

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

This Ramsar Information Sheet has been converted to meet the 2009 – 2012 format, but the RIS content has not been updated in this conversion. The new format seeks some additional information which could not yet be included. This information will be added when future updates of this Ramsar Information Sheet are completed. Until then, notes on any changes in the ecological character of the Ramsar site may be obtained from the Ecological Character Description (if completed) and other relevant sources.

1. Name and address of the compiler of this form:

Compiled by the Department of Conservation and Land Management (DCLM), with significant contributions by Tim Willing, Conservation Officer, DCLM, with assistance from: Chris Hassell, Broome Bird Observatory, Danny Rogers, Charles Sturt University, and Doug Watkins, Shorebird Flyway Officer, Wetlands International - Oceania.

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2. Date this sheet was completed/updated:

October 2003

3. Country:

Australia

4. Name of the Ramsar site:

The precise name of the designated site in one of the three official languages (English, French or Spanish) of the Convention. Alternative names, including in local language(s), should be given in parentheses after the precise name.

Roebuck Bay, Western Australia

5. Designation of new Ramsar site or update of existing site:

Roebuck Bay, Western Australia was designated on 7 June 1990

The previous RIS was dated 1998.

This RIS is for (tick one box only):

a) Designation of a new Ramsar site ☐; or

b) Updated information on an existing Ramsar site ☒

6. For RIS updates only, changes to the site since its designation or earlier update:

a) Site boundary and area

The Ramsar site boundary and site area are unchanged: ☐

or

If the site boundary has changed:

- i) the boundary has been delineated more accurately ☐; or
- ii) the boundary has been extended ☐; or
- iii) the boundary has been restricted** ☐

and/or

If the site area has changed:

- i) the area has been measured more accurately ☒; or
- ii) the area has been extended ☐; or
- iii) the area has been reduced** ☐

** **Important note:** If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site:

Refer to Annex III of the *Explanatory Note and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

- i) a hard copy (required for inclusion of site in the Ramsar List): ☒;
- ii) an electronic format (e.g. a JPEG or ArcView image) ☒;
- iii) a GIS file providing geo-referenced site boundary vectors and attribute tables ☐.

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park, etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

8. Geographical coordinates (latitude/longitude, in degrees and minutes):

Provide the coordinates of the approximate centre of the site and/or the limits of the site. If the site is composed of more than one separate area, provide coordinates for each of these areas.

Latitude: (approx.) 17° 58' S to 18° 16' S; Longitude: (approx.) 122° 08' E to 122° 27' E

9. General location:

Include in which part of the country and which large administrative region(s) the site lies and the location of the nearest large town.

Roebuck Bay is located in the Shire of Broome (local authority) in the State of Western Australia (population ca. 1.95 million in 2003). Roebuck Bay extends from Fisherman's Bend, immediately east of the town of Broome (population ca. 13,500 in 2001), to south of Sandy Point.

10. Elevation: (in metres: average and/or maximum & minimum)

Sea level

11. Area: (in hectares)

34 119 ha

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

Roebuck Bay is a tropical marine embayment with extensive, highly biologically diverse, intertidal mudflats. The site is internationally important for at least 20 species of migratory shorebirds with total numbers of waders using the site each year estimated at over 300 000. This makes Roebuck Bay one of the most important sites for shorebird conservation in the East Asian-Australasian Flyway.

13. Ramsar Criteria:

Tick the box under each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11). All Criteria which apply should be ticked.

1 •	2 •	3 •	4 •	5 •	6 •	7	8 •	9
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14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

The Criteria under which Roebuck Bay was originally nominated as a Ramsar Site were:

1(a) (It is a particularly good example of a specific type of wetland, characteristic of its region).

3(a) (It regularly supports 20,000 waterfowl).

3(c) (Where data on populations are available, it regularly supports 1% of the individuals in a population of one species or a subspecies of waterfowl).

Since that time, the Criteria have been further developed and re-numbered by Ramsar Conferences of the Contracting Parties. Furthermore, a re-assessment indicates that the site meets the following criteria:

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

[Includes former **criterion 1(a)**]

The Site is a superb example of a tropical marine embayment, and is one of only a dozen intertidal flats worldwide where benthic food sources support huge numbers of waders.

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Loggerhead Turtles *Caretta caretta* (nationally endangered) and Green Turtles *Chelonia mydas* (nationally vulnerable) regularly use the Site as a seasonal feeding area and as a transit area on migration. Flatback Turtles *Natator depressus* (nationally vulnerable) regularly nest in small numbers around Cape Villaret during the summer months.

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

Extensive sampling of benthic invertebrates within part of the Site during 1997 found that the total density of macrobenthic animals (greater than 1 mm in size) was 1,287 individuals per square metre. Only 10% of the taxa found could be identified to species level within three months, revealing a remarkable diversity of as-yet-undescribed benthic fauna. The total intertidal invertebrate diversity is estimated to be between 300 – 500 species.

Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

The Site is one of the most important migration stopover areas for shorebirds in Australia and globally. It is the arrival and departure point for large proportions of the Australian populations of several shorebird species, notably Bar-tailed Godwit *Limosa lapponica*, some of which fly non-stop between continental East Asia and Australia.

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

[Former **criterion 3(a)**]

The Site regularly supports over 100,000 waterbirds. The highest number of shorebirds counted at the site was 170,900 in October 1983 and allowing for turnover, the total number of shorebirds using the site may exceed 300,000 annually. It is the fourth most important site for waders in Australia in terms of absolute numbers and the most important in terms of the number of species it supports in internationally significant numbers (Criterion 6).

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

[Former **criterion 3(c)**]

The Site regularly supports more than 1% of the population of at least 22 wader species (20 migratory and 2 resident species): Large Sand Plover *Charadrius leschenaultii*, Oriental Plover *C. veredus*, Mongolian Plover *C. mongolus*, Red-capped Plover *C. ruficapillus* (resident), Grey Plover *Pluvialis squatarola*, Bar-tailed Godwit *Limosa lapponica*, Black-tailed Godwit *L. limosa*, Red Knot *Calidris canutus*, Great Knot *C. tenuirostris*, Red-necked Stint *C. ruficollis*, Curlew Sandpiper *C. ferruginea*, Sanderling *C. alba*, Eastern Curlew *Numenius madagascariensis*, Little Curlew *N. minutus*, Whimbrel *N. phaeopus*, Greenshank *Tringa nebularia*, Common Redshank *T. totanus*, Grey-tailed Tattler *T. brevipes*, Terek Sandpiper *T. terek*, Ruddy Turnstone *Arenaria interpres*, Asian Dowitcher *Limnodromus semipalmatus*, and Pied Oystercatcher *Haematopus longirostris* (resident).

Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

The Site supports an exceptionally high (globally) biomass of benthic invertebrates, including many species believed to be new to science, which enables the Site to support internationally significant numbers of migratory shorebirds (Criteria 5 and 6). The total intertidal invertebrate diversity is estimated to be between 300 – 500 species, placing the Site amongst the most diverse mudflats known in the world.

Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

The Site's extensive mangal system is an important nursery area for marine fishes and crustacea, particularly prawns.

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Dampierland (terrestrial bioregion) and Canning (marine meso-scale bioregion)

b) biogeographic regionalisation scheme (include reference citation):

Interim Biogeographic Regionalisation for Australia (IBRA) Version 5.1 (Cummings and Hardy 2000), and the Interim Marine and Coastal Regionalisation for Australia (IMCRA) Version 3.3 (IMCRA Technical Group 1998).

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Roebuck Bay is a megascale irregular-curved embayment, mostly occupied by intertidal mudflats and indented in the east by microscale linear tidal creeks. The Bay is bounded to the north-west and far south-east by low sand ridges (e.g. Bush and Sandy Points), and to the east and far north by coastal flat of Holocene marine sediment. A long red cliff, 2-6 m in height, of pindan soil with occasional patches of brown lateritic gravel, overlying yellowish-red Broome Sandstone of Cretaceous age dominates the northern shore of the Bay. At the base of the cliff, occasional dinosaur footprints are preserved in sandstone.

Roebuck Bay has a very large tidal range which exposes around 160 square kilometres of mudflat, approximately 45% of the total bay area, with tides travelling at up to 20cm/sec mid cycle (Hickey et al. 1998; Piersma et al. 2002). Most of the mudflat area is inundated by each high tide and at times, spring tides and/or cyclones may cause the adjoining coastal flats to become inundated. The tidal system is semi-diurnal with average tidal amplitude of 5.7m. Tidal range varies from c. 1 m on neap tides to 10.5 m on the highest spring tides (Rogers pers comms. 2002). These factors dominate the intertidal ecology.

Median and mean annual rainfall at Broome are 510 mm and 561 mm respectively, mostly falling in December-March; annual evaporation is c. 3050 mm. Eleven cyclones have passed within 50 km of Broome in the past 70 years.

On 20 April 2000, Cyclone Rosita crossed the coast over Thangoo Station, causing catastrophic damage to vegetation along the southern coast of Roebuck Bay and to buildings at Ecobeach Resort, near Cape Villaret (Willing pers comms. 2002).

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, and climate (including climate type).

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

19. Wetland Types

a) presence:

Circle or underline the applicable codes for the wetland types of the Ramsar "Classification System for Wetland Type" present in the Ramsar site. Descriptions of each wetland type code are provided in Annex I of the *Explanatory Notes & Guidelines*.

Marine/coastal: A • B • C • D • E • F • G • H • I • J • K • Zk(a)

Inland: L • M • N • O • P • Q • R • Sp • Ss • Tp • Ts • U • Va •
Vt • W • Xf • Xp • Y • Zg • Zk(b)

Human-made: 1 • 2 • 3 • 4 • 5 • 6 • 7 • 8 • 9 • Zk(c)

b) dominance:

List the wetland types identified in a) above in order of their dominance (by area) in the Ramsar site, starting with the wetland type with the largest area.

G, I, B

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

The site is one of the most important migration stopover areas for shorebirds in Australia and globally. Roebuck Bay is the arrival and departure point for large proportions of the Australian populations of several shorebird species (notably Bar-tailed Godwit *Limosa lapponica*), some of which fly non-stop between continental East Asia and Australia. Roebuck Bay is a rich wader feeding ground, supporting an exceptionally high (globally) macro-invertebrate biomass, including many species believed new to science (G. Pearson, pers. comm.). The Bay is also a major nursery area for marine fishes and crustaceans. Plant structural formations: Low closed-forest to open-scrub (mangrove) in periform arrangement in the east and south of the Bay; low shrubland (samphire) inland of the mangroves. Surrounding areas support low open-woodland (pindan) over grassland.

North-western Australia is the most important region for migratory waders on the continent, regularly supporting over 500 000 birds, with up to 850 000 birds using it annually. This region is considered to be the arrival and departure point for large proportions of the Australian populations of several migratory shorebird species. The major sites in the region are Eighty Mile Beach (also a Ramsar Site) and Roebuck Bay.

The largest number of waders counted at Roebuck Bay is 170 000 in October 1983 and it regularly supports over 100 000 birds. Based on this data, it is the fourth most important wader site in Australia in terms of absolute numbers and the most important in terms of the number of species it supports in internationally significant numbers (Rogers per comms. 2002). Shorebird numbers are highest in the austral spring when Palearctic migrants stop here to feed on their southward migration. The area also supports about 30 000 birds during winter, at a time of year when few adults of breeding age remain in Australia, and considerably larger numbers over summer, because many migrating birds remain in northern Australia rather than continuing south (Minton *et al.* In press). Fewer birds stop on the north-western coast to feed on the northwards migration but, nevertheless, numbers in autumn are very high.

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14, Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Seagrass Beds: Extensive seagrass beds occur in Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis* (Prince 1986). The most vigorous stands grow in areas that are exposed for less than two hours at low tide. These meadows are important feeding grounds for Dugong and Green Turtle (*Chelonia mydas*).

Mangroves: Broome is situated in the south-west Kimberley mangrove region (Johnstone 1990). This region runs from Cape Leveque, near the northern tip of the Dampier Peninsula, south to Whistle Creek, at the northern end of Eighty Mile Beach. Eleven mangrove species are known to occur in Roebuck Bay (Semeniuk et al. 1978). Within Roebuck Bay, Johnstone (1990) divides the mangroves into a northern and southern section.

The northern section is estimated to cover 640 ha and consists of a low open to closed forest of *Avicennia marina*, *Aegiceras corniculatum*, *Camptostemon schultzei* and *Rhizophora stylosa* with some *Aegialitis annulata* understorey. The common species on the landward and seaward edge of the mangroves is *Avicennia marina*. Scattered shrubs and trees of *Excoecaria agallocha* occur on the outer fringe.

The 200 ha Thangoo section is described as mixed woodland (to 5 m) of *Avicennia marina*, *Bruguiera exaristata*, *Osbornia octodonta* and *Camptostemon schultzei*. *Ceriops tagal* occurs as closed thickets on the landward zone with some *Excoecaria agallocha* (Johnstone 1990).

The mangroves have highest species diversity and tallest trees in Dampier and Crab Creeks and in Yardoogarra Creek, the inlet between Bush Point and Sandy Point. In these areas there is distinct zonation of the mangroves. The typical sequence of species in landward direction is *Avicennia*, *Rhizophora*, *Ceriops* and samphire or salt flats (Chalmers and Woods 1987).

Landward of the mangroves are areas of bare flats that are inundated on high spring tides. The hyper-salinity of the soil in these areas inhibits the establishment of vegetation.

Samphire Flats: Samphire also occurs landward from the edge of the mangroves. The dominant species in this community are: *Halosarcia halocnemoides*, *Muellerolimon salicorniaceum*, *Neobassia astrocarpa*, *Suaeda arbusculoides*, *Sesuvium portulacastrum* and *Hemichroa diandra* (Chalmers and Woods 1987). These flats may be inundated by some high tides.

Saline Grasslands: The saline grass plains are slightly higher in elevation than the samphire flats and the soil has a lower salinity. The dominant species is Saltwater Couch *Sporobolus virginicus*, which forms dense grassland 15-20 cm tall. Other species are *Dicanthium fecundum*, *Eragrostis falcata* and *Salsola kali*. Towards the edge of the grass plains, at the interface with pindan soils, occur thickets of *Melaleuca acacioides*, which grow to 10 m in height.

Pindan: Pindan is the name given to the open woodland, which occurs inland from the low cliffs between Fisherman's Bend and Crab Creek. The main tree species are: *Eucalyptus dampieri*, *Eucalyptus flavescens*, *Eucalyptus zygomorpha*, *Gyrocarpus americanus*, *Terminalia petiolaris*, *Lysiphyllum cunninghamii*, *Ventilago viminalis*, *Premna acuminata*, *Hakea macrocarpa*, *Persoonia falcata*, *Atalaya hemiglaucula* and *Gardenia pyrifolia*. The main shrub species are: *Acacia eriopoda*, *Acacia colei*, *Acacia adoxa*, *Pavetta kimberleyana*, *Carissa lanceolata*, *Distichostemon hispidulus*, *Ehretia saligna* and *Santalum lanceolatum* (Kenneally et al. 1996).

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 14. Justification for the application of the Criteria) indicating, e.g., which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Waterbirds: Roebuck Bay supports internationally significant numbers of at least 22 wader species (20 migratory and 2 resident species), all of which occur in numbers well in excess of 1% of the

flyway population (or Australian population, in the case of resident species). Highest counts for these species are:

Large Sand Plover	26 900	(Watkins 1993a)
Oriental Plover	8 700	(Watkins 1993a)
Mongolian Plover	1 057	(Watkins 1993a)
Red-capped Plover	3 300	(Watkins 1993a)
Grey Plover	1 300	(Watkins 1993a)
Bar-tailed Godwit	65 000	(Watkins 1993a)
Black-tailed Godwit	7 374	(Watkins 1993a)
Red Knot	11 200	(Watkins 1993a)
Great Knot	22 600	(Watkins 1993a)
Red-necked Stint	19 800	(Watkins 1993a)
Curlew Sandpiper	6 000	(Watkins 1993a)
Sanderling	1 510	(Watkins 1993a)
Eastern Curlew	2 160	(Watkins 1993a)
Little Curlew	5 000	(Watkins 1993a)
Whimbrel	1 020	(Watkins 1993a)
Greenshank	1 000	(AWSG data)
Common Redshank	16	(C. Hassell, pers. comm.)
Grey-tailed Tattler	3 180	(Watkins 1993a)
Terek Sandpiper	1 000	(Watkins 1993a)
Ruddy Turnstone	2 060	(Watkins 1993a)
Asian Dowitcher	414	(Rogers et al. 2000)
Pied Oystercatcher	190	(Watkins 1993a)

All of the migratory shorebirds are listed under the Japan – Australia Migratory Bird Agreement (JAMBA) and the China – Australia Migratory Bird Agreement (CAMBA) and are specially protected as matters of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation Act (1999).

A total of 64 waterbird species have been recorded, including four darters and cormorants, 11 herons and allies, 34 shorebirds and 11 gulls and terns (Broome Bird Observatory, unpublished data). One or two Beach Thick-knee *Esacus magnirostris* occur occasionally.

Waterbird Breeding: Four species found breeding in the vicinity of the Bay: Striated Heron *Butorides striatus*, Black-necked Stork *asiaticus* (sometimes breeds in taller mangroves south of Crab Creek), Osprey *Pandion haliaetus* and Brahminy Kite *Haliastur indus* (C. Hassell, pers. comm.). Black-winged Stilt *Himantopus himantopus*, Masked Lapwing *Vanellus miles*, Whiskered Tern *Chlidonias hybridus*, and Black Swan *Cygnus atratus* are known to nest at Kidneybean Claypan, in addition to several mangrove-specialised passerines in that habitat (D. Rogers, pers. comm.)

In November 1999, 29 Little Tern *Sterna albifrons* nests with one to three egg clutches were noted on the sand-spit at the mouth of “Jack’s Creek”, just south of Yardoogarra Creek (G. Swann, pers. comm.). Nearby, Bush Point is an important roost for this species, with a flock of 1200 recorded there in April 1996 (Collins & Jessop 1997).

Shorebird Migration Stop-over: 36 migrant shorebird species occur, including vagrants and species recorded at Kidneybean Claypan such as Swinhoe’s Snipe, Spotted Redshank, Long-toed Stint, Pectoral Sandpiper, Ruff, Red-necked Phalarope and Little Ringed Plover (D. Rogers, pers. comm.). Roebuck Bay is a principal arrival site in August-October for large proportions of the Australian populations of many shorebird species, especially larger species that travel non-stop from China to Australia. There is high turnover due to shorebirds moving onwards (e.g. to southeastern Australia:

some species arriving in Victoria within weeks) after feeding at the Bay to restore energy levels. However, very large numbers remain through summer and smaller numbers (mostly birds one to two years old) through winter. The area is also important (lower numbers) for northward departure of shorebirds; massed daytime departures of shorebirds occur in March-April. Shorebird departures from the site have been successfully tracked by radar (Lane & Jessop 1985) and afternoon migration watches (e.g. Tulp et al. 1994, Hassell 2000). Most birds depart between 1600 and 1800 hours, just prior to darkness, flying north-north-west. Most birds migrate in single species flocks with an average flock size of <100, though flocks of up to 2,000 are occasionally seen. Eastern Curlew, Greater Sand Plover and Great Knot are the first species to leave, commencing in the first week of March and mostly departing before the end of the month. Birds prefer to leave when tail winds are blowing at altitudes of 600-2,500 m (Minton et al., 2000).

Shorebird Banding: Banding of NW Australian shorebirds with a yellow plastic leg flag, attached to the right tibia, commenced in August 1992. This has greatly facilitated rapid visual recognition of birds captured in NW Australia at key stop-over sites and furnished valuable information in delineating migration routes, with over 36,000 waders flagged (Minton and Jessop 1999). Lists of sightings away from flagging locations (including China, Korea and Russia) have been published at almost annual intervals in the journal *Stilt*.

Shorebird Species Ecology: Rogers (1999a) classified shorebirds (and others) in Roebuck Bay as belonging to seven guilds on the basis of prey choice and foraging method. In order of abundance, these are:

- tactile hunters of macrobenthos, feeding mainly in sea-edge flocks (Great Knot, Red Knot, Bar-tailed Godwit, Black-tailed Godwit, Asian Dowitcher);
- tactile hunters of microbenthos, feeding mainly along sandy sea-edges or near tidal creeks (Curlew Sandpiper, Red-necked Stint, Broad-billed Sandpiper, Marsh Sandpiper, Sharp-tailed Sandpiper);
- visual hunters of slow surface-dwelling prey, feeding mainly on reefs or mangrove fringes (Common Sandpiper, Sooty Oystercatcher, Pied Oystercatcher, Silver Gull, Ruddy Turnstone);
- visual hunters of small fast prey, mainly occurring in the sandier western parts of Roebuck Bay, often near-shore (Grey Plover, Red-capped Plover, Greater Sand Plover, Lesser Sand Plover, Grey-tailed Tattler, Terek Sandpiper);
- visual hunters of fast large prey, mostly favouring soft mudflats in N.E. Roebuck Bay (Eastern Curlew, Whimbrel, Greenshank, Striated Heron and Black-necked Stork);
- kleptoparasites (only Gull-billed Tern, which robs large crabs from Whimbrels); and
- pelagic hunters of nekton (animals of the pelagic zone) and neuston (animals that live on the surface film), mainly associated with creek-lines in eastern Roebuck Bay (Black-winged Stilt, Red-necked Avocet, Reef Egret, Little Egret, Great White Egret, White-faced Heron, and Royal Spoonbill).

The majority of Little Curlew generally arrive at Broome in the third week of September, where birds utilise urban irrigated grassland such as sports ovals and Broome Golf Course. Departure on northward migration is more variable, usually commencing during the last week of March and extending to mid April (Collins and Jessop 2001).

Sand flats between Dampier Creek and Fishermans Bend provide habitat for many sand-dwelling benthic animals and are an important feeding area for Terek Sandpipers. In 2000, sand flats adjacent to Town Beach were found to be an important feeding area for both Lesser Sand Plovers and Red Knots, with high bivalve densities close inshore (D. Rogers, pers. comm.). Both these areas lie outside the Ramsar Site.

Shorebird Roosting: High tide diurnal roosts of 1 000-15 000 shorebirds occur at several sites at the base of the cliffs and on beaches between Fisherman's Bend and Crab Creek (C. Hassell, pers. comm.). These roosts are subject to considerable disturbance from raptors and sometimes humans. A larger roost of up to 50 000 shorebirds occurs at Bush Point. Exceptionally high tides force many birds to roost inland of the mangroves and some species (e.g. Whimbrels) routinely roost in the mangroves. It appears that during high tides at night, shorebirds do not roost on the northern beaches. Instead, they move behind the Crab Creek mangroves to areas such as "Kidneybean Claypan" on Roebuck Plains (Collins et al. 2001, Rogers et al. 2001) and to the southern end of Cable Beach (west of Roebuck Bay). During cyclones waders retreat to areas inland of the mangroves in large numbers (Jessop and Collins 2000.)

Roost choice in northern Roebuck Bay reflects the need of shorebirds to avoid excessive heat stress and minimise disturbance. Shorebirds show a strong preference for roosts where a damp substrate lowers local temperature (Rogers 1999b). During diurnal high tides reaching 5.9-8.5 m, the major roosting areas are Town Beach and beaches between Dampier Creek and Fishermans Bend. On neap high tides small, raised mudflats just south of Crab Creek are significant roosts. Cable Beach is favoured during nocturnal high tides, other than at neaps. Bush Point is a very large roost, mainly used by shorebirds feeding in the southern sector of Roebuck Bay. During spring tides over 9 m, shallow-water open areas at the rear of mangroves are important nocturnal roosts and are also utilised to a lesser extent diurnally (D. Rogers, pers. comm.).

Shorebird Numbers: Shorebird numbers in Roebuck Bay start to increase in August of each year with the arrival of adult birds after breeding. Numbers continue to rise until November as the juvenile birds arrive. In March numbers decline as adults return to breed in the Northern Hemisphere. Birds in their first year of life and some adults remain in Australia during the breeding season. In Roebuck Bay shorebird numbers in May to July are probably 20-30 per cent of the non-breeding season population – numbers are augmented by young birds from southeast and southern Australia that have undertaken a partial migration (D. Rogers, pers. comm.). In June/July 2003, a total of 37,500 waders were using Roebuck Bay (6,800 on the northern beaches and 30,700 at Bush Point), with 8 species present in internationally significant numbers (Pied Oystercatcher, Large Sand Plover, Red-capped Plover, Grey-tailed Tattler, Bar-tailed Godwit, Great Knot, Red-necked Stint, Sanderling – Minton et al. in press). The highest number of waterbirds (shorebirds) counted was 170 900 in October 1983 (national rank 4); allowing for turnover, the total number of shorebirds using the Bay may exceed 300 000 annually.

Grassland Birds: The saline grasslands of Roebuck Plains are important habitat for Oriental Plovers *Charadrius veredus*, Australian Pratincole *Stiltia isabella*, Oriental Pratincole *Glareola maldivarum* and Little Curlew *Numenius minutus*, as well as uncommon species such as Yellow Chat *Epthianura crocea* and Grass Owl *Tyto capensis* (D. Rogers, pers. comm.)

Bats: Insectivorous bats of the mangroves at Crab Creek have been studied as part of a larger study of the bat guilds in the Kimberley mangroves (McKenzie and Rolfe 1986). The species recorded were: *Taphozous flaviventris*, *Chaerephon jobensis*, *Mormopterus* nov. sp (Churchill 1998, p. 207), *Chalinolobus gouldii*, *Nycticeius greyi*, *Pipistrellus westralis* (Churchill 1998, p. 168-169) and *Nyctophilus arnhemensis*. Two species of flying fox (*Pteropus alecto* and *Pteropus scapulatus*) and one blossom bat (*Macroglossus minimus*) also occur at Broome.

Marine Fauna: A survey of dugongs *Dugong dugon* in the Kimberley, conducted by the Department of Conservation and Land Management in 1984 (Prince 1986), estimated the population in Roebuck Bay at 50 - 100 individuals. Dugongs are listed as a migratory species that is specially protected as a matter of national environmental significance under the Commonwealth Environment Protection and Biodiversity Conservation Act (1999).

Dolphins are known to occur in the Bay and include the Irrawaddy Dolphin *Orcaella brevirostris* which is listed as a migratory species and is specially protected as a matter of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999). Prince (1986) counted 37 dolphins during an aerial survey of the dugong population. All cetaceans within Australian waters are specially protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999).

Nationally threatened species that use the site include Loggerhead Turtle *Caretta caretta* (endangered) and Green Turtle *Chelonia mydas* (vulnerable). Loggerhead Turtles use the Bay as a seasonal feeding area and as a transit area on migration. The recovery of tagged Loggerhead Turtles indicated that some of the individuals nest on the sandy beaches near Exmouth. Flatback Turtles *Natator depressus* (vulnerable) regularly nest in small numbers around Cape Villaret during summer months (T. Willing, pers. obs.). Nationally threatened species are specially protected as matters of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999).

The extensive mangal is an important nursery area for marine fishes and crustacea, particularly prawns.

The Western Australian Museum has collected information on fiddler crabs (George and Jones 1982). Nine of the 17 species of fiddler crabs (*Uca* spp.) that occur in Australia have been recorded at Broome (Chalmers and Woods 1987). The scientific importance of the mangrove habitats and flats for the study of crabs has been noted in previous studies of the area (Chalmers and Woods 1987).

Benthic Fauna: Studies have also commenced on the benthic fauna of the mudflats by researchers associated with the Broome Bird Observatory, the Royal Netherlands Institute for Sea Research and the Department of Conservation and Land Management. The zoobenthic biomass near Crab Creek has been estimated to average 13.9 g ash free dry mass/m² (Tulp and de Goeij 1994). This is an index of the food availability in the top 30 cm of the mudflat.

In June 1997, the northern sector of Roebuck Bay's inter-tidal mudflats was quantitatively sampled in a grid pattern for benthic animals at over 500 sites. This was the first detailed mapping of benthic biodiversity ever undertaken on tropical intertidal mudflats. 17,700 individual animals were collected (Piersma et al. 1998). A total of 161 taxa were identified from sampling with another 30 taxa discovered opportunistically. The total density of macrobenthic animals retained on a 1 mm sieve was 1,287 ind./sq. m. Polychaete worms, especially the families Chaetopteridae and Oweniidae, dominated the fauna in terms of biomass (45%) and abundance (70% of all individuals). In abundance, bivalves comprised 12.5%, crustaceans 8%, brittle stars 4.2% and gastropods 2.5%. Only 10% of the taxa could be confidently assigned a species name within 3 months, revealing that the Bay holds a remarkable diversity of as-yet-undescribed benthic fauna (Pepping et al. 1999). Total intertidal invertebrate diversity is estimated at between 300 and 500 species – among the richest mudflats known in the world (Piersma et al. 1998). A preliminary examination of benthic invertebrate data gathered in 2002 suggests that there was considerable variation in the distribution and abundance of many invertebrates and sea grasses in the intertidal areas of the northern end of Roebuck Bay since previous surveys were undertaken in 1997 and 2000 (Piersma et al. 2002; Pepping et al. 1999). This may in part be due to the effects of Cyclone Rosita which crossed the coast at the site in April 2000.

23. Social and cultural values:

a) Describe if the site has any general social and/or cultural values e.g., fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values:

Roebuck Bay lies in the traditional estate of Aboriginal people belonging to both Jukun and Yawuru groups. In the Yawuru language, the Bay is named *Nalen Nalena* (Worms 1944). The northern shore from Burrugun (Dampier Creek), past the law grounds at Ganin (Fishermans Bend), to Mangkalagun (Crab Creek) was an important area for seasonal meetings, exchanging gifts, arranging marriages and settling disputes. In addition, many localities have Dreamtime stories associated with them (Lands & Mann 1990). Numerous shellfish middens, marking former camping places, can still be seen along coastal cliffs and dunes. Aboriginal people continue to make extensive use of the Bay's natural resources e.g., gathering shellfish, fishing and hunting Dugong.

The pearling industry has been established at Broome since the 1880s, initially for mother-of-pearl, but since 1956 has focused on high value cultured pearls. Broome's pearling history has contributed greatly to its multicultural character, bringing together Aboriginal, European and Asian (notably Japanese, Chinese, Filipino and Malay) peoples. The principal cultural event in the Broome calendar is Shinju Matsuri (Festival of the Pearl), held in July-August.

Broome Bird Observatory near Fall Point was opened in 1988; it is operated by Birds Australia, has full-time wardens and is used as an educational, research and recreation facility focusing on Roebuck Bay and its environs.

Recreational fishing is important near Broome and the Fall Point coast and there are several boat-launching sites in both areas. Much of the shoreline along the eastern side of the Bay is inaccessible, other than by boat at high tide.

Low cliffs offer a panoramic view across the northern Bay and the contrast of pale blue sea, dark green mangroves and red cliffs is particularly appealing. The cliffs and Crab Creek area offer one of the best places in the world for viewing shorebirds, because of the unique combination of accessibility, high species richness, very high densities and numbers.

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning?

If Yes, tick the box ☒ and describe this importance under one or more of the following categories:

- i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:
- ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:
- iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:
- iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

a) within the Ramsar site:

The Government of Western Australia has control over marine areas of the site. A Native Title Claim, lodged over the Bay by Yawuru Aboriginal Corporation in 1994, awaits resolution. The landward sections of the site are Unallocated Crown Land, except for a small reserve gazetted for the purpose of a Bird Observatory.

b) in the surrounding area:

Pastoral leases surround most of the Bay, excepting the north-western end where the Broome town site is located, and Fall Point, where the Broome Bird Observatory is located.

25. Current land (including water) use:

a) within the Ramsar site:

At present there is light recreational use of the northern part of Roebuck Bay, principally fishing and bird watching. There is also commercial fishing, pearling and industrial use, with deepwater port facilities at Broome. Crude oil from the Blina Oilfield, 300km north-east of Broome, is exported from Broome Port by tankers, which also deliver refined fuel products from Kwinana Refinery. Live cattle exports to Indonesia and the Philippines (74,000 head in 1999) are significant at Broome Port. Exploration permits for petroleum are held over the wetland area and there is a mining tenement around the Bush Point area. There are several commercial pearl farm leases in the Bay.

b) in the surroundings/catchment:

Grazing of cattle occurs on pastoral leases (Roebuck Plains and Thangoo Stations). The Broome urban area (residential and industrial) is adjacent to the site, with high human population (13,500 in 2001, growing at 4-5%).

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

a) within the Ramsar site:

Existing and foreseeable land uses are compatible with Roebuck Bay remaining an important site for waders. High tide wader roosts along much of the northern shore of the Bay are vulnerable to disturbance from off-road vehicles and pedestrian traffic. Careful management of increasing tourism is necessary to reduce disturbance at important roosts, especially on the accessible northern shore of the Bay.

b) in the surrounding area:

There is a proposal to construct a new international airport at a site 8 km north of the northern shore of Roebuck Bay and approximately 12 km NE of Broome. The Environmental Protection Authority has determined (EPA Bulletin 1017) that the proponent is obliged to prepare a Flora and Fauna Management Plan. The latter is to include a detailed assessment of the airport's impact on migratory waders.

Petroleum exploration may occur in future and, subject to appropriate environmental safeguards to maintain the ecological character of the wetland and habitat for waterbirds using it, will be compatible with the status of a Wetland of International Importance.

Proposed mining operations in the hinterlands behind the mangroves could result in de-watering of shallow surface aquifers, potentially affecting biodiversity values in the Bay. Similar impacts could occur from proposed intensive irrigated agriculture (e.g. for cotton) in the catchment area of the Bay. Industrial pollution and accidental sewage spills from the nearby township of Broome have the potential to adversely impact upon the benthic fauna, but the risks are reduced by the effect of strong tidal flushing.

The impact of commercial net fishing operations on the benthic fauna of the Bay and on indigenous fish harvests is not well understood (G. Pearson, DCLM, pers. comm.).

27. Conservation measures taken:

a) List national and/or international category and legal status of protected areas, including boundary relationships with the Ramsar site:

In particular, if the site is partly or wholly a World Heritage Site and/or a UNESCO Biosphere Reserve, please give the names of the site under these designations.

The site is listed on the Register of the National Estate.

b) If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate):

Ia ☐; Ib ☐; II ☐; III ☐; IV ☐; V ☐; VI ☐

c) Does an officially approved management plan exist; and is it being implemented?:

d) Describe any other current management practices:

WWF together with the local Aboriginal group Rubibi is implementing a shorebird conservation project involving community education and involvement in activities that will minimise the effects of human disturbance along the northern shores of Roebuck Bay. An ongoing community-based monitoring program of the benthic macrofauna has been undertaken since 1996.

Site management actions taken include:

- limiting vehicle access to beaches along the northern shore of the Bay;
- controlling human activity on the northern shore at high tide;
- developing a guided eco-tourism program by Broome Bird Observatory;
- developing an "Accident Response Plan" for the Port of Broome;
- promoting self-monitoring of dugong hunting by Aboriginal people;
- assessing full sustainability of fishing operations in the bay; and
- assessing impact of hovercraft use on the intertidal flats.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

There is a proposal to have a Marine Park declared in Roebuck Bay (Burbidge et al, 1991). A subsequent report (DCLM, 1994) recommended that the Marine Park boundaries should extend from the north side of Gantheaume Point to Cape Villaret, including coastal areas of pastoral lease, but excluding the jurisdiction of the Port of Broome.

Watkins (1993b) and Watkins et al. (1997) identified management issues for the site and the Department of Conservation and Land Management held preliminary discussions with the Shire of Broome in 2001 and community workshops in 2002 (Pearson, pers. comm.). Development and implementation of options for the future management of Roebuck Bay are dependent on extensive consultation with numerous community and Aboriginal stakeholders.

29. Current scientific research and facilities:

e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Birds Australia (formerly the Royal Australasian Ornithologists Union) operates an Observatory at the northern end of the wetland, which is staffed by full-time wardens and is used as an educational, recreational and research facility focussed on Roebuck Bay and its environs.

Broome Bird Observatory and a local volunteer group undertake regular cannon netting and wader banding on a monthly basis. The Australasian Wader Studies Group conducts large scale banding of waders as part of regular expeditions at intervals of approximately 18 months to two years. These

expeditions commenced in 1981. Many international participants have been involved, including Asian researchers (most sponsored by Environment Australia) seeking training in shorebird studies.

Several studies have focussed on the behaviour and ecophysiology of migratory waders, including shorebird roost choice, heat avoidance behaviour and preparation for migration (Tulp and de Geoijs 1994; Battley 2000; Rogers 1999a, 1999b, 2000).

The Department of Conservation and Land Management (DCLM) in collaboration with the Royal Netherlands Institute for Sea Research (NIOZ), Curtin University of Technology, Washington Central University, the University of Western Australia, Western Australian Museum, and the Birds Australia Broome Bird Observatory have undertaken extensive mapping of benthic invertebrate biodiversity in the mudflats of Roebuck Bay (Pepping et al. 1999; Piersma et al. 2002). The large spatial dataset generated by the research has been analysed and managed using innovative Geographic Information System (GIS) techniques (Hickey et al. 1998). The Netherlands Institute for Sea Research (NIOZ), in collaboration with DCLM, is supervising a postgraduate evaluation of the molluscan fauna of Roebuck Bay.

Curtin University, in collaboration with DCLM, has two current postgraduate studies focused on Roebuck Bay – one on hydrology (Vogwill) and the other on the nature and distribution of sediments (Oldmeadow).

Broome Bird Observatory and Environs Kimberley, in collaboration with DCLM and NIOZ, is conducting ongoing research into the sediments and benthos of the Bay with local community and Aboriginal support.

Environs Kimberley, Broome Bird Observatory, DCLM, NIOZ and Coastcare are preparing a photographic book on the ecology of the bay, due for release in late 2003.

30. Current communications, education, participation and awareness (CEPA) activities related to or benefiting the site:

e.g. visitors' centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Broome Bird Observatory has several walk-trails and interpretive displays, which are open to visitors. Telescopes can be hired and courses on the ecology of the Bay and its shorebirds are run periodically. Planning has commenced for a dedicated Visitor Centre to be constructed.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Recreational use consists of fishing, crabbing, sightseeing and bird watching. One commercial hovercraft company has operated scenic tours in the Bay since 1990. There is also growing tourist use of the wetland, especially in the cooler months of the dry season (May to September). Broome Airport recorded 195,000 passenger arrivals in 1999-2000.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept of Agriculture/Dept. of Environment, etc.

Government of Western Australia (territorial) and the Department of Conservation and Land Management (functional).

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Several State Government agencies are involved in management of the site. The key agency is the Department of Conservation and Land Management, because of the Ramsar Listing of the site.

The contact details for the management office are:

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PO Box 65
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34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

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