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Distribution and population estimates of four crane species in Ethiopia: a global crane hotspot facing increasing threats

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Summary

Four species of crane occur in Ethiopia, making the country the most important in Africa for cranes. Black-crowned *Balearica pavonina* and Wattled Cranes *Bugeranus carunculatus*, both listed as Vulnerable, are resident species, while Common *Grus grus* and Demoiselle Cranes *Anthropoides virgo*, both listed as Least Concern, are migrants. We assessed the distribution and minimum population size of four crane species at the most important and main crane sites during 2007–2019. Some potentially important sites, particularly for Black-crowned Cranes, were not able to be surveyed. Breeding areas of resident cranes were also surveyed. Results showed that Black-crowned Cranes were mainly distributed in the Gambela and Lake Tana areas and the minimum population estimate was 3319 individuals. Wattled Cranes were distributed in Bale Mountains National Park, Lake Tana, Jimma wetlands, Bonga and central Rift Valley areas and the minimum population estimate was 366. Migratory Common Cranes were found in Lake Tana, central Ethiopia, south-central Rift Valley, and some places in southern Ethiopia with the highest populations recorded at Lake Tana and secondly at Debre-Zeit. The minimum population estimate for Common Cranes was 70 000. Migratory Demoiselle Cranes were restricted to the northwestern corner of Ethiopia and the minimum population estimate of 21 500 was based on previously published data. Wetlands are the main habitats for cranes and in Ethiopia these habitats are being degraded and are under increasing threat from overgrazing, water extraction for irrigation, siltation, and habitat loss from farming. Key wetland sites that should be protected or sustainably managed include those at Gambela, Lake Tana (Chimba and Yiganda, in particular), and the Boyo and Jimma areas. Cheleleka at Debre-Zeit, Sululta plain around Addis Ababa, and Shesher floodplain in Lake Tana are important roosting sites for Common Cranes.

Keywords Black-crowned Crane, Common Crane, Demoiselle Crane, threats, Wattled Crane, breeding sites, wetlands

Introduction

Globally, eleven of the fifteen species of cranes are considered threatened at the species level, while several additional subspecies are also at risk of extinction (BirdLife International 2020a). Six species of cranes occur in Africa, of which four are found in

Ethiopia. Two species are resident, Black-crowned Crane *Balearica pavonina* and Wattled Crane *Bugeranus carunculatus,* and two species are migratory, Common Crane *Grus grus* and Demoiselle Crane *Anthropoides virgo*.

Black-crowned Cranes, listed as Vulnerable on the IUCN Red List, are resident throughout the western part of Ethiopia, including the western highlands, and in Rift Valley lakes and rivers (BirdLife International 2020b, Yohannes 1996, Nowald *et al*. 2007). They primarily feed in uplands during the non-breeding season, utilizing food resources after crops have been harvested. During the breeding season they use both uplands and wetlands (Urban & Gichuki 1991).

Wattled Cranes are listed as Vulnerable on the IUCN Red List and isolated populations occur in Ethiopia and South Africa, which are not considered different subspecies (Beilfuss *et al*. 2007, BirdLife International 2020c). This species primarily feeds in wetlands during both seasons, although Ethiopian birds may make greater use of drier habitats during the non-breeding season than those in southern Africa (Urban & Gichuki 1991). Nesting pairs of Wattled Cranes establish large (often >1 km^2) territories, generally in shallow wetlands with minimal human disturbance (Urban & Gichuki 1991).

Common Crane is a long-distance migrant that predominantly winters in northern Africa, including Ethiopia (Johnsgard 1983, Ellis *et al* 1996, Nowald *et al*. 2007, Ojaste *et al*. 2020). During both migration and wintering, this species prefers to forage in agricultural fields, pastures, and meadows, and to roost in shallow lakes, bogs, rivers, along the edges of reservoirs, and in other wetlands (Archibald & Lewis 1996, Nowald 1996).

The range and status of the Demoiselle Crane in Ethiopia is unclear, and its distribution has retracted considerably due to human pressure (Johnsgard 1983). Although little is known about this species' foraging habitats, they seem to use drier open fields with dispersed trees of *Balanites aegyptica*, and have been observed flying to agricultural fields in far north-western Ethiopia (Gebremedhin *et al*. 2009)(Fig.1).

Figure 1. Demoiselle Crane roosting site at Tekeze River, Kafta Sheraro National Park (photo: Abadi Mehari Abrha).

The breeding season of cranes in Africa, though still imperfectly understood, is also likely to be affected by the alternation of wet and dry seasons (Fishpool & Evans 2001). The annual cycle of cranes can be divided into a 3–5 month breeding period and a longer 7–9 month non-breeding period (Archibald & Lewis 1996). Except

for Wattled Cranes (Tarboton 1984) and Sarus Cranes *Grus antigone* (Sundar 2009), which remain on their breeding territories throughout the year, other crane species are largely gregarious during the non-breeding period and they migrate or are nomadic.

The major threat facing cranes in Africa is the loss, transformation, and degradation of their habitat, particularly wetlands (Tarboton 1984, Treca 1996, Nowald *et al*. 2007, Aynalem & Bekele 2008a). Behind this threat lies a combination of causal factors, which are all strongly linked to an expanding human population; these include development and expansion of intensive agriculture, wetland conversion to agriculture, and draining and irrigation projects (Daddy & Ayeni 1996, Aynalem & Bekele 2008a, 2008b).

Limited information is available on the distribution, nest sites, and population status of cranes in Ethiopia (Ash & Atkins 2009, Redman *et al*. 2009, Beilfuss *et al*. 2007, Aticho *et al*. 2018, Hadis 2018). The objectives of this study were to assess the distribution and population size of all four crane species in select areas of Ethiopia; to investigate potential nesting sites; and to investigate the main threats to crane habitats.

Methods

Study sites

Survey sites were selected based on information of crane occurrence gathered mainly from local communities during crane monitoring which began in 2007, and also from consulting the literature (Beilfuss *et al*. 2007, Nowald *et al*. 2007, Gebremedhin *et al*. 2009, Ash & Atkins 2009, Redman *et al*. 2009). Eleven survey sites were selected based on the known presence of cranes (Fig. 2). These sites were mainly wetland areas where it is easier to find cranes than in drier or upland foraging areas. For Black-crowned and Wattled Cranes, crop fields located adjacent to wetlands were also included. We surveyed the most important and main crane sites in Ethiopia. However, some potentially important sites were not possible to be surveyed, particularly for Black-crowned Cranes, and these include the northern corner of Lake Turkana at the border of Kenya and Ethiopia, the southern part of Ethiopia, and some sites within Gambela National Park that are only accessible by aircraft. For Common, Wattled and Demoiselle Cranes almost all the best sites were surveyed.

A total of 75 surveys from 2007 to 2019 were conducted. Due to logistical, financial and capacity constraints, surveys were not conducted in 2010, except for Demoiselle Cranes, nor in 2016 or 2018. Survey sites are listed below, and the number of surveys conducted at each site is shown in brackets.

1. North-western Ethiopia: Lake Tana area wetlands, including Chimba, Yiganda, Dirma, and Fogera floodplains (mainly Shesher and Wallala) (16); and Kafta-Sheraro National Park (7)
2. Central Ethiopia: Debre-Zeit area, including Akaki (Aba-Samuel reservoir), Cheleleka, and associated wetlands near Addis Ababa (Sululta) (9)
3. South-central Ethiopia: Chuche, Wanchicho and Archuma wetlands (12), Dalocha and Wondogenet (3), and Boyo wetland (3)

4. South-western Ethiopia: Jimma wetlands, including Cheleleki and Boye (11) and the Bonga area, including Alemgono and Doli wetland in Gimbo district (8)
5. South-eastern Ethiopia: Bale Mountain National Park (BMNP) (1) and Melka Wakena (1)
6. Gambela area (1)
7. Other opportunistic sightings outside of the main survey sites (3)

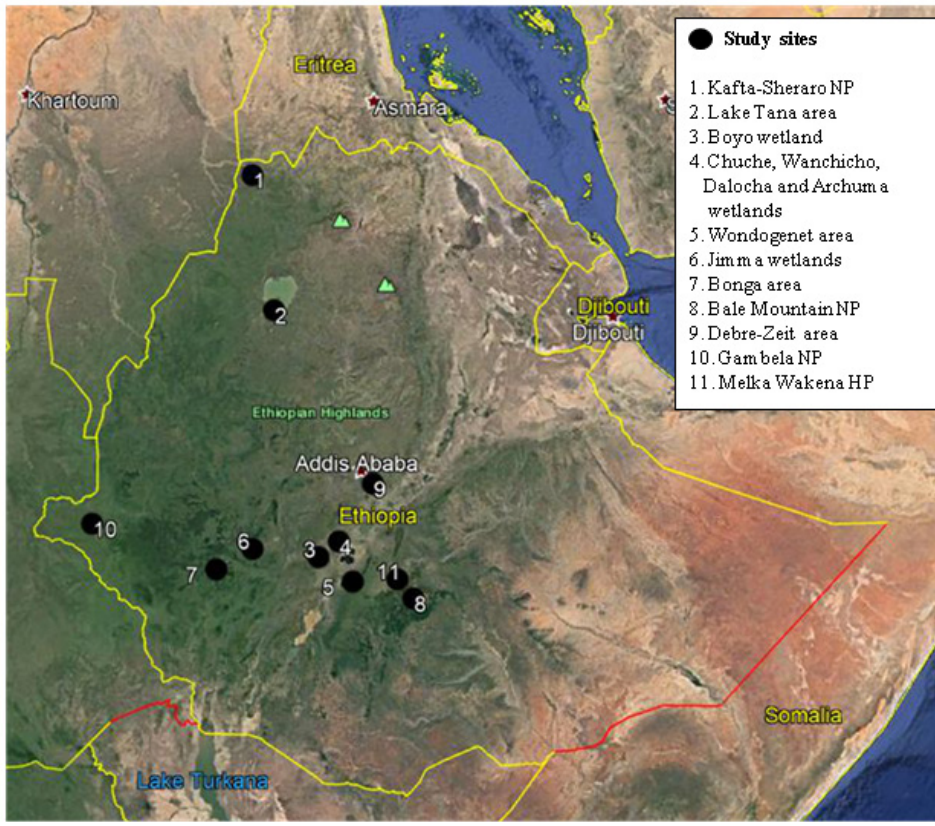

Figure 2. Map of the surveyed sites in Ethiopia.

Survey methods

Surveys were mostly accomplished within 10–15 days by two teams who surveyed the northern and southern routes respectively. The coordinates of each study site were recorded as well as the habitat type, such as crop fields or wetlands, and whether the site was used for nesting or roosting. Coordinates for each group of cranes were also recorded.

For Black-crowned and Wattled Cranes, a transect line was walked along the edge of the wetland and any crop fields. Transect line lengths ranged from 500 to 1000 m, depending on the size and accessibility of the site (Sutherland 1996, Lloyd *et al*. 1998). Because flock sizes are relatively small for these species, exact counts were made. To minimize disturbance, particularly when there were large flocks of

Common Cranes, a waiting period of 3 to 5 min before counting was applied (Sutherland 2000, Hostetler & Main 2001). Because juveniles had not yet fledged, they were counted under 'nesting sites', but were not included in population estimates.

Counting Common Cranes during the daytime is very difficult because they disperse widely in crop fields while foraging. However, despite daytime behaviour, they come together at night-time roosting sites. Individuals of this species fly at the same time, often in large flocks. For this reason Common Crane numbers were only estimated at roost sites during the late afternoon as they flew into their roosts, and during the early morning before they left their roosts. Roosting sites were surveyed only at Lake Tana, Debre-Zeit, Wanchicho, Chuche, Archuma, Boyo, and other smaller sites, e.g. Sululta, Muketri and Aba-Samuel near Addis Ababa, and a few others. The number of flocks was recorded using direct observation with binoculars and spotting scopes. The total number of cranes was estimated by a factor of ten (e.g. 10, 20,…100). Flocks were assigned a flight takeoff direction (south, west, north, and east) to avoid double counting, and each counter was assigned to count in one direction only (Bibby *et al*., 1998).

Very few Demoiselle Cranes were observed and these were counted opportunistically with population estimates based on Gebremedihin *et al*. 2009.

Minimum population estimates

Minimum population estimates for each species were made using the largest number of individuals observed at one survey site per year summed across all the survey sites for that year. Based on our experience and the narrow survey period, it is unlikely that cranes moved long distances, i.e. between survey sites, and could have been counted more than once during any survey year. Since the survey effort made for each site was not uniform throughout the study period and not all sites were able to be counted every year, it was not feasible to apply any statistical tests. Similarly, our results do not represent the population size of each species for the country, but are rather a minimum estimate for some of the most important crane sites in Ethiopia.

Breeding areas

Breeding sites of Black-crowned and Wattled Cranes were identified based on the presence of non-fledged juveniles, which indicated that the area was being used for nesting. We also relied on unpublished data, reports, and published literature to identify breeding areas for the two resident crane species (Nowald *et al*. 2007, Aynalem *et al*. 2011, Aticho *et al*. 2018).

The habitats of breeding cranes were noted, as well as any threats at each site, although this was not done systematically. Definitions of habitats used were:

1. Wetlands: areas that are covered by water seasonally or all year round, including marshes, estuaries, and mudflats situated at river mouths, and along rivers
2. Floodplains: nearly flat plains along the course of a stream or river that are naturally subject to flooding during periods of high discharge or in the rainy season; however, the areas will have little vegetation cover
3. Lakes: areas filled with water, localized in a basin surrounded by land, apart from any river or other outlet that serves to feed or drain the lake. Crane nests were found along vegetated lakeshores on elevated ground, and at one site, nests were located in small lakes or ponds surrounded by water

Results

Black-crowned Crane

Distribution

The Black-crowned Crane is distributed in the north-western, central, and south-central Rift Valley areas and in south-western parts of Ethiopia (Bonga, Gambela, and the Jimma area). The largest single concentrations of this species were found in Gambela (n = 1880) and Lake Tana areas (n = 1619) in 2009 and 2019, respectively (Table 1). A significant number of Black-crowned Cranes were also found in the southwestern regions of the country, including the Jimma area wetlands, such as Boye and Cheleleki. Smaller numbers were found in the Cheleleka Lake and the Debre-Zeit area. They were also recorded in Boyo and Archuma wetlands. However, no observations were recorded in lakes Ziway, Langano, or Abijjata although visits were made several times (Table 1).

Minimum population estimate

The maximum total number of 3319 Black-crowned Cranes was recorded in 2019, which included the Gambela area for the first time. Therefore, the total population is expected to exceed this number because our study did not cover all of the breeding sites in the country, nor were all of the study areas surveyed each year. This result could serve as baseline information that will be expected to increase as surveys are improved in the future. The number of cranes counted varied considerably between years (Table 1).

Wattled Crane

Distribution

The distribution of the Wattled Crane can be divided into breeding and non-breeding ranges. While Wattled Cranes were located in the Lake Tana area in the northwest and in the Jimma area in the southwest during both breeding and non-breeding seasons, at other sites their presence was seasonal. They were found in the Boyo wetland, Melka Wakena reservoir, Archuma wetlands, and Chuche and Wanchicho areas in south-central Ethiopia only during the non-breeding season. In Bale Mountain National Park, Wattled Cranes were only present during the breeding season from August to November (Tadele 2018). Strongholds of the non-breeding population appear to be the Melka Wakena hydropower reservoir and the Boyo wetland (Table 1).

Minimum population estimate

A maximum of 366 Wattled Cranes were recorded during the breeding and non-breeding seasons in 2017 (Table 1).

Common Crane

Distribution

Common Cranes were recorded in north-western Ethiopia, in the Lake Tana area, in central Ethiopia, in the Debre-Zeit area, and in the south-central Archuma wetlands, Chuche, Wanchicho and also Dalocha areas (Table 1). These sites were known roosting places, but it does not mean that Common Crane do not occur in other places. Because this species is migratory, large flocks occur in scattered locations given suitable

conditions. Common Cranes can also be found on the Sululta plain and at the Akaki Aba-Samuel reservoir near Addis Ababa.

Minimum population estimate

The migratory population of Common Cranes in Ethiopia has been estimated at 67 150 in 2014 (Nowald *et al*. 2014). During our survey in 2015, 70 000 were estimated, which nearly matches the estimate of Nowald *et al*. (2014) using the same flock-counting method. In the Lake Tana area, 20 000 or more cranes have been counted regularly since 2009. But more recently their numbers at Lake Tana have significantly reduced (n = 10 309 in 2019) due to intensive agriculture/irrigation and invasive species (SAZ pers. obs.).

Demoiselle Crane

Distribution

Ash & Atkins (2009) reported the occurrence of this species in three places, including Lake Tana, Gallabat, and Aseita, but at other sites its occurrence was uncertain. However, during the study period, Demoiselle Cranes were restricted mostly to the northwestern corner of Ethiopia as passage migrants. This species was not recorded at any survey site outside of this area. The occurrence of this species in Kafta Sheraro National Park (Tekeze River) was only confirmed by the study team in 2011, although the population found was small.

Minimum population estimate

During our surveys, only three Demoiselle Cranes were counted in Kafta-Sheraro National Park in February 2011. However, 21 500 Demoiselle Cranes were reported from this same area during February 2009 (Gebremedihin *et al*. 2009). We therefore used the record of Gebremedihin *et al*. (2009) as our minimum population estimate for this migratory species.

Table 1. Exact counts of Black-crowned (BCC) and Wattled Crane (WC), and estimates of Common (CC) and Demoiselle (DC) Cranes from survey sites in Ethiopia (2007–2019). Numbers in parentheses following the study sites refer to site locations on the map (Fig. 1). 'Others' refers to cranes opportunistically observed outside of the survey sites. Numbers in bold represent the highest annual count; x = no survey was conducted; 0 = survey was conducted, but no cranes were observed; [a]Nowald *et al*. 2014; [b]NABU crane report, 2019; [c]Gebremedhin *et al*. 2009; [d]Woldemariam *et al*. 2018.

Year	Species	Kafta-Sheraro NP (1)	Lake Tana area (2)	Boyo (3)	Chuche Wanchicho Dolocha Archuma (4)	Wondo genet (5)	Jimma wetlands (6)	Bonga area (7)	Bale Mountain NP (8)	Debre-Zeit area (9)	Gambela area (10)	Melka Wakena HP (11)	Others	Total
2007	BCC	x	1102	14	x	0	25	x	x	6	x	x	24	1171
2008	BCC	x	572	x	x	x	x	x	x	x	x	x	x	572
2009	BCC	x	1619	x	x	x	x	x	x	x	x	x	x	1619
2011	BCC	x	496	x		x	x	x	x	x	x	x	x	496
2012	BCC	0	1107	x	20	x	62	x	x	2	x	x	x	1245
2013	BCC	x	x	x	x	x	315	x	x	x	x	x	x	315
2014	BCC	x	890	x	x	x	412	x	x	x	x	x	x	1302
2015	BCC	x	650	65	0	x	214	0	x	4	x	x	x	933
2017	BCC	x	932	x	x	x	433	27[d]	x	x	x	x	x	1392
2019	BCC	x	1245[b]	11	0	x	179	X	0	4	1880	0	0	3319
2007	WC	x	5	56	17	1	x	x	x	0	x	x	4	83
2008	WC	x	12	x	x	x	x	x	x	x	x	x	x	12
2009	WC	x	27	x	x	x	x	x	x	x	x	x	x	27
2011	WC	0	26	x	54	x	x	x	x	x	x	x	x	80
2012	WC	0	30	163	21	x	4	x	x	0	x	x	x	218
2013	WC	x	x	x	x	x	19	x	x	x	x	x	x	19
2014	WC	x	30	x	x	x	28	x	x	x	x	x	x	58
2015	WC	x	18	132	23	x	18	1	x	x	x	x	x	192
2017	WC	x	10	78	72	x	28	9[d]	x	x	x	169	x	366
2019	WC	x	12[b]	151	0	x	4	x	0	0	0	136	0	303
2007	CC	x	3807	27	9600	0	x	x	x	34750	x	x	5066	53250
2008	CC	x	305	x	x	x	x	x	x	x	x	x	x	305

Year	Species	Kafta-Sheraro NP (1)	Lake Tana area (2)	Boyo (3)	Chuche Wanchicho Dolocha Archuma (4)	Wondo genet (5)	Jimma wetlands (6)	Bonga area (7)	Bale Mountain NP (8)	Debre-Zeit area (9)	Gambela area (10)	Melka Wakena HP (11)	Others	Total
2009	CC	x	21508	x	9500	x	x	x	x	28000	x	x	x	59008
2011	CC	0	22000	x	14100	x	x	x	x	9350	x	x	16720	62170
2012	CC	0	10000	x		x	0	x	x	10000	x	x	x	20000
2013	CC	x	30000	x	7800	x	x	x	x	12450	x	x	16900	67150[a]
2014	CC	x	0	x	x	x	x	x	x	x	x	x	x	0
2015	CC	x	30000	1000	15000	x	x	x	x	10000	x	x	14000	70000
2019	CC	x	10319[b]	x	x	x	x	x	x	x	x	x	0	10319
2009	DC	x	0	x	x	x	x	x	x	x	x	x	x	21500[c]
2010	DC	x	0	0		0	0	0	0	0	x	x	0	3

Nesting sites of Black-crowned and Wattled Cranes

During our surveys, most of the breeding sites for both Black-crowned and Wattled Cranes occurred in the Lake Tana area in northwestern Ethiopia. For Black-crowned Cranes in the Jimma wetlands, a total of seven and nine juveniles were recorded in 2014 and 2015, respectively.

Wattled Crane nests were found in the Lake Tana area, Jimma wetlands, and in Bale Mountain National Park. During the first week of February 2012, we found four breeding pairs of Wattled Cranes, each with a single pre-fledged juvenile, and 10 non-breeding birds in Chimba, Lake Tana area. The pre-fledged juveniles were about two-weeks old. An additional two pre-fledged birds were also recorded at the end of February of the same year. In Jimma, one pre-fledged juvenile, one sub-adult (both in February 2014), and a fledged juvenile (2015) were recorded. However, in Boyo four fledged juveniles were also recorded in 2012 (Feb), and another four fledged juveniles were recorded in mid-2016 (Jun). In February 2016, one pair with a pre-fledged juvenile was also recorded in the Bale Mountain National Park. In this park, during a nesting study by Hadis (2018), a total of six chicks were recorded in 2015 (n = 2), 2016 (n = 3) and 2017 (n = 1).

Crane habitats and threats

The habitats, and their threats are summarized in Table 2. None of the sites, even National Parks, are fully protected, and they suffer from agricultural encroachment, drainage for irrigation, infestations of invasive plant species, as well as other threats. Some roosting sites, such as Cheleleka around Debre-Zeit, are being converted into agricultural land. The central Rift Valley areas such as Chuche, Wanchico and Archuma wetlands, water is being drained for agricultural purposes. The occurrence of water hyacinth *Eichhornia crassipes* in the Lake Tana area is an increasing threat to the Common Crane roosting site, because the plant impedes movement, the cranes are forced to use only shallow water areas without hyacinth for roosting. The hyacinth at Lake Tana is expanding at an alarming rate.

Table 2. Habitat type and threats observed during 2007–2019.

Region	Study sites	Habitat type	Threats	Species	Use
North-west	Lake Tana	Lake	Siltation and water hyacinth infestation	BCC, WC	Breeding & Non-Br
North-west	Chimba and Yiganda	Wetland	Overgrazing and agricultural encroachment	BCC, WC	Breeding & Non-Br
North-west	Dirma	Wetland	Invasion by water hyacinth, siltation, overgrazing	BCC	Breeding & Non-Br
North-west	Shesher and Wallala	Floodplain	Agricultural encroachment, sequential farming and draining	CC, BCC	Non-breeding
North-west	Kafta-Sheraro National Park	Acacia woodland	Agricultural encroachment	DC	Non-breeding
Central	Cheleleka	Lake	Irrigation (water draining), pollution by agricultural pesticides, and domestic waste dumping	BCC, CC	Non-breeding
South-central	Chuche	Floodplain	Water draining, siltation, invasive weeds	BC, CC	Non-breeding
South-central	Wanchicho	Floodplain	Water draining, siltation, invasive weeds	BC, CC	Non-breeding
South-central	Archuma	Floodplain	Water draining, siltation, invasive weeds	BC, CC	Non-breeding
South-central	Boyo	Wetland	Irrigation, overgrazing, siltation and invasive species	WC, CC, BCC	Non-breeding
South-west	Cheleleki	Wetland	Overgrazing	BCC, WC	Breeding site
South-west	Boye complex	Wetland	Overgrazing and conversion	BCC, WC	Breeding site
South-west	Bonga area	Wetland	Wetland loss and degradation	WC	Non-breeding
South-west	Gambela	Wetland	No threat	BCC	Breeding
South-east	Bale Mountain National Park	Afro-alpine	Overgrazing and agricultural encroachment	WC	Breeding
South-east	Melka Wakena HP reservoir	Reservoir	No threat	WC	Non-breeding

Discussion

Black-crowned Crane

Substantial numbers of Black-crowned Crane occur in Ethiopia, including an estimated 1000 around Lake Tana and at least 100 in Ethiopia's southern Rift Valley (Williams *et al*. 2003, Beilfuss *et al*. 2007). Our survey estimates show that the population of Black-crowned Crane in Ethiopia is more than reported thus far and that the Gambela and Lake Tana areas hold the largest populations. The Lake Tana population has been surveyed in numerous years and our results agree with the Crane Monitoring Group's report in 2007 (Nowald *et al*. 2007). More studies are still needed to fully assess the Gambela population. We suspect the population estimate for this region may be higher because previous estimates during 2014 and 2019 counted more than 400 cranes each year. These results were not included in our minimum population estimate to avoid the possibility of double-counting with the Gambela population. Therefore, future surveys should aim to count these two populations on the same day. Black-crowned Cranes were often found nesting in smaller wetlands than Wattled Cranes, except in the Bale Mountain National Park.

Wattled Cranes

This species has a large distribution range and occurs in different habitats across the country (Urban & Walkinshaw 1967). However, within this range, the species is restricted to particular sites. Previous studies reported 62 Wattled Cranes at Boyo wetland (Yilma 1998). In 2012, however, 163 were recorded, the largest number of this species recorded in Boyo during our survey. Previous reports suggested that the Ethiopian population is less than 200 (Beilfuss *et al*. 2007). More recently, in 2017, 319 individuals were recorded in the central Rift Valley area and 28 were recorded in the Jimma area (Aticho *et al.* 2018, Haddis 2018). During this study, 366 Wattled Cranes were counted in 2017, which includes data from the Bonga area (Woldemariam *et al*. 2018). This indicates that the population of Wattled Cranes in Ethiopia could be estimated at more than 366 if other sites that were not visited are included. Our data suggest that Lake Tana could be the most important nesting site for Wattled Cranes in Ethiopia because breeding was recorded during all years when surveys were conducted.

Common Cranes

The majority of Common Cranes remain in Ethiopia from October to March, but some stay until April and mid-May (Nowald *et al*. 2010). They are mainly found in the western highlands and frequently in the Rift Valley areas (northwestern and central Ethiopia). Nowald *et al*. (2010) suggested that this species could be found throughout the country except in the very dry northeast. However, the occurrence of this species is highly associated with the presence of suitable feeding grounds and roosting sites. A similar ecological survey suggested that Common Cranes preferred aquatic ecosystems of the larger freshwater lakes and rivers, highland streams and marshes, and the species feeds in grasslands, including the highland acacia grasslands, short savannah grassland, and semi-desert savannah as well as agricultural land (Yohannes 1996, Nowald *et al*. 2014, Aynalem *et al*. 2011).

Demoiselle Cranes

A survey of Demoiselle Cranes recorded 21 500 cranes in 2009 in Kafta-Sheraro National Park (Gebremedihin *et al.* 2009). Although supposedly a passage migrant, local communities have reported that Demoiselle Cranes do overwinter in the area between December and April. Our survey conducted in the first week of February 2011, however, recorded a much lower number, which suggests that further research is needed to understand the ecology of the species in Ethiopia in general and in Kafta-Sheraro National Park in particular.

Breeding sites

Breeding sites of cranes could not be found everywhere because the suitability of nesting sites is determined by the presence or absence of disturbance, adequate water levels, and other factors that influence nest site selection criteria. Several authors have reported that cranes nest where the risk of predation is minimal (Archibald & Meine 1996, Claire *et al*. 1996, Bento *et al*. 2007, Sundar 2009).

Threats

Globally, freshwater ecosystems have been altered by human disturbance, such as agriculture, urban development, impoundment, channelization, mining, road construction, and species introduction (LaBonte *et al*. 2001). This has led to severe deg-

radation and loss of biodiversity (Vinson & Hawkins, 1998) and as a result, these ecosystems have become one of the most endangered on the planet (Dudgeon *et al*. 2006).

All of the wetland habitats where cranes are found in Ethiopia are unprotected, including biosphere reserves, except for the Bale Mountain National Park, which is legally protected and currently under consideration to be listed as a World Heritage site. The main threats to wetlands are overgrazing, water extraction for irrigation, siltation, and sequential farming (Aynalem *et al*. 2011, Mekonnen & Aticho, 2011, Aynalem 2017, Aticho *et al.* 2018, Hadis 2018).

Lake Cheleleka, the Boyo wetland, and the floodplains of Archuma, Chuche, and Wanchicho are areas with high human population densities and thus the threats to cranes in these areas are directly related to competition for resources, with irrigation and overgrazing being the primary threats. The early arrival of Common Cranes causes considerable crop damage because the duration of their stay is longer and leads to prolonged damage (Nowald *et al*. 2014, Hadis 2018). This situation could become a growing challenge. Cattle grazing also directly affect *Eleocharis* spp. that is food sources for Wattled Cranes mainly in the Boyo area. In this area, poor land management and water drainage for agricultural purposes is an increasing challenge. Agricultural development is being practised without caution and this activity is destroying the breeding sites for cranes. Local people are diverting the natural water flow to cultivate crops and vegetables. Rapid sedimentation resulting from severe soil erosion in the surrounding uplands also affects the hydrological regime because it speeds up drying and destroys the vegetation, particularly herbaceous macrophytes. Emphasis should be given to save the remaining wetlands through various site-relevant interventions.

The main features of the nesting behaviour of cranes are generally similar in all species, except for Blue Crane *Anthropoides paradiseus* and Demoiselle Crane, 13 species build nests in shallow wetlands with low emergent vegetation (Johnsgard 1983). However, across Ethiopia the breeding and wintering sites of cranes are under continuous threat (Aynalem 2017, Aynalem *et al*. 2017). Further, deliberate nest site destruction, killing for bushmeat, or poaching cranes for illegal trade, are not common in Ethiopia (Zelelew 2013). The culture and religious taboos of the country play a significant role in protecting wild birds directly, but do not prevent habitat destruction.

Some farmers have shown an interest in killing or scaring cranes to protect their crops from damage. At all study sites, Wattled Cranes are perceived as crop pests by farmers. Similarly, in the Lake Tana area, Black-crowned Cranes consume local crops like tef *Eragrostis tef*, finger millet *Eleusine coracana*, and rice and as a result farmers want to get rid of cranes in the area (Aynalem *et al*. 2011). The same is true in Boyo, where Wattled Cranes cause extensive damage by foraging on germinating maize seeds, and the mature crops of wheat and tef.

In conclusion, minimum population estimates of cranes during our survey (2007–2019) were estimated at 3319 Black-crowned Cranes, 366 Wattled Cranes, 70 000 Common Cranes, and 21 500 Demoiselle Cranes. Although our surveys suggested an increase in crane populations in Ethiopia, we suspect that the increase was due to improved and more frequent surveys.

Based on the occurrence of cranes, there are key sites identified during our survey that we recommend should be protected or otherwise sustainably managed. The Gambela area wetlands, the Lake Tana wetlands (Chimba and Yiganda in particular),

and the Boyo and Jimma wetlands are key sites for crane conservation. In addition, Cheleleka, in the Debre-Zeit area, the Sululta plain around Addis Ababa, and the Shesher floodplain in Lake Tana are important roosting sites for Common Cranes.

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