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New Zealand Black-browed Albatross *Diomedea melanophrys impavida* and Grey-headed Albatross *D. chrysostoma* Banded at Campbell Island: Recoveries from the South Pacific Region

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Summary: Albatross banded at Campbell Island, New Zealand have been recovered at a very low rate over 30 years. From 24 000 New Zealand Black-browed Albatross banded, 77 birds have been recovered from beaches and vessels around the south-west Pacific Ocean. The seasonal distribution of juvenile, sub-adult, and adult New Zealand Black-browed Albatrosses are described, and the incidence of recoveries from vessels and beaches is examined. Sub-adults were more susceptible to capture on vessels than other age-classes, whereas juveniles were found more frequently on beaches than by other means. The proportion of adult birds recovered from vessels indicated that they associate with fisheries more commonly in winter than during the breeding season. Recoveries were restricted to Australasian and western South Pacific waters. One Grey-headed Albatross was recovered from 9000 birds banded.

The seasonal distribution of Black-browed Albatrosses *Diomedea melanophrys* and Grey-headed Albatrosses *D. chrysostoma* has been well described (Marchant & Higgins 1990; Reid et al. in press). For population-specific studies, the origin of birds observed at sea is important, but can rarely be determined by ship-board observers. The Campbell Island populations of Grey-headed Albatross and New Zealand Black-browed Albatross *D. m. impavida* have declined significantly since the 1940s (Moore & Moffat 1990; Waugh et al. 1999). However, very little is known about the ecology and at-sea distributions of these populations (Prince et al. 1994).

Black-browed Albatrosses are the most commonly caught albatrosses on long-line vessels in Australian (Brothers 1991; Klaer & Polacheck 1995) and northern New Zealand waters (Murray et al. 1993; Baird 1996). Grey-headed Albatrosses have also been reported in both tuna and squid fisheries around the Australasian region (Bartle 1991; Murray et al. 1993). An analysis of the population dynamics of these two populations has shown that for at least New Zealand Black-browed Albatross, fisheries mortality is a possible cause of the declines in numbers which occurred between the late 1960s and early 1990s (Waugh et al. 1999).

Recoveries of New Zealand Black-browed Albatross and Grey-headed Albatross banded at Campbell Island are reviewed in this paper. The types of recovery and the seasonal and geographic patterns of recoveries in relation to age are given. Post-fledging migration is treated in particular detail as ship-board observers rarely differentiate between juveniles of Black-browed and New Zealand Black-browed Albatrosses.

Methods

Banding

Between 1957 and 1996, 23 150 New Zealand Black-browed Albatross were banded at Campbell Island (52°S, 169°E), of which 17 950 were pulli, and the remainder were adults. During the same period, 7050 Grey-headed Albatross were banded, of which 5300 were pulli and 1750 were adults (Cossee 1995; Dept. of Conservation unpubl. data; SMW unpubl. data). Banding totals have been rounded down to the nearest 50 and provide conservative estimates of numbers of birds banded. Aluminum bands were used until the late 1950s and were replaced by monel bands until *c.* 1967. Stainless-steel bands were used from then until the present. Band loss is expected to have been high for aluminum bands and wear of bands is more apparent for monel than stainless-steel bands (SMW pers. obs.),

but the extent of band loss has not been quantified for these populations.

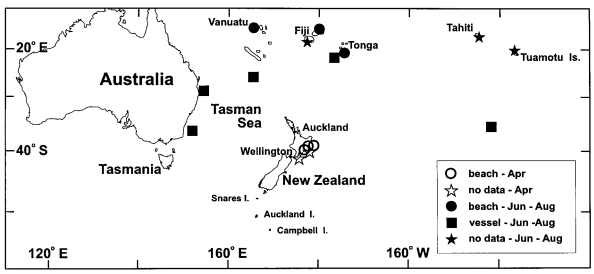
Recovery and banding data have been made available by the Banding Office, Science and Research Division, Department of Conservation, Wellington. All recoveries made between 1967 and 1996 are included and all occurred in the South Pacific area.

New Zealand Black-browed Albatross return to the Campbell Island breeding colonies in late August and chicks fledge between mid-April to May. Grey-headed Albatross return to Campbell Island to breed in early September, with chicks fledging in early to mid-May (Moore & Moffat 1990).

Analysis

Recoveries were grouped by age and type of recovery. Age-classes are: juvenile, from fledging to one year; sub-adult, ages one to six years inclusive; and adult, ages seven years and older. Two birds of unknown age when banded were included with adult recoveries. Juvenile recoveries were mapped monthly to examine the post-fledging migration. Where the distribution of juvenile recoveries overlapped in geographic range, monthly data were combined (June–August and October–March).

(a)



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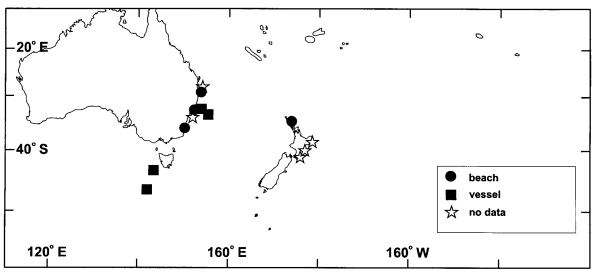


Figure 1 Recoveries of juvenile New Zealand Black-browed Albatross after fledging during (a) April and winter (June–August) and (b) summer (October–March).

Three types of recovery were identified: *beach* for birds found at coastal sites, including those found dead in inshore waters; *vessel* for live and dead birds found on vessels or away from shore; and *no details*, where the mode of recovery was uncertain. All of this last type came from sites at the coast and all were of juveniles: these records were included with beach recoveries for statistical analysis. A further three recoveries from the mid-Pacific included in the discussion of distribution were excluded from more detailed analysis due to insufficient data. A Chi-squared test was used in the analysis of recovery types within age-groups (Sokal & Rohlf 1981).

Vessel recoveries are further segregated into vessel type and mode of recovery. Where a vessel was identified as a long-liner, recoveries were classed as *caught on line or hook* if it was apparent that the recovered bird had died during fishing operations (90% of long-line recoveries).

Results

New Zealand Black-browed Albatross recoveries

A total of 77 recoveries of New Zealand Black-browed Albatrosses have been recorded away from Campbell Island, all within the Pacific region. The distribution of 75 recoveries of these has been mapped for the three age-groups of birds by season (Figs 1–3). The distributions of recoveries of the age-groups were separated into the winter (April–August) and summer months (September–March). These latter months coincide with breeding activities at Campbell Island.

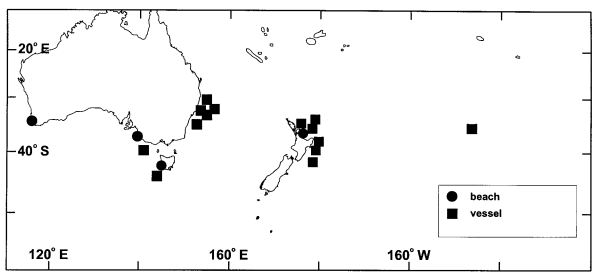
Juveniles Thirty juveniles were recovered. The five banded birds recovered during April came only from the east coast of the North Island, New Zealand from coastal locations (Fig. 1a). There were no recoveries during May or September. During the winter 12 birds were recovered from June onwards: three from beaches in the sub-tropics north and east of New Zealand (Fig. 1a); four from unknown sources; and five from the east coast of mainland Australia from vessels. During summer birds were found on beaches along the east coasts of Australia and the North Island, New Zealand. Vessel recoveries were from the eastern Australia and south-west of Tasmania (n = 13, Fig. 1b).

Sub-adults Thirty-two sub-adults were recorded, widely distributed through the latitudes 30°S–40°S. During winter (n = 19, Fig. 2a), the main concentration of recoveries came from vessels off the eastern coasts

of Australia and New Zealand, though beach recoveries were widespread along southern Australia. In summer, six beach recoveries came from the northern New Zealand coast to the sub-tropics and seven vessel recoveries from around southern Australia (Fig. 2b).

Adults During winter, 11 adults were recovered from the Tasman Sea and waters east of New Zealand, mainly between the longitudes 150°E–180°E. In summer, three adults were recovered from the east coast of Australia and west of Tasmania (Fig. 3).

(a)



(b)

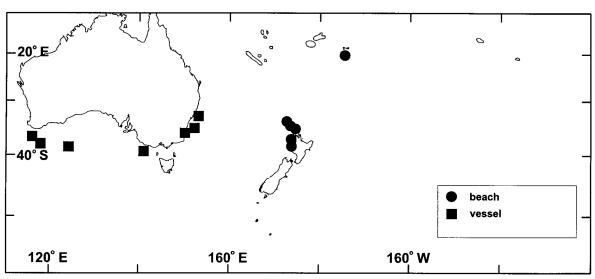


Figure 2 Recoveries of sub-adult New Zealand Black-browed Albatross during (a) winter (April–August) and (b) summer (September–March).

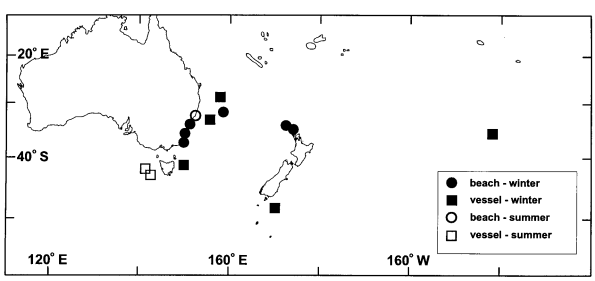


Figure 3 Recoveries of adult New Zealand Black-browed Albatross during (a) winter (April–August) and (b) summer (September–March).

Types of recovery by age group

The age-groups and types of recovery are shown in Table 1. For juveniles and sub-adults, differences in recovery type within age-classes were significant (χ^2 = 6.72, $P < 0.05$), with more juveniles found on beaches and more sub-adults recovered from vessels than if recovery type and age-class were independent. Adults were recovered from vessels and beaches at similar rates.

Vessel recoveries

About half of all recoveries came from vessels (53%), trawlers, long-liners, research vessels and vessels of unknown type. The commonest type of recovery was of birds caught in lines or hooks (46%) although five other modes of recovery were documented (Table 2).

Of the 39 recoveries reported from vessels, 17 birds were released alive: Ten had their bands removed and seven retained their bands. Birds released with their bands on have not been recaptured at Campbell Island.

Grey-headed Albatross recoveries

Only one Grey-headed Albatross recovery has been reported. This bird was caught by a long-liner at *c.* 40°S, 105°E in November 1976 and was six years old.

Discussion

While recovery data can enable a detailed and accurate examination of the origin of birds recovered, describing a species' distribution from such records may involve biases resulting from variable reporting practices. However, in detailing the recoveries of New Zealand Black-browed Albatrosses from Campbell Island, we attempt to clarify some of the uncertainties about the range and distribution of this population. Black-browed Albatrosses typically feed over neritic waters, whereas Grey-headed Albatrosses favour oceanic waters (Prince

Table 1 Age groups and recovery types for New Zealand Black-browed Albatrosses banded at Campbell Island. Percentages of age-group per recovery type are shown in parentheses. * includes recovery of adult with no date details.

Recovery	Total	Juvenile	Sub-adult	Adult
Vessel	39 (53%)	9 (35%)	22 (69%)	8 *(53%)
Beach	34 (47%)	17 (65%)	10 (31%)	7 (47%)
Total	73	26 (36%)	32 (44%)	15 (21%)

Table 2 Recoveries of New Zealand Black-browed Albatross from vessels: —, no recoveries; L, long-liner; T, Trawler; O, Unknown or Other; Juv., juvenile; Sub-ad., sub-adult..

Mode of recovery	Vessel	Total	Juv.	Sub-ad.	Adult
Caught on line or hook	O	9	3	5	1
	L	9	2	5	2
On vessel at sea	O	5	1	4	—
	L	1	—	—	1
Caught in net	O	7	2	2	3
	T	2	—	2	—
'Tangled in fishing gear'	O	2	—	1	1
'Died for food'	O	2	1	1	—
'Knocked down under trawl warps'	T	2	—	2	—
Total		39	9	22	8

et al. 1998) and are thus much less likely to be encountered by vessels (Weimerskirch et al. 1988). The low rate of recovery of banded birds (0.3 per 1000 banded for New Zealand Black-browed Albatrosses and 0.01 per 1000 Grey-headed Albatrosses banded) appears to be typical for albatrosses (Croxall & Prince 1990), but necessitated pooling all years of data. For this reason, analysis of temporal changes in recovery types and age-groups has not been undertaken. Our discussion is limited to seasonal patterns of occurrence in each age-class, and the incidence of recovery types within age-classes.

New Zealand Black-browed Albatross recoveries

Juvenile recoveries illustrate the post-fledging migration of birds from Campbell Island. During the first year of life New Zealand Black-browed Albatross fledglings appear to travel north from Campbell Island past eastern New Zealand in April, through the sub-tropics in winter, and then move back southward through the western Pacific Ocean and Tasman Sea during spring to summer.

In April, during the first month after fledging, juveniles appear to use the waters east of New Zealand as a corridor to the sub-tropics. The lack of recoveries from the eastern South Island coast and from the coasts north of East Cape (at the eastern tip of the North Island) indicates that fledglings probably do not use the inshore waters of the east coast of New Zealand as a foraging ground. Prevailing currents and wind conditions probably account for the occurrence of 100% of juvenile recoveries during April from coastal locations along the south east coast of the North Island. Birds may be washed ashore after dying exhausted near shore or at sea, having used energy reserves accumulated as fledglings on Campbell Island.

From June to August, recoveries were distributed widely throughout the sub-tropics north of New Zealand, from eastern Australian coastal waters to the mid-South Pacific. The two recovery types (vessel n = 5, beach n = 6) had overlapping ranges and were in more northerly latitudes (18°S to 36°S) than recoveries of this age-class during other months. Recoveries from the eastern Pacific were more easterly and northerly than most other recoveries (n = 3).

Thirteen spring and summer recoveries (Fig. 1b) indicated that juveniles moved south and were found in inshore waters, predominantly off the east coast of Australia, but also off the eastern North Island, New Zealand (nine beach recoveries). Vessel recoveries were exclusively from off eastern Australia (n = 4) from 32°S to south of Tasmania at 48°S. No recoveries were reported from the sub-tropics during these months.

Sub-adult recoveries were the most widely dispersed of all age-groups, both in winter and summer, with a wide longitudinal range (summer, 115°E–174°W; winter, 115°E–146°W), but most recoveries showed a more restricted latitudinal range (28°S–43°S) than for other age-groups. They were almost entirely absent from the sub-tropics with only one recovery at 20°S.

During winter, beach recoveries were widespread from western and southern Australia, to the north of New Zealand (n = 4). Vessel recoveries were clustered around the eastern coasts of the Australian mainland (n = 6) and the North Island, New Zealand (n = 6), but two were from southern Australia and one from the mid-Pacific (Fig. 2a). In New Zealand waters, the clustering closely reflected the incidence of long-line winter fishing grounds, with fishing effort progressing from the Wairarapa coast to the Bay of Plenty–East Cape (i.e. northward along the east coast of the North Island) between May and August (Murray et al. 1993), and comprising 39% of the New Zealand longline fishery 1989–93 (Duckworth 1995). A similar clustering of vessel recoveries and long-line fishing activities occurred in the Tasman Sea and Australian areas. Since 1971, in the waters south of Australia and west of New Zealand between the latitudes 30°S to 55°S, winter long-line fisheries have been concentrated off the New South Wales–Victoria coast between July to September, moving to southern Tasmanian waters in October to

December (Polacheck & Tuck 1995). The high incidence of vessel recoveries may indicate that in winter, sub-adult birds are common ship-followers and scavengers from fishing vessels.

Summer recoveries were split cleanly between six (beach) around northern New Zealand and Tonga and seven (vessel) around the south-eastern and southern coasts of the Australian mainland (Fig. 2b). This split probably reflects the occurrence of vessels around each land-mass. A large tuna long-line fishery operates south of Australia and records since 1971 show intensifying activity from October to December in this area (Polacheck & Tuck 1995), whereas around New Zealand, long-lining activity is at its peak in the winter months (Murray et al. 1993). Recoveries were generally more southerly in winter (range 28°S–43°S) than in summer (range 20°S–39°S).

Adult recoveries differed in number and range between the summer and winter months. During winter, 11 adult birds were found dispersed widely around the Tasman Sea and the south western Pacific Ocean east of New Zealand. This indicates that they have a more northerly and dispersed distribution than in summer, with a broader latitudinal range (28°S–42°S) than during the summer months (32°S–44°S). From at-sea observations this species is most commonly seen in southern Australian waters during March to June (Marchant & Higgins 1990; Reid et al. in press), and most common off Victoria during May to July and New South Wales in May to September. It is one of the most numerous species around the southern New Zealand mainland in October (Petyt 1995) and is also common off Victoria and southern New South Wales (Marchant & Higgins 1990). Reid et al. (in press) suggest that birds seen during August to October in southern Australian waters are non-breeders.

The three recoveries from the western Tasman Sea during summer indicate that birds, whether breeding or non-breeding, have a more restricted and southerly range (32°S to 44°S) than during winter. These findings are consistent with at-sea survey data from southern Australian waters, where New Zealand Black-browed Albatross are rarely seen in the breeding months (Marchant & Higgins 1990; Reid et al. in press). Many adult birds will be commuting from Campbell Island to feeding grounds during summer, and their distribution is probably not well defined by the recovery data. The scarcity of recoveries during summer suggests that birds are not common near land masses, and either do not regularly associate with vessels, or forage outside fishing zones, perhaps in the southern Pacific Ocean, west or east of Campbell Island. From ship-board observations, Petyt (1995) found New Zealand Black-browed Albatross uncommon around the squid fishery on the Snares and Auckland Shelves, but was most abundant around and south of Campbell Island in summer.

Adult birds were recovered more often in winter than in summer. We propose two associated reasons to explain this: first, that birds spend time relatively close to landmasses in winter, and natural mortality in coastal waters gives a greater probability of recovery than if birds were wintering over oceanic waters. Second, the distribution of adult birds in winter overlaps temporally and spatially with that of long-line fisheries for tuna, and therefore interactions with fisheries are more likely to occur in these months. The Japanese tuna fishery in Australasia has typically been more intensive from April to September than during the summer (Polacheck & Tuck 1995).

Types of recovery by age group

Within age-groups, there were different patterns of recovery types. For juvenile birds, 65% of recoveries were from the *beach* category. A possible explanation is that these first-year birds may be in poorer condition than older birds and are therefore more frequently found on beaches, pushed into coastal waters when they are exhausted and washed ashore by currents and winds. They may be recovered from vessels infrequently either because they do not associate with them or, more likely, because they lack maneuverability and competitive skills to approach baits and maintain prime positions for seizing discards and baits behind vessels.

Sub-adult birds, in contrast, were recovered twice as often from vessels (69%) as from beaches (31%). Thus, it would appear that after the first year of life, these birds had learnt to scavenge offal and baits from fishing operations. The lower incidence of beach recoveries is most likely explained by better body condition and foraging skills in older birds.

Adult birds were recovered with equal frequency from beaches (47%) and vessels (53%). This may indicate that birds spent little time in the regions where fisheries operated and were thus less susceptible than sub-adults to mortality associated with fishing vessels. The majority (86%) of beach recoveries were from the non-breeding months, when birds are widely dispersed and may be moulting.

Vessel recoveries

Three main hot-spots for vessel interactions can be noted from the recoveries: in winter off the east coast of the North Island of New Zealand and around Tasmania, and the eastern coast of the mainland of Australia from around 30°S–37°S in both seasons. In all age-classes, the commonest mode of vessel recovery was 'caught on line or hook' on long-line vessels or vessels of unknown type (50% of adults, 55% of juveniles and 45% of sub-adults). Composition of by-catch from long-liners of New Zealand Black-browed Albatross within the New Zealand waters shows a similar pattern to that demonstrated by band recoveries. In the fishery, a high proportion (39%) of albatrosses caught during 1989–92 from the waters east of the New Zealand mainland were of this species (Murray et al. 1993). Of New Zealand Black-browed Albatrosses caught on Japanese tuna long-lines in New Zealand waters during 1988–92, 71% were juveniles or sub-adults. In the Australian long-line fishery, Black-browed Albatrosses are the most commonly caught albatross species (Klaer & Polacheck 1995), with the majority of identified individuals originating from Campbell Island (R. Gales pers. comm.).

The recoveries in association with trawlers or caught in nets were next most common in all age-classes (38% of adults, 22% of juveniles and 27% of sub-adults). The practice of taking birds for food by fishing crews in modern times is poorly documented (Gales 1993). Both recoveries documented here were from one vessel in 1979 and were among two other banded albatrosses of different species so recovered. These and the remaining modes of recovery document that a range of fisheries are important in contributing to seabird mortality.

Grey-headed Albatross recoveries

The scarcity of Grey-headed Albatross recoveries indicates that birds are seldom found near coasts and do not interact with vessels to the same extent as New Zealand Black-browed Albatross. A similar result was found for Grey-headed Albatross at South Georgia (Prince et al. 1994). Surveys of birds following trawl vessels in the Benguela region, South Africa (Ryan & Moloney 1988), throughout New Zealand subantarctic waters (Petyt 1995) and around long-line vessels in the Indian Ocean (Cherel et al. 1996) found that Grey-headed Albatross were infrequent ship-followers.

Paradoxically, in beach recovery records from New Zealand during 1960–83, Grey-headed Albatross was the most commonly occurring albatross species (Powlesland 1985), found mainly on west Auckland beaches (64%) in September (40%), but also common during June–August (40%). Powlesland (1985) found the high incidence of Grey-headed Albatross intriguing, as this species is known to favour oceanic waters (Weimerskirch et al. 1988). From the absence of Campbell Island banding returns, it would seem unlikely that high numbers of Grey-headed Albatross in New Zealand coastal waters in the winter and spring would be from the Campbell Island population. The birds identified during beach surveys could have come from other populations. There is strong evidence that birds from South Georgia use the waters of New Zealand and Australia as a wintering ground, after making a westward migration after the end of their breeding season (Prince et al. 1998).

Conclusions

Distinctive age-specific and seasonal differences in the distributions of New Zealand Black-browed Albatrosses probably relate to the different foraging habits of the age-classes and restraints imposed by reproduction. The distributions of all age-groups only overlap completely in winter, when they are found mainly in the Tasman Sea and New Zealand neritic waters. Different proportions of age-classes were recovered on beaches and from vessels with birds between one to six years of age most likely to be recovered from vessels. The seasonal and age-specific patterns of recovery are in concurrence with the demographic data on New Zealand Black-browed Albatross bycatch, and the seasonal distribution of fisheries effort.

The paucity of band recoveries of Grey-headed Albatrosses do not currently provide an effective means of outlining the species' distribution but confirm its pelagic distribution compared to Black-browed Albatrosses.

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