Waterbird Population Dynamics in the Middle Mahakam Wetlands of East Kalimantan over 23 years

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Summary: Between 1988 and 2011, a total of 57 species of waterbirds, as well as twelve raptor and six kingfisher species regularly utilizing wetlands, were recorded in the Middle Mahakam Wetlands of East Kalimantan, Indonesia. Waterbirds included 27 shorebird species from five families, twelve herons (Ardeidae), six rails and crakes (Rallidae), four terns (Sternidae), three ducks (Anatidae) and two storks (Ciconiidae). Based on IUCN (2013) criteria, six listed species are threatened: one (White-shouldered Ibis) is Critically Endangered, another (Storm's Stork) is Endangered and four (Chinese Egret, Lesser Adjutant, Wallace's Hawk-Eagle, Blue-banded Kingfisher) are Vulnerable. The Middle Mahakam Wetlands are one of Borneo's most important wetland areas. They are part of a highly dynamic landscape that has historically changed its appearance many times. Today, the birds of these unique wetlands are endangered by a plethora of threats comprising large scale land conversion, fire, hunting and live capture of waterbirds, illegal logging and pollution. Despite the considerable efforts of local NGOs to address some of these issues, conservation measures are still limited and insufficient to protect this natural asset.

Ringkasan: Antara 1988 dan 2011, sebanyak 57 jenis burung air, ditambah 12 jenis burung pemangsa dan 6 jenis raja-udang yang seringkali menggunakan lahan basah, telah tercatat di Daerah Mahakam Tengah, Kalimantan Timur, Indonesia. Jenis burung air termasuk 27 cerek dari 5 famili, 12 jenis kuntul/cangak/bambangan (Ardeidae), 6 tikusan (Rallidae), 4 dara laut (Sternidae), 3 belibis (Anatidae) dan 2 bangau (Ciconiidae). Menurut IUCN, satu jenis (ibis karau) sangat terancam punah (Cr), 1 bangau (bangau stork) terancam (En), dan empat (kuntul Cina, bangau tongtong, elang Wallace, raja udang kalung biru) adalah rawan (Vu). Daerah Lahan Basah Mahakam Tengah adalah satu lahan basah terpenting di Kalimantan. Daerah tersebut merupakan bagian dari wilayah yang memiliki dinamika perubahan lansekap yang tinggi yang seringkali berubah bentuknya sepanjang sejarah. Dewasa ini, burung-burung di lahan basah yang unik ini terancam oleh perubahan fungsi lahan secara besar-besaran, kebakaran vegetasi, perburuan dan penangkapan burung air, pembalakan liar dan polusi. Terlepas dari usaha-usaha keras dari LSM lokal, langkah-langkah perlindungan masih sangat terbatas dan tidak memadai.

Introduction

The Middle Mahakam Wetlands (MMW) of East Kalimantan are among the largest wetland areas of Borneo (MacKinnon *et al.* 1996). They cover more than 500,000 ha of shallow peat lakes, seasonally flooded plains and vast swamps, as well as large

freshwater and peatswamp forests partially adjacent to heavily disturbed lowland rainforest, where there is logging, coal mining, and oil palm and wood plantations. Due to large seasonal and annual variations of rainfall, as well as El Niño events with their associated forest fires, the MMW represent a dynamic, continually changing landscape.

Until the 1980s, the Mahakam Lakes had been almost unstudied. Starting with the Indonesian-German GTZ-TAD project, hydrological and ichthyologic studies were conducted (e.g. Zuppke 1979; Rosenthal & Baum 1980; Ansyahari *et al.* 1984; Christensen 1988), followed by a number of other zoological studies, focusing on crocodiles (Cox 1993; Budiono 2001), hydrology and fishes (Suryadiputra *et al.* 2000), Irrawaddy dolphin *Orcaella brevirostris* (Kreb & Budiono 2005; Kreb *et al.* 2007; Kreb *et al.* 2010), general waterbirds (Gönner 2000a; Budiono *et al.* 2006, 2007a, 2007b), Wandering Whistling-duck *Dendrocygna arcuata* (Fredriksson *et al*. 2006; Soeyitno 2008), Lesser Adjutant *Leptoptilos javanicus* (Kasyanto & Yusni 2002; Budiono *et al.* 2002, 2007a,b; Budiono & Kreb 2009), White-shouldered Ibis *Pseudoibis davisoni* (Sözer & van der Heijden 1997; Sözer & Nijman 2005), and pheasants (Sözer *et al.* unpubl. data), as well as its socio-economy (Yayasan Konservasi RASI 2006). The Centre for International Forestry Research (CIFOR) has intensively studied the peatlands and fires in the northern part of the MMW (Chokkalingam 2004; Chokkalingam *et al.* 2005; Hope *et al.* 2005).

The biodiversity of the wider MMW is impressive with 63 recorded mammal species, including Proboscis Monkeys *Nasalis larvatus* and wild Banteng *Bos javanicus*, 114 fish, 24 reptile and six amphibian species (Suryadiputra *et al.* 2000; Gönner 2010). Two crocodile species, the Siamese Crocodile *Crocodylus siamensis* and False Gavial *Tomistoma schlegeli*, are found in the marshes (Cox 1993; Budiono 2001), as well as seven turtle and terrapin species, which were intensively collected and traded during the drought of 1997/98 (Jepson *et al.* 1998; Gönner 2002).

Of the 276 bird species recorded in the MMW, 61 (22.1%) fall under the IUCN categories (IUCN 2013) of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Near-Threatened (NT) (Gönner 2010). This includes White-shouldered Ibis (CR), Storm's Stork *Ciconia stormi* and Bornean Peacock-Pheasant *Polyplectron schleiermacheri* (EN), Chinese Egret *Egretta eulophotes*, Lesser Adjutant, Wallace's Hawk-Eagle *Nisaetus nanus*, Large Green-Pigeon *Treron capellei*, Blue-banded Kingfisher *Alcedo euryzona* and Blue-headed Pitta *Pitta baudii* (VU).

This paper summarizes the results of waterbird observations from the MMW over a period of more than 20 years (1988-2011) and discusses habitat changes, threats and conservation issues. The paper is partially based on an earlier publication (Gönner 2000a), as well as on a more recent unpublished report (Gönner *et al*. 2012) that provides full observation details, including phenology charts and daily totals of many species.

Study site

The Middle Mahakam Wetlands cover more than 500,000 ha of the interior of East Kalimantan (Fig. 1). A total of 32 shallow peat lakes are situated in the MMW, each with a surface area between 1.2 ha and 15,000 ha (Suryadiputra *et al.* 2000). The

three largest lakes are Danau (D) Jempang (0°25'S, 116°12'E; 15,000 ha, on average), D Semayang (13,000 ha) and D Melintang (11,000 ha). The area of the lakes' water surface varies depending on rainfall in the upper catchment area of Sungai Mahakam (Mahakam River) and its tributaries. During the rainy season (generally November – June) it may cover more than 60,000 ha, while during the dry season (July – October) many lakes shrink by up to 96%, or even dry out completely in extremely dry years (e.g. 1982/83, 1991, 1994, 1997/98, 2002, 2006; Plate 1).

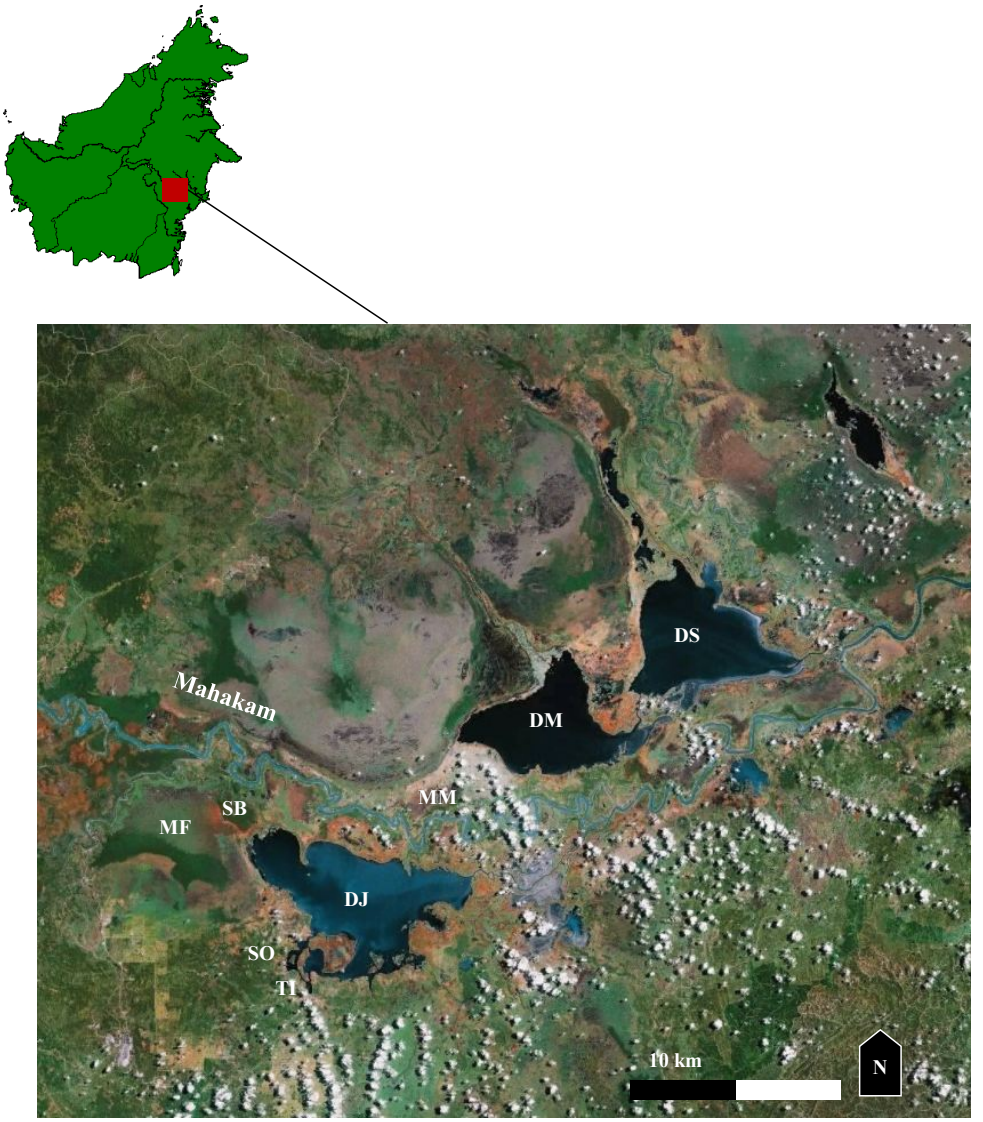

Fig. 1: Landsat image of Middle Mahakam Wetlands (MMW) based on Landsat 7 (26 August 2000). Sites mentioned in the text: DJ, Danau Jempang; DM, Danau Melintang; DS, Danau Sembilang; DSi, Danau Siran; MF, Metau Forest; MM, Muara Muntai; SB, Sungai Baroh; SO, Sungai Ohong; TI, Tanjung Isuy

The lakes' maximum depth is about 6-7 m with annual fluctuations of more than 6 m (Christensen 1988; Suryadiputra *et al.* 2000), while surrounding peatlands are flooded to a depth of up to 3 m during the rainy season (Chokkalingam *et al.* 2005). The largest river is Sungai (S) Mahakam (920 km long, 1-4 km wide), which is fed by many tributaries, such as S Kedang Pahu, S Kedang Kepala, S Kedang Rantau, S Belayan, S Enggelam, S Baroh, S Ohong, S Bongan and S Perian.Vast peatswamp forests to the north of D Melintang and D Semayang feed these two lakes (especially D Melintang) with blackwater, rich in humic acid (Plate 2). The surrounding peatlands are largely ombrogenous, acidic, and nutrient poor, with the peripheral areas subject to riverine inundation. Peat depth averages 8 m and is greater than 15 m in some areas (Chokkalingam *et al.* 2005). The Metau forest, west of D Jempang, comprises c. 4,100 ha of tropical lowland (dipterocarp) and peat or freshwater swamp forest. In 1995, the forest still comprised some 13,500 ha. Since then, it was heavily encroached from its edges due to conversion to oil palm plantations, coal mining and upland farming (Yayasan Konservasi RASI 2011). Water from these forests drains partially into both the S Kedang Pahu and S Baroh, and, hence, into D Jempang.

The two larger northern lakes, D Melintang and D Semayang, drain into S Mahakam, while the situation is more complicated in the case of D Jempang. Depending on the water level, the main connection between D Jempang and the river between Muara Muntai and Jantur either becomes the lake's main inlet (high level of river water) or the main outlet (low level). Especially along this connection, sedimentation from the upstream parts of Mahakam is high and adds to the occasional isolation of D Jempang from the remaining hydrological system, resulting in low oxygen levels and clogging with floating weeds (mainly water hyacinth). In the southern part of MMW, such as along S Ohong, the peatswamp and alluvial forests are adjacent to lowland rainforest, which though heavily disturbed, substantially adds to the overall biodiversity of the area.The regional climate is characterized by a dry season from July to October and a wet season from November to June (MacKinnon *et al.* 1996). The MMW receives an average annual rainfall of 2,100-2,400 mm, though annual differences are significant. The maximum temperature ranges from 30 to 34°C, and the minimum temperature from 22 to 24°C. The average relative humidity fluctuates between 72% and 90% (Ansyahari *et al.* 1984; Gönner 2002).

The vegetation of the lakes includes more than 86 aquatic plant species. It is dominated by floating weeds (Plate 3), mainly *Salvinia* spp., Water Hyacinth *Eichhornia crassipes*, Giant Sensitive Plant *Mimosa pigra* and *Polygonum barbatum*, which at certain times may cover more than 90% of the lakes' surface (Rosenthal & Baum 1980; Suryadiputra *et al.* 2000).

The following classification of habitat types mainly follows van Balen & Prentice (1997) for reasons of convenience and comparison. The same classification (though using different abbreviation) was also used by Gönner (2000a).

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Plate 1. Danau Jempang during dry conditions in September 1997

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Plate 2: Danau Semayang in April 2005

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Plate 3. Immersed grasslands, Danau Jempang, October 2005

Open water bodies (Appendix 1: OW) were found mainly on the larger lakes, comprising D Jempang (DJ), D Melintang (DM), D Semayang (DS) and D Siran (DSi). Depending on the season and year, the lakes may completely dry up or become (at least partly) covered by aquatic/ floating vegetation (AQ). In most years the lakes were deepest from December until May and shallowest from July until October. In March-April 1996, June-August 1998, March-April 1999, as well as October 2006, all lakes were covered by thick carpets of Water Hyacinth and floating grasses. The blackwater lake DM was covered with floating grass, *Polygonum barbatum* and *Salvinia* sp and, less frequently than in DJ and DS, Water Hyacinth. In such conditions, boating on the lakes is virtually impossible. During the extreme dry seasons of 1993, 1997, 2002 and 2006 the lakes became dry, exposing vast mudflats (MD) between early July and October. They were soon covered by colonising weeds (*Polygonum barbatum*, *Mimosa pigra*) and various grasses.

Swamps of immersed sedge and grassland (IM) occurred on DJ, especially around Jantur and, at least during low water levels, between Tanjung Jone and Muara Ohong. Depending on the season, this habitat also occurred in the southern parts of DM and DS. This habitat supported *Mimosa* shrubs (MI) around the islands on DJ, as well as along water ways between the lakes during low water conditions, and in the lower part of Ohong river. Other habitats include the vast peatswamp forests north of DM and DS, as well as the Metau forest, west of DJ, and freshwater swamp forests (FW) surrounding the larger lakes. Riparian (FR) forest occurred along rivers and tributaries.

Methods

Observations

Most observations were made using binoculars from rather unstable, flat *ces* motorboats. Occasionally, especially during low water conditions, spotting scopes with an amplification factor of 15-45 were used. We collected waterbird data within the framework of several separate studies. Between July 1993 and January 2008, the first author conducted 66 transect counts of waterbirds on D Jempang between Tanjung Isuy and Muara Muntai. As the size of the lakes varied enormously with water level, transect counts were performed in all seasons. The first author also made opportunistic observations during 288 days covering a period of 56 months between May 1988 and January 2008.

Budiono and the Yayasan Konservasi RASI team collected waterbird data over 39 days during April-May 2005, September 2005, September 2006 and June 2007 (Budiono *et al*. 2007). These surveys covered the area between Muara Kaman and Melak, including the three large lakes and neighbouring swamps at times with different water levels. Data on live-captured birds were collected in June 2007, April 2008 and in May/August 2009. In April/May and June/July 2010, the biodiversity of Metau forest was studied intensively (Yayasan Konservasi RASI 2011).

Between June 2005 and October 2006 monthly counts of Wandering Whistling-duck were conducted on D Jempang, D Semayang and D Melintang. In addition, traders were visited in all major villages and captive birds were counted (Fredriksson *et al*. 2006). Interviews with hunters were carried out by Soeyitno between January and September 2007 (Soeyitno 2008). Additional data from a

Wetlands International expedition to Danau Perian in 2000 (primary data provided to the first author by Wetlands International Indonesia Programme), as well as counts by the NGO LORIES (Kasyanto & Yusni 2002) on all three larger lakes were also included in the analysis.

Data analysis

To investigate the effects of the extreme drought and fires of 1997/98, data collected along the D Jempang transect were compared prior to, and after the event for selected species. The highest daily totals per month (hereafter referred to as monthly maxima) were ranked for each species over time. The ranks were then compared between the sampling periods prior to (July 1993 to March 1997), and after the event (June 1998 to January 2008) by using a two-tailed Mann-Whitney U-Test. Significant changes were inferred if $p < 0.05$.

Results

A total of 57 waterbird species were found in the MMW, including three ducks, two storks, twelve herons, one ibis, one cormorant, one darter, species, six rails and crakes, 27 waders, and four terns. In addition, twelve raptor species and six kingfisher species were recorded in wetland habitats. Mudflats (MD) supported the highest number of species (41), while swamps with *Mimosa* shrubs (MI) hosted six more species than swamps covered with sedge and grasslands (IM) and 13 more species than swamps with aquatic vegetation (AQ) only (Appendix 1).

Breeding was proved or was highly suspected (*) for several species, including Oriental Darter *Anhinga melanogaster*, Javan Pond-Heron *Ardeola speciosa*, Black Bittern* *Dupetor flavicollis*, Cinnamon Bittern* *Ixobrychus cinnamomeus*, Yellow Bittern* *Ixobrychus sinensis*, Purple Heron *Ardea purpurea*, Intermediate Egret *Egretta intermedia* and Great Egret *Ardea alba*, Lesser Adjutant, Black-necked Stilt *Himantopus leucocephalus* (Plate 4) and Little Tern *Sterna albifrons*. The latter two species used the dry lake shores in August/September for opportunistic breeding (e.g. in 2006). In the case of the Black-necked Stilt this is the first breeding record for Borneo (cf. Mann 2008).

At least six species of crakes and rails are resident in the MMW, including rather large populations of Purple Swamphen *Porphyrio porphyria* (Plate 5), Common Moorhen *Gallinula chloropus* and White-browed Crake *Porzana cinerea*. The Buff-banded Rail *Gallirallus philippensis* (Plate 6) was recorded here for the first time on Borneo in September 2003 (Robson 2005; Mann 2008). In September 2003 and September 2004, the Little Black Cormorant *Phalacrocorax sulcirostris* was observed on DS. This was the first record of the species on Borneo in over 150 years (Nijman *et al.* 2005).

Beside their relevance as an important breeding area, the swamps were used by migratory waterbirds for foraging and roosting. Communal roost sites of Great Egret and Purple Heron were visited by the birds predominantly from July to October. Large numbers of Javan Pond-Heron roosted at several sites, typically in *Mimosa* habitats, throughout the year. While prior to 2001 several hundred Wandering Whistling-ducks were counted at roost sites in the MMW, mainly between July and October, these numbers dramatically increased in 2003 and 2004

with counts of more than 10,000 birds (Fig. 2a, Plate 7). This might have been due to an invasion of this species possibly as a response to the emergence of suitable habitat (see below) or habitat destruction elsewhere (e.g. Central Kalimantan). Breeding was reported by local fishermen, but remains to be confirmed.

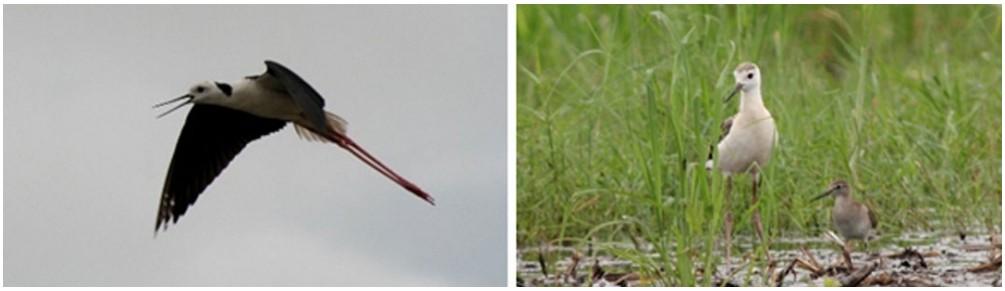

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Plate 4. Black-necked Stilts (adult and juvenile) on Danau Jempang, September 2006; left, adult; right, juvenile with Wood Sandpiper.

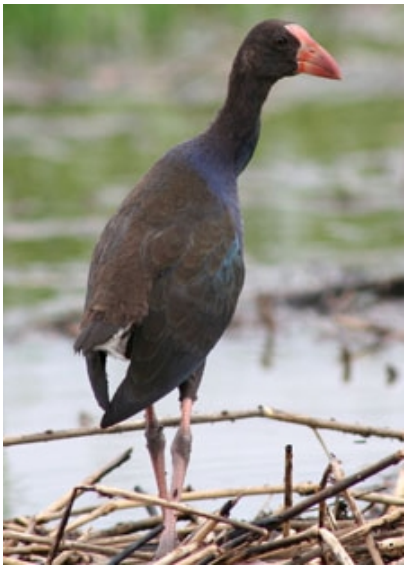

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Plate 5. Purple Swamphen, Danau Jempang, October 2005.

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Plate 6. Buff-banded Rail, Sungai Baroh, September 2006.

Various other species showed similar dynamics over time with occasional invasion-like patterns in some years and much smaller numbers in others. Similar to Wandering Whistling-duck, the numbers of Cattle Egret *Bubulcus ibis* and Little Egret *Egretta garzetta*, as well as Wood Sandpiper *Tringa glareola,* were particularly high in 2004 (and partially in 2005) when suitable habitat (immersed grasslands) was abundant (Fig. 2b, c, e). Purple Swamphen benefited in years with plentiful floating vegetation (e.g. 1996, 1999; Fig. 2f), while migratory waders fully depend on the water level of the Mahakam lakes. Significant numbers of waders were only observed in extremely dry years (1993, 1997 and 2004), when the lakes had virtually disappeared. The vast mudflats and grasslands provided excellent feeding habitats for plovers, sandpipers and stints. For example, c. 10,000 Wood Sandpipers were counted on 9 November 2004 (DJ).

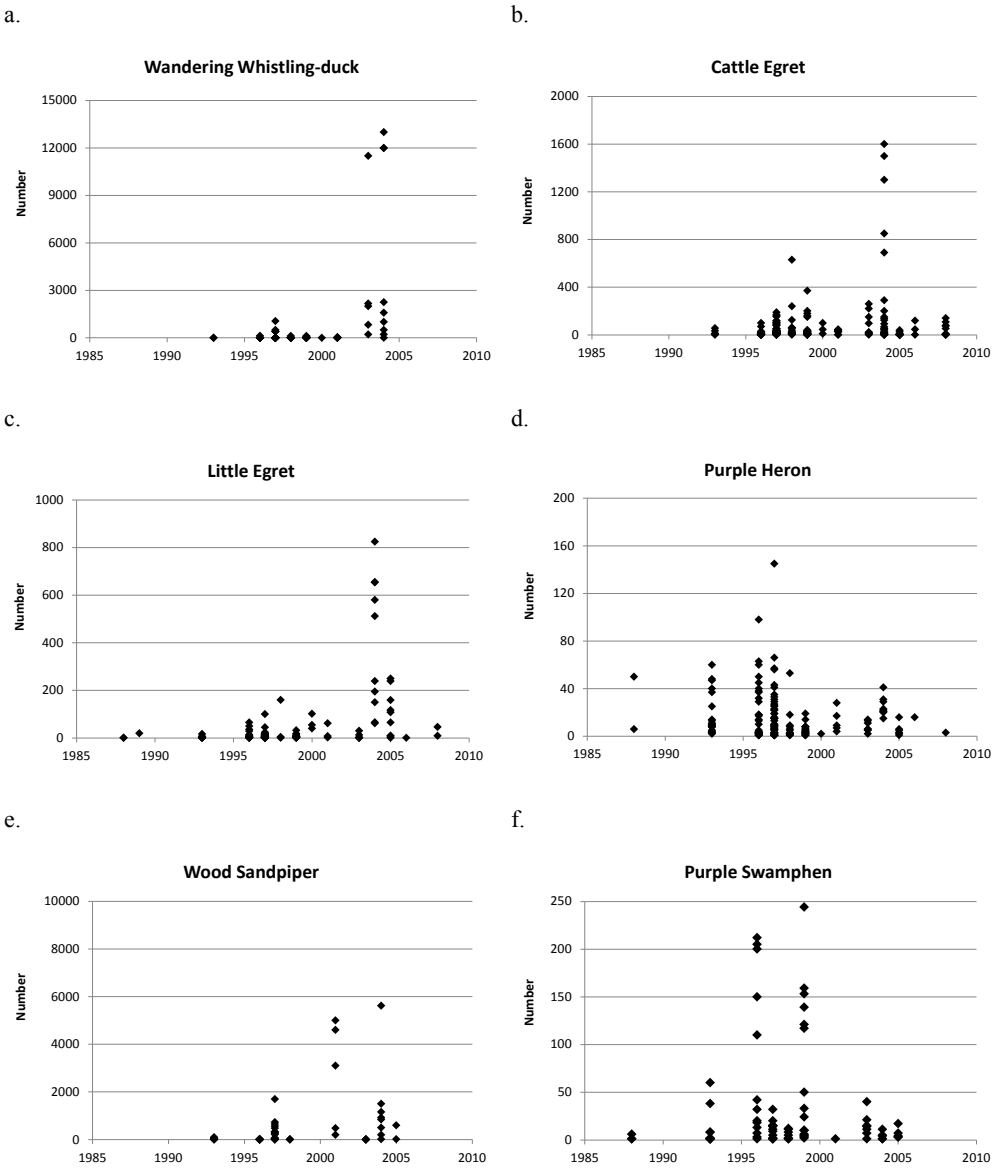

Fig. 2. Daily total counts of selected waterbird species observed in the Middle Mahakam Wetlands, East Kalimantan, between 1988 and 2008: (a), Wandering Whistling-duck (n = 78 observations); (b), Cattle Egret (n = 130); (c), Little Egret (111); (d), Purple Heron (160); (e), Wood Sandpiper (63); (f), Purple Swamphen (80).

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Plate 7. Wandering Whistling-ducks, Danau Jempang, September 2004.

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Plate 8.Whiskered Terns in breeding and non-breeding plumages, with one White-winged Tern, Danau Jempang, May 1999.

During drier periods, the shallow lakes also attracted large numbers of Whiskered Terns *Chlidonias hybridus* (Plate 8), such as the 3,758 counted on 13 August 1997, and Little Terns *Sterna albifrons*, as well as Javan Pond Herons (c. 10,000 on DJ, 7 August 1996), Great Egrets and Purple Herons (Fig. 2d), which fed on dying fish. Whiskered Terns of both northern (*C. h. hybridus*) and austral (*C. h. javanicus*) origin visited the MMW in large numbers for feeding while on passage, and in smaller numbers during their non-breeding seasons (Fig. 3).

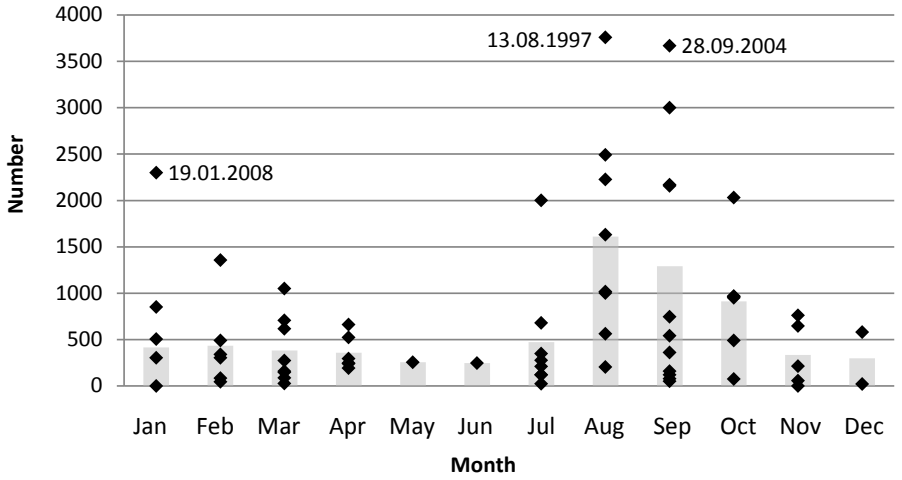

Fig. 3. Monthly phenology of Whiskered Terns along the transect between Tanjung Isuy (TI) and Muara Muntai (MM); Dots, transect counts with dates of the highest counts; grey columns, monthly means

Comparisons of monthly maxima of daily totals prior to and after the 1997/98 event revealed significant changes for five of the 14 species examined. While numbers increased for Cattle Egret, Wandering Whistling-duck, and Wood Sandpiper and Common Moorhen, a significant decline was detected for Purple Heron (cf. Fig. 2d). No significant differences were found for Great Egret, Little Egret, Javan Pond Heron, Lesser Adjutant, Purple Swamphen, Brahminy Kite *Haliastur indus*, Whiskered Tern, Little Tern, and Stork-billed Kingfisher *Pelargopsis capensis.* Data for other species were insufficient to allow meaningful analyses.

Discussion

The number of waterbird species recorded at the MMW (Table 1) is higher than that reported at the Sungai Negara wetlands of South Kalimantan (van Balen & Prentice 1997), Danau Sentarum in West Kalimantan (van Balen & Dennis 2000) and Tanjung Puting National Park in Central Kalimantan (Jalan & Galdikas 1987; Nash & Nash 1988). The disparity is probably mainly due to the longer period of sampling in the MMW, which included the wintering period for migratory Palearctic-breeding waders. In addition, some regional biogeographic phenomena, such as the observed influx of Javanese species (see below), may have contributed to the high waterbird diversity of the MMW.

Table 1. Comparison of number of bird species of several wetlands in Borneo

	Waterbirds*	Birds of prey**	Kingfishers**
Middle Mahakam	57	12	6
Sungai Negara	46	9	6
Tanjung Puting	21	6	5
Danau Sentarum	24	10	4

*As defined by Wetlands International, ** species utilizing wetlands

Dynamics of waterbirds and habitats

The observed dynamics of waterbirds in the MMW are the result of many interrelated factors, including seasonality and extreme weather events, as well as habitat changes and pressure on particular species due to human activities. Changes in water levels have a clear impact on habitats and, therefore, the occurrence, spatial distribution and abundance of migratory species. Not surprisingly, mudflats attracted many migratory waders when they were exposed, and swamps with more complex emergent vegetation, i.e. *Mimosa* shrubs, hosted more species than those with simply floating vegetation. Habitat changes appear to be more pronounced in D Jempang (Plate 9) than in the two northern lakes which have a somewhat more stable hydrology, probably due to more regular water supply from the vast peatswamp forests and blackwater rivers. Such satellite imagery and field notes suggest that after 1997/98 the habitat structure of D Jempang and its surroundings changed more frequently from open water bodies to open swamps of immersed sedge and grassland or mudflats, than prior to 1997/98. These habitats clearly benefited species, such as Wandering Whistling-duck, egrets, Holarctic waders and terns (Fig. 1). The grasslands hosted large numbers of grasshoppers and other insects, as well as freshwater molluscs, and they probably also provided new spawning habitat for many fish species.

The increased cover of aquatic plants at other times of the year may have benefitted some rails and crakes (e.g. Purple Swamphen in 1996 and 1999; Fig. 1f), while the thick carpets of Water Hyacinth hamper movement and may deter other species. Taylor (1996, cited in Mann 2008) suspected that the Dusky Moorhen *Gallinago tenebrosa*, which has not yet been recorded in the MMW, might be less tolerant to Water hyacinth than the Common Moorhen *G. chloropus*.

The underlying causes of the observed habitat dynamics remain, to some extent, speculative. Siltation at the influx to D Jempang may have increased due to logging in the upstream parts of S Mahakam (cf. Suryadiputra *et al*. 2000), as well as in lowland and peatswamp forests surrounding the MMW (especially in the course of decentralisation of the forestry sector between 1999 and 2003, cf. Siswanto & Wardojo 2005). The conversion of Metau forest (see above) may have reduced the hydrological buffering function of this peatswampforest west of D Jempang leading to more extreme changes of the lake's water level. However, all of these hypotheses would need to be further tested, especially as impacts of climate change on regional precipitation patterns may come on top.

Changes in abundance of some species may also be related to habitat destruction elsewhere. E.g. loss of suitable habitats in South and Central Kalimantan due to fire and land conversion to oil palm plantations, as well as intensive hunting pressure (see below) may have led to the influx of Wandering Whistling-ducks into the MMW in 2003/04. The fact that several species of Javanese origin (e.g. Sunda Teal *Anas gibberifrons*, Little Black Cormorant *Phalacrocorax sulcirostris*, Black-necked Stilt *Himantopus leucocephalus* and Oriental Pratincole *Glareola maldivarum*) were observed for the first time in the MMW after 1997/98 possibly indicate the impact of further habitat losses on Java (cf. Nijman *et al.* 2005).

26 Aug 2000

31 May 2003

11 Aug 2009

Plate 9. Landsat 7 images of the MMW in three years between 2000 and 2009.

Habitat changes, as well as hunting and live-capturing most likely contributed to the observed decline of Purple Heron (Fig, 1d). This species may have suffered from the loss of breeding habitat in swamp forests, similar to the White-shouldered Ibis (see Sözer & Nijman 2005). After their breeding grounds became more accessible due to land conversion, Purple Herons were also frequently collected from their nests (see below), which may have contributed to their overall decrease. At first glance, rather surprisingly, no negative trend was detected for Lesser Adjutant (Plate 10). Destruction of habitat and live-capturing certainly had a negative impact on the overall population. However, as feeding habitats (immersed vegetation, mudflats) occurred now over a longer period of time along the transect route, observed numbers may have been higher compared to earlier years when the storks were more confined to peatswamp forests (e.g. 170 birds near SB, 26 Aug 1996) and small, rather inaccessible lakes, such as D Siran (50 birds, 14 Sep 1996). Such large numbers were not recorded any more after 1997/98.

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Plate 10. Lesser Adjutants, Danau Jempang, June 2007.

Hunting and live-capture of waterbirds

Although commercial bird trapping has occurred in the MMW for many years (e.g. Jepson *et al.* 1998; Gönner 2002), its scale dramatically increased after 2001 when the live capture of Wandering Whistling-ducks reached a level of more than 1,000 birds per month, to be exported (as food) to Banjarmasin, South Kalimantan. Monitoring surveys conducted in the MMA between 2005 and 2007 revealed that at least 15,719 birds were caught in 2005, 12,260 in 2006, and 4,034 from January to September 2007 (Soeyitno 2008). The birds were caught at night with mist nets, attracted by decoy birds and tape recorders, or from motor boats by using strong spotlights and nets. On rare occasions poison (rice mixed with pesticide) was used to paralyse the ducks, as observed in October 2004 (DJ, Plate 11).

In MMW, the commercial capture of Wandering Whistling-ducks was organized and conducted by Banjarese people who formerly trapped the species in the Sungai Negara swamps of South Kalimantan. When the population there declined in 2000/01, the hunters switched to the MMW where now large bird flocks started to appear (possibly due to the pressure in Sungai Negara). According to

Soeyitno (2008), three groups of bird trappers, comprising some 50 people, operated between 2001 and 2004, while a new group joined them in 2005-06. By 2007 only two groups remained active, possibly due to decreasing catches. Besides the Wandering Whistling-duck, at least 13 other waterbird species were caught as by-catch, including large numbers of Purple Swamphen, which were locally sold as food in Tanjung Isuy during 2003/04.

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Plate 11. Poisoned ducks, Danau Jempang, October 2004

BUDIONO

Plate 12. Captive Lesser Adjutants, Melintang village, June 2007.

An even older tradition is the live capture of Lesser Adjutants (Plate 12) and herons. During a survey in June 2007, Budiono *et al.* (2007a) recorded a total of 207 individual birds of 16 species that were captured from the wild and kept as pets in nearby villages. The most numerous were Purple Herons (57 individuals), Lesser Adjutants (39), Black-crowned Night Herons *Nycticorax nycticorax* (16) and White-breasted Waterhen *Amaurornis phoenicurus* (14), as well as Wandering Whistling-ducks (43, at one location). According to interviews conducted by Budiono *et al.* (2007a), between 2000 and 2007 at least 527 Lesser Adjutants and 281 Purple Herons were caught from the wild, mainly from Metau forest. The vast majority (90%) of Lesser Adjutants were caught as adults and directly sold as food, or as a pet. The remaining 10% are juveniles taken from their nests, often located in Kahoi *Shorea balangeran* trees and raised as pets until they become adult. Most respondents owning a Lesser Adjutant kept them as pets (50%) or held them as pets until someone purchased them (41%). A few (9%) kept storks for their own consumption at some stage. All Purple Herons were captured as juveniles from their nests in the swamp forest surrounding the lakes.

Droughts and fire

Prolonged droughts were recorded in the MMW as early as 1877-78 and 1914, with accompanying widespread fires in 1914 (Bock 1881; Brookfield *et al.* 1995, cited in Chokkalingam *et al.* 2005a). In fact, Hope *et al.* (2005) found strong evidence that fires occurred throughout the history of the MMW peatlands, especially during the last 3,000 years with increasing frequency during the last millennium. The prolonged droughts during El Niño years, such as 1982/83 and 1997/98, created suitable conditions for fires. While during non-El Niño periods only 17-24% of the

peatlands were burnt annually, c. 45% of the peatland area north of Mahakam River burnt during the El Niño fires of 1982/83, and even 72-85% burnt during the 1997/98 El Niño, 54% of which constituted mature forest that had not previously been burnt (Lennertz & Panzer 1983; Siegert *et al.* 2001; Chokkalingam 2004). The droughts were accompanied by strong winds which helped fires ignite and spread (Schindele *et al.* 1989; Gönner pers. observ. 1997/98), although the proximate fire causes were probably all of anthropogenic origin (Gönner 1999, 2000b).

According to Chokkalingam *et al.* (2005) fires are deliberately lit by villagers to change the vegetation into more suitable fishing grounds, including new water pools and shallow lakes, to keep waterways for boat traffic open, and to provide flushes of nutrients that stimulate algal growth and maintain high levels of fish populations, as reported for the Sungai Negara wetlands in South Kalimantan (MacKinnon *et al.* 1996). The 1997/98 fires in the northern peatswamp forests of the MMW were probably also caused by villagers in the course of collecting turtles and harvesting tree bark in the peatswamp forests. Fire was used to improve access into the forest, for camping, and to concentrate the turtles in damp areas and catch them easily by burning off the surrounding vegetation (Jepson 1998; Chokkalingam *et al.* 2005a). Many of these newly opened-up areas have been repeatedly burnt since 1998 for maintaining and enlarging open floodplains suitable for fishing purposes. Fires in the surrounding lowland rainforest south of the Mahakam were largely caused by land clearing activities for oil palm plantations (Gönner 1999).

While forest regrowth was relatively rapid following the 1982/83 fires, the closed-canopy forests decreased drastically following the 1997/98 fires from 63% to 4% of the landscape, while scrubby vegetation increased from 11% to 33% and sedge-grasslands from 11% to 30% (Chokkalingam *et al.* 2005). Fire may destroy some habitats, including peatswamp forest, but it also creates new forms of habitats, especially open swamps with immersed sedge and grassland, as well as grassland with *Mimosa* shrubs with positive impacts for some species as described above.

Conclusions

The landscape of the MMW is highly dynamic. Wetland habitats change frequently over time, partly due to temporal variations in climate and partly due to anthropogenic causes, such as conversion of forest to open pit coal mining and oil palm plantations. Changes in the species composition and abundance of waterbirds relate to the habitat dynamics, which result in influxes of migrants (e.g. Wandering Whistling-duck, Wood Sandpiper, Whiskered Tern), as well as opportunistic breeding of some species (e.g. Black-necked Stilt and Little Tern). Anthropogenic habitat loss, hunting and live capture must have a deleterious effect on the Lesser Adjutant and Purple Heron.

While species conservation programmes have been initiated by local NGOs, such as Yayasan Konservasi RASI, more integrated approaches are needed to better protect the unique habitats and their dynamic processes. As local people are dependent on natural resources the introduction of a strict conservation regime for the MMW, such as a national park, is not realistic. Biodiversity conservation should instead become an integral part of sustainable land use planning. Approaches, such as *The Economics of Ecosystems and Biodiversity* (TEEB 2012; Kosmus *et al.* 2012)

may help to raise the awareness of local and regional decision makers of the real value of wetlands, such as the MMW. In order to slow down further habitat loss, we recommend the immediate implementation of the following actions:

- Designation of the MMW as a UNESCO biosphere reserve and listing it as a Ramsar site (criteria have been positively checked);
- Designation of the Metau forest and D Siran as protected areas (breeding sites of Lesser Adjutant) at district level;
- Rehabilitation and strict protection of the heavily disturbed peatswamp forests and riparian forest as important habitats for a large numbers of bird species and primates;
- National funding of regular patrols of BKSDA rangers and strict law enforcement, including fines for owners of newly captured animals and the use of poison for catching ducks and fish;
- Introduction of organic farming methods for crop cultivation around and, during dry seasons, in the lakes;
- Preparation of a TEEB study for the MMW by a local university or NGO.

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Appendix 1. List of waterbirds and wetland-dependent species recorded in the MMW. While wetland-dependent kingfishers and birds of prey are covered, passerines, as well as birds only recorded in swamp forests and riparian forests are not included. A complete list of the avifauna of MMW, comprising 276 species, has been prepared by Gönner (2010). Abbreviations of the habitat types and abundance categories, partly following van Balen & Prentice (1997) are as follows:

OW: Open water bodies
AQ: Swamp with submerged/floating Aquatic vegetation
IS: Swamp with immersed sedge and grasslands
MI: Swamp with *Mimosa* shrubs
MD: Mudflats
FW: Freshwater/peatswamp forest
FR: Riparian forest

C: common
U: uncommon
L: local
R: rare
B: breeding
B?: breeding suspected
M: migrant
* in captivity

		OW	AQ	IS	MI	MD	FW	FR
Wandering Whistling-Duck	*Dendrocygna arcuata*	*C*	*C*	*CB?*	-	*U*	-	-
Sunda Teal	*Anas gibberifrons*	*R*	-	-	-	-	-	-
Garganey	*Anas querquedula*	*UM*	*UM*	-	-	-	-	-
Storm's Stork	*Ciconia stormi*	-	-	*R*	-	*R*	*R*	-
Lesser Adjutant	*Leptoptilos javanicus*	-	-	*C*	*C*	*U*	*U*	-
White-shouldered Ibis	*Pseudibis davisoni*	-	-	-	-	-	*R*	*R*
Purple Heron	*Ardea purpurea*	-	-	*C*	*CB?*	*C*	-	-
Great Egret	*Ardea alba*	-	-	*C*	*CR*	*C*	-	-
Intermediate Egret	*Egretta intermedia*	-	-	*U*	*U*	*U*	-	-
Little Egret	*Egretta garzetta*	-	-	*U*	*U*	*C*	-	*U*
Chinese Egret *	*Egretta eulophotes*	-	-	-	-	-	-	-
Cattle Egret	*Bubulcus ibis*	-	-	*C*	*C*	*L*	-	-
Striated Heron	*Butorides striata*	-	-	-	*R*	-	-	*R*
Javan Pond-Heron	*Ardeola speciosa*	-	*C*	*C*	*CB*	*C*	*U*	-
Cinnamon Bittern	*Ixobrychus cinnamomeus*	-	-	-	*UB?*	-	-	-
Yellow Bittern	*Ixobrychus sinensis*	-	-	-	*UB*	-	-	-
Black Bittern	*Dupetor flavicollis*	-	-	-	*UB?*	-	*U*	-
Black-crowned Night-Heron	*Nycticorax nycticorax*	-	-	-	*R*	-	-	*R*
Little Black Cormorant	*Phalacrocorax sulcirostris*	*R*	-	-	-	-	-	-
Oriental Darter	*Anhinga melanogaster*	-	-	*L*	-	-	*L*	*L*
Peregrine Falcon	*Falco peregrinus*	*RM*	-	-	-	*RM*	-	-
Black-thighed Falconet	*Microhierax fringillarius*	-	-	-	-	-	*L*	*L*
Osprey	*Pandion haliaetus*	*R*	-	-	-	-	-	-
Black Kite	*Milvus migrans*	*R*	-	-	-	-	-	-
Black-winged Kite	*Elanus caeruleus*	-	-	-	*L*	-	*L*	-
Brahminy Kite	*Haliastur indus*	*C*	*C*	*C*	*C*	*C*	*C*	*C*
Crested Serpent-Eagle	*Spilornis cheela*	-	-	-	-	-	*U*	*U*
White-bellied Fish-Eagle	*Haliaeetus leucogaster*	*U*	-	-	-	*U*	*U*	*U*
Grey-headed Fish-Eagle	*Icthyophaga ichthyaetus*	*U*	-	-	-	*U*	*U*	*L*
Lesser Fish-Eagle	*Ichthyophaga humilis*	*R*	-	-	-	-	*U*	*L*
Changeable Hawk-Eagle	*Spizaetus cirrhatus*	-	-	-	*C*	*U*	*U*	*U*
Wallace's Hawk-Eagle	*Nisaetus nanus*	-	-	-	-	-	*R*	*L*
Ruddy-breasted Crake	*Porzana fusca*	-	-	-	*R*	-	-	-
White-browed Crake	*Porzana cinerea*	-	-	*C*	*C*	-	-	-
White-breasted Waterhen	*Amaurornis phoenicurus*	-	-	-	*C*	-	-	*U*
Buff-banded Rail	*Gallirallus philippensis*	-	-	*R*	-	-	-	-
Common Moorhen	*Gallinula chloropus*	-	*C*	*C*	*U*	-	-	-

		OW	AQ	IS	MI	MD	FW	FR
Purple Swamphen	*Porphyrio porphyrio*	-	*C*	*C*	*U*	-	-	-
Black-necked Stilt	*Himantopus leucocephalus*	-	-	*UB*	-	-	-	-
Black-winged Stilt	*Himantopus himantopus*	-	-	*R*	-	-	-	-
Grey Plover	*Pluvialis squatarola*	-	-	-	-	*UM*	-	-
Pacific Golden Plover	*Pluvialis fulva*	-	-	-	-	*CM*	-	-
Little Ringed Plover	*Charadrius dubius*	-	-	-	-	*CM*	-	-
Mongolian Plover	*Charadrius mongolus*	-	-	-	-	*RM*	-	-
Comb-crested Jacana	*Irediparra gallinacea*	-	*L*	-	-	-	-	-
Swinhoe's Snipe	*Gallinago megala*	-	-	-	-	*RM*	-	-
Common Snipe	*Gallinago gallinago*	-	-	-	-	*UM*	-	-
Whimbrel	*Numenius phaeopus*	-	-	-	-	*RM*	-	-
Far-Eastern Curlew	*Numenius madagascariensis*	-	-	-	-	*RM*	-	-
Black-tailed Godwit	*Limosa limosa*	-	-	-	-	*RM*	-	-
Bar-tailed Godwit	*Limosa lapponica*	-	-	-	-	*RM*	-	-
Common Redshank	*Tringa totanus*	-	-	-	-	*UM*	-	-
Common Greenshank	*Tringa nebularia*	-	-	-	-	*UM*	-	-
Wood Sandpiper	*Tringa glareola*	-	-	-	-	*CM*	-	-
Green Sandpiper	*Tringa ochropus*	-	-	-	-	*UM*	-	-
Marsh Sandpiper	*Tringa stagnatilis*	-	-	-	-	*UM*	-	-
Terek Sandpiper	*Tringa cinereus*	-	-	-	-	*RM*	-	-
Common Sandpiper	*Actitis hypoleucos*	-	-	-	-	*CM*	-	*U*
Great Knot	*Calidris tenuirostris*	-	-	-	-	*RM*	-	-
Red-necked Stint	*Calidris ruficollis*	-	-	-	-	*CM*	-	-
Temminck's Stint	*Calidris temminckii*	-	-	-	-	*RM*	-	-
Long-toed Stint	*Calidris subminuta*	-	-	-	-	*CM*	-	-
Curlew Sandpiper	*Calidris ferruginea*	-	-	-	-	*UM*	-	-
Red-necked Phalarope	*Phalaropus lobatus*	-	-	-	-	*UM*	-	-
Oriental Pratincole	*Glareola maldivarum*	-	-	-	-	*R*	-	-
Whiskered Tern	*Chlidonias hybrida*	*CM*	*CM*	*CM*	-	*CM*	-	-
White-winged Tern	*Chlidonias leucopterus*	*UM*	*UM*	*UM*	-	*UM*	-	-
Great Crested-Tern	*Sterna bergii*	*RM*	-	-	-	-	-	-
Little Tern	*Sterna albifrons*	*C*	*C*	*C*	*C*	*LB*	-	-
Sacred Kingfisher	*Todirhamphus sanctus*	-	*UM*	-	*UM*	-	*UM*	*UM*
Black-capped Kingfisher	*Halcyon pileata*	-	-	-	-	-	-	*RM*
Stork-billed Kingfisher	*Pelargopsis capensis*	-	*C*	-	*C*	-	-	*C*
Common Kingfisher	*Alcedo atthis*	-	*UM*	-	*UM*	-	-	*UM*
Blue-eared Kingfisher	*Alcedo meninting*	-	-	-	*U*	-	-	*C*
Blue-banded Kingfisher	*Alcedo euryzona*	-	-	-	*R*	-	-	-
Total number of species		**15**	**13**	**20**	**26**	**41**	**16**	**20**