Information Sheet on EAA Flyway Network Sites (SIS) – 2017 version

Available for download from http://www.eaaflyway.net/about/the-flyway/flyway-site-network/

Categories approved by Second Meeting of the Partners of the East Asian-Australasian Flyway Partnership in Beijing, China 13-14 November 2007 - Report (Minutes) Agenda Item 3.13

Notes for compilers:

1. The management body intending to nominate a site for inclusion in the East Asian - Australasian Flyway Site Network is requested to complete a Site Information Sheet. The Site Information Sheet will provide the basic information of the site and detail how the site meets the criteria for inclusion in the Flyway Site Network. When there is a new nomination or an SIS update, the following sections with an asterisk (*), from Questions 1-14 and Question 30, must be filled or updated at least so that it can justify the international importance of the habitat for migratory waterbirds.

2. The Site Information Sheet is based on the Ramsar Information Sheet. If the site proposed for the Flyway Site Network is an existing Ramsar site then the documentation process can be simplified.

3. Once completed, the Site Information Sheet (and accompanying map(s)) should be submitted to the Flyway Partnership Secretariat. Compilers should provide an electronic (MS Word) copy of the Information Sheet and, where possible, digital versions (e.g. shapefile) of all maps.

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1. Name and contact details of the compiler of this form*:

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2. Date this sheet was completed*:

DD/MM/YYYY

13/01/2013

3. Country*:

Australia

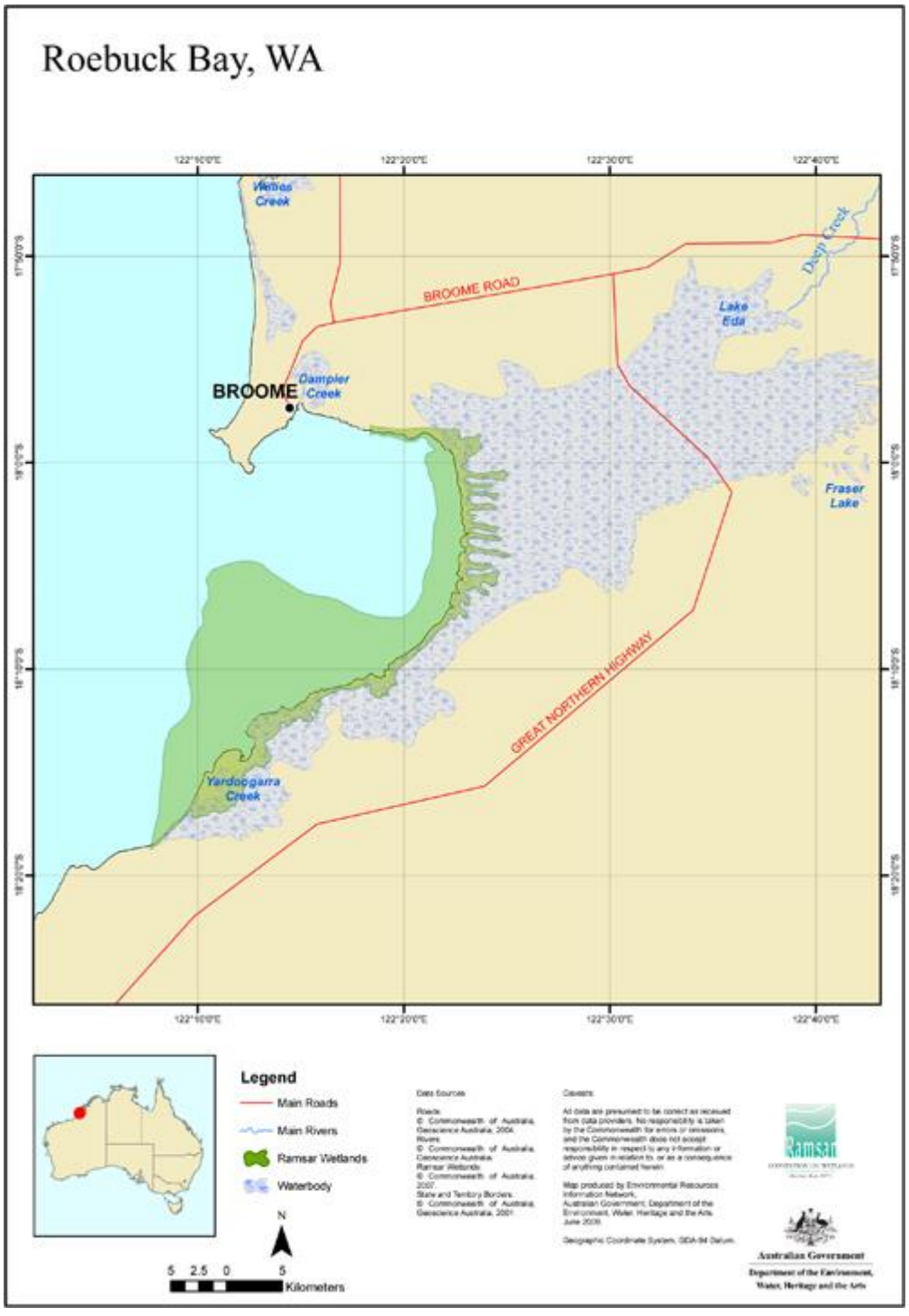
4. Name of the Flyway Network site*:

Accepted English transcription of the Site's name.

Roebuck Bay, Western Australia

5. Map of site*:

The most up-to-date available and suitable map of the wetland should be appended to the SIS (only in digital format and shape file). The map must clearly show the boundary of the site. Please refer to the "Digitising Site Boundaries in Google Earth" file linked here.



6. Geographical coordinates (latitude/longitude, in decimal degrees)*:

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

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

Sea level

8. Area*:

The total area of the site, in hectares. If the areas of discrete site units are known, please also list each of these together with the names (or labels) used to identify and differentiate these units.

34,119 ha

9. General overview of the site*:

A brief (two sentences) summary of the site, mentioning principal physical and ecological functions, and its importance for migratory waterbirds.

Roebuck Bay is located in the Shire of Broome (local authority) in the State of Western Australia (population ca. 1.95 million in 2003), Australia. Roebuck Bay extends from Fisherman's Bend, immediately east of the town of Broome (population ca. 11,547 in 2006), to south of Sandy Point (see map attached).

The site is one of the most important migration stopover and non-breeding 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 shorebird 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.

10. Justification of Flyway Site Network criteria*:

Please provide waterbird count information (with year of latest count) that demonstrates that the site meets the criteria of the Flyway Site Network (Annex 1). That is:

- it regularly supports > 20 000 migratory waterbirds; or,
- it regularly supports > 1 % of the individuals in a population of one species or subspecies of migratory waterbird; or,
- it supports appreciable numbers of an endangered or vulnerable population of migratory waterbird
- it is a “staging site” supporting > 5 000 waterbirds, or > 0.25% of a population stage at the site.

A listing of the populations of migratory waterbirds covered by the East Asian – Australasian Flyway Partnership and the 1% thresholds is attached (Annex 3).

The “staging site” criterion is particularly difficult to apply and application of this should be discussed with the Secretariat. Also note that some species have several populations that are very difficult to distinguish in the field.

North-western Australia is the most important region for migratory shorebirds 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.

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 shorebirds using the site each year in many years estimated at over 100,000. Roebuck Bay remains one of the most important sites for shorebird conservation in the East Asian-Australasian Flyway.

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

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 shorebirds in Australia in terms of absolute numbers and the most important in terms of the number of species it supports in internationally significant numbers. A total of 40,577 shorebirds were counted at the site during the summer of 2009-2010 (Shorebirds 2020 database),

Shorebird numbers are highest in the Austral spring when Palaearctic migrants stop here to feed on their southward migration. The area also often 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. Fewer birds stop on the north-western coast to feed on the northwards migration but, nevertheless, numbers in autumn are very high.

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.

Roebuck Bay supports internationally significant numbers of at least 21 shorebird species (19 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:

Species	Highest Count	EAAF 1% threshold	Source
Greater Sand Plover *Charadrius leschenaultia*	**26 900**	1,000	Bamford et. al. 2008
Oriental Plover *C. veredus*	**8 700**	700	Bamford et. al. 2008
Lesser Sand Plover *C. mongolus mongolus*	**1 057**	400	Watkins 1993a
Red-capped Plover *C. ruficapillus* (resident)	**6 531**	950	Rogers et al. 2011
Grey Plover *Pluvialis squatarola*	**1 300**	1 250	Bamford et. al. 2008
Bar-tailed Godwit *Limosa lapponica*	**65 000**	1 700	Bamford et. al. 2008
Black-tailed Godwit *Limosa limosa*	**7 374**	1 600	Bamford et. al. 2008
Red Knot *Calidris canutus*	**11 200**	2 200	Bamford et. al. 2008
Great Knot *C. tenuirostris*	**30 361**	3 800	Rogers et al. 2011
Red-necked Stint *C. ruficollis*	**19 800**	3 150	Bamford et. al. 2008
Curlew Sandpiper *C. ferruginea*	**6 000**	1 800	Bamford et. al. 2008
Sanderling *C. alba*	**3 235**	220	Rogers et al. 2011
Eastern Curlew *Numenius madagascariensis*	**2 160**	380	Bamford et. al. 2008
Little Curlew *N. minutus*	**5 000**	1 800	Bamford et. al. 2008
Whimbrel *Numenius phaeopus variegatus*	**1 100**	550	Rogers et al. 2011
Common Greenshank *Tringa nebularia*	**1 000**	1 000	Bamford et. al. 2008
Grey-tailed Tattler *T. brevipes*	**3 185**	400	Bamford et. al. 2008
Terek Sandpiper *Xenus cinereus*	**1 840**	500	Bamford et. al. 2008
Ruddy Turnstone *Arenaria interpres*	**2 060**	350	Bamford et. al. 2008
Asian Dowitcher *Limnodromus semipalmatus*	**414**	230	Bamford et. al. 2008
Pied Oystercatcher *Haematopus longirostris (*Resident)	**547**	100	Rogers et al. 2011

Eight migratory shorebird species were recorded in numbers above the 1% criterion level during the summer of 2009/10; 5,595 Bar-tailed Godwit *Limosa lapponica*, 1,187 Whimbrel *Numenius phaeopus*, 634 Terek Sandpiper *Xenus cinereus*, 2,332 Grey-tailed Tattler *Tringa brevipes*, 19,762 Great Knot *Calidris tenuirostris*, 3,076 Red Knot *Calidris canutus*, 1,238 Greater Sand Plover *Charadrius leschenaultii, and* 898 Oriental Plover *Charadrius veredus* (Shorebirds 2020 database).

11. Wetland Types*:

List the wetland types present (see Annex 2). List the wetland types in order of their area in the Flyway Network site, starting with the wetland type with the largest area.

B **Marine subtidal aquatic beds**; includes kelp beds, sea-grass beds, and tropical marine meadows.

G **Intertidal mud, sand or salt flats.**

I **Intertidal forested wetlands;** includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

12. Jurisdiction*:

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

Territorial: Government of Western Australia

Functional: Department of Environment and Conservation

13. 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 and the title and/or name and email address/phone number of the person or persons in this office with direct responsibility for managing the wetland.

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

The contact details for the management office are:

Department of Environment and Conservation
PO Box 65
Broome WESTERN AUSTRALIA, 672

14. Bibliographical references*:

A list of key technical references relevant to the wetland, including management plans, major scientific reports, and bibliographies, if such exist. Please list Web site addresses dedicated to the site or which prominently feature the site, and include the date that the Web site was most recently updated. When a large body of published material is available about the site, only the most important references need be cited, with priority being given to recent literature containing extensive bibliographies.

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Australia : behaviour, timing and possible migration routes. *Ardea* 82, 201-221.

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From the Ramsar Information Sheet (RIS) for Roebuck Bay

15. 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).

16. Physical features of the catchment area:

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

17. Hydrological values:

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

18. General ecological features:

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

The site is one of the most important migration stopover and non-breeding 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 shorebird 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 shorebirds 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 shorebirds 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 shorebird 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 Palaearctic 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.

19. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy 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 SIS.*
(Please add here the species which do not come under sec no 14)

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 schultzii* 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 schultzii. 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 zygophylla*, *Gyrocarpus americanus*, *Terminalia petiolaris, Lysiphyllum cunninghamii, Ventilago viminalis, Premna acuminata, Hakea macrocarpa, Persoonia falcata, Atalaya hemiglauca* and *Gardenia pyriformis.* 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).

20. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 10. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the SIS.*

(Please add here the species which do not come under sec no 14)

Waterbirds: Roebuck Bay supports internationally significant numbers of at least 21 shorebird species (19 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).

All of the migratory shorebirds are listed under the Japan – Australia Migratory Bird Agreement (JAMBA), the China – Australia Migratory Bird Agreement (CAMBA) and the Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA) 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, 40 shorebirds and 11 gulls and terns (Broome Bird Observatory, unpublished data). One or two Beach Stone-curlew *Esacus magnirostris* occur occasionally.

Waterbird Breeding: Four species found breeding in the vicinity of the Bay: Striated Heron *Butorides striata,* Black-necked Stork *Ephippiorhynchus 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 south-eastern 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 shorebird 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 Curlews 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 75 000+ 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 shorebirds 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 shorebirds 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 (*Macroglossusminimus*) 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 Australian Snubfin Dolphin *Orcaella heinsohni* 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 E*nvironment 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/m_2 (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.

21. Social, economic and cultural values:

a) Describe if the site has any general social, economic 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 Burrgugun (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 BirdLife 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? (Double-click the checkbox to check and choose "Checked" under "Default Value" from "Check Box Form Field Options" window)

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: ☐

22. Land tenure/ownership:

a) Within the Flyway Network site:

The Government of Western Australia has control over marine areas of the site. A Native Title Claim was lodged over the Bay by Yawuru Aboriginal Corporation in 1994. 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.

23. Current land (including water) use:

a) Within the Flyway Network 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. Live cattle exports to Indonesia and the Philippines 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 (11,547 in 2006, growing at 4-5%).

24. 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 Flyway Network site:

Existing and foreseeable land uses are compatible with Roebuck Bay remaining an important site for shorebirds. High tide shorebird 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 was 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 shorebirds.

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.).

25. Conservation measures taken:

a) List national and/or international category and legal status of protected areas, including boundary relationships with the Flyway Network 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.

In 2012, a 304 km^2 '*Roebuck Commonwealth Marine Reserve*' was proposed (IUCN Category VI). This new reserve provides connectivity with proposed state Marine Park. The Marine

Reserve aims to protect foraging areas adjacent to important breeding areas for migratory seabirds, shorebirds and marine turtles.

b) If appropriate, list the IUCN (1994) protected areas category/ies which apply to the site (tick the box or boxes as appropriate, see Annex 3):

Ia ☐; Ib ☐; II ☐; III ☐; IV ☐; V ☐; VI ☐; N/A ☐

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

If yes, is it being implemented?: If no, is one being planned?

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.

26. 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.

27. Current scientific research and facilities:

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

BirdLife 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 shorebird banding on a monthly basis. Global Flyway Network have a paid employee working in Roebuck Bay on shorebirds. Money is sourced from BirdLife-Netherlands. Main activities are the capture, banding and resighting of shorebirds and also the education and involvement of the local community in ‘citizen science’.

The Australasian Wader Studies Group conducts large scale banding of shorebirds 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 shorebirds, including shorebird roost choice, heat avoidance behaviour and preparation for migration (Tulp and de Geoij 1994; Battley 2000; Rogers 1999a, 1999b, 2000).

The then 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 BirdLife 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, supervised 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, are conducting ongoing research into the sediments and benthos of the Bay with local community and Aboriginal support.

28. Current communications, education and public 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. Global Flyway Network involves the community in 'citizen science'. GFN have regular radio and occasional TV appearances to promote the bays ecological values.

29. 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.

30. Threats*:

Which of the following threats is present historically – when the threat stopped but the effects are still there (H), currently (C) or potentially (P)?

	Historically	Currently	Potentially
Residential and commercial development			
housing and urban areas	☐	☐	☐
commercial and industrial areas	☐	☐	☐

tourism and recreation areas	☐	☐	☐
Agriculture and aquaculture			
annual and perennial non-timber crops	☐	☐	☐
wood and pulp plantations	☐	☐	☐
livestock farming and ranching	☐	☐	☐
marine and freshwater aquaculture	☐	☐	☐
Energy production and mining			
oil and gas drilling	☐	☐	☐
mining and quarrying	☐	☐	☐
renewable energy	☐	☐	☐
Transportation and service corridors			
roads and railroads	☐	☐	☐
utility and service lines	☐	☐	☐
shipping lanes	☐	☐	☐
flight paths	☐	☐	☐
Biological resource use			
hunting and collecting terrestrial animals	☐	☐	☐
gathering terrestrial plants	☐	☐	☐
logging and wood harvesting	☐	☐	☐
fishing and harvesting aquatic resources	☐	☐	☐
Human intrusions and disturbance			
recreational activities	☐	☐	☐
war, civil unrest and military exercises	☐	☐	☐
work and other activities	☐	☐	☐
Natural system modifications			
fire and fire suppression	☐	☐	☐
dams and water management/use	☐	☐	☐
other ecosystem modifications	☐	☐	☐
Invasive and other problematic species and genes			
invasive non-native/alien species	☐	☐	☐

problematic native species	☐	☐	☐
introduced genetic material	☐	☐	☐
Pollution			
household sewage and urban waste water	☐	☐	☐
industrial and military effluents	☐	☐	☐
agricultural and forestry effluents	☐	☐	☐
garbage and solid waste	☐	☐	☐
air-borne pollutants	☐	☐	☐
excess energy	☐	☐	☐
Geological events			
volcanoes	☐	☐	☐
earthquakes/tsunamis	☐	☐	☐
avalanches/landslides	☐	☐	☐
Climate change and severe weather			
habitat shifting and alteration	☐	☐	☐
droughts	☐	☐	☐
temperature extremes	☐	☐	☐
storms and flooding	☐	☐	☐

Please write here any additional threats and comments/queries you have on the threats.

Annex 1: Criteria for the inclusion of sites in the Flyway Site Network

(From the Partnership Text)

To be considered for inclusion in the Flyway Site Network, this Partnership adopts the following criteria:

a. Convention on Wetlands (Ramsar, Iran, 1971) criteria for internationally important sites for migratory waterbirds. That is:

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

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

   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.

b. The staging criteria as applied under the Asia - Pacific Migratory Waterbird Conservation Strategy. That is:

   i. A staging site should be considered internationally important if it regularly supports 0.25% of individuals in a population of one species or subspecies of waterbirds on migration.

   ii. A staging site should be considered internationally important if it regularly supports 5,000 or more waterbirds at one time during migration.

c. Under exceptional circumstances a site can be nominated if it supports migratory waterbirds at a level or stage of their life cycle important to the maintenance of flyway populations. Justification of such nominations will be considered by the Partnership on a case by case basis.

Annex 2: Ramsar Classification System for Wetland Type

The codes are based upon the Ramsar Classification System for Wetland Type as approved by Recommendation 4.7 and amended by Resolutions VI.5 and VII.11 of the Conference of the Contracting Parties. The categories listed herein are intended to provide only a very broad framework to aid rapid identification of the main wetland habitats represented at each site.

To assist in identification of the correct Wetland Types to list in section 19 of the RIS, the Secretariat has provided below tabulations for Marine/Coastal Wetlands and Inland Wetlands of some of the characteristics of each Wetland Type.

Marine/Coastal Wetlands

A -- **Permanent shallow marine waters** in most cases less than six metres deep at low tide; includes sea bays and straits.

B -- **Marine subtidal aquatic beds**; includes kelp beds, sea-grass beds, tropical marine meadows.

C -- **Coral reefs**.

D -- **Rocky marine shores**; includes rocky offshore islands, sea cliffs.

E -- **Sand, shingle or pebble shores**; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

F -- **Estuarine waters**; permanent water of estuaries and estuarine systems of deltas.

G -- **Intertidal mud, sand or salt flats**.

H -- **Intertidal marshes**; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.

I -- **Intertidal forested wetlands**; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

J -- **Coastal brackish/saline lagoons**; brackish to saline lagoons with at least one relatively narrow connection to the sea.

K -- **Coastal freshwater lagoons**; includes freshwater delta lagoons.

Zk(a) – **Karst and other subterranean hydrological systems**, marine/coastal

Inland Wetlands

L -- **Permanent inland deltas**.

M -- **Permanent rivers/streams/creeks**; includes waterfalls.

N -- **Seasonal/intermittent/irregular rivers/streams/creeks**.

O -- **Permanent freshwater lakes** (over 8 ha); includes large oxbow lakes.

P -- **Seasonal/intermittent freshwater lakes** (over 8 ha); includes floodplain lakes.

Q -- **Permanent saline/brackish/alkaline lakes**.

R -- **Seasonal/intermittent saline/brackish/alkaline lakes and flats**.

Sp -- **Permanent saline/brackish/alkaline marshes/pools**.

Ss -- **Seasonal/intermittent saline/brackish/alkaline marshes/pools**.

Tp -- **Permanent freshwater marshes/pools**; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.

Ts -- **Seasonal/intermittent freshwater marshes/pools on inorganic soils**; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

U -- **Non-forested peatlands**; includes shrub or open bogs, swamps, fens.

Va -- **Alpine wetlands**; includes alpine meadows, temporary waters from snowmelt.

Vt -- **Tundra wetlands**; includes tundra pools, temporary waters from snowmelt.

W -- **Shrub-dominated wetlands**; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.

Xf -- **Freshwater, tree-dominated wetlands**; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.

Xp -- **Forested peatlands**; peatswamp forests.

Y -- **Freshwater springs; oases**.

Zg -- **Geothermal wetlands**

Zk(b) – **Karst and other subterranean hydrological systems**, inland

Note: "**floodplain**" is a broad term used to refer to one or more wetland types, which may include examples from the R, Ss, Ts, W, Xf, Xp, or other wetland types. Some examples of floodplain wetlands are seasonally inundated grassland (including natural wet meadows), shrublands, woodlands and forests. Floodplain wetlands are not listed as a specific wetland type herein.

Human-made wetlands

1 -- **Aquaculture** (e.g., fish/shrimp) **ponds**

2 -- **Ponds**; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).

3 -- **Irrigated land**; includes irrigation channels and rice fields.

4 -- **Seasonally flooded agricultural land** (including intensively managed or grazed wet meadow or pasture).

5 -- **Salt exploitation sites**; salt pans, salines, etc.

6 -- **Water storage areas**; reservoirs/barrages/dams/impoundments (generally over 8 ha).

7 -- **Excavations**; gravel/brick/clay pits; borrow pits, mining pools.

8 -- **Wastewater treatment areas**; sewage farms, settling ponds, oxidation basins, etc.

9 -- **Canals and drainage channels, ditches.**

Zk(c) -- **Karst and other subterranean hydrological systems**, human-made

Annex 3: IUCN Protected Areas Categories System

IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

Ia Strict Nature Reserve

Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values.

Ib Wilderness Area

Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park

Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature

Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area

Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape

A protected area where the interaction of people and nature over time has produced an area of distinct charcter with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources

Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems.