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Cover: *Euphaea pseudodispar* shot at Kalindi River, Thirunelly, Wayanad district, Kerala. © Muneer P.K.

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COMMUNICATION

Population and distribution of Wattled Crane *Bugeranus carunculatus*, Gmelin, 1989 at lake Tana area, Ethiopia

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Abstract: The Wattled Crane is listed as Vulnerable on the IUCN Red List, and isolated population occurs in Ethiopia. This study was conducted in Chimba wetlands, Lake Tana area from October–2013 to December–2014. The objectives were to understand the distribution and population status of the Wattled crane and assess the vegetation characteristics and threats of the ecological units. The population size and density of cranes in the study area was determined from weekly counts carried out in equal-sized sampling units. The total survey area was divided into square grids, and each of them was 1.23 square km wide/size. A total of 10 grid squares, which have an area of 12.32 square km were considered for density analysis. Although the total area of the study was 208.2 km^2, unsuitable habitats, such as forest or farmlands were excluded. Counts of cranes were made at known sites. The density was calculated as the average number of cranes counted per unit area. A total of 32 cranes were recorded. The density of cranes in the study area is 2.6 per km^2. Cranes were located in Addis Amba, Dehena Mesenta, Latamba, and Legdia local administrative areas. The number recorded in each area varied, the largest (17) was recorded in Latamba Kebele and the fewest (2) in Legdia. The dominant vegetation type of Chimba wetlands is emergent macrophyte. However, the papyrus bed represents about 10% of the wetland. Species of vegetation other than papyrus bed is represented by a 20 quadrat study. A total of 26 macrophyte species belonging to 10 families were recorded. Intensive cultivation, draining of the wetland, habitat degradation, overgrazing of the wetland, overharvesting of papyrus, invasive species, and over-flooding are the major threats of wetlands.

Keywords: Blue Nile, conservation, density, ecological units, egg, habitat destruction, macrophytes, nesting site, threats, wetlands.

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Author contributions: The authors have conducted the project and collected data in the field at various times. Both authors have participated in organizing and analyzing the data. The second author participated in shaping and commenting the manuscript while the first author write the draft paper.

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INTRODUCTION

Cranes (family Gruidae) are among the world's most threatened birds. Of the six species occurring in Africa, Wattled Cranes are listed as 'Vulnerable' on the IUCN Red List. Isolated populations occur in Ethiopia and South Africa, which are not considered different subspecies (Beilfuss et al. 2007; BirdLife International 2020). Wattled Cranes range across 11 countries from Ethiopia to South Africa, the majority occurring in the extensive flood plain systems of southern Africa's large river delta (especially the Kafue, Okavango, and Zambezi). They are also found in smaller wetlands throughout their range.

The status and distribution of the Wattled Crane is of particular conservation concern because of the species' life history traits (e.g., delayed sexual maturity and low reproductive output) and specialized habitat requirements (Johnsgard 1983). Wattled Cranes are the most wetland-dependent of all Africa's cranes (Meine & Archibald 1996). When hydrological conditions are not satisfactory at a particular location due to drought, flooding, or inappropriate water management, most Wattled Cranes fail to initiate nesting (Douthwaite 1974; Konrad 1981). The availability of the Wattled Crane's main food source, underground tubers of spike rushes (*Eleocharis* spp.), water lilies (*Nymphaea* spp.) and various sedge species (especially *Cyperus* spp.), is also negatively affected by disruption in the regular annual cycle of flooding and drying (Beilfuss 2000).

Three populations of the Wattled Crane are recognized. The core population occurs in southern central Africa on the primary floodplains and dambos of the upper Congo, Zambezi, and Okavango river basins. More isolated populations occur in Ethiopia and South Africa, with the Ethiopian population likely to be a distinct subspecies (Jones 2003). However, this isolated population presently is not considered as a separate subspecies (Beilfuss et al. 2007).

The total population of the species was 13,000–15,000 in 1974–1994. However, it declined to 8,000 in 2004, with the highest population residing in Zambia (4,500). The population and distribution of Wattled Cranes in Ethiopia is poorly known. A survey report in 2004 estimated less than 200 birds (Beilfuss et al. 2007). However, a recent survey in 2017 suggested that a total of 366 were recorded because additional survey sites were added (Zelelew et al. 2020).

The three species of cranes found in Ethiopia; Wattled Crane, Eurasian Crane and the Black Crowned Crane occur in different sites of the Lake area (Francis & Aynalem 2007; Aynalem et al. 2011). Wetlands of Chimba, Yiganda, Gorgora and the Fogera wetland plain are the major locations for the cranes. Past records show that the Wattled Cranes occurred over a large range and different habitats in Ethiopia (Urban & Walkinshaw 1967). However, recent studies showed that they are distributed in the central, southern, and northwestern parts of the country (Zelelew et al. 2020). Chimba wetlands are the breeding grounds of the Wattled Crane (Aynalem et al. 2011). Although these sites are known for breeding and foraging, total population estimate of the species is still not known. Therefore, baseline information on the distribution, population of the species, the vegetation characteristics of the wetlands, and threats to the species can provide a starting point for future monitoring, conservation planning, and developing management intervention. Therefore, the objectives of this study were to determine the distribution, population estimate, and assess the vegetation characteristics of the wetlands, and the threats of ecological unit conservation targets.

MATERIALS AND METHODS

Study area

The study was conducted in the lake Tana area of Ethiopia. The southwestern part of the lake, particularly the wetlands situated along the Gilgel Abay River, was the main focus of the study (Figure 1). Lake Tana is the largest lake in Ethiopia, ca. 68 km wide and ca. 73 km long, and is the source of the Blue Nile. About 83 wetland bird species have been recorded here and their total population around Lake Tana is likely to exceed 100,000 individuals seasonally (Francis & Aynalem 2007).

Chimba wetlands are situated along the Gilgel Abay River. It is bounded by 13 local administrative Kebeles (small districts that have at least 2,000 households), whereas the wetland itself covers four Kebeles: Latamba, Legdia, Addis Amba, Dehena, and Mesenta. Seasonal flooding occurs during the rainy season, June–September. Conventional farming is practiced in the area. Chimba wetlands harbor an enormous number of resident and migratory bird populations. It is home to the largest Black Crowned Crane population of Ethiopia next to the Gambela wetland flood plains (Zelelew et al. 2020). It is also the only place where extensive papyrus beds remain in the Lake Tana area.

The study area is situated within the temperate, cool sub-humid highland agro-ecological zone (Sime & Solomon 2017). The elevation of Chimba wetland area varies from 1,790–1,812 m. The mean annual rainfall at

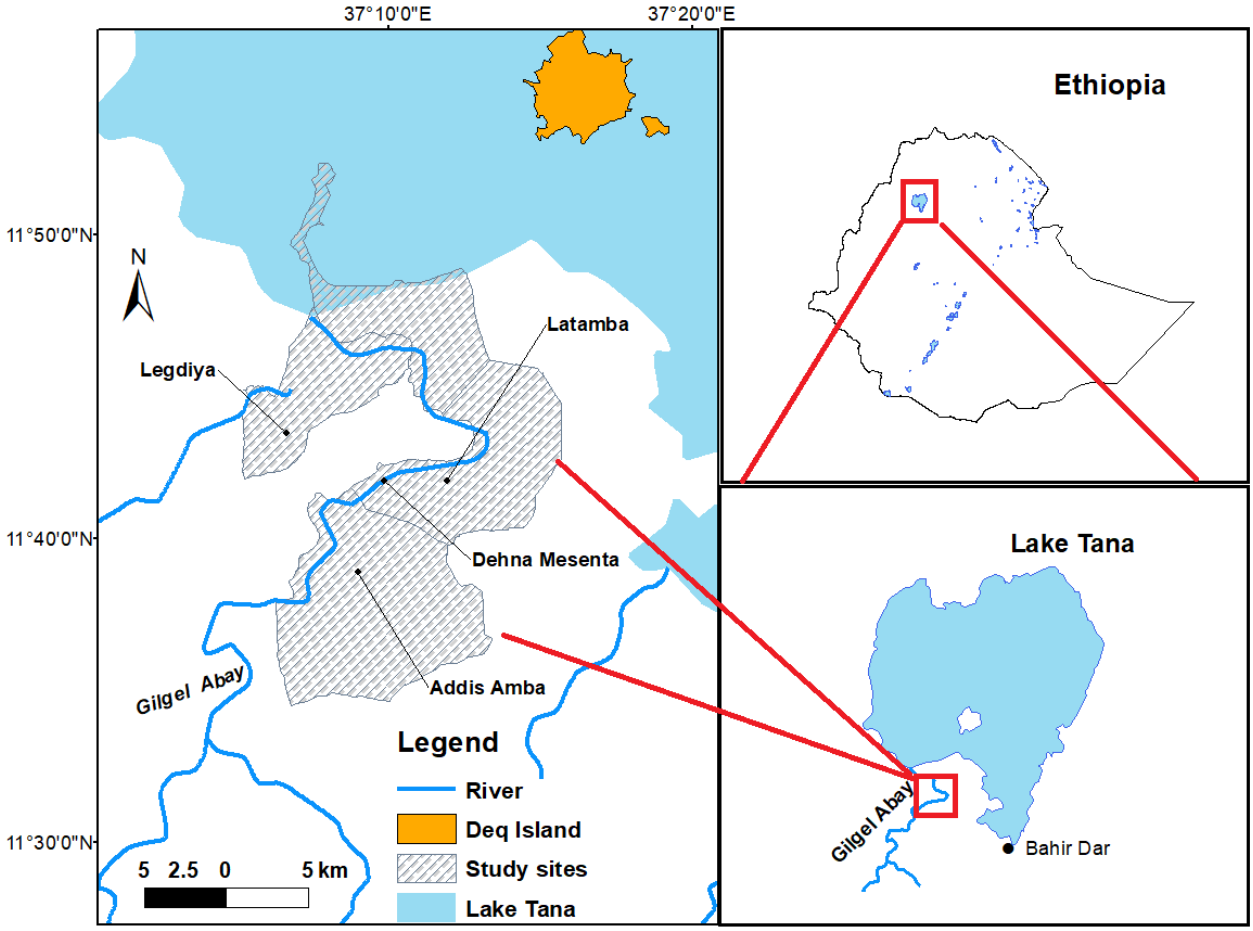

Figure 1. Study area, Chimba wetlands, and southwestern parts of Lake Tana.

Bahir Dar station is 1,439 mm. The rainfall in the area has a unimodal peak extending from May–October followed by the dry season from November–April. Ninety five percent of the annual rainfall occurs during the wet season (May–October).

The geographical coordinates where Wattled Crane occurs was recorded and mapped using ArcGIS 9.3 Software to show where the species are concentrating. Single species count method was employed. The typical feature of the habitat was determined (Bibby et al. 1992; Sutherland 1996; Lloyd et al. 1998).

Distribution and population

The population size and density of cranes in Lake Tana area was assessed from 10 October 2013 to 30 December 2014. The study area was divided into 1.23 km squares based on the size of the wetland and transferred to a GIS map during field work. Weekly counts of cranes were made in 10 grid squares selected systemically where cranes reside (Krebs 1978).

Search for cranes started from 0800 h up to 1800 h since the survey area was spread out and inaccessible. Ground surveys were done by walking and a car was used to reach the study areas.

Breeding pairs (territorial pairs) and non-breeding ones (in this case family groups) were searched for by a person walking along the edge of the wetland and stopping frequently to scan using binoculars and spotting scope for birds. When nests were encountered the distance from the observer and the approximate coordinates of the nests were recorded by indicating the position relative to the grid map. Additional information such as crane roosting site, foraging places, nesting sites and any local movement of cranes from the local people was recorded while surveying the birds.

The population size and density of cranes in the study area was determined from weekly counts carried out in equal-sized sampling units as described by Joly (1969). These sampling units using *x* and *y* coordinates a 'go to' function in the GPS was practiced in the field to find the exact place. A total sampled area of 12.32 km^2 where cranes occur was considered. However, the total area of

the study was 208.2 km^2. Areas that were covered by unsuitable habitat, such as forest or farm land, were excluded. Counts of cranes were made at known sites.

The population density (R, birds/square km), was estimated using the following equation,

$$R = \sum y / \sum z$$

where, *y* is the number of birds in a quadrat and *z* is the area of the quadrat. The population size (Y) for each survey period was calculated from the average number of birds counted in each quadrat.

Vegetation

Macrophytes were collected at each sampling site using one by one meter quadrat sampling method. A total of 20 quadrats were collected. The quadrats were laid along a diagonal line with an interval of 50 m. Papyrus were excluded for sampling since the vegetation cover is distinct and known (10% cover). The collected unknown specimens were identified to the species or genus level at the Addis Ababa University Herbarium. The proportion of macrophyte cover per sampled area was estimated.

Materials

Observations were carried out with the aid of Nikon 12 x 25 © binoculars and 20–60x Swarovski Telescope. GPS eTrex® model 2004 was used to apply 'Go to' function, which was used to find the specified selected quadrat, and also to limit the transect length. Grid map was used during the actual field work. Sony '16' optical lens digital camera and Leica professional camera were utilized to take pictures of the habitat components, features, and the macrophytes.

Threats

Threat types for each ecological unit were listed out during field observation. Then each threat type was evaluated based on their "severity" and "scope", and their conservation priority was also evaluated by "ranking" them as very high, high, medium and low. The ecological units' such as wetlands, indigenous trees, macrophytes, shrubs and some wild animals' were the conservation targets in the area. Their conservation status of these ecological units were evaluated based on the threat types that are listed out already. And hence to indicate the degree of threat severity, a "severity" index was assigned for each threat. A very high level was given for the total eliminated ecological unit in the area, high for seriously degraded, and medium for moderately degraded and low for slightly impaired ecological components. Whereas, for the "scope", which shows the extent of damage of the area, spatially: very high evaluation was given for 75% prevalence of the threat, high for 50–75 % widespread threats, medium for the threats that are localized in limited spots, and low for very localized spread. Based on this evaluation, a threat matrix table was developed to provide priority of management action to conserve which ecological unit.

RESULTS

Distribution and population

A total of 30 adults and two juvenile Wattled Cranes were recorded in the sampled area (Image 1). The density of Wattled Cranes in the study area is 2.6/ km^2.

Cranes were observed in four Kebele's areas (Legdia, Latamba, Dehena Mesenta, and Addis Amba). The number of Wattled Cranes recorded in each Kebele was: Addis Amba, five; Legdia, two; Dehena Mesenta, eight; and Latamba, 17. All places are nesting sites for the species. However, Latamba Kebele was a very important site for Wattled Crane nesting sites because the nesting area is larger than the others.

Lam Gebya, Basha Dangela at Latamba Kebele, and Addis Amba area are nesting sites that are far apart from each other. During the study period, two nests were identified. The nesting sites were located where disturbance from people were less. The average water depth where the nests are built was about 60 cm. The nesting materials were mainly sedge plants cut from the surrounding area. However, no chick was observed. But, for the first time, one egg that weighed 213.7 g was measured during October 2014.

Vegetation characteristics

The dominant vegetation type of Chimba wetlands are the emergent macrophytes and papyrus bed. A total of 26 macrophytes belonging to 10 families were recorded (Table 1). However, the major macrophytes were: *Cyperus rotundus, C. papyrus, Echinochloa colona, E. stagnina, Hygrophila schulli, Ipomoea aquatic, Leersia hexandra, Ludwigia stolonifera, Nymphaea nouchali, Oryza longistamina, Perscaria senegalensis, Potamogeton thunbergii*, and *Sacciolepis africana*.

The papyrus bed represents about 10% of the wetland area and is located around 'Achifi Gott' and 'Lamm Gebya' in Latamba Kebele and Dhana Mesenta area. The proportion of macrophytes other than papyrus was estimated in the sample quadrat (Figure 2).

Image 1. Sampled area Wattled Cranes in Chimba wetland. © Shimelis Aynalem Zelelew, 2014.

Table 1. List of macrophytes in Chimba wetlands (Local status), Lake Tana area, 2014.

Family	Species	Growth habit	Status	Remark
Acanthaceae	*Dyschoriste radicans* Nees	Herb	LC	Weed
	Dyschoriste sp.	Herb	LC	Weed
	Hygrophila schulli (Hamilt.) MR. & S.M. Almeida	Herb	LC	Weed
Ceratophyllaceae	*Ceratophyllum demersum*	Submerged		
Convolvulaceae	*Ipomoea aquatic* Forssk.	Emergent	LC	Aquatic floater
Cyperaceae	*Cyperus papyrus* L.	Aquatic	LC	Emergent
	Cyperus longus L.		LC	Emergent
	Cyperus macrostachyos	Sedge	LC	Emergent
	Cyperus dives		LC	Emergent
	Cyperus rotundus			
Menyanthaceae	*Nymphoides indica* (L.) O.Kunze	Water herb		Float leaves
	Nymphaea lotus	Water herb		Float leaves
	Nymphaea nouchali var. caerulea	Water herb		Float leaves
Onagraceae	*Ludwigia stolonifera* (Guilt L. & Perl'.) Raven	Creeper		Aquatic
	Ludwigia sp.			
Poaceae	*Hyperrhenia rufa* Staps	Grass	LC	Terrestrial
	Andropogon gayanus Kunth.	Grass		Terrestrial
	Snowdenia polystachya Pilg	Grass		
	Echinochloa colona (L.) Link	Aqu.Grass		Aquatic
	Echinochloa stagnina (Retz.) P. Beauv.	Aqu.Grass		Aquatic
	Leersia hexandra SW.	Aquatic		
	Sacciolepis africana CE. Hubb. & Snowden			
	Oryza longistaminata A. Chev. & Roehr.	Aquatic		
	Eleusine africana	Semi aquatic		Edge part of wetland
	Phragmites australis. (Cav.) Trin. ex Steud.	Aquatic		
Pollygonaceae	*Persicaria senegalensis* (Meisn.) Sojak	Aquatic	LC	Creeper
Potamogetonanceae	*Potamogeton thunbergii* Cham. & Schlecht.	Submerging		
Typhaceae	*Typha latifolia*	Aquatic		

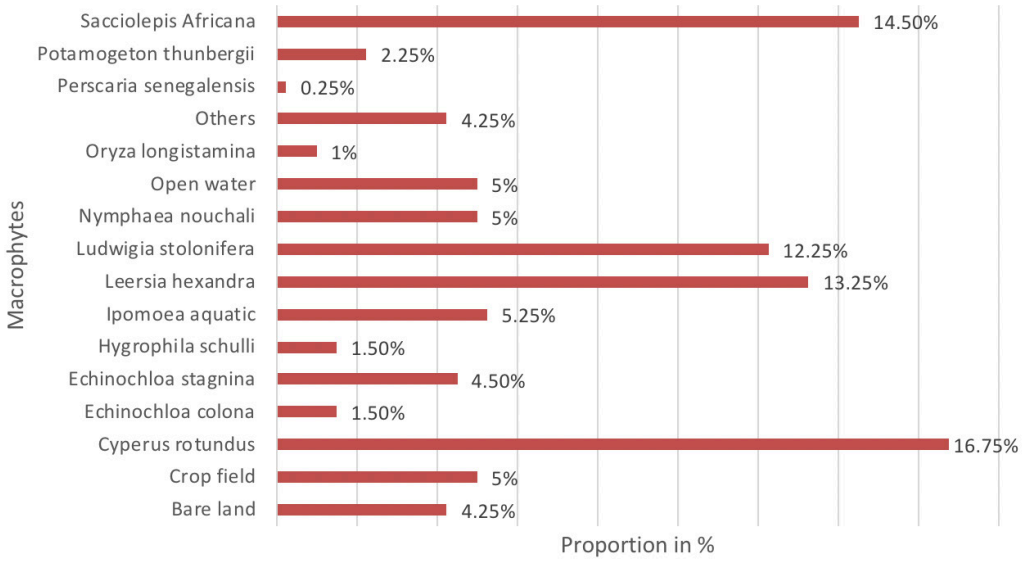

Figure 2. Relative proportion of macrophytes, except papyrus in Chimba wetlands, 2014

Image 2. Pumping water for Khat C. edulis cultivation at Chimba wetland Lam Gebya area. © Shimelis Aynalem Zelelew, 2013.

Ecological unit conservation targets threats

The ecological unit conservation targets were identified as: wetlands, riverine habitat, indigenous trees (like fig trees, *Sezigum gunensie*, *Millettia ferruginea*, *Mimousops kummel*), macrophytes (like some of them C*yprus papyrus*), fishes, some primate species (Grivet Monkey and Common Baboons), mammals (Water Buck), birds (like cranes, water birds, passerine birds), and amphibians and reptiles (Table 2). The threats that are potentially of harm to these ecological units are listed out (Table 2).

As observed in the study area, water is drained for Khat *Catha edulis* cultivation (Image 2). Expansion of this activity has affected the wetland ecosystem as the wetland dries fast before the next rain. The presence of a large cattle population has also degraded the nesting sites of cranes. Bare land is created around the wetland (Image 3). The flood also results in sediment accumulation. This has affected Wattled Crane feeding and nesting sites. Some wetland vegetation is being rooted out due to intensive cultivation.

Seasonal flooding during the wet season and water shortage during the dry season and self-removal of wet biomass were observed. Overgrazing, wetland draining, habitat fragmentation, and farming have affected the natural ecological process, which have impacts on breeding and feeding sites of cranes. This creates competition for habitat, reduction of breeding grounds leading to decrease in the viable population, and ecosystem destruction. Encroachment of agriculture on wetlands and overgrazing have affected the papyrus bed that is important for breeding and feeding sites of birds, reptiles, amphibians, and fishes as well. Since the area is a communal land, there is no proper management activity.

Table 2. Ecological unit conservation targets, threat. and ecological levels.

	Ecological unit conservation targets	Threats	Severity	Scope	Ranking	Ecological level
1	Wetlands and Gilgel Abay riverine habitat	Habitat degradation	High	V. High	V. High	Ecosystem
		Draining of wetland	Medium	Low	Low	Ecosystem
		Over grazing	Medium	V. high	V. high	Ecosystem
		Cultivation and encroachment	Medium	High	High	Ecosystem
		Vegetation removal	High	Medium	high	Ecosystem
		Flooding	High	High	High	Ecosystem
		Invasive species	Medium	High	Medium	Ecosystem
2	Indigenous trees macrophyte and shrubs	Deforestation	High	V. High	V. High	Community
		Overgrazing	High	V. High	V. High	Community
		Agriculture encroachment	High	V. High	V. High	Community
		Sedimentation	High	Medium	High	Community
		Invasive species	Medium	Medium	Medium	Community
3	Fig trees, *Sezigum gunensie* , *Millettia ferruginea, Mimousops kummel* , *Cyprus papyrus*	Deforestation	V. High	V. High	V. High	Species
		Charcoal making	Medium	Medium	Medium	Species
		Construction	Medium	Low	Low	Species
		Lumber production	Medium	Low	Low	Species
		Burning (intentional)	Low	Low	Low	Species
4	Fish	Overfishing	Medium	Low	Low	Species
		Habitat loss	High	Low	Medium	Species
		Water Channelization	Medium	Low	Low	Species
		Wetland degradation	High	Medium	Medium	Species
5	Primate species Grivet Monkey and Common Baboons; Water Buck	Habitat degradation	V. High	V. High	V. High	Species
		Killing (to remove them)	Low	Low	Low	Species
		Grazing competition	Low	Low	Medium	Species
6	Birds (cranes, water birds, passerine birds)	Wetland degradation	High	V. High	V. High	Species
		Vegetation removal	High	High	V. High	Species
		Overgrazing	High	V. High	V. High	Species
		Breeding and feeding site loss	High	High	V. High	Species
7	Amphibians and reptiles	Wetland degradation	V. High	High	High	Species
		Killing (to remove them)	High	High	High	Species
		Food shortage	V. High	V. High	V. High	Species
		Breeding and feeding sites loss	V. High	V. High	V. High	Species
		Decreased water flow	Medium	Medium	High	Species

Image 3. Siltation after flooding in Chimba wetland adjacent to Gilgel Abay River. © Shimelis Aynalem Zelelew, 2013.

DISCUSSION

The occurrence of 32 individuals of Wattled Cranes showed that the population has increased compared to 27 recorded in 2009 (Aynalem et al. 2011). It could be even more since inaccessibility and the limited position available to view the majority area of the breeding wetlands could underestimate the number of breeding nests recorded and also the number of juveniles. In addition to this factor, delayed sexual maturity and low reproductive output and specialized habitat requirements could account for low number of population (Johnsgard 1983). Particularly, when hydrological conditions are not satisfactory at a particular location due to drought, flooding, or inappropriate water management, most Wattled Cranes fail to initiate nesting (Douthwaite 1974; Konrad 1981). The lack of availability of the Wattled Crane's main food source, underground tubers of spike rushes (*Eleocharis* spp.), water lilies (*Nymphaea* spp.), and various sedge species (especially *Cyperus* spp.), also affects the annual cycle of flooding and drying (Beilfuss 2000).

Wattled Cranes are distributed in the extensive wetland areas of Legdia, Latamba, Dehena Mesenta and Addis Amba Kebele. The distribution of cranes and the number of individuals/population is related to the presence of secure habitats, nesting and feeding sites. Several of the Wattled Cranes were located around their nesting sites because most cranes need undisturbed nesting sites, except the Indian Sarus Crane (*Grus antigone*), which is highly tolerant of human activity. Wild cranes generally nest in isolated places where the risk of predation is minimal (Archibald & Meine 1996; Claire et al. 1996; Bento et al. 2007; Sundra 2009); but studies carried out on nest success of Greater Sandhill Cranes at Malheur National Wildlife Refugia, Oregon showed that nest concealment has no relationship with nest success (Ivey 2007). However, in the breeding grounds of Wattled Crane at Lake Tana, nests were built in secure and inaccessible places. This kind of behavior accounted for fewer number of nesting sites at Chimba area though there is more than 208 ha of papyrus bed. Similarly, the breeding and nesting sites have been repeatedly used by the species since the beginning of 2008 at Lake Tana area (Aynalem et al. 2011). This indicates that Wattled Cranes are loyal to their nesting sites. Unless they are disturbed, nesting site consistency has been also reported by Bento et al. (2007) in the Marromeu complex of the Zambezi Delta.

Papyrus swamp is an important habitat supporting a wide diversity of species such as Sitatunga Antelope *Tragelaphus spekei* and African Python *Python sebae* (Aynalem & Mengitu 2017); several birds with restricted distribution, including the Papyrus Lesser Swamp Warbler *Acrocephalus glacilirostris* at Chimba wetlands. They provide breeding and feeding ground for numerous species of fish, and also grazing of large herbivores (Aynalem 2017).

The two major threats to wetlands in the area are habitat destruction through agricultural development and over-exploitation (Aynalem 2017). This has affected Wattled Crane feeding and nesting sites. Some wetland vegetation is being rooted out due to intensive cultivation, because private lands are not clearly demarcated from communal ones.

Apart from major biodiversity and ecological ecosystem services, a wide range of regulatory ecosystem services are provided by Papyrus swamps. The services include water, carbon and nitrogen cycles and buffering capacity for sediment and nutrient loads, as well as services of benefit to communities, including biofuel, drinking water, building materials, and flood control (Maltby 1986).

Seasonal flooding during the wet season and water shortages during the dry season and self-removal of wet biomass were observed. Overgrazing, wetland draining, habitat fragmentation, and farming have affected the natural ecological process. These practices have affected the breeding and feeding sites of cranes. This creates habitat competition, reduction of breeding grounds leading to decrease in viable population, and ecosystem destruction. Encroachment of agriculture on wetlands and overgrazing have affected the papyrus bed that is important for breeding and feeding sites of birds, reptiles, amphibians and fishes as well; this phenomenon was described in developing countries (Dugan 1990). Since the area is a communal land, there is no proper management activity.

Threats on the ecological setup of wetlands arose from two major directions. First, from natural processes, which could affect the normal functioning of natural processes derived from natural forces such as seasonal flooding during the wet season and water shortage during the dry season. This phenomenon is linked to the Inter Tropical Convergent Zone (ITCZ) location of the area (Mohamed et al. 2005). The ITCZ is characterized by a low-pressure zone at the meeting point between the dry northeasterly and moist southwesterly winds, and is the major reason for a rainfall season in the area. Bahir Dar annual rainfall records show there are pronounced periods of wetter and drier fluctuations. The early period (1966–1977) was comparatively

wet (average 1,661 mm), but this was followed by a dry period (1978–1987) with an annual average of 1,239 mm. The driest year in the record was 1983, with an annual rainfall of 895 mm. The wettest year was 1973, when the total rainfall was 2,036 mm. The mean and median of the annual series rainfall were 1,439 mm and 1,468 mm, respectively. Seventy percent of the annual rainfall was above 1,300 mm and 80% was above 1,200 mm. Self-removal of wet biomass could also account as a threat. Overgrazing, wetland draining, habitat fragmentation, and farming have also impacted the area. This phenomenon leads to competition, reduction of breeding grounds, and then decrease of viable population. In Chimba area, encroachment of agriculture on wetlands and overgrazing are affecting the papyrus bed.

Wattled Cranes are flagship species requiring extensive wetlands for feeding, breeding and resting. Chimba wetlands are the only areas that support these life processes for this globally threatened species. Since the area is free grazing land, community based sustainable utilization management must be implemented to save this threatened species and other life forms as well.

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