Science for Saving Species

Research findings factsheet

Project 5.1.1

Threatened Species Recovery Hub

National Environmental Science Programme

Migration pathways and flight altitude selection of far eastern curlew

In brief

Migratory shorebirds such as the far eastern curlew and whimbrel undertake migrations for many thousands of kilometres across the East Asian-Australasian Flyway to breed in the northern hemisphere every year. Recent research has highlighted the significant impacts of habitat loss and destruction on these threatened birds' survival, particularly within the Yellow Sea region of the East China Sea part of their migrations.

We caught 22 far eastern curlew and 9 whimbrels from non-breeding regions from around Australia and fitted them with GPS trackers to learn about their specific migratory pathways.

We compared variations in timing, routes, use of stopover sites and breeding grounds. We examined impacts of human-driven land modification in breeding and non-breeding sites used by populations spending the non-breeding season in different parts of Australia. We determined what drives selection of flight altitude during migration. We also identified serious threats to the future conservation of these two migratory shorebirds.

We found that the migration paths of these birds overlap considerably, but that birds from south-eastern Australia set off on migrations earlier and stop in more southern breeding grounds in northern China, where human modification were more substantial to their preferred habitats. Migrating shorebirds showed a preference for low altitude flight, where they expend less energy and can navigate more easily. We found a need to mitigate threats in breeding grounds, but also to protect non-breeding habitats in Australia, where these birds spend over half of each year.

Migrating shorebirds prefer to fly at low altitude, where they can expend less energy and navigate more easily. Image: Amanda Lilleyman

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Background

Many species of migratory shorebird, such as the far eastern curlew (*Numenius madagascariensis*) and whimbrel (*Numenius phaeopus*), spend their non-breeding season in Australia and each year migrate along the East Asian-Australasian Flyway before returning.

The flyway connects essential habitats used by these birds from around Australia with their breeding grounds in northern China and eastern Siberia. The birds travel for thousands of kilometres, making important stopovers along the way. Environmental conditions and threats encountered along this journey impact their reproductive success and survival.

At each stopover, birds may be threatened by the loss or disturbance of habitat, or hunting. Loss of key habitats, particularly in the Yellow Sea region, is a significant driver of population decline for shorebirds. Soft sediment (mudflat) habitats are essential for the feeding birds but have been "reclaimed" by coastal developments and are being lost with rising sea levels in many places along the flyway.

When birds migrate, certain altitudes and atmospheric conditions reduce the energetic cost of migration and reduce loss of body water while flying. Atmospheric conditions such as humidity, wind speed, air temperature and air pressure are all drivers of these preferences and have the potential to impact migration success. Therefore, individual birds may vary not only in their selection of atmospheric variations but also in their choice of migratory path to minimise these impacts.

The far eastern curlew has declined by two-thirds or more at its non-breeding grounds in Australia, and is listed as Endangered on the IUCN Red List. However, the declines have not been uniform across the country. Numbers at sites near Broome and Darwin have been stable or even increasing but numbers at coastal sites from Moreton Bay around to South Australia and including Tasmania have declined greatly. These non-uniform declines suggest that birds using the different regions are exposed to different intensities of threat across their migration cycles.

Improving our understanding of the different migration paths within the East Asian-Australasian flyway, and how environmental variables and human driven threats affect migration success, we can help inform migratory shorebird conservation and minimise impacts into the future.

Research aims

We aimed to identify the key factors that lead to successful migrations for shorebirds.

We sought explanations for the varying rates of decline in different migratory shorebird populations from around Australia.

We also aimed to identify which atmospheric conditions most significantly impacted the selection of flight altitude and, ultimately, the success of long-distance migrations.

Curlews feeding in Darwin Harbour. Birds from north-western Australia fly further north during migrations and leave their non-breeding grounds two to three weeks later than birds from the south-east of Australia. Image: Amanda Lilleyman

What we did

Researchers and volunteers from a number of international universities, government departments and non-government organisations collaborated on this project between 2017 and 2021.

We captured far eastern curlew and whimbrels from non-breeding sites around Australia. Twenty-two far eastern curlew were captured in four locations: Roebuck Bay in Western Australia, Darwin Harbour in the Northern Territory, Moreton Bay in Queensland and Yallock Creek in Victoria. Nine whimbrels were captured in Roebuck Bay in Western Australia. All birds were fitted with tracking devices to record the location of the birds during their migrations. We collected 27,021 tracking position fixes for the curlew and 2,114 fixes for the whimbrel.

We assessed the routes that individual birds followed, as well as any stopovers along the way in their migrations. The remote tracking data was also supported by on-ground observations of tagged birds in Australia and at stop-over sites.

We measured the altitude at which birds flew during their migrations. Using a global atmospheric dataset, we determined the wind speed and direction, cloud cover, air temperature and humidity that birds experienced along the flight, and their relative importance to the birds. We also calculated the percentage of time that they spent flying above, in or below clouds in cloudy conditions to determine whether the birds were avoiding cloud cover.

We compared the degree of human impacts on the habitats

A far eastern curlew is fitted with a GPS tracker before its migration. Image: Gavin O'Brien

utilised by the shorebirds using a global map of human modification. This map combines 13 stressors, including human settlements and agriculture, to give a metric of human modification ranging from 0–1, at a resolution of 1 km^2.

We also assessed what proportion of time was spent in each country along the East Asian-Australasian flyway, averaged across individuals and years.

Key findings

This study provides a comprehensive evaluation of the migratory network used by populations of the Critically Endangered far eastern curlew from around Australia.

The most important finding has been that curlew from different regions of Australia appear to have geographically distinct breeding areas, which might explain regional differences in population trend. Thus, all curlew from Moreton Bay and Corner Inlet in south-east Australia bred farther south in the Amur River basin than did individuals from Broome and Darwin in north-west Australia. The habitat in these more southerly breeding grounds has been developed more intensively, primarily for agriculture, than has the breeding habitat further north. The birds face added pressure when they come to Australia with the coastal mudflats in south-east Australia having been more heavily altered than those in north-west Australia.

The differences in breeding area are consistent with the faster rates of decline reported for monitored curlew populations in south-east Queensland, New South wales, Victoria, Tasmania and south-east South Australia than those in the north-west of the continent. We found that individuals migrating from the south-east of Australia leave their non-breeding grounds two to three weeks earlier than individuals from north-west Australia. Historically, these birds probably benefited from leaving earlier because they gained first access to breeding sites. Curlews breeding further south would have had less exposure to harsher conditions experienced further north earlier in the breeding season. Today, however, these southerly sites are more heavily modified by humans.

All curlew are also likely to be affected by developments along the shores of the Yellow Sea where birds tagged at Broome and Darwin mixed with those from Moreton Bay and Corner Inlet. Fortunately, management actions starting to be undertaken in the Yellow Sea region, such as the introduction of World Heritage migratory bird sanctuaries, benefits both populations of curlew migrating through the region.

The far eastern curlew that we tracked used stopover sites in East Asia outside the Yellow Sea and some Japanese islands only during their northward migration. These sites may have been providing

Key findings (continued)

refuge from cyclones and other adverse weather events. Birds travelling from the north-west of Australia had more stopover opportunities than did individuals travelling from south-east Australia, which took a more easterly migration route over the open ocean.

We found that, despite occasional high-altitude migrations at up to 5,550 m above ground, the shorebirds preferred to fly well below 1,000 m, particularly along the coast. Their secondary preference was for altitudes where wind support and visibility were greatest. Wind support is when wind speed and direction benefit the migrating bird during flight. The migrating shorebirds did not appear to select flight altitude based on humidity or air temperature. We think that flight at higher altitudes increases the loss of water from the lungs, due to the air being less water-saturated. So, flying at lower altitudes, which has higher air densities that increase uplift, may both reduce water loss and the need to flap their wings as frequently compared to higher altitudes. This means that the curlew can cover greater distances using less effort, reducing the energetic cost of migrating. Birds flying at lower altitudes are better able to assess ground speed and flight direction, which they use to measure wind support and drift. The shorebirds can then improve their navigation precision while minimising energy and time wasted on correcting course mid-flight. Finally, we found that curlew (and closely related whimbrels) avoided cloud cover while flying, probably to make navigation easier.

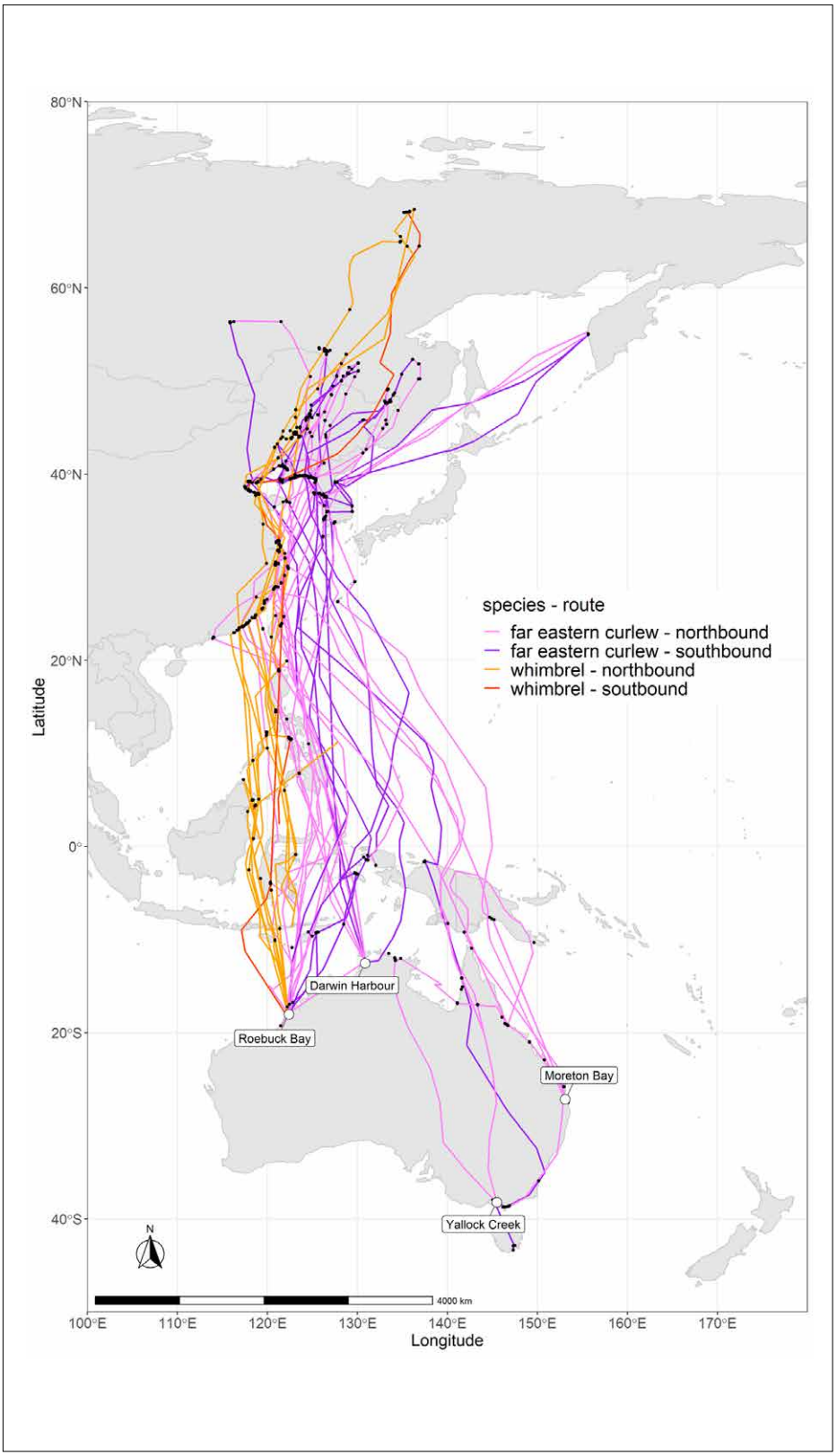

Figure 1: *Migratory routes of far eastern curlew (purple) and whimbrels (brown). Sites of transmitter deployment are marked by white dots. Stationary sites are marked by black dots.*

Research implications

These findings are most important for conservation groups and decision-makers who have jurisdiction over any of the breeding or non-breeding habitats used by migratory shorebirds. In providing a deeper understanding of the requirements of these birds and the threats to their persistence, we can better inform protective measures.

Though much of the recent research concerning these migrants has focused on the impacts of habitat loss and degradation in the Yellow Sea breeding grounds, we found that far eastern curlew spend on average nearly 60% of the year in Australia. The remainder of their year divided between China (15%), Russia (8%) and the rest scattered through multiple countries along the flyway. The proportion of time spent in Australia is highest for young birds that must mature before their first breeding migration. Adopting a holistic, global, annual cycle approach to research and conservation will improve the outlook for these highly threatened species.

In Australia, increased monitoring and protective measures are required for shorebirds, particularly the populations visiting south-east Australia, which have declined severely in the past few decades. The most important sites are well-known – the curlews did not highlight any unknown locations in Australia - but they require better protection from development and disturbance.

Further north on the flyway, a major knowledge gap exists about the contribution of other Pacific stopover sites to the population dynamics of these shorebirds as they migrate. Research is also needed to assess hunting pressures in the breeding grounds. Hunting presents a potentially serious threat to far eastern curlew populations outside Australia.

While population trends are stable or positive in northern Australia, the highly altered landscapes of the south-east Australian non-breeding sites and human-driven pressures to shorebird populations may potentially be significant and may be contributing to declines in those populations. This region bears a considerable responsibility for ensuring the persistence of migratory shorebird species by correctly managing coastal developments and mitigating threats from human pressures.

The role of some inland stopover sites north of the Yellow Sea region and near breeding grounds are poorly understood. They may be important courtship and pair-formation sites, or act as temporary "waiting rooms" while environmental conditions at the breeding grounds improve, or they may serve as important post-breeding refuelling sites. These stopover sites largely coincided with agricultural landscapes. Future research is required to improve understanding of the role that these sites play in the reproductive and migration biology of the curlew.

Our study of selection of flight altitude during migrations by the far eastern curlew and whimbrel can be used to look for the effects of climate change on these birds in

Knowing where, and at what altitude the curlew fly during migrations can help us to alleviate threat of bird strikes to both birds and infrastructure. Image: Amanda Lilleyman

Research implications (continued)

the future. Increasing ground and air temperatures may force migrants to fly at higher altitudes to stay cool, leading to increased loss of body water and energy expenditure during flight. These birds would then likely need to land more regularly to rest and feed, forcing them into sub-optimal habitat more regularly. While we cannot yet model future changes, we now have a baseline against which we can test these hypotheses.

Projected increased storm severity and frequency could also lead to changes in the timing and success of migrations. One of the tracked curlew from Victoria reached northern Australia and turned back after encountering a cyclone, skipping its northward migration for the year. This could significantly affect food availability in stopover sites, temperatures at breeding grounds and, ultimately, survival.

Sea-level rise also presents a considerable threat to key habitats, causing the loss of intertidal feeding grounds.

Finally, knowing that the birds are frequently flying below 1,000 m altitude, especially along the coasts, can help alleviate the threat of bird strikes to both birds and infrastructure such as air traffic, wind farms, power lines and other human-made structures.

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Curlew spend almost 60% of each year in Australia at non-breeding grounds. The remainder of their year is spent between China (15%), Russia (8%) and multiple countries along the flyway. It is important we take a global approach to their conservation. Image: Amanda Lilleyman

Further Information

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