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COMMUNICATION

A RAPID ASSESSMENT OF WATERBIRDS AND THE MANGROVE STATUS IN THE MENABE ANTIMENA PROTECTED AREA, MADAGASCAR

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INTRODUCTION

Mangroves are among the most productive ecosystems on Earth (Clausen et al. 2010) and of great ecological importance (Carugati et al. 2018). While supporting high floral and faunal diversity, mangroves also provide essential products to humans, such as food, fuel, and various construction materials (Rasolofo 1997; Baba et al. 2013). Additionally, mangroves and its adjacent mudflats provide essential services to human coastal populations like water filtration, protection from storms, and coastal erosion (Jones et al. 2016). Finally, mangroves and mudflats contribute significantly to climate change mitigation via sequestering massive amounts of CO₂ (Sanderman et al. 2018). Despite their ecological importance, mangroves are subjected to various human pressures, and large areas of mangroves are converted to agricultural farmland or are overexploited for marine and forestry products. It is estimated that more than 35% of the world's mangroves have been lost since 2000 (Carugati et al. 2018).

Madagascar has approximately 2% of the world's mangroves and this represents the second largest extent of mangroves of any country in the western Indian Ocean (Shapiro et al. 2019). Most of Madagascar's mangroves are located along the western coast of the island. One of the most significant remaining mangrove areas is in the Menabe Antimena Protected Area (MANAP), covering approximately 13,000ha (Goodman et al. 2018). The MANAP is a protected area under IUCN category V (harmonious landscape). The dry forests of the MANAP have been subjected to drastic deforestation in recent years (Zinner et al. 2014; Hudson et al. 2019), and protection measures of dry forests are so far mostly ineffective. According to analysis of data on globalforestwatch.org, more than 65,000ha have been lost since 2001 (Global Forest Watch 2014; Zinner et al. 2014; Hudson et al. 2019), with annual deforestation rates up to 10%. Compared to dryland forest, mangrove loss in Madagascar seems to be considerably lower (around 2.4% from 2006 to 2016 in MANAP; Goodman et al. 2018) based on nationwide GIS analysis of mangrove dynamics using remote sensing imagery (Jones et al. 2016). The same study, however, indicates that the loss of mangrove forest within the Tsiribihina Manambolo Delta (which includes similar habitat to the north, net loss of 12,612ha, 38.4%) from 1990 to 2010 is one of the largest in Madagascar. Although such GIS-based studies are of considerable importance to mangrove mapping and conservation, remote sensing does not fully allow the assessment of mangrove degradation as it cannot

distinguish specifically between naturally open-canopy mangrove areas and highly degraded areas (Hamilton & Casey 2016; Jones et al. 2016). Field-based surveys to assess threats and mangrove degradation or quality are, therefore, essential and contribute to a better understanding of mangrove dynamics and support conservation management decisions.

The mangroves and mudflats of the MANAP are an important refuge for numerous species (Goodman et al. 2018), including iconic and threatened species such as Madagascar Sacred Ibis *Threskiornis bernieri*, Madagascar Heron *Ardea humbloti*, Madagascar Teal *Anas bernieri*, and Madagascar Plover *Charadrius thoracicus*. Due to this diversity, parts of the mangroves of the MANAP are also declared as Important Bird Area (IBA), 'Wetlands of the Tsiribihina delta and upper Tsiribihina River' (WTDUTR) (BirdLife International 2020a), and have recently been designated as a Ramsar site 'Mangroves de Tsiribihina' (MdT) (Image 1). The MANAP includes a second RAMSAR site, the 'Wetlands of Bedo' or 'Lac Bedo'. The site is located in the centre of the Menabe region only a few kilometres from the coastline and represents an important site for animals, specifically for birds and fish.

In general, reliable data on bird distribution and abundance are rare for bird species in centralwestern Madagascar and are often based on patchy observations collected infrequently by different scientists, tourists or hunters (Young et al. 2014). Therefore, it is of great importance to regularly update numbers on the diversity and abundance of bird taxa.

Given the ecological importance of mangroves and the increased human pressure seen in recent years in the MANAP, our study aimed to quantify waterbird populations, mangrove condition, and threats to mangrove habitat and waterbird species within the protected area in order to contribute to future conservation management.

MATERIALS AND METHODS

Three distinct coastal wetlands (all consisting of mangroves and mudflats) were visited and surveyed (see Image 1) within the MANAP from 24 September–2 October 2019. The three sites were chosen to represent approximately the whole range of mangroves in the MANAP. Image 1 depicts bird records during the survey in September 2019. Site 1 Tsangajoly (Baie de Borongeny and Namangoa, lat. -19.830528, lon. 44.501139) is also part of the MdT Ramsar site and Important Bird Area

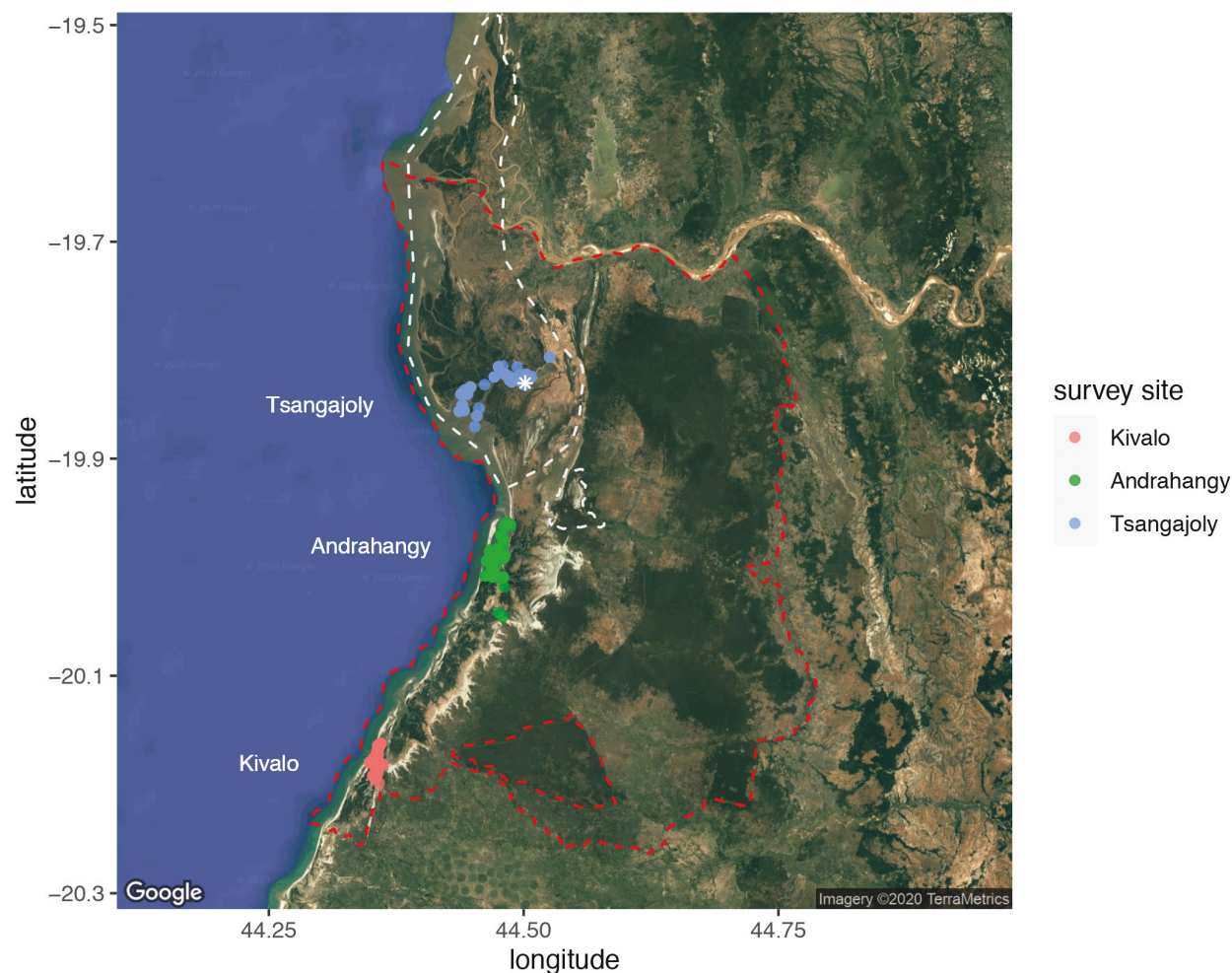


Image 1. Bird survey GPS points and three main observation areas: white dotted lines—Ramsar site boundaries (northern area= Wetlands of Tsiribihina, southern area= Lac Bedo south) | red-dotted line—boundary of Menabe Antimena Protected Area | *—Lodge de la Saline, each point can also represent multiple species of birds.

WDTUTR. This site has been surveyed for birds relatively recently (www.Ramsar.org) along with its designation as a Ramsar site. Surveys in Tsangajoly were started from the Lodge de la Saline, an abandoned shrimp farm that has been modified into an ecolodge with fantastic birdwatching opportunities. Given time constraints and relatively recent data for birds, we only focused on the southern third of the approximately 47,000 ha area. Site 2, Andrahangy (lat. -19.971611, lon. 44.466000), is south of the Tsiribihina delta and does not belong to the Ramsar site MdT. Site 3, Kivalo (lat. -20.208056, lon. 44.331361), is the most southern site visited within the MANAP.

Each area was surveyed using either a motorboat (site 1) or local dugout canoes (site 2 & 3). Observed birds were identified to the species level following Hawkins et al. (2015) and counted using binoculars. Several stops were conducted on mudflats or the shoreline to count

large aggregations of waterbirds using a zoom telescope. Local fishermen were additionally interviewed for the presence and absence of certain key species and threats on an ad libitum basis.

Occurrence and abundance of waterbirds was compared and discussed in relation to relevant Ramsar criteria. The Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, provides nine criteria to use in the assessment and designation of Wetlands of International Importance. The Ramsar Criteria relevant to the assessment of the importance of the mangroves of the MANAP for waterbirds are as follows:

Criterion 2: A wetland should be considered internationally important if it supports Vulnerable, Endangered, or Critically Endangered species or threatened ecological communities.

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.

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

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

The Ramsar convention came into force in Madagascar in 1999. Since then, Madagascar has designated an area of 2,147,911 ha as wetlands of international importance.

Mangrove quality was assessed using a rapid assessment tool developed using a freely available custom-made application of the kobo toolbox (www.kobotoolbox.org). A detailed description of the method can be found in Zöckler et al. (2021). In short, the scale ranges from 1 (low quality) to 6 (high quality). Each level considers different aspects of mangrove degradation, such as shape, height, diameter at breast height (DBH) of remaining mangroves as well as presence/absence of logging and percentage of light to floor. Bird occurrences and mangrove quality data were collected using a custom-made application (Android Open Data Kit/KoBo APP) using a smartphone. GPS precision was between 5 and 97 m with a mean of 26 m. Maps and images were created using R version 3.5.3 (R Core Team 2019).

RESULTS

Bird diversity and abundance

We observed 71 species of birds (Annexe, Table 1). Of these, special attention was given to waterbirds and globally threatened species, some of which were found in high numbers at individual sites.

Globally threatened bird species

The survey revealed interesting new data points for several threatened species. Specifically, Andrahangy shows profound structural habitat variation, including lagoons, sandbanks, salt flats, and mudflats, interspersed into the mangroves. The area is likely to be very important for the Madagascar Plover *Charadrius thoracicus*. Both, the Madagascar Teal and the Madagascar Plover exceed the 1% Ramsar threshold at single sites, Tsangajoly and Andrahangy (see Table 1). Of the Madagascar Teal (Image 3) 30 individuals were observed at Tsangajoly (Image 4) and 26 Madagascar Plover (Image 5) at Andrahangy. Eight individuals of the Madagascar Heron were seen at Tsangajoly (Image 6 & 7).

Furthermore, we did not observe the Madagascar Sacred Ibis *Threskiornis bernieri* and the Madagascar Fish Eagle *Haliaeetus vociferoides* in either of the survey areas. Although we could not observe this Ibis during the survey, interviews with local communities consistently revealed Andrahangy as the location where the Madagascar Sacred Ibis was most observed recently.

Important waterbird observations

Although none of the other waterbird species were observed in numbers over 1% of the flyway population (Wetlands International 2012) Whimbrel, Grey Plover, and Curlew Sandpiper were recorded for Madagascar in comparatively large numbers (Safford & Hawkins 2013). Almost 2,000 Whimbrel and 600 Grey Plover were counted at Tsangajoly on 25 and 26 of September. The observation of 130 Bar-tailed Godwits on 25 September in Tsangajoly is exceptional and noteworthy. In the same area were large numbers of terns (both Common and Roseate Terns plus a few Lesser and Greater Crested Terns) of over 3,500 individuals on 26 September. Such high numbers were not observed at the same site the day before. It might be possible that these large gatherings coincide with certain tidal cycles and could be easily missed when surveying at different tides.

In Andrahangy, the most common waterbird was the Curlew Sandpiper with over 2,200 individuals. A more thorough survey of additional intermediary sites between the survey areas might yield much higher counts in numbers potentially significant for the flyway population beyond the 1% flyway threshold of 4,000 birds.

Mangrove quality

Image 2 shows the results of the three areas surveyed within the MANAP and the scale of the mangrove quality assessment ranging from 1–6. The average mangrove quality varies but ranges were still relatively high (Table 2) at all three sites, indicating an overall good quality of mangroves. Threats and losses, however, were identified and observed. The area around Tsangajoly appears least degraded. Some cutting by local people was observed at several sites, and browsing by cattle and goats on the edges impacts the mangroves' quality. In some cases, the mangroves have been heavily impacted and stunted by persistent browsing by livestock.

As well as being impacted by resource use of local communities, the mangroves at Tsangajoly were affected by the establishment of shrimp ponds by the company AQUAMEN; this led to the elimination of significant areas until shrimp production was abandoned in 2007 after a

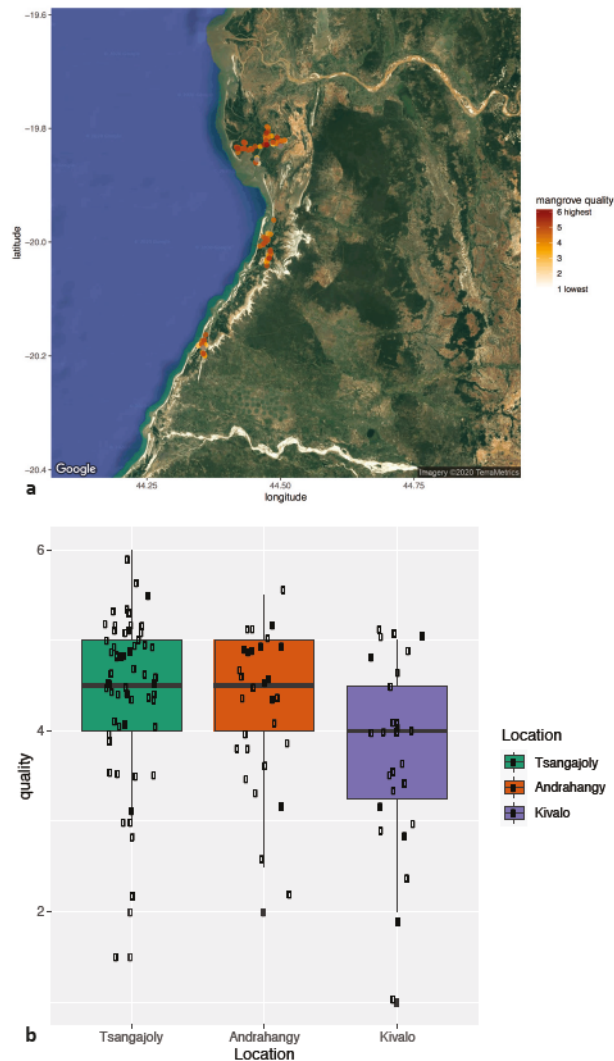


Image 2. a—survey sites for the mangrove quality/degradation assessment within the MANAP | b—visual comparison of mangrove quality among sites.

virus had infected all shrimps globally. The company created an eco-resort, Lodge de la Saline, which now offers fantastic birdwatching opportunities. The former shrimp ponds are now managed for waterbirds, and the owners have restored at least some of the areas where mangroves are recovering.

In Andrahangy and especially Kivalo, constant pressure from local people for construction wood and firewood has a visibly higher impact, resulting in a lower, but still reasonably high by national/global standards, average mangrove quality scores of 4.3 and 3.8, respectively, compared to 4.5 at Tsangajoly (see Table 1 and Image 2b). Details of the mangrove degradation assessment in the MANAP can be found in Zöckler et al. (2021).



Image 3. Madagascar Teal at Tsangajoly saline pond.



Image 4. Madagascar Teal and Lesser Flamingo at Tsangajoly saline pond.



Image 5. Madagascar Plover at Andrahangy.

Table 1. Distribution and abundance of birds recorded in the mangroves and mudflats of the MANAP during the survey period 24 Sep–2 Oct 2019; water birds exceeding 1% are indicated in bold letters.

	Family	Species	Scientific Name	Tsangajoly	Andrahangy	Kivalo	Total
1	Anatidae	Madagascar Teal	<i>Anas bernieri</i>	30	2	0	32
2	Anatidae	Red-billed Teal	<i>Anas erythrorhyncha</i>	15	0	0	15
3	Anatidae	White-faced Whistling-duck	<i>Dendrocygna viduata</i>	300	0	1	301
4	Apodidae	Madagascar Swift	<i>Cypsiurus parvus gracilis</i>	0	4	0	4
5	Caprimulgidae	Madagascar Nightjar	<i>Caprimulgus madagascariensis</i>	0	2	0	2
6	Burhinidae	Madagascar Pratincole*	<i>Glareola ocularis</i>	0	0	6	6
7	Charadriidae	Madagascar Three-banded Plover*	<i>Charadrius bifrontatus</i>	0	0	1	1
8	Charadriidae	Common Ringed Plover	<i>Charadrius hiaticula</i>	70	26	12	108
9	Charadriidae	Greater Sandplover	<i>Charadrius leschenaultii</i>	10	45	30	85
10	Charadriidae	White-fronted Plover	<i>Charadrius marginatus</i>	1	10	19	30
11	Charadriidae	Lesser Sand-Plover	<i>Charadrius mongolus</i>	35	2	0	37
12	Charadriidae	Kittlitz's Plover	<i>Charadrius pecuarius</i>	0	0	12	12
13	Charadriidae	Madagascar Plover	<i>Charadrius thoracicus</i>	0	26	15	41
14	Charadriidae	Pacific Golden Plover	<i>Pluvialis fulva</i>	0	1	0	1
15	Charadriidae	Grey Plover	<i>Pluvialis squatarola</i>	600	80	2	682
16	Dromadidae	Crab-plover	<i>Dromas ardeola</i>	0	24	0	24
17	Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i>	120	0	2	122
18	Scolopacidae	Common Sandpiper	<i>Actitis hypoleucos</i>	20	20	40	80
19	Scolopacidae	Ruddy Turnstone	<i>Arenaria interpres</i>	10	10	12	32
20	Scolopacidae	Sanderling	<i>Calidris alba</i>	15	8	4	27
21	Scolopacidae	Curlew Sandpiper	<i>Calidris ferruginea</i>	170	2200	300	2670
22	Scolopacidae	Bar-tailed Godwit	<i>Limosa lapponica</i>	130	0	0	130
23	Scolopacidae	Whimbrel	<i>Numenius phaeopus</i>	1900	100	25	2025
24	Scolopacidae	Common Greenshank	<i>Tringa nebularia</i>	90	25	0	115
25	Scolopacidae	Terek Sandpiper	<i>Xenus cinereus</i>	158	21	9	188
26	Laridae	Grey-headed Gull	<i>Chroicocephalus cirrocephalus</i>	2	0	0	2
27	Sternidae	Caspian Tern	<i>Hydroprogne caspia</i>	41	0	0	41
28	Sternidae	Lesser Crested Tern	<i>Sterna bengalensis</i>	102	0	0	102
29	Sternidae	Greater Crested Tern	<i>Sterna bergii</i>	80	0	0	80
30	Sternidae	Common Tern	<i>Sterna hirundo</i>	3010	0	0	3010
31	Sternidae	Roseate Tern	<i>Sterna roseata</i>	436	0	0	436
32	Sternidae	Saunders's Tern	<i>Sternula saunderi</i>	0	1	3	4
33	Ardeidae	Great White Egret	<i>Ardea alba</i>	60	0	0	60
34	Ardeidae	Grey Heron	<i>Ardea cinerea</i>	6	1	0	7
35	Ardeidae	Madagascar Heron	<i>Ardea humbloti</i>	8	0	0	8
36	Ardeidae	Purple Heron	<i>Ardea purpurea</i>	1	0	0	1
37	Ardeidae	Striated Heron	<i>Butorides striata</i>	8	4	4	16
38	Ardeidae	Western Reef-egret	<i>Egretta garzetta gularis</i>	25	3	9	37
39	Ardeidae	Little Egret	<i>Egretta gazetta dimorpha</i>	60	4	5	69
40	Ciconiidae	African Openbill	<i>Anastomus lamelligerus</i>	0	0	2	2
41	Ciconiidae	Yellow-billed Stork	<i>Mycteria ibis</i>	1	0	0	1
42	Threskiornithidae	African Spoonbill	<i>Platalea alba</i>	6	0	0	6

	Family	Species	Scientific Name	Tsangajoly	Andrahangy	Kivalo	Total
43	Threskiornithidae	Glossy Ibis	<i>Plegadis falcinellus</i>	0	2	0	2
44	Columbidae	Madagascar Turtle-dove	<i>Nesoenas picturata</i>	0	0	+	0
45	Columbidae	Madagascar Green-pigeon	<i>Treron australis</i>	0	0	7	7
46	Columbidae	Namaqua Dove	<i>Oena capensis</i>	+	0	0	+
47	Alcedinidae	Madagascar Kingfisher	<i>Crythornis madagascariensis</i>	2	7	4	13
48	Meropidae	Olive Bee-eater	<i>Merops superciliosus</i>	2	7	5	14
49	Upupidae	Madagascar Hoopoe	<i>Upupa marginata</i>	0	0	1	1
50	Cuculidae	Madagascar Coucal	<i>Centropus toulou</i>	1	0	8	9
51	Cuculidae	Red-capped Coua	<i>Coua ruficeps</i>	0	0	1	1
52	Acciptridae	Black Kite	<i>Milvus migrans</i>	+	+	0	0
53	Acciptridae	Madagascar Harrier-hawk	<i>Poyboroides radiatus</i>	3	2	2	7
54	Falconidae	Madagascar Kestrel	<i>Falco newtoni</i>	0	1	0	1
55	Rallidae	White-throated Rail	<i>Dryolimnas curveri</i>	1	2	8+	11+
56	Turnicidae	Madagascar Buttonquail	<i>Turnix nigricollis</i>	4	0	2	6
57	Acrocephalidae	Madagascar Swamp-warbler	<i>Acrocephalus newtoni</i>	+	+	0	0
58	Cisticolidae	Common Jery	<i>Neomixis tenella</i>	+	+	+	0
59	Dicruridae	Crested Drongo	<i>Dicrurus forficatus</i>	+	3	0	3
60	Nectariniidae	Souimanga Sunbird	<i>Nectarina souimanga</i>	0	4	2	6
61	Ploceidae	Madagascar Fody	<i>Foudia madagascariensis</i>	+	0	0	0
62	Ploceidae	Madagascar Mannikin	<i>Lepidopygia nana</i>	+	0	0	+
63	Pycnonotidae	Madagascar Bulbul	<i>Hypsipetes madagascariensis</i>	0	+	+	0
64	Turdidae	Madagascar Magpie-robin	<i>Copsychus albospectularis</i>	+	0	+	0
65	Vangidae	White-headed Vanga	<i>Artamella viridis</i>	1	0	3	4
66	Vangidae	Sickle-billed Vanga	<i>Falcula palliata</i>	0	0	5	5
67	Vangidae	Common Newtonia	<i>Newtonia brunneicauda</i>	+	1	3	4
68	Phoenicopteridae	Lesser Flamingo	<i>Phoeniconaias minor</i>	120	0	0	120
69	Psittacidae	Grey-headed Lovebird	<i>Agapornis canus</i>	1	0	20	21
70	Psittacidae	Vasa Parrot	<i>Coracopsis sp.</i>	7	94	2	103
71	Strigidae	Madagascar Scops-owl	<i>Otus rutilus</i>	1	2	0	3

*not in mangroves but brackish water close to Baobab Amoureux/Mangily

Table 2. Average mangrove quality in the MANAP in Sep 2019 (max. range 1–6).

	Site	Average (range) mangrove quality	No of mapped mangrove sites
1	Tsangajoly	4.5 (1.5–6.0)	59
2	Andrahangy	4.3 (2.0–5.5)	29
3	Kivalo	3.8 (1.0–5.0)	27

DISCUSSION

To the best of our knowledge, the mangrove quality assessment is the most detailed field-based assessment of mangrove quality in the region to date, and highlights

the importance of the MANAP for conservation of this ecosystem in Madagascar. In the following, we briefly discuss our results in the light of Red Listed Species and species that qualify for the >1% Ramsar threshold at the three sites that were investigated.

Three bird species observed during our survey in the MANAP are listed as globally threatened and belong to the five (*Ardea humbloti*, *Anas bernieri*, *Haliaeetus vociferoides*, *Amaurornis olivieri*, *Cathartus thoracicus*) restricted range species of global conservation concern that qualify the WTDUTR as Important Bird Area (Project Zicoma 2001).

The Madagascar Teal *Anas bernieri* is endemic to Madagascar and only distributed along the western coastal stretch of the island. It is assessed as per the IUCN



Image 6. Madagascar Heron at Tsangajoly saline ponds.



Image 9. Crab Plovers *Dromas ardeola* in Andrahangy.



Image 7. African Spoonbill, Grey-headed Gull, White-faced Whistling Duck, and Madagascar Heron in a former shrimp pond at the Lodge de la Saline.



Image 8. Madagascar Three-banded Plover *Charadrius bifrontatus* in brackish water close Baobab Amoureux.

Red List as globally ‘Endangered’ and with estimated 1,000–1,700 mature individuals (BirdLife International 2016a) possibly the most threatened species observed. The species is well known from the MANAP, specifically Lac Bedo, which is also designated as a Ramsar site. Our survey adds one more occurrence for the Madagascar Teal in Andrahangy, which is about 2km away from Lac Bedo. Young et al. (2014) counted several birds in the salines of Menabe coastal wetlands and warned about fragmentation of the population. In total, we counted 30 birds simultaneously at Tsangajoly (Lodge de la Saline). As the area is large and difficult to survey it is likely that more birds are present. Although it is known that the species occurs in loose groups of up to 40 individuals outside the breeding season, such a high number of individuals at one place suggests that the ponds of the Lodge de la Saline represent a crucial refuge for this species. The total amount of birds (32) equals 1.9–3.2 % of the estimated global population. Population size increased north of the MANAP at Manambolamaty between 1999–2011 (Razanfindrajao et al. 2017).

Madagascar (Black-banded) Plover *Charadrius thoracicus* is assessed as ‘Vulnerable’ on the IUCN Red List (BirdLife International 2020b). The species is confined to coastal habitats, and in total, we recorded at least 41 individuals in Andrahangy and Kivalo sandy mudflats. The total population has been estimated based on suitable habitat models at around 3,100 (2,700–3,500) individuals (Long et al. 2008); however, due to continuous habitat loss (Zefania & Skekely 2013), this number could already be very much lower today. According to the last IUCN Red List assessment, the 2008 estimate equates to between 1,800 and 2,300 mature individuals. Our 41 individuals, therefore, exceed the 1% (1.7–2.3 %) threshold of the global population of

this species. Individuals observed seem to prefer sandy mudflats only. The area visited in Tsangajoly estuary does not contain many of these habitats. Therefore, it was not surprising not to find the species here, although it was reported to occur in 2016 (www.Ramsar.org). Safford (1993) reported aggregations of (12 individuals) in the Tsiribihina delta as well. In Andrahangy, we recorded at least 26 different birds, all distributed in the southern part. Usually, the bird is observed in groups of 2–10 birds (BirdLife International 2020b), however, congregations of 26 and 15 respectively seem to be unusual and merit special attention. More detailed survey work is necessary and might reveal even higher numbers in the area. The coastal wetlands of the MANAP might be one of their main strongholds along Madagascar's western coast (Young et al. 2014).

Another endemic water bird in the area is the Madagascar Heron *Ardea humbloti*, listed as globally 'Endangered'. The species prefers coastal wetlands but has also been observed inland (Sartain & Hawkins 2013; BirdLife International 2020b). The total number of mature individuals is estimated at 1,000 (BirdLife International 2016b). A severe threat to this species is the replacement of suitable nesting trees around wetlands. Ten individuals have been reported at Lake Kimanaomby within the MANAP (Chechia 2020). In total, we observed eight birds, all in Tsangajoly (Lodge de la Saline) wetlands, which equals 0.8% of the global population; the true number using the area seems almost certain to exceed the 1% threshold. The species was also recorded in the Tsiribihina delta by Safford (1993) and in 2016 (Ramsar 2020).

Given the short time frame of the survey, this underlines the importance of the wetlands of the MANAP, specifically the lakes and the abandoned shrimp ponds of the Lodge de la Saline, for this species.

The latter applies as well to the Madagascar Fish-Eagle *Haliaeetus vociferoides* (CR) and potentially the Madagascar Sacred Ibis, which are known to exist but could not be recorded during our survey. The Madagascar Sacred Ibis was one of the species given special attention in this study. After consultation with local stakeholders and interviews with local villagers in preparation of the survey, two sites were specifically chosen for the search of this species.

Safford (1993) recorded 44 individuals in Tsiribihina delta and Baie de Borongeny accessed via Tsangajoly (site 1) was listed with 31 birds during the last published Ramsar designation survey in 2016 (Ramsar 2020). Andrianarimisa & Razafimanjato (2010) estimated the total population less than 2,000 individuals and listed

10 individuals from four sites within the MANAP. All interviewed villagers, even in a community at the shoreline of the Baie de Borongeny (site 1), consistently mentioned Andrahangy as the best place to see the Madagascar Sacred Ibis. In general, interviews revealed that the species exists at all three locations. In Andrahangy, a fisherman reported a sighting earlier the same day, however, we were not able to confirm this observation. Although its presence was broadly confirmed by local fishermen, not detecting the species during our survey could be due to its seasonal secretive behaviour, but also due to relatively low numbers of individuals. Interviews suggest the species is still present in the surveyed areas, but challenging and irregularly observed. As the species is most vocally active during the breeding season and roosts in small colonies (Safford & Hawkins 2013), a future survey should be conducted during the breeding and wet season in November–April to increase the chance of detecting the species. Interviews with local fishermen did not reveal any species-specific threats, such as collecting eggs in the area. Egg collection is known to be a major threat for water birds in the MANAP (PAG Menabe Antimena 2014). Individual answers, however, might be influenced by the anxiety of the person interviewed of potential punishment for conducting illegal activity in the PA. As this species is very difficult to confuse with any other species (at least when not in flight), monitoring by community members might be a good solution to conduct surveys more regularly in the future. Overall, our numbers of waterbirds (Tsangajoly >7500; Andrahangy > 2500; Kivalo ~500) is comparable to survey estimates of other IBAs in the Antsalova region further north, specifically the Bemamba and Manambolomaty wetland complex, where waterbird numbers range 266–4,105 across survey sites (see Razafimanjato et al. 2007; Table 1).

Recommendations

We recommend several measures to improve waterbird and mangrove conservation in the area. More emphasis should be put on raising environmental awareness in local communities of the importance of the mangroves for people and nature. Mangrove communities should be included in existing training programs to transfer knowledge of sustainable resource use. For example, mangrove cutting for firewood is a significant driver of mangrove degradation and could be decreased by promoting fuel-efficient stove solutions.

Furthermore, our rapid survey revealed mangrove degradation details, which cannot be achieved using

remote sensing technologies. This knowledge is essential for identifying important sites for mangrove restoration as degraded mangroves can be restored much more easily than those already destroyed. It is, therefore, recommended to extend the degradation assessment to the remaining wetlands in Menabe.

More survey work is needed for the Andrahangy and Kivalo areas which currently lie outside existing Ramsar sites, as they seem to be important for Madagascar Plover, Madagascar Teal, potentially the Madagascar Sacred Ibis, and the Curlew Sandpiper, of which more than 2,000 individuals were counted at Andrahangy alone. It is worth considering an extension of the existing Ramsar site to include the Andrahangy and Kivalo area into the Ramsar site network. Both sites contained mangroves with low levels of degradation. Community projects have been initiated in Kivalo and Andrahangy. Both of them are still running and should be strengthened in the future. Both sites offer excellent opportunities for community-based tourism, but implementation appeared difficult on site, however, additional concepts for conservation benefits of local fishermen have to be developed. The ongoing covid19 crisis shows that community-based tourism should not be the only alternative income strategy for local communities supporting conservation.

The Lodge de la Saline (previously AQUAMEN) at Tsangajoly, a former shrimp farming company that has been turned into a private protected area, seems to be a significant site for the future management of several endemic threatened bird species in the area. Therefore, it is recommended to ensure strong collaboration with the owners and consider integrating the abandoned shrimp ponds to waterbird conservation measures.

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Author contribution: All authors conducted field work. MM and SNR organized the survey. CZ & MM wrote the manuscript and analyzed the data.

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