SHOEBILL POPULATION ESTIMATES IN TANZANIA FROM 2,500 IN 1990 TO < 200 BIRDS IN 2011: WHAT WENT WRONG?

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ABSTRACT

Shoebill is a threatened African endemic wetland specialist bird with fragmented distribution in a narrow belt extending from Sudan to Zambia. The global population is estimated at 5,000-8,000 birds and listed under CITES Appendix II. In Tanzania it is confined to Malagarasi-Moyowosi swamps and Kagera wetlands. Since 1990 there has been a series of aerial counts of Shoebill in the Moyowosi swamps. The actual counts have varied from 578 in 1992 to 9 in 2001, whereas the population estimates during the same period varied from 2,528 to 134 birds. In 2005, 23 and 43 birds were counted by two different teams in Malagarasi. The first ecological study from 2004 to 2007 in the Moyowosi gives an estimate of 100 birds. This ecological study and a recent survey in Kagera region suggest that Shoebill aerial surveys overestimated the population sizes and do not reflect the population crash they depict. The reasons for overestimation could have come mainly from extrapolation based on surveyed areas ignoring specialized Shoebill habitat requirements and inconsistency in seasons of counting. For example, our recent survey in Kagera wetlands has revealed that the previously thought to be good habitats for about 100 birds are in fact covered by tall-dense papyrus which is avoided by Shoebill, and we estimate not more than a dozen pairs surviving there. In Malagarasi, shoebills tend to be clustered in few swamps during dry seasons. In this paper, we further discuss the above factors and give detailed microhabitat requirements of the Shoebill in both Malagarasi and Kagera wetlands that may aid in future surveys to improve estimates. We conclude that the Shoebill population sizes in Tanzania has largely been overestimated by aerial counts but the current conservative number of few hundred (< 200) birds is realistic and thus immediate conservation measures are needed.

Key words: *Shoebill, Tanzania*

INTRODUCTION

Knowing population sizes of threatened birds helps to design conservation measures. It could gauge the impacts of habitat disturbances, harvesting (Lambert 1993) and assess whether or not isolated populations are viable (Githiru & Lens 2006, Buckland *et al* 2008). Population sizes are important for IUCN-Red List classification and help the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to sort different birds species and subpopulation of particular species to its appropriate appendices. Due to limited resources and inaccessibility of some bird's habitats such as Shoebill *Balaeniceps rex*, aerial counts have become popular (Howard & Aspinwall 1984, Dinesen & Baker 2006, Roxburgh & Buchanan 2010) but need to be improved by using recent advancement in remote sensing which must incorporate ground observations.

Shoebill is a bird of inaccessible swamps of Africa. Its range extends from Southern Sudan to Zambia with a narrow disconnected distribution in between. Its population is said to be declining in all its range habitats. However, data from many countries are not as good and useful for population estimates. For example its population in Burundi and Malawi is unknown (BirdLife International 2011). According to BirdLife International (2011) the current population estimates in other countries is as follows; Sudan (c. 5000, 50-80% of global population), Uganda (100-500), Zambia (500-1,000), Democratic Republic of Congo (< 1,000), Rwanda and Ethiopia 50 birds each and there are 100-500 birds in Tanzania.

Aerial population count of Shoebill in Tanzania began in early 1990s. However, there has been a huge variation in these estimates. The population estimates have varied from 2,500 in 1990 to about 1,000 birds in 2000 (Tanzania Wildlife Research Institute 2002, Dinesen & Baker 2006). These counts were part of the general wildlife counting in Malagarasi ecosystem. During the same period, the population in Kagera wetland was assumed to be around 100 based on the available habitats (Baker 1996). Recent aerial and ground surveys focused on Shoebill in Malagarasi, have either failed to give estimates due to very few observations or estimated the number to few hundred (TAWIRI 2005, Dinesen &Baker 2006, Nahonyo & Msuya 2008). These controversial or inconsistency in Shoebill population estimates may have led to Tanzanian government not backing up the proposal to uplift Shoebill to Appendix I of CITES. In this paper we review the past aerial surveys and use our data from recent ecological studies (2004-2011) on the Shoebill in both Malagarasi and Kagera wetlands to suggest the best way to improve future estimates.

MATERIAL AND METHODS

Study sites

In Tanzania Shoebill is confined to Kagera and Moyowosi swamps (Leader-Williams &Tibanyenda 1996) with odd records from Mara and Rukwa (Baker 1996). Malagarasi–Moyowosi wetlands were gazetted as Ramsar site in 2000. The site (3,250,000 ha) is made up of different habitat types including woodlands, open waters, seasonal floodplains, and permanent swamps. The latter two habitats are important for Shoebill. The major rivers in Malagarasi are Igombe, Malagarasi, Moyowosi and Ugalla. Nyamagoma and Sagara are the major lakes in there.

Kagera region is approximately 250 km north of Malagarasi-Moyowosi (Fig. 1). Water bodies cover 29% (11,885 km^2) of its area. Swamps are abundant and wide spread and the Kagera, Ngono and Mwisa are the major rivers in the region. There are several riverine lakes along Kagera River, the major ones being Rushwa, Rwakajunju and Bisongou in Karagwe district. Ikimba and Burigi are the two major inland lakes. Lake Victoria forms the largest portion of the waterbodies in the region.

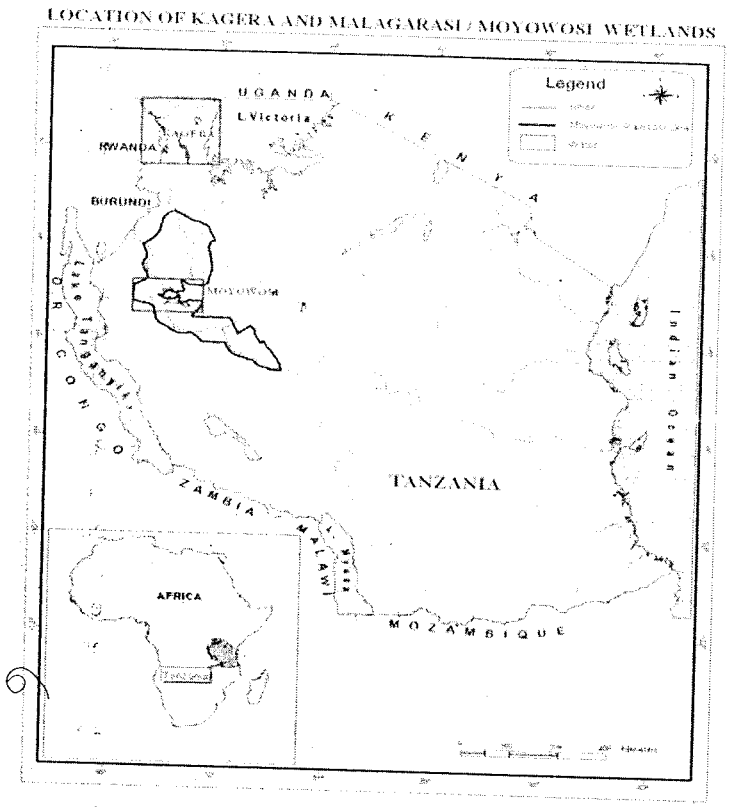


Figure 1: Moyowosi and Kagera wetlands. Central part (highlighted) of Malagarasi-Moyowosi Ramsar Site is the most important site for Shoebill. It is where the two major lakes are located.

Aerial counts

A summary of the aerial Shoebill counts in Malagarasi from 1990 to 1998 and a detailed aerial survey including methodology in 2001is given by Dinesen and Baker (2006). In 1995, the first ground-based waterbird count including the shoebill was conducted in the eastern part of Malagarasi ecosystem (Baker 1996). In 2005 two different teams conducted aerial surveys of the Shoebill and Wattled Crane *Bugeranus carunculatus* (TAWIRI 2005). A review was done to summarize these survey reports with respect to methodology, areas of coverage, seasons and estimates of Shoebill population.

Ecological surveys in Malagarasi and Kagera wetlands

From 2004 to 2007, applied ecology research on Shoebill was carried out in the Malagarasi Ramsar Site. The survey sites were located at Kasisi, Chagu, Sagara, Mpandamlowoka, Lumbe and Kabere Swamps covering major potential sites for shoebills. Shoebill was constantly monitored at all these sites by different teams during the same period. From 2010-2011, a detailed study was conducted in a core area of the ramsar site (at Lake Nyamagoma and Lumbe Swamp) especially to establish habitat requirements of the Shoebill. Water levels to gauge index of extent of flooding were monitored at Mfumu (sub-village of Kasisi) and detailed observations of Shoebill were made at Kasisi and its surroundings. Rainfall data were taken from Kibondo hydromet upstream of Lake Nyamagoma. All major wetlands of Kagera region large enough to support shoebills were surveyed from October 2010 to May 2011, and vegetation were qualitatively characterized.

RESULTS

Past aerial surveys – a review

Data from aerial surveys in Malagarasi wetlands (1990-2005) are summarized in Table 1. Dinesen and Baker (2006) highlights the counts from 1990-2001 including all data sources there in. Data for 2003 and 2005 are given by Kaaya *et al* (2007). The 2001 and 2005 surveys were site and species specific (Shoebill and Wattled Crane) surveys and failed to give precise estimates of shoebills due to few records. The rest of the surveys were general wildlife counts to advice the government for wildlife hunting quota which included few game birds such as Shoebill, Wattled Crane, Goliath Heron *Ardea goliath*, and Saddle-billed Stork *Ephippiorhynchus senegalensis*. The area surveyed from 1990-2005 varied from 32,500 to 2,125 km^2 with an average of 12,741 ± 10,920. All surveys were conducted in dry season except that of 1993, 1994, 1998 and 2003. Kaaya *et al* (2007) gives a total of 92 shoebills counted by TAWIRI in September-October 2006 from at least four different locations with the Malagarasi ecosystem.

Table 1: Shoebill numbers recorded and estimated during aerial surveys in Malagarasi ecosystem 1990-2005.

	1990	1992	1993	1994	1995	1998	2000	2001	2001	2003	2005
Estimate	**2528**	**2489**	**1028**	**689**	**723**	**235**	**997**	**134**	**100s****	**374**	-
SE (±)	899	642	443	241	102	-	296	46	-	157	-
Actual count	**78**	**578**	**35**	**45**	**61**	**15**	**136**	**9**	**56**	**41**	**43/23***
Time/season	Sept	Nov	June	Wet	Dry	May	Dry	Nov	Nov	June	Sept/Oct
Location	SA	GR	SA	GR	GR	GR	GR	RS	SA	SA	SA
Methods	TC	SRF	TC	SRF	SRF	SRF	SRF	SRF	SRF	SRF	SRF/TC
Area (km²)	20183	2125	4188	21870	3771	21870	21666	32500	7%RS	4548	5173

*Counted by two different teams during the same season, ** actual estimates were not established but authors speculated that Malagarasi comprise of 100 or few hundred birds (Dinesen &Baker2006).

Key: GR; Moyowosi-Kigosi Game Reserve, RS; Ramsar Site, SA; Specific Area, SRF; Transect count, TC; Total Count.

Distribution and abundance of shoebill 2004-2007

Kabere swamps complex in northern Moyowosi game reserve, Nyalusazi swamps along the Malagarasi River and swamps around Lake Nyamagoma were found to be the most important habitats for Shoebill. Highest recorded number of Shoebill at Kabere was 20 birds in October 2006, while at Sagara 10 birds were the highest in October 2004. Highest record at Chagu (northern part of Lake Nyamagoma) was of 20 birds in July 2004. Kasisi (swamp at confluences of major rivers of Malagarasi, lower part of Lake Nyamagoma) was found to be the most important site for Shoebill although numbers fluctuated (Table 2) as it was in other sites. Peak observations were noted in the months of August to September and January. Forty one individuals were recorded in the first week of September and another peak appeared in the week three of February 2006 when 42 birds were recorded.

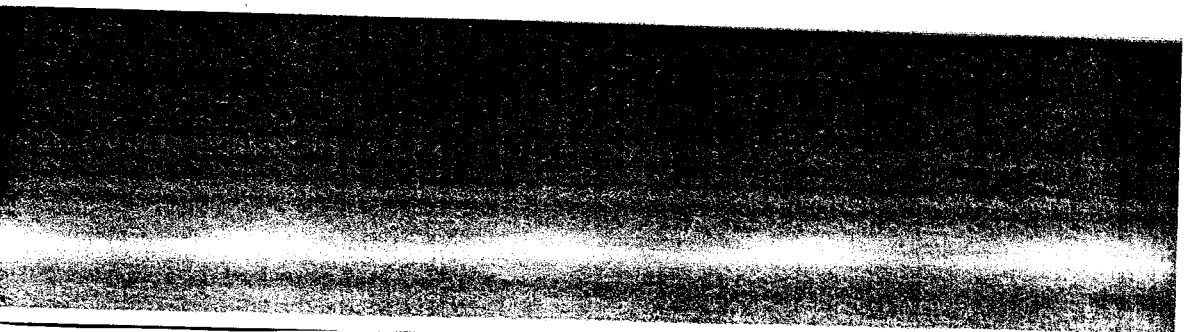


Table 2: Spatio-temporal changes in abundance of Shoebill at Kasisi 2004-2007

Site	July 2004-June 2005	July 2005-June 2006	July 2006-Dec 2007
Fukutu	71	15	62
Mgwezi	14	24	120
Itunda	12	15	42
Selukele	10	0	25
Magwemagwe	0	6	54
Izambi	17	0	24
Kichangani	0	8	22

Based on total counts in core Shoebill areas the study suggests a population size of 50-100 birds in Malagarasi wetlands and the population was probably declining (Fig. 2).

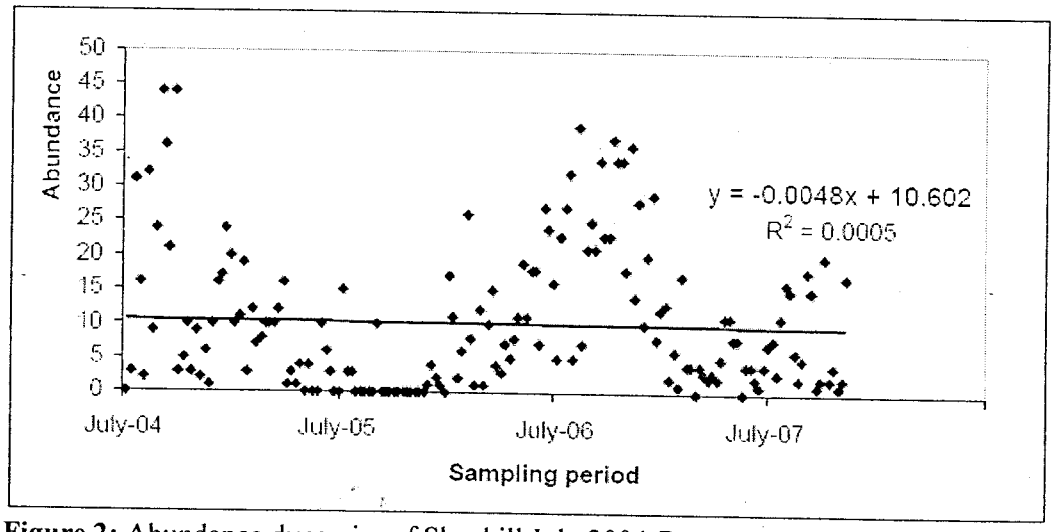


Figure 2: Abundance dynamics of Shoebill July 2004-December 2007.

Shoebill trade

According to CITES database (CITES 2012), between 1989 and 2010, 94 live shoebills were exported from Tanzania. Among those, 56 were imported for zoos and 36 for commercial purposes while no reasons were given for the rest. Singapore was on top of the importing countries with over 24% followed by the United States of America (21%), Netherlands (12%), Japan (11%) and the balance went to China (8 individuals), Arab Emirates (6 individuals), Czech Republic (5 individuals), Belgium (4 individuals), Qatar (3 individuals) and South Africa and Mexico both imported 2 birds each. These data do not include other shoebills that are indicated in CITES databaseto be traded between other countries but citingTanzania to be the original source. Given the small population (< 500 individuals) of this bird in Tanzania, no doubt that live trade is significantly impacting on its survival in the wild. In addition, there is a possibility that others are still caged in Tanzania and countless individuals

may have died in the process of being caught or shipped to exporting destinations, data that are never reported.

Shoebill habitat association: Vegetation and hydrology (2004-2007, 2010-2011)

Shoebills avoided papyrus *Cyperus payrus* and other emergent vegetation composed of *Typha capensis*, *Miscanthus violaceus*, and occupied short vegetation communities relatively open to allow upper parts of birds to be above vegetation while underneath there is water and probably fish. Shoebill preferred short vegetation (68 ±5.53 cm) about half of its own height of 120cm (Pearson correlation -267, P=0.049, N=55).Most of these short vegetations were dominated by *Eleocharis dulcis*. No Shoebill (N=55) were recorded in any dry habitats from April 2010-December 2010 and there was no clear pattern either with regards to preference between shallow (<40 cm, 48%) and deep water levels (≥ 40 cm, 52%). This is because Shoebill is adapted to walking on floating vegetation. There was a weak positive correlation ($y = 13.2x + 360.5$, $R^2 = 0.0016$, data for 2004-2007) between Shoebill and plant species diversity. Papyrus and other emergent vegetation occurred in dense vegetation with an extensive coverage of the swamps forcing Shoebill to occupy patches of short vegetation in between or fringes of habitats along the main water channels.

Swamps at Kasisi acted as refuge for Shoebill during dry season (Fig. 3). Chagu swamps were invaded with livestock from September forcing shoebills to vacate and probably move downwards to Kasisi (Fig. 4). This suggests that when the Malagarasi floodplains are flooded Shoebill distribution is scattered. For example, in 2010 and 2011 surveys at Lumbe swamps recorded 4-6 birds between May and June when the swamp is at high flood.

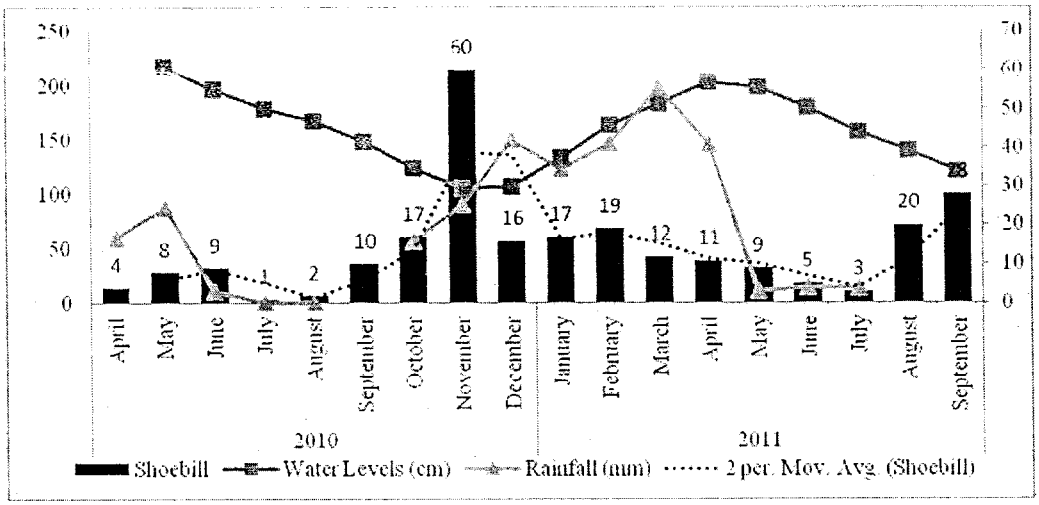


Figure 3: Response of Shoebill (monthly total) to flooding extent at Kasisi. When the lake level is at high, the floodplains elsewhere become suitable as some shoebills move from Kasisi and vice versa.

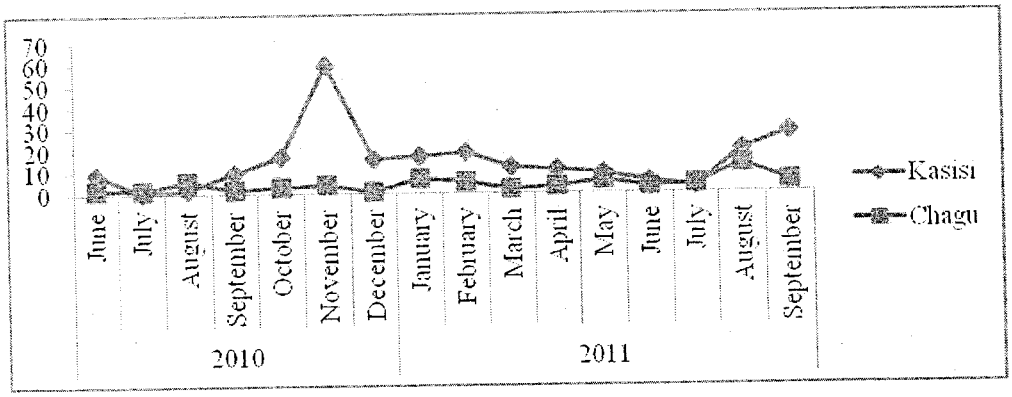


Figure 4: Shoebill abundances at Kasisi and Chagu both at Lake Nyamagoma swamps

Kagera wetlands survey

Altogether, 15 sites were surveyed at all major wetlands in the region (Fig. 5) and five birds were recorded at three different sitesalong the Ngono River during different visits from October 2010 to May 2011.

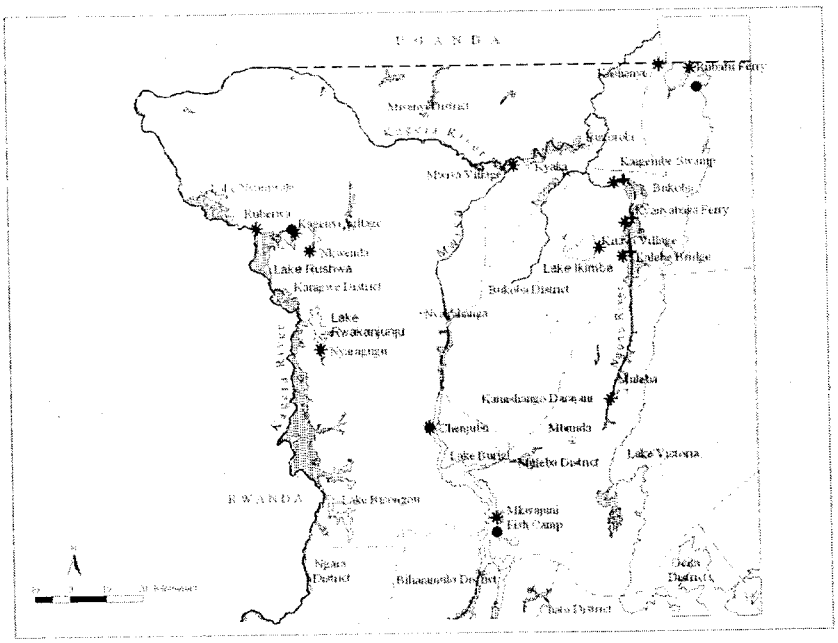


Figure 5: Distribution of Shoebill in Kagera region. ***Key:*** solid circles, previous shoebill records; cross sign, records made during this study; continuous line, rivers; vertical hashed line, swamps. Sampling sites are marked by multiple cross sign.

Shoebills were recorded in dry (January), short rain (October) and wet (April) seasons suggesting that they are year-round resident of these swamps. Shoebill was not re-sighted at Lake Rushwa, Victoria and Burigi where past records exist.Although it was not possible to produce a precise estimation of Shoebill numbers in Kagera, if we assume that our observations represented pairs and we double to account for the unsurveyed areas especially on the lower course of Kagera River, we estimate the current population of Shoebill in Kagera wetlands is about a dozen pair.

Based on our experiences from Malagarasi, highlighted above, we characterize Shoebill habitats in Kagera region in three categories; suitable, unsuitable and intermediate (Table 3) following the 2010-2011 surveys in the region.

Table 3: Shoebill habitat characterization at major wetlands in Kagera region

Major wetlands	**Suitability**	**Reasons for suitability categorization**
Riverine lakes	Unsuitable	Banana farming, fishing and settlements near the lakes. Uninhabited swamps were dominated by homogenous stands forming a floating mat of dense papyrus
Inland lakes (Ikimba and Burigi)	Unsuitable	Dense papyrus, small swamps along the lakes shores, farming, grazing and fishing (permanent fishing camps at Burigi)
Lake Victoria	Unsuitable	No swamps, sand beaches, and fishing
Kagera River	Intermediate	Except the segment from Kyaka to Ugandan border, most areas we visited were either completely covered by dense-tall papyrus or water was running fast in which Shoebill could not fish.
Ngono River	Suitable	Swamps had mixed vegetations including papyrus, floodplains (short grasses), short floating meadows, communities of rooted floating leaved and free floating euhydrophytes including water lilies and water hyacinths. This provides mosaic microhabitats for feeding and possibly nesting. There were very little human activities within these swamps. However, sporadic burning of swamps was observed.

DISCUSSION

The Shoebill population estimates for Malagarasi ecosystem ranged from 134 (TAWIRI 2002) to 2,489 (Jones & Hill 1994). These vast differences in population sizes have been a result of different methodologies especially with extrapolation of surveyed areas and limited knowledge about specialized habitat for Shoebill. Although

higher records of 578 in 1992 may indicate local movements of shoebills from elsewhere in the region because in the late 1980s and early 1990s much of the sub-Saharan Africa experienced a prolonged drought (Tiften & Mulele 1994) that affected most of the key habitats for shoebill.Different methodology has also led to different Shoebill population estimates in Zambia. Both in aerial surveys but using different strip widths, Kamweneshe *et al* (2003) used 500 m and estimated >200 birds while Roxburgh and Buchanan (2010) used 210 m to give estimate of 1,760 shoebills in Zambia. Therefore, it is unjustifiable to compare aerial surveys before 2000 in Malagarasi given the extrapolation made on the surveyed areas. It is also important to note that the surveys were aimed at counting large mammals, which may not have been suitable for shoebills. With improved method standardization, recent aerial surveys in 2001 and 2005, which were site specific (core broad habitats for shoebills), have failed to compute population estimates due to limited sightings but gave qualified statements putting the population in Malagarasi to few hundred birds. These results were supported by our ground monitoring. However, we acknowledge that there could be other inaccessible places by ground teams. The claim that there is suitable habitat for 100 birds in Kagera (Baker 1996) was not supported by our surveys there, as most area were either covered by tall-dense papyrus or threatened by human activities. A detailed ornithological survey at Lake Burigi in 2008 did not find Shoebill either (Mutagwaba 2010).

Shoebill is wetland specialist bird, its habitats are unique and it responds quickly to flooding regimes. Dense and tail vegetations are avoided as they obstruct take off and fishing. However, this is found to be unique for shoebills in Tanzania and Lake Victoria in Uganda (Dinesen&Baker 2006). In other areas, Shoebill inhabits vegetation dominated by papyrus, reeds and grasses particularly *Miscanthidium* (Hancock *et al* 1992). The available suitable habitat for Shoebill in Malagarasi is smaller and its extent varies with seasons, suggesting that most past aerial estimates were exaggerated. TAWIRI (2005) estimates about 5,173 km^2 (12.4%) to be suitable habitats for Shoebill in Malararasi-Moyowosi Ramsar Site, which is made up of 1,335 km^2 permanent swamps and 3,838 km^2 of grassland. During the wet season, about 2,500 km^2 of inundated floodplain occurs on two tributaries of the Moyowosi, the Kigosi and Gombe Rivers. There are also about 1,800 km^2 of floodplains and permanent swamps on the Ugalla River and its tributaries (Hughes & Hughes 1992). In addition, the wetland vegetation cover declined by 2.51% per year between 1984 and 2001 (Kashaigili & Majaliwa 2010). Our results on habitat preferences suggest that the actual available area for Shoebill in Malagarasi is less than these estimates and even so in dry seasons.

In dry season, grasslands become unavailable for shoebills and not all permanent swamps are good for shoebills. Dense-tall papyrus dominates the Malagarasi and Kagera swamp vegetation, with *Typha*, *Carex* and other emergent vegetation also

present, these aren't available for Shoebill. When water recedes from floodplains shoebills tend to concentrate in good swamps especially along the main water channels with significant floating vegetation. During this period, other water pools become unavailable for shoebill as most waterbirds concentrate on there and shoebill is incapable of this competition due to its fishing habits. Lake Nyamagoma swamps are the most suitable habitat for shoebills. About 41% (N=92) of all counts in Malagarasi in 2003 were around the Lake Nyamagoma swamps (Kaaya *et al* 2007). In addition, of the 66 birds counted by two different teams in September-October 2005, 32 ± 23 were found at this lake (TAWIRI, 2005).

Dinesen and Baker (2006) and Roxburgh and Buchanan (2010) recommend some useful notes with regard to Shoebill population estimates but both studies claim that permanent swamps and grasslands are suitable for shoebill without making any exceptions. Roxburgh and Buchanan (2010) used remote sensing techniques supported with limited ground observation and estimated 1,296 birds which was higher by 550% than previous estimates in Zambia. In most cases modelling of species habitat relationships are simplified especially when there is limited knowledge of the target species and this may produce inaccurate or biased outputs. However, the use of remote sensing techniques and occupancy modelling will give definitive estimates when a broad range of factors especially species habitat requirements is incorporated and this should be supported by unlimited number of records. These techniques have been useful as they can quickly give answers to what fraction of landscape does the species occupy and how many individuals of this species are in the landscape (Mackenzie & Nichols 2004). Therefore, if properly used, given the available dataset of distribution and habitat requirements, could help to improve future surveys (estimates) of Shoebill in Tanzania.

CONCLUSION AND RECOMMENDATION

Although there is no consensus to the actual shoebill population in Tanzania but it is clear that the population is in very small and probably declining. The available habitats for Shoebill are even smaller than have been projected. While awaiting for an agreeable estimate which will take into consideration of some of our recommendations below, we suggest to the government to support uplifting of Shoebill status to CITES Appendix 1 and initiate a special program to protect the Shoebill and its habitats using the already available skills and enthusiasm from the locals who have participated in Shoebill studies from 2004 until to date. Most of the core habitats for this species are threatened by livestock grazing especially in dry season and illegal hunting is also suspected.

In order to improve future population estimates we recommend the following;

1. Habitat suitability maps be developed (consider habitat requirements) which will establish the minimum area of potentially suitable areas for shoebills and thus be target for future surveys. This will allow remote sensing and occupancy modelling for Shoebill.
2. Future surveys for total counts be conducted in dry season in potential suitable habitats. This is because shoebills show a non-random distribution and local movements in Malagarasi swamps. Transect aerial estimates in dry season may result in an overestimates as higher density may be found in small areas when dry. Aerial counts should be reconciled with ground surveys.
3. Satellite tracking or any other means of tagging will be useful to understanding the Shoebill movements within and beyond the Malagarasi swamps.

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