



Life along land's edge

A new book documents
the amazing birds and
other wildlife of
Roebuck Bay.



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Photos by Jan van de Kam

Roebuck Bay and Eighty Mile Beach were 'discovered' as shorebird havens only two decades ago. During a dedicated effort to map the distribution of shorebirds on the Australian continent in the early 1980s, volunteers affiliated to the Royal Australasian Ornithologists Union (now Birds Australia) searched most shorelines of the Kimberley region by air, and visited Roebuck Bay on the ground. Only then did the presence of huge masses of shorebirds become known to the ornithological community.

These aerial and ground counts were immediately followed by more detailed investigations by the Australasian Wader Studies Group. First of all, the puzzle of the origin of the many shorebirds in Roebuck Bay and Eighty Mile Beach needed to be solved. Researchers in Roebuck Bay captured many shorebirds, and banded them with uniquely numbered metal rings and a coloured flag to indicate their capture in north-western Australia. From late in 1981 until 2003, about 40,000 shorebirds were fitted with numbered bands and coloured flags in Roebuck Bay. This effort has yielded about 750 sightings away from the bay,



in 12 countries, that tell us in detail about their migration routes and the whereabouts of their breeding grounds.

Big and bird-rich mudflats are rare

There are only a dozen or so areas in the world with huge intertidal flats rich in shorebirds, and north-western Australia offers two: Roebuck Bay and Eighty Mile Beach. Most areas of this intertidal hall of fame are found at temperate latitudes and/or are in river deltas. Only Roebuck Bay, Eighty Mile Beach and the extensive deposits off Guyana in South America are truly tropical. In addition, the north-western Australian areas are examples of intertidal flat systems without connections to large river outlets. And to make them even more special, Roebuck Bay and Eighty Mile

Previous page

Main The rock brigade: grey-tailed tattlers, ruddy turnstones and Terek sandpipers like roosting on rock stacks and are not deterred by a bit of spray.

Below Eastern curlews, bar-tailed godwits and a silver gull have landed in the waterline east of the Broome Bird Observatory. Smaller shorebird species, such as red knots and curlew sandpipers, are alighting.

Beach are within the 'Indopacific biogeographic region', which has the highest biodiversity of marine organisms in the world. Coincidentally, the tundras and taigas of far eastern Russia harbour the most diverse shorebird fauna of the circumpolar region, and many of these birds move to Roebuck Bay during the northern winter.

So, the uniqueness of Roebuck Bay has several dimensions. The bay lies in a corner of the Indian Ocean where the tides are among the largest on the Australian continent. Roebuck Bay is at the receiving end of the most species-rich of all shorebird flyways, and these shorebirds end up in the most biodiverse marine province of the



Right Very low tides at Gantheaume Point expose a dazzling variety of life clinging to the rocks, including green algae and bright blue compound ascidians. Also visible are a few corals and an alngate giant clam (*Tridacna maxima*). The turbid waters of nearby Roebuck Bay are not very good habitat for corals and giant clams, as both need sunlight to make a living.

Below left and right The same place—the coast near Broome Port—on different tides. The bay looks very different when the tide is out and the enormous intertidal flats are exposed.



world. Be it within the context of Australia, Australasia or the world, Roebuck Bay has no match.

International importance

The East Asian–Australasian flyway is very large. Birds migrating through this flyway breed in the far northern hemisphere, over an area extending from about 40° to 80°N, from Taymyr in the west to Alaska in the east. There is a funnelling effect on migration, as a large proportion of these birds refuel on the huge mudflats of the Yellow Sea. Further south they fan out again, and non-breeding grounds extend from south-east Asia to New Zealand.

Shorebirds occur in many parts of Australia. The greatest riches are along the tropical coasts of the north. Peak counts of well over half-a-million shorebirds have been made along Eighty Mile Beach, about another half-a-million are estimated to use the Northern Territory coast and about a quarter-of-a-million more occur in

Queensland, on the south-eastern coast of the Gulf of Carpentaria. Roebuck Bay, a much smaller area, holds maximum numbers of about 200,000 shorebirds, with perhaps 100,000 more using the adjacent catchment area of Roebuck Plains. To put this in context, maximum shorebird numbers are estimated at around 200,000 in South Australia and also in Victoria.

Sites are officially classified as being of international significance 'to a species' if they are inhabited by more than one per cent of the total flyway population of that species. By this measure, Roebuck Bay is the most important site for shorebirds in Australia: 20 migratory species occur there in internationally significant numbers (see the table on page 36). In addition, it is quite possible that this is also true of common sandpipers, marsh sandpipers and broad-billed sandpipers,

all of which are probably undercounted in the bay because of various technical difficulties in counting them. Finally, more than one per cent of the population of four species of resident waders is likely to occur in Roebuck Bay. The Gulf of Carpentaria and Eighty Mile Beach have similar (but slightly lower) numbers of species occurring in internationally significant numbers. In southern Australia, where species diversity is lower, no site comes close.

The migrant lifestyle

Red knots are a perfect example of the migrant lifestyle of many of Roebuck Bay's shorebirds. From the perspective of somebody in Broome, the cycle starts in late February (in the late wet season). Red knots start to replace their dull grey non-breeding plumage with a much more colourful plumage of rusty red feathers. They also





Left Two red knots in prime breeding condition, ready to depart to the tundra of the New Siberian Islands.

Shorebirds occurring in internationally significant numbers in Roebuck Bay and adjacent Roebuck Plains

Species	Estimated minimum flyway population	Highest single count in Roebuck Bay	More than one per cent of flyway population at Roebuck Bay
Asian dowitcher	23,000	414	Yes
bar-tailed godwit	325,000	65,000	Yes
black-tailed godwit	160,000	7,374	Yes
common greenshank	55,000	1,000	Yes
curlew sandpiper	180,000	6,000	Yes
eastern curlew	38,000	2,160	Yes
great knot	380,000	22,600	Yes
greater sand plover	100,000	26,900	Yes
grey plover	125,000	1,300	Yes
grey-tailed tattler	40,000	3,180	Yes
little curlew	180,000	55,000	Yes
oriental plover	70,000	8,700	Yes
oriental pratincole	75,000	50,000	Yes
red knot	220,000	11,200	Yes
red-necked stint	315,000	19,800	Yes
ruddy turnstone	31,000	2,060	Yes
sanderling	22,000	1,510	Yes
sharp-tailed sandpiper	160,000	3,000	Yes
Terek sandpiper	50,000	1,000	Yes
whimbrel	55,000	1,020	Yes
lesser sand plover	130,000	1,057	Nearly
marsh sandpiper	100,000	620	Nearly
broad-billed sandpiper	25,000	115	Nearly
common sandpiper	30,000		Nearly
*pied oystercatcher	10,000	190	Yes
*red-capped plover	95,000	3,300	Yes
*red-kneed dotterel	26,000	80	Nearly
*black-winged stilt	266,000	3,000	Yes
*sooty oystercatcher	4,000	30	Nearly

*Non-migratory species

start to load up the fuel for flight: fat. With the addition of less than one gram per day, fuelling is quite slow in Roebuck Bay compared with what red knots can do at staging sites in the northern hemisphere. In temperate regions, they may achieve fuelling rates of up to four grams per day. By April and early May, the red knots have increased in mass from 105 grams to about 160 grams, and they are ready for take off. Late in the afternoon, after a few hours of nervous calling, flocks of 20 to 100 birds take off, spiral up and then head in a northerly direction in a V-formation, straight across the Broome Peninsula and then over the Timor Sea.

In all likelihood, these red knots continue to fly for two to three days, at altitudes of up to five kilometres, to cover the 6,000 kilometres to the extensive mudflats of the northern Yellow Sea, in China and North Korea, which are emerging from under winter ice at this time of year. They will try to use any favourable tail winds found at high altitudes over the South China Sea. In northern China, they have only a few weeks to refuel before taking off for the 4,000-kilometre-long flight to the breeding grounds on the New Siberian Islands, a tundra archipelago in the Arctic Ocean due north of Japan.

Life is very busy from mid-June to late July. The red knots have a little less than four weeks to court, mate, lay a clutch of four eggs and complete incubation, and then another three weeks to raise the chicks to a stage where they can fly. And off they go again, making a similar trip south, arriving in Broome some time in September. The young birds have to do it on their own, and take longer, arriving in late September and October. What follows is a period of moult to replace the worn flight feathers, during which the birds grow their 'winter' plumage. This may be the only time of year that shorebirds are not really stressed for time.

Scientists at work in the mud

The ornithologists who were so impressed with the amazing numbers and diversity of birds in Roebuck Bay were quick to realise that such an abundance of birds could only stay alive in the presence of abundant food resources. Preliminary efforts by staff from the Department of Conservation and Land Management (CALM) in the late 1980s were followed, in February–May 1991, by a more detailed study of shorebirds and their invertebrate food sources by two Dutch students. It became clear then that the sands and muds of Roebuck Bay were rich feeding grounds.

The first large-scale effort to assess the biodiversity of Roebuck Bay's intertidal flats, which took place in June 1997, was partially repeated in

March 2000 and repeated and extended in June 2002. Using a grid of geographical coordinates that could be located using Global Positioning Systems (GPS), every gridpoint on the intertidal flats was visited on foot, by boat or by hovercraft.

At each gridpoint (200 metres apart along the northern shores and 400 metres apart in the rest of the bay) the invertebrates living on and in the upper 20 to 30 centimetres of the flats were mapped. The surface characteristics of the mud were recorded, a small sample of soft sediment was collected for

subsequent grain size measurements, and several cores of mud were sieved through one-millimetre-wide mesh to retrieve the invertebrates. The content, usually consisting of dead shell fragments mixed with live animals, was packed in plastic bags to be sorted to species level back at the Broome Bird Observatory. Bringing together a huge voluntary effort (150 people were involved in the 2002 campaign) with a group of dedicated specialists, Roebuck Bay now has some of the best-mapped intertidal flats in the world.

From March 1996, volunteers from

Right A group of specialists making detailed observations on the bivalves living in the mud and sand near Dampier Creek.

Below This black-winged stilt is a visitor from inland Australia. The adjacent mudskoper indicates that this bird was in an uncharacteristic salt water habitat.

Below right A male bar-tailed godwit gorges itself on a large polychaete worm on the soft mud in the eastern part of Roebuck Bay.





Above This onuphid bristle worm (*Diopatra* species) lives in a tough tube.
Photo – Marc Lavaleye

Left The black-necked stork stands almost as tall as a person, and is also impressive when it stalks over the mudflats with its long legs.

Below left A handful of cockles (*Anadara granosa*) and the smaller, more elongate *Anomalocardia squamosa*. Both species are heavy-shelled animals that do not burrow deeply. Cockles have been eaten by local Aboriginal people for many generations, and dominate middens (shell mounds) around Roebuck Bay.

Broome (organised through the Broome Bird Observatory) have also maintained another research program believed to be the only one of its kind in the world. At two muddy sites and two sandy sites, not far from the observatory, the invertebrates are sampled at monthly intervals to document seasonal and annual changes in their abundance. Every month, large numbers of cores are sieved at each site,

and the remains are sorted, counted and preserved, then sent to The Netherlands for specialist scrutiny. These investigations have shown that the wildlife of the intertidal flats is highly seasonal, and that some invertebrate species show considerable changes in abundance from year to year.

Amazing mudflats

The research by scientists from Australia, The Netherlands and the USA revealed that Roebuck Bay contained some of the most biodiverse mudflats in the world. In total, about 30,000 animals were measured and identified to about 265 species, a figure that will expand when specialists have sorted out the more difficult groups like the bristle worms.

Through this major effort, Roebuck Bay is now one of the most extensively sampled tropical mudflats in the world. Yet every year new animals are found in the bay, proving that its total richness of animal life is not uncovered completely. For example, the many samples taken during the research expeditions only covered a total surface of 40 square metres, a minuscule fraction of the

whole intertidal area of the bay. Even in the samples taken, millions of tiny animals were flushed through the coarse, one-millimetre mesh of the sieves and escaped discovery.

The bewildering diversity of the Roebuck Bay flats is in stark contrast to that of equivalent habitats within temperate regions. In the Wadden Sea in western Europe, for example, the diversity of bivalves is only a tenth that of Roebuck Bay. There, the stress for animals due to the large changes in temperature, salinity and food over the course of a year must be even greater than at Roebuck Bay. In this context, Roebuck Bay, with a world record number of species for a mudflat, is the more stable environment, although you would not say so while slowly sinking into the mud while sampling.





Above A high tide recedes from grey mangroves. These mudflats near Crab Creek are an especially important feeding area for shorebirds at low water on neap tides. They hold large numbers of mudskippers and sentinel crabs, and this prey attracts birds such as eastern curlew and whimbrels.

The conservation challenge

Roebuck Bay is a proposed marine conservation reserve. It was declared a Wetland of International Importance in 1990 under an international agreement called the Ramsar Treaty. This officially recognised its importance as a wetland refuge for many thousands of migratory shorebirds. In the future, there will be greater pressure on the wetland habitats, especially shorebird habitats, of Roebuck Bay. By far the most serious of these is disturbance by people. Uncontrolled use of off-road vehicles, disturbance from other means such as unleashed dogs or from horse riding, and loss of habitat through saltmarsh reclamation, drainage or filling are all serious threats. Others include the control of urban run-off, industrial pollutants, excessive boat traffic and overfishing, all of which could interrupt or destroy food chains. Yet, the biodiversity is entwined with the human history of Roebuck Bay. For thousands of years, Aboriginal communities favoured Roebuck Bay because they could always find food from the mudflats or nearby mangrove forests.

The conservation of Roebuck Bay seems to be at odds with an economically expanding Broome. However, keeping the bay in its present near-pristine state will help to keep the fishing and pearling industries healthy.

It has other benefits too, as there is a clear shift in tourist behaviour. Instead of just lying on the beach and staying in a good hotel, tourists are now more likely to seek a more active holiday that includes excursions to nearby natural attractions. Thus, the growth and the very existence of Broome depend on maintaining a healthy Roebuck Bay. To ensure the shorebird migration and other wildlife activities continue in harmony with human presence, organisations like Rubibi Aboriginal Land Heritage and Development Group and the Broome Bird Observatory host and coordinate a range of awareness raising activities. Through cooperative works with CALM, the Shire of Broome, tour operators, community groups such as Environs Kimberley and Minyirr Coastal Park, and supported by organisations such as WWF Australia, it is hoped that the environmental and cultural values of the area are protected and the level of human disturbance minimised.

Danny Rogers, a birdwatcher, mudbasher and PhD student, has had a lifetime association with shorebird research.

Theunis Piersma heads a research team at the Royal Netherlands Institute for Sea Research devoted to shorebirds and their interactions with intertidal benthic organisms and is professor of animal ecology at the University of Groningen.

Marc Lavaleye, a biologist with the Royal Netherlands Institute for Sea Research, has been involved in benthic work in Roebuck Bay since studies began.

Grant Pearson, a researcher with CALM's Biodiversity Conservation Group, has had a long association with shorebird and benthic research with a particular interest in intertidal ecosystems.

Petra de Goeij is a freelance biologist and ornithologist from The Netherlands. She was half of the first two-person team of biologists to study the feeding ecology of shorebirds in Roebuck Bay.

Dutch wildlife photographer Jan van de Kam has spent most of his life making pictures and films, and writing books about landscapes, plants and animals. In recent years he has focused mainly on shorebirds, following them from their Arctic breeding grounds to the places where they spend their winter. This work brought him to Australia, where he became hooked on the beauty of Roebuck Bay.

This article is based on *Life along land's edge: wildlife on the shores of Roebuck Bay, Broome*, a full colour hard cover book just released by CALM for \$39.95.



- 53 The Inering Hills—not just a bump in the landscape
A group of farmers are helping to protect a threatened ecological community only found on private farmland in the Shire of Carnamah.
- 56 Threatened invertebrates—our forgotten biodiversity
We take a closer look at some of the amazing Western Australian invertebrates that are listed as threatened.

Regulars

- 3 Contributors and Editor's letter
- 9 Bookmarks
Life along land's edge: wildlife on the shores of Roebuck Bay.
The Bird Man: The Extraordinary Story of John Gould.
Eagles, Hawks and Falcons of Australia.
- 18 Feature park
Jurien Bay Marine Park.
- 17 Endangered
Rough emu bush.
- 62 Urban antics
Brown goshawk.

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