Migrations and movements of birds to New Zealand and surrounding seas

Compiled by
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Cover: A flock of waders wheels over the sand at Farewell Spit, on the northern tip of the South Island, New Zealand. *Crown copyright: Department of Conservation Te Papa Atawhai (1978). Photographer: Dick Veitch*

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ABSTRACT

Natural range, migration routes (if any), New Zealand distribution and abundance, and movements have been reviewed for all migrant and vagrant birds recorded in New Zealand. Up to about 200 000 arctic-breeding waders make summer landfall in New Zealand annually. Seabirds breeding on New Zealand's offshore islands and subantarctic archipelagos, and dispersing annually within Pacific waters, number millions. Among other migrant birds, c. 30 000 New Zealand-born fledgling gannets and white-fronted terns cross the Tasman Sea annually, along with similar numbers of South Island-breeding banded dotterels; in addition, unknown thousands of two cuckoo species migrate annually between New Zealand forests and islands in the tropical southwestern Pacific, and straggling individuals of many species making landfall or reaching New Zealand's coastal waters may well number thousands each year. Altogether 44 foreign-breeding species arrive annually, and 32 New Zealand-breeding species depart annually on extensive journeys before returning to breed. A further 80 species have breeding populations both in New Zealand and elsewhere (mostly Australia). Those species regularly reaching New Zealand in large numbers, or which journey away from New Zealand on annual pilgrimages, are almost exclusively coastal or oceanic inhabitants, and almost all migrant birds come via Australia. For waterfowl, New Zealand is not on any migration pathway, and New Zealand's waterfowl population is isolated from all others, except occasional Australian vagrants. Southeastern Australia is the most likely source of most vagrant birds recorded in New Zealand and is also the winter haunt of three New Zealand-breeding species. Influxes of Australian vagrants generally occur during severe drought in central and southern Australia. Significant opportunities for interaction, and possible disease transmission, between migrants/vagrants and resident birds on the New Zealand mainland or at sea/on islands are: visits by vagrant seabirds to New Zealand-breeding colonies of the same or related species; co-occurrence of migratory and resident individuals of white-fronted terns, gannets, and banded dotterels at summer breeding sites or at pre-migratory assemblies; migrant cuckoos and their host species in forest habitats; and co-occurrence of migrant waders with indigenous waders and other waterbirds at estuaries (and selected coastal lakes). Sites of particular abundance, or which are potential disease sampling sites, for these species are identified.

Keywords: birds, waders, seabirds, dotterels, cuckoos, migrants, vagrants, species interaction, Arctic, east Asia, Pacific, Australia, New Zealand

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1. Introduction

Despite its geographic isolation, New Zealand is a seasonal destination for Northern Hemisphere-breeding birds, a breeding site of both land and sea birds that migrate away during the austral winter, and a welcome landfall for a plethora of species straggling beyond their normal ranges.

The scale of bird movements to and from New Zealand is considerable. Between 100 000 and 200 000 arctic-breeding waders make summer landfall annually (Sagar et al. 1999). Seabirds breeding on New Zealand's offshore islands and subantarctic archipelagos, and dispersing annually over oceanic waters, number millions (Taylor 2000a, b). Up to 30 000 fledglings of two coastal seabirds which breed on mainland New Zealand cross the Tasman Sea annually (Marchant & Higgins 1990a), along with similar numbers of an indigenous inland-breeding wader (Pierce 1999). Unknown thousands of two cuckoo species traverse annually between New Zealand forests and islands in the tropical southwestern Pacific. Finally, straggling individuals making landfall or reaching New Zealand's coastal waters, may well number thousands each year.

Equally substantial is the diversity of species involved in these annual or irregular movements. Although three taxonomic groupings dominate—waterfowl, waders, and petrels—members of 13 bird families arrive in New Zealand annually, or with regularity. Our review has identified 44 foreign-breeding species arriving annually, and irregular occurrences in New Zealand of a further 110 species. Thirty-two New Zealand-breeding species depart annually on extensive journeys to overseas waters or lands before returning again to breed. These are the species whose journeys are detectable; for 80 species with breeding populations in New Zealand and elsewhere, the arrivals of immigrants are undetectable unless those individuals carry markers to indicate their origin.

Those species regularly reaching New Zealand in large numbers, or which journey away from New Zealand on annual pilgrimages, are almost exclusively coastal or oceanic inhabitants. The most abundant annual immigrants, arctic-breeding waders, confine their presence in New Zealand to estuaries, and to a much lesser extent, coastal lakes. The most abundant New Zealand-breeding migrants, seabirds, are almost all occupants of the oceans and (seasonally) oceanic islands and rarely reach New Zealand's mainland, or other lands, except as beach wrecks. The significant exceptions are two New Zealand coastal-breeding seabirds (gannet, white-fronted tern) that undertake annual trans-Tasman movements to Australian coasts, South Island inland-breeding banded dotterels that over-winter in southeast Australia, and the two cuckoos. It is mostly the unpredictable vagrants (those arriving unexpectedly having strayed well beyond their normal range, often a consequence of storm conditions) and stragglers (birds that have simply over-flown their normal range) that are the conspicuous and scattered arrivals to the pastoral and urban landscapes of New Zealand's main islands.

Substantial annual movements are not solely the characteristic of species that range internationally. Most New Zealand-breeding species demonstrate some degree of post-breeding dispersal (especially by newly-fledged young), some

disperse to follow seasonally-available foods at widely-spaced locations (e.g. kereru and some honey-eaters from forests to rural and urban habitats, swans from freshwater lakes to estuaries), while others (e.g. gulls and waders) follow well-defined seasonal migrations from key breeding sites to wintering sites. These are as predictable and regular as the migrations of international migrants. While the co-occurrence of migrant and indigenous waders is restricted to coastal and estuarine sites, and occasionally to coastal lakes, banded dotterels, pied stilts and South Island pied oystercatchers disperse well inland to breed in (predominantly) pastoral landscapes, and wrybills breed inland on the beds of some South Island braided rivers, thereby providing a pathway for disease transmission away from the coast.

In the context of disease transmission, all movements and any resulting habitat overlaps are important, because they offer links and pathways connecting indigenous species and international migrants.

1.1 REVIEW CONTENT

In this review, we have followed a brief which requested:

1. Documentation of the species and numbers (annually and seasonally) of birds (waders, waterfowl, seabirds, other migrants, e.g. cuckoo, herons, egrets) that arrive in New Zealand, including:
   - Origins of migratory birds
   - Migratory routes, stopover sites, feeding and breeding habitats in the New Zealand archipelago
   - Frequency and timing of migration, favoured sites within New Zealand
2. Identification of potential habitat overlaps (temporally and spatially) of migratory birds (waders, waterfowl, seabirds, others) with endemic species, specifically:
   - Any significant congregating sites for waterfowl
   - Location of seabirds while outside New Zealand (i.e. at sea or on land), main nesting colonies in New Zealand, and movements between colonies in New Zealand
   - A review of the links between breeding and wintering sites of indigenous wading bird species

While this inevitably highlights species reaching New Zealand from other lands, we have documented the movements within New Zealand of resident species undertaking conspicuous seasonal travels to and from sites where they can co-occur with the international migrants. The seasonal movements and sites of special abundance of the indigenous waders are presented in a separate report (Dowding & Moore 2006).

As requested, we present data for the species covered by our review in four sections—waders, waterfowl, seabirds, and others. We provide an overview of each group and then highlight the sites around New Zealand at which migratory species are most abundant soon after their arrival and during their time in New Zealand. We have also attempted to highlight pathways of interaction between resident and migratory species, and indicate key locations where this interaction commences, or is most extensive.

2. Waders

Species of waders or shorebirds (Order Charadriiformes) are conspicuous annual migrants to and from New Zealand. One species (banded dotterel) breeds in New Zealand and the majority of its population winters in southeastern Australia (Pierce 1999). The rest of the migrant waders reaching New Zealand undertake trans-equatorial migration from high-latitude breeding grounds of the Northern Hemisphere to estuarine sites in the tropics and temperate Southern Hemisphere, where they spend most of the austral summer.

New Zealand lies at the southern end of the East Asian–Australasian flyway for waders (source: www.tasweb.com.au/awsg/eafw.htm). In the last 15 years, migration routes and important stopover sites of waders using this flyway have been discerned from banding studies conducted by the Australasian Wader Study Group, and, in the Auckland area, by the New Zealand Wader Study Group. These groups have now captured many thousands of waders and marked them with uniquely numbered metal leg-bands; many have also had location-specific coloured plastic leg-flags and/or leg-bands attached (e.g. white in New Zealand, yellow in Victoria, orange in northwestern Australia). Recoveries of banded birds (either captured alive or found dead) has allowed movements of individuals to be determined while sightings of leg-flags or leg-bands have established linkages between banding site and subsequent stopover, breeding or wintering sites.[1]

Banded dotterels migrate from New Zealand breeding sites to Australia. Alaskan-breeding bar-tailed godwits are believed to reach New Zealand in a single direct 12 000 km flight across the Pacific (Reigen 1999; Minton et al. 2001) while Pacific golden plovers, turnstones, pectoral sandpipers, Hudsonian godwits, and wandering tattlers appear to arrive via a broader front through islands in the central and southern Pacific. Fifteen other species reaching New Zealand annually (see Table 1A) arrive via the East Asian–Australasian migration route, having bred on the steppes of central and northeastern Asia, and the tundra of Siberia and Alaska. Most move down the eastern coast of Asia to southeast Asia and Australasia, with 1–3 stops en route. A further six species (Table 1C) following the East Asian–Australasian migration route have been recorded regularly, but not annually. The southward migration route and principal stopover areas for lesser knots and bar-tailed godwits are shown in fig. 1 of Reigen (1999). Northern Australia is a key stopover for all birds moving down through Asia en route to New Zealand. Four species (Table 1B) breed in both Australia and New Zealand, and incursions of new birds from Australia would not be detectable by direct observation.

Twenty-three further species occur in New Zealand only as very rare vagrants or stragglers (Table 1D). Three are of Australian origin, the remainder breed in the Northern Hemisphere either across the Arctic (four species), in Asia only (five species) or in North America only (10 species). While the Asian species generally follow the East Asian–Australasian flyway, the North American species

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[1] Findings arising from these studies, in both interim and final form, are regularly published in the journal *Stilt* and newsletter *The Tattler* (the latter can be sourced from www.tasweb.com.au).

migrate south along the Pacific coastline, except for bristle-thighed curlew, which moves to Pacific islands.

Lesser (red) knot, numbering 45 000–70 000 annually, and bar-tailed godwit (85 000–110 000) are the most numerous of the species reaching New Zealand (Sagar et al. 1999)—the former sourced from the Siberian arctic and the latter mostly from Alaska. Together they constitute > 90% of each summer's immigrant waders (Sagar et al. 1999). Many bar-tailed godwits fly directly to New Zealand from Alaska, but some follow the same route as lesser knots, south to New Zealand along the Asian coast (Reigen 1999: fig. 1). They appear to include only two stopovers before they reach northern Australia: namely the southwestern shores of the Sea of Okhotsk and the Korean flank of the Yellow Sea (Reigen 1999; Minton et al. 2001). Present understanding is that—Alaskan godwits apart (Reigen 1999)—almost all Arctic waders en route to New Zealand stopover in northern Australia before proceeding either direct to New Zealand or via estuaries along the southeast Australian coast (Lane 1987).

2.1 TIMING OF ARRIVAL IN NEW ZEALAND

Members of the Ornithological Society of New Zealand, the New Zealand Wader Study Group, and the Miranda Naturalists' Trust, have made considerable efforts to document the migrant species reaching New Zealand, their numbers, and their distribution (see *Notornis 46(1)* 1999), but confirmation of exact timing of arrival has proved elusive. The main difficulty in determining arrival times lies in identifying migrant birds that have just arrived in the country from those that have overwintered. Typically, 10 000–25 000 waders (7–18% of the austral summer population) remain in New Zealand for the austral winter; these are probably mainly sub-adult birds and a few adults that chose not to make the 12 000 km journey back to their breeding grounds in a particular year. Another difficulty, especially at smaller estuaries (where it is easier to count total numbers), is distinguishing migrant birds that have just arrived in the country from those that arrived at another site within New Zealand, fed and recovered from the rigours of the flight, and then moved on. Thus, the interpretation of spring–early summer changes in wader numbers at single estuaries (e.g. Firth of Thames—Veitch 1999; Manukau—McKenzie 1967; Nelson estuaries—Hawkins 1980; Owen & Sell 1985) remains problematic.

The timing of arrival probably varies from species to species, and will depend on factors such as the timing of their breeding season (which may be affected by timing of snow-melt in the previous northern spring), breeding cycle, migration route, and tide and weather conditions at stopover sites. At stopover sites, waders will wait for favourable weather to provide tail-winds for the next leg of the journey. Other factors, e.g. disturbance by people or birds of prey at stopover sites, can affect the rate of fat deposition and hence affect the timing of onward movement.

The present consensus view is that most migrants arrive in New Zealand in small groups over a wide period in the spring and early summer. The initial influx of knots is in mid-September, while that for godwits is early October (Robertson & Heather 1999; Veitch 1999). The peak of the migratory wader population in New Zealand is reached in December–January (Sagar et al. 1999).

Departures have proved easier to monitor because, as the time for departure draws closer, birds feed more voraciously to accumulate fat deposits (adding as much as 70% to their lean weight) to fuel their migration, and they also become more restless. It is also relatively easy to witness the departure of a flock of waders, preceded by the roosting birds calling and then separating themselves from roosting flocks, before flying off in a typical V-formation towards the open ocean. Again, it is sometimes difficult to distinguish between international migration and internal movements to sites further north or west, or shifts of birds to major estuaries to join up with others physiologically ready to migrate.

Most migrant waders leave New Zealand in small, usually single-species flocks from late February to early April. It is presumed that some of the rarer waders attach themselves to departing flocks of more numerous species, but this has not been documented.

2.2 HABITATS OCCUPIED IN NEW ZEALAND

Typically, migrant waders feed in the intertidal zone of estuaries and harbours, or on the shores of coastal lagoons and large shallow wetlands; a few species feed in the intertidal zone of rocky shores. Apart from banded dotterels—the majority of which migrate to Australia for the winter (Pierce 1999)—very few migrant waders are seen beyond the coastal edge; i.e. on braided river beds, on shores of inland lakes, or on inland grassland.

At high tides, waders tend to congregate in flocks at regularly used roosts, mainly on shellbanks, sandbanks, or sandspits. Most species will roost on marsh-turf, *Salicornia* flats, pasture, or on ploughed paddocks if no other suitable roosts are handy, or when disturbed from traditional coastal roosts. At roosts, migrant species intermingle, and any native waders present will join them.

2.3 MOVEMENTS WITHIN NEW ZEALAND

Apart from a very detailed Ornithological Society of New Zealand study of the region-specific movements within and beyond New Zealand of banded dotterels that have been colour-banded (Pierce 1999), little information is available about the movements of migrant waders within the country. **This is the single largest gap in present understanding of wader ecology in New Zealand.** There is circumstantial evidence, from monthly counts at a number of estuaries (e.g. Hawkins 1980; Veitch 1999), that some migrants move from one estuary to another after reaching New Zealand, but how far and how frequently remains unknown. These same counts suggest a general trend for birds to move south after initial arrival in spring, and then to move north in summer or early autumn to congregate at northern harbours before departing. It will require either individual waders to be colour-banded or leg-flagged, or for them to be radio-tagged, to be able to identify the amount, direction, and seasonal pattern of internal movements.

The range of species reaching New Zealand during the austral summer, their regularity of occurrence, and their abundance are presented in Table 1.

TABLE 1. SPECIES OF WADERS (ORDER CHARADRIIFORMES) REACHING NEW ZEALAND AS ANNUAL OR OCCASIONAL MIGRANTS, OR AS VAGRANTS.

COMMON NAME	SCIENTIFIC NAME	ABUNDANCE* AND LIKELY SOURCE
A. Migrants—annual occurrence in New Zealand		
Banded dotterel	*Charadrius bicinctus*	Abundant, Trans-Tasman
Large sand dotterel	*Charadrius leschenaultii*	Uncommon, Asia
Mongolian dotterel	*Charadrius mongolus*	Uncommon, Asian Arctic
Pacific golden plover	*Pluvialis fulva*	Common, Arctic
Grey plover	*Pluvialis squatarola*	Uncommon, Arctic
Turnstone	*Arenaria interpres*	Abundant, Arctic
Lesser knot	*Calidris canutus*	Abundant, Arctic
Great knot	*Calidris tenuirostris*	Uncommon, Asian Arctic
Curlew sandpiper	*Calidris ferruginea*	Uncommon, Asian Arctic
Sharp-tailed sandpiper	*Calidris acuminata*	Uncommon, Asian Arctic
Pectoral sandpiper	*Calidris melanotos*	Uncommon, Siberia/Alaska
Red-necked stint	*Calidris ruficollis*	Common, Arctic Siberia
Eastern curlew	*Numenius madagascariensis*	Uncommon, Asia
Whimbrel	*Numenius phaeopus*	Uncommon, Arctic
Bar-tailed godwit	*Limosa lapponica*	Abundant, Arctic Alaska
Black-tailed godwit	*Limosa limosa*	Uncommon, Arctic Siberia
Hudsonian godwit	*Limosa haemastica*	Uncommon, Arctic Alaska
Siberian tattler	*Tringa brevipes*	Uncommon, Asian Arctic
Wandering tattler	*Tringa incana*	Uncommon, Arctic
Greenshank	*Tringa nebularia*	Uncommon, Asian Arctic
Marsh sandpiper	*Tringa stagnatilis*	Uncommon, Eurasia
Terek sandpiper	*Tringa terek*	Uncommon, Asian Arctic
B. Vagrants—not detectable in New Zealand among resident population		
Pied oystercatcher	*Haematopus ostralegus*	Australia
Pied stilt	*Himantopus himantopus*	Australia
Black-fronted dotterel	*Charadrius melanops*	Australia
Spur-winged plover	*Vanellus miles*	Australia
C. Migrants—not annually occurring in New Zealand		
Oriental pratincole	*Glareola maldivarum*	Rare, Asia
Japanese snipe	*Gallinago hardwickii*	Rare, Asia
Sanderling	*Calidris alba*	Rare, Asian Arctic
Broad-billed sandpiper	*Limicola falcinellus*	Rare, Asian Arctic
Little whimbrel	*Numenius minutus*	Rare, Asian Arctic
Common sandpiper	*Tringa hypoleucos*	Rare, Asian Arctic
D. Vagrants—detectable in New Zealand		
Painted snipe	*Rostratula benghalensis*	Australia
Australian red-necked avocet	*Recurvirostra novaehollandiae*	Australia
Red-capped dotterel	*Charadrius ruficapillus*	Australia
Ringed plover	*Charadrius hiaticula*	Arctic
Oriental dotterel	*Charadrius veredus*	Asia
Red-kneed dotterel	*Erythrogonys cinctus*	Australia
American golden plover	*Pluvialis dominica*	American Arctic
Dunlin	*Calidris alpina*	Arctic
Baird's sandpiper	*Calidris bairdii*	American Arctic
White-rumped sandpiper	*Calidris fuscicollis*	American Arctic
Little stint	*Calidris minuta*	Asian Arctic
Long-toed stint	*Calidris subminuta*	Asian Arctic
Least sandpiper	*Calidris minutilla*	American Arctic
Western sandpiper	*Calidris mauri*	American Arctic
Ruff	*Philomachus pugnax*	Asian Arctic
Asiatic dowitcher	*Limnodromus semipalmatus*	Asia
Bristle-thighed curlew	*Numenius tahitiensis*	American Arctic
Upland sandpiper	*Bartramia longicauda*	N. America
Stilt sandpiper	*Micropalama himantopus*	N. America
Grey phalarope	*Phalaropus fulicarius*	Arctic
Red-necked phalarope	*Phalaropus lobatus*	Arctic
Lesser yellowlegs	*Tringa flavipes*	N. America
Wilson's phalarope	*Phalaropus tricolor*	N. America

* Abundance listed as 'Rare' (< 50), 'Uncommon' (50–100), 'Common' (100–1000), 'Abundant' (> 1000).

3. Waterfowl

New Zealand is not on any migration pathway for waterfowl (Order Anseriiformes, Family Anatidae—ducks, geese, swans). Extensive and continent-wide seasonal movements of waterfowl are restricted to Northern Hemisphere land masses, where the species involved breed at high latitudes and over-winter in more benign temperate regions north of the equator. There are no regular trans-equatorial movements by waterfowl.

New Zealand's waterfowl population is, by and large, isolated. There is no regular pattern of movement of waterfowl between New Zealand and its nearest neighbour, Australia, nor between New Zealand and islands of the Pacific. However, New Zealand shares many of its native species with Australia, thus providing clear evidence of historic trans-Tasman dispersal. Some species resident in New Zealand are also resident on Chatham Island and the subantarctic islands, also indicative of historic across-sea movements. Such movements undoubtedly still occur, but are only detectable by some sudden influx (e.g. grey teal in 1957, see Marchant & Higgins 1990b), by the bird being banded (e.g. Balham & Miers 1959), by genetic analysis, or by a new colonisation (e.g. mallard to Chatham, Auckland, and Campbell Islands).

Ducks, especially *Anas* species, demonstrate a propensity to disperse across seas and to colonise small isolated islands (Weller 1980), which is a habit of small rails (Rallidae) also (Ripley 1977). Thus, a steady trickle of waterfowl species reaching New Zealand, as singles or as small flocks, can be expected, and does occur. The majority of detected vagrants are Australian species; seven of nine vagrant species recorded in New Zealand over the past 150 years occur only in Australia (Table 2). The two 'Northern Hemisphere' vagrants (northern shoveler, northern pintail), while widespread in North America, Asia, and Europe, also occur on Hawaii and, occasionally, Tahiti, and are mostly likely to have originated from Pacific sources.

Waterfowl are primarily inhabitants of freshwaters. Two endemic species (blue duck, brown teal) have specialised habitat requirements (steep gradient streams/rivers, and swamps and slow-flowing streams, respectively). Two other species (paradise shelduck, Canada goose) are primarily grassland feeders. The principal haunts of the other breeding species are wetlands containing extensive areas of open water. Coastal or lowland lakes of high fertility are places where waterfowl congregate in highest numbers. Only two species, black swan and mallard, regularly occur in estuarine/marine areas, but even there, mallards will not venture far from sources of freshwater. Black swan is the only species that consistently, and in large numbers, co-occurs with migrant waders at estuaries.

Waterfowl generally show two distinct patterns of dispersion/aggregation during their annual cycle. During the spring breeding season (August–November for most species), pairs disperse to occupy small ranges along the margins of large wetlands, or to small and isolated wetland areas (temporary or permanent), where they establish breeding territories. Each species tends to be scattered at low density, with groups often occupying terrain where they are not seen during the rest of the year. The two most common species—paradise shelduck and

mallard—are also most widely dispersed in spring and have the most extensive contact with humans and farm animals at this time. Both are common throughout agricultural land, using any small drain, pond, or temporary wet area as breeding habitat. Both species also use similar habitat on the fringes of urban areas.

Second, after November waterfowl start to aggregate in flocks and, by January, almost all species have profoundly clumped distributions. These large aggregations serve initially as moult gatherings, but they also attract newly-fledged young. By March, these aggregations are at their peak, maintained at least in part by the usual autumnal decline in wetland water levels everywhere. With the exception of black swans, all of these aggregations are on major freshwater or brackish lakes. Black swans also aggregate on selected tidal harbours (especially Farewell Spit, Kaipara, Tauranga, and Awarua Bay) to moult.

As late autumn-winter rains refill wetlands, the waterfowl population disperses more widely but, in general, birds are still aggregated as flocks. The annual hunting season for waterfowl (May–June) also influences distribution and flock size at this time.

Four waterfowl are not included in this review because they are not migrants. The two rarest waterfowl (blue duck, brown teal) are year-round occupants of their breeding areas. Mute swan, are a very rare acclimatised species with a total population which probably does not exceed 200 in the wild, is mostly confined to coastal Canterbury wetlands. Feral farm geese occur as highly sedentary flocks with unrecorded distribution and abundance.

TABLE 2. EXTANT WATERFOWL (DUCKS, GEESE, SWANS) RECORDED IN NEW ZEALAND.
Two endemic flightless species restricted to Auckland and Campbell Islands are not listed.

		COMMON NAME	SCIENTIFIC NAME
Endemic species		Blue duck	*Hymenolaimus malacorhynchos*
		Brown teal	*Anas chlorotis*
		Paradise shelduck	*Tadorna variegata*
		New Zealand scaup	*Aythya novaeseelandiae*
Native species		Grey duck*	*Anas superciliosa*
(shared with Australia)		Australasian shoveler	*Anas rhynchotis*
		Black swan*	*Cygnus atratus*
		Grey teal	*Anas gracilis*
Acclimatised species		Mallard*†	*Anas platyrhynchos*
		Mute swan	*Cygnus olor*
		Canada goose	*Branta canadensis*
		Greylag goose (feral, domestic)	*Anser anser*
Vagrants‡	NH	Northern shoveler	*Anas clypeata*
	NH	Northern pintail	*Anas acuta*
	Au	Cape barren goose	*Cereopis novaehollandiae*
	Au	Plumed whistling duck	*Dendrocygna eytoni*
	Au	Australian wood duck	*Chenonetta jubata*
	Au	Chestnut teal	*Anas castanea*
	Au	White-eyed duck	*Aythya australis*
	Au	Australian shelduck	*Tadorna tadornoides*
	Au	Pink-eared duck	*Malacorhynchos membranaceus*

* Present on Chatham Island.

† Mallard is also acclimatised in southeastern Australia.

‡ NH = Species from the Northern Hemisphere (Asia and North America); Au = from Australia.

4. Pelagic seabirds

Breeding in New Zealand waters (from the Kermadec Islands to Campbell Island) are 65 taxa of Procellariiformes (albatrosses, petrels, and shearwaters) and Sphenisciformes (penguins).

These two orders are composed, primarily, of pelagic seabirds that forage well beyond coastal margins. Mostly, they nest in large colonies, either as single-species clusters (especially penguins) or as mixed associations with other pelagic and non-pelagic seabirds. Both migratory and non-migratory species nest on the same islands, and sometimes different species share the same nests in overlapping seasons or have separate chambers in interconnecting burrow systems. Close physical contact with conspecifics and other seabird species is the norm in these seabird communities.

Twenty-seven taxa are migratory, each with some or all of their population regularly moving from one oceanic zone to another (Table 3). Their migrations, although predominantly confined to the Pacific, extend to almost all oceans of the world except the North Atlantic. A further 32 taxa may be regarded as dispersive; although individuals range over large distances, their movement patterns are too inconsistent to be termed migrations. Only six pelagic taxa (all penguins) are considered to be sedentary, i.e. they do not range beyond New Zealand coastal waters (Table 3).

TABLE 3. MIGRATORY STATUS OF PELAGIC SEABIRDS BREEDING IN NEW ZEALAND.

MIGRATORY STATUS* & GEOGRAPHIC RANGE	BREEDING STATUS†	COMMON NAME	SCIENTIFIC NAME
M–NP	E	Mottled petrel	*Pterodroma inexpectata*
M–NP	E	Pycroft's petrel	*Pterodroma pycrofti*
M–NP	E	Chatham petrel	*Pterodroma axillaris*
M–NP	N	Black-winged petrel	*Pterodroma nigripennis*
M–NP	N	White-naped petrel	*Pterodroma cervicalis*
M–NP	N	Kermadec petrel	*Pterodroma neglecta*
M–NP	N	Wedge-tailed shearwater	*Puffinus pacificus*
M–NP	N	Flesh-footed shearwater	*Puffinus carneipes*
M–NP, EP	E	Cook's petrel	*Pterodroma cookii*
M–NP, EP	E	Buller's shearwater	*Puffinus bulleri*
M–NP, EP	N	Sooty shearwater	*Puffinus griseus*
M–EP	E	Antipodean wandering albatross	*Diomedea antipodensis*
M–EP	E	Chatham albatross	*Thalassarche eremita*
M–EP	E	Northern Buller's (Pacific) albatross	*Thalassarche* nov. sp.
M–EP	E	Southern Buller's albatross	*Thalassarche bulleri*
M–EP	E	Black petrel	*Procellaria parkinsoni*
M–EP	E	Westland petrel	*Procelleria westlandica*
M–EP	E	NZ white-faced storm petrel	*Pelagodroma marina maoriana*
M–EP, SA, SO	N	Salvin's albatross	*Thalassarche salvini*
M–SA, SO	E	Northern royal albatross	*Diomedea sanfordi*

Table continued next page >>

TABLE 3—*Continued.*

MIGRATORY STATUS* & GEOGRAPHIC RANGE	BREEDING STATUS†	COMMON NAME	SCIENTIFIC NAME
M–SA, SO	E	Southern royal albatross	*Diomedea epomophora*
M–SA, SO	E	White-capped albatross	*Thalassarche steadi*
M–TS/A	E	Hutton's shearwater	*Puffinus huttoni*
M–TS/A	E	Fluttering shearwater	*Puffinus gavia*
M–TS/A, SWP	E	Gibson's wandering albatross	*Diomedea gibsoni*
M–TS/A, SWP	E	Campbell albatross	*Thalassarche impavida*
M–SWP	N	Black-bellied storm petrel	*Fregetta tropica*
D–SP	E	Chatham Island taiko	*Pterodroma magentae*
D–SP	E	Grey-faced petrel	*Pterodroma macroptera gouldi*
D–SP	E	Fulmar prion	*Pachyptila c. crassirostris*
D–SP	E	Chatham Island fulmar prion	*Pachyptila crassirostris pyramidalis*
D–SWP	E	Kermadec little shearwater	*Puffinus assimilis kermadecensis*
D–SWP	E	North Island little shearwater	*Puffinus assimilis haurakiensis*
D–SWP	E	Kermadec white-faced storm petrel	*Pelagodroma marina albiclunis*
D–SWP	E	Southern diving petrel	*Pelecanoides urinatrix chathamensis*
D–SWP	N	Northern diving petrel	*Pelecanoides u. urinatrix*
D–SWP	N	White-bellied storm petrel	*Fregetta g. grallaria*
D–SWP, SO	E	Snares Cape pigeon	*Daption capense australe*
D–SWP, SO	E	Snares crested penguin	*Eudyptes robustus*
D–SWP, SO	E	Erect-crested penguin	*Eudyptes sclateri*
D–SWP, SO	E	Fiordland crested penguin	*Eudyptes pachyrhynchus*
D–SWP, SO	N	Broad-billed prion	*Pachyptila vittata*
D–SWP, SO	N	Fairy prion	*Pachyptila turtur*
D–SWP, SO	N	South Georgian diving petrel 'Codfish Island'	*Pelecanoides georgicus*
D–SO	N	Indian yellow-nosed albatross	*Thalassarche carteri*
D–SO	N	Grey-headed albatross	*Thalassarche chrysostoma*
D–SO	N	Black-browed albatross	*Thalassarche melanophrys*
D–SO	N	Light-mantled sooty albatross	*Phoebetria palpebrata*
D–SO	N	Northern giant petrel	*Macronectes halli*
D–SO	N	White-headed petrel	*Pterodroma lessonii*
D–SO	N	Soft-plumaged petrel	*Pterodroma mollis*
D–SO	N	White-chinned petrel	*Procellaria aequinoctialis*
D–SO	N	Grey petrel	*Procellaria cinerea*
D–SO	N	Antarctic prion	*Pachyptila desolata banksi*
D–SO	N	Lesser fulmar prion	*Pachyptila crassirostris eatoni*
D–SO	N	Subantarctic little shearwater	*Puffinus assimilis elegans*
D–SO	N	Grey-backed storm petrel	*Oceanites nereis*
D–SO	N	Subantarctic diving petrel	*Pelecanoides urinatrix exsul*
D–SO	N	Eastern rockhopper penguin	*Eudyptes chrysocome filholi*
S	E	White-flippered penguin	*Eudyptula minor albosignata*
S	E	Chathams little blue penguin	*Eudyptula minor chathamensis*
S	E	Northern little blue penguin	*Eudyptula minor iredalei*
S	E	Southern little blue penguin	*Eudyptula minor minor*
S	E	Cook Strait little blue penguin	*Eudyptula minor variabilis*
S	E	Yellow-eyed penguin	*Megadyptes antipodes*

* Movements are indicated as migratory (M), dispersive (D), or sedentary (S). The geographic range of movements are North Pacific (NP), South Pacific (SP), eastern Pacific (EP), South Atlantic (SA), circum-polar southern ocean (SO), Tasman Sea/Australian coast (TS/A), and southwest Pacific (SWP). Sedentary species (S) remain within the New Zealand continental shelf.

† Breeding status is indicated as endemic (breeding only in New Zealand = E) or native (also breeding elsewhere = N).

Pelagic seabirds are either annual breeders, returning to the colonies each year to nest, or biennial breeders, nesting only in alternate years if they are successful in rearing a chick, although they may nest in successive years if unsuccessful. In addition to the breeders there are large numbers of non-breeders (juveniles, pre-breeding adults, and unpaired former breeders) which may comprise about 50% of the population in the longer-lived species (Warham 1990, 1996). This non-breeding component, and especially birds in their first or second years, may remain in the migration or dispersal zone even when the breeders have returned back to New Zealand waters. During the breeding season, breeders of most species tend to forage over the New Zealand continental shelf or in deeper water of the southwest Pacific. A few species (e.g. southern Buller's albatross—Stahl et al. 1998) may reach the coastal waters of Australia at this time and an Antipodean albatross has been tracked to the South American coast while breeding (Nicholls et al. 1996).

New Zealand's seas are also visited by 39 taxa of seabirds that do not breed locally; 13 of these arrive annually, while the remainder are rare vagrants (Table 4).

On the basis of their non-breeding season dispersion, pelagic seabirds in New Zealand waters fall into four groups with respect to their risks of exposure to, and transmission of, avian diseases.

- **Endemic and native seabirds that spend most of their life at sea and only visit land during the breeding season**—Consisting only of Procellariiformes, birds of this group breed on New Zealand's offshore islands or, in markedly lesser numbers, at mainland colonies. However, they spend the rest of their lives at sea; they feed only in the open ocean, they moult while at sea, they sleep on the sea, and generally never touch land outside of New Zealand. During their adolescent prospecting phase, in the 1–3 years prior to breeding, the young pre-breeders return to their natal, or nearby, colony to court and establish future nest sites. A tiny percentage (< 1%) of individuals may briefly visit more distant colonies before returning to their natal New Zealand colony.
- **Seabirds that spend most of their life at sea but moult on land**—This group consists solely of penguins. They feed and sleep in the open ocean, but come ashore to breed, usually at their site of birth, and to replace their feathers. If the bird cannot return to its natal or breeding site to moult, it will do so on any convenient land.
- **Sedentary pelagic seabirds**—These are all the penguins that breed in New Zealand (Table 3) and feed within coastal and inshore waters. Their movements are local and along the New Zealand coast.
- **Visiting seabirds**—These birds (Table 4) breed in other countries, but spend some part of their life cycle as pelagic seabirds. They either visit New Zealand annually or as vagrants blown by storms or prevailing winds from distant oceans.

Pelagic seabirds which breed in New Zealand have been reported from many overseas localities (Marchant & Higgins 1990a), but mostly as beach wrecks (dead or dying) on coastlines of Australia, Pacific Islands, North America, South America, and South Africa. As they forage close to other land masses during migration and dispersal they will inevitably form mixed flocks with other local

seabird species. For example, Gibson's wandering albatrosses visit east Australian waters (Walker & Elliot 1999) and Campbell Island black-browed albatrosses visit the coastal waters of Chile (Moore & Battam 2000). Only on very rare occasions have New Zealand-breeding species been observed ashore at seabird colonies elsewhere. For example, Chatham albatross on Albatross Island off Tasmania (Brothers & Davis 1985), a Buller's shearwater on Cabbage Tree Island off Australia (D'Ombrain & Gwynne 1962), and Salvin's albatross

TABLE 4. NON-BREEDING PELAGIC SEABIRDS OCCURRING AS REGULAR MIGRANTS OR AS RARE VAGRANTS IN THE NEW ZEALAND OCEANIC REGION.

BREEDING RANGE*	STATUS†	COMMON NAME	SCIENTIFIC NAME
NP, SP, TS/A	RM	Short-tailed shearwater	*Puffinus tenuirostris*
NP, SP	RM	Wilson's storm petrel	*Oceanites oceanicus*
EP, SWP	RM	New Caledonian petrel	*Pterodroma leucoptera caledonica*
SA, SO	RM	Snowy (wandering) albatross	*Diomedea exulans*
SA, SO	RM	Southern giant petrel	*Macronectes giganteus*
SO	RM	Antarctic fulmar	*Fulmarus glacialoides*
SO	RM	Cape pigeon	*Daption capense capense*
SO	RM	Thin-billed prion	*Pachyptila belcheri*
SO	RM	Salvin's prion	*Pachyptila s. salvini*
SO	RM	Blue petrel	*Halobaena caerulea*
SO	RM	Kerguelen petrel	*Lugensa brevirostris*
SO	RM	King penguin	*Aptenodytes patagonicus*
SO	RM	Royal penguin	*Eudyptes schlegeli*
NP	V	Laysan albatross	*Phoebastria immutabilis*
NP	V	Newell's shearwater	*Puffinus newelli*
NP	V	Leach's storm petrel	*Oceanodroma*
NP, SP	V	Bulwer's petrel	*Bulweria bulwerii*
NP, SP	V	Phoenix petrel	*Pterodroma alba*
NP, SP	V	Christmas Island shearwater	*Puffinus nativitatis*
NP, EP	V	Juan Fernandez petrel	*Pterodroma externa*
NP, EP	V	Stejneger's petrel	*Pterodroma longirostris*
NP, EP	V	Pink-footed shearwater	*Puffinus creatopus*
NP, TS/A	V	Providence petrel	*Pterodroma solandri*
SP	V	Tahiti petrel	*Pseudobulweria rostrata*
SWP, TS/A	V	Norfolk Island little shearwater	*Puffinus assimilis assimilis*
SWP, TS/A	V	Australian white-faced storm petrel	*Pelagodroma marina dulciae*
TS/A, SO	V	Shy (Tasmanian) albatross	*Thalassarche cauta*
SO	V	Sooty albatross	*Phoebetria fusca*
SO	V	Antarctic petrel	*Thalassoica antarctica*
SO	V	Macaroni penguin	*Eudyptes c. chrysolophus*
SO	V	Moseley's rockhopper penguin	*Eudyptes chrysocome moseleyi*
SO	V	Chinstrap penguin	*Pygoscelis antarctica*
SO	V	Adelie penguin	*Pygoscelis adeliae*
SO	V	Gentoo penguin	*Pygoscelis papua*
SA, SO	V	Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*
SA, SO	V	Magellanic penguin	*Spheniscus magellanicus*
SA, SO	V	Western rockhopper penguin	*Eudyptes chrysocome chrysocome*
NA	V	Cory's shearwater	*Calonectris diomedea*
NA	V	Manx shearwater	*Puffinus puffinus*

* Breeding range abbreviations given in Table 3.

† Status as regular migrants (RM) or as rare vagrants (V).

ashore on Diego Ramirez Island, Chile (Arata 2003). Penguins are reported more frequently as visitors to coastlines or seabird colonies in other countries. For example, Fiordland crested penguins have been reported moulting ashore in southern Australia on many occasions (Marchant & Higgins 1990a), while erect-crested and Snares crested penguins have been seen ashore at the Falkland Islands (Woods 1988; Lamey 1990).

For native seabirds (those that breed in New Zealand and also in other countries), there is little chance of detecting those from overseas populations unless they are banded. This does happen occasionally, e.g. a black-browed albatross, banded on Macquarie Island, was found ashore on Campbell Island (Moore et al. 2001). Band recoveries of overseas seabirds caught at sea on fishing boats or washed up on beaches have also been reported, e.g. northern giant petrels from Macquarie and Crozet Islands, and black-browed albatross from South Georgia and the Kerguelen Islands (Marchant & Higgins 1990a).

Although inter-colony movements of pelagic seabirds have rarely been reported, it is apparent that a small percentage of individuals in even the most philopatric species move between colonies. For example, banded grey-faced petrels have been recorded moving between two colonies in Taranaki, three colonies in west Auckland, four islands in the Hauraki Gulf, and three sites in the Bay of Plenty and East Island (G. Taylor, H. Clifford, DOC, unpubl. data). Similarly, northern royal albatross have moved between Taiaroa Head and Chatham Islands colonies, and southern royal albatross between Campbell and Auckland Islands (Robertson 1993). This pattern of low-level inter-colony dispersal and prospecting may well be typical of all pelagic seabird populations.

Instances of New Zealand pelagic seabirds prospecting as a prelude to establishing new colony sites are more frequently recorded, no doubt because a bird ashore where no others exist is very obvious. Black-winged petrels have been recorded prospecting at a number of islands around northern New Zealand and sites on the Chatham Islands (Jenkins & Cheshire 1982; Tennyson 1991), an Antarctic prion was found ashore on Houruakoupara Island off Chatham Island (Imber 1994), Chatham and black-browed albatross have been seen at Snares Western Chain (Miskelly et al. 2001), and northern Buller's albatross were found breeding on Rosemary Rock, Three Kings group in 1983 (Wright 1984). At the Chatham Islands, recent observations indicate that other species of albatross (Antipodean, Salvin's, white-capped) are prospecting and breeding on islands away from their main colonies (G.A. Taylor, DOC, pers. obs.).

Seabirds visiting New Zealand waters as rare migrants or vagrants generally avoid coming too close to land. If found ashore they are usually storm-blown or beach-cast individuals, typically weakened from malnutrition or injury (Taylor 1996, 1999). In some seasons, large wrecks occur and hundreds, even thousands, of birds wash ashore, e.g. Antarctic fulmars in 1999, Salvin's prions in 2002, sooty shearwaters frequently (Powlesland 1992; Taylor 2004). Beach-cast birds are often juveniles still inexperienced at finding food or adults undergoing moult (especially when loss of flight feathers coincides with sustained periods of severe weather). Returning migrants may also occur amongst beach-casts, especially in those seasons when natural food supplies are affected by high sea temperatures and low nutrient availability. Live birds washed up on beaches or blown inland seldom survive.

Occasionally, seabirds banded at overseas locations are washed up dead on New Zealand beaches (Marchant & Higgins 1990a). Among these have been wandering (snowy) albatross from South Georgia and Crozet Islands, southern giant petrels from Marion Island and coastal Antarctica (Casey Station, Cormorant Island, Lawrie Island, South Shetlands) and Cape pigeons from various sites in Antarctica (Terra Adelie, Lawrie Island, Weddel Sea) (Marchant & Higgins 1990a; Taylor 2004). A thin-billed prion banded on the Kerguelen Islands was found on the West Coast (Imber 2003).

In general, vagrant pelagic species don't make landfall. However, just as some New Zealand species make occasional landfall overseas, so vagrants from elsewhere may occasionally be found amongst seabird colonies in New Zealand, e.g. an Atlantic yellow-nosed albatross at Middle Sister Island, Chatham Islands (Robertson 1975), sooty albatross on Antipodes Island (Tennyson et al. 2002), Christmas shearwater on Curtis Island, Kermadec Islands (Taylor & Tennyson 1994), Leach's storm petrels on Rabbit Island, Chatham Islands (Imber & Lovegrove 1982), and Juan Fernandez petrels on Rangatira Island, Chatham Islands (Imber et al. 1991).

5. Other species

Apart from waterfowl, waders, and pelagic seabirds, there is a large variety of other species making annual or irregular visits to New Zealand and its coastal waters. Although this group totals 99 species (Table 5), just 14 can be considered to be migrants (consistent but short-term visitors during the austral summer), and of these only four (Australasian gannet, white-fronted tern, shining cuckoo and long-tailed cuckoo) involve thousands of birds coming ashore on the main islands. Most of the other 85 species arrive as vagrants or stragglers to mainland New Zealand, probably involving just a few individuals per species per year at most.

5.1 MIGRANTS

Four regular migrants are Northern Hemisphere-breeding seabirds (Arctic skua, pomarine skua, long-tailed skua, and Arctic tern—Table 5A) whose ranges in their non-breeding season extend as far as the New Zealand region. They rarely venture inland, preferring to roost on exposed beaches, headlands or islets in the company of gulls or terns, if they come ashore at all.

Three species of terns—white-winged black, common, and little—arrive most summers in small (< 50) numbers. Although all are thought to originate from Asia, their exact countries of origin are unknown. They occupy coastal habitats while in New Zealand and associate with other tern species, although white-winged black terns occasionally venture up rivers with broad braided beds.

The Australasian gannet and white-fronted tern are New Zealand breeding species that migrate to Australian coastal waters for their adolescence or during the non-breeding season (Marchant & Higgins 1990a). They make coastal landfall in Australia and on their return to New Zealand, associate at roosts or nesting sites on beaches, headlands and small offshore islands with adult gannets and terns that have over-wintered in New Zealand waters.

Two species of egrets—little and cattle—arrive from Australia to over-winter here and return in the spring. Fewer than 10 little egrets arrive most years and inhabit coastal mudflats and wetlands. However, several hundred cattle egrets are annual visitors (Heather & Robertson 2000), and they forage over moist pastures, often in close association with cattle and farmland birds, such as starlings, magpies, white-faced herons, and black-backed gulls.

The grey ternlet may not be a migrant to New Zealand since the small population that occasionally nests on offshore islands and islets off Northland and Bay of Plenty coasts may disperse just as far as the seas about the Kermadecs in winter. They are rarely seen along mainland coasts of New Zealand, preferring to remain well offshore.

The remaining two migrants, the shining cuckoo and long-tailed cuckoo, are unique in that they are New Zealand's only migratory forest birds. Arriving in August and September and breeding while here, they migrate to Pacific islands within Melanesia, Micronesia, and/or Polynesia, to over-winter (Higgins 1999).

Occasionally, shining cuckoos are seen in town and city parks, and in shrubby urban and rural sections, but generally both cuckoos favour forests where their host species occur.

TABLE 5. THE LIKELY SOURCE OF 'OTHER' SPECIES OCCURRING AS MIGRANTS OR VAGRANTS IN THE NEW ZEALAND REGION.

LIKELY SOURCE*	COMMON NAME	SCIENTIFIC NAME
A. Migrants		
Au	Australasian gannet	*Morus serrator*
Au	Little egret	*Egretta garzetta*
Au	Cattle egret	*Bubulcus ibis*
NH	Arctic skua	*Stercorarius parasiticus*
NH	Pomarine skua	*Stercorarius pomarinus*
NH	Long-tailed skua	*Stercorarius longicaudus*
AS	White-winged black tern	*Chlidonias leucopterus*
Au	White-fronted tern	*Sterna striata*
AS	Little tern	*Sterna albifrons*
NH	Arctic tern	*Sterna paradisaea*
AS	Common tern	*Sterna hirundo*
PI	Grey ternlet	*Procelsterna cerulea*
PI	Shining cuckoo	*Chrysococcyx lucidus*
PI	Long-tailed cuckoo	*Eudynamys taitensis*
B. Vagrants—breeding range restricted to Kermadec Islands		
	Red-tailed tropicbird	*Phaethon rubicanda*
	Masked booby	*Sula dactylatra*
	Sooty tern	*Sterna fuscata*
	Common noddy	*Anous stolidus*
	White-capped noddy	*Anous tenuirostris*
	White tern	*Gygis alba*
C. Vagrants—detectable in New Zealand		
Au	Hoary-headed grebe	*Poliocephalus poliocephalus*
PI	White-tailed tropicbird	*Phaethon lepturus*
Au	Australian pelican	*Pelecanus conspicillatus*
SA	Cape gannet	*Morus capensis*
Au, PI	Brown booby	*Sula leucogaster*
PI	Greater frigatebird	*Fregata minor*
PI	Lesser frigatebird	*Fregata ariel*
Au	Darter	*Anhinga melanogaster*
Au	White-necked heron	*Ardea pacifica*
Au	Intermediate egret	*Egretta intermedia*
Au	Little bittern	*Ixobrychus minutes*
Au	Glossy ibis	*Plegadis falcinellus*
Au	Australian white ibis	*Threskiornis molucca*
Au	Yellow-billed spoonbill	*Platalea flavipes*
Au	Black kite	*Milvus migrans*
Au	Nankeen kestrel	*Falco cenchroides*
Au	Black falcon	*Falco subniger*
Au	Black-tailed native-hen	*Gallinula ventralis*
Au	Dusky moorhen	*Gallinula tenebrosa*
Au	Brolga	*Grus rubicundus*
Au	Whiskered tern	*Chlidonias hybrida*
Au, AS	Gull-billed tern	*Gelochelidon nilotica*
Au, PI	Crested tern	*Sterna bergii*
Au, PI	Bridled tern	*Sterna anaethetus*
AS	Oriental cuckoo	*Cuculus saturatus*
Au	Pallid cuckoo	*Cuculus pallidus*
Au	Fan-tailed cuckoo	*Cacomantis flabelliformis*
Au	Common koel	*Eudynamys scolopacea*

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* Northern Hemisphere (NH), Asia (AS), South Africa (SA), Pacific islands (PI), or Australia (Au).

TABLE 5—*Continued*

LIKELY SOURCE*	COMMON NAME	SCIENTIFIC NAME
Au	Channel-billed cuckoo	*Scythrops novaehollandiae*
Au, PI	Barn owl	*Tyto alba*
AS	Spine-tailed swift	*Hirundapus caudacutus*
AS	Fork-tailed swift	*Apus pacificus*
Au	Kookaburra	*Dacelo novaeguineae*
Au	Dollarbird	*Eurystomus orientalis*
Au	Australian tree martin	*Hirundo nigricans*
Au	Fairy martin	*Hirundo ariel*
Au, PI	Black-faced cuckoo-shrike	*Coracina novaehollandiae*
Au	White-winged triller	*Lalage tricolour*
Au	Satin flycatcher	*Myiagra cyanoleuca*
Au	Black-faced monarch	*Monarcha melanopsis*
Au	White-browed woodswallow	*Artamus superciliosus*
Au	Masked woodswallow	*Artamus personatus*
Au	Willie wagtail	*Rhipidura leucophrys*
D. Vagrants—not detectable in New Zealand among resident population		
Au	Australian crested grebe	*Podiceps cristatus*
Au	Australian little grebe	*Tachybaptus novaehollandiae*
Au	Black shag	*Phalacrocorax carbo*
Au	Pied shag	*Phalacrocorax varius*
Au	Little black shag	*Phalacrocorax sulcirostris*
Au	Little shag	*Phalacrocorax melanoleucos*
Au	White-faced heron	*Ardea novaehollandiae*
Au	White heron	*Egretta alba*
Au, PI	Reef heron	*Egretta sacra*
Au, PI	Nankeen night heron	*Nycticorax caledonicus*
Au	Royal spoonbill	*Platalea regia*
Au, PI	Australasian harrier	*Circus approximans*
Au, PI	Banded rail	*Rallus philippensis*
Au, PI	Spotless crake	*Porzana tabuensis*
Au, AS	Marsh crake	*Porzana pusilla*
Au, PI	Pukeko	*Porphyrio porphyrio*
Au	Australian coot	*Fulica atra*
Au	Black-backed gull	*Larus dominicanus*
Au	Red-billed gull	*Larus novaehollandiae*
Au	Caspian tern	*Sterna caspia*
Au	Fairy tern	*Sterna nereis*
Au	Sulphur-crested cockatoo	*Cacatua galerita*
Au	Crimson rosella	*Platycercus elegans*
Au	Eastern rosella	*Platycercus eximius*
Au	Sacred kingfisher	*Halcyon sancta*
Au	Welcome swallow	*Hirundo tahitica*
Au	Richard's pipit	*Anthus novaeseelandiae*
Au	Silvereye	*Zosterops lateralis*
Au	Australian magpie	*Gymnorhina tibicen*
E. Vagrants—sedentary European and Asian passerines introduced to Australia and New Zealand that would be undetectable as vagrants in New Zealand		
Au	Skylark	*Alauda arvensis*
Au	Blackbird	*Turdus merula*
Au	Song thrush	*Turdus philomelos*
Au	Greenfinch	*Carduelis chloris*
Au	Goldfinch	*Carduelis carduelis*
Au	House sparrow	*Passer domesticus*
Au	Starling	*Sturnus vulgaris*
Au	Myna	*Acridotheres tristis*

* Northern Hemisphere (NH), Asia (AS), South Africa (SA), Pacific islands (PI), or Australia (Au).

5.2 VAGRANTS

The remaining species (the vagrants and stragglers) arrive irregularly as individuals or as small flocks.

Six species (Table 5B)—all seabirds with breeding populations on the Kermadec Islands—are encountered periodically as live or dead individuals on northern North Island beaches, mainly after strong winds force birds south from their usual range. The survivors remain for a few days before disappearing, presumably heading back north to their preferred subtropical seas. If live birds come ashore, they are generally found roosting with gannets and/or terns.

Forty-three species occur as detectable vagrants (Table 5C)—detectable because they have no resident populations in New Zealand. Most originate from Australia (36), arrive in small numbers (5–10) when they do so, but are not seen in most years. While some are seabirds or wetland inhabitants, several are likely to be seen in open habitats, such as farmland and parks, e.g. herons, egrets, ibises, raptors, and cuckoos. Individuals of these species arrive in New Zealand probably as a result of being forced offshore by severe storms when involved in autumn or spring movements along the eastern coastline of Australia, or when migrating between Tasmania and Victoria/New South Wales.

A further 29 species (Table 5D) have natural resident populations in both Australia and New Zealand. While trans-Tasman movements of individuals or small flocks are generally undetectable, there is evidence that such movements may occur. For example, individuals or small flocks being encountered in mid-Tasman (black shag, welcome swallow), exhausted individuals found along western coasts, small flocks arriving at locations were the resident population is absent or scarce (little shags on Campbell Island, flock of white herons in Northland), or recent population establishment following persistent arrival (Australasian coot, nankeen night heron). While most of these species inhabit wetlands or coastal habitats, two farmland-inhabiting species, Australasian harrier and black-backed gull, are capable of long-distance flights, and may well be making trans-Tasman crossings regularly.

A final group of 8 species (Table 5E) that may arrive as vagrants to New Zealand consists of passerines introduced to both Australia and New Zealand from Europe (7) and Asia (1). Each species is found in southeast Australia and New Zealand, and an individual arriving in New Zealand would go undetected. None of these species normally exhibits migratory or seasonally dispersive behaviour and the likelihood of vagrants reaching New Zealand seems remote. Even so, the natural establishment of populations of some (e.g. starling, blackbird) on New Zealand's outlying islands, and observations of others at sea (song thrush, goldfinch) indicates their potential for occasional trans-Tasman dispersal.

Therefore, among the 'others' are numerous species which reach New Zealand as vagrants, but only about half of which are likely to be detected. Vagrants are of considerable interest among the small bird-watching fraternity in New Zealand and some people devote considerable time each year to seeking and documenting their presence (see issues of *Notornis* and *Southern Bird*). However, it is probably among the species that have populations in both Australia and New Zealand that vagrants from the Australian populations most frequently reach New Zealand, and this will go undetected most of the time.

Most of these species are capable of making long-distance flights because of their migratory or dispersive habits within Australia. Many are nomadic species that take advantage of ephemeral, inland wetlands. Their numbers increase markedly when these wetlands are available, but they are forced to coastal areas when the inland wetlands dry up. It is during these movements to and between coastal habitats during extreme drought events that small flocks of these species are most likely to reach New Zealand.

6. Overview

6.1 ORIGINS AND ROUTES

Diverse though the range of species reaching New Zealand's mainland may be, there is one common landmass from which, or through which, almost all migrant birds come: Australia. Present understanding is that all Northern Hemisphere-sourced migrant waders—except for some or all of the Alaskan godwits (Reigen 1999)—spend time in northern Australia before travelling on to New Zealand. All but a handful of waterfowl reaching New Zealand have come from Australia, and all migrants and vagrants that occupy freshwater and terrestrial habitats when in New Zealand (two cuckoo species excepted) have arrived from Australia. Australia is New Zealand's ornithological front door.

Initial landfalls of waders in Australia are spread over a broad region from about Broome in the northwest to the Gulf of Carpentaria in the northeast (Lane 1987). There follows a confusing trickle of birds down the estuaries of Australia's east coast before crossing the Tasman Sea, and/or direct movement to estuaries in Victoria before journeying on to New Zealand (see Lane 1987). It is possible that waders reaching different parts of New Zealand from Australia arrive via different routes. For example, migrant waders reaching Southland have never included birds wearing markers applied in north-eastern Australia or at northern New Zealand estuaries (P. Battley, pers. comm.). Overall, there have been too few sightings of individually marked birds to indicate precise pathways of travel from Australia to New Zealand. However, it is also possible well-defined pathways do not actually exist and that there is a 'dribble' of small flocks departing for New Zealand from any of the estuaries on Australia's eastern coast.

For waterfowl and many of the 'other' freshwater or terrestrial species reaching New Zealand, the most likely points of origin appear to lie in southeastern Australia (New South Wales, Victoria, and Tasmania). Although few of these species, other than cattle egrets (Maddock 1990), have reached New Zealand wearing bands, all are common in that part of Australia. Freshwater inhabitants, so abundant on the wetlands of Australia's interior following rains, retreat to the continent's southeastern lowland wetlands when the interior goes dry (Kingsford & Norman 2002). Drought-induced movements of waterfowl, egrets, and other water birds across the Tasman Sea (e.g. as occurred in 1957, 1983, 1996) may represent the most predictable pathway of bird arrivals on the New

Zealand mainland next to the annual wader, gannet and white-fronted tern migrations.

Pelagic seabirds may be similarly influenced. The Pacific oceanic environment is subjected to the vagaries of El Niño-southern oscillation (ENSO) events which alter sea surface temperatures over large areas. For example, the El Niño phase lowers sea surface temperatures around southern New Zealand (Greig et al. 1988) while at the same time increasing temperatures in the central and eastern Pacific. Conversely, the La Niña phase is accompanied by extensive warm water intrusions into New Zealand and southern Australian waters which in turn affect the availability of fish for many pelagic seabirds (especially penguins, see Mickelson et al. 1992; Fraser & Lalas 2004). While the abundance of Northern Hemisphere-breeding skuas and terns in New Zealand waters has not been shown to be influenced by ENSO events, an unprecedented wreck of skuas (mostly long-tailed skuas) on Northland and Horowhenua beaches in January 1983 at the height of the 1982–83 El Niño (Melville 1985) suggests such an influence.

ENSO events seem also to influence winter distributions and survival of migrating New Zealand-breeding seabirds, e.g. flesh-footed and sooty shearwaters (Marchant & Higgins 1990a). Warm equatorial waters extending north along the Californian coast, or south along the Chilean coast, force pelagic seabirds to forage much further offshore than in years when cool currents run close to the coastlines (M. Imber, pers. comm.). This was especially pronounced during the El Niño of 1996/97 when sooty shearwaters 'disappeared' from Californian coastal waters (G. Taylor, DOC, unpubl. data).

Patterns of winter dispersion of New Zealand-breeding seabirds in central, northern, and southern Pacific waters are not well-studied. Even assuming that there is little significant annual variation in these patterns, it is not unreasonable to conclude that, in strong La Niña years, some of these migratory seabirds may feed in closer proximity to the shoreline of the Americas than would normally be the case.

6.2 OPPORTUNITIES FOR INTERACTIONS BETWEEN MIGRANTS AND RESIDENT BIRDS

One reason for monitoring interactions between migrants and resident birds is the potential for transmission of novel diseases from the migrants to resident bird populations which lack natural resistance to them. Four significant opportunities for interaction between migrants/vagrants and resident birds on the New Zealand mainland or at sea/on islands are apparent:

- Visits by vagrant seabirds to New Zealand breeding colonies of the same or related species
- Co-occurrence of migratory and resident individuals of white-fronted terns, gannets, and banded dotterels at summer breeding sites or at pre-migratory assemblies
- Interaction between migrant cuckoos and their host species in forest habitats
- Co-occurrence of migrant waders with indigenous waders and other waterbirds at estuaries (and selected coastal lakes)

6.2.1 Seabird visits

Visits by foreign-bred seabirds to colonies of the same species breeding in New Zealand waters have been recorded occasionally (see section 4. Pelagic seabirds, above), but undoubtedly occur much more frequently than these few sightings of banded individuals indicate. Since most of the significant seabird colonies are now restricted to islands remote from the New Zealand mainland, these exotic visitors are most unlikely ever to make landfall on New Zealand's mainland. All pelagic seabirds (see Table 3) still breeding on New Zealand's two main islands (sooty shearwater excepted) are endemic, so there is little likelihood of foreign-born seabirds visiting mainland sites.

6.2.2 Migrant New Zealand mainland breeders

For three mainland-breeding species (banded dotterel, gannet, white-fronted tern), the breeding season provides an opportunity for large numbers of birds that had over-wintered in Australia to mingle with those that did not.

Banded dotterels are dispersed breeders, and intermingling of migrants and 'stay-at-homes' immediately upon their return may be more limited than for the two colonial-nesting seabirds. Post-migratory or pre-breeding aggregations have not been highlighted in ecological summaries of banded dotterel (e.g. Marchant & Higgins 1993; Pierce 1999), and migrants may return directly to their breeding or natal ranges. However, the migrant banded dotterels breed over a large area of southern South Island (Pierce 1999) and their summertime interactions will extend to a range of other species sharing their open-land habitat (e.g. South Island pied oystercatcher, pied and black stilts, spur-winged plover, waterfowl). It is in late summer, and after breeding, that migrants form conspicuous pre-migratory gatherings. The South Island inland-breeding population moves to the coast (e.g. to Wainono Lagoon; Ashley River estuary; Rakaia, Ashburton, and Waitaki River mouths; Lake Ellesmere), mingling there with resident dotterels or those that migrate within New Zealand, and with other indigenous and Northern Hemisphere migratory shorebirds as well (Pierce 1999; Dowding & Moore 2006). Over-wintering locations of banded dotterels in Australia include both coastal and inland sites.

Gannets and white-fronted terns, on the other hand, are colonial breeders. Returning migrant gannets are usually not mature and stay at the fringes of the colonies for 1–3 years before first nesting. However, returning migrant terns include adults which will nest within pecking distance of each other and of those that may not have migrated. Although both species return annually to nest at traditionally used sites, white-fronted terns are the more labile and some of their colonies can arise spontaneously where none has previously occurred, e.g. on newly created sandspits at mouths of small rivers or streams. Gannets typically nest in single-species aggregations, whereas white-fronted terns often nest in association with, or alongside, other species, e.g. Caspian terns, red-billed gulls.

Gannets and white-fronted terns also show contrasting roosting behaviours. Gannets come to land at defined locations close to, or at, their nesting colonies (Marchant & Higgins 1990b), but otherwise sleep on the water. The white-fronted terns, however, roost on the shoreline, either in single-species flocks or in association with gulls and other terns. The terns provide opportunities for multi-species contacts that gannets do not.

6.2.3 Cuckoos

The two species of New Zealand-breeding cuckoos spend the austral winter in different parts of the tropical Pacific: long-tailed cuckoos on islands east of Fiji in the central Pacific, shining cuckoos mainly in the Solomon Islands in the western Pacific. Long-tailed cuckoos are thought to make landfall in New Zealand after non-stop over-water flights, whereas most shining cuckoos are thought to reach New Zealand via northeastern Australia. Both species disperse through the forests of North, South, and Stewart Islands and onto near-shore well-forested islands on which their principal hosts species are numerous. Direct interaction with other forest birds appears to be restricted to those they parasitise. Shining cuckoos lay most of their eggs in the nests of grey warbler, or Chatham Islands robin, whereas long-tailed cuckoos parasitise mostly whiteheads in North Island and brown creepers on South and Stewart Islands, and mohua (yellowhead), now an endangered species, in its remnant South Island range. On some near-shore islands from which mammalian predators have been removed and which are now managed as nature reserves (e.g. Hauturu/Little Barrier Island, Tiritiri Matangi, Kapiti, Whenua Hou/Codfish), the cuckoos are now more numerous and conspicuous than formerly, presumably a response to the greater abundance of their hosts. As a consequence, the cuckoos now share habitat with a wide range of rare or threatened species translocated to these islands for their protection.

Patterns and localities of arrivals and departures of cuckoos are, by and large, unknown. It is assumed that both species use the north of the North Island as arrival and departure points, but there is no evidence that this is so. The pattern of dispersal within New Zealand immediately following landfall is also unknown.

6.2.4 Co-occurrence of migrant waders with indigenous waders and waterbirds

The estuarine and coastal lake habitats exploited by Northern Hemisphere migrant waders while in New Zealand are habitats also for a diversity of indigenous bird species. Three groupings of indigenous species predominate in these habitats—waders, gulls, and waterfowl—and each potentially provides a different pathway for the transmission of exotic avian diseases away from the coastal fringe.

The extent of co-occurrence of migratory and indigenous waders, and principal localities at which it occurs, has been chronicled by Dowding & Moore (2006) and will not be given detailed discussion here. It is sufficient to reiterate these points.

- All populations of indigenous waders have direct contact with Northern Hemisphere migrant waders at some time during their annual cycle.
- Newly-fledged indigenous waders (the age class generally most susceptible to new diseases and to disease transmission) form extensive flocks at many coastal sites in late summer at a time when the migrant wader population is at its annual peak.
- Enduring contact between over-wintering migrant waders and the majority of each indigenous wader species' population during April–August occurs at northern North Island estuaries, especially at Manukau and Kaipara Harbours and Firth of Thames.

- Co-occurrence of migrant and indigenous waders is restricted to coastal and estuarine sites, and occasionally to coastal lakes, but banded dotterels, spur-winged plovers, pied stilts, and South Island pied oystercatchers disperse well inland to breed in (predominantly) pastoral landscapes. Wrybills also breed inland on the beds of some South Island braided rivers, thereby providing a pathway for disease transmission away from the coast.

Black-backed and red-billed gulls are present year-round at all significant estuaries inhabited by Northern Hemisphere migrant waders. Although both species are generally thought of as having clumped distributions and being especially common where humans provide ready food (e.g. rubbish tips, urban waterfronts, and some industrial areas—Heather & Robertson 2000), estuaries are important feeding and roosting sites for many gulls, especially during their non-breeding season.

Two waterfowl—mallard and black swan—are common at estuaries, but small numbers of loafing grey teal, shoveler, and paradise shelduck may also occur.

Mallards are closely associated with freshwater, and during low tides, when mudflats are exposed, they tend to occur along the edges of channels and in the estuary's upper reaches. At high tide they also tend to move back into the lower reaches of contributory streams or rivers, often roosting near the freshwater–saltwater interface. When feeding in estuaries, mallards most often dabble in moist mud substrates, sieving the fluid surface layers through their bill to extract invertebrates. In the process they ingest surface mud. Although they do feed extensively in estuaries, for many mallards this feeding is incidental to their primary use of estuaries as safe daytime refuges. Much of their feeding is done at night on surrounding land and freshwaters, including sites frequented by many other bird species, livestock, and humans.

Black swans are attracted to beds of *Zostera* and *Enteromorpha* in estuarine and protected marine areas. Many lowland lakes that formerly supported large swan populations have become eutrophic (e.g. Ellesmere, Waikare, Wairarapa, Whangape) and their beds of aquatic macrophytes have been replaced by a phytoplankton soup, so these estuarine plants have assumed greater importance as a year-round food source for swans. Nowadays, and at all times of year, the majority of New Zealand's 60 000 swans are present in estuaries (NZ Fish & Game, unpubl. data). It is not clear whether they feed in precisely the same locations within estuaries as migratory waders. *Zostera* tends to grow in coarse sediment and to trap further sand, thereby creating a micro-environment in which waders are seldom seen feeding (M. Williams, pers. obs.). However, waders do feed in clear areas within *Zostera* beds. Swans feed most intensively over these beds on rising tides when the vegetation is lifted off the substrate and the birds are floating. They feed least intensively when the *Zostera* is exposed and they have to pick the plant from the substrate while standing. Thus, there is potentially both a temporal and spatial separation between the feeding activities of waders and swans in estuaries.

If swans do feed over parts of the estuaries where they can potentially come into contact with the faeces of migratory waders, they would provide a significant conduit between estuaries and freshwater wetlands for the transmission of pathogens to other waterbirds. There are frequent, but seasonally-influenced, movements of swans between estuaries and freshwater

wetlands, and this dispersal is geographically extensive. In these freshwater wetlands, interaction with a very wide range of species is possible. For example, Moore et al. (1984: table 5a) identified 84 bird species at Lake Wairarapa and in its surrounding wetlands; 30 (36%) of these were birds whose primary or exclusive habitat was ecotonal vegetation at the wetland periphery. O'Donnell (1985: table 3) recorded 158 species (55% of New Zealand's avifauna) at Lake Ellesmere, 116 of which exploited the lake proper or its marginal vegetation and, of these, 80 were regular inhabitants. Vegetation characteristics of the lake margins, and the timing and pattern of water level fluctuations determined diversity of the wetland's avian community.

6.3 POTENTIAL DISEASE SAMPLING SITES

For vagrants, the spasmodic and unpredictable arrival of individuals makes the monitoring of their disease status impossible, short of attempting to capture or shoot them, one-by-one, soon after they arrive. Most vagrants are of Australian origin (Table 5)—especially from Tasmania–Victoria–New South Wales—and their disease status can reasonably be expected to be a subset of that within the populations from which they are derived. Keeping abreast of the disease status of birds in southeast Australia would appear to be a sensible precaution.

Southeast Australia is also significant for being the winter haunt of part of the populations of three New Zealand-breeding species—gannet, white-fronted tern and banded dotterel. For migrants such as these, disease sampling at colonial breeding sites offers an opportunity to intercept non-breeding individuals that have most recently returned from Australian waters, and to assess breeding individuals that have had a longer residence in New Zealand waters.

For gannets and white-fronted terns, the trans-Tasman movements are predominantly by fledglings, and many remain in Australian waters for more than a year. Their return to New Zealand waters is assumed to coincide with their onset of sexual maturity, but supporting data are lacking, e.g. 'gannets return to New Zealand aged 2–5 and first breed at 4–7 years' (Marchant & Higgins 1990b). For gannets, large colonies at Cape Kidnappers (Hawke's Bay), Horuhoru Island (Hauraki Gulf), White Island (Bay of Plenty), or Gannet Island (near Kawhia) would be suitable sampling sites. White-fronted terns first breed at age 3–6 (Mills & Shaw 1980). For them, colonies at Kaikoura Peninsula, Boulder Bank (Nelson), Papakanui Spit (Auckland), Waitaki River mouth (Otago), and Tiwai Spit (Invercargill) each contain > 200 birds and would be suitable sampling sites (Powlesland 1998).

For banded dotterels, only birds from the southern South Island population cross the Tasman Sea annually. Because they are so widely dispersed at breeding sites immediately following their return from Australia, catching or sampling birds then would be impracticable. An alternative may be to sample birds at inland or coastal pre-migratory assembly locations in January–February, e.g. Lake Ellesmere or Wainono Lagoon (South Canterbury).

The two migratory cuckoos disperse widely within New Zealand forests and, as stated above, their abundance is probably related to the abundance of their host

species. Long-tailed cuckoos are more abundant on Hauturu/Little Barrier Island (Hauraki Gulf) and Kapiti Island (Wellington) than elsewhere, and these two islands may prove effective sampling sites. However, shining cuckoos are more widely and evenly distributed, and any significant lowland forest patch could serve as a useful disease sampling location during October–December. In addition, many individuals of both species of cuckoo are injured following impacts with windows. Many injured and dead cuckoos are handed into Department of Conservation offices and museums each year, and some of these birds may be suitable for disease screening. Because both cuckoos have known and limited winter ranges beyond New Zealand, knowledge of the disease status of birds throughout these ranges could help identify whether the cuckoos are likely to carry any undesirable pathogen to New Zealand.

Waders are present in New Zealand estuaries in large numbers (100 000–200 000) throughout the summer, and in lesser numbers (up to 50 000) during winter (Sagar et al. 1999). Although any large-sized estuary could serve as an appropriate capture and sampling location, Kaipara and Manukau Harbours (Auckland), northern Tauranga Harbour (Bay of Plenty), Farewell Spit (Nelson), and New River estuary/Awarua Bay (Invercargill) are places where the co-presence of large numbers of waterfowl (especially black swans) provides the opportunity to assess possible pathogen transmission from waders to waterfowl and gulls.

Finally, for the monitoring of disease in seabirds, the choice of sampling location could depend on the species, or species groupings, of interest. Taylor (2000 a, b) and Robertson et al. (2003) provide detail of the significant breeding sites of seabirds on the New Zealand mainland, nearshore islands, and distant islands within the New Zealand region.

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