Information Sheet on Ramsar Wetlands (RIS) – 2009-2012 version

Available for download from http://www.ramsar.org/ris/key_ris_index.htm.

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).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.

2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 14, 3rd edition). A 4th edition of the Handbook is in preparation and will be available in 2009.

3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

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

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Sydney South NSW 1232 Australia
Ramsar_program@environment.nsw.gov.au

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DD MM YY	Designation date
21 02 84	

Site Reference Number
287

2. Date this sheet was completed/updated:

April 2012

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.

Hunter Estuary Wetlands

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

This RIS is for (tick one box only)**:**
a) Designation of a new Ramsar site ❑; or
b) Updated information on an existing Ramsar site ☑

The Hunter Estuary Wetlands was designated on 21 February 1984 and only included the Kooragang Nature Reserve at the time (referred to as Kooragang below). In 2002 Shortland Wetlands (now known as Hunter Wetlands Centre Australia) was added to the site.

This is an update of the previous RIS which was dated October 2002.

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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.

The area of the Kooragang component of the Ramsar site, based on its 25 March 1983 gazettal as Kooragang Nature Reserve, was originally 2,926 hectares. The area has recently been calculated more accurately as 3,388 hectares. The difference in areas results from the method used to estimate the area for Kooragang Nature Reserve when it was gazetted, which resulted in an approximation of its area. The updated calculation of the area based on spatial data is considered to be more reliable, as it uses technology which was not available when the Ramsar site was established in 1984. The difference in area is not the result of an extension to or a reduction in the Ramsar site's boundary.

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:

The Hunter Estuary Wetlands Ramsar site, including both Kooragang and Hunter Wetlands Centre Australia, was assessed against the current Ramsar Listing criteria in 2010 as meeting Criteria 2, 4 and 6. In the previous 2002 RIS the site had been assessed as meeting Criteria 1, 3, 4, and 6. Criteria 1 and 3 are no longer met because of a change in the Australian approach to bioregionalisation in 2008. Bioregionalisation is now undertaken at the level of Australian Drainage Divisions or Integrated Marine and Coastal Regionalisation of Australia rather than Interim Biogeographic Regionalisation of Australia (IBRA). Australian Drainage Divisions on the whole cover a larger area in comparison to IBRA.

Criterion 2 is now met because of the presence of three nationally and internationally listed species. The estuary stingray (*Dasyatis fluviorum*) listed as Vulnerable on the IUCN Red List (Version 2009.1) and the green and golden bell frog (*Litoria aurea*) listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity* Conservation *Act 1999* (the EPBC Act) have been recorded from within the Kooragang component of the Ramsar site. The Australasian bittern (*Botaurus poiciloptilus*) listed as Endangered on both the EPBC Act and the IUCN Red List (Version 2009.1) has been recorded from within both the Kooragang and the Hunter Wetlands Centre Australia components of the site.

There have been significant changes in the critical components and processes since the time of listing namely:

- there has been a 9% increase in the area of mangrove forests and a 41% decrease in the area of saltmarsh within the Hunter Estuary Wetlands since the time of listing in 1984. There has been an

increase in tidal range during this period which has been attributed as one of the major factors in mangrove expansion and a consequent decline in the extent of saltmarsh within the Kooragang component of the Ramsar site. This has reduced the area of saltmarsh which is roosting and foraging habitat for migratory shorebirds;

- between 1984 and 2007 there has been an overall decline in the number of species of migratory shorebirds recorded annually in the Kooragang component of the Ramsar site; from 25 to 13 species;
- between 1984 and 2007 there has been a decline in the number of non-resident shorebirds regularly recorded within the Kooragang component of the site from 17 to 13 species; and
- between 1984 and 2007 there has been an overall decline in the number of migratory shorebirds of 50% (from 6,800 annually recorded at the time of listing to 3,200 in 2007). These declines in migratory shorebird numbers and species in the Hunter Estuary may be linked to the decline in saltmarsh in the estuary and consequential reduction in available roosting and foraging habitat.

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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.

The boundary of the Kooragang component of the Ramsar site is the boundary of the Kooragang Nature Reserve as gazetted on 25 March 1983, 19 April 1985 and 28 November 1986, which is now part of the Hunter Wetlands National Park as declared under the *National Parks Estate (Lower Hunter Region Reservations) Act 2006*[1].

The Hunter Wetlands Centre Australia component of the Ramsar site comprises the land owned by Shortland Wetlands: Lot 5 DP233520, Lot 2 DP1043133, Lot 7 DP233520 and most of Lot 1 DP1069498. The Ramsar site excludes the portion of Lot 1 DP1069498 that contains a car park, visitor facilities, roads and utility services.

A detailed boundary description of the Hunter Wetlands Centre Australia component is provided in Appendix 1.

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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.

Kooragang: Latitude: 32º51'S; Longitude: 151º46'E

Hunter Wetlands Centre Australia: Latitude: 32º53'S; Longitude: 151º41'E

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[1] Clause 2 "Revocation of Nature Reserve and reservation as Hunter Estuary National Park" of Schedule 6 to the *National Parks Estate (Lower Hunter Region Reservations) Act 2006* states:

"(2) **Kooragang Nature Reserve**
An area of about 2,926 hectares, being so much of Kooragang Nature Reserve as comprises the land designated as 1104-02 on the diagram catalogued Misc R 00320 (Edition 2) in the Department of Environment and Climate Change, subject to any variations or exceptions noted on that diagram."

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.

The Hunter Estuary Wetlands Ramsar site is located in the estuary of the Hunter River at Newcastle on the central coast of New South Wales, approximately 160 kilometres north of Sydney. The Hunter River is a major coastal river that discharges to the ocean at Newcastle. The population of Newcastle at 1986 census (close to the time of listing) was 129 490. The population of Newcastle at the most recent census in 2006 was 149 075.

The Hunter Estuary Wetlands Ramsar site comprises two parts: the former Kooragang Nature Reserve and the Hunter Wetlands Centre Australia. The former Kooragang Nature Reserve, now part of Hunter Wetlands National Park, is located in the estuary of the Hunter River, approximately 7 km north of Newcastle on the coast of New South Wales. The Hunter Wetlands Centre Australia is located in the Ironbark Creek catchment in the Newcastle suburb of Shortland, 2.5 km south west of the Kooragang component.

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

0-10m ASL

11. Area: (in hectares)

Kooragang: 3,346 hectares (GDA 1994 MGA Zone 56)

Hunter Wetlands Centre Australia: 42 hectares (GDA 1994 MGA Zone 56).

Total area of the Ramsar site: 3,388 hectares (GDA 1994 MGA Zone 56).

See section 6a for an explanation for the change in area.

12. General overview of the site:
Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Hunter Estuary Wetlands Ramsar site comprises Kooragang (designated to the Ramsar List in 1984) and Hunter Wetlands Centre Australia (added to the site in 2002). Kooragang was a Nature Reserve but is now part of the Hunter Wetlands National Park which was declared in 2006. The boundary of the Hunter Wetlands Centre Australia component of the Ramsar site is 2.5 kilometres from the Kooragang component and is connected to it by a wildlife corridor consisting of Ironbark Creek, the Hunter River and Ash Island, much of which is now reserved within the Hunter Wetlands National Park.

The Kooragang component of the Ramsar site lies within the estuarine section of the Hunter River. It has become known as one of the most important bird study areas in New South Wales. The area is extremely important as both a feeding and roosting site for a large seasonal population of Palaearctic shorebirds (including some that stay over winter) and as a staging site for in-transit migrants. The site also supports a large number of resident shorebirds and other waterbirds.

The Hunter Wetlands Centre Australia component of the Ramsar site is a small but unique complex of wetland types surrounded by urban development along three boundaries. Previously degraded, this urban wetland has been restored with the key objectives of wetland conservation, education and community involvement. The site provides habitat for a diverse range of wetland species, including waterbirds at a critical stage of their lifecycles and threatened species.

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
❑	☑	❑	☑	❑	☑	❑	❑	❑

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).

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

Common Name	Scientific name	IUCN	National Status
Estuary stingray	*Dasyatis fluviorum*	Vulnerable	Not listed
Australasian bittern	*Botaurus poiciloptilus*	Endangered	Endangered (EPBC Act, 1999)
Green and golden bell frog	*Littorea aurea*	Vulnerable	Vulnerable (EPBC Act, 1999)

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.

One hundred and twelve species of waterbirds have been recorded from the Hunter Estuary Ramsar site including both the Hunter Wetlands Centre Australia and the Kooragang components. Forty-one species of migratory birds recorded at Kooragang and twenty one species at Hunter Wetlands Centre Australia are presently listed as migratory under the EPBC Act which includes species other than shorebirds, such as the great egret (*Ardea alba*), cattle egret (*Ardea ibis*), terns (*Sterna* spp.), glossy ibis (*Plegadis falcinellus*), and the white-breasted sea-eagle (*Haliaeetus leucogaster*). Forty-five of these migratory species are recorded under the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and/or Republic of Korea - Australia Migratory Bird Agreement (ROKAMBA) and Convention on the Conservation of Migratory species of Wild Animals (Bonn Convention). See Appendix 7 for full list of species.

The Hunter Estuary is an important site for migratory shorebirds which are present for up to eight months of the year between September and April. In February 1986, 6,800 migratory shorebirds were recorded in the Hunter Estuary (Herbert 2007a). In January 2007, 3,200 migratory shorebirds were recorded in the Hunter Estuary (Herbert 2007a). The Kooragang component of Hunter Estuary Wetlands Ramsar site now regularly supports 13 species of non-resident migratory shorebirds (Herbert 2007a). The Fullerton Cove area within the Kooragang component has been identified as the most important foraging area for the majority of these migratory shorebirds in the Hunter Estuary (Herbert 2007a). Stockton Sandspit and the Kooragang Dykes which lie within the Kooragang component are the most important roosting and foraging areas for migratory shorebirds within the Hunter Estuary (Herbert 2007a).

The Hunter Wetlands Centre Australia component regularly provides habitat for at least seven species of migratory shorebird. Both the Kooragang and the Hunter Wetlands Centre Australia components also support a large number of species (up to 28) at a critical seasonal stage of their breeding cycle, including cattle egrets (*Ardea ibis*), white ibis (*Threskiornis molucca*) and black-winged stilts (*Himantopus himantopus*) (Herbert 2007a). Twenty-eight bird species have been recorded breeding at the Hunter Wetlands Centre Australia component and 24 bird species have been recorded breeding at the Kooragang component. There is an important egret and ibis breeding site within the Melaleuca swamp, at the Hunter Wetlands Centre Australia, with 55 white ibis nests recorded at the Shortland Wetlands in 2006-07 (Herbert 2007a).

The Hunter Estuary Wetlands also provides refuge for a number of species during periods of inland drought. The Hunter Wetlands Centre Australia component of the Ramsar site is a drought refuge for species such as freckled duck (*Stictonetta naevosa*), pink-eared duck (*Malacorhynchus membranaceus*), Australian pelican (*Pelecanus conspicillatus*), and glossy ibis (*Plegadis falcinellus*) (Albrecht and Maddock 1985). The Hunter Wetlands Centre Australia and the Kooragang components are also important for local resident ducks, herons and other waterbirds, with up to 2,000 ducks recorded at both sites during dry periods (Winning 1989).

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.

The Hunter Estuary Wetland Ramsar site regularly supports 1% of the population of the eastern curlew (*Numenius madagascariensis*), which is 380 individuals for the East Asian-Australasian Flyway population (Bamford et al. 2008). At the time of listing in 1984, 653 eastern curlews were recorded in the Hunter River Estuary (Australasian Wader Studies Group data cited in Bamford et. al. 2008). Since then the numbers of eastern curlew have ranged from 800 – 1000 in the 1990s, to 400 – 600 individuals between 2000 and 2007 (Herbert 2007a). See table of population numbers below.

One other species of waterbird that has been regularly observed in numbers greater than 1% of the individuals in a population is the red-necked avocet (*Recurvirostra novaehollandiae*), for which the 1% threshold is 1100 individuals (Wetlands International 2006). This nomadic shorebird is found throughout Australia and is considered to be a non-breeding resident of the Hunter Estuary. At the time of listing in 1984, only small numbers of red-necked avocets (less than 20) were recorded within the estuary (Herbert 2007a). Since then numbers have increased significantly with maximum counts of 5032 in 2006 and 7000 in 2007 (Herbert 2007a). Between 1999 and 2007 over 2000 red-necked avocets have been recorded in the Hunter Estuary in all years except in 2000 when there were around 100 birds present (Herbert 2007a). Up to 5000 birds (spring 2006) have been recorded foraging and roosting at Stockton Sandspit within the Kooragang component of the Ramsar site (Herbert 2007a).

Population numbers of waterbird species

English name	Scientific name	Population number			1% level[1]
		1984	Late 1990's[2]	2000 - 2007[2]	
Eastern curlew	*Numenius madagascariensis*	653	800 – 1,000	400 – 600	380
Red-necked avocet	*Recurvirostra novaehollandiae*	< 20		5,032 (in 2006) 7,000 (in 2007) (max. counts)	1100

[1] Bamford et al. 2008; [2] Herbert 2007a

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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:

South East Coast Drainage Division

b) biogeographic regionalisation scheme (include reference citation):

Australian Drainage Divisions
(Commonwealth of Australia (Bureau of Meteorology) 2011. Australian Hydrological Geospatial Fabric)

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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.

Kooragang

The Kooragang component of the Ramsar site comprises the northern part of Kooragang Island and Fullerton Cove, two areas that lie in the estuarine section of the Hunter River. Kooragang Island originally consisted of several smaller islands or bars that were mostly separated by narrow mangrove lined channels (NPWS 1998). One of the larger channels was Moscheto Creek which linked the north and south arms of the river. Over time the islands were reclaimed and as a result the hydrological regime of what became "Kooragang Island" and the Hunter Estuary was modified (NPWS 1998). In the 1950s to control deposition and siltation of the Newcastle port area artificial filling of channels and the construction of training walls was undertaken (NPWS 1998). Restrictions in tidal, normal and flood river flows have resulted from the reclamation. Flows through the south arm of the Hunter River have increased. Moscheto Creek was occluded at its southern end by an industrial railway to become tidal via the north arm only (NPWS 1998).

Fullerton Cove is a large, shallow embayment north of Kooragang Island. It has a maximum depth of two to three metres at its centre and at low tide large areas of mudflats are exposed. In 1970, a levee bank was built around Fullerton Cove in an effort to ameliorate flooding in low-lying areas of Newcastle, downstream of Kooragang Island (NPWS 1998). Drains were installed to reclaim the significant wetland areas behind the levees for agriculture. This levee provides some protection to agricultural lands during minor floods but the levee is overtopped in major floods (NPWS 1998).

The lower Hunter River is a barrier estuary formed by the deposition of sediments in swamps and flats lying between the inner and outer coastal barrier sands (NPWS 1998). The sediments on Kooragang Island and adjacent estuarine areas comprise black silty and highly saturated soft clays to a depth of about 2 metres which are underlain by a light grey and silty sand (NPWS 1998). Salinities may vary from 70% in evaporative salt marsh areas to 8% behind levees where the soil is generally more fertile and regularly flooded by fresh water (NPWS 1998).

In a recent study of acid sulphate soils in the Lower Hunter River Estuary, Fullerton Cove and surrounding areas were ranked as high risk of acid sulphate soils (NSW DPI 2008). There was a high level of stored acidity in the subsoil profile around Fullerton Cove and at some locations the acid sulphate soils layer was within 0.3 metres of the soil surface NSW DPI (2008). However, all soil sample sites in wetland areas on Kooragang Island were ranked as medium risk (NSW DPI 2008). This was due to the deeper nature of acid sulfate soil at most sites, the natural water regime of the site and the absence of artificial drainage lines (NSW DPI, 2008).

The tidal variation for Kooragang Island is 0.1 metre to 2 metres. Average temperatures range from a mean minimum of 8.4°C to a mean maximum of 25.5°C. Mean annual rainfall is 1139 millimetres.

Hunter Wetlands Centre Australia

The Hunter Wetlands Centre Australia component of the Ramsar site is a restored and remnant wetland bounded on the south by the suburb of Shortland, on the east by a major arterial road, on the north by an old landfill site and on the west by Ironbark Creek and Hexham Swamp. There are strong ecological links between Hexham Swamp, Hunter Wetlands Centre Australia and the western end of Kooragang (NPWS 1998).

The wetlands are in a natural drainage depression, a remnant of extensive tidal and floodplain wetlands that once extended east of Ironbark Creek. Changes in the natural flow regime have been caused by the construction of floodgates on Ironbark Creek and a drainage canal from Sandgate Road to Ironbark Creek, the establishment of a garbage dump, the construction of a power transmission line and associated access roads and development as a sporting complex (Winning 1989). These actions restricted the entry of saline tidal water, changing the wetlands from a brackish to fresh water regime (Winning 1989). All of these actions pre-date the establishment of Hunter Wetlands Centre Australia and its addition as a component of the Ramsar site.

The Hunter Wetlands Centre Australia component of the Ramsar site is situated on Quaternary estuarine/lacustrine sediments including silts and clays (Matthei 1995). The site consists of seven discreet but interconnected ponds and a freshwater channel with a combined waterway area comprising 35% of the total site area (BMT WBM 2008). Four of these ponds are natural and three are man-made. The man-made ponds have been constructed on old landfill sites that were subsequently used as sporting fields. The largest of the wetlands is Ironbark Marsh situated at the downstream end of the site with an estimated surface area of 8.4 hectares (BMT WBM 2008). Two other large waterbodies within the site are Melaleuca Swamp with a surface area of 2.8 hectares and Water Ribbon Pond with a surface area of 2.2 hectares. The smallest waterbody within the Hunter Wetlands Centre Australia component of the Ramsar site is Farm Dam Pond with an estimated waterway area of 0.23 hectares (BMT WBM 2008). The depth of the ponds varies from 0.5 to 0.8 metres although there are deeper areas within the artificially constructed BHP Billiton Pond, where deep channels up to 2 metres deep or more have been excavated around islands (BMT WBM 2008).

Water flows into the site from south-east and then flows north-west through the series of ponds and exits the site into Ironbark Creek. The most upstream wetland within the Hunter Wetlands Centre Australia component of the Ramsar site is Melaleuca Swamp which receives overflow water from Middleton Swamp (outside the site boundary) and also receives stormwater runoff (BMT WBM

2008). There are several culverts (pipe outlets) and small channels providing connections between individual waterbodies. The level of pipe and channel inverts and high flow by-pass structures determines the depth of the water and the temporary storage volume available within each waterbody (BMT WBM 2008).

There is no tidal variation in the wetlands within the site. The area of the catchment is approximately 56 hectares and includes the urban suburbs of Shortland and Warabrook (BMT WBM 2008).

Water quality is consistent with natural, freshwater ponds. Abiotic measurements indicate that pH is generally between 6.2 and 7.9. Water temperature varies seasonally between 14ºC and 24ºC and turbidity is usually less than 10 NTU (Nephelometric Turbidity Units). Salinity is less than 1% (Grace and Francesconi 1997).

The water flowing from the Hunter Wetlands Centre Australia component of the Ramsar site enters Ironbark Creek and subsequently the Hunter River. At peak flood times Hunter Wetlands Centre Australia becomes a storage area for approximately 42 000 cubic metres of water (Sinlaparommard 1999).

Most of the Hunter Wetlands Centre Australia component of the Ramsar site is elevated and is therefore not affected by acid sulphate sediments (NSW DPI 2008). However, there are lower lying areas within the site such as Ironbark Marsh and the Canoe trail, which are subject to acid sulfate soil risk (NSW DPI 2008).

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17. Physical features of the catchment area:
Describe the surface area, general geology and geomorphological features, general soil types, and climate (including climate type).

The Hunter River is a major coastal river that discharges to the ocean at Newcastle. It has several important tributaries, including the Goulburn River, Williams River, Paterson River, Glennies Creek and Pages Creek. The Hunter River Basin encompasses an area of 21,451 square kilometres.

The Hunter catchment has a diversity of vegetation and geomorphological features, including alpine rainforests in the Barrington Tops, dissected sandstone landscapes within the Great Dividing Range, open grasslands and woodlands in the Upper Hunter, and alluvial floodplains, estuarine wetlands and mangrove forests in the Lower Hunter where the Hunter Estuary Wetlands are located.

Acid sulphate soils which occur naturally over extensive low-lying coastal areas, predominately below five metres AHD (Australian Height Datum) are widespread in the Lower Hunter Estuary.

The climate of the area is temperate with average diurnal temperatures ranging from a minimum of 8.4°C to a maximum of 25.5°C over the year at Newcastle. There is moderate variation in annual rainfall with the higher rainfall months being March through to June and the driest months being August to October. Mean annual rainfall at Newcastle is 1,139 millimetres.

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

Neither the Kooragang nor the Hunter Wetlands Centre Australia components of the Ramsar site contribute to groundwater recharge or flood control. Flood waters pass through the Hunter Estuary via the Kooragang component of the Ramsar site but as previously stated it does not have a significant role in flood control.

Fullerton Cove within the Kooragang component of the Ramsar site has a role in trapping sediment as the Hunter River flows through the estuary to the sea. There have also been recent attempts to restore tidal flows to the wetlands behind Fullerton Cove. There is a ring drain which runs behind Fullerton Cove and discharges at two sets of floodgates, one of which has been fitted with Smart Gates which can be remotely operated to allow tidal flows into the Tomago Wetland which is part of the Kooragang component of the Hunter Estuary Ramsar site (NSW DPI 2008). The Smart Gates have been installed as part of the Tomago Rehabilitation Project which aims to restore an area which was

formerly saltmarsh by allowing tidal inundation to occur, improving habitat for migratory shorebird roosting, as well as juvenile fish and crustaceans.

The Hunter Wetlands Centre Australia component of the Ramsar site receives stormwater. The wetlands act as settling ponds trapping sediments, thereby, reducing turbidity and sedimentation in the receiving waters of Ironbark Creek and the Hunter Estuary. The wetlands also mitigate peak stormwater flows, reducing the velocity of water within the site and maintaining ecological flows to the receiving waters. In addition, one-way flap-gates have been constructed at the outlets of the Hunter Wetlands Centre Australia to prevent tidal backwater inundation by high tides when the Ironbark Creek floodgates are opened (BMT WBM 2008). In 2009, three of the flood gates in Ironbark Creek were opened as part of a Hexham Swamp Rehabilitation Project which is being implemented by the Hunter-Central Rivers Catchment Management Authority (HCRCMA) with the aim of restoring tidal flows in Ironbark Creek and Hexham Swamp (Hunter Wetlands Centre Australia Annual Report 2009). The HCRCMA has also acquired easements to flood land around Ironbark Creek and the margins of the Hexham Swamp as part of the rehabilitation project.

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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.

Kooragang: F, I, G, H, Xf

Note that the previous RIS identified eight Ramsar wetland types (all in the marine coastal class) which included four of the wetland types identified above (F, I, G, and H) as well as D, E, J and K. During the preparation of the Ecological Character Description (ECD) for the Kooragang component of the Ramsar site a review of the habitat mapping that was done close to the time of listing in 1983 by Outhred and Buckney (1983) was undertaken. Only four wetland types in the marine coastal class were identified as occurring – estuarine waters (F), inter-tidal mud, sand or salt flats (G), inter-tidal marshes (H) and inter-tidal forested wetlands (I). There were no rocky marine shores (D), sand, shingle or pebble shores (E), coastal brackish/saline lagoons (brackish to saline lagoons with at least one relatively narrow connection to the sea) (J) or coastal freshwater lagoons (K) wetland types identified within the Kooragang component.

A fifth wetland type, freshwater, tree-dominated wetlands (Xf), was identified as occurring within the site during the preparation of the ECD.

Hunter Wetlands Centre Australia: Ts, Ss, Xf, Type 2

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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.

Kooragang

Habitat types have been mapped within this component of the Ramsar site (Outhred and Buckney 1983; Winning 1996) and include mangrove forests and salt marshes. There are two mangrove communities, one comprised of only grey mangrove (*Avicennia marina*) which is widespread and common in the Kooragang component of the Hunter Estuary Wetland in areas subject to tidal inundation. The other community has an overstorey of grey mangrove, with a shrub layer of river

mangrove (*Aegiceras corniculatum*) and occurs along the margins of tidal channels which are subject to regular tidal flows. This community is most prevalent around the headwaters of Moscheto Creek.

Saltmarsh dominated by beaded glasswort (*Sarcocornia quinqueflora*) and saltwater couch occurs in areas within Kooragang which are regularly inundated, while sea rush (*Juncus kraussii*) saltmarsh has a more restricted distribution and occupies areas that are not subject to daily tidal inundation and where salinity was high (Outhred and Buckney 1983).

Brackish swamps dominated by sedges (*Scirpus* ssp.) as well as arrowgrass (*Triglochin* sp), common reed (*Phragmites australis*) and broad leaved cumbungi (*Typha orientalis*) occur in the south of Kooragang Island within the Ramsar site.

Patches of *Casuarina glauca* woodland are found in the north of the Kooragang component of the Ramsar site where it occupies areas that are intermittently flooded after heavy rainfall but remains brackish due to the presence of saline groundwater.

On the northern boundary of the site there is a small six hectare remnant of broad-leaved paperbark (*Melaleuca quinquenervia)* dominated coastal swamp forest and an eight hectare remnant of dry sclerophyll forest on coastal sands which is dominated by blackbutt (*Eucalyptus pilularis*) with tall saw banksia (*Banksia serrata*) in the understorey.

There are two disturbance induced vegetation communities which occur extensively within the Kooragang component of the Ramsar site, saline pasture and pasture which occupy areas that had been modified and drained, and support a mixture of pasture and saltmarsh species including beaded glasswort and saltwater couch. In areas where salinity is lower, the introduced grasses, blown grass (*Agrostis avenacea*), couchgrass (*Cynodon dactylon*) buffalo grass (*Stenotaphrum secundum*), kikuyu (*Pennisetum clandestinum*) and paspalum (*Paspalum dilatatum*) are dominant.

Other ecological features include: the open water of Fullerton Cove and the North Arm of Hunter River, the mudflats in Fullerton Cove and Fern Bay, the sandflats on the islands in the North Arm and at Stockton Sandspit and the rock retaining walls and ponds at the Kooragang Dykes.

Hunter Wetlands Centre Australia

The Hunter Wetlands Centre Australia component of the Ramsar site was originally part of the estuarine wetlands of lower Ironbark Creek, with saltmarsh and mangroves extending well into the present site.

Today the site represents a remnant wetland that maintains its ecological connections to fresh, brackish and saline wetlands elsewhere in the estuary through its connection to Ironbark Creek. Although the floodgates on Ironbark Creek are still in place, their management has been modified and in 2009, three of the flood gates were opened to allow increased tidal flows into the creek system and the adjacent Hexham Swamp. The opening of the floodgates may result in the enhancement of the brackish wetland values on the Hunter Wetlands Centre Australia component of the Ramsar site.

The main habitats and vegetation types on the site include restored semi-permanent/seasonal freshwater ponds and marshes, natural semi-permanent/seasonal brackish ponds and marshes, freshwater swamp forests and a coastal estuarine creek.

Variations in water levels in the ponds result in a significant range of vegetation succession across the site annually, contributing to biodiversity values, especially in macro-invertebrate populations.

The most significant wetland plant community at the Hunter Wetlands Centre Australia component of the Ramsar site is the *Melaleuca* swamp forest, dominated by broad-leaved Paperbark (*Melaleuca quinquenervia*). The swamp forest is remnant of a plant community that was once very widespread in the Newcastle area.

The Hunter Wetlands Centre Australia component is significant for a range of plant communities that have been successfully re-introduced to the site, including:

- open rainforest developed around remnant rainforest species dominated by turpentine (*Syncarpia glomulifera*), lilly pilly (*Acmena smithii*), scentless rosewood (*Synoum glandulosum*), cheese tree (*Glochidion ferdinandi*) and bleeding heart (*Omalanthus populifolius*)

- open eucalypt woodland dominated by swamp mahogany (*Eucalyptus robusta*), red bloodwood (*Eucalyptus gummifera*) and grey gum (*Eucalyptus punctata*)
- *Melaleuca* shrubland dominated by tall honey myrtle (*Melaleuca nodosa*), swamp paperbark (*Melaleuca ericifolia*), prickly-leaved paperbark (*Melaleuca styphelioides*), and swamp millet (*Isachne globosa*)
- *Acacia* shrubland dominated by Sydney golden wattle (*Acacia longifolia*);
- wet heath dominated by *Callistemon citrinus, Banksia robur* and Christmas bells (*Blandfordia grandiflora*)
- *Casuarina* forest dominated by swamp oak (*Casuarina glauca*).

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*.

Kooragang

A list of flora species compiled by Winning (1996) identified 112 species of vascular plants at Kooragang Island (Appendix 6) which form many distinct habitat types (see Category 16). The mangrove and saltmarsh areas are particularly good examples of these plant communities.

The estuarine herb *Zannechellia palustris* has been recorded immediately adjacent to the western end of the Kooragang component. This herb is only found in the Newcastle/Lake Macquarie area and along Ironbark Creek.

Hunter Wetlands Centre Australia

Over 150 flora species occur on the site (Appendix 6) within 22 vegetation communities (Beretta 1998). Vegetation communities include: closed *Commersonia* forest, closed mangrove forest, open planted rainforest, *Casuarina* forest, open *Melaleuca* swamp forest, open woodland, wet heath, *Banksia* shrubland, *Acacia* shrubland, water Couch wet meadow, closed *Typha* rushland, closed *Phragmites* reed swamp, *Juncus* rushland and several large remnant eucalypt trees.

The site contains a high diversity of original and rehabilitated plant communities and has undergone a committed landscaping effort (see Category 17).

Introduced plants occurring in the Ramsar site include alligator weed (*Alternanthera philoxeroides*), dock (*Rumex* spp.), pennywort (*Hydrocotyle bonariensis*), spear thistle (*Cirsium vulgare*), blackberry (*Rubus fruticosus*), bitou bush (*Chrysanthemoides monilifera*), lantana (*Lantana camara*), pampas grass (*Cortaderia selloana*), spiny rush (*Juncus acutus*), kikuyu (*Pennisetum clandestinum*), couchgrass (*Cynodon dactylon*), paspalum (*Paspalum dilatatum*) and buffalo grass (*Stenotaphrum secundatum*).

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*.

The Hunter River Estuary is renowned for its birdlife. Over 250 species of birds have been recorded across the Hunter Estuary Wetlands site (Appendix 2). The occurrence of migratory waterbirds is of particular importance. In 2007, 3,500 migratory shorebirds were recorded in the Estuary (Herbert 2007a). Thirty-seven migratory shorebird species have been record from the Kooragang component of the Ramsar site and 21 species from the Hunter Wetlands Centre Australia component, with 14 of these species common to both areas (Appendix 2).

Of these there are at least 45 migratory species presently listed under the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) and/or Republic of Korea Government - Australia Migratory Bird Agreement - (ROKAMBA).

The Hunter Estuary Wetlands are also important for other waterbirds, including non-migratory

shorebirds (e.g. red-necked avocet, black-winged stilt), ducks (e.g. chestnut teal), grebes, pelicans, cormorants, darters, herons, ibis, egrets, spoonbills, crakes, rails, water hens, coots, gulls, and terns. The estuary is also important for threatened waterbird species including the Australasian bittern (*Botaurus poiciloptilus)*, which is listed as endangered on both the EPBC Act and the IUCN Red list (Version 2009.1). The Australasian bittern has been recorded within both components of the Ramsar site. Herbert (2007a) considered the Australasian bittern to be a breeding resident in the Hunter Estuary because it has been recorded in all months and there are extensive areas of suitable wetland habitat available, namely freshwater or brackish wetlands with a dense cover of *Phragmites, Juncus* or *Typha* species.

The site provides habitat for nationally and internationally threatened species. The green and golden bell frog (*Litoria aurea*) which is listed as vulnerable nationally under the EPBC Act occurs in brackish/freshwater wetlands on Kooragang Island. A project is currently underway to re-introduce the green and golden bell frog to the Hunter Wetlands Centre Australia component of the Ramsar site.

Threatened species present in the Hunter Estuary Wetlands Ramsar site (listed under the New South Wales *Threatened Species Conservation Act 1995*) include black-necked storks (*Ephippiorhynchus asiaticus*), Australasian bittern, comb-crested jacana (*Irediparra gallinacea*) and magpie geese (*Anseranas semipalmata*). Black-necked storks regularly use the site during their nomadic movements throughout the lower Hunter region. Comb-crested jacana is a rare species within the lower Hunter region. It has been reported at Kooragang Island and is a rare visitor to the Hunter Wetlands Centre Australia component of the Ramsar site. In 1987, the Wetlands Centre initiated a re-introduction of the locally extinct magpie goose and now supports a breeding population of more than 100 geese. The Centre is one of four centres hosting a freckled duck captive-breeding program.

A total of seven mammal species have been recorded within the Hunter Wetlands Centre Australia component of the Ramsar site with only two of these being native. Several species of frogs, tortoise, skinks and snakes have been recorded at the site, all of which are common to the region (Appendix 4). Six species of frogs have been recorded within the Kooragang component of the Ramsar site.

The school prawn trawl fishery is the principle fishery within the Hunter Estuary (MHL 2003) and is one of three remaining estuary prawn fisheries in New South Wales, the others being the Clarence and the Hawkesbury.

The Hunter Estuary supports the tenth-largest fin fishery in New South Wales, with approximately 140 000 kilograms of fish harvested per annum (The Ecology Lab 2006). Six species of fin fish are harvested commercially. The main commercial fish species is sea mullet with 85 690 kilograms of fish caught per year (MHL 2003). Other commercial fish species that are caught include eels, fantail mullet, silver biddy and bream (MHL 2003).

The vulnerable estuary stingray (*Dasyatis fluviorum*) which inhabits mangrove fringed rivers and estuaries has been recorded from the Hunter Estuary. Pond life at the Hunter Wetlands Centre Australia component of the Ramsar site is abundant. Six species of fish have been recorded (see Appendix 3). A wide diversity of macro-invertebrates is present including many sensitive insect larvae. Macro-invertebrate surveys routinely record molluscs, bloodworms, caddisfly larvae, gastropods, beetles, bugs, water fleas, seed shrimps, copepods and nymph forms of dragonfly, damselfly, stonefly and mayfly (Bischof and Brown 1996).

There are four introduced fish species recorded from the Ramsar site: mosquito fish (*Gambusia holbrooki*), European carp (*Cyprinus carpio*), Oriental goby (*Carassius auratus*) and yellowfin goby (*Acanthogobius flavimanus*) (Ruello 1976, Copeland 1993). Other introduced animals in the Ramsar site include the fox (*Vulpes vulpes*), black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*), and domestic dogs (*Canis familiaris*), and cats (*Felis cattus*).

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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:

Kooragang

The Kooragang component of the Ramsar site and the surrounding areas have become known as one

of the most important bird study areas in New South Wales. The site is used for both research and recreational bird watching. There is a limited amount of recreational fishing within the estuarine waters within the Ramsar site.

The Worimi and Awabakal Aboriginal tribes were the earliest inhabitants of the lower Hunter Estuary (NPWS 1998). There are four known Aboriginal sites within the boundaries of the Ramsar site and a further seven are along the edge of the boundary (Aboriginal Heritage Information Management System, DECCW). There are many isolated artefacts, artefact scatters, middens, carved and scarred trees, and campsites scattered around the lower Hunter but they occur particularly along the riverbanks and within the dunes along Stockton Bight.

There are a few European historic sites within the Kooragang component of the Ramsar site. These include concrete footings of an old munitions store on Sandy Island, a timber bridge, a mature Moreton Bay Fig associated with early farming and a half submerged timber drogher.

Hunter Wetlands Centre Australia

Historically the site, now occupied by the Hunter Wetlands Centre Australia, would have been used by Aboriginal people as a food and materials source due to their productive and dynamic nature. The present site was occupied by the Pambalong people, a smaller tribe of the Awabakal People (Sokoloff 1974).

The Hunter Wetlands Centre Australia component of the Ramsar site contains a significant archaeological site that is believed to have been a factory site for the production of stone tools (Bangent 1990; Winning 1989).

The Hunter Wetlands Centre Australia component has retained its importance in the fabric of the local community since a community campaign to save and restore the wetlands. In 1984 the actions of the local conservation group gained support for the restoration of the degraded wetlands and the development of what was then known as the Shortland Wetlands. This was an ambitious project at that time. Now trading as The Hunter Wetlands Centre Australia, the Centre continues to attract strong community support and involvement.

The Hunter Wetlands Centre Australia promotes wetland conservation and wise use through communication and education, passive recreation and community involvement and acts as a focal point for community-based environmental interest groups that represent valuable partnerships. The Hunter Bird Observers Club, Australian Plant Society and the Society for Frogs and Reptiles contribute expertise and resources to the sustainable management of the site. The successful restoration of the Hunter Wetlands Centre Australia component of the Ramsar site has been supported by the investment of many thousands of volunteer hours and valuable partnerships with interest groups such as those mentioned above.

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:

Kooragang

This component of the Ramsar site is Crown land dedicated as a National Park under the NSW *National Parks and Wildlife Act 1974*. The Kooragang component was gazetted as a Nature Reserve in 1983 under the NSW *National Parks and Wildlife Act 1974* and was known as the Kooragang Nature Reserve. In 2006 the Hunter Wetlands National Park was declared which included the Kooragang Nature Reserve and Hexham Swamp Nature Reserve.

Hunter Wetlands Centre Australia

This component of the Ramsar site (1% of the total Ramsar site) is freehold land owned by Hunter Wetlands Centre Australia Ltd, trading as The Hunter Wetlands Centre Australia, a company limited by guarantee and owned by its (600) members. It operates as a not-for-profit conservation organisation and is managed by a volunteer Board of Directors.

b) in the surrounding area:

Surrounding lands are a mixture of freehold and other public authority managed lands.

Land ownership in the surrounding area includes residential landholders, Newcastle City Council, Hunter Water Corporation, NSW Roads and Traffic Authority, Hunter Catchment Management Trust and NSW Department of Environment, Climate Change and Water.

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25. Current land (including water) use:

a) within the Ramsar site:

Kooragang

This component of the Ramsar site is permanently dedicated as a National Park and is used as a wetlands conservation area. A substantial amount of ornithological, wetlands ecology and fisheries research together with bird watching is carried out within the Kooragang component. Surrounding areas are privately owned and used for heavy industry and pastoral activities.

Hunter Wetlands Centre Australia

The Hunter Wetlands Centre Australia component is a privately owned reserve which is used for wetlands conservation and management, education, tourism and recreation.

b) in the surroundings/catchment:

Kooragang

An area adjoining the Kooragang component on Kooragang Island (Ash Island) is being rehabilitated (known as the Kooragang Wetland Rehabilitation Project) and is used for conservation purposes. The southern part of Kooragang Island is zoned industrial and includes coal loading and port facilities. The area behind Fullerton Cove is used for farming, mostly grazing.

Hunter Wetlands Centre Australia

The immediate surrounding area includes residential, water delivery infrastructure, a sports ground, roads, former local government landfill site, market gardens, railway line, a cemetery, as well as significant conservation areas adjacent to the site. It is important to note that approximately one-third of the Newcastle Local Government Area is classified as wetland. However, Newcastle also has an industrial economic base, including coal imports, a working port and small, medium and heavy manufacturing.

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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:

Kooragang

The main threats to ecological character of the Kooragang component of the Hunter Estuary Wetlands Ramsar site are related to human activities, namely:

- changes in tidal range due to dredging, the installation and operation of flood mitigation

structures, drainage works and increased sedimentation (as a result of past catchment clearing) leading to mangrove expansion and a subsequent decline in the extent of saltmarsh

- changes in the freshwater/saltwater balance due to landward drainage also leading to a decline in the extent of saltmarsh.

Saltmarsh is an important foraging and roosting habitat (diurnal and nocturnal) for migratory shorebirds. The decline in saltmarsh from the changes in tidal range and changes in the freshwater/saltwater balance has been linked to the decline in migratory shorebirds within the Kooragang component of the Ramsar site. The decline in the distribution and extent of saltmarsh has resulted in a loss of foraging and roosting habitat.

To address some of the decline in saltmarsh, smart floodgates have been installed on the ring drain in the Tomago Wetland part of Kooragang as part of the Tomago Rehabilitation Project. This project aims to restore the former saltmarsh by allowing tidal inundation to occur, improving habitat for migratory shorebird roosting, as well as juvenile fish and crustaceans (NSW DPI 2008).

Introduced animals are a moderate threat to the Kooragang component of the Ramsar site. Domestic dogs (*Canis familiaris*), foxes (*Vulpes vulpes*) and cats (*Felis cattus*) affect bird populations through direct disturbance and predation. Black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*) compete with native species in the area. Rats are also known to take both waterfowl eggs and their hatchlings as food. There are a small number of hares and rabbits within the Kooragang component of the Ramsar site; however, they are a minor threat due to absence of suitable habitat for them.

Introduced weeds are a moderate threat to the Kooragang component of the Ramsar site. Four weeds are established within the site, bitou bush (*Chrysanthemoides monilifera*), alligator weed (*Alternanthera philoxeroides*), Water hyacinth (*Eichornia crassipes*) and pampas grass (*Cortaderia selloana*). Spiny rush (*Juncus acutus*) occurs in part of Kooragang but is considered a minor threat.

Hunter Wetlands Centre Australia

In 1971, floodgates were installed in Ironbark Creek. The purpose of this installation was to mediate flood control for surrounding areas. Opening of the floodgates to restore tidal flows in Ironbark Creek and tidal inundation of Hexham Swamp is the main objective of the Hexham Swamp Rehabilitation Project which is currently being implemented by the HCRCMA (BMT WBM 2008). One-way flap-gates have been constructed at the outlets of the Hunter Wetlands Centre Australia component of the Ramsar site to prevent tidal backwater inundation by high tides when the Ironbark Creek floodgates are opened (BMT WBM 2008). In 2009, three of the flood gates were opened which has resulted in increased salinity in the soil and allowed part of the area adjacent to the lower part of Ironbark Creek to be underwater at high tide (Hunter Wetlands Centre Australia 2009). The HCRCMA has purchased around 670 hectares of land within Hexham Swamp as well as other easements to flood other land around the margins of the swamp as part of the program to restore tidal inundation within Hexham Swamp.

Many exotic plant species occur at the Hunter Wetlands Centre Australia component of the Ramsar site (see Appendix 6). The spread of weeds may be enhanced by local residents who dump rubbish on the site, clear vegetation near their fences and plant exotic tree species. The most serious aquatic weed species include alligator weed (*Alternanthera philoxeroides*), dock (*Rumex* spp.) and pennywort (*Hydrocotyle bonariensis*).

Introduced animals that pose the most serious threat to native fauna at the site include the black rat (*Rattus rattus*), house mouse (*Mus musculus*), red fox (*Vulpes vulpes*), domestic cat (*Felis catus*), common myna (*Acridotheres tristus*), common starling (*Sturnus vulgaris*) and mosquito fish (*Gambusia holbrooki*).

The black rat poses a threat to shore-breeding birds, shorebirds, and the long-necked tortoise by predating eggs and nestlings. Red foxes have been recorded preying on juveniles of egrets and pose a threat to other species such as ground nesting and ground feeding birds. Rabbits may exacerbate the effects of soil erosion and brown hares pose a threat to the regeneration of vegetation. Predation by mosquito fish is listed as a key threatening process under the NSW *Threatened Species Conservation Act 1995*. It is considered a threat to the green and golden bell frog (Morgan and Butterner in NPWS

2002b) as well as macro-invertebrate communities.

Some of the remnant natural wetlands on the site have exhibited signs of eutrophication, such as emission of odorous gases (e.g. Hydrogen sulphide), algal blooms and dominance by eutrophytes (e.g. *Triglochin procera, Spirodela pusilla, Azolla* spp.). Eutrophication may occur as a result of a concentration of nutrients, changes in water quality parameters such as pH, urban run-off and a build-up of bird faeces. The substrate of the artificial ponds may also increase eutrophication as it contains high nutrient material which was previously dumped on the site as fill.

b) in the surrounding area:

Kooragang

The lower catchment of the Hunter River is highly industrialised and urbanised. The mouth of the River has been developed as one of Australia's most important ports. The regular annual dredging of the harbour and entrance to remove silt and increase the depth of the river channel for shipping has contributed to the increased tidal range by increasing the inflow of tidal waters into the estuary (MHL 2003, Herbert 2007b). The increase in tidal range has been implicated in the expansion of mangroves and decline in saltmarsh within the Hunter Estuary.

Further industrial expansion adjacent to the Kooragang component of the Ramsar site is proposed and potential impacts on the Ramsar values are currently being assessed. Land development continues near the Kooragang component of the Ramsar site and upstream along the Hunter River and this could accelerate soil erosion and water pollution in the vicinity of the Ramsar site. Soil erosion and water pollution are considered moderate threats.

Air pollution from nearby aluminium and steel industries is a minor threat. Oil spills are considered a major threat but to date none have occurred within the Kooragang component of the Ramsar site.

Hunter Wetlands Centre Australia

There is potential for development of the landfill site adjacent to Hunter Wetlands Centre Australia component of the Ramsar site that is owned by Newcastle City Council and has been closed since 1992.

A proposed extension to the existing freeway to the east of the site could potentially impact on the wetland. There is, however, a buffer zone between the Ramsar site and the development proposal.

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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 Kooragang component of the Ramsar site forms part of the Hunter Wetlands National Park which was gazetted in 2006 under the NSW *National Parks and Wildlife Act 1974*. The Kooragang component was originally gazetted as a Nature Reserve in 1983 just prior to the time of listing in 1984.

The Hunter Wetlands Centre Australia component of the Ramsar site was established as a private conservation reserve in 1985.

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:

Kooragang

A Plan of Management was prepared for the Kooragang Nature Reserve in 1998 (NPWS 1998) which

aims to preserve and enhance the area for nature conservation. A plan of management is being prepared for Hunter Wetlands National Park, which will include the Kooragang component of the Ramsar site, and is expected to be completed by 2014. Until a new plan of management is prepared, the provisions of the existing plan of management will continue to be implemented.

The current Plan of Management is being implemented and includes:

- water quality and catchment management
- management of native and introduced flora and fauna
- wetland rehabilitation
- cultural heritage
- fire management
- use and promotion of the nature reserve.

Specific conservation measures currently being undertaken, or undertaken recently, include:

- the re-introduction of tidal regimes into the Tomago buffer lands to increase the wetland habitat in the nature reserve
- rehabilitation of Sandy Island for migratory shorebird roosting
- mangrove removal and ongoing management of the Stockton Sandspit for shorebird roosting
- artificial roost construction in Fullerton Cove
- monthly shorebird monitoring
- pampas grass control has been implemented since 2003
- a management strategy for the control of alligator weed.

Hunter Wetlands Centre Australia

This component of the Ramsar site was established as a conservation reserve in 1985. The site restoration has included the creation of two new ponds, development of tracks, building of structures and interpretation to support education uses. Management plans using a catchment management approach were developed and implemented to guide restoration work, on-going management and public access. A long-term revegetation plan has been implemented to improve degraded habitat and introduce new habitat types.

Management is under the direction of a volunteer site committee which meets quarterly and includes staff, volunteers and technical advisors.

Monitoring of a broad range of ecosystem functions and values has been intermittent. Monitoring of bird species, egret breeding and ibis roosting and recording of plant species have been maintained.

The Hunter Wetlands Centre Australia component is one of four centres hosting a freckled duck captive-breeding program. The program began with 17 ducks and since 1993, 52 ducklings have hatched and 36 have survived. Fifteen of these have been given to Tidbinbilla Nature Reserve as part of their captive-breeding program.

The Hunter Wetlands Centre Australia component also has a program to re-introduce green and golden bell frogs to the site. The Centre has created a frog habitat enclosure. In April 2009, hundreds of green and golden bell frog tadpoles were released into tubs and cages specially designed by Newcastle University. In March 2010, more than 850 young bell frogs were released into specially constructed ponds and enclosures at the Hunter Wetlands Centre Australia component. Their growth and survival is being monitored.

The restoration of the site has been used to promote broad conservation of all local wetlands. The involvement of the local community has played a major role in the restoration project, site management, project development, plantings, programs and administration.

Since 1996 over 32,000 trees have been planted on the site into four zones:

1. Visitor Centre Zone (native Australian plants).

2. Constructed Wetlands (plants native to the local region).

3. Natural Wetlands (plants native to the site).

4. Rainforest Zone (a rehabilitated rainforest).

These plantings have significantly changed the landscape, enhancing natural processes on the site. The distribution and abundance of these plant communities create a stable and complex ecosystem that contributes to hydrologic processes, soil stabilisation and fauna diversity. The reedy margins provide breeding and feeding areas for waterfowl and vegetation in shallow pool margins provides foraging sites for shorebirds.

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28. Conservation measures proposed but not yet implemented:
e.g. management plan in preparation; official proposal as a legally protected area, etc.

Kooragang

Rehabilitation of wetland areas within and adjacent to the Ramsar site and now within the Hunter Wetlands National Park have been undertaken under the auspices of the Kooragang Wetland Rehabilitation Project. The project aims to restore and/or enhance the habitat for migratory birds and waterfowl and has proposed that:

- lands within the reserve previously reclaimed for agriculture and flood mitigation are to be rehabilitated to wetland
- the hydrology created by artificial regulation devices on parts of Kooragang Island are to be modified
- degraded vegetation communities in the reserve are to be rehabilitated.

Hunter Wetlands Centre Australia

A Management Plan to guide the on-going management of the Hunter Wetlands Centre Australia component of the Ramsar site to maintain its ecological character and values has been prepared (Ekert 2002). The '*Shortland Wetlands: Site Management Plan 2002 – 2009*' (Ekert 2002) aims to enhance the management practices that have been in place since the start of the restoration project in 1984-85. The Plan is designed to accommodate the on-going involvement of local communities. The Wetlands Centre's focus on communication, education and public awareness has influenced the objectives and actions in the Plan. A key aim is the development and implementation of a Monitoring Plan to identify changes in key factors relevant to the ecological character of the site.

An Operations Management Plan, which will guide management of the wetlands' hydrology, was prepared in 2011. The *Operations Management Plan – Hunter Wetlands Centre September 2011* will be incorporated in the Site Management Plan when it is reviewed in the future (Ken Conway, pers. comm. 2012).

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29. Current scientific research and facilities:
e.g., details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Kooragang

The only research facility in the Kooragang component of the Ramsar site is a small bird hide at Stockton Sandspit.

Kooragang Island has been the subject of a number of ecological studies undertaken by various organisations including the University of Newcastle, Hunter Bird Observers Club, Hunter Wetlands Centre Australia, Hunter Catchment Management Trust, Ironbark Creek Catchment Management Committee, Kooragang Wetland Rehabilitation Project, Hunter Water Corporation and various environmental consultancy companies.

Currently research is being undertaken in the following areas:

- banding and plumage studies of wading birds, water bird counts, the success of waterbird breeding and changes in migration patterns
- geomorphological changes to the Hunter River Estuary

- water quality monitoring
- alligator weed.

Hunter Wetlands Centre Australia

There are no active research facilities currently operating at the Wetlands Centre. However, there is a significant body of work about the site, its development and Centre activities that has been produced by students and by technical staff employed as consultants in past years. The Hunter Wetlands Centre Australia has produced 37 scientific publications, four reports, poster papers at international conferences and contributed to three books. An extensive bibliographical list of publications relating to the Hunter Wetlands Centre Australia component of the Ramsar site (Burgess 2002) is held in the Wetlands Centre Library.

Research related to the site forms part of the Wetlands Centre Library collection. The library is extensive and unique. It has grown over the past 17 years to form a detailed collection of resources which describe local wetlands and environmental issues. The library is available to the public and is staffed by volunteers who respond to community needs. There is high potential for the on-going involvement of research students from nearby Newcastle University in projects relevant to the management of the site.

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30. 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.

Kooragang

The Kooragang component of the Ramsar site offers significant opportunities for environmental education since it is readily accessible to a large number of people from Newcastle and the lower Hunter Valley.

Hunter Wetlands Centre Australia provides interpretation of the Hunter Wetlands Centre Australia component of the Ramsar site. It also organises regular visits to the Kooragang component for researchers and students of wetland conservation.

The Kooragang Wetland Rehabilitation Project also has interpretation facilities and a model environmentally sustainable farm adjacent to the Kooragang component of the Ramsar site. The construction of educational facilities in the bird hide at the Stockton Sandspit is also proposed.

Signs that outline the principles of the Ramsar Convention and the conservation values of the Ramsar Site have been erected at the site.

Hunter Wetlands Centre Australia

The Hunter Wetlands Centre Australia uses communication and education as key processes to promote wetland values, conservation and wise use management. Development on the site to support education includes the Visitors Centre, an extensive system of tracks, viewing platforms, decks, boardwalks and interpretation signs. An elevated bird hide provides access to nesting and roosting birds. Canoe facilities allow access to tidal creeks adjacent to the site.

The Visitors Centre is a large building containing an interpretation display with live and static displays, free-standing binoculars, information booklets and brochures, a souvenir shop, café, facilities and offices. Disabled access is available in the Centre and on some of the walks. A Sensory Trail provides access to the wetlands for visitors with sensory impairment.

The Wetlands Centre's school education program is underpinned by a valuable partnership with NSW Department of Education and Training (DET). The Wetlands Environmental Education Centre, a DET facility, manages the programs for approximately 8,000 school visitors annually. Students from kindergarten to year 12 enjoy programs relevant to the NSW curriculum and their stage of schooling.

An Environmental Learning Centre is to be built at Hunter Wetlands Centre Australia through funding from the Australian Government's Local Schools Working Together Program. The Environmental Learning Centre will be a shared education facility supported by a partnership between the Community sector, NSW Department of Education and Training and Catholic Schools Office. The facility will allow increased student access to the existing school education program that has operated at the Hunter Wetlands Centre Australia for over 20 years. The new facility will be available for

students and teachers from all education sectors.

The Hunter Wetlands Centre Australia programs and achievements have resulted in a greater understanding of wetlands in the Hunter region, increasing community support for other major wetland rehabilitation projects. This provides an excellent demonstration of the role education can play to build understanding of wetland values and functions.

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

Kooragang

Currently the Kooragang component of the Ramsar site is not promoted as a tourist destination. Some limited, low impact recreational uses are permitted within the National Park and include fishing, boating and bird watching. The Kooragang component receives approximately 5,000 visitors per year.

Hunter Wetlands Centre Australia

The Hunter Wetlands Centre Australia component of the Ramsar site offers a range of outdoor recreation facilities with easy access to high-conservation-value wetlands for visitors. Facilities include bush-walking trails, boardwalks, observation decks, elevated bird hide and canoes.

As an ecotourism facility, the Hunter Wetlands Centre Australia complements other attractions in Newcastle and provides environment-focused tourism supported by environmental education. The Centre receives 127,000 visitors per annum (Ken Conway, pers. comm. 2012).

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

Territorial: Government of New South Wales

Functional: Office of Environment and Heritage, NSW.

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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.

Kooragang

NSW National Parks and Wildlife Service is responsible for management of Hunter Wetlands National Park:

Area Manager
Newcastle Area
NPWS
PO Box 351
Jesmond NSW 2299

Phone: 02 4946 4100

Hunter Wetlands Centre Australia

Hunter Wetlands Centre Australia Ltd is responsible for management of Hunter Wetlands Centre Australia:

Hunter Wetlands Centre Australia
PO Box 292
Wallsend NSW 2287

Phone: 02 4951 6466

hwca@wetlands.org.au

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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.

Albrecht, G. and Maddock, M. (1985). *Avifauna of the Hunter Wetlands Centre* . Wetlands (Australia) 5(2): 53-69.

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Appendix 1: Boundary Description of Hunter Wetlands Centre Australia (McDiarmid 2009).

- Commences at a point on the southern side of Ironbark Creek being the northern-most parcel corner of Lot 5 DP233520 at the point nearest to 32º52'04.05568"S, 151º41'28.65230"E and follows the northern parcel boundary of Lot 5 DP233520 in an easterly direction at a point nearest to 32º52'04.38841"S, 151º41'30.86851"E.
- Then heading south easterly along the north eastern boundary of parcel Lot 5 DP233520 at a point nearest to 32º52'26.41221"S, 151º41'57.40183"E.
- Then heading southerly along the eastern parcel boundary of Lot 5 DP233520 at a point nearest to 32º52'27.63140"S, 151º41'57.14334"E.
- Then continuing in a southerly direction following a series of lines along the eastern parcel boundary of Lot 2 DP1043133, common with parcel Lot 4 DP1043133, at a point nearest to 32º52'34.96212"S, 151º41'52.67829"E.
- Then continuing in a southerly direction along the proposed north west boundary of land to be acquired by the NSW Roads and Traffic Authority to a point on the boundary of Lot 2 DP1043133, common with parcel Lot A DP334475 at a point nearest to 32°52'38.04450"S, 151°41'51.11309"E.
- Then continuing in a westerly direction along the southern parcel boundary of Lot 2 DP1043133, common with parcel Lot A DP334475, at a point nearest to 32º52'37.89685"S, 151º41'50.09690"E.
- Then continuing in a westerly direction along the common boundary between parcel Lot 2 DP1043133 and Lot 100 DP1134395 at a point nearest to 32º52'37.53336"S, 151º41'49.19806"E.
- Then continuing in a westerly direction across Lot 100 DP1134395, then along the southern boundary of Lot 100 DP1134395 common with DP 270610 then Lot 102 DP1134395 at a point nearest to 32º52'35.15129"S, 151º41'42.05743"E.
- Then in a northerly direction along the western boundary of Lot 100 DP1134395 common with Lot 4 DP230124 at a point nearest to 32º52'34.60377"S, 151º41'41.95402"E.
- Then continues in a westerly direction following a series of lines on the southern parcel boundaries of Lot 2 DP1043133 and Lot 7 DP233520 at a point nearest to 32º52'30.85568"S, 151º41'32.08360"E.
- Then in a northerly direction following a series of lines along the western parcel boundaries of Lot 7 DP 233520 and Lot 2 DP 1043133 at a point nearest to 32º52'15.00933"S, 151º41'36.10932"E.
- Then in a westerly direction following a series of lines along the southern parcel boundary of Lot 5 DP233520 to the south western parcel boundary corner of that lot, being a point on the southern bank of Ironbark Creek at a point nearest to 32º52'10.69394"S, 151º41'12.21045"E.
- Then following the southern bank of Ironbark Creek as defined by DP230124 to the point of commencement.

Cadastre information from NSW Department of Lands Digital Cadastre Database August 2008.

Reference

McDiarmid, G. 2009. Survey and Mapping the Boundary of the Shortland Wetland Component of the Hunter River Estuary Ramsar Wetland – Draft Boundary Description and Mapping. Unpublished Report to the Australian Government Department of the Environment, Water, Heritage and the Arts. GHD, Newcastle, NSW.

Appendix 2: Bird species recorded at the Hunter Wetlands Centre Australia and the Kooragang component of the Hunter Estuary Wetlands

Records for Hunter Wetlands Centre Australia from Barden (2002). Records for Kooragang compiled from Clarke and van Gessel (1983), Holmes, van Gessel and Kendall, Morris, Clarke and van Gessel *in* NPWS (1998), NPWS (2002a) and Herbert (2007a).

Key

E1 Listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

E2 Listed as 'Endangered' under the NSW *Threatened Species Conservation Act 1995* (TSC Act)

E3 Listed as 'Endangered' under the IUCN Red List (Version 2009.1)

V1 Listed as 'Vulnerable' under the EPBC Act

V2 Listed as 'Vulnerable' under the TSC Act

V3 Listed as 'Vulnerable' under the IUCN Red List (Version 2009.1)

M Migratory species listed on the EPBC Act and listed under international bilateral migratory bird treaties: Japan-Australia (JAMBA), China- Australia Migratory Bird Agreements, (CAMBA) or Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

***** Introduced species

\# Recorded at the site

nr Not recorded at the site

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
GALLIFORMES				
Phasianidae				
Coturnix chinensis	King quail		nr	#
Coturnix ypsilophora	Brown quail		#	#
ANSERIFORMES	WATERFOWL			
Anatidae	Ducks			
Anas castanea	Chestnut teal		#	#
Anas clypeata	Northern shoveler	M	#	nr
Anas gracilis	Grey teal		#	#
Anas querquedula	Mallard		#	nr
Anas querquedula	Garganey	M	#	nr
Anas rhynchotis	Australasian shoveler		#	#
Anas superciliosa	Pacific Black duck		#	#
Aythya australis	Hardhead		#	#
Biziura lobata	Musk duck		#	#
Chenonetta jubata	Australian wood duck		#	#
Cygnus atratus	Black swan		#	#
Dendrocygna arcuata	Wandering Whistling-Duck		#	nr
Dendrocygna eytoni	Plumed whistling-duck		#	#
Malacorhynchus membranaceus	Pink-eared duck		#	#

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Oxyura australis	Blue-billed duck	V2	#	nr
Stictonetta naevosa	Freckled duck	V2	#	#
Tadorna tadornoides	Australian shelduck		nr	#
Anseranatidae	Magpie goose			
Anseranas semipalmata	Magpie goose	V2	#	nr
PODICEPIDIFORMES	GREBES, DARTERS, CORMORANTS			
Podicepididae	Grebes			
Podiceps cristatus	Great Crested grebe		nr	#
Poliocephalus poliocephalus	Hoary-headed grebe		nr	#
Tachybaptus novaehollandiae	Australasian grebe		#	#
Anhingidae (w)	Darters			
Anhinga melanogaster	Darter		#	#
Pelecanidae (w)	Pelicans			
Pelecanus conspicillatus	Australian pelican		#	#
Phalacrocoracidae (w)	Cormorants			
Phalacrocorax carbo	Great cormorant		#	#
Phalacrocorax melanoleucos	Little Pied cormorant		#	#
Phalacrocorax sulcirostris	Little Black cormorant		#	#
Phalacrocorax varius	Pied cormorant		#	#
CICONIIFORMES	HERONS, STORKS AND IBIS			
Ardeidae	Herons and egrets			
Ardea alba	Great egret	M	#	#
Ardea ibis	Cattle egret	M	#	#
Ardea intermedia	Intermediate egret		#	#
Ardea pacifica	White-necked heron		#	#
Botaurus poiciloptilus	Australasian bittern	E1, V2, V3	#	#
Butorides striatus	Striated heron		nr	#
Egretta garzetta	Little egret		#	#
Egretta novaehollandiae	White-faced heron		#	#
Ixobrychus flavicollis	Black bittern	V2	nr	#
Ixobrychus minutus	Little bittern	V3	#	#
Nycticorax caledonicus	Nankeen night heron		#	#
Ciconiidae	Storks			
Ephippiorhynchus asiaticus	Black-necked stork	E2	#	#

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Threskiornithidae	Ibis and spoonbills			
Platalea flavipes	Yellow-billed spoonbill		#	#
Platalea regia	Royal spoonbill		#	#
Plegadis falcinellus	Glossy ibis	M	#	#
Threskiornis molucca	Australian white ibis		#[2]	#
Threskiornis spinicollis	Straw-necked ibis		#	#
FALCONIORMES	DIURNAL BIRDS OF PREY			
Accipitridae	Hawks, eagles and kites			
Accipiter cirrocephalus	Collared sparrowhawk		#	nr
Accipiter fasciatus	Brown goshawk		#	nr
Accipiter novaehollandiae	Grey goshawk		#	nr
Aquila audax	Wedge-tailed eagle		#	nr
Aviceda subcristata	Pacific baza		#	#
Circus approximans	Swamp harrier		#	#
Circus assimilis	Spotted harrier		#	nr
Elanus axillaris	Black-shouldered kite		#	
Erythrotriorchis radiatus	Red goshawk	V1, V2	#	nr
Haliaeetus leucogaster	White-bellied sea-eagle		#	
Haliastur indus	Brahminy kite		#	nr
Haliastur sphenurus	Whistling kite		#	
Hieraaetus morphnoides	Little eagle		#	nr
Lophoictinia isura	Square-tailed kite		nr	#
Pandion haliaetus	Osprey		#	nr
Falconidae	Falcons			
Falco cenchroides	Nankeen kestrel		#	nr
Falco longipennis	Australian hobby		#	#
Falco peregrinus	Peregrine falcon		#	#
Falco subniger	Black falcon		#	#
GRUIFORMES	RAILS, CRANES AND BUSTARDS			
Rallidae	Rails, crakes and gallinules			
Gallirallus philippensis	Buff-banded rail		#	#
Rallus pectoralis	Lewin's rail		#	#
Porzana pusilla	Baillon's crake		#	#
Porzana fluminea	Australian Spotted crake		#	#
Porzana tabuensis	Spotless crake		#	#
Porphyrio porphyrio	Purple swamphen		#	#
Gallinula tenebrosa	Dusky moorhen		#	#
Fulica atra	Eurasian coot		nr	#

[2] White ibis now breeding in the estuary (Herbert 2007a), 55 nests recorded in 2006/07 at the Hunter Wetlands Centre

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
CHARADRIIFORMES	WADERS AND GULLS			
Burhinidae	Thick-knees			
Esacus neglectus	Beach stone-curlew	E2	nr	#
Charadriidae	Plovers and lapwings			
Charadrius bicinctus	Double-banded plover		nr	#
Charadrius lescenaultii	Greater sand plover	M, V2	nr	#
Charadrius mongolus	Lesser sand plover	M, V2	nr	#
Charadrius ruficapillus	Red-capped plover		nr	#
Charadrius veredus	Oriental plover	M	nr	#
Elseyornis melanops	Black-fronted dotterel		nr	#
Erythrogonys cinctus	Red-kneed dotterel		#	#
Pluvialis fulva	Pacific golden plover	M	nr	#
Pluvialis squatarola	Grey plover	M	nr	#
Vanellus miles	Masked lapwing		#	#
Vanellus tricolor	Banded lapwing		nr	nr
Haematopodidae (w)	Oystercatchers			
Haematopus longirostris	Pied oystercatcher	V2	nr	#
Haematopus fuliginosus	Sooty oystercatcher	V2	nr	#
Laridae	Gulls, skuas			
Larus novaehollandiae	Silver gull		nr	#
Sterna nilotica	Gull-billed tern		nr	#
Sterna striata	White-fronted tern		nr	#
Chlidonias hybridus	Whiskered tern		#	#
Chlidonias leucopterus	White-winged black tern	M	#	#
Sterna albifrons	Little tern	E2, M	nr	#
Sterna bergii	Crested tern		nr	#
Sterna caspia	Caspian tern	M	#	#
Sterna hirundo	Common tern	M	nr	#
Recurvirostridae	Stilts and avocets			
Cladorhynchus leucocephalus	Banded stilt		nr	#
Himantopus himantopus	Black-winged stilt		#	#
Recurvirostra novaehollandiae	Red-necked avocet		#	#
Rostratulidae	Snipe			
Rostratula benghalensis	Painted snipe	M	nr	#
Scolopacidae	Sandpipers			
Actitis hypoleucos	Common sandpiper	M	nr	#
Arenaria interpres	Ruddy turnstone	M	nr	#
Calidris acuminata	Sharp-tailed sandpiper	M	#	#
Calidris alba	Sanderling	M, V2	nr	#
Calidris canutus	Red knot	M	nr	#
Calidris ferruginea	Curlew sandpiper	M	#	#
Calidris melanotus	Pectoral sandpiper	M	nr	#
Calidris ruficollis	Red-necked stint	M	#	#

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Calidris tenuirostris	Great knot	M, V2	nr	#
Gallinago hardwickii	Latham's snipe	M	#	#
Heteroscelus brevipes	Grey-tailed tattler	M	nr	#
Heteroscelus incana	Wandering tattler	M	nr	#
Limicola falcinellus	Broad-billed sandpiper	M, V2	nr	#
Limnodromus semipalmata	Asian dowitcher	M	nr	#
Limosa lapponica	Bar-tailed godwit	M	nr	#
Limosa limosa	Black-tailed godwit	M, V2	nr	#
Numenius madagascariensis	Eastern curlew	M	nr	#
Numenius minutus	Little curlew	M	nr	#
Numenius phaeopus	Whimbrel	M	nr	#
Philomachus pugnax	Ruff	M	nr	#
Tringa glareola	Wood sandpiper	M	#	#
Tringa nebularia	Common greenshank	M	#	#
Tringa stagnatilis	Marsh sandpiper	M	#	#
Tryngites subruficollis	Buff-breasted sandpiper	M	nr	#
Xenus cinereus	Terek sandpiper	M, V2	nr	#
COLUMBIFORMES	PIGEONS			
Columbidae	Pigeons and doves			
Chalcophaps indica	Emerald dove		#	nr
Columba leucomela	White-headed pigeon		#	nr
Columba livia	Rock dove	*	#	#
Geopelia humeralis	Bar-shouldered dove		#	nr
Lopholaimus antarcticus	Topknot pigeon		#	nr
Macropygia amboinensis	Brown cuckoo-dove		#	nr
Ocyphaps lophotes	Crested pigeon		#	nr
Streptopelia chinensis	Spotted-dove	*	#	nr
PSITTACIFORMES	COCKATOOS, PARROTS AND LORIKEETS			
Cacatuidae	Cockatoos			
Cacatua galerita	Sulphur-crested cockatoo		#	nr
Cacatua roseicapilla	Galah		#	nr
Cacatua sanguinea	Little corella		#	nr
Cacatua tenuirostris	Long-billed corella		#	nr
Calyptorhynchus funereus	Yellow-tailed black-cockatoo		#	nr
Nymphicus hollandicus	Cockatiel		#	nr
Psittacidae	Parrots and lorikeets			
Alisterus scapularis	King parrot		#	nr
Glossopsitta pusilla	Little lorikeet		#	nr
Platycercus adscitus	Pale-headed rosella		#	nr
Platycercus eximius	Eastern rosella		#	#
Psephotus haematonotus	Red-rumped parrot		#	nr
Trichoglossus chlorolepidotus	Scaly-breasted lorikeet		#	nr
Trichoglossus haematodus	Rainbow lorikeet		#	nr

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Centropodidae	Coucal			
Centropus phasianinus	Pheasant coucal		#	nr
Cuculidae	Cuckoos			
Cacomantis variolosus	Brush cuckoo		#	nr
Chrysococcyx basalis	Horsfield's bronze-cuckoo		#	#
Chrysococcyx lucidus	Shining bronze-cuckoo		#	nr
Cuculus pallidus	Pallid cuckoo		#	nr
Cuculus saturatus	Oriental cuckoo	M	#	#
Eudynamys scolopacea	Common koel		#	nr
Scythrops novaehollandiae	Channel-billed cuckoo		#	nr
STRIGIFORMES	OWLS			
Strigidae	Hawk owls			
Ninox novaeseelandiae	Southern boobook		#	nr
Tytonidae	Barn owls			
Tyto alba	Barn owl		#	nr
Tyto capensis	Grass owl	V2	nr	#
Tyto novaehollandiae	Masked owl	V2	#	nr
CAPRIMULGIFORMES	NIGHTJARS AND RELATIVES			
Podargidae	Frogmouths			
Podargus strigoides	Tawny frogmouth		#	nr
APODIFORMES	SWIFTS			
Apodidae	Swifts			
Hirundapus caudacutus	White-throated needletail	M	#	nr
CORACIIFORMES	KINGFISHERS, ROLLERS AND BEE-EATERS			
Alcedinidae	Water kingfishers			
Alcedo azurea	Azure kingfisher		#	#
Coraciidae	Rollers			
Eurystomus orientalis	Dollarbird		#	nr
Halcyonidae	Tree kingfishers			
Dacelo novaeguineae	Laughing kookaburra		#	#
Todiramphus macleayii	Forest kingfisher		#	#
Todiramphus sanctus	Sacred kingfisher		#	#
Meropidae	Bee-eaters			
Merops ornatus	Rainbow bee-eater	M	#	nr
PASSERIFORMES	SONGBIRDS			
Artamidae	Woodswallows, magpies, butcherbirds and currawongs			
Artamus leucorynchus	White-breasted woodswallow		#	#
Cracticus nigrogularis	Pied butcherbird		#	nr
Cracticus torquatus	Grey butcherbird		#	nr
Gymnorhina tibicen	Australian magpie		#	#
Strepera graculina	Pied currawong		#	nr
Campephagidae	Cuckoo-shrikes and trillers			

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Coracina novaehollandiae	Black-faced cuckoo-shrike		#	#
Lalage sueurii	White-winged triller		#	#
Cinclosomatidae	Whipbirds and quail-thrushes			
Psophodes olivaceus	Eastern whipbird		#	nr
Climacteridae				
Cormobates leucophaeus	White-throated treecreeper		nr	#
Corvidae	Ravens and crows			
Corvus coronoides	Australian raven		#	#
Dicaeidae	Flowerpeckers			
Dicaeum hirundinaceum	Mistletoebird		#	nr
Dicruridae	Monarchs, fantails, magpielarks and drongos			
Dicrurus bracteatus	Spangled drongo		#	nr
Grallina cyanoleuca	Australian magpie-lark		#	#
Monarcha melanopsis	Black-faced monarch		#	nr
Myiagra inquieta	Restless flycatcher		#	#
Myiagra rubecula	Leaden flycatcher		#	nr
Rhipidura fuliginosa	Grey fantail		#	#
Rhipidura leucophrys	Willie wagtail		#	#
Rhipidura rufifrons	Rufous fantail		#	nr
Fringillidae	Finches			
Carduelis carduelis	European goldfinch	*	#	nr
Hirundinidae	Swallows and martins			
Hirundo ariel	Fairy martin		#	nr
Hirundo neoxena	Welcome swallow		#	#
Hirundo nigricans	Tree martin		#	nr
Hirundo rustica	Barn swallow	M	#	nr
Maluridae	Fairy-wrens			
Malurus cyaneus	Superb fairy-wren		#	#
Malurus lamberti	Variegated fairy-wren		#	nr
Stipiturus malachurus	Southern emu-wren		#	nr
Meliphagidae	Honeyeaters			
Acanthorhynchus tenuirostris	Eastern spinebill		#	nr
Anthochaera carnunculata	Red wattlebird		#	nr
Anthochaera chrysoptera	Little wattlebird		#	nr
Epthianura albifrons	White-fronted shat		nr	#
Lichenostomus chrysops	Yellow-faced honeyeater		#	nr
Lichmera indistincta	Brown honeyeater		#	#
Manorina melanocephala	Noisy miner		#	nr
Melithreptus brevirostris	Brown-headed honeyeater		#	nr
Melithreptus lunatus	White-naped honeyeater		#	nr
Myzomela sanguinolenta	Scarlet honeyeater		#	nr
Philemon citreogularis	Little friarbird		#	nr
Philemon corniculatus	Noisy friarbird		#	nr

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Phylidonyris nigra	White-cheeked honeyeater		#	nr
Phylidonyris novaehollandiae	New Holland honeyeater		#	nr
Plectorhyncha lanceolata	Striped honeyeater		#	#
Motacillidae	Pipits and wagtails			
Anthus novaeseelandiae	Richard's pipit		#	#
Motacilla flava	Yellow wagtail	M	#	nr
Acrocephalidae	Marsh- and tree-warblers			
Acrocephalus stentoreus	Clamorous reed-warbler		#	nr
Cisticolidae	Cisticolas			
Cisticola exilis	Golden-headed cisticola		#	#
Sylviidae	Old world warblers			
Cincloramphus cruralis	Brown songlark		nr	#
Cincloramphus mathewsi	Rufous songlark		#	#
Megalurus gramineus	Little grassbird		#	#
Megalurus timoriensis	Tawny grassbird		#	#
Turdus merula	Common blackbird	*	#	nr
Oriolidae	Orioles			
Oriolus sagittatus	Olive-backed oriole		#	nr
Sphecotheres viridis	Figbird		#	nr
Pachycephalidae	Whistlers and shrike-thrushes			
Colluricincla harmonica	Grey shrike-thrush		#	nr
Falcunculus frontatus	Crested shrike-tit		#	nr
Pachycephala pectoralis	Golden whistler		#	nr
Pachycephala rufiventris	Rufous whistler		#	nr
Pardalotidae	Pardalotes, gerygones, scrubwrens and thornbills			
Acanthiza chrysorrhoa	Yellow-rumped thornbill		#	#
Acanthiza nana	Yellow thornbill		#	#
Acanthiza pusilla	Brown thornbill		#	nr
Acanthiza reguloides	Buff-rumped thornbill		#	nr
Gerygone levigaster	Mangrove gerygone		nr	#
Gerygone olivacea	White-throated gerygone		#	nr
Pardalotus punctatus	Spotted pardalote		#	nr
Pardalotus striatus	Striated pardalote		#	nr
Sericornis frontalis	White-browed scrubwren		#	nr
Passeridae	House sparrows and grass finches			
Lonchura castaneothorax	Chestnut-breasted mannikin		#	#
Neochmia temporalis	Red-browed finch		#	nr
Passer domesticus	House sparrow	*	#	nr
Taeniopygia bichenovii	Double-barred finch		#	#
Taeniopygia guttata	Zebra finch		#	#
Petroicidae	Australasian robins			
Eopsaltria australis	Eastern yellow robin		#	nr

Scientific Name	Common Name	Status	Hunter Wetlands Centre	Kooragang component
Petroica multicolor	Scarlet robin		#	nr
Petroica rosea	Rose robin		#	nr
Sturnidae	Starlings			
Acridotheres tristis	Common myna	*	#	nr
Sturnus vulgaris	Common starling	*	#	nr
Zosteropidae	White-eyes			
Zosterops lateralis	Silvereye		#	#

Appendix 3: Bird Species recorded breeding at the Hunter Estuary Wetlands

The following is a list of species recorded breeding at the Hunter Wetlands Centre Australia (from Barden 2002), and indicates those species also known to breed at the Kooragang component (Clarke and Van Gessel 1983; Herbert 2007a). Count data refers to the Hunter Wetlands Centre Australia only.

The great egret (*Ardea alba*), intermediate egret (*Ardea intermedia*), little egret (*Egretta garzetta*) and cattle egret (*Ardea ibis*) are seasonal visitors to the site. They arrive at the Hunter Wetlands Centre Australia during spring for their breeding season (Baxter 1994).

The numbers of white ibis (*Threskiornis molucca*) at the site increase significantly over autumn and winter as migrants from inland breeding colonies come to the coast for non-breeding seasonal foraging (Maddock 2002).

Straw-necked ibis (*Threskiornis spinicollis*) are very few in summer but large numbers migrate to the region during autumn and winter. Up to 7000 of these birds use the *Melaleuca* swamp forest for night roosting. The numbers start to drop during August as they set out on their return journey inland (Maddock 2002).

Nankeen night herons (*Nycticorax caledonicus*) use the site for night foraging and day roosting during the non-breeding season.

* Recorded at the Kooragang component and the Hunter Wetlands Centre Australia

\# Recorded at the Hunter Wetlands Centre Australia only

† Recorded at the Kooragang component only

Common Name	Scientific Name	Count
† Brown quail	*Coturnix ypsilophora*	
# Magpie goose	*Anseranas semipalmata*	over 100
# Wandering whistling duck	*Dendrocygna arcuata*	30-50 (over 100 birds in 2000)
† Musk duck	*Biziura lobata*	
* Black swan	*Cygnus atratus*	6-20
* Australian wood duck	*Chenonetta jubata*	20-50
* Pacific black duck	*Anas superciliosa*	up to 100
* Grey teal	*Anas gracilis*	up to 100
* Chestnut teal	*Anas castanea*	up to 100
* Hardhead *	*Aythya australis*	20-40
* Australasian grebe	*Tachybaptus novaehollandiae*	10-30
* Little black cormorant	*Phalacrocorax sulcirostris*	up to 100
* Little pied cormorant	*Phalacrocorax melanoleucos*	up to 100
* White-faced heron	*Egretta novaehollandiae*	2-4 (up to 22)
* Little egret	*Egretta garzetta*	4-over 100
* Great egret	*Ardea alba*	40-400
* Intermediate egret	*Ardea intermedia*	20-900
* Cattle egret	*Ardea ibis*	200-1400
† Striated heron	*Butorides striatus*	
* Nankeen night heron	*Nycticorax caledonicus*	20-100

Common Name	Scientific Name	Count
* Australian white ibis	*Threskiornis molucca*	2-6 (over 1000 birds roosting)
† Swamp harrier	*Circus approximans*	
# Brown goshawk	*Accipiter fasciatus*	2
* Whistling kite	*Haliastur sphenurus*	2
† Lewin's rail	*Rallus pectoralis*	
† Baillon's crake	*Porzana pusilla*	
* Purple swamphen	*Porphyrio porphyrio*	10 - 100
* Dusky moorhen	*Gallinula tenebrosa*	10-100
* Eurasian coot	*Fulica atra*	10-40
† Red-capped plover	*Charadrius ruficapillus*	
* Black-fronted dotterel	*Elseyornis melanops*	6-18
* Red-kneed dotterel	*Erythrogonys cinctus*	2-10
* Masked lapwing	*Vanellus miles*	6-10
† Pied oystercatcher	*Haematopus longirostris*	
† Black-winged stilt	*Himantopus himantopus*	
* Sacred kingfisher	*Todiramphus sanctus*	4-10
# Barn owl	*Tyto alba*	2
† Clamorous reed-warbler	*Acrocephalus stentoreus*	
† Golden-headed cisticola	*Cisticola exilis*	
† Little grassbird	*Megalurus gramineus*	
† Tawny grassbird	*Megalurus timoriensis*	

Appendix 4: Mammals including bats, reptiles, amphibians and fish recorded at the Hunter Wetlands Centre Australia and the Kooragang component of the Hunter Estuary Wetlands

Species list for Hunter Wetlands Centre Australia compiled from observations made by Kevin Markwell over a period of several years and is supported by the Ecological Study of the State Highway No 23 – Shortland to Pacific Highway Corridor by Macdonald Wagner (1984). Species list for Kooragang from records compiled by the Kooragang Wetland Rehabilitation Project (undated). Fish species for the Kooragang component are provided in Appendix 4.

Key

E2 Listed as 'Endangered' under the TSC Act

V1 Listed as 'Vulnerable' under the EPBC Act

V2 Listed as 'Vulnerable' under the TSC Act

***** Introduced species

\# Recorded at the site

nr Not recorded at the site

Common Name	Scientific Name	Status	Hunter Wetlands Centre	Kooragang component
MAMMALS				
Northern brown bandicoot	*Isoodon macrourus*		#	
Common brush-tailed possum	*Trichosurus vulpecula*			#
Eastern grey kangaroo	*Macropus giganteus*			#
White-striped mastiff bat	*Tadarida australis*			#
Little freetail bat	*Mormopterus sp. 2*			#
Gould's wattled bat	*Chalinolobus gouldii*			#
Chocolate wattled bat	*Chalinolobus morio*			#
Little bent-wing bat	*Miniopterus australis*	Vulnerable		#
Large bent-wing bat	*Miniopterus schreibersii oceanensis*	Vulnerable		#
Fishing bat	*Myotis adversus*			#
Gould's long-eared bat	*Nyctophilus gouldi*			#
Eastern broad-nosed bat	*Scotorepens orion*			#
Little Forest Bat	*Vespadelus vulturnus*			#
Water rat	*Hydromys chrysogaster*		#	
House mouse	*Mus musculus*	*	#	
Black rat	*Rattus rattus*	*	#	
Brown hare	*Lepus capensis*	*	#	
European rabbit	*Oryctolagus cuniculus*	*	#	
Red fox	*Vulpes vulpes*	*	#	
REPTILES				
Long-necked Tortoise	*Chelodina longicollis*		#	

Common Name	Scientific Name	Status	Hunter Wetlands Centre	Kooragang component
Striped skink	*Ctenotus robustus*		#	
Grass skink	*Lampropholis delicata*		#	
Weasel skink	*Lampropholis mustelinum*		#	
Three-toed skink	*Saiphos equalis*		#	
Eastern Water skink	*Sphenomorphus quoyii*		#	
She-oak skink	*Tiliqua casuarinae*		#	
Eastern water dragon	*Physignathus lesueurii ssp lesueurii*			
Swamp snake	*Hemiaspis signata*		#	
Red-bellied black snake	*Pseudechis porphyriacus*		#	#
Green tree snake	*Dendrelaphis punctulata*			#
AMPHIBIANS				
Green and golden bell frog	*Litoria aurea*	V1,E2	#	#
Bleating tree frog	*Litoria dentate*		#	
Dwarf Green tree frog	*Litoria fallax*		#	#
Peron's tree frog	*Litoria peroni*		#	#
Tyler's tree frog	*Litoria tyleri*		#	
Green tree frog	*Litoria caerulea*		#	#
Common eastern froglet	*Crinia signifera*		#	#
Striped marsh frog	*Limnodynastes peroni*		#	#
Spotted grass frog	*Lymnodynastes tasmaniensis*		#	#
FISH				
Cox's gudgeon	*Gobiomorphus coxii*		#	
Firetail gudgeon	*Hypseleotris galii*		#	
Flathead gudgeon	*Philypnodon grandiceps*		#	
gudgeon	*Philypnodon sp. nov.*		#	
Short-finned eel	*Anguilla australis*		#	#
Mosquito fish	*Gambusia holbrooki*	*	#	#

Appendix 5: Fish recorded within the Hunter Estuary and likely to occur within the Kooragang component of the Hunter Estuary wetlands

Sources: Kooragang Wetland Rehabilitation Project (undated), Ruello (1976), Copeland (1993), Shepherd (1994)15, Williams, Hannan & Balashov (1995), Gibbs, McVea & Louden (1999), The Ecology Lab (2006)

KEY

E1 Listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

E2 Listed as 'Endangered' under the NSW *Threatened Species Conservation Act 1995* (TSC Act)

V1 Listed as 'Vulnerable' under the EPBC Act

V2 Listed as 'Vulnerable' under the TSC Act

V3 Listed as 'Vulnerable' under the IUCN Red List (Version 2009.1)

F freshwater

FE Freshwater euryhaline

* Introduced species

M Marine

ME Marine euryhaline

Family	Species	Common Name	Salinity class	Status
Anguillidae	*Anguilla australis*	Short-fin eel	FE	
	Anguilla reinhardtii	Long-fin eel	FE	
Antennariidae	*Antennarius striatus*	Striped anglerfish	M	
Atherinidae	*Atherinosoma microstoma*	Smallmouth hardyhead	FE	
Blenniidae	*Omobranchus anolius*	Oyster blenny	ME	
Callionymidae	*Callionymus limiceps*	Rough-headed dragonet	ME	
Carangidae	*Caranx sansun*	Papuan trevally	M	
	Pseudocaranx dentex	White travally	M	
	Trachurus novaezelandiae	Yellowtail scad	M	
Chandidae	*Ambassis jacksoniensis*	Port Jackson glassfish	ME	
	Ambassis marianus	Estuary/Ramsay's glassfish	ME	
Clupeidae	*Herklotsichthys castelnaui*	Southern/Castelnau's herring	M	
	Hyperlophus translucidus	Glassy sprat	M	
	Hyperlophus vittatus	Sandy sprat	M	
	Potamalosa richmondia	Freshwater herring	FE	
	Sardinops sagax neopilchardus	Australian sardine	M	
Cynoglossidae	*Paraplagusia bilineata*	Lemon tongue-sole	M	

Family	Species	Common Name	Salinity class	Status
Cyprinidae	*Carassius auratus*	Goldfish	F	*
	Cyprinus carpio	European carp	F	*
Dactylopteridae	*Dactyloptena orientalis*	Flying gurnard	M	
Dasyatididae	*Dasyatis fluviorum*	Estuary stingray	ME	V3
Diodontidae	*Dicotylichthys punctulatus*	Three-bar porcupinefish	ME	
Eleotrididae	*Gobiomorphus australis*	Striped gudgeon	F	
	Gobiomorphus coxii	Cox's gudgeon	F	
	Hypseleotris compressa	Empire gudgeon	FE	
	Philypnodon grandiceps	Flathead gudgeon	F	
	Philypnodon sp. A	Dwarf flathead gudgeon	F	
Elopidae	*Elops hawaiensis*	Giant herring	ME	
Engraulidae	*Engraulis australis*	Australian anchovy	M	
Enoplosidae	*Enoplosus armatus*	Old wife	M	
Galaxiidae	*Galaxias maculatus*	Common jollytail	FE	
Gerreidae	*Gerres subfasciatus*	Silver biddy	ME	
Gobiidae	*Acanthogobius flavimanus*	Oriental goby	ME	*
	Afurcagobius tamarensis	Tamar river goby	ME	
	Arenigobius bifrenatus	Bridled goby	ME	
	Arenigobius frenatus	Half-bridled goby	ME	
	Bathygobius krefftii	Krefft's Frillgoby	ME	
	Cristatogobius gobioides	Crested oyster goby	ME	
	Favonigobius exquisitus	Exquisite sand goby	ME	
	Favonigobius lentiginosus	Eastern long-finned goby	ME	
	Glossogobius biocellatus[3]	Sleepy goby	ME	
	Gobiopterus semivestitus	Glass goby	ME	
	Mugilogobius paludis	Mangrove goby	ME	
	Mugilogobius stigmaticus	Checkered mangrove goby	ME	
	Pseudogobius sp. 9	Blue-spot goby	FE	
	Redigobius macrostoma	Large-mouth goby	ME	
	Taenioides mordax/purpurascens	Eel goby	ME	
Hemiramphidae	*Hyporhamphus regularis*	River garfish	ME	
Kyphosidae	*Girella tricuspidata*	Luderick / Blackfish	ME	
Lutjanidae	*Lutjanus argentimaculatus*	Mangrove jack	ME	
Monacanthidae	*Meuschenia freycineti*	Six-spine leatherjacket	M	

[3] This species name is not in current use, it may refer to *Psammogobius biocellatus* (sleepy goby), which is listed as near-threatened on the IUCN red list (Version 2009.1) or it may be *Glossogobius giuris* (tank goby), which is common.

Family	Species	Common Name	Salinity class	Status
	Meuschenia trachylepis	Yellow-finned leatherjacket	M	
	Monacanthus macrolepis	Fan-bellied leatherjacket	M	
	Cleidopus gloriamaris	Knightfish/Pineapplefish	M	
Monodactylidae	*Monodactylus argenteus*	Silver batfish	ME	
Mugilidae	*Liza argentea*	Flat-tail mullet	ME	
	Mugil cephalus	Sea mullet	ME	
	Myxus elongatus	Sand mullet	ME	
	Paramugil georgii	Fantail mullet	ME	
Muraenescocidae	*Muraenesox cinereus*	Pike eel	ME	
Paralichthyidae	*Pseudorhombus arsius*	Large-tooth flounder	ME	n/e
	Pseudorhombus jenynsii	Small-tooth flounder	ME	n/e
Percichthyidae	*Macquaria colonorum*	Estuary perch	FE	n/e
	Macquaria novemaculeata	Australian bass	FE	n/e
Platycephalidae	*Platycephalus arenarius*	Flag-tail flathead	M	n/e
	Platycephalus bassensis	Sand flathead	M	n/e
	Platycephalus fuscus	Dusky flathead	M	n/e
Pleuronectidae	*Ammotretis rostratus*	Longsnout flounder	ME	n/e
Plotosidae	*Cnidoglanis macrocephalus*	Estuary catfish	ME	n/e
	Euristhmus lepturus	Longtailed catfish	ME	n/e
Poeciliidae	*Gambusia holbrooki*	Mosquitofish	F	n/e
Pomatomidae	*Pomatomus saltatrix*	Tailor	M	n/e
Priacanthidae	*Priacanthus macracanthus*	Spotted big-eye	M	n/e
Pseudomugilidae	*Pseudomugil signifer*	Southern blue-eye	FE	n/e
Retropinnidae	*Retropinna semoni*	Smelt	F	n/e
Scatophagidae	*Scatophagus argus*	Tiger/Spotted scat	ME	n/e
	Selenotoca multifasciata	Striped/Banded scat, butterfish	ME	n/e
Sciaenidae	*Argyrosomus japonicus*	Jewfish/Mulloway (juveniles)	M	n/e
Scorpaenidae	*Centropogon australis*	Fortescue	M	n/e
	Notesthes robusta	Bullrout	FE	n/e
Sillaginidae	*Sillago ciliata*	Sand whiting	ME	n/e
	Sillago maculata	Trumpeter whiting	ME	n/e
Soleidae	*Aseraggodes macleayanus*	Narrow banded sole	M	n/e
	Synaptura nigra	Black sole	ME	n/e
Sparidae	*Acanthopagrus australis*	Yellowfin Bream	ME	n/e
	Rhabdosargus sarba	Tarwhine	M	n/e
Sphyraenidae	*Sphyraena novaehollandiae*	Short finned sea pike	M	n/e
	Sphyraena obtusata	Striped sea pike	ME	n/e

Family	Species	Common Name	Salinity class	Status
Syngnathidae	*Vanacampus phillipi*	Port Phillip Pipefish*	M	n/e
Terapontidae	*Pelates quadrilineatus*	Trumpeter	M	n/e
	Pelates sexlineatus	Eastern striped trumpeter	M	n/e
	Terapon jarbua	Crescent perch	ME	n/e
Tetraodontidae	*Marilyna pleurosticta*	Toadfish	ME	n/e
	Tetractenos glaber	Smooth toadfish	ME	n/e
	Tetractenos hamiltoni	Common toadfish	ME	n/e
	Torquigener pleurogramma	Weeping toado	ME	n/e
	Torquigener squamicauda	Brushtail toadfish	ME	n/e
Triglidae	*Chelidonichthys kumu*	Red gurnard	ME	n/e
Urolophidae	*Trygonoptera testacea*	Common stingaree	ME	Least concern

Appendix 6: Flora species recorded at Hunter Wetlands Centre Australia and the Kooragang component of the Hunter Estuary Wetlands

Hunter Wetlands Centre data relates to occurrence and abundance and is taken from Lightfoot (2000); Kooragang data relates to occurrence only and is taken from Winning (1996).

Key

A Abundant

C Common

U Uncommon

R Rare

K occurs at Kooragang

* Exotic

\# Planted

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
CLASS FILICOPSIDA	FERNS		
Zamiaceae			
Macrozamia communis	Burrawang	U	
Azollaceae			
Azolla pinnata	Common azolla	C	
Dennstaedtiaceae			
Pteridum esculentum	Bracken	U	
Sinopteridaceae			
Cheilanthes distans	Bristly cloak fern		K
Pellaea falcata	Sickle fern		K
CLASS CONIFEROPSIDA	CONIFERS		
Podocarpaceae			
Podocarpus elatus	Plum pine		K
CLASS MAGNOLIOPSIDA			
DICOTS			
Acanthaceae			
Pseuderanthemum variabile	Pastel flower	R	
Aizoaceae			
Tetragonia tetragonoides	New Zealand spinach		K

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Amaranthaceae			
Alternanthera denticulata	Lesser joyweed	U	
**A. philoxeroides*	Alligator weed	C	
**Ameranthus viridis*	Green ameranth	C	
Apiaceae			
**Foeniculum vulgare*	Fennel	A	
**Hydrocotyle bonariensis*	Kurnell's curse	A	
H. laxiflora	Stinking pennywort	U	
Asclepiadaceae			
**Araujia hortorum*	Moth plant	R	
Cynanchum elegans		K	
**Gomphocarpus fruticosus*	Narrow-leaved cotton bush	K	
Asteraceae			
**Ambrosia artemisiifolia*	Annual ragweed	C	
**Artemisia verlotiorum*	Mugwort	U	
**Aster subulatus*	Wild aster	U	
**Bidens pilosa*	Pitchforks	U	
Cassinia quinquefaria	Biddy bush	U	
**Chrysanthemoides monilifera var. rotundata*	Bitou bush	U	
**Cirsium vulgare*	Spear thistle	R	
**Conyza albida*	Tall fleabane	C	
**Conyza bonariensis*	Flaxleaf Fleabane	K	
**Cotula coronopifolia*	Water buttons	C	K
**Crepsis capillaris*	Smooth hawksbeard	*U*	
**Galinsoga parviflora*	Potato weed	R	
**Hypochoeris radicata*	Flatweed	C	K
Senecio linearifolius	Fireweed groundsel	C	
**S. madagascariensis*	Fireweed	C	K
**Xanthium occidentale*	Noogoora burr	R	
Avicenniaceae			
Avicennia marina	Grey mangrove	C	K
Brassicaceae			
Capsella bursapastoris	Shepherd's purse	U	
Lepidium campestre	Field cress	R	
Campanulaceae			
Wahlenbergia gracilis	Sprawling bluebell	K	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Capparaceae			
Capparis arborea	Native pomegranate		K
Caprifoliaceae			
**Lonicera japonica*	Japanese honeysuckle	U	
Cassythaceae			
Cassytha glabella			K
Cassytha pubescens			K
Casuarinaceae			
Casuarina glauca Swamp	She-oak	C	K
Celastraceae			
Elaeodendron australe			K
Celastrus australis	Staff climber		K
Celastrus subspicata	Large-leaved staff vine		K
Chenopodiaceae			
Atriplex australasica		U	
**A. prostrata*			K
Einadia hastata	Berry saltbush		K
Sarcocornia quinqueflora	Beaded glasswort		K
Suaeda australis	Austral seablite		K
Convolvulaceae			
Dichondra repens	Kidney weed	C	K
Dilleniaceae			
Hibbertia scandens	Golden guinea flower	U	
Ebenaceae			
Diospyros australis	Black plum		K
Elaeocarpaceae			
#Elaeocarpus grandis	Blue quandong	R	
#E. obovatus	Hard quandong	R	K
Elatinaceae			
Elatine gratioloides	Waterwort		K
Euphorbiaceae			
Breynia oblongifolia	Coffee Bush		K
Croton verreauxii	Green native cascarilla		K
**Euphorbia peplus*	Petty spurge	C	K
Glochidion ferdinandi	Cheese tree	C	
#Omalanthus populifolius	Bleeding heart	R	
**Ricinus communis*	Castor oil plant	U	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Fabaceae/Caesalpinioideae			
**Senna pendula*	Winter senna	U	
Fabaceae/Faboideae			
Glycine microphylla	Small-leaf glycine	R	
Hardenbergia violacea	False sarsaparilla	R	
**Trifolium dubium*	Yellow suckling clover	C	
**T. repens*	White clover	C	K
**Vicia sativa*	Common vetch	C	
Fabaceae/Mimosoideae			
#Acacia baileyana	Cootamundra wattle	R	
#A. elongata		R	
A. falcata	Falcate wattle		
A. longifolia	Sydney golden wattle	A	
A. maidenii			K
A. parramattensis	Parramatta green wattle	U	
A. sophorae	Coastal wattle	U	
Flacourtiaceae			
Scolopia braunii	Flintwood		K
Fumariaceae			
**Fumaria bastardii*	Bastard's fumitory	R	
Gentianaceae			
Schenkia spicata	Spike centaury		K
Geraniaceae			
Geranium solanderi var. solanderi	Native geranium	U	
Lauraceae			
#Cryptocarya hypospodia	Rib-fruited pepperberry	R	
Lobeliaceae			
Pratia purpurascens	Whiteroot		K
Loranthaceae			
Amyema cambagei			K
Malvaceae			
#Hibiscus tiliaceous	Cottonwood hibiscus	R	
**H. trionum*	Bladder ketmia	R	
**Modiola caroliniana*	Red-flowered mallow	C	K
**Sida rhombifolia*	Paddy's lucerne	C	K
Meliaceae			
Dysoxylum fraserianum	Rosewood		K
Synoum glandulosum	Scentless rosewood	U	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Toona ciliata	Red cedar	R	
Menispermaceae			
Sarcopetalum harveyanum	Pearl vine		K
Stephania japonica	Snake vine	U	
Moraceae			
#Ficus coronata	Sandpaper fig	R	
F. obliqua	Small-leaved fig		K
#F. fraseri		R	
#F. racemosa		R	
F. rubiginosa	Port Jackson fig		K
Maclura cochinchinensis	Cockspur Thorn		K
Streblus brunonianus	Whalebone Tree		K
Myrsinaceae			
Aegiceras corniculatum	River mangrove		K
Myrtaceae			
#Acmena smithii	Lilly pilly	R	
#Austromyrtus bidwillii	Python tree	R	
Backhousia myrtifolia	Grey myrtle		K
#Callistemon citrinus	Crimson bottlebrush	R	
Callistemon salignus	Willow bottlebrush		K
#Eucalyptus deanei	Mountain blue gum	R	
#E. gummifera	Red bloodwood	R	
E. maculata	Spotted gum	U	
#E. punctata	Grey gum	R	
E. robusta	Swamp mahogany	U	
#Leptospermum polygalifolium	Tantoon	U	
Melaleuca ericifolia	Swamp paperbark	U	K
M. erubescens	Pink honeymyrtle	R	
M. linariifolia	Snow-in-summer	C	K
M. nodosa	Ball honeymyrtle	R	
M. quinquenervia	Broad leaved paperbark	A	
M. sieberi			K
M. styphelioides	Prickly leaved paperbark	U	K
Syncarpia glomulifera	Turpentine	C	
#Syzygium australe	Brush cherry	R	
#S. crebrinerve	Purple cherry	R	
#S. leuhmannii	Riberry	R	
#S. paniculatum	Magenta lilly pilly	R	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
#Waterhousea floribunda	Weeping lilly pilly	R	
Oleaceae			
Jasminum volubile	Stiff jasmine		K
**Ligustrum sinense*	Small-Leaved privet	U	
Notelaea longifolia	Large mock-olive		K
Onagraceae			
Ludwigia peploides	Water Primrose		K
**Oenothera spp.*			K
Passifloraceae			
**Passiflora edulis*	Common passionfruit	U	
Phytolaccaceae			
**Phytolacca octandra*	Inkweed	R	
Pittosporaceae			
Bursaria spinosa	Blackthorn	R	
Pittosporum spinescens	Wallaby apple		K
Pittosporum revolutum	Wild yellow jasmine		K
Pittosporum undulatum	Sweet pittosporum	C	K
Plantaginaceae			
**Plantago lanceolata*	Plantain or lamb's tongues	C	K
**P. major*	Large plantain	U	
Podocarpaceae			
#Podocarpus elatus	Plum pine or brown pine	R	
Polygonaceae			
Muehlenbeckia gracillima	Slender lignum	R	K
Persicaria decipiens	Slender knotweed	U	
P. hydropiper			K
P. lapathifolia	Pale knotweed	C	K
**Polygonum arenastrum*	Sand wireweed	U	
**Rumex crispus*	Curled dock	C	
Portulaceae			
Portulaca oleracea	Pigweed	C	
Proteaceae			
#Banksia integrifolia	Coastal banksia	R	
B. robur	Swamp banksia	C	
Grevillea robusta	Silky oak	R	
#Hakea salicifolia	Willow-leaved hakea	R	
#Stenocarpus salignus	Scrub beefwood	R	
#S. sinuatus	Fire tree	R	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Ranunculaceae			
Clematis aristata	Old man's beard		K
Clematis glycinoides	Headache vine	C	
Rosaceae			
**Rosa bracteata*	Macartney Rose		K
**Rubus fruticosus*	Blackberry	C	
Rutaceae			
#Acronychia oblongifolia	White aspen	R	
Geijera salicifolia			K
#Melicope elleryana	Pink-flowered doughwood	R	
Sapindaceae			
Alectryon subcinereus	Native quince		K
**Cardiospermum grandiflorum*	Balloon vine	R	
#Cupaniopsis anarcardiodes	Tuckeroo	R	K
#Dipliglottis australis	Native tamarind	R	
#Harpullia pendula	Tulipwood	R	
Rhysotoechia bifoliolata	Two-leaved tuckeroo		K
Sapotaceae			
#Planchonella australis	Black apple	R	
Scrophulariaceae			
Bacopa monnieri	Bacopa	C	
Solanaceae			
**Datura stramonium*	Common thornapple	R	
**Solanum mauritianum*	Wild tobacco bush	U	
**S. nigrum*	Black-berry nightshade	C	
Sterculiaceae			
Commersonia fraseri	Brush kurrajong	U	
Tropaeolaceae			
**Tropaeolum majus*	Nasturtium	R	
Urticaceae			
Dendrocnide photinophylla	Shiny-leaved stinging tree		K
Urtica incisa	Stinging nettle	R	K

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Verbenaceae			
Clerodendrum tomentosum	Hairy clerodendrum		K
**Lantana camara*	Lantana	C	K
**Verbena bonariensis*	Purpletop	A	K
Violaceae			
Viola hederacea	Ivy-leaved violet	U	
Vitaceae			
Cayratia clematidea	Native grape		K
Cissus antarctica	Kangaroo vine		K
MONOCOTS			
Alliaceae			
**Nothoscordum inodorum*	Onion weed	R	
Amaryllidaceae			
**Narcissus jonquilla*	Jonquil	R	
Arecaceae #*Livistona australis*	Cabbage tree palm	U	K
Commelinaceae			
Commelina cyanea	Scurvy weed	U	
**Tradescantia albiflora*	Wandering jew	U	
Cyperaceae			
Bolboschoenus caldwelli	Coast clubrush	C	K
Carex inversa			K
Carex?pumila			K
**Cyperus eragrotis*	Umbrella sedge	U	
C. odoratus	Fragrant sedge	C	
**C. papyrus*	Papyrus	R	
C. polystachyos			K
C. tetraphyllus			K
Eleocharis acuta	Spike rush	R	
Fimbristylis ferruginea			K
Schoenoplectus litoralis			K
Schoenoplectus validus	River clubrush	U	
Hydrocharitaceae			
Vallisneria gigantea	Giant ribbon weed	C	
Iridaceae			
**Romulea rosea var. australis*	Onion grass	C	

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
Hydrocharitaceae			
Vallisneria gigantea	Giant ribbon weed	C	
Iridaceae			
**Romulea rosea var. australis*	Onion grass	C	
Juncaceae			
**Juncus acutus*	Spiny rush	R	K
J. krausii	Sea rush	C	K
J. polyanthemus			K
J. usitatus	Common rush	C	K
Juncaginaceae			
Triglochin striatum			K
Triglochin multifructum		C	
Triglochin procera	Water ribbons		K
Liliaceae			
Blandfordia grandiflora	Christmas bush	C	
Lomandraceae			
Lomandra longifolia	Spiny-headed mat rush	C	
Philesiaceae			
Eustrephus latifolius	Wombat berry		K
Geitonoplesium cymosum	Scrambling lily		K
Poaceae			
Lachnagrostis filiformis			K
Avena barbata	Bearded oats		K
**Briza maxima*	Quaking grass	C	
**B. minor*	Shivery grass	C	K
Bromus catharticus	Prairie grass		K
**Chloris gayana*	Rhodes grass	C	
**Cortaderia selloana*	Pampas grass	R	K
Cynodon dactylon	Couch	C	
Dichelachne micrantha	Shorthair plumegrass		K
**Echinochloa crus-gali*	Barnyard grass	C	
Ehrharta erecta	Panic veldtgrass		K
Isachne globosa	Swamp millet	C	
Lolium spp.	Ryegrass		K
**Lolium temulentum*	Darnel	C	
**Melinis repens*	Red natal grass	R	
Microlaena stipoides	Weeping grass		K
Oplismenus imbecillis			K

Scientific Name	Common Name	Hunter Wetlands Centre	Kooragang
**Panicum maximum*	Guinea grass	C	
**Paspalum dilatatum*	Paspalum	C	K
Paspalum vaginatum	Saltwater couch		K
P. distichum	Water couch	A	
**Pennisetum clandestinum*	Kikuyu grass	A	K
Poa annua	Winter grass		K
Sporobolus indicus	Parramatta grass		K
**Sporobolus elongatus*	Slender rat's tail grass		
Sporobolus virginicus	Sand couch / saltwater couch		
Stenotaphrum secundatum	Buffalo grass		
Ruppiaceae			
Ruppia ?polycarpa			K
Typhaceae			
Typha orientalis	Broadleaf cumbungi		K
Zannichelliaceae			
Zannichellia palustris			K

Appendix 7: Species listed as migratory under international migratory bird treaties

Scientific Name	Common Name	International migratory bird treaty
Anas clypeata	Northern shoveler	CAMBA, JAMBA, ROKAMBA
Anas querquedula	Garganey	Bonn, CAMBA, JAMBA, ROKAMBA
Ardea alba	Great egret	CAMBA, JAMBA
Ardea ibis	Cattle egret	CAMBA, JAMBA
Plegadis falcinellus	Glossy ibis	Bonn, CAMBA
Charadrius lescenaultii	Greater sand plover	Bonn, CAMBA, JAMBA, ROKAMBA
Charadrius mongolus	Lesser sand plover	Bonn, CAMBA, JAMBA, ROKAMBA
Charadrius veredus	Oriental plover	Bonn, JAMBA, ROKAMBA
Pluvialis fulva	Pacific golden plover	Bonn, CAMBA, JAMBA, ROKAMBA
Pluvialis squatarola	Grey plover	Bonn, CAMBA, JAMBA, ROKAMBA
Chlidonias leucopterus	White-winged black tern	CAMBA, JAMBA, ROKAMBA
Sterna albifrons	Little tern	Bonn, CAMBA, JAMBA, ROKAMBA
Sterna caspia	Caspian tern	CAMBA, JAMBA
Sterna hirundo	Common tern	CAMBA, JAMBA, ROKAMBA
Rostratula australis	Australian painted snipe	CAMBA
Actitis hypoleucos	Common sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Arenaria interpres	Ruddy turnstone	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris acuminata	Sharp-tailed sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris alba	Sanderling	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris canutus	Red knot	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris ferruginea	Curlew sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris melanotus	Pectoral sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris ruficollis	Red-necked stint	Bonn, CAMBA, JAMBA, ROKAMBA
Calidris tenuirostris	Great knot	Bonn, CAMBA, JAMBA, ROKAMBA
Gallinago hardwickii	Latham's snipe	Bonn, CAMBA, JAMBA, ROKAMBA
Heteroscelus brevipes	Grey-tailed tattler	Bonn, CAMBA, JAMBA, ROKAMBA
Heteroscelus incana	Wandering tattler	Bonn, CAMBA, JAMBA,
Limicola falcinellus	Broad-billed sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Limnodromus semipalmata	Asian dowitcher	Bonn, CAMBA, JAMBA, ROKAMBA
Limosa lapponica	Bar-tailed godwit	Bonn, CAMBA, JAMBA, ROKAMBA
Limosa limosa	Black-tailed godwit	Bonn, CAMBA, JAMBA, ROKAMBA
Numenius madagascariensis	Eastern curlew	Bonn, CAMBA, JAMBA, ROKAMBA
Numenius minutus	Little curlew	Bonn, CAMBA, JAMBA, ROKAMBA
Numenius phaeopus	Whimbrel	Bonn, CAMBA, JAMBA, ROKAMBA
Philomachus pugnax	Ruff	Bonn, CAMBA, JAMBA, ROKAMBA
Tringa glareola	Wood sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Tringa nebularia	Common greenshank	Bonn, CAMBA, JAMBA, ROKAMBA
Tringa stagnatilis	Marsh sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA
Tryngites subruficollis	Buff-breasted sandpiper	JAMBA, ROKAMBA
Xenus cinereus	Terek sandpiper	Bonn, CAMBA, JAMBA, ROKAMBA

Scientific Name	Common Name	International migratory bird treaty
Cuculus saturatus	Oriental cuckoo	CAMBA, JAMBA, ROKAMBA
Hirundapus caudacutus	White-throated needletail	CAMBA, JAMBA, ROKAMBA
Merops ornatus	Rainbow bee-eater	JAMBA
Hirundo rustica	Barn swallow	CAMBA, JAMBA, ROKAMBA
Motacilla flava	Yellow wagtail	CAMBA, JAMBA, ROKAMBA