SEABIRDS OF EASTERN COOK STRAIT, NEW ZEALAND, IN AUTUMN

By J. A. BARTLE

ABSTRACT

The distribution and abundance of seabirds in eastern Cook Strait during autumn is described. Notes on identification and behaviour are also included.

Three coastal currents of mixed subtropical and subantarctic origin intermingle in eastern Cook Strait. Seabird assemblages of this region are dominated in autumn by large numbers of non-breeding migratory shearwaters from northern New Zealand. These birds leave in early May and are replaced by subantarctic species. White-capped Mollymawks, Salvin's Mollymawks and Giant Petrels are numerous in early autumn prior to their dispersal into the eastern boundary currents.

The seasonal variability of food for offal-feeding petrels is much less than for species which feed solely on pelagic organisms. This explains the rarity with which Flesh-footed Shearwaters, Cape Pigeons, Westland Black Petrels and albatrosses are cast ashore, and limits the value of storm-killed records as indices of petrel abundance.

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INTRODUCTION

There have been no detailed studies on the distribution of seabirds over continental shelf waters in the central New Zealand region. Seasonal changes in density and species composition of the seabird flocks during autumn are very marked in this area, and this survey is concerned with such changes.

This paper summarizes observations on the seabirds of the eastern Cook Strait region (Fig. 1) made from the steam trawler *Maimai* between mid-February and mid-May 1966. Observations ranged from the Kairakau Rocks (approximately 40°S) and Castlepoint in the north to Banks Peninsula (about 44°S) in the south. Most were made off the Kaikoura Coast, particularly in the neighbourhood of Cape Campbell (Fig. 1). I have also included information on

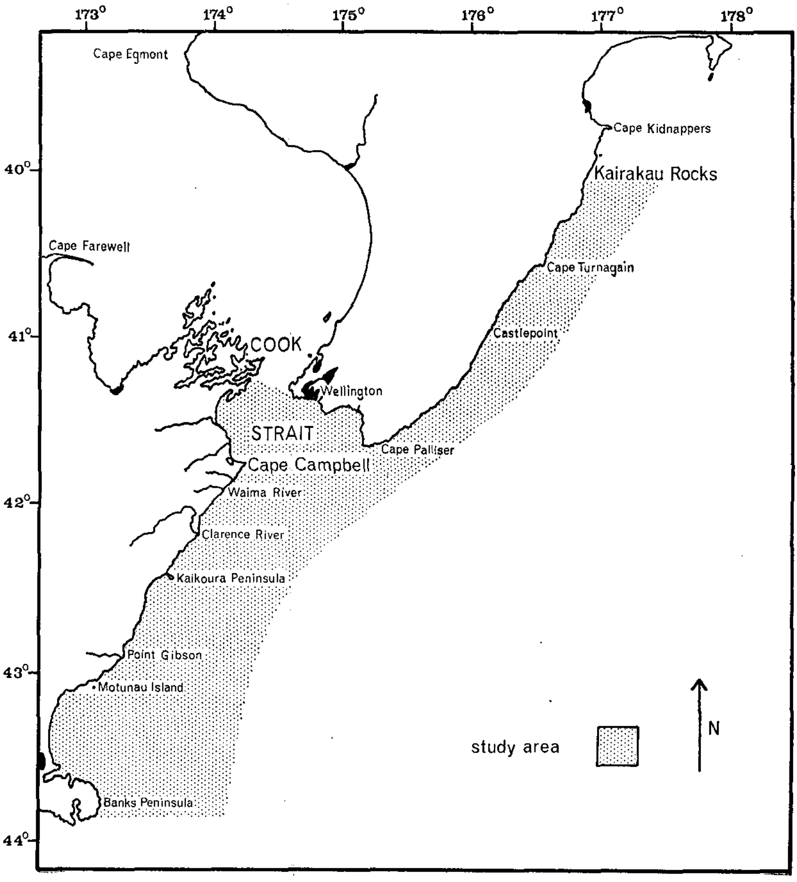

FIGURE 1 — The eastern Cook Strait region.

seabirds recorded off Castlepoint in May, July, and November 1965. For comparative purposes seabirds sighted in the western approaches to the Strait between 1960 and 1969 have been briefly discussed.

The valuable notes of Mr Fred Abernethy were freely used. These permitted a check of my conclusions against observations made in the same area nearly a decade earlier. Supplementary material from the Beach Patrol Scheme of the Ornithological Society of New Zealand was included by permission of the convener. Extensive records of " storm-killed " seabirds are kept by the scheme, and some species found dead on the shores of the Strait have not been identified at sea in the area.

OBSERVATION METHODS

Between mid-February and mid-May 1966 the *Maimai* was fishing on an average of 4 days each week, with periods from 3 to 12 days being spent at sea. Up to 16 hours were spent working on deck each day, and few opportunities were missed to keep ornithological records.

In some respects fishing vessels are ideal seabird observatories. Large quantities of edible refuse in the form of fish viscera and heads as well as undersized and non-marketable fish are discharged overboard. This brings many seabirds close to the ship where detailed examinations can be made.

Not all seabirds are attracted to a vessel when refuse is thrown overboard. Of 23 species of seabirds recorded from the *Maimai,* 7 did not normally approach the vessel closely, and in one case specific identification using binoculars was impossible. However, 3 of these 7 species were attracted on board at night by the powerful floodlights used during night gutting and were examined in the hand. Sometimes birds drawn to daylight gutting also flew aboard accidentally. Once on board, these birds had great difficulty in clambering back into the sea, and were easily captured. Fifty-nine birds of 12 species were banded. Some were obtained when they flew aboard and others were snatched by the wingtip as they flew alongside. Most were caught using a dip net with a duralumin handle 4 metres in length and a mouth diameter of 1 metre. Birds around the trawler were watched with 8 x 40 binoculars whenever possible, but systematic observations could not be maintained.

THE EASTERN COOK STRAIT REGION

Three main surface water movements give rise to the coastal circulation around New Zealand. To the south lies the West Wind Drift; to the north of the North Island, the Trade Wind Drift; and west of both islands, the Tasman Current. The coastal currents are derived from these water movements, together with the effects of local winds (Brodie 1960).

Subtropical and subantarctic waters meet at the Subtropical Convergence in the southern Tasman Sea. Most of the subtropical water lying north of the Convergence flows north along the west coast of New Zealand as the Westland Current (Fig. 2), but some

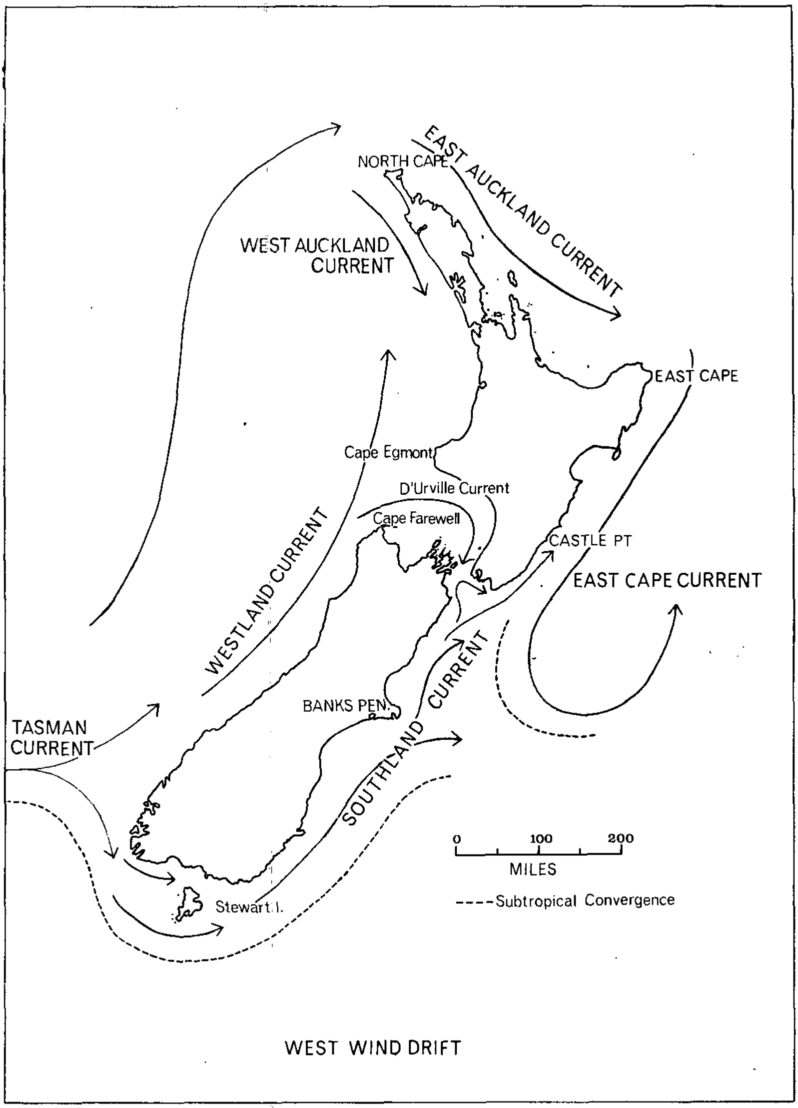

FIGURE 2 — Coastal circulation in the New Zealand region (diagramatic).

is deflected to the south around Stewart Island and through Foveaux Strait (Brodie 1960, Houtman 1966). This water and the subantarctic water associated with its offshore limits forms the Southland Current which flows up the east coast as far as Castlepoint and sometimes to Gisborne (Brodie 1960). The Southland Current sweeps through the eastern end of Cook Strait before passing northwards along the Wairarapa Coast (Heath 1969).

Associated with this current are a number of subantarctic seabirds. Truly migratory species, present in this cool water zone during summer, almost disappear on trans-equatorial migrations to the North Pacific during the southern winter.

The Westland Current arises as a branch of the modified subtropical water of the counter-clockwise circulation in the Tasman Sea (the Tasman Current). A strong indraught of this water from off Cape Farewell into Cook Strait is known as the D'Urville Current (Brodie 1960). This current transports warm surface water usually as far as the Cook Strait Narrows.

Derived from the East Auckland Current (Barker & Kibblewhite 1965), the south-flowing East Cape Current bounds the north-flowing Southland Current to the east. South of Castlepoint the warm water usually lies well offshore (Fig. 2). The exception to this is in the deep waters of the canyons near the coast at Cook Strait (Garner 1961, Heath 1971) and Kaikoura (Houtman 1965). Associated with this current are a number of seabirds which breed in northern New Zealand and thus both subtropical and subantarctic species intermingle in Cook Strait during autumn.

The land mass of New Zealand is set athwart what would otherwise be a zonal eastwards flow (with the West Wind Drift and the Trade Wind Drift lying well to the south and north respectively of New Zealand). The Subtropical Convergence lying between the subtropical and subantarctic water, is displaced in the New Zealand area. Surface isotherms representing the Convergence may be close together or widely spaced (Garner & Ridgway 1965), and the Convergence may be difficult to detect. Deacon (1945) suggested that the idea of a convergence region would be useful because the New Zealand area is one where the positions of sharp boundaries in water properties fluctuate, rather than one of gradual transition. Because water masses of such diverse origins affect the area, Cook Strait itself may be regarded as lying within such a region.

Deacon (1937) thought that the Subtropical Convergence approached the land near Cape Egmont to the west of New Zealand, but subsequent work showed that the Westland Current is basically subtropical (Brodie 1960). Thus the Convergence is more properly shown as marking the boundary between the Tasman Current and West Wind Drift west of New Zealand (Garner 1959, 1961) and between the East Cape Current and the West Wind Drift south and east of New Zealand (Burling 1961, Jillett 1969).

The system is complicated by the presence of subantarctic water at the surface north of Banks Peninsula (Garner 1961). This water mass was previously considered a branch of the West Wind Drift, but Heath (1972) found it to represent the cooler subsurface water of the Southland Current (which is essentially subtropical at the surface off Otago). Nevertheless, a convergence is recognized where this cooler Southland Current water meets the warmer water of the D'Urville Current to the west (in the Cook Strait Narrows) and the *subtropical East Cape Current to the north* and east (Garner 1959, 1961).

The Subtropical Convergence is well marked east of Banks Peninsula where subantarctic water is directed eastwards toward the Chatham Islands along the southern margin of the Chatham Rise (Burling 1961).

The most important bathymetric feature of the area, the Hikurangi Trench, extends south-westwards close to the coast of the North Island, and depths of over 2000 metres are reached only 80 kilometres offshore. The continental shelf off the south-east coast of the North Island is very narrow, and canyons are cut into the slope between Castlepoint and Kaikoura. The Hikurangi Trench gradually becomes shallower further south, and finally disappears near Banks Peninsula.

Warm tongues of surface and subsurface water extend into the Cook Strait and Kaikoura Canyons (Heath 1971), upwelling close inshore. These influence the plankton communities (Grieve 1966, Bartle 1972, Bradford 1972), and hence seabird densities.

Against this hydrological background (see also Brodie 1973, Heath 1973) it is apparent that studies based largely on transects across the Narrows (as was that of Secker 1969; also Fowler 1972) cannot provide a balanced picture of the seabirds in the Cook Strait area. The conditions which prevail in the Narrows are not typical of other areas within the Strait which are differently influenced by the three water masses.

Cassie (1960) remarked on the oceanic conditions which prevailed at Abernathy's stations off Castlepoint, Cape Campbell, Weld Cone and Kaikoura, and sometimes all of these stations were influenced by the same body of water (the Southland Current) and possessed similar plankton communities (see also Bartle 1972).

Gales are more frequent in Cook Strait than elsewhere in New Zealand except for Foveaux Strait (Watts 1947). The autumn pattern is one of violent storms alternating with prolonged periods of surprisingly calm weather. On less than half of the days when the *Maimai* was at sea during the study period was the average windspeed estimated to exceed 24 kts described by meteorologists as a " strong breeze."

SYSTEMATIC ACCOUNT OF THE BIRDS

In this section each species observed from the *Maimai* is listed, with brief notes on numbers, distribution and behaviour. Other species which are known to occur in Cook Strait have been included, although not recorded during the present survey. The species are discussed under two headings — those which are normally attracted to refuse thrown overboard, and regularly follow ships; and, secondly, birds which are not usually attracted to waste discharges. Within each of the two sections nomenclature and systematic order follow the "Annotated Checklist of the Birds of New Zealand" (OSNZ 1970).

1. Seabirds associated with trawlers:

WANDERING ALBATROSS *(Diomedea e. exulans)*

These birds were recorded regularly throughout autumn, but never in large numbers. Usually only one or two birds were seen on the outskirts of a voracious flock of 10-20 Royal Albatrosses. They seem less bold than this latter species, and perhaps refuse is less important in their diet. A large proportion of the Wandering Albatrosses in Cook Strait were in brown juvenile plumage, a feature also noted by Kinsky (1968).

ROYAL ALBATROSS *(Diomedea epomophora)*

Moderate numbers of this albatross were present in Cook Strait, and both the Northern Royal Albatross *(D. epomophora sanfordi)* and the Southern Royal Albatross *(D. e. epomophora)* were seen regularly. The Southern Royal Albatrosses outnumbered the northern form by about 6 to 1, and this remained constant throughout autumn.

After some practice, it became easy to distinguish the subspecies at a glance. The northern form is distinctly smaller and there are no white feathers among the dark upper wing coverts, thus increasing the contrast between the dark upper wing and the white leading edge and back. The extent of dark upper wing coverts on *D. e. epomophora* was usually much less, although Serventy *et al.* (1971) exaggerated this feature in their descriptions and sketches and their account is very misleading. All upper wing coverts of the southern race have white tips, giving the dark upper wing surface a speckled appearance (F. C. Kinsky pers. comm.). This was found to be the most useful character for distinguishing between the two subspecies at sea.

The numbers of Royal Albatrosses seen in Cook Strait during this survey appear very high when compared with the results of Norris (1965) or Secker (1969). It seems that these workers may have been confusing Wanderers with Royals, for I have had many opportunities since 1966 to observe albatrosses in the area, and on every occasion the number of Royals has exceeded the number of

Wanderers. Most of my identifications have been made from trawlers at distances of 2-5 metres, and at this range the dark lines on the cutting edges of the mandibles of Royals are unmistakable.

Royal Albatrosses were largely diurnal and rested on the water upwind of the vessel as it drifted overnight. Nevertheless, they would come in to night gutting. Activity usually began about 2 hours before sunrise.

Richdale (1950) suggested that pairs associate at sea between breeding seasons. On many occasions " neck-nibbling," " trumpeting " and displays with outstretched wings were seen between pairs and trios.

BLACK-BROWED MOLLYMAWK *(Diomedea melanophris melanophris)*

All adult Black-browed Mollymawks which could be subspecifically identified were of the southern dark-eyed form. My later observations have shown that the honey-eyed *D. m. impavida* has a more northerly distribution in New Zealand coastal waters, and is rarely seen off the east coast south of East Cape. Significantly, 5 out of the 7 long-distance recoveries of banded *impavida* have come from the tropical Pacific (Robertson 1972, 1973), close to the northern extreme of the winter range for Black-browed Mollymawks determined by Summerhayes (1969). Banding evidence thus supports the hypothesis of a more northerly autumn and winter range for *impavida,* not only in coastal waters, but throughout the South-West Pacific. However, the nominate race is not confined to the cool Southland Current, for I have also seen a few dark-eyed adults in northern waters.

Mr F. Abernethy (pers. comm.) did not record Black-browed Mollymawks in the area during early summer, his earliest record being on 19 February 1957 at Cape Campbell. I could not make observations during early summer, but my first record on 22 February 1966 (also at Cape Campbell) agreed well with Abernethy's findings. Secker (1969) noted the absence of the species from the Narrows in early summer.

Black-browed Mollymawks were never seen in large numbers, but regular sightings were made after the middle of March. It was rare for more than 2 or 3 to come in to gutting.

An unexpected feature was the high incidence of birds with juvenile plumage. At least 2 birds in 3 had variable juvenile markings (see also Kinsky 1968). The youngest birds seen had completely dark underwings, grey heads and necks, and dark grey bills. In older birds the axial streak of the underwing lightens and the grey head and neck become white. At this age the bill is usually flesh-pink, with a black tip to both mandibles. An anomalous individual was seen with adult plumage but a slate coloured bill showing irregular patches of yellow. This was probably an immature bird (Murphy 1936). The abundance of birds with juvenile plumage suggests that Cook Strait is a wintering ground for juvenile birds.

This species is almost entirely diurnal (see also Murphy 1936) and rarely came in to night gutting. The birds were rather shy and did not usually approach the boat very closely, being easily intimidated by the larger White-capped and Salvin's Mollymawks.

BULLER'S MOLLYMAWK *(Diomedea bulleri)*

This small mollymawk is rarely cast ashore on Wellington beaches, and is generally not common in Cook Strait during autumn. However, numbers are higher to the south (Norris 1965), and groups may appear irregularly close inshore (Secker 1969). None were seen until 28 March 1966 at Cape Campbell. This compares well with Mr F. Abernethy's earliest record (21 March 1957), also at Cape Campbell. Abernethy thought that the species was totally absent from the Strait during summer, but Secker (1969) provided records from mid-December onwards. It is rare, however, to see more than lone birds until late April.

Maximum numbers of Buller's Mollymawks were observed from the *Maimai* off Point Gibson, which was not a regular fishing ground. This species is not associated with the fishing grounds to the same extent as the large mollymawks and great albatrosses, which were almost absent from Point Gibson in April.

Buller's Mollymawks were the shyest of the mollymawks which came in to gutting. They kept out at the edge of the flocks and were chased away by the larger mollymawks. More frequently Buller's Mollymawks flew about the stationary vessel without alighting amidst the mass of birds squabbling over offal. Norris (1965) also noticed their reluctance to follow vessels for any length of time, and no flying birds were seen from the *Maimai* at night.

WHITE-CAPPED MOLLYMAWK *(Diomedea c. cauta)*

The inappropriately-named Shy (or White-capped) Mollymawks were the largest, boldest and most common of the mollymawks in the area. They were especially numerous off the Kaikoura Coast, and offal from trawlers must form the major part of their diet in Cook Strait.

When only one fishing vessel was at sea the local population, usually spread around 6 trawlers, converged on one boat. The estimated 800 birds of this species which came in to morning gutting at Cape Campbell on 28 March 1966 indicates the size of the local population. White-capped Mollymawks are largely diurnal, but can be active during night gutting. They rest on the water overnight, becoming active about 2 hours before sunrise. During the day large numbers follow trawlers, awaiting the disposal of waste.

White-capped Mollymawks breed only on islands in Bass Strait and off Tasmania, as well as at the Auckland Islands (Serventy *et al.* 1971). The breeding season does not end until early March (Falla *et al.* 1966) on these distant islands, whereas numbers of White-capped Mollymawks are highest in Cook Strait during late summer. By early May densities have greatly decreased.

Increased numbers of adult White-capped Mollymawks in Cook Strait during the fledgling period may reflect a northward dispersal of non-breeders. Pairs were often seen engaged in typical courtship activities such as " neck-nibbling." This seemed contagious, and would often spread to a dozen pairs in a small flock. Prolonged courtship such as this is a feature of non-breeding petrels (Bartle 1968). Similar dispersals occur within other species, for Richdale (1963) showed that unemployed Sooty Shearwaters *(Puffinus griseus)* also leave the nesting grounds at the fledgling stage of the breeding cycle. Cook Strait may be a summer feeding area for the non-breeding White-capped Mollymawks which disperse more widely during the winter (Serventy *et al.* 1971).

SALVIN'S MOLLYMAWK *(Diomedea cauta salvini)*

Salvin's Mollymawks are easily (and reliably) distinguished from adult White-capped Mollymawks by the possession of a dark mandibular unguis, which can be seen from a considerable distance. Other characters (especially bill colour and the grey head and neck) are less reliable for distinguishing Cook Strait populations of *salvini* in autumn from the nominate race and may explain the paucity of sight records of *salvini from* Cook Strait. The few birds which Secker (1969) sighted were probably juveniles and newly moulted adults with their characteristic grey heads since he did not record them until April. In late summer the grey of the head and neck is usually reduced by abrasion to a pearly grey wash on the face and neck contrasting with the white crown (*salvini* moults in February according to Kinsky 1968). Many birds have the whitish heads which were once thought to characterize a separate subspecies, *layardi,* but these were considered by Murphy (1936) and later workers to be the result of plumage wear. The bill in Salvin's and White-capped Mollymawks is also very variable in colour, ranging from greyish shades through a horn colour (perhaps predominant) to flesh and yellowish tones. The overall bill colour of *salvini* is not always darker than *cauta cauta,* as stated by Serventy *et al.* (1971). Bill colour is especially unreliable for distinguishing juvenile birds, but, as with the White-capped Mollymawk, birds in juvenile plumage are rarely seen in Cook Strait during autumn. Juvenile Salvin's Mollymawks have been seen with a grey head and neck and a grey bill with dark tips to both the upper and lower mandible.

Numbers of Salvin's Mollymawks were consistently lower than those of the White-capped Mollymawk. Usually the ratio is about 1:2. For instance, on 28 March 1966 when an estimated 800 White-capped

Mollymawks were seen following the *Maimai,* there were about 300 Salvin's Mollymawks as well. This subspecies is much less frequently washed ashore on the Wellington coast than *cauta cauta,* but the wreck of nearly 40 *salvini* in February 1947 (Cunningham 1948) showed that there were large numbers in the Strait at that time

Both White-capped and Salvin's Mollymawks are essentially birds of the cool Southland Current and West Wind Drift, and both are less frequently seen in the western approaches to Cook Strait. However, the location of trawling grounds may also be a factor in restricting their distribution. The reduced number of Salvin's Mollymawks in Cook Strait during the winter can be accounted for by an eastward dispersal into the eastern boundary currents of the South Pacific and South Atlantic. They have been regularly recorded from the Peru Current and the Benguela Current, mainly during May and June (Murphy 1936).

The feeding relationship between this subspecies and the White-capped Mollymawk is interesting. Invariably the peck order is determined by size, and the slightly larger subspecies prevails.

CHATHAM ISLAND MOLLYMAWK *(Diomedea cauta eremita)*

This distinctive subspecies breeds only on Pyramid Rock in the Chatham Islands. Records away from the seas adjacent to the breeding area are exceedingly few (Imber 1966) and probably represent stragglers rather than any definite dispersal. Nevertheless, the small total population (cf. Dawson 1973: 226) must be taken into account, especially when compared with other mollymawks. The east coast of the South Island was included within this subspecies' range in the *Annotated Checklist of the Birds of New Zealand* (OSNZ 1970), but Imber (1966) listed only 2 records for the area.

An adult Chatham Island Mollymawk was seen on 23 February 1966 near Cape Campbell. The chrome yellow bill and sooty head and nape were clearly seen on several occasions. During the next few days this bird was attracted in to gutting, but it was not a particularly voracious scavenger compared with the White-capped and Salvin's Mollymawks.

GIANT PETREL *(Macronectes giganteus)*

The Northern Giant Petrel *(M. g. halli)* had not been clearly differentiated from the nominate race at the time of this survey. The following observations probably refer to a mixed population consisting of both subspecies although very few pale adults were seen from the *Maimai,* or by Secker (1969).

I had been expecting to see large numbers of this well-known scavenger but the population in the open sea was surprisingly small. McIlwaine (1964) described the large flocks which occur at the outlet to the Ngauranga freezing works in Wellington Harbour; and many hundreds of Giant Petrels once congregated at the Tory Channel Whaling Station (Dawbin 1948: 19). But in 1956-57, while the Whaling Station was still operating, Mr F. Abernethy rarely saw more than 6 Nellies at once in the open sea, and I never recorded more than 4 together during the autumn of 1966. These low numbers contrast with the flocks of up to 110 birds sometimes recorded by McIlwaine off Ngauranga in March.

Giant Petrels (or Nellies) were less frequently seen by day and usually followed the ship's wake. Nellies came in to gutting at night and were shy and difficult to catch. These birds always retreated when challenged by ane of the mollymawks. Nearly half of the Nellies wore bands which may suggest that the same birds return to particular wintering grounds over many years (see also Kinsky 1958).

Giant Petrels are found in Cook Strait at all times of the year (Bull & Boeson 1961a, 1961b, 1963; Boeson 1964; McIlwaine 1964; Secker 1969) and no consistent changes in numbers were observed over autumn. McIlwaine made a detailed study of seasonal trends in the numbers of Giant Petrels (from 1958 to 1962) off Ngauranga, in Wellington Harbour. A very high correlation was found between the number of Nellies and the amount of offal, with peak numbers of Nellies between November and February. She accounted for their reduced abundance in autumn and winter by proposing that the birds left Ngauranga and fed across Cook Strait at the Tory Channel Whaling Station where the whaling season lasted from March to August. Unfortunately McIlwaine obtained no actual counts of Giant Petrels at Tory Channel and was unable to verify her suggestion. After the Whaling Station had permanently closed, Secker (1969) made counts from Ngauranga which showed exactly the same pattern, with fewer birds in autumn and winter. Hence McIlwaine's concept of a fairly constant number of Giant Petrels in Cook Strait must now be incorrect. Secker's explanation of the September-December peak in numbers as the result of higher air and sea temperatures is also untenable. Minimum sea temperatures are not reached until September in Cook Strait (Bartle 1972) and, in any case, Giant Petrels are denizens of waters with predominantly subantarctic characteristics (Murphy 1936).

Although little information is available, it seems that the departure of the large spring and summer population of mainly non-breeding Giant Petrels from Cook Strait may be associated with a winter dispersal pattern similar to that of the *Diomedea* species which obtain a large part of their food by scavenging. Few Nellies were seen north of New Zealand by Summerhayes (1969) in winter and P. E. Roberts (pers. comm.) in summer suggesting an east-west dispersal rather than a latitudinal movement. Banding recoveries (Robertson 1972) also support this interpretation.

A surprising observation, which Abernethy (pers. comm.) confirmed, was that Nellies are more common along the eastern coast of the North Island (south of Kairakau Rocks) than off the east coast of the South Island (north of Banks Peninsula). On 4 April 1966 Nellies were very common just north of Cape Palliser, but only an occasional bird was to be seen off the Kaikoura Coast (only 65 kilometres south) later in the day. During a week's observation of seabirds from the shore at Castlepoint (3-9 July 1965) Nellies were the only petrels recorded. On most days they could be seen flying north or south along the coast either singly, or in groups of up to four. Often they came quite close inshore, within 100 metres of the beach. The records of Norris (1965) also show these trends, yet from an oceanographer's viewpoint these areas appear very similar, with mixed Southland Current water carrying characteristic planktonic organisms (Bartle 1972) along the continental shelves off both coasts.

SNARES CAPE PIGEON *(Daption capensis australis)*

All the Cape Pigeons seen from the *Maimai* in autumn were of this dark-backed subspecies which breeds in the New Zealand subantarctic region. Adults of the nominate race always have a much whiter back despite varying effects of plumage wear (see Murphy 1936: Fig. 58). *Daption c. capensis* is present in Cook Strait in small numbers later in the year as more recent observations and band recoveries have shown.

Cape Pigeons are normally absent from Cook Strait in summer and early autumn. None were observed by Abernethy (pers. comm.) after 7 December in 1955 and 20 December in 1956, and the last birds to be caught had started to moult (see also Murphy 1936). In 1956 Cape Pigeons returned to the trawling grounds in Cook Strait on 10 April (Abernethy). Ten years later the first Cape Pigeons were seen from the *Maimai* on 28 February, but only scattered birds were noted before mid-April. An average of 30 birds followed the vessel and came in to gutting during the rest of April and early May. Mr Abernethy has told me that an increase from 30 to 500 in the number of birds coming in to gutting can be expected by late May, and a further jump to 1000 birds may occur in early June. A similar peak of abundance in winter also occurs off South America (Murphy 1936) and in Australian seas (Serventy *et al.* 1971). But since the closing of the Tory Channel Whaling Station winter populations of Cape Pigeons in Cook Strait may have declined (Bartle unpubl.).

A high proportion of Cape Pigeons still carried bands nearly 10 years after the intensive banding efforts of Mr Abernethy off Cape Campbell and others at the Whaling station. Between 10% and 30% of the many hundreds of Cape Pigeons sighted were banded. Three recoveries were made from the *Maimai* of birds previously banded in Cook Strait, supporting the idea that Cape Pigeons return to the same wintering grounds year after year.

Cape Pigeons seem equally active by night as by day. They will come in to night gutting and differ from albatrosses and mollymawks in following the ship if it is under way at night. When the *Maimai* was drifting at night Cape Pigeons could be seen flying around at the edge of the pool of light cast by the floodlamps. Unlike Nellies and Westland Black Petrels, Cape Pigeons came boldly in to daytime gutting as well. They frequently engaged in courtship activities such as neck-nibbling at these times.

WESTLAND BLACK PETREL *(Procellaria westlandica)*

The numerous accounts of the oceanic distribution of southern seabirds contain few references to this robust species and I have therefore summarized all available information on the identification, distribution and behaviour of the Westland Black Petrel at sea. The species was not described until 1946 and during the next decade the only records away from the breeding grounds were of lone birds which had flown aboard the inter-island ferry between Wellington and Lyttleton in winter. In recent years an extensive distribution in the Tasman Sea and into Cook Strait became apparent from scattered storm-killed specimens found on beaches near Wellington and Auckland (e.g. Kinsky 1968, Imber 1971) and New South Wales (McGill 1959). A few sight records such as those of P. E. Roberts (pers. comm.) have confirmed this extensive distribution west of New Zealand and extended it to 29°S in summer.

The Westland Black Petrel is easily confused with other large dark petrels at sea, especially those with dark underwings and pale bills. Species likely to be confused with Westland Black Petrels in Cook Strait include Black Petrels *(Procellaria parkinsoni)*, White-chinned Petrels *(Procellaria aequinoctialis)* and Flesh-footed Shearwaters *(Puffinus carneipes)*. My observations of Westland Black Petrels at many places around the New Zealand coast suggest that the paucity of earlier observations is mainly the result of incorrect identifications. For example, the " large black petrels with dark underwings (and) feet, no grey face, bill yellow horn coloured with black tip " recorded by Dell (1960) as moderately common between Banks Peninsula and Wellington in February 1959 must have been *westlandica* and not *parkinsoni* as he thought. The pale yellowish latericorn and ramicorn contrast with the blackish nails of the upper and lower mandibles in *westlandica* and can be seen at some distance. This is the most reliable way of distinguishing these birds from Black Petrels which have more evenly coloured bluish bills.

Bill colour is also important for separating *westlandica* from *aequinoctialis*. White-chinned Petrels with very little white on the chin occur regularly in New Zealand waters, although none were seen from the *Maimai*. The white feathers on the chin may not always be visible from the side and the birds can appear uniformly black. Birds without any white on the chin are also known from the New Zealand area (Oliver 1955). But the yellowish nails of both mandibles of *aequinoctialis* can be seen at sea and form the most useful character for distinguishing between *westlandica* and *aequinoctialis.*

In flight, the Westland Black Petrel has a similar build to the Flesh-footed Shearwater. The wings appear longer, but the most distinctive features of *westlandica* are the darker plumage and paler bill. The bill of *westlandica* is noticeably pale because of its large size in relation to the head. The glossy feathers under the wing do not appear pale as in *carneipes,* and flight patterns are similar except that the aerial manoeuvres of the larger petrel seem more measured.

When resting on the water Westland Black Petrels float high, like gulls, giving them a distinctly fat appearance with heavy, rounded lines. The species does not look to be much larger than a shearwater, but the fat appearance is characteristic. White-chinned Petrels also float high (Murphy 1936).

In autumn Westland Black Petrels are black compared with the worn brownish plumage of the Flesh-footed Shearwaters. The contrast between the species is especially noticeable on the breast. Under a bright light, the head and neck of *westlandica* seem darker than the rest of the body.

In addition to the dark underwing, the shorter neck and broader wing distinguish the Westland Black Petrel from the other dark shearwaters, particularly the Sooty Shearwater *(Puffinus griseus).* The flight also involves much less flapping than with the Sooty Shearwater.

Westland Black Petrels are quite variable in size. Few measurements are available, but the largest individuals handled were estimated to be 50% heavier than the smallest. These variations were also reflected in bill size. All birds examined appeared to be adult and comparable variation in size can be found among adults on the breeding colony (Bartle unpubl.).

Mr. F. Abernethy was the first to positively identify Westland Black Petrels at sea, in the spring of 1956. He observed individuals off Kairakau Rocks and near Cape Campbell. The species was seen coming in to gutting in small numbers. Abernethy recorded Westland Black Petrels during September and October, with a last record for the season from Cape Campbell on 5 November 1956. There are few records of Westland Black Petrels in New Zealand waters after the end of the breeding season in December, and it is possible that the birds disperse northwards during summer.

Birds reappear on the breeding colony in late March to clean out burrows (Bartle unpubl.) and Westland Black Petrels can be seen in Cook Strait from then onwards. My earliest record is of a number seen on the night of 21 March 1966 at Cape Campbell, and P. E. Roberts (pers. comm.) has also noted their reappearance at sea off the breeding grounds at this time. In Cook Strait numbers remained fairly low during March and early April and the birds did not usually approach the ship by day. During late April and May the species can be seen regularly, although rarely in large numbers. Up to 30 birds often come in to night gutting in May.

The Westland Black Petrel is now known to be evenly distributed throughout the eastern approaches to Cook Strait. Numbers seen off Kairakau Rocks and Banks Peninsula are as high as at Cape Campbell, and I have subsequently recorded birds as far north as East Cape (Bartle unpubl.). The range therefore includes virtually all of the cooler waters off the east coast of New Zealand which support a sizeable trawl fishery.

Early in the season the birds seemed shy and only congregated about the *Maimai* at night. They often remained on the outskirts of the pool of light cast by the vessel's floodlights, feeding on the planktonic animals attracted to the surface by the light. By late April numbers of Flesh-footed Shearwaters and Westland Black Petrels around the ship at night were about equal, but as the Flesh-footed Shearwaters began their northward migration the larger species predominated. Westland Black Petrels were more frequently seen following the ship and coming in to gutting by day as the season advanced. The boldness of the birds increased, and by mid-May the population was consuming considerable amounts of offal.

It seems that the number of Westland Black Petrels which frequent trawling grounds has increased during the last 20 years. Abernethy never recorded more than 8 birds together in 1956-1957 whereas I often counted 30 birds coming in to gutting in 1966. More recently (May 1968) several hundred birds have been seen together in central Cook Strait (Bartle unpubl.), while Secker (1969) did not record any there before 1965. These observations suggest that either the species is extending its range, or that the total population is increasing (or both). On the other hand, the apparent increase in the numbers of Westland Black Petrels on the trawling grounds may reflect an increasing dependence on offal for food.

The possibility of such a change occurring in a petrel population was shown by Fisher (1952) who described how the Fulmar *(Fulmarus glacialis)* had greatly increased in the North Atlantic. Fisher attributed this to additional food supplies from the fishing and whaling industries.

Jackson (1958) estimated the total population of Westland Black Petrels on the breeding grounds in 1955 to be between 3000 and 6000 birds. Although the area of the breeding colony has become reduced in recent years my estimate (based on counts and capture-recapture data) of the total population at the colony in 1972 was 6000 to 10,000 birds (Bartle unpubl.). Thus there is some evidence that the total population of Westland Black Petrels has increased perhaps because of the additional food supplies provided by trawlers.

FLESH-FOOTED SHEARWATER *(Puffinus carneipes)*

In summer and early autumn this shearwater is the most abundant of the seabirds which feed on offal from trawlers in Cook Strait. Very few are cast ashore and beach records give no indication of their numbers. Up to 1000 Flesh-footed Shearwaters could be seen following the vessel in March, but by early April numbers were reduced, with fewer than 50 birds coming in to gutting. On 5 May 1966 these shearwaters abruptly disappeared. This hiatus represented the reparture of the species on migration to the North Pacific and no birds were seen after this date.

Cook Strait populations of Flesh-footed Shearwaters are largely confined to the main trawling grounds. Whereas large numbers could be seen off Cape Campbell and north of the Clarence River mouth, few were seen off Cape Palliser and Point Gibson, or in Clifford Bay (only 30 kilometres from Cape Campbell). Banding results suggest that these populations on the trawling grounds were probably mainly non-breeders from colonies in northern New Zealand. Five Flesh-footed Shearwaters banded in Cook Strait have been recovered near breeding colonies in the Bay of Plenty (Kinsky, 1958, 1959). However, nearly 50 birds were recaptured by Abernethy on the fishing grounds where he had banded them (Kinsky 1957, 1958), suggesting a return to the same feeding areas after the trans-equatorial migration.

Flesh-footed Shearwaters are strongly diurnal. They did not follow the *Maimai* when it was under way at night, unlike Cape Pigeons. Only a few birds came in to night gutting and these individuals seemed wary. Some birds fed on the plankton attracted to the sea surface under the ship's lights.

BLACK-BACKED GULL *(Larus dominicanus)*

Black-backed Gulls were rarely seen more than 8 kilometres offshore. Several dozen of these gulls usually accompanied the *Maimai* when fishing in Clifford Bay, off the Clarence River mouth, or near Kaikoura Peninsula. Gulls were rare on the trawling grounds 20 kilometres off Cape Campbell. Norris (1965) also noted their restriction to inshore waters. None were observed in eastern Cook Strait at night, although some follow inter-island rail ferries across the Narrows by night as well as by day.

RED-BILLED GULL *(Larus novaehollandiae scopulinus)*

In the open waters of Cook Strait Red-billed Gulls have a distribution similar to Black-backed Gulls. Red-billed Gulls were, however, usually present in larger numbers and up to 70 were often seen off Kaikoura Peninsula where there is a large breeding colony. A high proportion of the diet of gulls which breed near Kaikoura may be made up of planktonic animals (Mills 1969) captured close inshore, and Red-billed Gulls are less voracious scavengers than Black-backed Gulls. Numbers remained fairly constant throughout autumn, and no mass movements were observed along the coasts.

2. Birds which rarely follow vessels

(a) Seabirds

NORTHERN BLUE PENGUIN *(Eudyptula minor subspecies)*

This penguin has a widespread breeding distribution along the shores of Cook Strait. Scattered birds were recorded close to the coast but were difficult to see except on calm days. A few individuals were observed up to 20 kilometres offshore. No seasonal changes in numbers were noted.

GREY-HEADED MOLLYMAWK *(Diomedea chrysostoma)*

Assessment of the abundance of Grey-headed Mollymawks in Cook Strait by beach records alone would be very misleading. Over many years storm-killed corpses of this species have far outnumbered other mollymawks (Bull & Boeson 1961a, 1961b, 1963; Boeson 1964; Imber 1971) except after the cyclone of April 1968, when none was found (Kinsky 1968). Yet Grey-headed Mollymawks are not common in Cook Strait during autumn, and none was seen from the *Maimai,* or by Norris (1965). This absence of records may be partly caused by the unwillingness of this mollymawk to follow vessels and feed on offal (J. M. Moreland pers. comm.) although these birds regularly feed on galley refuse in other areas (Murphy 1936).

Abernethy (pers. comm.) and Secker (1969) saw small numbers at sea in Cook Strait. Secker recorded Grey-headed Mollymawks most frequently in the areas of tidal turbulence through the Narrows, where they fed in association with prions and shearwaters.

ANTARCTIC PRION *(Pachyptila desolata desolata)*

On the night of 22 March 1966 a bird of this species flew aboard the *Maimai* north of the Clarence River mouth. It was tentatively identified as being a member of the nominate race from Kerguelen Island on the basis of bill shape. The bird was banded and released.

Although *P. desolata alter* is perhaps the most frequently occurring Antarctic Prion in New Zealand waters (P. E. Harper pers. comm.), immature vagrants from the Kerguelen Island population of Antarctic Prions are occasionally found dead on New Zealand beaches (Harper 1972), usually during winter. Several species of prions which breed in the subantarctic zone of the Indian Ocean occur off the New Zealand coast in winter, sometimes in large numbers. During summer and autumn these species are usually absent and the only prions frequently cast ashore are Fairy Prions.

FAIRY PRION *(Pachyptila turtur)*

The Fairy Prion is one of the most common petrels in Cook Strait. Many thousands were often seen, especially on windy days. Prions were encountered throughout the area, but were much more abundant further than 8 kilometres from the coast. Secker (1969) noted this trend and also found that, within the Narrows, prions were largely confined to areas of tidal turbulence. A tendency to feed upwind along areas of tidal turbulence was apparent off the Kaikoura Coast, but prions were not limited to these areas.

Extraordinary short-term variations in abundance occurred over both time and space. It is difficult to detect any relationship between prion numbers and the availability of the planktonic components of their diet in the Cook Strait area (Bartle 1972 and unpubl.). Temporal variations in abundance may occur on an hourly basis and need not follow the tidal cycle as Secker (1969) suggested. Sometimes prions were absent for several days and then thousands would suddenly appear.

These irregular short-term variations in abundance masked long-term trends and no definite seasonal changes were recorded. An impression that Fairy Prions were less common in April and May is contrary to beach patrol evidence for dead Fairy Prions are more frequently picked up after April (Bull & Boeson 1961a, Kinsky 1968, Imber 1971).

Prions do not follow fishing vessels and tended to avoid the *Maimai.* They were very active at night and were often seen flying about on the perimeter of the light cast by the ship. Harper believes that many prions feed at night, and his account of the feeding behaviour of *Pachyptila belcheri* in subantarctic waters (Harper 1972) precisely describes the feeding patterns seen in *P. turtur* in Cook Strait. Unlike *P. belcheri,* Fairy Prions also feed voraciously by day.

BULLER'S SHEARWATER *(Puffinus bulleri)*

Buller's Shearwaters were the most frequently seen seabirds in eastern Cook Strait during autumn. They were distributed evenly throughout the area and it was exceptional to encounter dense flocks as with Fairy Prions or Sooty Shearwaters. Because of these differences in distribution patterns Fairy Prions and Sooty Shearwaters far outnumbered Buller's Shearwaters at times but, over the whole season, the latter species predominated.

These findings show that Secker (1969) was mistaken in describing Buller's Shearwater as a " rare passage migrant " in Cook Strait. But Abernethy (pers. comm.) saw fewer Buller's Shearwaters in Cook Strait between 1956 and 1958, and Jenkins (1947) has recently presented evidence showing that this species has greatly extended its range and abundance in southern coastal waters. Norris (1965) did not see any of these shearwaters south of Cape Palliser in 1962, whereas by 1966 they were often to be seen from the *Maimai* as far south as Banks Peninsula, and individuals now occur regularly in Foveaux Strait (Jenkins 1974).

Buller's Shearwaters breed only on the Poor Knights Islands which lie in subtropical waters off the east coast of northern New Zealand at 35°30'S. They are trans-equatorial migrants, most birds returning to New Zealand waters in early September (Vooren 1972) and leaving in early May. Eggs are laid on the Poor Knights Islands during late November and early December with a peak on 29 November (Bartle unpubl.).

Vast numbers reach northern waters in September and slowly spread down the coasts during October and November (Jenkins 1974). Buller's Shearwaters favour the open waters of the continental shelves and are less common within 2 kilometres of the coast (Bartle unpubl.) or more then 60 kilometres offshore (Jenkins 1974).

The seasonal pattern in Cook Strait shows anomalous features which I have interpreted as reflecting the activity of non-breeding birds. Non-breeding Buller's Shearwaters sometimes spend the summer in the Peru Current (Murphy 1936, P. C. Harper pers. comm.) and the birds which dally in the North Pacific into November (Murphy 1936) must be non-breeders despite their enlarged gonads.

Although I recorded Buller's Shearwaters from the western approaches to Cook Strait in October 1961 and November 1963, in 1956 *the first birds did* not reach Cape Campbell *until* 17 December (F. Abernethy pers. comm.). Numbers increase slowly during summer and a peak of abundance is attained between February and May. Decreased numbers of Buller's Shearwaters in the Bay of Plenty after January are thought to reflect an exodus of non-breeding birds from the area (Vooren 1972). Richdale (1963) showed that the numbers of unemployed Sooty Shearwaters frequenting the nesting grounds were much reduced after February, and an analogous pattern may be expected in *bulleri* which has a similar breeding cycle and a high proportion of unemployed birds on the breeding grounds (Bartle unpubl., C. M. Vooren pers. comm.). Hence the peak in numbers of Buller's Shearwaters in Cook Strait between February and May corresponds with a decline in northern waters and probably represents a southward dispersal of non-breeders.

Buller's Shearwaters remained abundant in Cook Strait until the last week of April and all birds disappeared abruptly on 2 May 1966. Two birds were seen in Clifford Bay on 23 May 1966, nearly 3 weeks after the main departure. Jenkins (1974) has 3 records of birds in northern waters in June, and between June and August at least 16 Buller's Shearwaters have been found dead on New Zealand beaches (Bull & Boeson 1961a, 1961b, 1963; Boeson 1964, Imber 1971). However, some of these corpses may have been dead for many weeks when found.

This evidence suggests that small numbers of Buller's Shearwaters overwinter in New Zealand waters. These could be inexperienced juvenile and non-breeding birds and recent observations (mid-May 1971) show that significant numbers of Buller's Shearwaters continue to visit their breeding grounds in winter (Bartle unpubl.). My conjecture that these are non-breeders whose hormonal cycles have been disrupted by failure to find a nesting site or mate must remain speculative in the absence of a detailed breeding study.

Buller's Shearwaters do not usually follow ships or come in to gutting although there are cases of exceptional behaviour as on 23 May 1966 when birds were feeding on fish offal.

SOOTY SHEARWATER *(Puffinus griseus)*

Sooty Shearwaters were seen throughout the Cook Strait area although, unlike the other shearwaters, they were rarely sighted within 8 kilometres of the coast. In early autumn numbers were highest in the centre of the Strait.

Seasonal patterns of distribution and abundance in this trans-equatorial migrant are different from the other large shearwaters which occur in the area. Whereas the main breeding grounds of Buller's and Flesh-footed Shearwaters are in northern New Zealand, the breeding grounds of the Sooty Shearwater are widespread. Small colonies are found from the Three Kings Islands southwards, but the largest colonies are in Foveaux Strait and in the subantarctic zone. Hence there is a resident population of Sooty Shearwaters in Cook Strait with huge flocks passing through on migration.

In summer and early autumn large numbers could be seen, sometimes in flocks stretching to the horizon, but on most occasions, Buller's Shearwaters outnumbered Sooty Shearwaters by a ratio of about 5:1. In May, however, seemingly endless streams of Sooty Shearwaters pass through Cook Strait, with individuals flying close together and in one direction. These streams may be as narrow as several hundred metres but, in the course of several hours, many thousands of birds will pass.

Richdale (1963) documented the return of Sooty Shearwaters to their breeding grounds in Foveaux Strait in late September. Further north, at Pipinui Point on the western shore of Cook Strait, I found them clearing out burrows two weeks earlier (Bartle unpubl.). Abernethy (pers. comm.) observed groups of up to 50 birds off Kairakau Rocks on 30 August 1956, and those may have been locally breeding birds which had just arrived.

A very different seasonal pattern is evident from observations made on the wintering grounds in the North Pacific. Off the California coast numbers are highest in September, with a peak of abundance south-east of Hawaii during September and October (King 1970). These birds must be non-breeders and, in fact, large numbers of unemployed birds do not appear on the breeding colonies until the onset of egg-laying, in late November (Richdale 1963). The vast numbers of Sooty Shearwaters encountered by Abernethy (pers. comm.) off Kairakau Rocks on 3 October 1956 may have been non-breeders passing southwards to the nesting grounds.

According to Richdale, unemployed birds leave New Zealand waters in early April, with most of the breeding birds following later in the month. By the end of the first week in May nearly all chicks have left their burrows (Richdale). A peak in the number of Sooty Shearwaters south-east of Hawaii in March (King 1970) may represent the early arrival of the unemployed birds. Therefore it appears that migratory behaviour changes with age and breeding status and this explains some of the variations in abundance at sea.

The numbers of Sooty Shearwaters in Cook Strait remained relatively constant until 29 April 1966. All birds seen prior to this date had the worn brown plumage characteristic of adults nearing the end of their breeding cycle, in contrast to the sooty black of the newly fledged young. During the next 10 days numbers of Sooty Shearwaters decreased until they were almost entirely absent. This decline probably represented the departure of the locally breeding adults. On 9 May the first dark-plumaged juveniles appeared and numbers built up rapidly until 12 May when thousands of juveniles migrating from their southern nesting grounds passed through Cook Strait.

None was seen after this date except for a few birds which came in to gutting on 21 and 23 May 1966. As in the case of Buller's Shearwater, I believe that these were probably overwintering non-breeders. Ninety-eight Sooty Shearwaters have been found on New Zealand beaches between June and August (Bull & Boeson 1961a, 1961b, 1963; Boeson 1964; Imber 1971).

Sooty Shearwaters are not normally attracted to fishing boats, but during the autumn migration up to 6 birds at a time came in to gutting. They fed voraciously on fish offal and followed the *Maimai* for many hours. Most (but not all) of these birds were juveniles.

FLUTTERING SHEARWATER *(Puffinus gavia)*

Fluttering Shearwaters are abundant in Cook Strait and storm-killed specimens may be found at nearly all times of the year. The species breeds on several islands in the Strait and most of the birds seen at sea probably nest locally (Oliver 1955).

It proved to be impossible to differentiate *P. gavia* from the closely related *P. huttoni*. Although *gavia* and *huttoni* are said to be distinguishable at sea under good conditions these small shearwaters tended to avoid the *Maimai* and never fed on fish offal. I have grouped records of these shearwaters into a single category referred to as "*gavia/huttoni*" but fear that this method of lumping observations has concealed differences in behaviour.

Nearly all sightings of "*gavia/huttoni*" were made within 5 kilometres of the shore. Both Norris (1965) and Secker (1969) commented on the inshore distribution of Fluttering Shearwaters in Cook Strait. *P.* "*gavia/huttoni*" were much more common in the

Narrows than off the exposed Kaikoura Coast which supports Secker's contention that Fluttering Shearwaters favour inlets and bays rather than the open sea.

Fewer "*gavia/huttoni*" were seen in Cook Strait during late summer and early autumn, in accordance with Secker's observations and beach patrol evidence. During April and May "*gavia/huttoni*" were recorded particularly frequently because the *Maimai* spent relatively more time fishing within 8 kilometres of the coast.

HUTTON'S SHEARWATER *(Puffinus huttoni)*

Hutton's Shearwater breeds at an altitude of more than 1200 metres in the Seaward Kaikoura Range. Six young Hutton's Shearwaters were attracted by the ship's lights and flew aboard the *Maimai* on dark misty nights (22-24 March 1966) as we were trawling off the Waima River, 65 kilometres north of the main breeding colony. These birds had apparently flown straight from the nest as they still bore some down. Young birds fresh from their burrows are regularly attracted on board the inter-island ferries as they pass along the Kaikoura Coast (Falla *et al.* 1966).

WHITE-FACED STORM PETREL *(Pelagodroma marina maoriana)*

This species is very rarely seen at sea in eastern Cook Strait despite the presence of breeding colonies on Sentinel Rock and Motunau Island. Few specimens are washed ashore and no White-faced Storm Petrels were picked up after the cyclone of April 1968 (Kinsky 1968). None was seen in the area by Norris (1965), Secker (1969), or from the *Maimai,* although Abernethy (pers. comm.) saw the occasional bird. White-faced Storm Petrels generally feed well out to sea (Richdale 1965), especially after the chicks hatch in late November (Vooren 1972). The species is absent from coastal waters after the end of the breeding season in February (Falla *et al.* 1966, Vooren 1972).

NORTHERN DIVING PETREL *(Pelecanoides urinatrix urinatrix)*

There are sizeable Diving Petrel colonies on several islands at the western entrance to Cook Strait and this species can usually be seen over the tide rips nearby. Inshore waters close to the breeding grounds are favoured and few birds fly south through the Narrows into eastern Cook Strait. None was recorded by Secker (1969) during 24 crossings of the Narrows, yet they are common around The Brothers islands only 17 kilometres to the north.

One Diving Petrel was seen from the *Maimai* in Clifford Bay and Abernethy (pers. comm.) saw scattered flocks in eastern Cook Strait in spring and summer. Only one specimen was found on the southern coast of the North Island after the cyclone in April 1968 (Kinsky 1968) reflecting the rarity of this species in eastern Cook Strait during autumn.

AUSTRALIAN GANNET *(Sula bassana serrator)*

Large numbers of gannets nest at Cape Kidnappers, north of Kairakau Rocks. They are very common off the east coast of the North Island in autumn and many fly westwards through Cook Strait into the Tasman Sea. There are no breeding colonies off the east coast between Cape Kidnappers and The Nuggets (Otago) and gannets are rare in the cooler waters of the Southland Current between Cape Palliser and Banks Peninsula. None was seen off the Kaikoura Coast in autumn although Abernethy (pers. comm.) has a few records from Cape Campbell.

Gannets are essentially birds of inshore waters and fly very close to the rocky shores of the Wellington and Wairarapa Coasts. Few birds are seen more than 3 kilometres from the coast-line.

SKUAS (*Stercorarius* species)

Three skuas occur in Cook Strait. Arctic Skuas *(S. parasiticus)* are regularly seen in summer and Pomarine Skuas *(S. pomarinus)* have also been recorded (Heather 1972). The Southern Skua *(S. skua lonnbergi)* is seen less frequently than the Arctic Skua.

All three species are more often associated with the warm D'Urville Current than with the Southland Current. I have seen Arctic Skuas and Southern Skuas on many occasions north of the Narrows, but skuas were recorded only once from the *Maimai,* when a pair of Arctic Skuas were seen in Clifford Bay on 9 May 1966. Abernethy (pers. comm.) also found skuas to be relatively rare in eastern Cook Strait.

WHITE-FRONTED TERN *(Sterna striata)*

This common and widespread coastal species is rarely recorded offshore although small flocks can sometimes be seen as far out as the Cape Campbell trawling grounds (15-25 kilometres offshore).

(b) Land birds

SOUTH ISLAND FANTAIL *(Rhipidura f. fuliginosa)*

On 24 March 1966 a fantail flew on board the *Maimai* 8 kilometres off the Waima River mouth. The *Maimai* was surrounded by dense sea mist at the time. At first the fantail was disorientated, but it proceeded to catch small winged insects in the scuppers and showed no inclination to leave. About 7 hours after the fantail had joined the vessel the mist dispersed and the bird departed towards the shore, flying strongly.

SILVEREYE *(Zosterops l. lateralis)*

Silvereyes have colonized many outlying islands and now occur widely in the New Zealand subantarctic zone (OSNZ 1970). Individual birds and small flocks were often seen in the rigging of the *Maimai* when we were within 5 kilometres of the coast. Unlike the fantail, Silvereyes never stayed on board for more than a few minutes. Silvereyes were usually seen on board in misty weather, but this was not invariable. Sometimes small passerines, probably of this species, were seen by the ship's lights at night.

GENERAL ASPECTS OF BEHAVIOUR AND DISTRIBUTION

1. Changes in numbers of petrels during autumn

Of the 21 species and subspecies of Procellariiformes seen in eastern Cook Strait during autumn, 11 breed in the subantarctic region and 10 breed either locally or in northern New Zealand. The autumn seabird communities are dominated by large numbers of unemployed migratory shearwaters which nest outside the area. The most striking seasonal change occurs when these shearwaters leave in early May and are replaced by petrels from the subantarctic zones of the South-West Pacific and Indian Oceans. A visual indication of this transition can be obtained from Fig. 3, which shows the seasonal variation for 6 selected summer-breeding species. Three of these nest in the subantarctic zone and overwinter in coastal waters and the others are shearwaters which breed in New Zealand and migrate to the North Pacific during the southern winter. Daily changes in numbers are not plotted and the diagrams are smoothed to emphasize overall trends. Although the changes in abundance are shown relative to the highest numbers of each species, the various widths of the kite diagrams are not comparable between species. For instance, never more than 8 Buller's Mollymawks were seen together, yet the maximum width of the diagram for Sooty Shearwater abundance represents more than 10,000 birds per day.

Taniguchi & Nishizawa (1971) found that the seasonal peak of primary productivity occurs at different times in the mixed subantarctic and subtropical water where they meet east of Cook Strait. Primary productivity in mixed subantarctic water is three times greater in summer, but the primary productivity of subtropical water is highest in winter. The life cycles of some planktonic organisms on which petrels feed in Cook Strait are adjusted to produce maximum abundance following these phytoplankton peaks (Bartle 1972). This suggests that the shearwaters which breed in subtropical waters during summer can maximize their use of food resources by concentrating in cooler waters during autumn. Petrels which breed in subantarctic waters in summer achieve similar efficiency by moving into subtropical waters during winter to reach a peak there in early spring. Nevertheless attempts at relating petrel abundance to plankton biomass (Jespersen 1929, Bailey 1966) can be very misleading in the absence of detailed information on seabird diets and the specific composition of plankton. Peaks of plankton biomass in the upper 200 metres of the sea are often caused by the prevalence of species unavailable as food for petrels.

Trawling provides food for seabirds in areas where they might otherwise face starvation. Seasonal changes in the distribution of seabirds which feed on offal need not be related to the abundance of pelagic organisms. Among the species attracted to trawlers the

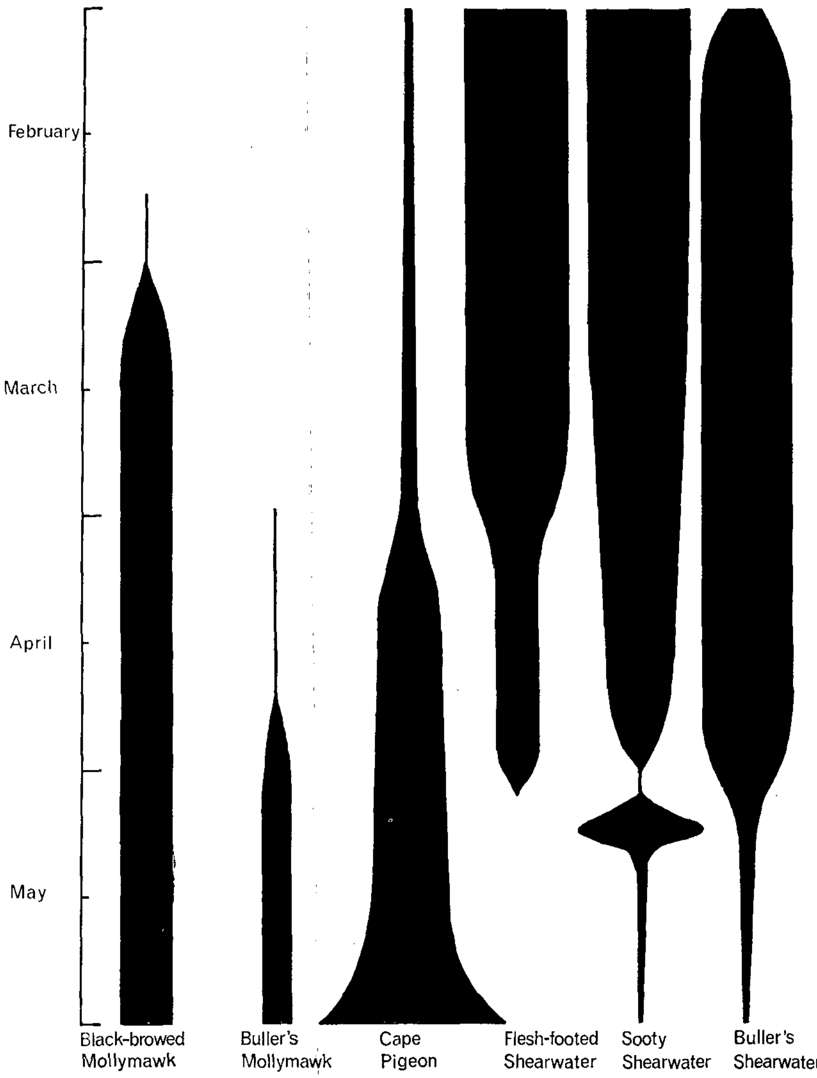

FIGURE 3 — Seasonal changes in numbers of some Cook Strait Procellariiformes.

most noticeable change occurs in the abundance of Flesh-footed Shearwaters and Cape Pigeons. Flesh-footed Shearwaters are very common until their departure in early May whereas moderate numbers of Cape Pigeons appear in mid-April and the full size of the overwintering population is not reached until June.

2. *Distribution and behaviour of petrels which do not usually follow ships*

The distribution and abundance of petrels which feed mainly on pelagic organisms showed wide variations within the limited area of eastern Cook Strait. Wind seemed to be the proximate factor governing the pattern of distribution in coastal waters. Moderate winds are needed so that petrels can obtain enough lift from the updraughts caused by waves to reach the airspeeds necessary for gliding flight (Jameson 1958). Large numbers of Sooty and Buller's Shearwaters as well as Fairy Prions were very rarely seen in calm weather although strong winds did not always lead to their reappearance. On calm days in the Hauraki Gulf rafts of petrels are often seen resting on the sea surface. However, rafting behaviour was rare in Cook Strait and on windless days the petrels must feed elsewhere.

Throughout New Zealand coastal waters a constant pattern of inshore and offshore seabird communities is evident. The inshore belt, extending from the coast to 8 kilometres offshore, is characterised by the presence of Fluttering Shearwaters and Diving Petrels. Blue Penguins, gulls, terns and gannets are almost entirely confined to this region. The offshore belt, which extends further than 8 kilometres offshore, is characterised by Fairy Prions and Sooty Shearwaters. Buller's Shearwaters occur throughout both zones.

3. *Behaviour and abundance of offal-feeding species*

Enormous numbers of seabirds may be attracted to a trawler if it is the only one working the grounds. For instance, at morning gutting on 28 March 1966 about 2,150 Procellariiformes of 11 varieties were counted nearby. These included 800 White-capped Mollymawks, 300 Salvin's Mollymawks, and about 1000 Flesh-footed Shearwaters. Later in the season when the number of mollymawks and Flesh-footed Shearwaters had declined, Abernethy recorded up to 1000 Cape Pigeons following his vessel.

These birds can differentiate between a trawler and a coaster of similar size. If the trawler while on passage passed a coaster close by, birds would detach themselves from the coaster and follow the trawler in increased numbers.

When the net is being hauled, the birds invariably congregate on the starboard side where the cod-end will come up. This is almost always the windward side, but when there was no wind scavenging seabirds still clustered off the starboard side of the *Maimai* showing that they can differentiate between the bow and stern of a stationary trawler. Although expectant seabirds will gather to starboard even when no net is being hauled, the clatter of the winch always caused a rapid increase in the number of scavengers by the ship's side.

Because a relatively constant amount of fish refuse is discharged throughout the year, the seasonal variability of food for offal-feeding species is much less than for species which feed wholly on pelagic organisms. This has wide implications for the population dynamics of offal-feeding species and may explain the rarity with which Flesh-footed Shearwaters, Cape Pigeons, Westland Black Petrels and albatrosses are cast ashore on beaches when compared with the abundance of storm-killed pelagic feeding shearwaters and prions. The highest rates of mortality occur among the immature non-breeders (Serventy *et al.* 1971). Yet it is this age group of offal-feeding species which is conspicuously abundant around trawlers in Cook Strait during late autumn, and these birds may thus build up food reserves which enable them to withstand the storms which kill many thousands of pelagic-feeding seabirds of similar age in winter. Hence the value of beach mortality records as indicators of the birds present at sea is limited.

Variations in the activity of offal-feeding petrels cannot be correlated with the number of fishing vessels at sea or with the weather but seem part of a rhythm caused by overeating when food is available, followed by periods of abstinence.

Before the advent of whaling and fishing all petrels must have fed almost entirely on pelagic organisms. Some species quickly adapted their behaviour to gain maximum advantage from these new sources of food. If one assumes that the abundance of petrels is ultimately limited by food, it seems that albatrosses, Nellies, Cape Pigeons and Flesh-footed Shearwaters must have increased in numbers. Other species may be in intermediate stages of behavioural adaptation. The Westland Black Petrel, for instance, normally feeds intensively on fish offal, but would often glide past the ship, taking no interest in gutting. This species seemed especially shy in early autumn and preferred to feed on the plankton under the ship's light rather than the fish offal nearby. Perhaps Sooty Shearwaters, which occasionally come in to gutting, will become increasingly dependent on this source of additional food.

Among the offal-feeding species at the ship's side there is much squabbling over the ample food supply, which is such that many times the present population of offal-feeding species could be supported were it not for the wastage. Nevertheless, it is interesting to note that the peck-order is based solely on size, the larger species obtaining preference. It seems likely with the reduction of fish waste at sea and the introduction of factory trawlers that the first offal-feeding petrels to suffer will be the smallest.

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Mr J. A. Bartle,
37 Sefton Street,
Wadestown,
Wellington 1