

Survey of Population Status and Distribution of Maccoa Duck, *Oxyura maccoa* in Kenya's Rift Valley and Central Wetlands

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ABSTRACT

Concerns about the declining population and change in distribution of Maccoa Duck's northern population and particularly in Kenya suggested that a survey was needed; however knowledge of the species threat status was also poor. A desktop survey of wetland sites where Maccoa Duck had been reported in the past was first done and later their location were identified using Google Earth. Other wetlands within the area of study with no historical records of Maccoa Duck but were thought to potentially harbour the species were also noted. We carried out fieldwork surveys between December 2014 and January to July 2015, where 79 wetland sites were visited. Fourteen of these wetlands had previous documented records of Maccoa Duck. A total of 14 individuals of Maccoa Duck were encountered in only 3 out of the 79 visited sites. Subsistence activities were singled out to be the greatest threat to wetlands within Maccoa Duck range. 83% had livestock grazing taking place within the wetland while 25.5% were being cultivated. Maccoa Duck showed no preference to small wetlands embedded within agricultural lands and neither was it clear whether the species preferred protected areas with large water masses because of the low count. This low population figure implies an increased conservation concern for Maccoa Duck among conservation agencies especially in light of habitat loss and degradation. Protecting and preserving habitats within the species range and educating local community on the plight of wetlands should also be of high priority.

Introduction

Maccoa Duck *Oxyura maccoa* is a naturally rare species endemic to Africa, with two populations occurring in two separate regions in the continent: northern population (Kenya, Eritrea, Ethiopia and Tanzania) and southern population (Angola, Botswana, Namibia, South Africa and Zimbabwe) (Berruti et al., 2007). The species has a small global population estimated at 9,000 – 11,750 (Berruti et al., 2007). According to Birdlife International (2012), Maccoa Duck's population is decreasing and its status is likely to be upgraded to vulnerable if the trend continues. In 2004, the species was categorized as Least concern only to be upgraded three years later (2007) to Near Threatened (Birdlife International, 2012), an indication of the rapid decline the species is experiencing. Moreover, it was listed as regionally Endangered in the East African Regional Red Data Book (Bennun and Njoroge, 1996) and is one of the priority species for conservation according to AEW (Berruti et al., 2007). An International Species Action Plan under the auspices of AEW was developed as a result of the rising concern of the decline of the species. In the last 10 years, the eastern Africa population (specifically Kenya and Tanzania) has declined by as much as 50% (Berruti et al, 2007). Due to its rarity and shyness, little attention has been given to Maccoa Duck in Kenya and most parts of Africa. Consequently, the probable reasons for the rapid decline of the Maccoa Duck population are poorly understood (Birdlife International, 2013).

Maccoa Duck prefers large and small permanent and temporary freshwater wetlands and alkaline wetlands (Birdlife International, 2012). When breeding, the species particularly prefers habitat with emergent vegetation for mounting nests. Even though the Kenya bi-annual waterfowl counts have recorded its presence in Rift valley (Lake Nakuru, Lake Naivasha, Lake Ol' Bolos sat and Lake Elementeita) and some small wetlands in Nairobi, other opportunistic observations confirms its presence in other small and unprotected ponds and swamps in Rift valley and Central Kenya with an altitude range of above 1500 meters above sea level not covered by the counts. Most of these small wetlands have never been surveyed. The population status, distribution and threats facing the species in these wetlands are scanty and have not been clearly documented. To obtain a basis for an effective conservation program for Maccoa Duck, there is need to survey both documented and undocumented wetland habitats for the species for its current range and population estimate.

Maccoa Duck Oxyura maccoa Survey - Rift Valley and Central Highland Wetlands, Kenya

The purpose of this study was to determine the current population status, distribution and threats of Maccoa Duck within the Rift Valley and Central highland wetlands of Kenya.



Photo 1: *Jane Dam, Molo Grasslands*

Study Area, Methods and Data Analysis

The study was conducted in the Rift Valley and Central highland wetlands of Kenya between December 2014 and January to July 2015. Before the start of the survey, data on the wetlands where the species had been previously recorded was collated particularly from the Kenya Birdfinder database (web-based bird mapping project), annual water fowl census and individual birders (mostly from the Ornithology Section of the National Museums of Kenya). Google Earth image (2014) of the study area was zoomed in to identify the location of these small wetlands and any other wetland (dams) within the study area. Due to the extent of the study area, the wetlands were classified into three regions (1. Mau-Nakuru Circuit, 2. Kinangop/Nyandarua-Naivasha region, and 3. Nairobi Circuit).

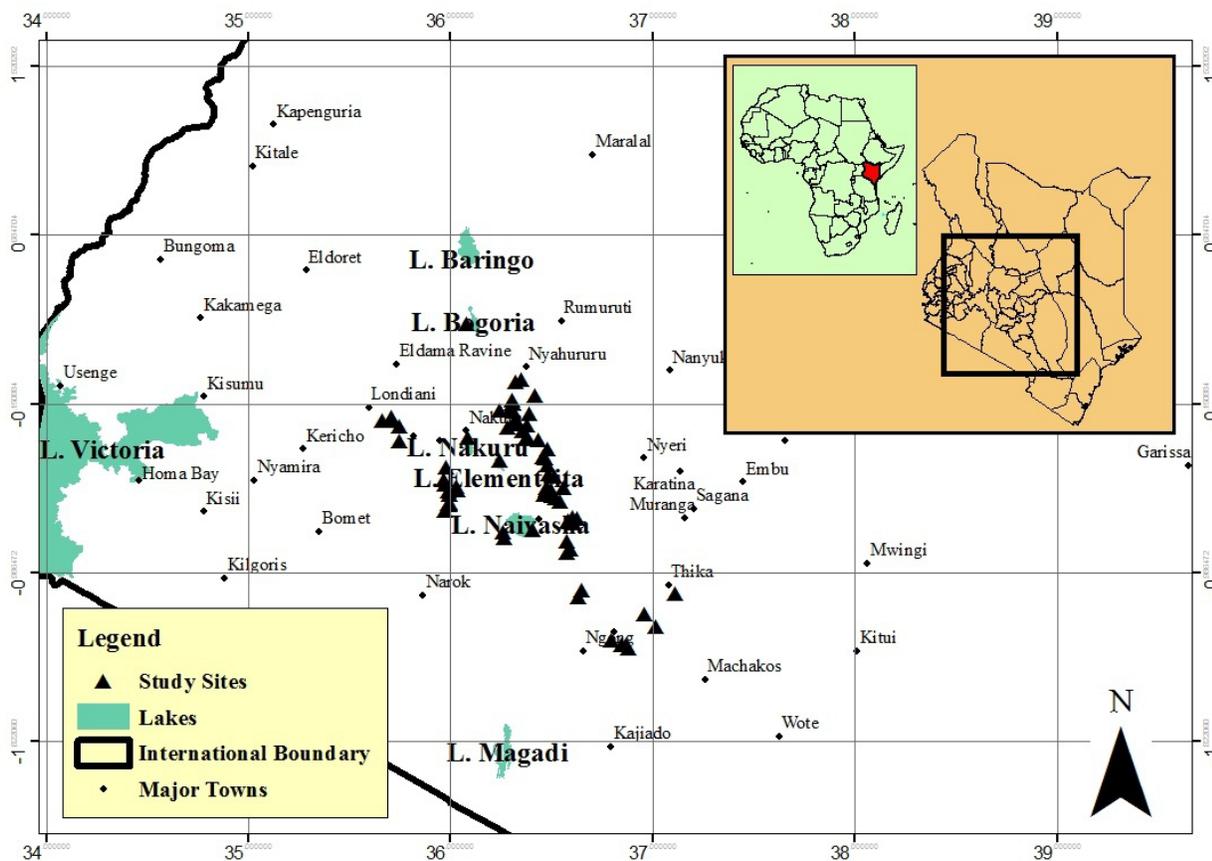


Figure 1: Distribution of wetland sites surveyed for Maccoa Duck in the period December- July 2014/2015

In each region, experienced local bird guides helped in locating wetlands which were not captured by Google Earth and would potentially harbor Maccoa Ducks. In the end 79 wetland sites were surveyed

which included 14 wetland where the Maccoa Duck had been previously recorded. Thirty of these small wetlands were within the Mau-Nakuru Circuit and were visited between 27th March and 16th April, 2015. Thirty three of the wetlands were within the Kinangop/Nyandarua-Naivasha region (visited between December 2014 and January 2015 while two of the wetlands sites within this circuit where Maccoa Duck had been recorded in the past were revisited (Lake Sonachi, Lake Oloidien) in July 2015. Within Nairobi Circuit, nine wetlands were visited between December 2014 and January-March 2015. Manguo Swamp (within Nairobi Circuit) where Maccoa Duck has persisted over the years was revisited at least three times between May and July 2015. Seven of the large Rift Valley Lakes (included in the 79 wetland sites) were visited during the annual waterfowl counts (January to February 2015). This includes Lakes Ol Bolossat , Elementeita, Oloidien , Naivasha, Nakuru Sonachi (Crater Lake) and Bogoria.

The initial visits of all the regions coincided with the end of the breeding season of Maccoa Duck noted in Brown & Briton (1980). Revisits in Lake Sonachi, Oloiden and Manguo swamp done between May and July 2015 fell within the past documented breeding season of Maccoa Duck in these regions.

Observations were made using 10x50 binoculars and telescopes at several vantage points (fixed point count) depending on the size of the wetland. In addition to bird counts, general notes were taken on the characteristics of the habitats and possible waterbirds threats, and several villagers were briefly interviewed about waterfowl threats at each locality. Locations were recorded to the nearest 10 meters using a Global positioning System (GPS, Garmin Extrex 20) and locality names were based on information from local bird guides, villagers and Google Earth. Where the local bird guides and villagers were not sure about the name of the dams, the wetland was given the name of the nearest local school or market place.

To comprehensively document the population and distribution of Maccoa Duck within the study area, records from other observers during the study period are included. To encourage and solicit data from other observers, an article seeking the information was published in January 2015, in the Nature Net (Nature Kenya's monthly newsletter), mainly targeting birders. The article described the purpose of the project and who to contact in case any Maccoa Duck sightings were made. In addition, an email bearing the same message was circulated to KenyabirdsNet which is a yahoo- Email forum where

Kenyan birders share their sightings. Local bird guides involved in this survey were also encouraged to monitor wetlands within their home area and report any Maccoa Duck presence in the course of the project period and in future.

To estimate current populations, we used individual numbers from direct counts within the small wetlands visited during this survey, number of Maccoa Ducks counted during the January- February annual waterfowl counts within the Rift Valley Lakes (L. Nakuru, L. Ol' Bolossat, L.Naivasha and L. Elementeita L. Oloidien and L. Sonachi) and any sightings reported by other observers. Global positioning system data were used for creating current distribution maps for Maccoa Duck in Arc GIS 10.1. Statistical analysis were done using SPSS Version 7 software. Threats to the wetlands were analyzed for the 72 small wetland within agricultural areas that were visited during this study. Threats to the seven large lakes visited during the Annual Waterfowl Counts in January, 2015 were not included in the statistical analysis.

Results

A total of 14 individuals of Maccoa Ducks were recorded in three sites between December 2014 and July 2015 (see table 1). An average of five individuals were recorded in Manguo Swamp (March and July 2015); Four at Lake Ol' Bolos sat (February 2015) and Five at Lake Sonachi (Crater Lake) in January and July 2015. Sixty Four percent (9/14) of the total number of Maccoa Ducks recorded during the study were found in protected wetlands (Lake Ol' Bolos sat and L. Sonachi). Of the three sites in which Maccoa Ducks were recorded, none of those were new- the duck had been recorded in all the sites before. Maccoa Duck was noted to be breeding at Lake Sonachi during a repeat survey in July 2015 (2 adults (male and female) and one juvenile were observed.

Locality Name	Latitudes	Longitude	Altitude (m.a.s.l)	No. of Birds	Conservation Status	Date Recorded
Manguo Swamp	-1.105948	36.634574	2277	5	NP	March 2015 (5 individual) May 2015 (5) July 2015 (5)
Lake Ol Bolossat	-0.109937	36.423205	2332	4	P	February 2015
Lake Sonachi (Crater Lake)	-0.782917	36.259914	1904	5	P	February 2015 (5) and July 2014 (3)

Table 1: Wetland sites where Maccoa Duck was recorded during this survey

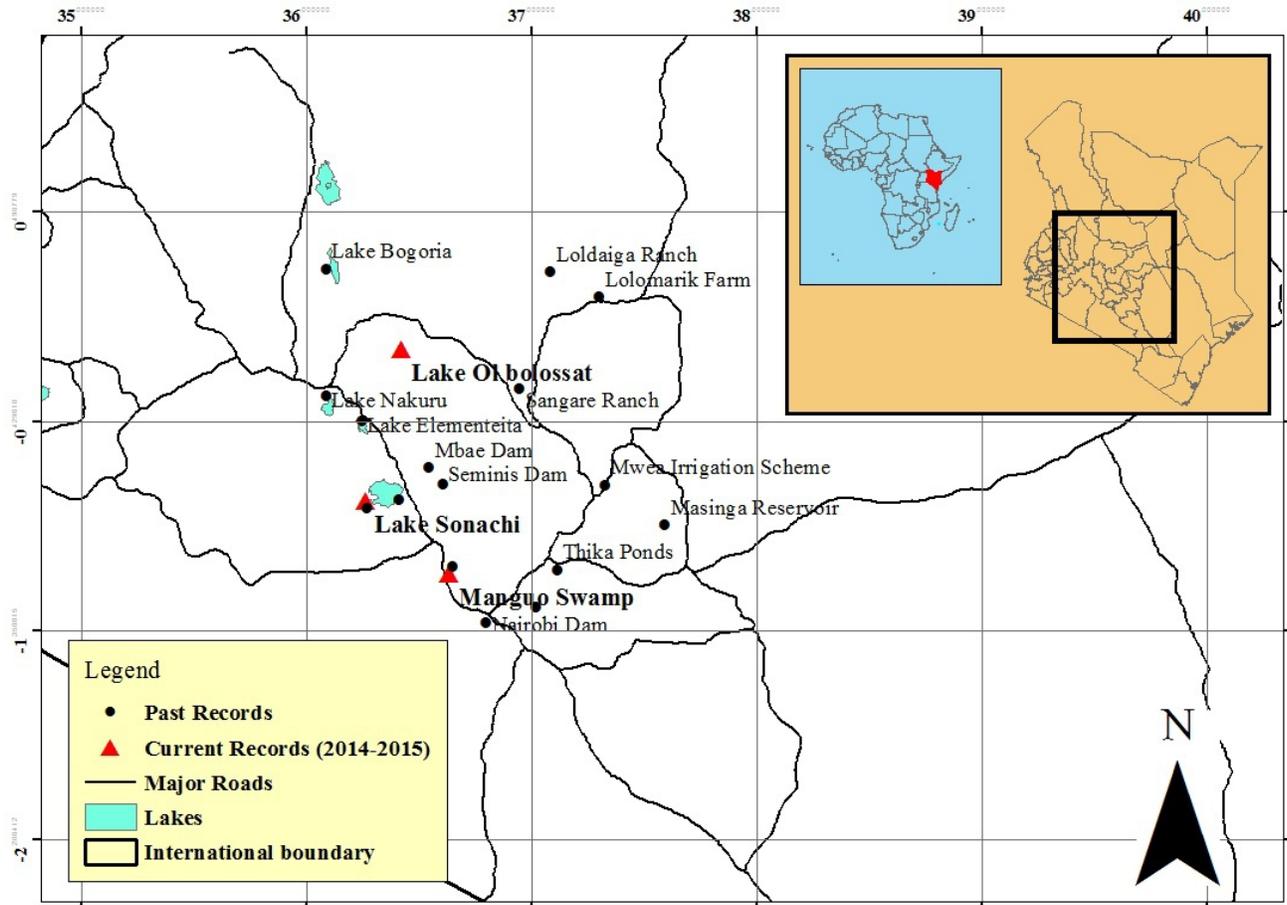


Figure 2: Distribution of wetlands where *Maccoa Duck* was recorded during this study (red triangles) and wetlands with past records (Pre-2014) and the species (black dots)

Threats and conservation challenges of the wetlands visited

It was obvious that during our study, most of the wetlands surveyed were experiencing serious environmental problems which would potentially influence the presence and survival of *Maccoa Duck* in them. Eighty two percent of the wetlands sites were unprotected; that is they were communally owned and had no limitation to wetland resource exploitation.

More than half (55.4%) (40/72) of the wetlands, were situated at a distance between 0.5 km to 1 km away from the farmlands. 33.8% (24/72) were less than 500 meters away from the farms. Only 9.7% (7/72) of the small wetlands were more than 1 km away from the farmlands. About two thirds of the wetlands visited 67.7% (49/72) were silted and had high turbidity (see figure 4). Notably, most of the dams within the Mau-Nakuru Circuit were being rehabilitated. The main rehabilitation activity being

removal of silt. At the time of the visits, few or no water birds were encountered within the circuit since the wetlands had been highly disturbed in the process of rehabilitation.



Photo 2: *Newly rehabilitated community dam in Molo Grasslands*

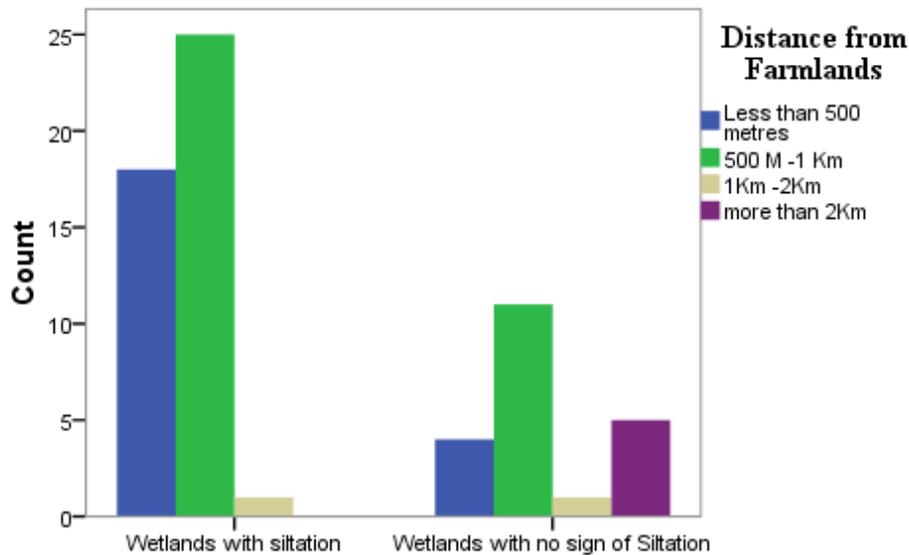


Figure 3: *Wetlands with and without siltation against the distance of the wetlands from farmlands*

Thirty (41.5%) out of the 72 small wetlands surveyed were severely eutrofied with hardly any open waters to support diving water birds

such as Maccoa Duck while 24.6% (18/72) and 33.8% (24/72) of the wetlands had moderate and negligible eutrophication respectively.



Photo 3: *One of the wetland site in Kinangop covered with algae blooms and hardly no open waters*

Eighteen (25.5% of 72) of the small wetlands had farming activities taking place within and around the wetlands. Eighty three percent (60/72) of the wetlands had evidence of livestock grazing within the riparian area of the wetlands. Animals found grazing included cows, sheep, goats and donkeys.



Photo 4: Sheep grazing at Seminis Dam (one of the wetland with past records of Maccoa Duck), South Kinangop

Forty three percent (31/72) of the dams had evidence of other human disturbance related to incompatible uses such as washing clothes and cars, waste disposal and harvesting of macrophytes, while 58% (42/72) of the dams had evidence of water abstraction for domestic use and irrigation.

Discussion

The results of this study affirm that Maccoa Duck is rare, sparsely distributed and confined to few wetlands within the highlands of Kenya than was previously thought. A total of 14 individuals of Maccoa Duck were recorded in three sites (Lake Ol Bolossat; Manguo Swamp and Lake Sonachi/ Crater Lake - see coordinates in Appendices 1) which is an alarming population decline as compared to the internationally known Maccoa Duck numbers of approximately 1000 individuals in Kenya (Berruti et.al 2007). This study failed to record Maccoa Ducks in some of its preferred sites e.g Lake Oloidien which at one point had a peak of 263 individuals in January 2003 (Owino, 2003), a time coinciding with our study period. However, it should be noted that Maccoa Duck makes local movements that may vary from year to year during the breeding and non-breeding seasons (Berruti et al , 2007), but,

little is known about these movements in Kenya and East Africa at large. Colahan (2005) suggests that Maccoa Duck may fly well up to 500Km. Given that the distance between Maccoa Duck's known range in Kenya and that of the species' population in Tanzania is about 500 km (estimation with Google Earth); it may seem logical to consider that the two countries might be sharing the same Maccoa Duck populations. If that is the case, this study may as well have taken place at a time when the ducks were in occurrence in other wetlands and presumably not in Kenya but elsewhere in East Africa and thus the low count.

It is also noteworthy that Maccoa Duck showed evidence of breeding at Lake Sonachi. During a repeat survey at Lake Sonachi in July 2015 two adults and one juvenile were encountered. Based on this survey; it was evident that there was an overall decrease in preferred wetlands for Maccoa Duck with no indication of preference of the duck to small dams within agricultural areas. According to past records of Maccoa Duck in Kenya, the species showed unbiased preference between protected and unprotected wetlands. This study could not determine the species current preference because the species was detected in only three sites out of 79 that were surveyed.

Wetland threats in relation to Maccoa Duck

Based on our study results it seems possible that the overall low count of Maccoa Duck within the study and subsequent absence of the duck in most of the wetlands visited within its known range are largely linked to the environmental condition of the wetlands. For example, more than half of the wetland sites visited were either severely eutrofied, with high turbidity and/or had incompatible land use activities linked to subsistence activities of local communities living around the wetlands. Crucially, eutrophication can negatively affect the Maccoa Duck particularly due to its feeding behavior. Maccoa Duck is a benthivorous duck that dives to feed on macro-invertebrate prey (also known as benthic invertebrates) in the water columns. Several studies have shown that eutrophication reduces benthic fauna's population and species abundance (Seitz et.al 2009; MacDonald 2006; Tománková 2013) which may in turn affect food availability for benthivores. Most of the wetlands (big or small) where Maccoa Duck has been recorded in Kenya are prone to commercial-fertilizer-induced eutrophication since they are sandwiched within agricultural potential areas. Both eutrophication and water turbidity are also known to affect the ability of diving water birds to get their prey as a result of reduced amount of open water and water transparency respectively.

Additionally, diminishing agricultural plots as a result of land subdivision to cater for the bulging population leaves no space for livestock grazing in the Kenyan highlands. Since agricultural practices within the highlands of Kenya are mainly mixed-small-scale farming (livestock keeping and crop cultivation), livestock are grazed on communal places such as road sides or wetlands. This explains why more than three quarters (83%) of the small wetland sites visited during this study had evidence of livestock grazing. The availability of suitable grounds to breed for Maccoa Duck is undermined by removal of emerged macrophytes through grazing and wetland cultivation. In addition, grazing in wetlands has the potential of interfering with breeding water birds through disturbance. Livestock in wetlands may trample on the wetland vegetation where wetland birds such as Maccoa Duck mount their nests and or cause immature abandonment of the brood. Wetland cultivation on the other hand reduces the size of the wetlands, interferes with the nutrient stability of the wetland through input of fertilizers and pesticides all which directly or indirectly affect the survival of water birds within the wetland.

Diving ducks have been found to be more intolerant of human disturbance than other water birds. As such, human presence is likely to impact on Maccoa Duck's behavior and habitat selection being one of the diving ducks. Further, human disturbance can cause water birds to expend more energy flying and spend less time feeding, reducing body condition and the ability to reproduce (Haramis et al. 1986). Repeated disturbance may even make the birds to shift distribution patterns, forage in less preferred habitats or emigrate (Schwemmer et al. 2011, Havera et al. 1992). For example, lack of Maccoa Ducks in Lake Naivasha and Oloiden, which otherwise have supported a good number in the past years, can be to some extent likened to the constant disturbance of engine boats used either for fishing or tourism. On the other hand, Maccoa Duck has persisted in Manguo Swamp over the years despite the wetland being a few meters from a busy Nairobi- Nakuru highway and Limuru road to the south. This only means there is still much to learn about the response of Maccoa Duck to human disturbance depending on the type of disturbance, condition of the impact area and other parameters.

In contrast, in some generally pristine areas such as Lake Nakuru, a state protected National Park and an internationally recognized Ramsar Site, and which was known to be Maccoa Duck's stronghold in Kenya (Lewis and Pomeroy 1989; Zimmerman et. al 1999), the species has not been recorded for a long period now (Annual Waterfowl Census, *in litt*). Last records of Maccoa Duck in lake Nakuru

during the Annual Waterfowl Counts was in January 2009 (Annual Waterfowl Counts, *in litt*). Water levels in Lake Nakuru have dropped and risen for the past couple of years probably due to climate change. In the process of the sporadic water levels the salinity of the water in the lake is disrupted therefore impacting on the invertebrates' composition and abundance and their availability to a diving benthivorous water bird such as Maccoa Duck. The influence of rising of water level can be even more complicated as it can lead to the disappearance of some microhabitats (emergent vegetation) important for Maccoa Duck breeding. Maccoa duck nests are built on wetland vegetation in deep waters (Tarbaton, 2001) and therefore are prone to flooding when water level rises.

Conservation Implication

Through this study it is evident that wetland degradation through subsistence farming (characterized by intensive small scale agriculture) is the biggest threat to Maccoa Duck survival in small wetlands within Rift valley and Central highlands of Kenya. Further, there is no clear legislation in Kenya that protects local wetlands and this exposes Maccoa Duck and other wetland species relying on local wetlands to eminent local extirpation or extinction. Normally, most local wetlands are communal and therefore reserved as government property under the local county council or central government. However, due to the weak government supervisory roles in such wetlands, there is free access to every member of the community leading to their continuous over-exploitation and degradation. Clearly, Maccoa Duck is becoming rarer within its range and even within its known stronghold the species is declining drastically. In Thika Sewage Ponds for example over 44 individuals were recorded during the January 2008 waterfowl counts (Annual Waterfowl Counts, *in litt*) but no Maccoa duck has been recorded ever since. This is the same case in Lake Nakuru which was once a stronghold and breeding ground for the duck. Given the current small numbers of Maccoa Duck individuals, and the lack of effective conservation measures of its preferred habitat in Kenya and perhaps the entire northern population, the population status of Maccoa Duck should be reviewed regularly by National legislators and by the IUCN to improve its protection status. Preserving suitable habitat throughout its range in Kenya should be the highest priority for conserving this species. Educating local people about the importance of wetlands and their preservation are critical for not only the survival of Maccoa Duck, but also for other wetland bird species and associated biodiversity.

Further studies

This survey provided much needed information regarding both the spatial distribution and numbers of Maccoa Ducks and threats to the species' habitat. Unfortunately, a single survey is unlikely to address spatial distribution and population well. Therefore, a long-term monitoring strategy for Maccoa Duck needs to be established in Kenya to identify with confidence the population trend of the species in Kenya and critical sites for its conservation.

There is limited data on the breeding biology (particularly breeding success) of Maccoa Duck and its local habitat needs especially for the northern population. Breeding has been largely studied in South Africa, but it is important to note the geographic and climatic difference between South Africa and Kenya. In other words what the Maccoa Duck might be doing in Southern Africa may be completely different to its biological activity in Kenya and elsewhere in East Africa and therefore a comprehensive study on the breeding biology of the species in this part of Africa is paramount.

Further studies are required on the movement of this species. It is not known what Maccoa Duck does outside the breeding season and whether or not the species is indeed sedentary throughout. There are possibilities that Maccoa Duck migrates from Kenya to Tanzania therefore, geo-tracking studies of the species will help unravel their movement patterns.

Due to its feeding habits and food preference Maccoa Duck can be highly sensitive to any wetland changes or anthropogenic disturbance. It is therefore necessary to conduct ecological studies to investigate the relationship between Maccoa Duck presence and abundance and wetland limnology.

Acknowledgement

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List of Appendices

Appendix 1: Wetlands visited in search for Maccoa Duck including the population status of the species in each site.

Section 1: Wetlands with current records of Maccoa Duck. Section 2: Wetlands with past records of Maccoa Duck but in which no individuals were recorded during this study; Section 3: Other wetland sites visited within the area of study with no historical records of Maccoa Duck. Conservation Status: P: Protected sites(both state and private protected); NP: Not Protected

	Locality Name	Latitudes	Longitude	Altitude (m.a.s.l)	No. of Birds	Conservation Status	Source
Section 1: Wetlands in which Maccoa Duck was recorded in between December- July 2014/2015							
1	Manguo Swamp	-1.105948	36.634574	2277	5	NP	This study
2	Lake Ol Bolossat	-0.109937	36.423205	2332	4	P	Waterfowl Counts
3	Lake Sonachi (Crater Lake)	-0.782917	36.259914	1904	5	P	This study/Waterfowl Counts
Section 2: Wetlands with historical records of Maccoa Duck but no records of the species during this study							
4	Thika Sewage Works	-1.08791	37.114558	1440	0	P	This study
5	Limuru wetland	-1.072489	36.649847	2340	0	NP	This study
6	Lake Naivasha	-0.775181	36.408407	1887	0	P	Waterfowl Counts
7	Lake Oloidien	-0.811063	36.269988	1903	0	P	This study/Waterfowl Counts
8	Mbae Dam	-0.633912	36.545419	2452	0	NP	This study
9	Seminis/ Douglas Dam	-0.708984	36.604098	2573	0	NP	This study
10	Dandora/Ruai Sewage Ponds	-1.25268	37.01872	1483	0	P	This study
11	Lake Nakuru	-0.315538	36.085521	1768	0	P	Waterfowl Counts
12	Lake Bogoria	0.24858	36.0847	1007	0	P	Waterfowl Counts
13	Lake Elementaita	-0.426437	36.247233	1801	0	P	Waterfowl Counts
14	Nairobi Dam	-1.320632	36.797828	1684	0	NP	This study
Section 3: Wetlands with no historical records of Maccoa Duck surveyed during this study							

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15	Jane Dam (Molo)	-0.332202	35.748268	2648	0	NP	This study
16	Molo Town Site 1	-0.262034	35.749323	2442	0	NP	This study
17	Molo Town Site 2	-0.231297	35.711729	2518	0	NP	This study
18	Nyanda Dam (Molo Grasslands)	-0.217048	35.710029	2505	0	NP	This study
19	Nyakinyua Dam (Molo Grasslands)	-0.23367	35.662048	2750	0	NP	This study
20	Ruai Reservoir (Nairobi National Park)	-1.343737	36.869934	1645	0	P	This study
21	Embakasi Reservoir (Nairobi National Park)	-1.360197	36.883682	1631	0	P	This study
22	Eland Hollow Dam (Nairobi National Park)	-1.34595	36.850972	1644	0	P	This study
23	Kenyatta University Sewage	-1.192424	36.961534	1510	0	P	This study
24	Metta Dam (Molo Grasslands)	-0.57399	36.037166	2522	0	NP	This study
25	Chelelach Dam (Molo Grasslands)	-0.561059	36.032577	2431	0	NP	This study
26	Mwisho wa Rami Site 3 (Molo Grasslands)	-0.635697	35.996622	2883	0	NP	This study
27	Mwisho Wa Rami Dam (Molo Grasslands)	-0.644331	35.99958	2883	0	NP	This study
28	Mwisho wa Rami Site 1 (Molo Grasslands)	-0.647053	35.995216	2869	0	NP	This study
29	Mwisho wa Rami Site 2 (Molo Grasslands)	-0.64586	35.990686	2844	0	NP	This study
30	Gachembe Dam (Molo Grasslands)	-0.678197	35.972623	2819	0	NP	This study
31	Mau Narok Dam 1 (Molo Grasslands)	-0.597767	35.999093	2639	0	NP	This study
32	Mau Narok Dam 2 (Molo Grasslands)	-0.59776	35.999041	2622	0	NP	This study
33	Mau Narok Dam 3 (Molo Grasslands)	-0.584159	35.990838	2572	0	NP	This study
34	DemuTown (Molo Grasslands)	-0.545983	35.976224	2547	0	NP	This study
35	Taita Mauche Dam (Molo)	-0.522426	35.967148	2536	0	NP	This study

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	Grasslands)						
36	Ndeffo Dam (Molo Grasslands)	-0.461613	35.979276	2294	0	NP	This study
37	Mathakwa Site 2	-0.2629	36.284701	2516	0	NP	This study
38	Gwa Kiongo Dam	-0.178802	36.245547	2715	0	NP	This study
39	Silanga Primary School Dam	-0.246832	36.327032	2622	0	NP	This study
40	Silanga Site 1 (Nyandarua)	-0.235977	36.326126	2654	0	NP	This study
41	Johana Munge Dam	-0.280285	36.358014	2428	0	NP	This study
42	Silanga Site 2	-0.229383	36.325198	2690	0	NP	This study
43	Silanga Site 3	-0.223696	36.325875	2723	0	NP	This study
44	Pasenga Site 1	-0.18894	36.313098	2748	0	NP	This study
45	Kinia Dam	-0.167114	36.300596	2740	0	NP	This study
46	Gichaka Dam	-0.145598	36.308258	2621	0	NP	This study
47	Uhuru Primary School Bridge Dam	-0.144967	36.312531	2602	0	NP	This study
48	Tala Dam (Ndodori)	-0.128747	36.309593	2587	0	NP	This study
49	Gathaje Dam	-0.038035	36.326395	2463	0	NP	This study
50	K.A.R.I Ol Joro Rok Dam	-0.030383	36.353249	2378	0	P	This study
51	Baru Dam	-0.603309	36.505094	2422	0	NP	This study
52	North Kinangop Dam 4	-0.602798	36.504526	2419	0	NP	This study
53	Tony/ Matundura Dam	-0.614181	36.523108	2437	0	NP	This study
54	North Kinangop Dam 3	-0.576087	36.500725	2410	0	NP	This study
55	Makumi/ Dirisha Dam	-0.57609	36.500726	2410	0	NP	This study
56	KKY Dam	-0.574776	36.476438	2413	0	NP	This study
57	North Kianangop Dam 1	-0.575105	36.476516	2417	0	NP	This study
58	Magogo Dam	-0.563488	36.474391	2407	0	NP	This study
59	Mishida Dam	-0.590694	36.473792	2427	0	NP	This study
60	Hill's Dam (Kinangop Resource Centre)	-0.596697	36.468429	2437	0	NP	This study
61	Karia Ga Kinari	-0.871304	36.597851	2679	0	NP	This study

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62	Soko Mjinga Wetland	-0.886487	36.576915	2671	0	NP	This study
63	Maina Iringu (Kenyatta) Dam	-0.82824	36.575837	2684	0	NP	This study
64	Heni (south Kinangop)	-0.737673	36.61411	2543	0	NP	This study
65	Githabai Dam	-0.728536	36.582219	2563	0	NP	This study
66	Miti Iri Dam	-0.733263	36.587322	2571	0	NP	This study
67	Kariakor Dam	-0.71473	36.629797	2555	0	NP	This study
68	North Kianangop Dam 2	-0.562114	36.564013	2447	0	NP	This study
69	Kanyara Dam	-0.495753	36.490493	2396	0	NP	This study
70	Maningi Dam	-0.505848	36.516226	2414	0	NP	This study
71	Tigoni Dam	-0.452364	36.481255	2377	0	NP	This study
72	Ya Theruri Dam	-0.414421	36.461326	2335	0	NP	This study
73	Mang'arashi Dam	-0.415223	36.469531	2353	0	NP	This study
74	Godon Dam	-0.374074	36.483588	2367	0	NP	This study
75	Waithaka Dam	-0.327979	36.435341	2323	0	NP	This study
76	Muiru Dam (Ol kalau)	-0.321134	36.380783	2313	0	NP	This study
77	Mumbi Dam (Ol kalau)	-0.312342	36.378792	2322	0	NP	This study
78	Sheba Hospital Dam (Ol kalau)	-0.253525	36.380079	2371	0	NP	This study
79	Nyakaga Dam (Rurii)	-0.197567	36.393627	2369	0	NP	This study

Appendix 2: Pictorial illustration of field work activities and observations during the Maccoa Duck Survey

 <p>Human disturbance- washing clothes in wetlands</p>	 <p>Wetland very close to residential houses with livestock grazing on the riparian zone</p>	 <p>Wetland cultivation and livestock grazing at the Molo grasslands</p>
 <p>Eucalyptus plantation on the wetlands- a typical phenomena in most wetlands in the Kenyan Highlands</p>	 <p>Highly turbid wetland in Nyandarua with Eucalyptus plantation around the riparian zone</p>	 <p>Project team having a moment with curious kids grazing near a Gichaka wetland in Nyandarua</p>



Water abstraction for a green house farm at the Molo grasslands



Dominic Kimani (part of the project team) interviewing some of the local community members.



Project leader and a colleague consulting on a wetland polluted with garbage near a residential house in Molo Grasslands



Some of the incompatible wetland uses that would potentially scare away water birds. (Farmers washing carrots for market at a wetland in Kinangop)