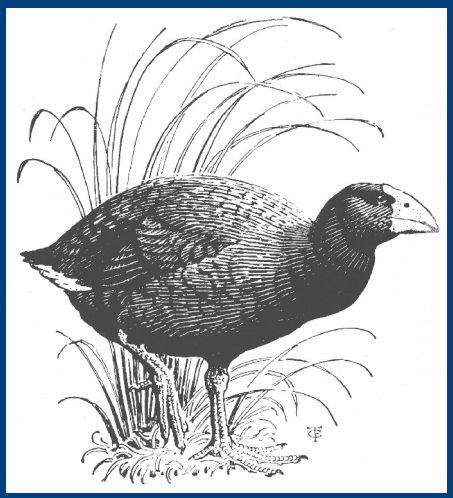
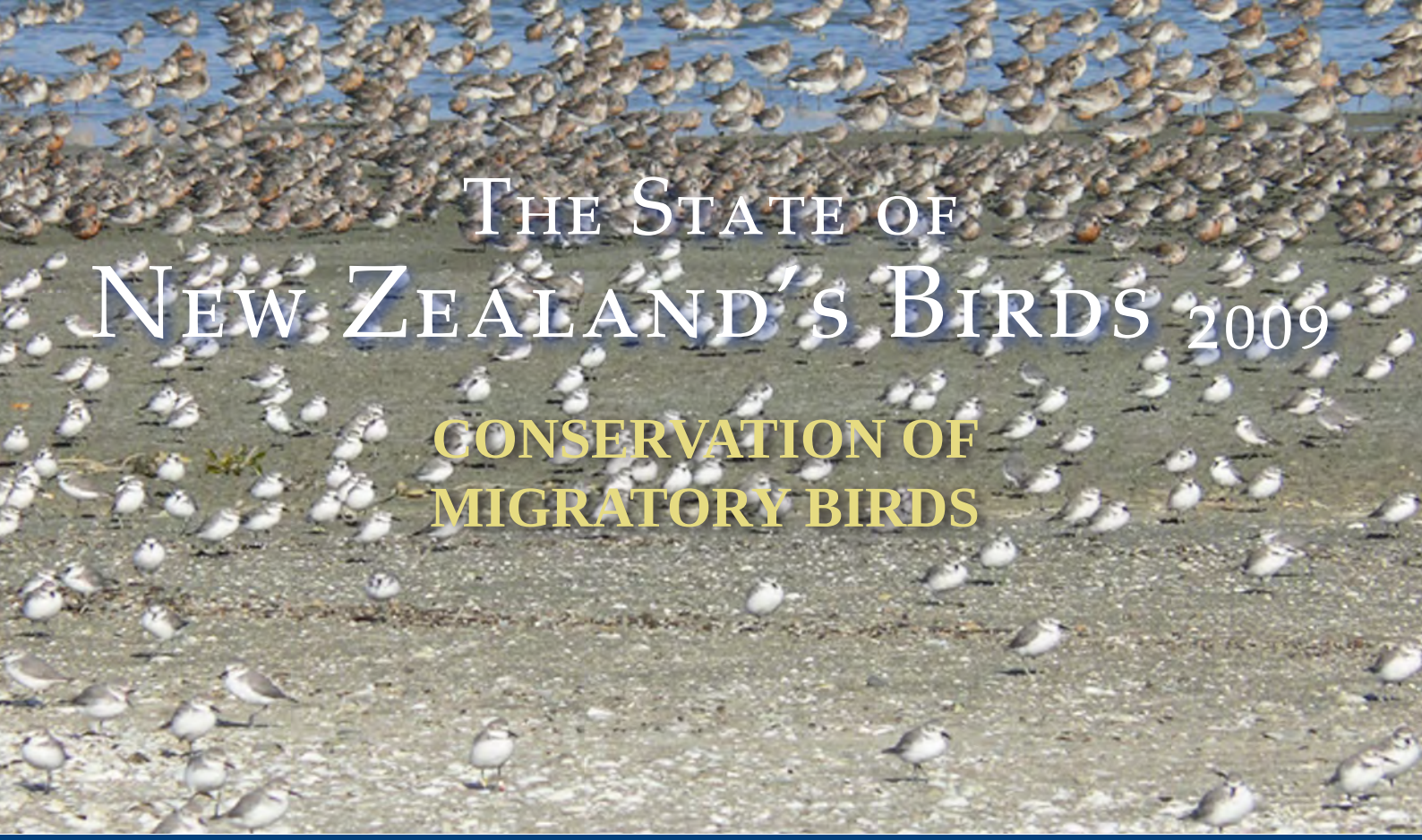
The State of New Zealand's Birds 2009

Conservation of Migrant Birds



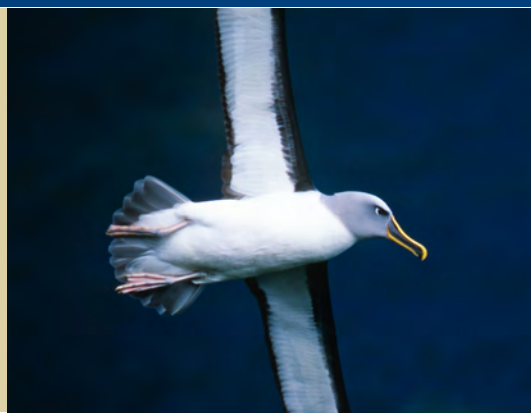


The State of New Zealand's Birds 2009

CONSERVATION OF MIGRATORY BIRDS

Compiled and edited by Kerry-Jayne Wilson

Most of New Zealand's terrestrial birds either remain year round in the same location, or like the tui and bellbird, make short distance movements in response to the seasonal availability of food. The threats these sedentary species face are largely localised, which means that conservation can be tackled at a local level. A few species take more extensive movements, breeding in one part of New Zealand and over wintering in another. For example, the wrybill breeds on South Island braided rivers but most then fly north to over-winter in the Auckland region. However, some New Zealand birds, including many of our seabirds and shorebirds are true long-distance migrants and spend part of the year far from our shores. For example, sooty shearwaters and godwits both migrate to the Arctic, while Chatham and royal albatrosses move to South American seas after breeding. While migratory species may be protected in New Zealand, they face threats both en route and at their international destinations. Understanding both the threats faced by migrant birds, and the requirements for their conservation, pose difficult challenges that need to be met at both the local and international level.



Introduction

In northern temperate regions, the migration of birds is familiar even to lay people, as many of the birds they see day to day are migratory, appearing then leaving with the onset and end of summer. In North America there is a Migratory Birds Treaty which protects many migratory species in both breeding and wintering ranges. In contrast, lay people and even many bird-watchers in New Zealand are unfamiliar with most of our migratory birds. Although a few cities now celebrate the arrival and departure of godwits or shining cuckoos, most of our migratory birds breed on remote islands and feed at sea, or live on muddy estuaries where only keen bird watchers bother to go.

While researchers may know the breeding and wintering ranges, and migration routes in broad terms, for most migratory species, the routes followed and destinations of the New Zealand populations are poorly known. Recent tracking studies on two of our best known species, the bar-tailed godwit and sooty shearwater show their movements are much more complex and wondrous than even the scientists imagined. For some other species we have only the vaguest knowledge of their international travels.

In this report we wish to:

1. Identify those species that breed in New Zealand and regularly migrate to other parts of the world, those that breed elsewhere and spend part of the year in New Zealand, and those species that make regular seasonal movements from one part of New Zealand to another.
2. Identify the status and threats to those migratory species.
3. Describe population changes where these are known and highlight gaps in our knowledge that need to be filled in order to address threats, potential or actual to migratory species.
4. Report recent advances in technology that have enabled us to study the migratory paths of a few species in great detail and the scope for such methods to provide further insight into the movements of migratory birds.

For the purpose of this report a species is considered to be migratory if all, or a large proportion of the population, breeds in one region and regularly moves to a different range during the non-breeding months of their annual (or biennial) cycle. A number of birds, in particular many seabirds, are what scientists term dispersive. After breeding individuals disperse widely, moving in many directions, with some showing semi-regular patterns of movement, while others do not. These dispersive species are not considered in this report.

The views expressed by the contributors to this report do not necessarily represent those of the Ornithological Society of New Zealand, Inc. or the employers of the contributing authors.

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The Key Findings

Many of the internationally migrating species that either breed in New Zealand or spend their non-breeding months in this country are in decline but few are, as yet endangered. This has led to a degree of complacency that needs to be addressed. Unless the reasons for their decline are identified and reversed, future conservation of these species is likely to become more expensive and difficult.

The populations of most, possibly all of the northern-hemisphere breeding shorebird species that over-winter (i.e., spend our summer in New Zealand) are in decline. The major cause of their decline is probably the loss of key staging posts in eastern Asia. While the major threats to these internationally migrating shorebirds lie beyond our shores, the loss of intertidal habitats through the expansion of mangroves in northern New Zealand, and the loss of sea-grass beds through sedimentation and nutrient run-off are insidious ongoing threats to both internationally and nationally migrating shorebirds. The loss of high tide roost sites and increasing levels of disturbance by recreational activities pose additional threats to shorebirds. The decline in the numbers of knots using Farewell Spit suggests changes have occurred in the availability of benthic molluscs on which they feed.

There is an urgent need for a better knowledge of the movements of seabirds at sea. While we have a moderately good understanding of the at-sea movements of most albatross species that breed in the New Zealand region, the same cannot be said for other seabirds. For some species such as the Fiordland crested penguin and Pycroft's petrel, we do not even know if they are migratory. For the endangered Chatham petrel and taiko nothing is known of their movements at sea.

The ways climate change will impact on New Zealand birds has not been addressed. With an increase in sea-level, shorebirds will lose intertidal feeding areas unless dry land is allowed to convert to tidal flats. With global warming, Arctic-breeding shorebirds may be impacted by northward shifts in tundra vegetation, causing a loss of breeding habitat and changes in spring phenology, meaning they arrive too late to breed during the short peak in annual productivity. The impact climate change will have on seabirds is unknown but likely to be significant as it will probably result in changes to the marine environment which in turn could affect food availability.

Current studies of several species in the genus *Pterodroma* and of Hutton's shearwater will make important contributions to our understanding of the movements of these species. When coupled with prior and current studies of the at-sea movements of albatrosses, sooty shearwaters and a few other species, these tracking studies will help identify key areas for seabirds in and beyond our EEZ. These studies will help us to predict changes likely to be caused by climate change and better address impacts due to fisheries by-catch. Tracking studies of seabirds at sea have to date been restricted to breeding birds and until recently been confined to the breeding season. Newly developed technology has allowed year-long studies to be conducted but still virtually nothing is known of the destinations of pre-breeding age seabirds.

The conservation of international migrants requires a much higher degree of inter-country collaboration than is occurring at present. New Zealand is not a member of the East Asian-Australasian Flyway partnership. New Zealand's international collaboration on migratory shorebird research is largely dependent on special interest groups and the dedication of amateur ornithologists. New Zealand has played an important role in developing international measures to protect seabirds from fisheries bycatch but, has as yet contributed little to addressing other threats faced by migratory seabirds.

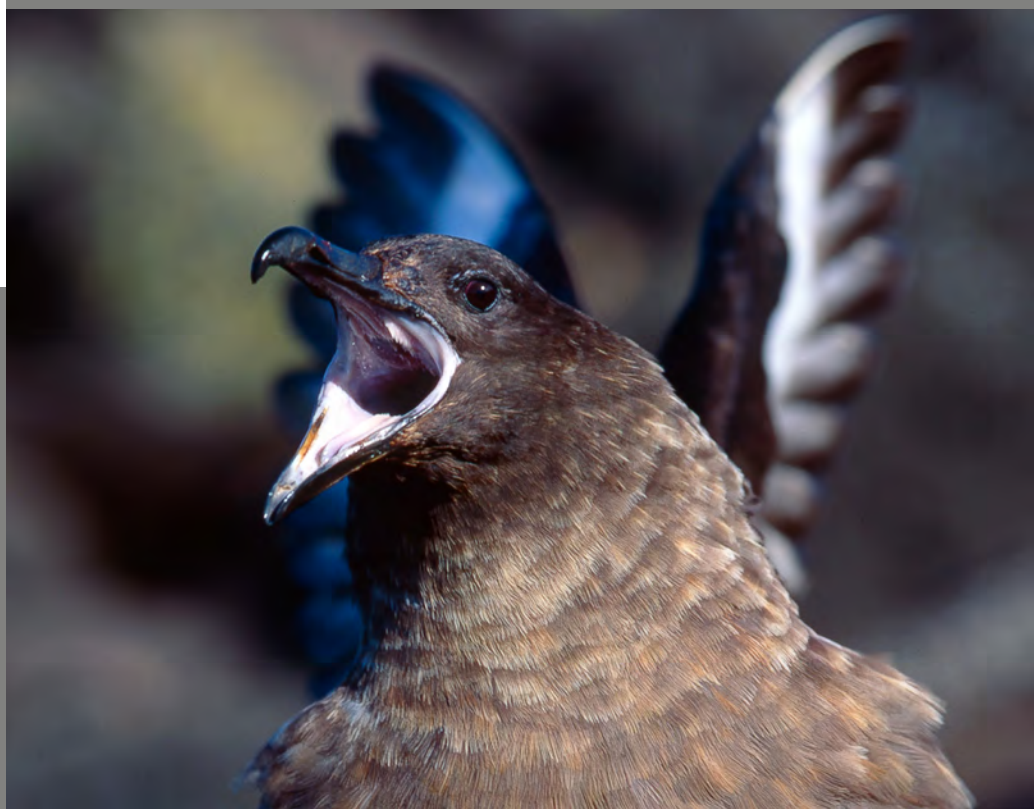
Both species of cuckoos that breed in New Zealand are migratory but the routes they follow between New Zealand and the remote tropical Pacific islands where they over-winter remains unknown. Declines in abundance of the long-tailed cuckoo are presumably linked to declines in their host species. As it is likely individual cuckoos are faithful to their host species as well as both their breeding and wintering locations there are multiple threats to their continued survival.

Migrating birds need to refuel at staging sites along their migration routes. The contrast between the godwits that use few staging posts, and knots that apparently use many, illustrates the species-specific nature of this issue. Shorebird researchers have made good progress in identifying the location and role of staging posts. This is much more difficult for seabirds and only in the last few years has technology allowed migration routes and foraging areas along the way to be identified. It is not yet known if our cuckoos make refuelling stops on migration.

Wind farms potentially pose a new threat to birds as they move from one part of New Zealand to another and, given the expected rapid expansion in wind farm construction it is now more important than ever that we know more about the movements of birds around this country.

The public has little familiarity with most of our migratory species. Greater advocacy is needed to raise awareness, firstly of the birds, then of the threats they face. The record breaking flights of the godwit E7 received great media coverage and she did much to raise people's awareness of godwits and the threats they face. Sooty shearwaters and some other petrels also make impressive migrations but the public has had little opportunity to hear of these.

Below: Brown skua. Populations of brown skua from the southern sub-Antarctic and Antarctic islands migrate north for the winter, while those from The Snares, Stewart Island and the Chatham Islands are sedentary. Photo by Dominique Filippi\i.



Top Left: A mixed flock of wrybills and bar-tailed godwits at Miranda in the Firth of Thames. Wrybills are short-distance migrants, moving between their South Island breeding grounds and wintering areas in North Island. Godwits are extreme long-distance migrants, moving between breeding grounds in Alaska and Siberia and New Zealand. Photo by Keith Woodley.

Above Left: Buller's albatross. One of several species of albatross that breed in New Zealand that migrate to South America between breeding seasons. Photo by Dominique Filippi.

Birds to Watch

International migrants that are still common but in decline: most, perhaps all Arctic-breeding shorebirds that over-winter in New Zealand, sooty shearwater, flesh-footed shearwater and perhaps other New Zealand breeding, trans-equatorial migratory seabirds, and the long-tailed cuckoo.

Species that migrate from one part of New Zealand to another or between New Zealand and Australia that are in decline: Hutton's shearwater, banded dotterel, wrybill, black-fronted tern, and white-fronted tern.

Other migratory species that are threatened or endangered: Chatham albatross, and Cook's petrel.

Endangered species whose movements are unknown: Chatham petrel, and Chatham taiko.

Other vulnerable, wide-ranging seabirds: Fiordland crested penguin, grey-headed albatross, Salvin's albatross, Gibson's albatross, white-chinned petrel, black petrel, and Westland petrel.

Left: Ruddy turnstone. One of several Eurasian waders that breed in the northern hemisphere and then migrate to New Zealand for the austral summer. Photo by P. Langlands.

Top: White-fronted tern. A declining species that migrates between sites within New Zealand. Photo by P. Langlands.

Above: The mottled petrel probably ranges further south and further north than any other species. Photo by Dominique Filippi.

Trans-equatorial Migratory Waders

Perhaps the best-recognised group of international migrants in New Zealand is the waders, or shorebirds (Charadriidae). Over a quarter of the world's shorebird species have been seen in the New Zealand region (63 of 213 species), yet just 14 of these breed in this country– the rest are vagrants or international migrants. Of these 50-odd internationally travelling shorebirds, only five occur in appreciable numbers in New Zealand – bar-tailed godwit, red knot, ruddy turnstone, Pacific golden plover and red-necked stint (Table 1). New Zealand hosts internationally significant numbers of godwits (the majority of the *baueri* subspecies), knots (potentially 80% of the *rogersi* subspecies), and turnstones (~30% of all of those counted in Australia and New Zealand.

Those trans-equatorial migrant shorebirds that 'winter' here breed in the Arctic and sub-Arctic regions of north-eastern Russia and western Alaska, and migrate via complex (and largely undocumented) routes along the East Asian-Australasian Flyway (EAAF) to spend their non-breeding season in New Zealand and Australia. Far northern breeding habitats, while typically frozen and inhospitable during winter, become highly productive during the short summer and are home then to millions of shorebirds and waterfowl that winter in lower latitudes. There are no comparable biomes in the Southern Hemisphere – the equivalent southern latitudes being in the Southern Ocean or even Antarctica.

The EAAF is recognised as the most threatened of the world's shorebird flyways. It is centred on the Yellow Sea region of eastern Asia, which is subject to probably the greatest rates of tidal flat reclamation currently occurring globally. This is highlighted by well-documented schemes such as the Saemangeum reclamation in South Korea. There, in 2007, a 33-km seawall was completed that enclosed (and in practical terms destroyed) 41,000 ha of tidal flats and shallow water. That site was previously the most important known staging post in Asia for migrating shorebirds, with up to a quarter of a million shorebirds (including godwits from New Zealand) using the site on their northward migration.

In general, international migrant shorebirds are more secure on their non-breeding grounds than while on migration. New Zealand tidal flats are not subject to the same large-scale reclamation pressures as in Asia and in New Zealand there is no legal hunting of any shorebirds. Habitat modification nevertheless does occur. In northern New Zealand, mangroves have increased greatly at some sites over recent

decades and now cover areas that formerly were tidal flats. Habitat changes can allow predators to access sand- or shell-banks that are used as high tide roosts. Introduced grasses and weeds also smother shell-banks and provide cover for introduced mammals. Sea-grass beds on tidal flats (which are typically rich in invertebrates and provide important feeding habitat for shorebirds) have decreased in some areas, probably as a result of sedimentation and nutrient run-off. Human disturbance is increasingly an issue at high tide roosts. In some sites wind-surfers and kite-surfers regularly disturb high tide shorebird congregations; on spring tides these roosts may be the only available sites for birds to use. Increased availability of 4WDs and quad bikes mean that few beaches remain immune to disturbance. Few sites in New Zealand have formal recognition of their importance to shorebirds. The Firth of Thames, Manawatu Estuary and Farewell Spit are New Zealand's only intertidal Ramsar sites; Farewell Spit is also a protected Scientific Reserve with restricted access.

Long-term, there are two further, insidious threats facing international migrants. One is pollution in the Yellow Sea, which has been shown to cause physiological deformities in shellfish and may have cumulative impacts on higher vertebrates. The other is climate change, which could have three main impacts.

1. Rising sea levels will reduce tidal flat area unless dry land is allowed to convert (back) into tidal flats.
2. Northward shifts in tundra vegetation may reduce available breeding habitat for many species.
3. Advances in spring phenology mean that long-distance migrants may arrive too late to match their breeding with the short annual peak in productivity.

Shorebird populations are typically monitored by counts at high-tide roosts. The first New Zealand population estimates were derived by the Ornithological Society of New Zealand (OSNZ) in the 1980's. Compared to those figures, current populations of most species have declined. Godwits now number ~80,000 compared with 100,000 in earlier surveys; knots declined steadily through the 1990's; turnstone and golden plovers, while insufficiently surveyed to estimate their populations accurately, have declined substantially at many sites around the country. Other species that occur in only small numbers in New Zealand are just as revealing. A widespread decline in curlew sandpipers in New Zealand matches trends in Australia. Eastern curlews declined through the 1980's and this may represent a retraction of the population away from the peripheries of their wintering range which is centred on Australia. In Tasmania, their numbers have declined by 65% since the 1950's.

It is evident that most shorebird populations in the East Asian-Australasian Flyway are in decline, and the conservation of international migrants demands collaborations between those countries in which they breed, overwinter and even those in which they stop on transit. The East Asian-Australasian Flyway Partnership is the major international framework for the conservation of migratory waterbirds in the Flyway. There are currently 10 countries that have endorsed the Partnership; New Zealand is not one of them. A key component of this scheme is the identification of important sites into a Flyway Site Network. Of the 41 shorebird sites nominated across 13 countries, just two (Firth of Thames and Farewell Spit) are in New Zealand. This is not because of lack of information on the importance of New Zealand's estuaries and harbours: 15 sites from Parengarenga Harbour in the Far North to the New River Estuary in Southland are recognised as holding internationally important numbers of godwits, knots or turnstones (Table 2). Australia has established bilateral agreements on the conservation of migratory birds with Japan, China and the Republic of Korea. New Zealand has no formal links with other Flyway countries. The impetus for international collaborations has instead come from special interest groups such as the Miranda Naturalists' Trust, who established a sister-site relationship with Yalu Jiang National Nature Reserve in China, the most important site for godwits in Asia. Most of what we know about the migrations of shorebirds along the Flyway has come from huge contributions of time and money from dedicated 'amateur' shorebirders, who have spent numerous long days banding and resighting birds over the past decades.

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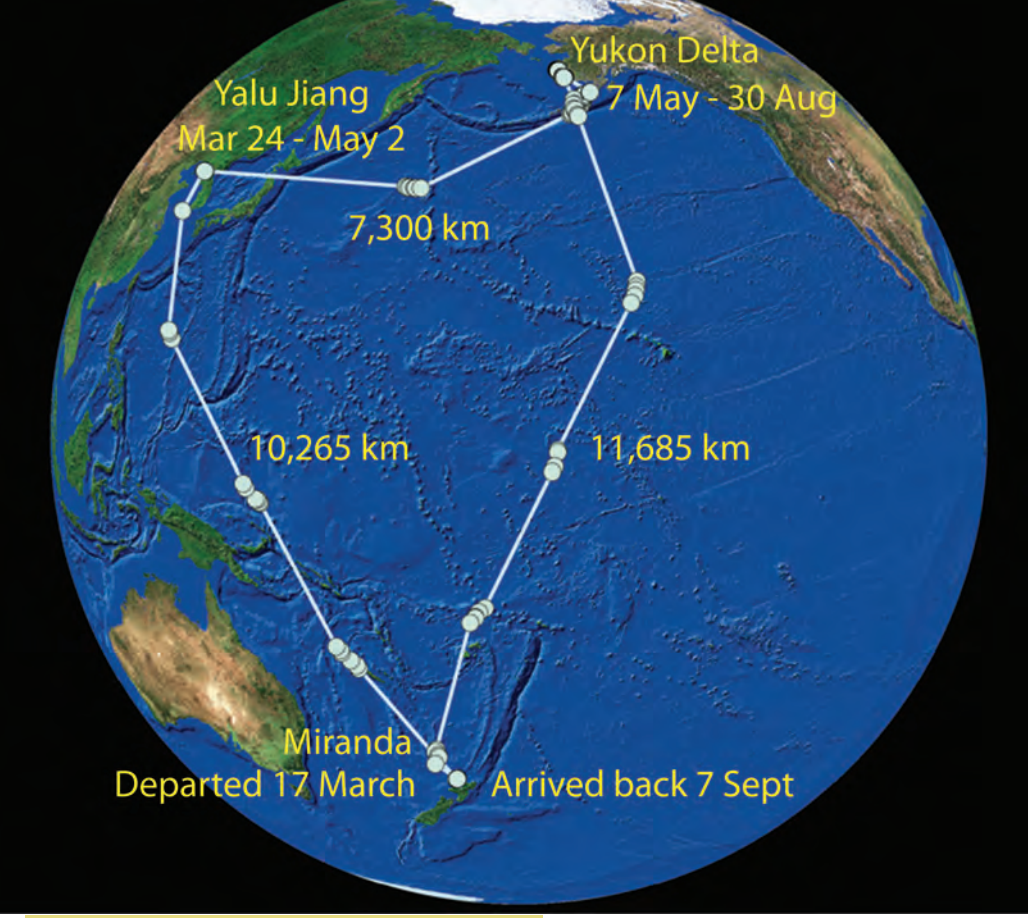
Below: Bar-tailed godwits face a number of human-made hazards in migration. Photo by P. Langlands.

Table 1. Trans-equatorial shorebirds occurring in New Zealand annually in numbers >10.

Species	New Zealand population	Trend
Bar-tailed godwit	*c.* 80,000	Declined from 1980's levels; currently probably increasing
Red knot	*c.* 30-40,000	Declined since the 1980's; variable between years
Ruddy turnstone	*c.* 2000-3000	Possibly declining
Pacific golden-plover	*c.* 300-650	Unknown but apparently less common than in the 1980's
Red-necked stint	*c.* 100-150	Unknown but less common than in the 1980's
Whimbrel	*c.* 90	Possibly declining
Curlew sandpiper	*c.* 20-50	Declined since the1980's
Sharp-tailed sandpiper	*c.* 20-50	Declined since the 1980's
Eastern curlew	*c.* 30	Declined since the 1980's



Bar-tailed Godwit

The bar-tailed godwits that breed in Alaska and 'winter' in New Zealand undertake one of the most impressive migrations of any animal. After breeding during the northern summer they congregate on the shores of the Yukon-Kuskokwim Delta, feeding intensively and reaching record levels of obesity before embarking on the longest non-stop flight documented for any migratory bird – direct across the Pacific Ocean to New Zealand. This flight is at least 11,500 km and takes around 8 days. That it was indeed without stops en route was confirmed by satellite telemetry in 2007 when E7, a bird caught and tagged before migrating north from the Firth of Thames in March, made landfall back in New Zealand on 7 September. Adult godwits spend the southern summer in New Zealand and in March embark on the second longest non-stop flight documented for any bird – 10,000 km to the shores of the Yellow Sea. There they refuel for about 5 weeks before migrating a further 6,500 km to the breeding grounds. This round-trip journey totals almost 29,000 km yet birds may set foot in just 3 countries, and as they are extremely site-faithful in New Zealand and probably also on migration, they may visit only half a dozen sites through the year. This strategy means they may be exposed to fewer risks than birds making multiple stops on migration, but it also means that they are probably at greater risk if these traditional sites are modified or destroyed.

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Red Knot

Red knots contrast greatly with godwits. They are highly mobile on the non-breeding grounds, moving readily between harbours and estuaries perhaps some hundreds of kilometres apart. They probably make several stops during their international migrations, but until recently only small numbers had been documented during migration. Knots leave New Zealand from early March to early April, yet newly-arrived, light birds have been caught in China in early May, indicating that they had arrived from a stopover somewhere between New Zealand and Asia. Birds colour-marked in New Zealand have been seen in the Gulf of Carpentaria in northern Australia during their northward migration, so at least some birds make a stopover in that region. Recent work has established that large numbers of red knots use the Bohai Sea region (northwestern part of the Yellow Sea), an area that is under heavy pressure from reclamation. Knots are mollusc specialists, generally swallowing bivalves whole and crushing them in their stomach. The uneven distribution of knots around the Yellow Sea suggests that the resources they use are also unevenly spread. Destruction of these key sites would have a disproportionate impact on the population as a whole. Details of the southward migration are almost entirely lacking. It is possible that most adult red knots embark on a long flight from eastern Russia (the Sea of Okhotsk) and overfly eastern Asia. Some adults are seen in Australia during southward migration, but there is no information on what proportion of the population stops there. Juveniles tend to visit Australia first before relocating to New Zealand in subsequent months or even years. The total population of knots in Australasia is not known. The historical estimate for the two subspecies present is 220,000 birds. The current number may be less than half that.

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Top left: The migration of E7. In 2007, this female bar-tailed godwit was tracked from the Firth of Thames to Yalu Jiang National Nature Reserve in China, and from there to the Yukon-Kuskokwim Delta. Map by L. Tibbitts and P. Battley.

Above: At the end of August, E7 returned to New Zealand, where she led a camera-shy existence on the mudflats of the Firth of Thames. She was arguably the most famous bird of any species in the international media that year. Photo by J.R. Conklin.

Ruddy Turnstone

Turnstones have a very catholic diet – in the non-breeding season they have been recorded feeding on a wide variety of marine invertebrates and even tern eggs, hamburgers, French fries, and carrion, including a human corpse! Thus, their distribution is unlikely to be limited by food. Nonetheless it remains a relatively scarce bird in New Zealand, with more than 100 turnstones being recorded at only eight sites: Parengarenga, Rangaunu, Kaipara and Manukau Harbours, Farewell Spit, Motueka Sandspit, Awarua Bay, and the New River Estuary. Migration paths are little studied and the origin of New Zealand's birds (whether from the Russian Far East and/or western Alaska) remains unknown. A 1960's study when over 16,000 were banded on the Pribilof Islands in the Bering Sea, resulted in records from throughout much of the Pacific, including New Zealand, and a suggestion of a generally clockwise migration with a return route through Asia. Recent sightings of turnstones colour-marked in New Zealand have been made in Taiwan and South Korea on their northward migration, and in north-west Australia and Victoria on the southward migration. The Australian sightings are a remarkable story – they were consecutively-banded birds from the same catch in Southland, and the bird seen in Victoria was re-sighted on migration at the same location the following year. Population trends are unknown and very difficult to determine due to the very scattered and widespread distribution of turnstones throughout the Pacific and Australasia during the non-breeding season; however, the species appears to be less numerous in New Zealand than formerly.

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Above: Mixed flock of bar-tailed godwits and red knots. Conservation of migrant waders depends not only on the continued health and survival of wetlands in New Zealand, but also along many staging posts in east Asia and on the breeding grounds in northern Asia and North America. Photo by K. Woodley.

The Importance of Staging Posts

Shorebird migrations rely on birds being able to refuel at staging sites after each migratory flight. For some species there may be just one or two stops en route between non-breeding and breeding grounds; others may make numerous small flights and require several sites. Shorebirds from New Zealand have been recorded on migration at sites in Australia, West Papua, Taiwan, China, the Korean Peninsula, Japan, Russia, and some Pacific Islands. Stopover sites allow birds to recover from long flights and to rebuild protein and fat reserves depleted during the flight. At the final staging site before reaching the breeding grounds, birds may also deposit nutrients that can provide a critical buffer against poor weather or contribute to the breeding effort. Failure to store adequate nutrients can result in lowered breeding success (as birds cannot invest fully in breeding or chick rearing) as well as decreased adult survival, both of which can contribute to population declines. Networks of staging sites have been likened to a chain, where a break at one point compromises the whole migration. There are certainly many mega-sites for shorebirds along the East Asian-Australasian Flyway, but researchers are only now starting to unravel how shorebirds use both large and small sites during migration.

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The Firth of Thames: A Special Spot for Shorebirds

Suitable non-breeding habitat for shorebirds must meet two requirements: abundant food and secure high-tide roosts. Each year the benthic fauna in the estimated 8500 ha of intertidal flats on the Firth of Thames supports large flocks of birds. Adjacent shell banks and other coastal margins provide high-tide roosts. The Firth is an important site for trans-equatorial species such as bar-tailed godwit and red knot. It is also important for New Zealand migrant species, in particular South Island pied oystercatcher and wrybill. Between January and August, the Firth supports over 40 per cent of the world's wrybill population. Breeding species include pied stilt, New Zealand dotterel and variable oystercatcher. The accessibility of shorebird habitat at Miranda makes it a magnet for birders. Spectacular flight displays by massed flocks each high tide never fail to enthral visitors. Recent satellite tracking of godwits has significantly boosted interest in these birds and the places where they occur. The Miranda Shorebird Centre offers information and interpretation, with a hide located at one of the major roosts.

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Above: Curlew sandpiper. One of the rarer species of waders that migrate from Siberia to New Zealand to escape the northern hemi-sphere winter. Photo by P. Langlands.

Farewell Spit: A Special Spot for Shorebirds

The ~10,000 ha of sand-flats at Farewell Spit provide one of the most important feeding areas for waders in New Zealand, hosting some 15,000 godwits, 6000 knots and 8000 South Island pied oystercatchers. Counts made by the Ornithological Society of New Zealand (OSNZ) since the 1960's indicate that while numbers of godwits and oystercatchers have remained relatively stable, knots have declined from ~27,000 to ~6000. Such a decline has not been recorded elsewhere in New Zealand, which suggests that Farewell Spit may be a less suitable area for this bivalve-eating specialist than formerly. A 2003 OSNZ survey of the food resources on the tidal flats established a baseline against which to document future change, but detailed studies are now needed to investigate seasonal and annual patterns of species distribution and abundance.

Farewell Spit is designated a Wetland of International Importance under the Ramsar Convention – one of only four coastal sites (three tidal, one lagoon) recognised in New Zealand– and the only one protected as a Nature Reserve. Offshore in Golden Bay, however, there is no protection and in recent years there have been proposals for coal shipment and oil and mineral exploration, each with attendant pollution risks. Expansion of marine farming for mussels could further reduce intertidal benthic food supplies for waders. The Ramsar Convention requires monitoring of the 'ecological character' of Ramsar sites, yet in New Zealand this is usually limited to OSNZ wader counts, which fail to address the underlying causes of any change in numbers. Whilst New Zealand's coastal wetlands may be under less immediate threat than many sites in East Asia we need to improve monitoring to meet our international obligations.

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Migratory Seabirds

So little is known of the movements of most seabirds that the number of migratory species may be under-estimated. For example, the Fiordland crested penguin is absent from its breeding grounds for at least 3 months between February/ March and June/July each year, but their whereabouts during this time is poorly known. A few penguins turn up in southern Australia, although it is generally assumed most remain in New Zealand. Even for some relatively well known species (e.g., Antipodean albatross), it is not known if there are regular movements between breeding and non-breeding ranges or if they disperse widely across the southern ocean. Breeding birds may also over-winter in different areas to younger birds. For example, grey-headed albatross juveniles appear to over-winter further north than adults. As nearly all species of albatrosses and some petrels are taken in fisheries bycatch, and different populations may have quite different movements, knowledge of their movements is of vital conservation importance. While there remain gaps in our knowledge of the movements of albatrosses, far less is known of the movements of shearwaters and petrels. Some species such as Chatham taiko and Chatham petrel have been seen at sea so seldom that virtually nothing is known about their movements.

The centre of distribution of many seabirds that breed in the Antarctic or the sub-Antarctic islands shifts north and south with the seasons, but the length of these movements and the variation from year to year and between populations is unknown. For example, the Antarctic fulmar breeds south of the Antarctic Convergence in summer and in winter some come as far north as New Zealand. Other species such as the brown skua differ between populations, with those breeding at the southern part of their range migrating north for winter, while those further north are sedentary. Over half of the skuas resident on Stewart Island, The Snares and Chatham Islands remain on those islands year round while most from more southern islands migrate. There are other variations on these seasonal shifts in distribution. The white-chinned petrel is apparently pelagic during the breeding season but then uses continental shelf waters during winter.

Until the late 1980's our knowledge of seabird migration came largely from land-based observers recording arrival and departure dates and shipboard observers recording birds at sea. This can only tell us so much. Who knows where those shearwaters seen mid-Pacific originated, or where they were going? All a shipboard observer can tell is the species, how many, and their direction at one instant in time. Furthermore, most ships seldom go where ornithologists want. However, with improved technology, the movements of albatrosses have been now been studied using transmitters that relay the position of the bird via satellites. The limited battery life and the cost of transmitters has meant that most studies were carried out on breeding birds but recent technological advances now allow longer deployments to study where birds go between seasons. In the last few years the development of ever-smaller transmitters and the development of GLS and other tracking technologies have allowed the migration paths of some petrels to be followed. Even today the migratory routes of very few species have been studied using tracking devices and even these have come from relatively few individuals. Much remains unknown about the movements of birds at sea, but as tracking technology becomes smaller and cheaper, knowledge of seabird movements is expanding rapidly. In the last two years, birds as small as Cook's petrel (190 gms) have been tracked for an entire year, something unimaginable a few years ago.

The migration of all seabirds is ultimately a likely response to food availability, with movements taking them between seasonally abundant food sources. However, little is known about the foods taken, the seasonal availability of those foods, and the productivity of the seas they utilise. Most species of albatross, some petrels and other seabirds are taken as fisheries by-catch in both breeding or non-breeding ranges. Climate change will also affect the marine environment and will affect food availability for some species. Migratory species are likely to be particularly at risk as they can be impacted in two or more parts of the world. For most species of migratory seabirds, we do not yet know what threat migration poses let alone the magnitude of those threats. For most seabirds this report can do little more than identify which species are migratory and highlight unknowns. We hope it will stimulate research to address the questions posed.

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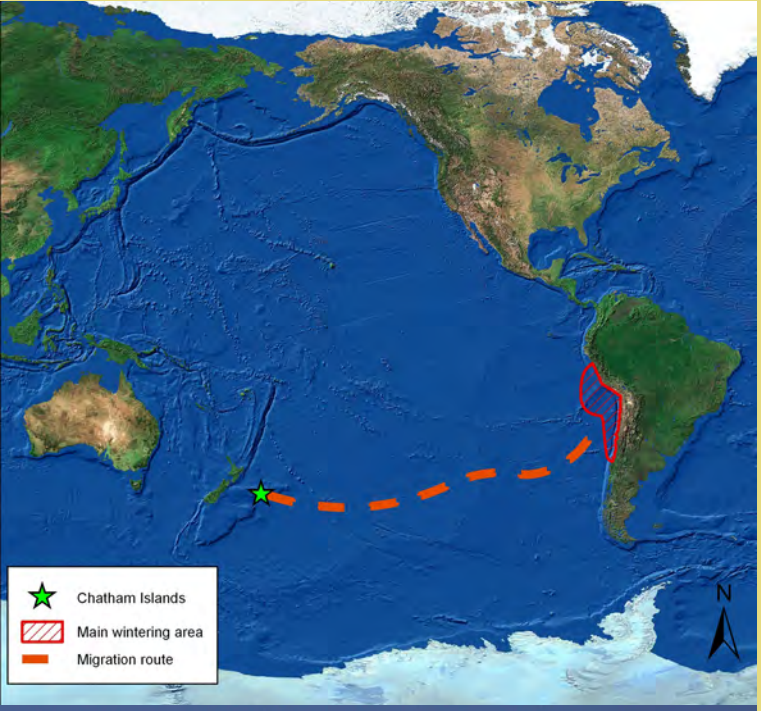
Table 2. Coastal wetlands in New Zealand of international importance for Arctic-breeding waders.

Site	Bar-tailed godwit	Red knot	Ruddy turnstone
Parengarenga Harbour, Far North	+	+	+
Houhora Harbour, Far North	.	+	.
Rangaunu Bay, Far North	+	+	.
Whangarei Harbour, Northland	+	+	.
Kaipara Harbour, North Auckland	+	+	.
Manukau Harbour, Auckland	+	+	.
Firth of Thames, South Auckland	+	+	.
Tauranga Harbour, Bay of Plenty	+	.	.
Ohiwa Harbour, Bay of Plenty	+	.	.
Kawhia Harbour, Waikato	+	.	.
Farewell Spit, Northwest Nelson	+	+	.
Motueka Estuary, Tasman Bay	+	.	.
Waimea Inlet, Tasman Bay	+	.	.
Avon-Heathcote Estuary, Canterbury	+	.	.
New River Estuary, Southland	+	.	.



Chatham Albatross, Cross Pacific Wanderers

The Chatham albatross is one of New Zealand's nine endemic albatross taxa. It breeds only on The Pyramid, a rock stack that is the southern-most of the Chatham Islands. The limited area of suitable breeding habitat restricts the population to about 5500 breeding pairs which makes the species at risk to unpredictable events. Listed as critically endangered by the IUCN, the latest Department of Conservation threatened species ranking classified the Chatham albatross as naturally uncommon with population numbers apparently stable throughout the last decade.

While at sea, the most common non-natural threat to albatross is bycatch in long-line or trawl fisheries. Chatham albatrosses are regularly taken as fisheries bycatch in the New Zealand exclusive economic zone (EEZ). However, little is known of their mortality outside the New Zealand EEZ, especially during their migration and wintering period.

Global Location Sensing (GLS) loggers are now being used to record the movements and behaviour of Chatham albatross throughout the year and over multiple years. Findings from a pilot study on three individuals in the late 1990's, indicated that breeding adults winter around the Humboldt Current upwelling off the northern Chilean and southern Peruvian coasts. Current studies underway support this, with the majority of birds leaving their breeding grounds in March and returning via the same route to the Chatham Rise in July. Crossing the Southern Pacific takes 20 days on average. Thus the birds spend three to four months in their wintering area, which is also the location of one of the world's richest commercial fisheries.

What triggers particular patterns of activity while at sea, the pattern of habitat selection at sea, and the potential to interact with fishing activities has yet to be determined and will be addressed in ongoing studies. Better knowledge of how actual and potential threats vary throughout the life cycle of the Chatham albatross will allow the development of more practical and effective conservation measures.

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Top and above: Migration route of Chatham albatross between Chatham Islands and western South America. Map and photo by L. Deppe.

Southern Breeding, Trans-equatorial Migratory Seabirds

At least nine species of petrels breed around New Zealand and winter in the north Pacific. Four species (wedge-tailed shearwater, black-winged petrel, white-necked petrel and Kermadec petrel) make relatively short migrations, breeding on the Kermadec Islands or northern New Zealand, and over-wintering in the tropical Pacific. Wedge-tailed shearwaters breed on many tropical and sub-tropical islands in both northern and southern hemispheres. It is likely that only those breeding at the northern and southern ends of their breeding range, including on the Kermadec Islands, are migratory, with those in the tropics remaining near their breeding locations throughout the year. Cook's petrels winter in the temperate north Pacific while sooty shearwater, Buller's shearwater, flesh-footed shearwater and mottled petrel spend the northern summer in sub-Arctic or Arctic seas.

Sooty shearwater and mottled petrel make the longest movements. Both species breed in southern New Zealand and our sub-Antarctic islands and over-winter in far northern waters, including the Bering Sea. These two species probably range closer to both poles than the Arctic tern, the bird often said to be the species with the longest migration. Both sooty shearwaters and mottled petrels forage as far as the Antarctic pack-ice even while breeding. The mottled petrel extends both further south and further north than the shearwaters.

Sooty shearwaters, Buller's shearwaters, flesh-footed shearwaters and mottled petrels finish breeding in April or May and all four species arrive in the north Pacific a month later. It was assumed that sooty shearwaters head north to Japan, turn east towards Alaska, and then south down the coast of North America before making a cross-Pacific journey to New Zealand in October. However, recent tracking studies show that their migratory paths are complex, with some birds crossing the Pacific to South American seas, then moving north, while others winter off Japan or the western U.S.A.

The routes followed by mottled petrel are less well known, but at-sea sightings suggest they take a more direct route through Tongan and Hawaiian seas on both northern and southern migrations. They leave New Zealand between March and May, with non-breeding or failed breeders departing first. Most are off Alaska from July to September, and then back at their breeding colonies in November. There is probably no single route followed by all birds and, as with the other migratory petrels, departure and arrival are spread over several months. The migratory paths of the other trans-equatorial migrants are not yet known. The complexity of the timings and routings revealed for the sooty shearwater may be indicative of the variation in other species.

In the Pacific, Wilson's storm petrel breeds only south of the Antarctic Convergence, then over-winters in tropical or sub-tropical waters north of the equator. A few pass through New Zealand during migration. The south polar skua that breeds in Antarctica is another trans-equatorial migrant. Some, presumably those from the Ross Sea sector, may make a clockwise loop around the Pacific Ocean, passing through New Zealand seas on route. As so little is known of the at-sea distribution of many seabirds, several other species may also make trans-equatorial movements.

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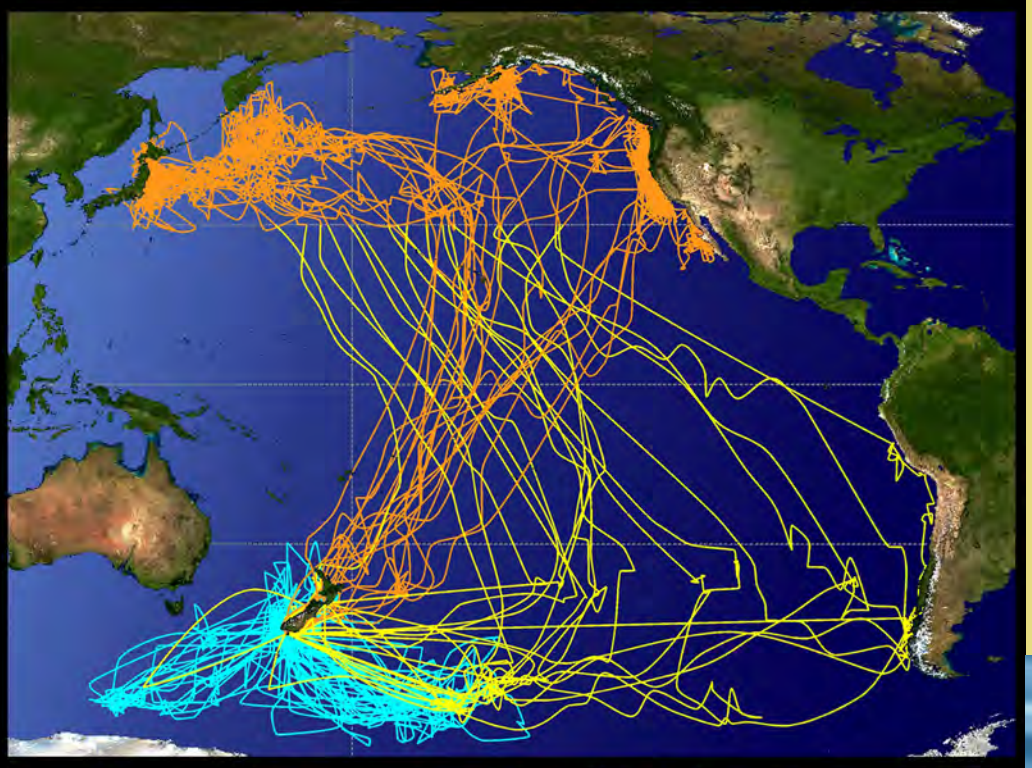

Left: The amazing migratory movements of the sooty shearwater. Birds fitted with light-based achival tags were followed from their breeding grounds in New Zealand, across the Pacific to their wintering grounds in the northern hemisphere, and then back to New Zealand in the spring. Map reprinted from Shaffer et al. (2006). Copyright National Academy of Sciences, USA.

Below, left: A sooty shearwater at the entrance to its burrow. This species breeds in declining numbers on a islands around New Zealand. Photo by G. Taylor.

Below: Sooty shearwater at sea. Photo by P. Landlands.

Below, right: Large flock of sooty shearwaters flying past the coast of Southland. Photo by P. Langlands.

Sooty Shearwaters Enjoy an Endless Summer

The breeding population of sooty shearwaters in the New Zealand region was recently estimated at 4.4 million pairs. Clearly this species is still abundant. However, populations have declined over recent decades, both at breeding sites within New Zealand and at their non-breeding wintering grounds in the eastern North Pacific, prompting the IUCN to upgrade the threat status for this species from 'Least Concern' to 'Near Threatened'.

In order to better understand the suite of threats facing sooty shearwaters throughout their annual cycle, it is essential to identify migratory pathways, the location of non-breeding destinations, and to quantify the use of these by sooty shearwaters. The development of miniaturised light-based archival tag technologies has enabled ever-smaller species of seabirds to be tracked over relatively large spatio-temporal scales. Such tags were deployed on sooty shearwaters breeding at Codfish Island (Whenuahou) and Mana Island, revealing not only habitat use during the breeding season, but additionally their extraordinary trans-equatorial post-breeding migration to the North Pacific. Sooty shearwaters followed a 'figure of 8' migration path, leaving New Zealand in an eastward direction, and then turning north-west into the North Pacific to one of three wintering areas – off Japan, Alaska or California – where birds remained before returning on a south-westerly heading to New Zealand. On average, birds travelled a total of over 64,000 km and transit rates reached 910 km per day as birds moved between northern and southern Pacific Oceans, exploiting prey resources over an 'endless summer'. Members of a breeding pair may travel to either the same, or to different wintering areas, which further suggests that sooty shearwaters may be a sensitive species with which to monitor the impacts of global climate change and marine ecosystem health.

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Current Research into the Movements of Small Petrels

Though tracking studies have provided tantalising insights into the biology of some of New Zealand's larger petrels, an understanding of the at-sea biology of the many smaller species remains a mystery. Recent advances in light-weight tracking technologies called global location sensors (GLS) now present exciting opportunities to study the behaviour of smaller seabirds. Current research by NIWA and San Jose State University in California is using GLS to understand the New Zealand seabird community, and in particular, a diverse group of closely related small birds known as the Cookilaria petrels. These small seabirds are some of the least studied petrels. They weigh around 200 grams, and most species breed only in New Zealand where they are threatened by a range of current or historic threats. Cookilaria petrels are thought to be migratory, thus susceptible to a range of conservation threats far beyond New Zealand waters. An understanding of the movements and at-sea biology of these species is thus essential for informed conservation management.

Species currently being tracked using GLS include the New Zealand breeding populations of black-winged petrel, Cook's petrel, Chatham petrel, mottled petrel and Pycroft's petrel, as well as Gould's petrel that breed in New South Wales, and the New Caledonia petrel. This research is seeking answers to questions such as: how a community of closely-related seabirds partition the available food; what are the locations of key foraging habitats; and where are their migratory pathways and wintering grounds? Initial results from year-round tracking of Cook's petrel have revealed the amazing spatial scales at which these small birds operate. During breeding, Cook's petrels forage far from their breeding grounds on Little Barrier Island, in oceanic waters of the Tasman Sea, and up to several thousand kilometres east of the North Island during foraging trips lasting only 3-7 days. During the non-breeding period, Cook's petrels take approximately 25 days to migrate to the North Pacific convergence 35 to 40 degrees north of the Equator.

A long-term goal of this research is to provide tracking data on smaller petrel species to complement those already collected by NIWA for larger New Zealand breeding petrels. These data will be used to model the location of seabird hotspots around New Zealand and to identify productive or biologically diverse marine areas important for management and/or legislative protection.

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Northern Breeding, Trans-equatorial Migratory Seabirds

Compared with the number of southern breeding trans-equatorial migrants, few species of seabird breed in the north and over-winter (spend the southern summer) in the Southern Hemisphere. Three species of jaegers (small skuas) breed in the Arctic and migrate south, with some individuals crossing the equator and a few birds coming as far south as New Zealand. The Arctic jaeger is a common visitor to New Zealand, but more often seen in northern than in southern parts of the country. The pomarine jaeger is a regular but uncommon visitor to New Zealand, with most birds spending the southern summer in warmer seas. The long-tailed jaeger is rarely seen in New Zealand and then only around the northern half of this country. The long-tailed jaeger is more pelagic than the other species so may be more common than the few sightings suggest. Jaegers obtain much of their food by harassing terns and other seabirds, forcing them to drop or regurgitate their food. The Arctic jaeger employs this feeding method more often than the other species of jaegers. The Arctic tern breeds in Arctic and sub-Arctic regions and spends the northern winter in the Southern Hemisphere, some as far south as the Antarctic pack-ice. Although they are moderately common in the Ross Sea, few are seen in New Zealand.

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Cross-Pacific Migratory Seabirds

A few seabirds breed in New Zealand, but then spend the non-breeding months in the eastern Pacific, with one or two species even rounding Cape Horn into Argentinean waters. Black petrels and white-faced storm petrels both over-winter in the eastern tropical Pacific. Some storm petrels migrate as far east as the Galapagos Islands. The black petrel winters off Central and South America between Guatemala and Peru. The black petrels breeding on Little Barrier Island depart between March and July. As with many petrels, chicks leave the breeding grounds a week or so after their parents.

The Westland petrel, which breeds only near Punakaiki on the South Island, appears to move east into the central Pacific to moult. Westland petrels may spend their early years off South America. Little shearwaters breeding on the Antipodes Islands are apparently migratory and may also spend their non-breeding months in the seas off Chile.

Both southern and northern royal albatross breed only every second year, spending their non-breeding years off South America. It is assumed they return by flying east, thus completing a circum-polar migration. Chatham albatross and Buller's albatross overwinter off Chile and Peru.

No South American breeding birds are known to over-winter around New Zealand. However, Salvin's prion presents a variation on this east-west migration. They breed in the southern Indian Ocean and move into Australian and New Zealand seas between breeding seasons.

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Cook's Petrel. This small petrel breeds on Little Barrier and Codfish Islands, and then migrates to the north Pacific Ocean. Recent tracking studies show that even during the breeding season they may travel thousands of kilometres in search of food. Photo by G. Taylor.

Fisheries Bycatch and Migratory Seabirds

Albatrosses and petrels are some of the most wide-ranging birds in the world, spending up to 95% of their lives at sea. The movements of only a few of these species have been studied in detail. Data on their ranges and foraging behaviours are vital for their protection while at sea, but can only be of benefit if the information is shared by agencies responsible for conservation.

BirdLife International recently reviewed the occurrence of seabird bycatch in fisheries. Those fisheries known to kill New Zealand breeding seabirds are: Chilean seas (Chilean longline fisheries), Benguela Current (Namibian and Angolan longline, South African longline and trawl fisheries), Southern Ocean (Japanese longline, and others), Australian waters (Australian longline fisheries), Brazilian seas (Brazilian longline fisheries), Patagonian shelf (Argentinean trawl fisheries), CCAMLR Convention Area (trawl and longline fisheries from countries managed under the CCAMLR agreement), and the Falkland Islands (United Kingdom trawl fisheries, and others). Birds may also be at risk elsewhere as there are considerable gaps in the coverage of this review.

A study by the New Zealand Ministry of Fisheries recently examined the capture of a suite of albatrosses and petrels in New Zealand trawl and longline fisheries. Species with the greatest risk of capture, in relation to their population sizes and distribution at sea were, in decreasing order: small albatrosses, large albatrosses, *Procellaria* petrels, and large shearwaters, in particular, sooty and flesh-footed shearwaters. Those less likely to be taken as bycatch were *Pterodroma* petrels, storm petrels, diving petrels and small shearwaters such as Hutton's and fluttering shearwaters. There still are large gaps in our knowledge of which species are most affected by bycatch, but targeting research effort at the groups most likely to be at risk would be a strategic approach. This would include all New Zealand's endemic albatrosses and large petrels. Although the breeding ranges are known for most albatrosses, their movements between breeding seasons is poorly understood and the movements of young birds remains a mystery.

There is a great deal to be learned about how seabirds interact with fisheries when on migration. Data sharing, such as through the Global Procellariiform Tracking Database can assist with the conservation of species at risk from fisheries. Ecological Risk Assessment in several fisheries have already used this database, and several New Zealand research teams have made significant contributions to these analyses. New data, especially on the smaller seabirds, and on the non-breeding ranges of all species can contribute to improved conservation of migrating species subject to fishery impacts.

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The Cuckoos, New Zealand's Terrestrial Migrants

Two species of cuckoos breed in New Zealand: the endemic long-tailed cuckoo (125 g), and the native shining cuckoo (23 g) which breeds also in Australia, New Caledonia and Vanuatu. Long-tailed cuckoos winter in a vast arc of islands extending 10,000 km from Palau in the west to Henderson Island (Pitcairn group) in the east, with perhaps a principal wintering range between Fiji and Tahiti. The New Zealand subspecies of shining cuckoo winters in the Bismarck Archipelago and Solomon Islands. Because of the great sea-distances involved, theirs is one of the most remarkable over-water migratory journeys of any land-bird in the world.

There has been negligible banding of cuckoos in New Zealand and there have been no recoveries overseas. Even with the latest technology the birds are still too small to carry tracking devices. Precise details of the migratory journeys are therefore lacking. For example, it is uncertain whether Lord Howe, Norfolk and the Kermadec Islands are a destination or a staging post for long-tailed cuckoos. Cuckoos moving north and west can presumably rest on these islands, but there are no staging posts for long-tailed cuckoos migrating north-east. Perhaps they take a more circular route to French Polynesia. For shining cuckoos, analysis of bill-widths (which are wider on average in New Zealand than in Australian birds) has shown that many travel north via eastern Australia rather than directly to Melanesia.

Long-tailed cuckoos parasitise the three species of *Mohoua*: whiteheads on the North Island and yellowheads and brown creepers on the South Island. The shining cuckoo parasitises grey warblers on the mainland and Chatham Island warblers on the Chathams. Cuckoos probably return to New Zealand by homing to their natal area, and there they most likely seek out as hosts for their own breeding attempts the same species that raised them. When migrating north, the cuckoos presumably return to specific tropical islands rather than wintering at random. It therefore seems likely that different geographical breeding populations of New Zealand cuckoos associate with particular wintering islands in the Pacific.

Fidelity to wintering islands may mean that environmental impacts, such as deforestation, on particular Pacific islands, have the potential to knock-out cuckoo populations in specific parts of New Zealand. Likewise, declines in host populations in New Zealand could eliminate cuckoos from Pacific islands. Grey warblers are currently in good numbers and seem well able to sustain their brood-parasites. However, any further decline in the range of the whitehead, brown creeper and Chatham Island warbler may impact adversely on the cuckoo populations that parasitise these species. Because the yellowhead is now critically endangered, there must have been a concomitant drastic loss of the cuckoos adapted to parasitise yellowheads. Particular Pacific islands to which the yellowhead-cuckoos once migrated must now lack wintering cuckoos.

When hosts are translocated to new areas, parasitism by cuckoos is unlikely to follow quickly by chance. If it should become a conservation aim to boost long-tailed cuckoo numbers, using recently-established whitehead populations for example, it may be necessary to cross-foster cuckoo eggs or nestlings from an "old" whitehead area to the new one.

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Shining cuckoo. Little is known about the migration of New Zealand cuckoos nor how they are impacted by habitat change on the wintering grounds in the tropical Pacific. Photo by M. Andersson.

Trans-Tasman Migratory Birds

A few species of seabirds and the banded dotterel breed in New Zealand and migrate across the Tasman to Australia, but for none of them is the extent of migration well known. For several species it appears that only young birds visit Australia. For the Australasian gannet, the situation is confused by the fact that the species breeds in both Australia and New Zealand. Some New Zealand hatched gannets have been reported in Australia only eight days after fledging, yet others remain in New Zealand for their first year. Many young gannets may travel thousands of kilometres north and west during their first three to four years, but once they reach breeding age, New Zealand gannets appear to disperse around the New Zealand coast between breeding seasons. Some New Zealand breeding white-fronted terns also migrate to Australia between breeding seasons, over-wintering between southern Queensland and eastern South Australia, although most disperse around New Zealand with pronounced year to year variation in their over-wintering locations.

Hutton's shearwaters and fluttering shearwaters both breed only in New Zealand, but large numbers migrate across the Tasman. The extent of this migration, their destinations and their movements around Australia remain largely mysterious. After breeding, adult fluttering shearwaters are thought to remain close to their breeding grounds while young and non-breeding birds appear to migrate to Australia where they can be locally common between southern Queensland and South Australia. Black-bellied storm-petrels that breed on the Auckland and Antipodes Islands also probably migrate north to the Coral Sea but the extent of this migration is unknown.

The Banded dotterel breeds only in New Zealand but some cross the Tasman to over-winter in south-east Australia while others migrate to northern New Zealand. There is regional variation in the extent to which populations are migratory and where they go, as described in the following section.

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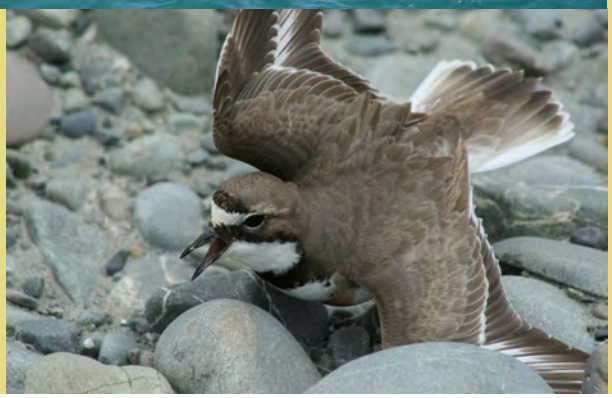

Top: Hutton's shearwaters breed in the seaward Kaikoura Mountains and over-winter in Australia where it is possible they circumnavigate the continent. Photo by G. Taylor.

Right: Banded dotterel breed in New Zealand but some populations migrate to Australia, some to northern New Zealand. Photo by P. Langlands.

Migration of Banded Dotterels: only Southerners go West

Banded dotterels are unique amongst New Zealand landbirds in that part of the population migrates to Australia. A study by the Ornithological Society of New Zealand (OSNZ) in the 1990's using catchment-based colour-banding revealed three broad patterns of post-breeding movement:

- A trans-Tasman migration of birds from the South Island high country to south-east Australia.
- Sedentary or local movements at several mainly coastal sites.
- A mainly south-to-north migration of birds from the western and northern South Island and southern North Island to tidal areas between Farewell Spit and the northern North Island.

The banded dotterel is not considered globally threatened, but the Department of Conservation currently lists the mainland race as Nationally Vulnerable. The total population of banded dotterels was estimated from OSNZ banding studies in the 1990's to be 50,000 birds. Subsequent studies on both sides of the Tasman have suggested that the population is declining. It is difficult to determine the extent of population decline because only a fraction of the entire population is counted during wader surveys due to their wide variety of roosting and high-tide foraging habitats. Apparent large declines at Parengarenga for instance could partly or wholly be an artefact of fewer of the "roosting" birds being located some years. However, the apparent overall decline based on flock counts is probably real and is supported by anecdotal observations of dotterel declines at some breeding habitats since the 1970s, including sites where the habitat appears little changed.

The threats to banded dotterels are poorly understood. Several studies have identified high levels of predation by cats, mustelids, rats and hedgehogs on adults, nests and young. Predation by introduced mammals, and degradation of breeding habitat, are likely to remain the key threats to banded dotterels on the breeding grounds.

Banded dotterels face a number of additional threats during migration. Because both migrant and sedentary birds utilise coastal habitats in the non-breeding period, both are increasingly threatened by coastal development. The coastal and harbour fringes of northern New Zealand and south-east Australia are increasingly subject to subdivision and development. The consequences to dotterels include the following:

- Loss of safe high tide roosting habitats resulting in reduced access to local foraging areas.
- Increased disturbance of birds at roost sites and feeding areas by people and their pets, and potentially predation by cats and dogs.
- Increased eutrophication of coastal wetlands.
- Possible increased collisions with power lines, wind turbines and other structures.

Managing banded dotterels in both New Zealand and Australia requires habitat protection and pest control at key sites on both the breeding and wintering grounds and improved public awareness of the threats facing these birds. Further research is required to determine local patterns of habitat use by the dotterels, in particular the importance of islands and other roost sites for migrating birds.

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Hutton's Shearwater: Trans-Tasman Traveller

Hutton's shearwaters only breed at high altitude in the seaward Kaikoura Mountains. Most evenings during the breeding season tens of thousands of birds can be seen rafting just off the Kaikoura coast waiting to head back into their mountain colonies. However, during the winter they leave New Zealand and migrate across the Tasman to spend their non-breeding season in Australian seas. This migration is not fully understood, but by piecing together data from a number of sources a pattern is emerging.

Bird count data from the Albatross Encounter's seabird watching trips shows that after being absent throughout winter, Hutton's shearwaters start returning to Kaikoura waters in early September. Numbers rapidly build up, reaching a peak by mid-October. Birds start returning to their breeding colonies in late September, often to find them still covered in snow. Numbers remain high in the sea off Kaikoura throughout the breeding season until late February/ March when they start to decline. Chicks fledge between mid-March and mid-April. By the end of April, Hutton's shearwaters are scarce in the seas off Kaikoura.

Beach patrol data from the Ornithological Society of New Zealand show a similar seasonal pattern with 75% of beach-wrecked birds recorded between October and March. Most of the beach-wrecked birds recorded during this time were found along the east coast of the South Island and the west coast of the North Island, suggesting that throughout the breeding season birds are feeding off these coasts.

Timings of sightings of Hutton's shearwater in Torres Strait and in Western and South Australia have led some authors to suggest the shearwaters make an anti-clockwise circumnavigation of Australia. Recoveries of banded birds certainly show that Hutton's shearwaters over-winter in Australian waters. All band returns during the breeding season are from New Zealand, and all recoveries from April to August are from Australia. However, the small number of Australian recoveries does not fully support the suggestion that they circumnavigate the continent, with all band recoveries having been made around southern Australia between Brisbane and Perth.

The Hutton's Shearwater Charitable Trust in collaboration with Microsoft Research and Oxford University has just started a three year project investigating the migration of Hutton's shearwater using geo-locator and GPS tracking. Over the next few years, it is hoped this technology will reveal the secrets of where these unique birds spend their winter.

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Birds that Migrate from one part of New Zealand to Another

A few species breed in one part of New Zealand and over winter in another part of the country. Several of these short-distance migrants involve birds that breed on South Island braided rivers but then move to the coast after breeding. The wrybill is the classic braided river migrant with virtually the entire population feeding on tidal flats in the Auckland region between breeding seasons. Black fronted terns also leave their river-bed breeding colonies late December to March returning in July and August, but they have no one destination, dispersing widely around the coast. Many Caspian terns that breed inland also move coastwards for winter.

Red-billed gulls are partially migratory, many of the birds from the huge Kaikoura and Nelson colonies move to the North Island for the winter, although they also remain common in the South throughout winter. Some South Island breeding Canada geese likewise migrate between high country breeding sites and coastal lakes wintering grounds. However, there is huge variation between populations. For example, geese at Lake Ellesmere mostly migrate to the high country to breed, while those resident on Lake Forsyth only 8 kilometres away are sedentary.

Bellbirds and tui in some parts of the country undertake movements in response to food availability. In some areas, these movements appear to be seasonal and regular while elsewhere the birds are resident. Welcome swallows and skylarks tend to be resident in the North Island but there is evidence of seasonal north-south movements for South Island breeding birds.

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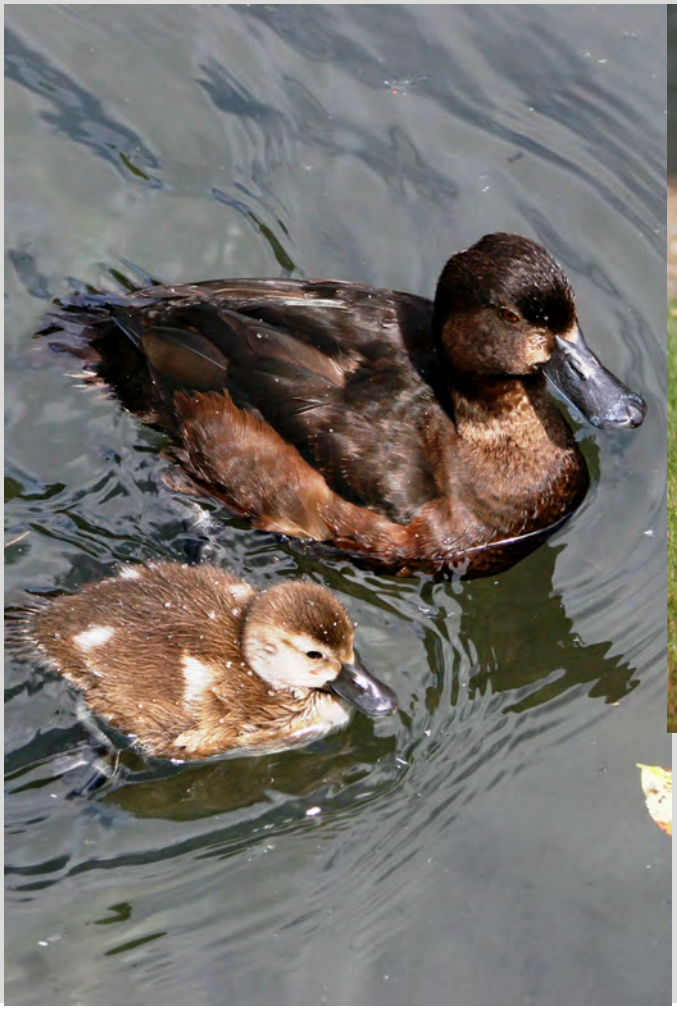
Moult Migrations of Waterfowl

New Zealand's waterfowl populations are relatively isolated; there are no regular movements of waterfowl between New Zealand and Australia or the Pacific islands. However, long-distance dispersals may be more common than we realise and periods of prolonged dry, windy conditions in New South Wales and Victoria may induce extensive trans-Tasman travel, particularly of grey teal and black swan, that could be difficult to detect here without detailed study. Recent documented movements of Canada geese, mallard and grey duck to Australia, of mallard to Lord Howe Island, New Caledonia, Raoul Island, Chatham Islands, and all the sub-Antarctic islands, and of plumed whistling duck, chestnut teal and Australian shelduck to New Zealand indicate that the Tasman and surrounding seas are not major barriers to waterfowl dispersal.

Within New Zealand at least four species (black swan, Canada goose, paradise shelduck and shoveler) undertake moult migrations and aggregate to moult and regrow their wing feathers. Historically, the largest and most conspicuous gathering of black swans was at Farewell Spit where birds from Hawkes Bay, Wairarapa, Manawatu, North Canterbury, West Coast and Marlborough intermingled in numbers sometimes reaching 20,000 birds. It is, however, almost 30 years since this aggregation was investigated and past patterns of assembly may have been overtaken by more regional gatherings on the proliferating *Zostera* beds of our tidal harbours. Similarly, the large but few South Island moult gatherings of Canada goose, such as those at Lakes Ellesmere and Forsyth, which attracted birds from a wide area of the eastern foothills, have diminished in importance as geese now moult on smaller water bodies or on rivers close to the fresh grasses that dry country irrigation now provide. The recent expansion of geese in the North Island is reflected by the presence of

Wrybills are endemic to New Zealand. They breed on the South Island's braided rivers and over-winter in Auckland region. Photo by P. Battley.



Left: New Zealand scaup. This endemic scaup may move from place to place on a regular annual basis but studies have not been sufficiently detailed to determine the extent and regularity of their movements. Photo by P. Langlands.

Above: A pair of paradise shelducks. The shelduck makes only very short migrations to congregate in small flocks at moulting sites. Photo by K.-J. Wilson.

moulting geese on many major lakes and, in two cases, within urban precincts.

Moult-induced movements of paradise shelducks have generally been of less than 30 km because of the bird's willingness to use farm ponds as moulting refuges. On the other hand, shoveler may be our most distant travelling water-bird. Presently only four major shoveler moulting sites are known, at each of which several hundred birds may gather, with individuals returning to the same site annually. One study of post-moult dispersal indicated shoveler travelled widely throughout New Zealand, some journeying from southern South Island to upper North Island and back in what may be a well-established annual pattern, influenced by the state and intensity of the El Nino-southern oscillation.

Grey teal and scaup may also undergo significant local and regional annual movements, perhaps to moult in flocks. Neither species has received other than cursory study. The rise and fall of winter scaup flocks on some lakes (e.g., Tarawera), hints at extensive local movement. The sudden arrivals and departures of grey teal flocks from shallow wetlands or sewage ponds in many parts of the country suggests this species may follow a similar pattern of annual nationwide movement to shoveler.

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Wind Farms and Birds

Wind generation currently contributes about 3% of New Zealand's energy production, but the forecast for expansion in wind-farm construction is likely to take this to nearly 20% over the next 10 years. To date, no published studies have assessed the impacts of wind-farms on birdlife in New Zealand. However, there have been several reviews of the international literature on the impacts of onshore wind-farms on birds. A key finding is that wind-farms tend to have variable effects on bird populations, which can be species-, season- and/or site-specific. The impacts include collision fatalities, habitat loss and disturbance. The main factors that contribute to collision fatalities are proximity to areas of high bird density or frequency of movements (migration routes, staging areas, wintering areas), the bird species involved (some are more prone to collision or displacement than others), landscape features that channel birds into areas with wind-farms and poor weather conditions. In many instances, the numbers of carcasses reported are likely to have been underestimates, as they are often based only on observed carcasses, without accounting for scavenging and searcher efficiency.

Habitat loss as a result of wind-farm construction would seem to have a minor impact on birds, as typically only 2–5% of the total wind-farm area is taken up by turbines, buildings and roads. However, the cumulative loss of sensitive or rare habitats may be significant, especially if multiple large developments are sited at locations of high bird use. Disturbance of birds as a result of wind-farm development may arise from increased activity of people at the site, and/or the presence, motion and noise of the turbines. The level of disturbance to birds has been shown to vary, depending on the availability of alternative feeding or breeding habitat. Although some of the findings from reviews of the international literature may be relevant to the New Zealand situation, it is important to realise that each wind-farm tends to have unique impacts as a result of topography, weather, habitats, land use, bird species and turbine characteristics.

In New Zealand the following species warrant particular consideration when present in the vicinity of a wind farm, or are likely to be moving through a wind farm on migration or during local movements: all kiwi, Australasian crested grebe, all penguins, threatened species of herons and their allies, blue duck, brown teal, New Zealand falcon, waders, and cuckoos. More research is required into the migratory behaviour of several native species to determine which wind-farm sites are most likely to result in collision fatalities.

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