Australia (Serventy *et al.* 1971). Whether specimens of this race occur on mainland New Zealand beaches is unknown.

A fifth subspecies is the Subantarctic Little Shearwater (*P.a. elegans*), which breeds in small numbers (150 pairs) on the Star Keys and Little Mangere Island of the Chathams Group and in large numbers (> 100 000 pairs) on Bollons, Archway and Inner Windward Islands of the Antipodes (Imber 1983). The subspecies also breeds on Tristan da Cunha and Gough Islands of the South Atlantic Ocean (Serventy *et al.* 1971). On Bollons Island, where Subantarctic Little Shearwaters breed in spring, young chicks were present in late November (Imber 1983). Shearwaters of this race probably lay most eggs in September and the young depart between late December and mid-February. The Subantarctic Little Shearwater seems to range fairly

widely, with some birds being found on South Island beaches (Imber 1985b) and possibly on southern North Island beaches.

During 1943-1988, 918 Little Shearwaters were found by patrollers at an average rate of 1.29 birds per 100 km of coast covered. The number of this shearwater found each year has varied markedly, the lowest number being 5 in 1972 and the greatest being 138 in 1973. Of the coastal regions, Auckland East had the greatest rate of recovery (3.62 birds/100 km of coast covered), followed by Bay of Plenty (3.48)(Table 5).

The much greater rates of recovery of Little Shearwaters for these two coastal regions than for the other regions (Table 5) reflects that *haurakiensis* breeds on islands only along the Auckland East and Bay of Plenty coastlines.

Figure 3 shows that the monthly rate of recovery of Little Shearwaters changed significantly ($p < 0.01$) during the year. There were two peaks of recoveries, one in July coinciding with the start of breeding and the other in November-December when fledglings depart the nesting islands.

Conclusion

Although some species of shearwater are absent from New Zealand waters in winter, such as Buller's Shearwater and Sooty Shearwater, small numbers of these species were found by patrollers during this period. These results do not necessarily indicate that a small proportion of these populations overwinters in the New Zealand region. Studies by J. Ogden (pers. comm.) of individually marked seabird corpses on Waikorea Beach (AW) showed that the remains of some individuals persist for weeks and even months on beaches. This is particularly so if the corpse is covered by sand soon after being washed ashore and then exposed by wind and tides weeks later. Thus, weeks after the bird was beached, patrollers can find portions of it, such as its skull, by which they can identify the bird to species level. Although some patrollers indicated the freshness of specimens (see Powlesland & Imber 1988), many did not, and even then it was difficult to determine in which month dried specimens or bones had been washed ashore. For these reasons the data have not been corrected to take into account how long a bird or part of one may have been on a beach.

This review of beach-wrecked shearwaters on New Zealand beaches indicates that the information derived from the Beach Patrol Scheme for common seabird species relates reasonably well to the movements of these species about our coasts. Although the numbers of seabirds found on beaches depends to some extent on suitable currents and winds to wash them ashore, most of the results agree well with the known biology and movements of the species derived from observations at nesting colonies and from ships. For example, the coasts where recoveries were greatest for each species breeding about New Zealand coincided with the coast or coasts where each species is known to breed. Also, the timing of peaks in recoveries, particularly for migrant species, coincided with the return of the birds to New Zealand waters and the departure of fledglings from the colonies. It is of interest that, for each species, the recoveries coinciding with the return of the shearwaters is greater than the peak relating to the departure of the chicks. Perhaps most of the mortality of fledglings occurs when they have migrated

well beyond our coastal waters. In most cases, the first peak of recoveries coincides not with the return of breeders, but two to six weeks later, with pre-breeders returning to the vicinity of the nesting islands (Warham 1985). Presumably this is because pre-breeders are less able to cope with the demands of the return migration than the breeders.

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