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WATERBIRDS OF ALKALINE LAKES IN WESTERN UGANDA

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ABSTRACT

Uganda's only alkaline lakes are found in the Queen Elizabeth Conservation Area and the adjoining Kyambura Wildlife Reserve. Both are Important Bird Areas, a status to which the birds of the lakes contribute. A total of 179 waterbird counts were made between 1984 and 2000, covering eight of the nine alkaline lakes, all of which are small explosion craters. Of the 75 species counted, all but three were non-specialists. Maxima are given for all species, together with seasonal data for five crater lakes. Four lakes regularly supported more than 1,000 Lesser Flamingos each, the maximum being 60,000. They were Maseche, Bagusa, Nshenyi and Munyanyange. Breeding has been attempted, but has been unsuccessful so far. The more important flamingo lakes had high values for conductivity, above 15,000 $\mu\text{S cm}^{-2}$, whilst species richness is associated with muddy shores and, probably, intermediate levels of alkalinity, between 10 and 50 Meq^{-1} . The lakes are important scenically, for ecotourism, and for the conservation of waterbirds and plants; whilst Lake Katwe's traditional production of salt is of considerable economic significance.

INTRODUCTION

The western rift valley in Uganda, also known as the Albertine Rift, contains over a hundred explosion craters. They originated during the development of the Rift, probably only a few thousand years ago (H. Osmaston, pers. comm.). Some 50 of the craters lie within the Queen Elizabeth Conservation Area (QECA), which includes the QE National Park, Kyambura Wildlife Reserve (KWR) and the Kazinga Animal Sanctuary. Together, these comprise two of Uganda's Important Bird Areas (Byaruhanga *et al.*, 2001). Eighteen of the craters contain lakes, and of those nine are alkaline. Regular counts have been made of the waterbirds on

these alkaline lakes, which support a higher diversity of species compared to the freshwater lakes. Several of the lakes lie within the Maramagambo Forest. This study includes all the alkaline lakes with high waterbird numbers and species richness, and one freshwater lake (figure 1). In this paper, we document the waterbirds as well as indicate the conservation importance of Uganda's only alkaline lakes.

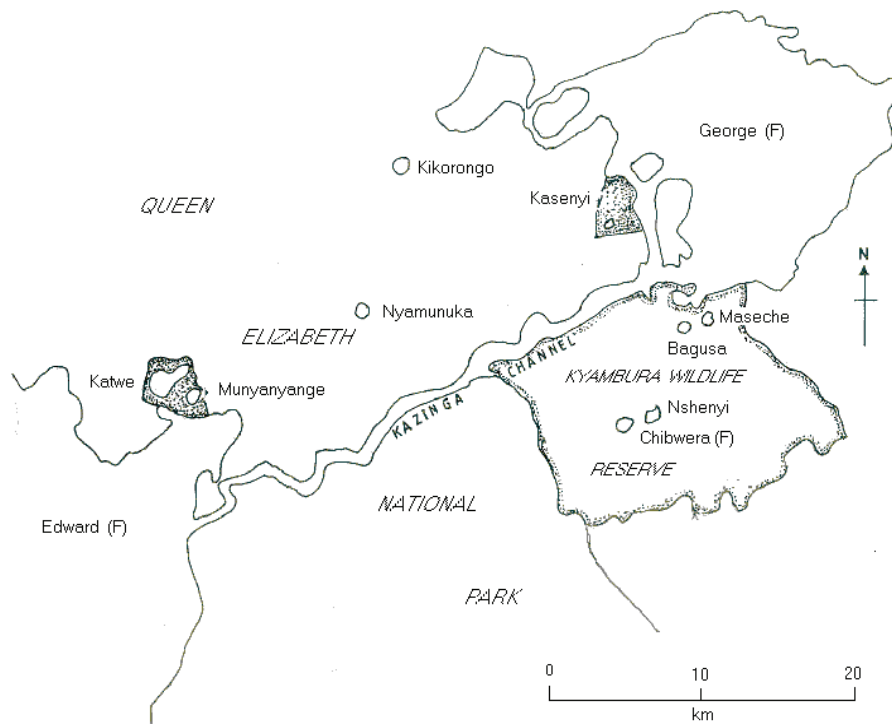


Figure 1. Part of the Queen Elizabeth Conservation Area ($29^{\circ}50'-30^{\circ}12' E$, $0^{\circ}00'-0^{\circ}10' south$), showing the crater lakes included in this study ((F) = Freshwater, the remainder being alkaline). The two parts of the Kazinga Animal Sanctuary are stippled.

The alkalinity of some of the lakes is largely associated with sodium and potassium salts, and presence of calcium and magnesium ions. For this reason, we prefer the term *alkaline* to *saline*. For hundreds of years, people have been extracting salt from Lake Katwe, which has sufficiently high concentrations of both sodium and chloride ions. In the 19th century, Lake Katwe was on the Arab trade routes because of its salt, as well as ivory. Presently it is the main salt industry in the area with several thousand people working, while a few others work for the only other, but small-scale, salt industry at Lake Kasenyi.

Whilst very small compared to the famous lakes in Kenya and Tanzania, in the eastern rift valley such as Bogoria, Natron and Nakuru, the alkaline lakes in western Uganda are of considerable ornithological interest. They are all shallow, with the depths of most being less than a metre. Other major characteristics of the lakes considered in this study are given in table 1.

Table 1. Key characteristics of the main crater lakes of the QECA. Except where otherwise indicated, figures for water chemistry are from C. Alokait (pers. comm.); they are averages of 3-4 readings from each lake, except for pH where the full range is given. Lake George is included for comparison.

	ALKALINE LAKES										FRESHWATER LAKES		
	Lakes with many flamingos ^a					Lakes with few flamingos					Chibwera	George	
	Maseche	Bagusa	Nshenyi	Munyanyange	Katwe	Nyamunuka	Kikorongo		Kasenji				
							Pre 1990	1998					
Approx. area (ha) ^c	35 ^c	35	50 ^c	50 ^c	250	90 ^c	80	90	40	80	24,000		
Conductivity (µS/cm)	45,000 ^d	110,000	110,000	37,000	385,000-455,000 ^d	88,000	16,300-34,600 ^d	9,000	80,000 ^d	600	300		
Alkalinity (meq/l)	710 ^d	-	-	-	1330-2120 ^d	-	144-498 ^d	125	377 ^d	110	125		
pH	8.6-10.7	8.7-12.3	8.5-11.5	8.9-9.5	10.0-11.6	10.5-11.7	9.4-10.0 ^d	8.0-10.1	11.8-12.7	7.7-9.2	7.3-9.0		

Notes a maxima exceeding 1000 (Table 2).

b lake areas as shown on 1:50,000 maps represent 'high water marks'

c completely dry in some years

d from Mungoma (1990)

MATERIALS AND METHODS

Waterbird counts have been carried out regularly at a number of lakes in Uganda since 1984, mainly by DP and MW (but see also the Acknowledgements); and at the KWR lakes since 1994 by a NatureUganda team led by AB. The counts were done using standard binoculars and telescopes. Most of these lakes are approximately 1 km or less across, but in some, notably Kikorongo and Munyanyange, many counts involved a complete circuit of the lake, on foot. Where time allowed, total counts were made, but not all counts at all lakes were total counts, and hence results are mainly given as maxima rather than averages.

Water in all the nine lakes was sampled by Christine Alokait in 1998; some of her data are included in table 1. Standard meters were used to determine the conductivity and pH. Conductivity is a measure (in micro-Siemens per centimetre) of total ionic nutrients in the water, and like pH is readily measured in the field. Alkalinity, which was measured in the laboratory by titration, reflects the amount of bicarbonate present, which in turn is important for algal production. These values are taken from a review by Mungoma (1990) which, however, included only four of the lakes in this study, those for Lake Kikorongo being pre-1990 values. Periodically Lake George's fresh waters overflow into the nearby Kikorongo. Between floods the water level in Lake Kikorongo drops as a result of evaporation, and it becomes increasingly alkaline. This was the case during the present study. Until 1992, the lake was small due to low water levels. A series of floods from 1993 onwards progressively raised the water level by about 10 metres and consequently diluted it, so that by the year 2000, its composition was approaching that of a freshwater lake (table 1).

RESULTS AND DISCUSSION

Numbers and seasonality

Table 2 shows the highest numbers of all species recorded at all lakes. The alkaline lakes fall naturally into three groups according to the numbers of Lesser Flamingos: (1) those that regularly support thousands of Lesser Flamingos, (2) those that have few, and (3) those that have none. Of the 75 species included in the table, 72 are waterbirds (*W* and *w*, as described in the footnote to table 2). The remaining few species, such as the Cattle Egrets, are included because of their regular use of the lake areas.

Seasonal data for the five most-frequently visited lakes are given, from west to east, in tables 3 to 7 (the KWR lakes are usually only visited for waterbird counts in January and July). Amongst the species that show marked seasonality are the five included in figure 2. At Lake Munyanyange, the peak numbers of most waterbird species, including Lesser Flamingos, occur from October to December when the lake levels are normally high. Flamingo numbers at all lakes vary greatly (see below) and undoubtedly long-distance migration is involved, since the nearest other places with thousands of flamingos are all in the eastern rift valley, more than 600 km away. They are probably mainly influenced by water levels, which indirectly affect their food supply; but sometimes, when the lakes dry up, the effect is direct.

The Avocet was only recorded twice in Uganda before 1980 (Carswell *et al.*, in press), but during the 1980s and 1990s it has been frequent at Lake Munyanyange. However, that is the only place in Uganda where it occurs regularly, primarily as a

Table 2. Maximum bird numbers recorded from all lakes, 1984–2000. Common and scientific names of birds, and the order of species, are from the Bird Atlas of Uganda (Carswell et al., in press), and are preceded by their atlas numbers.

		ALKALINE CRATER LAKES											FRESH WATER LAKE					
		Species of conservation concern ^a	Water-birds ^b	Lakes with many flamingos						Lakes with few flamingos				No flamingos				
				Maseche	Bagusa	Nshenyi	Munyanyanange	Katwe	Nyamunuka	Kikorongo		Kasenyi	Kitagata	Musunuli	Chibwera			
2	Little Grebe																	
	<i>Tachybaptus ruficollis</i>	R-RR	W	330	300	26	73											150
5	Greater Cormorant		W			1												
	<i>Phalacrocorax carbo</i>		W															
8	White Pelican		W										1400					
	<i>Pelecanus onocrotalus</i>		W															
9	Pink-backed Pelican		W	2			1											
	<i>P. rufescens</i>		W															
17	Cattle Egret		W		167	7	129											
	<i>Bubulcus ibis</i>		W															
21	Little Egret		W		19		11											
	<i>Egretta garzetta</i>		W															
22	Yellow-billed Egret		W	6			4											
	<i>E. intermedia</i>		W															
23	Great White Egret	R-VU	W		1		1											
	<i>E. alba</i>		W															
25	Grey Heron	R-NT	W			4												
	<i>Ardea cinerea</i>		w															
26	Black-headed Heron		w			1												
	<i>A. melanoccephala</i>		W															
27	Goliath Heron	R-NT	W															
	<i>A. goliath</i>		w															
28	Hamerhop		w	2			1											
	<i>Scopus umbretta</i>																	

	Species of conservation concern ^a	Water-birds ^b	ALKALINE CRATER LAKES												FRESH WATER LAKE		
			Lakes with many flamingos						Lakes with few flamingos							No flamingos	
			Maseche	Bagusa	Nshenyi	Munyanange	Katwe	Nyamunuka	Kikorongo		Kasenyi	Kitagata	Musumuli	Chibwera			
29	Yellow-billed Stork <i>Mycteria ibis</i>	W			3	2	2	2	122	127	12						
30	Open-billed Stork <i>Anastomus lamelligerus</i>	w						3			140						
34	White Stork <i>Ciconia ciconia</i>					1											
35	Saddle-billed Stork <i>Ephippiorhynchus senegalensis</i>	W				3						20					
36	Marabou Stork <i>Leptoptilos crumeniferus</i>	W			3	1	450	1	73	59	80						
38	Glossy Ibis <i>Plegadis falcinellus</i>	W			3		40										
39	Hadada <i>Bostrychia hagedash</i>	w			1	13	6										
42	Sacred Ibis <i>Threskiornis aethiops</i>	W			66	36	21		1								
44	African Spoonbill <i>Platalea alba</i>	W					1		6	4							
45	Greater Flamingo <i>Phoenicopterus ruber</i>	W					2			2							
46	Lesser Flamingo <i>P. minor</i>	G-NT, R-RR, R-NT	W	60,000 ^c	12-20,000 ^c	4000	4000	400	31	120	350						
47	Fulvous Whistling Duck <i>Dendrocygna bicolor</i>	W					17										
48	White-faced Whistling Duck <i>D. viduata</i>	W					65										
50	Egyptian Goose <i>Alopochen aegyptiacus</i>	W				13	2	85	2	15	280	3					

53	Knob-billed Duck		W							4	4					1										
57	Sarkidiornis melanotos		W													10										
	Yellow-billed Duck		W							5																
	Anas undulata		W								49															
60	Red-billed Teal		W																							
	A. erythrorhyncha		W																							
61	Hottentot Teal A. hottentota		W												13											
62	Garganey A. querquedula		W								21															
69	Osprey Pandion haliaetus		W														4			2						
76	Fish Eagle Haliaeetus vocifer		W			2	3				1						5			37						2
93	African Marsh Harrier	R-VU	W				1				2															
	Circus ranivorus		W																							
94	Eurasian Marsh Harrier		w								2						1									
	C. aeruginosus		W																							
178	Black Crane		W				1																			
	Amaurornis flavirostris		W																							
185	Grey Crowned Crane	R-NT	W								3															
	Balearica regulorum		W																							
186	African Finfoot	R-VU	W				1																			
	Podica senegalensis		W																							
197	Black-winged Stilt		W			3000	1000				4000					150				32						L
	Himantopus himantopus		W								67															
198	Avocet Recurvirostra avosetta		W																							
201	Water Thicknee		W					1			5	2														
	Burhinus vermiculatus		W																							
207	Common Pratincole		W																							
	Glareola pratincola		W																							
211	Ringed Plover		W								125															
	Charadrius hiaticula		W																							
212	Kittlitz's Plover C. pecuarius		W								400									37						
213	Three-banded Plover		W																							
	C. tricoloris		W																	2						
215	Kentish Plover		W																							
	Charadrius alexandrinus		W																							
216	White-fronted Sandplover		W								1															
	C. marginatus		W																							
219	Caspian Plover C. asiaticus										9									3						

	Species of conservation concern ^a	Water-birds ^b	ALKALINE CRATER LAKES										FRESH WATER LAKE			
			Lakes with many flamingos				Lakes with few flamingos				No flamingos					
			Maseche	Bagusa	Nshenyi	Munyaanyange	Katwe	Nyamunuka	Kikorongo	Kasenyi	Kitagata	Musunuli		Chibwera		
220	Grey Plover <i>Pluvialis squatarola</i>	W			1											
221	Wattled Plover <i>Vanellus senegallus</i>	W	2		25											
223	Spur-winged Plover <i>V. spinosus</i>	w	5	36	14	80	5	2	27	44	29					
225	Senegal Plover <i>V. lugubris</i>	W			18											
229	Little Stint <i>Calidris minuta</i>	W	35		4	1090		50	115	25	30					
231	Curlow Sandpiper <i>Calidris ferruginea</i>	W			140				185							
234	Ruff <i>Philomachus pugnax</i>	W	250	900	80	370		25	33		10					
236	Common Snipe <i>Gallinago gallinago</i>	W		1												
239	Black-tailed Godwit <i>Limosa limosa</i>	W				7			1							
241	Whimbrel <i>Numenius phaeopus</i>	W				6										
242	Curlow <i>N. arquata</i>	W				2										
243	Spotted Redshank <i>Tringa erythropus</i>	W				1				2						
244	Redshank <i>T. totanus</i>	W				1									1	
245	Marsh Sandpiper <i>T. stagnatilis</i>	W	2		1	30				4						

246	Greenshank <i>T. nebularia</i>	W		3		1	66	1	13											
247	Green Sandpiper <i>T. ochropus</i>	W					1													
248	Wood Sandpiper <i>T. glareola</i>	W		24	13	5	800													1
250	Common Sandpiper <i>Actitis hypoleucos</i>	W		13	6		2		1	3										2
254	Grey-headed Gull <i>Larus cirrocephalus</i>	W					10			2										
255	Black-headed Gull <i>L. ridibundus</i>	W					1													
257	Lesser Black-backed Gull <i>Larus fuscus</i>	W					1555													
258	Herring Gull <i>L. heuglini</i>	W					2													
259	Gull-billed Tern <i>Gelochelidon nilotica</i>	W		4		2	780						20	40						
264	White-winged Black Tern <i>Chlidonias leucopterus</i>	W		750	3000	20	1500	2	50	240	6	200	L							10
265	African Skimmer <i>Rynchops flavirostris</i>	W	G-NT,R- VU,R-RR							200	3									
290	Water Thick-knee <i>Psittacus erithacus</i>	W			1		3	2		36		16								
383	Pied Kingfisher <i>Ceryle rudis</i>	W								6	1	1								
	Number of counts			12	14	13	58	23	25	10	9	15	1	1	4					
	Number of species			21	24	20	56	9	16	37	30	24	5	0	6					

Notes: a – Global (G-) species from BirdLife International (2000); Regional (R-) species from Bennun & Njoroge (1996); VU = vulnerable, NT = Near-threatened, RR = Species of regional responsibility
b – Waterbirds as classified by Wilson (1995); W = Waterbird specialists, w = non-specialist species associated with water
c - 19 July 99 (M. Wilson)
P – present L – 'large numbers'

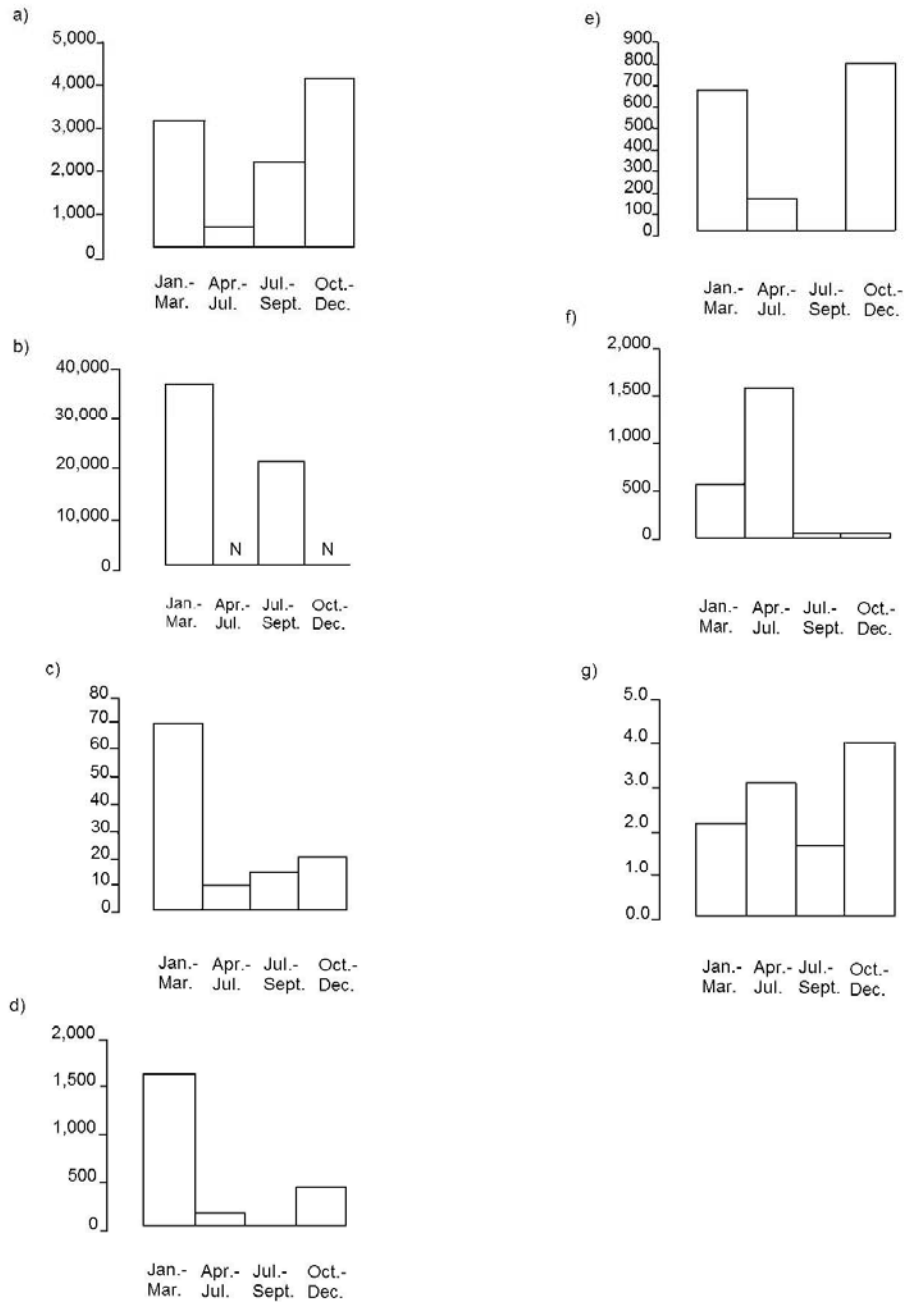


Figure 2. Seasonality in maximum numbers of several species, thus: a) Lesser Flamingo at Lake Munyanyange (LM); b) Lesser Flamingo, combined totals of KWR lakes (N = no count); c) Avocet at LM; d) Lesser Black-backed Gull at LM; e) Gull-billed Tern at LM; f) White-winged Black Tern at LM; g) Relative mean water levels at LM, on a 0–5 scale.

winter visitor, although its status elsewhere in East Africa is not clear (Britton, 1980, Lewis & Pomeroy, 1989, Zimmerman *et al.*, 1996). Lesser Black-backed Gulls and Gull-billed Terns are winter visitors too, whereas the White-winged Black Tern is predominantly a passage migrant with numbers peaking in April–June. These last three species feed extensively on Lakes George and Edward, which are fresh, using Lake Munyanyange (and occasionally other places such as the Kazinga Channel) for roosting. Interestingly, the White-winged Black Tern is most frequent elsewhere in QECA on autumn passage, mainly November–December (MW, pers. obs.).

Table 3. Maximum counts* for Lake Katwe, 1984-1999, arranged seasonally.

	Jan–Mar	Apr–June	July–Sept	Oct–Dec
17 Cattle Egret <i>Bubulcus ibis</i>			65	20
21 Little Egret <i>Egretta garzetta</i>			1	
25 Grey Heron <i>Ardea cinerea</i>	2			
36 Marabou Stork <i>Leptoptilos crumeniferus</i>	1			
46 Lesser Flamingo <i>Phoeniconaias minor</i>	335	400	310	175
50 Egyptian Goose <i>Alopochen aegyptiacus</i>			2	
201 Water Thicknee <i>Burhinus vermiculatus</i>	2			
223 Spur-Winged Plover <i>Vanellus spinosus</i>			5	
257 Lesser Black-Backed Gull <i>Larus fuscus</i>	5		1	120
264 White-Winged Black Tern <i>Chlidonias leucopterus</i>	2		1	
Number of counts	10	2	7	4
Water levels	- fairly high at all times -			

* No total counts, except for Lesser Flamingo

Conservation values

Some of the species recorded are of global conservation importance (BirdLife International, 2000), and others are on the East African Red Data List (Bennun and Njoroge, 1996). Both Lesser Flamingo and African Skimmer are globally-listed as near-threatened, and five additional species are considered to be regionally vulnerable (table 2). Four more species, including the White Pelican, are listed as being of lesser concern, regionally. (There is also an unconfirmed record of 1,800 White Pelicans on Lake Kasenyi (Byaruhanga *et al.*, 2001)). Several of these species have been recorded in significant numbers, with the Lesser Flamingo and White Pelican, together with the non-threatened Black-winged Stilt and Gull-billed Tern, exceeding the Wetland International's threshold numbers for congregatory species (Dodman *et al.* 1997). Today, the Kyambura craters are by far the most important site in Uganda for Lesser Flamingos. Because of their attractive, partly-forested setting, these craters also have considerable potential for tourism development. For quite different reasons, Lakes Kasenyi and Munyanyange could also become important tourist sites. Kasenyi is close to the most popular lion-viewing area in the QECA, whilst Munyanyange is only a 15-minute drive from the park headquarters at Mweya. It is a sanctuary, within the park, and can readily be circumnavigated by car or on foot, making bird-watching very easy. Fifty-three waterbird species (W and w) have been recorded from this small lake, indicating a remarkably high level of diversity.

Table 4. Maximum counts for Lake Munyanyange, 1984-1999, arranged seasonally.

	Jan–Mar	Apr–June	July–Sept	Oct–Dec
2 Little Grebe <i>Tachybaptus ruficollis</i>	45	28		73
8 White Pelican <i>Pelecanus onocrotalus</i>	3			
9 Pink-Backed Pelican <i>Pelecanus rufescens</i>			1	
17 Cattle Egret <i>Bubulcus ibis</i>	42	57	70	129
21 Little Egret <i>Egretta garzetta</i>	3		11	
23 Great White Egret <i>Egretta alba</i>				4
25 Grey Heron <i>Ardea cinerea</i>	1	4	1	1
26 Black-Headed Heron <i>Ardea melanocephala</i>	1	1	1	1
28 Hamerkop <i>Scopus umbretta</i>	1			
29 Yellow-Billed Stork <i>Mycteria ibis</i>	10		2	1
34 White Stork <i>Ciconia ciconia</i>		1		
35 Saddle-Billed Stork <i>Ephippiorhynchus senegalensis</i>				3
36 Marabou Stork <i>Leptoptilos crumeniferus</i>	102	190	450	200
38 Glossy Ibis <i>Plegadis falcinellus</i>	40	21	1	
39 Hadada <i>Bostrychia hagedash</i>	2			6
42 Sacred Ibis <i>Threskiornis aethiopica</i>	12	14	9	21
44 African Spoonbill <i>Platalea alba</i>		1		
45 Greater Flamingo <i>Phoenicopterus ruber</i>	4		2	
46 Lesser Flamingo ^a <i>Phoeniconaias minor</i>	3000	490	2000	4000
50 Egyptian Goose <i>Alopochen aegyptiacus</i>	3	32	23	85
53 Knob-billed Duck <i>Sarkidiornis melanotos</i>	2		4	1
57 Yellow-billed Duck <i>Anas undulata</i>		5		
60 Red-billed Teal <i>Anas erythrorhyncha</i>		15		49
61 Hottentot Teal <i>Anas hottentota</i>	13	2		12
62 Garganey <i>Anas querquedula</i>	21			
76 Fish Eagle <i>Haliaeetus vocifer</i>	1			1
93 African Marsh Harrier <i>Circus ranivorus</i>	2			
185 Grey-Crowned Crane <i>Balearica regulorum</i>				3
197 Black-winged Stilt <i>Himantopus himantopus</i>	600	250	120	260
198 Avocet <i>Recurvirostra avosetta</i>	67	9	20	20
201 Water Thick-knee <i>Burhinus vermiculatus</i>	2			5
211 Ringed Plover <i>Charadrius hiaticula</i>	5	125		1
212 Kittlitz's Sandpiper <i>Charadrius pecuarius</i>	60	400	30	4
213 Three-banded Plover <i>Charadrius tricollaris</i>			1	
219 Caspian Plover <i>Charadrius asiaticus</i>	9			
220 Grey Plover <i>Pluvialis squatarola</i>	1			
221 Wattled Plover <i>Vanellus senegallus</i>	10	25	10	2
223 Spur-winged Plover <i>Vanellus spinosus</i>	36	80	12	63
225 Senegal Plover <i>Vanellus lugubris</i>	18			
229 Little Stint <i>Calidris minuta</i>	500	20	45	1090
231 Curlew Sandpiper <i>Calidris ferruginea</i>	65	140	2	2
234 Ruff <i>Philomachus pugnax</i>	100	30	300	370
239 Black-tailed Godwit <i>Limosa limosa</i>	4	7		
241 Whimbrel <i>Numenius phaeopus</i>				6
242 Curlew <i>Numenius arquata</i>	1		2	
243 Spotted Redshank <i>Tringa erythropus</i>	1			1
244 Redshank <i>Tringa totanus</i>	1			
245 Marsh Sandpiper <i>Tringa stagnatalis</i>	25	1	4	7
246 Greenshank <i>Tringa nebularia</i>	66	1	4	5
247 Green Sandpiper <i>Tringa ochropus</i>	1	1		
248 Wood Sandpiper <i>Tringa glareola</i>	800	4	4	10
250 Common Sandpiper <i>Actitis hypoleucos</i>	1			2

	Jan–Mar	Apr–June	July–Sept	Oct–Dec
254 Grey-headed Gull <i>Larus cirrocephalus</i>	5	7	10	
255 Black-headed Gull <i>Larus ridibundus</i>				1
257 Lesser Black-backed Gull ^b <i>Larus fuscus</i>	1555	120		447
258 Herring Gull <i>Larus heuglini</i>				2
259 Gull-billed Tern <i>Gelochelidon nilotica</i>	650	150		780
264 White-winged Black Tern ^c <i>Chlidonias leucopterus</i>	500	1500	25	30
Number of counts ^d	19	12	11	15
Average water level ^e	2.1	3.0	1.6	3.9

NOTES

- a most pre-1990 maxima were <1000
 b only singles to 1987
 c mainly pre-1988
 d not all were 'complete'
 e from 0 = dry to 5 = full; the lake could be full at any time, in different years, but most frequently between October and March

Table 5. Maximum counts^a for Lake Nyamunuka, 1985-1999, arranged seasonally.

	Jan–Mar	Apr–June	July–Sept	Oct–Dec
17 Cattle Egret <i>Bubulcus ibis</i>		5		
25 Grey Heron <i>Ardea cinerea</i>			1	
29 Yellow-billed Stork <i>Mycteria ibis</i>		2		
36 Marabou Stork <i>Leptoptilos crumeniferus</i>	4	57	1	
46 Lesser Flamingo <i>Phoeniconaias minor</i>	45	65	75	70
50 Egyptian Goose <i>Alopochen aegyptiacus</i>	15		2	
53 Knob-billed Duck <i>Sarkidiornis melanotos</i>	2			
94 Eurasian Marsh Harrier <i>Circus aeruginosus</i>	1			
197 Black-winged Stilt <i>Himantopus himantopus</i>	150	50		30
211 Ringed Plover <i>Charadrius hiaticula</i>	5	4		
223 Spur-Winged Plover <i>Vanellus spinosus</i>	1			
229 Little Stint <i>Calidris minuta</i>	50	15		
234 Ruff <i>Philomachus pugnax</i>	20	25		
246 Greenshank <i>Tringa nebularia</i>	1			
250 Common Sandpiper <i>Actitis hypoleucos</i>	5	1		
264 White-Winged Black Tern <i>Chlidonias leucopterus</i>	50	50	50	
Number of counts	11	4	7	4
Average water level ^b	2.9	4.0	3.0	4.7

^a No total counts, except Lesser Flamingo

^b Scored as in Table 4

The alkaline lakes have other conservation values. These include salt licks for large mammals, and a number of rare salt-tolerant plants that occur around the edges of the lakes (A.B. Katende, pers. comm.).

Species richness (the total numbers of species) was higher in lakes with intermediate alkalinity (table 1) and especially on those that are shallow with large areas of exposed mud. Lake Munyanyange is so shallow that the larger species can often be seen wading hundreds of metres from the shore.

The congregations of Gull-billed Terns at Lake Munyanyange, Great White Pelicans at Kasenyi, and Lesser Flamingos in the KWR, all meet the criteria for Important Bird Areas. Clearly these crater lakes, like those to the south of Fort Portal (Pomeroy and Seavy, 2003), are of value for conservation, as well as for their physical attractions as landscape features, and economically for the salt.

Table 6. Maximum counts for Lake Kikorongo, 1984-1999, arranged seasonally. The lake was brackish prior to 1993, when floods from Lake George diluted the water. The two data sets are therefore shown separately.

	1984–1992				1993–2000			
	Jan– Mar	Apr– June	July– Sept	Oct– Dec	Jan– Mar	April– June	July– Sept	Oct– Dec
2 Little Grebe <i>Tachybaptus ruficollis</i>	8	10	4	4		14	42	
8 White Pelican <i>Pelecanus onocrotalus</i>						14	1400	
9 Pink-Backed Pelican <i>Pelecanus rufescens</i>	7			1	7		800	
17 Cattle Egret <i>Bubulcus ibis</i>	20		28			133	231	
21 Little Egret <i>Egretta garzetta</i>	11		1	3	8			
23 Great White Egret <i>Egretta alba</i>					2		16	
25 Grey Heron <i>Ardea cinerea</i>	59		1	18	12	41	51	
26 Black-headed Heron <i>Ardea melanocephala</i>							1	
27 Goliath Heron <i>Ardea goliath</i>					1			
28 Hamerkop <i>Scopus umbretta</i>	1		1	3	1			
29 Yellow-Billed Stork <i>Mycteria ibis</i>	122			29	1	127	23	
30 Open-billed Stork <i>Anastomus lamelligerus</i>	3		2					
35 Saddle-billed Stork <i>Ephippiorhynchus senegalensis</i>						12	20	
36 Marabou Stork <i>Leptoptilos crumeniferus</i>	73			2	3	59	5	
42 Sacred Ibis <i>Threskiornis aethiopica</i>	1							
44 African Spoonbill <i>Platalea alba</i>	6			1	4	2		
45 Greater Flamingo <i>Phoenicopterus ruber</i>							2	
46 Lesser Flamingo <i>Phoeniconaias minor</i>	31		10		10	7	120	
48 White-faced Whistling Duck <i>Dendrocygna viduata</i>							123	
50 Egyptian Goose <i>Alopochen aegyptiacus</i>	40	51	32	23	22		7	280
53 Knob-billed Duck <i>Sarkidiornis melanotos</i>	1							
69 Osprey <i>Pandion haliaetus</i>				4	1		2	1
76 Fish Eagle <i>Haliaeetus vocifer</i>	2			5	2		37	
94 Eurasian Marsh Harrier <i>Circus aeruginosus</i>				1				
185 Grey-Crowned Crane <i>Balearica regulorum</i>			2	2				
197 Black-winged Stilt <i>Himantopus himantopus</i>	4			7			32	
201 Water Thicknee <i>Burhinus vermiculatis</i>	36	16	14					
207 Common Pratincole <i>Glareola pratincola</i>	14							
211 Ringed Plover <i>Charadrius hiaticula</i>	6			4				
212 Kittlitz's Sandplover <i>Charadrius pecuarius</i>	65	45	37	12			37	
213 Three-banded Plover <i>Charadrius tricollaris</i>							2	
215 Kentish Plover <i>Charadrius alexandrinus</i>				1				
223 Spur-winged Plover <i>Vanellus spinosus</i>	22	27	13	9			44	
229 Little Stint <i>Calidris minuta</i>	115			19			25	
231 Curlew Sandpiper <i>Calidris ferruginea</i>	185			39				
234 Ruff <i>Philomachus pugnax</i>	33			2				
239 Black-tailed Godwit <i>Limosa limosa</i>	1							
242 Curlew <i>Numenius arquata</i>							2	
243 Spotted Redshank <i>Tringa erythropus</i>	1							
245 Marsh Sandpiper <i>Tringa stagnatalis</i>	4			4				
246 Greenshank <i>Tringa nebularia</i>	7			13				
250 Common Sandpiper <i>Actitis hypoleucos</i>	3		3	3				
251 Turnstone <i>Arenaria interpres</i>							2	
254 Grey-headed Gull <i>Larus cirrocephalus</i>	2							
259 Gull-billed Tern <i>Gelochelidon nilotica</i>					20			
264 White-winged Black Tern <i>Chlidonias leucopterus</i>	240		40	27	6			
265 African Skimmer <i>Rynchops flavirostris</i>	200		50	4		3		
383 Pied Kingfisher <i>Ceryle rudis</i>	6		1	2			1	
Number of counts	4	1	3	2	3	2	2	(2)

Table 7. Maximum counts* for Lake Kasenye, 1984–2000, arranged seasonally.

	Jan–Mar	Apr–June	July–Sept	Oct–Dec
8 White Pelican <i>Pelecanus onocrotalus</i>			75	70
9 Pink-backed Pelican <i>Pelecanus rufescens</i>			12	
17 Cattle Egret <i>Bubulcus ibis</i>			2	75
28 Hamerkop <i>Scopus umbretta</i>				2
29 Yellow-billed Stork <i>Mycteria ibis</i>		3	12	1
30 Open-billed Stork <i>Anastomus lamelligerus</i>	2	140	19	60
36 Marabou Stork <i>Leptoptilos crumeniferus</i>		51	80	
46 Lesser Flamingo <i>Phoeniconaias minor</i>	200	350	170	65
50 Egyptian Goose <i>Alopochen aegyptiacus</i>				3
197 Black-winged Stilt <i>Himantopus himantopus</i>	4	12	60	1
201 Water Thicknee <i>Burhinus vermiculatus</i>		8	22	37
207 Common Pratincole <i>Glareola pratincola</i>			1	
212 Kittlitz's Sandplover <i>Charadrius pecuarius</i>		2	20	7
213 Three-banded Plover <i>Charadrius tricollaris</i>			1	2
223 Spur-winged Plover <i>Vanellus spinosus</i>		6	16	29
229 Little Stint <i>Calidris minuta</i>		6	30	5
234 Ruff <i>Philomachus pugnax</i>			10	
248 Wood Sandpiper <i>Tringa glareola</i>		1		
250 Common Sandpiper <i>Actitis hypoleucos</i>	2	1		
259 Gull-billed Tern <i>Gelochelidon nilotica</i>				40
264 White-winged Black Tern <i>Chlidonias leucopterus</i>		60	200	3
383 Pied Kingfisher <i>Ceryle rudis</i>			1	
Number of counts	1	5	4	5
Average water level**	2.0	3.0	3.0	3.7

* No total counts, except pelicans and Lesser Flamingo

** Scored as in Table 4

Lesser Flamingos

There are interesting historical records of Lesser Flamingos at the QECA dating back to 1906 when attempted breeding was first recorded by Pitman (1942). In the 1930s, up to 40,000 Lesser Flamingos attempted to breed, mainly on Lake Kikorongo, but only a few were reported in the 1950s (Din & Eltringham, 1976). These birds were no longer found on Lake Kikorongo after it was diluted by heavy rains and flooding from Lake George in the early 1960s. However in 1968–1970 small numbers were seen on Lake Bagusa (Din & Eltringham, 1970). During that time the Lesser Flamingo was only an occasional visitor, in small numbers, to the QECA. A series of aerial counts over Lake Bagusa gave a peak of 1,121 in April 1969: then in 1974, 20,000 were found in a complete survey of the QECA (Din & Eltringham, 1976). During the 1990s, Lesser Flamingo numbers on Lake Bagusa ranged from 69 to 60,000 (Nature Uganda, unpublished), reflecting a general increase in the QECA.

Din & Eltringham (1976) pointed out that the major influxes of Lesser Flamingos in the QE area had been in every third decade: the 1900s, 1930s and 1960s, prompting them to comment '... before a further massive visitation by flamingos in the 1990s is forecast ...'. Remarkably, the numbers in the 1990s were as high as had ever been reported previously! And of the four decades with high flamingo numbers, breeding was attempted in all but the 1930s: recorded months with nests or eggs are from December to February. So far, however, no breeding attempt has been successful.

Alkaline lakes are expected to have a high biomass of algae and flamingos are more-or-less confined to a diet of algae (table 2). The algae are equally numerous on lakes with a conductivity value of only 37,000 $\mu\text{S cm}^{-2}$ as on those where the conductivity is much higher (figure 3). For comparison, values of conductivity on Lake Nakuru, where flamingo numbers

can exceed a million, are lower-ranging from 14,000 to 26,000 $\mu\text{S cm}^{-2}$ (Vareschi, 1978). Under these conditions the alga *Spirulina platensis*, a major food source of the Lesser Flamingo, flourishes.

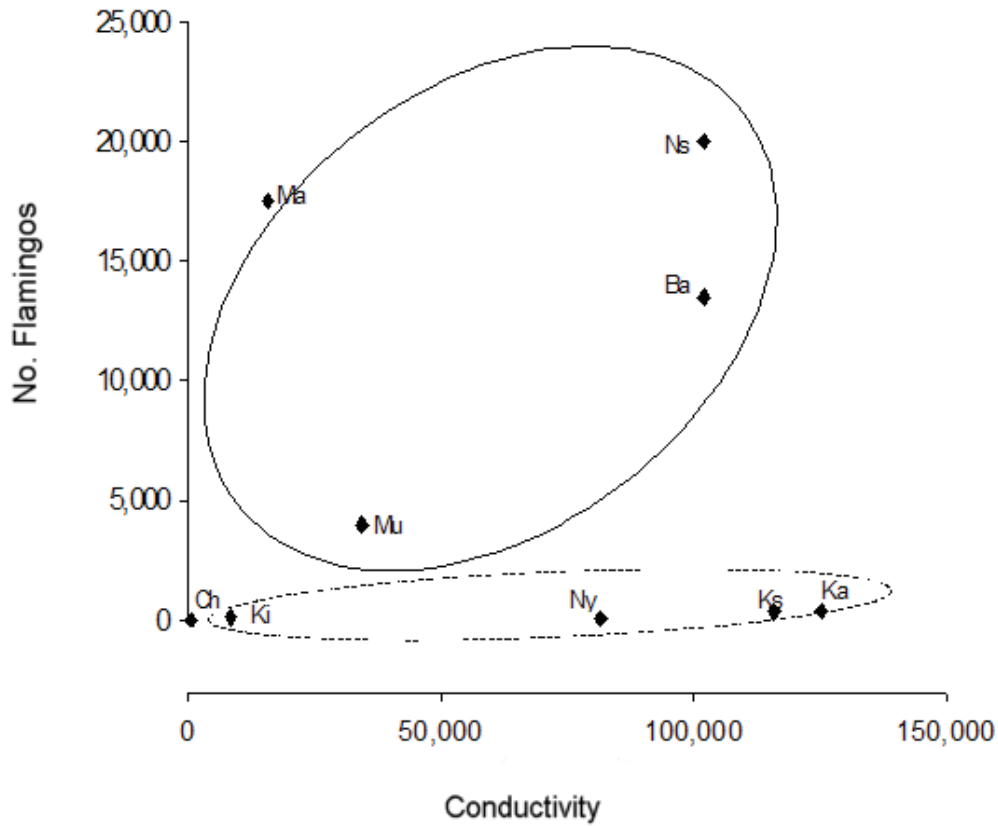


Figure 3. The range of conductivity values for lakes with many flamingos (solid line) is similar to that for lakes with few flamingos (dashed line). But they are absent from the freshwater lakes. The lakes are indicated by their initial letters: **B**agusa, **C**hibwera, **K**atwe, **K**ikorongo, **K**asenyi (**Ks**), **M**aseche, **M**unyanyange, **N**shenyi and **N**yamunuka. The two ellipses enclose lakes with many and few flamingos: the solid line being the former.

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