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Flamingo

Bulletin of the IUCN-SSC/Wetlands International
Flamingo Specialist Group

Edited by Rebecca Lee, Felicity Arengo and Arnaud Béchet

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This issue of *Flamingo* was edited by Rebecca Lee, Felicity Arengo and Arnaud Béchet, and was produced with financial support from the Wildfowl & Wetlands Trust (WWT). We are grateful to Brooks Childress for his guidance in the preparation of this bulletin, Colette Hall (WWT) for her help with design and printing, and Michelle O'Brien and Peter Cranswick (WWT) for their advice.

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Front cover photographs (clockwise from top left):

1. Puna Flamingos *Phoenicoparrus jamesi* at Laguna Colorada, Bolivia by Omar Rocha
2. Andean Flamingos *Phoenicoparrus andinus* at Laguna Colorada, Bolivia by Omar Rocha
3. Lesser Flamingos *Phoeniconaias minor* by Devesh Gadhvi
4. Puna Flamingo chick at Laguna Grande nesting site, Catamarca, Argentina by Patricia Marconi
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6. Chilean Flamingo *Phoenicopterus chilensis* in captivity at WWT Slimbridge, UK by Nick Cottrell
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9. Lesser Flamingos at Sua Pan, Botswana by Graham McCulloch

About the Flamingo Specialist Group

The Flamingo Specialist Group (FSG) is a global network of flamingo specialists (both scientists and non-scientists) concerned with the study, monitoring, management and conservation of the world's six flamingo species. Its role is to actively promote flamingo research, conservation and education worldwide by encouraging information exchange and cooperation among these specialists, and with other relevant organisations, particularly the IUCN-SSC, Wetlands International, the Ramsar Convention on Wetlands, the Convention on the Conservation of Migratory Species (CMS), the African-Eurasian Waterbird Agreement (AEWA) and BirdLife International. The group is coordinated from the Wildfowl & Wetlands Trust, Slimbridge, UK, as part of the IUCN-SSC/Wetlands International Waterbird Network.

Aims and objectives

- Developing and maintaining an active and comprehensive international network of *in situ* and *ex situ* flamingo conservation specialists (both scientists and non-scientists)
- Stimulating and supporting information exchange among flamingo conservation specialists
- Encouraging development and implementation of conservation action plans for the three species of greatest conservation concern: *Phoenicoparrus andinus*, *P. jamesi* and *Phoeniconaias minor*
- Promoting innovative conservation approaches and reconciliation of water conservation for people and for flamingos in the context of climate change and predicted water shortage
- Providing information and advice in support of the programmes of Wetlands International, IUCN-SSC and others that promote the conservation of flamingos and their habitats

FSG members include experts in both *in situ* (wild) and *ex situ* (captive) flamingo conservation and a wide-range of related fields, including breeding biology, infectious disease, toxicology, movement tracking and data management. There are currently 304 members representing 215 organisations around the world. Further information about the FSG, its membership, the members email list server and this bulletin can be obtained from Rebecca Lee at the address below.

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Editorial

Just over six months ago, I took over from Brooks Childress as Chair of the Flamingo Specialist Group (FSG). He's not an easy act to follow! And I have to admit being daunted by the task. Fortunately, however, flamingos are a topic for which I have almost endless energy. I first encountered flamingos as a child visiting the Wildfowl & Wetlands Trust's (WWT) captive collection at Slimbridge and 13 years later I found myself back at WWT collecting flamingo eggs and monitoring WWT's captive flamingo breeding programme. It was during that work, observing the complex interactions between parent birds sharing incubation and rearing tasks that I became fascinated by flamingos and my interest has only grown in subsequent years.

As well as flamingos, I feel strongly about the importance of information exchange. In 2008, I produced the Flamingo Resource Centre website (www.flamingoresources.org) and over the last five years I have been involved in a wide range of communication and coordination activities, including coordinating an international avian influenza task force for the UNEP Convention on Migratory Species (CMS) and working as a regional networker for the Ramsar Convention on Wetlands. I hope to draw on these experiences in my role as Chair of the FSG.

My goals and objectives for the FSG do not differ from those of Brooks and all of my thinking so far has been guided by the excellent Strategic Plan Brooks produced in 2009 to cover the period 2009–2012. As such, the work of the FSG is grouped into four programmes of work: 1) developing and maintaining the FSG network, 2) stimulating and supporting information exchange, 3) taking a leadership role in the development and implementation of actions plans, and 4) providing information to the IUCN-SSC, Wetlands International, Birdlife International, Ramsar and others.

Towards the goal of implementing action plans, we are in the final stages of establishing a Small Grants Fund. Currently, the funding available is very limited but we hope to find new donors to increase the number of grants available each year. Projects that contribute to the development or implementation of action plans will be prioritised. To connect with potential donors, as well as raise public awareness and find new opportunities for information exchange, I have established a Facebook page and a Twitter account for the FSG (for more information see the News Reports section). On a similar note we now have a dedicated FSG website (www.flamingo-sg.org). The site includes information about the group, our Strategic Plan, a News section, a Get Involved section as well as information about flamingos and their habitats. Eventually, the site will also provide a mechanism for us to compile new research, breeding reports and other monitoring data, and I plan to transfer the resources held on the Flamingo Resource Centre website to this new FSG site.

Observing conversations over the email list server and reading the wonderful submissions for this bulletin, it is obvious that the FSG has a very active, productive and dedicated membership. To further utilise the talents of our members, I am proposing a new organisational structure for the group involving a much larger number of people. My proposal is to establish species and thematic expert teams as well as a number of coordination roles, such as a website coordinator and a membership coordinator. This proposal will be circulated to members at around the same time as this bulletin is published.

As always, please contact me anytime if you have thoughts on the future direction of the group.

Rebecca Lee (rebecca.lee@wwt.org.uk)

A heartfelt thank you to Brooks

Following a successful 27-year business career in the USA, England, and Canada, Brooks and his wife, Sandy, moved to Kenya in 1991 where Brooks took up a new career in biodiversity conservation. He studied for a PhD on the breeding biology and feeding ecology of the Great Cormorants on Lake Naivasha, registered at University of Leicester (UK) and received his doctorate in Biological Sciences in 1998 (I first met Brooks the year previously when he asked me to comment on his PhD thesis). Brooks subsequently served as an honorary Research Associate in the Threatened Species Unit of the Wildfowl & Wetlands Trust and the Department of Ornithology in the National Museums of Kenya, Nairobi, as well as being an Honorary Visiting Fellow in the Department of Biology, University of Leicester.

In 2000 he conducted an expedition to St. Kitts – Nevis to determine the status and distribution of the globally threatened West Indian Whistling Duck, then between 2001 and 2009 conducted biometric, behavioural and satellite tracking studies of Lesser Flamingos in East Africa, including leading eight teams of Earthwatch volunteers to Lake Bogoria, Kenya, in a series of studies of local and long-distance movement patterns of the Lesser Flamingo. This gave him the ideal experience and background to take over as Chair of the FSG from Alan Johnson in November 2004.

His achievements as Chair were notable – he produced an international action plan for the Lesser Flamingo, including raising the US$37,000 needed to hold a workshop in Kenya. As a result of this, national action plans were produced for Kenya and Tanzania, and national action planning is underway in South Africa and Botswana. After some effective behind the scenes presentations and negotiations with the Tata Chemicals Executive Committee in Mumbai and London, Brooks played an important role in the successful campaign to convince the company not to develop a soda ash plant at Lake Natron.

He produced and implemented a new strategic plan for the FSG and improved the quality of the SG Bulletin *Flamingo*. Under his leadership the membership of the FSG increased from 37 to over 300 members. Brooks was instrumental in forming a Caribbean Flamingo Conservation Group and maintained an up-to-date members' database and list server for both groups, much to the satisfaction of IUCN-SSC.

Brooks was very successful in raising funds for flamingo conservation. With the notable support of Bill Hunt and the International Flamingo Foundation, Brooks raised almost US$100,000 during his term in office. This has recently led to an initiative to set up a small grants fund for the FSG.
Brooks has always been keen to publish his work, and he did so prolifically as first author and contributing author in peer-reviewed journals and many in non-peer-reviewed journals, as well as numerous reports and popular articles.

In July 2010, at the ripe young age of 70 and after five and a half years dedicated service, Dr. Brooks Childress stepped down as Chair of the Flamingo Specialist Group. I'm sure everyone will join me in wishing Brooks a very, very happy retirement.

Baz Hughes (Head of Species Conservation, Wildfowl & Wetlands Trust)

Membership summary

During 2009–10 membership grew 7% with nine new organisations and two new countries (Jordan and Pakistan) represented. Currently there are 304 members representing 215 organisations and agencies from 57 countries. Some 209 members are involved primarily with the conservation of flamingos in the wild (*in situ*), while 95 are involved primarily with flamingos in captivity (*ex situ*).

Country	Number of members	Country	Number of members
Algeria	6	Madagascar	2
Argentina	12	Mauritania	1
Bahamas	2	Mexico	14
Belgium	4	Morocco	2
Bolivia	1	Namibia	6
Botswana	3	Netherlands Antilles	2
Canada	1	Pakistan	1
Chile	8	Paraguay	3
Colombia	2	Peru	3
Cuba	2	Poland	1
Cyprus	4	Portugal	1
Czech Republic	2	Saudi Arabia	1
Denmark	1	Senegal	3
Djibouti	1	South Africa	8
Egypt	2	Spain	10
Ecuador	1	Suriname	1
Eritrea	1	Switzerland	2
Ethiopia	4	Tanzania	6
Finland	1	The Netherlands	11
France	8	Tunisia	2
Germany	6	Turkey	1
Guinea-Bissau	1	Turkmenistan	1
India	14	Uganda	1
Iran	2	United Arab Emirates	9
Italy	8	United Kingdom	52
Jordan	1	Uruguay	1
Kazakhstan	1	United States	52
Kenya	6	Venezuela	1
Libya	1		

Breeding & ringing reports

Greater Flamingo *Phoenicopterus roseus*

Southwest & South Asia

Contributors: Salim Javed, Bhavbhuti Parasharya

Table 1. Numbers of Greater Flamingo *Phoenicopterus roseus* breeding pairs and fledged chicks at known sites in southwest and south Asia in 2010.

Location	Nesting pairs	Fledged chicks	Comments
Abu Dhabi (breeding period: May – June)			
Bu Al Syaeef	0	0	Two birds ringed
India (breeding period: erratic, depending on rains, but mainly September – November)			
Bela-Mowana, Great Rann of Kachchh	Unknown	Unknown	
Boru salt pans, Great Rann of Kachchh	Unknown	Unknown	
"Flamingo City", Great Rann of Kachchh	Unknown	Unknown	Some breeding observed
Purabcheria mud flats, Little Rann of Kachchh	Unknown	Unknown	
Zinzuwada salt pans, Little Rann of Kachchh	0	0	No nesting since 2006
Iran (breeding period: May – June)			
Uromiyeh Lake	Unknown	Unknown	

East & Southern Africa

Contributors: Mark Anderson, Tania Anderson, Graham McCulloch

Table 2. Numbers of Greater Flamingo *Phoenicopterus roseus* breeding pairs and fledged chicks at known sites in east and southern Africa in 2010.

Location	Nesting pairs	Fledged chicks	Comments
Tanzania (breeding period: erratic, depending on rains, but mainly November – February)			
Lake Natron	Unknown	Unknown	See Lake Natron entry for Lesser Flamingos
Botswana (breeding period: erratic, depending on rains, but mainly November – February)			
Sua Pan	15,000	8–12,000	No ringing
Namibia (breeding period: erratic, depending on rains, but mainly November – February)			
Etosha Pan	0	0	No ringing
South Africa (breeding period: erratic, depending on rains, but mainly November – February)			
Kamfers Dam, Kimberley	1,200*	600	No ringing

* First time Greater Flamingo breeding has been recorded at Kamfers Dam.

Mediterranean and West Africa

Contributors: Arnaud Béchet, Christophe Germain and members of the Mediterranean and West African Greater Flamingo Network with data from Bouchibi Baaziz et al. (2010, in this report).

Breeding by Greater Flamingos in Mediterranean and West African countries during 2010 was reported at 18 sites. Over 65,000 pairs attempted to breed, based on nest counts in many instances, and an estimated 31,110 chicks were produced (Table 3).

Table 3. Numbers of Greater Flamingo *Phoenicopterus roseus* breeding pairs, fledged chicks and chicks ringed at known sites in the Mediterranean and West Africa in 2010.

Location	Nesting pairs	Fledged chicks	Chicks ringed	Ringing date (2010)
Spain (breeding period: April – June)				
Punta de la Banya (Ebro Delta)	2,022	631	400	1 August
Fuente de Piedra	19,483	8,118	611	7 August
Marismas del Odiel	2,150	558	548	17 July
Salinas de Santamaría (Cádiz)	12	0	0	
Manjavacas	1,500	850 – 1200	0	
Doñana	0	0	0	
France (breeding period: April – June)				
Fangassier (Camargue)	13,720	2,400	812	4 August
Italy (breeding period: April – June)				
Comacchio	3,282	1,822	422	
Margherita di Savoia	Unknown	400	0	20 July
Northern Po Delta	0			
Dogà, Lagoon of Venice	Unknown	0		
Diaccia Botrona	0			
Molentargius (Sardinia)	140	0	0	
Saline di Macchiareddu (Sardinia)	Up to 500 pairs	0	0	
Saline di Carloforte (San Pietro island)	0			
Siracusa (Sicily)	30	0		
Turkey (breeding period: April – June)				
Tuz Lake	Unknown	5,070		
Camalti (Gediz delta)	5,487	2,071		
Algeria (breeding period: April – August)				
Garaet Ezzemoul	At least 20	0		
El Goléa	At least 15	0		
Bazer Sakra	At least 300	0		
Chott Merouane	2,604	2,240		
Sebkhat Safioune	At least 61	0		
Tunisia (breeding period: April – June)				
Salines de Thyna	0			
Sebkhet Sejoumi	0			
United Arab Emirates				
Bu Al Syaeef (west Abu Dhabi Island)	0			
Mauritania (breeding period: March – July)				
Kiaones (Parc National du Banc d'Arguin)	8,700	5,400		
Aftout es Saheli	2,400	1,550		

Lesser Flamingo *Phoeniconaias minor*

Southwest & South Asia

Contributor: Bhavbhuti Parasharya

Table 4. Numbers of Lesser Flamingo *Phoeniconaias minor* breeding pairs and fledged chicks at known sites in southwest and south Asia in 2010.

Location	Nesting pairs	Fledged chicks	Comments
India (breeding period: erratic, depending on rains, but mainly September – November)			
Bela-Mowana, Great Rann of Kachchh	Unknown	Unknown	Colony size thought to be similar to last year – c. 70-80,000 chicks
Boru salt pans, Great Rann of Kachchh	Unknown	Unknown	
"Flamingo City", Great Rann of Kachchh	Unknown	Unknown	
Purabcheria mud flats, Little Rann of Kachchh	Unknown	Unknown	Breeding event June – July
Zinzuwada salt pans, Little Rann of Kachchh	0	0	No nesting since 2006

East Africa & southern Africa

Contributors: Mark Anderson, Tania Anderson, Graham McCulloch, Neil Baker.

Table 5. Numbers of Lesser Flamingo *Phoeniconaias minor* breeding pairs and fledged chicks at known sites in east and southern Africa in 2010.

Location	Nesting pairs	Fledged chicks	Comments
Tanzania (breeding period: erratic, depending on rains, but mainly November – February)			
Lake Natron		c. 18,000	These chicks could not be identified to species. It is, however, far more likely that these chicks were Lesser Flamingos rather than Greater Flamingos
Lake Eyasi	Unknown	Unknown	A few chicks observed but unlikely to have survived – 100s of abandoned eggs seen
Botswana (breeding period: erratic, depending on rains, but mainly November – February)			
Sua Pan	40–45,000	30–35,000	12 ringed and banded; satellite PTTs placed on 3 birds (in collaboration with MPI)
Namibia (breeding period: erratic, depending on rains, but mainly November – February)			
Etosha Pan	0	0	No breeding or ringing
South Africa (breeding period: erratic, depending on rains, but mainly November – February)			
Kamfers Dam, Kimberley	2,000	1,800	There were several thousand pairs breeding at the start of the season (Sep/Oct/Nov), but the island flooded in Nov 2009 – c. 80% of breeding area lost

Caribbean Flamingo *Phoenicopterus ruber*

Contributors: Xiomara Galvez, R. Migoya and Felicity Arengo

Table 6. Numbers of Caribbean Flamingo *Phoenicopterus ruber* breeding pairs and chicks fledged in 2010.

Location	Nesting pairs	Fledged chicks	Comments
Bahamas (breeding period: April – June)			
Lake Rosa, Great Inagua	0	0	No breeding in Bahamas
Bonaire (breeding period: October – March)			
Pekelmeer	Unknown	Unknown	
Cuba (breeding period: April – June)			
El Refugo de Fauna Rio Maximo	Unknown	Unknown	
Mexico (breeding period: April – September)			
Ría Lagartos Biosphere Reserve	3,500	2,700	225 chicks were ringed
Venezuela (breeding period: October – March)			
Refugio de Fauna Silvestre y Reserva de Pesca (Los Olivitos Wildlife Refuge and Fishing Reserve)	Unknown	Unknown	
La Restinga National Park, Margarita Island	Unknown	Unknown	
Ecuador			
Galápagos Archipelago	Unknown	Unknown	No report received

Chilean Flamingo *Phoenicopterus chilensis*

Contributors: Nelson Amado, Carlos Nassar, Sol Aguilar, Enrique H. Bucher, Patricia Marconi and Felicity Arengo (including data from F. Moschione, C. Rodríguez, H. Sosa, A. Sureda, R. Torres, P. Michelutti, M. Michelutti, S. Villalba, H. Paulini, M. Romano, I. Barberis and S. Martín).

Breeding by Chilean Flamingos *Phoenicopterus chilensis* during 2010 was reported at seven sites. At least 49,500 pairs attempted to breed, and an estimated 6,255 chicks were produced (not including 1,812 chicks in Bolivia that were not identified to species; Table 7).

Table 7. Number of Chilean Flamingo *Phoenicopterus chilensis* breeding pairs and fledged chicks at each known site in South America in 2010.

Location	Nesting pairs	Chicks fledged	Comments
Argentina (breeding period: December – February)			
Laguna Pozuelos	930	0	Breeding colony recorded on 16 February. Total number of nests 2,081. Number of active nests 930. On 18 March the colony was flooded and abandoned.
Salinas Grandes	1,500	216	Breeding colony recorded on 26 January
Mar Chiquita	32,700	5–7,000	Breeding colony recorded on 26 January
Laguna Melincué	0	0	No breeding
Laguna Llancanelo	13,866	2,500	One group of nests
Lago Aleusco	Unknown		
Bolivia (breeding period: December – February)			
Laguna Catalcito	Unknown	539	63 active nests in December 2010
Chile (breeding period: December – February)			
Salar de Coposa	0	0	
Laguna Huambune	0	0	
Salar de Huasco	0	0	
Salar de Loyoques	0	0	
Salar de Surire	0	0	

Andean Flamingo *Phoenicoparrus andinus*

Contributors: Nelson Amado, Cristian Rivera, Carlos Nassar, Sol Aguilar, Patricia Marconi and Felicity Arengo (including data from A. Sureda and R. Clark).

Breeding by Andean Flamingos *Phoenicoparrus andinus* during 2009/10 was reported at seven sites. An estimated 648 pairs attempted to breed producing only 80 known chicks (1,812 chicks in Bolivia that were not identified to species; Table 8).

Table 8. Number of Andean Flamingo *Phoenicoparrus andinus* breeding pairs and fledged chicks at each known site in South America in 2009/10.

Location	Nesting pairs	Chicks fledged	Comments
Argentina (breeding period: December – February)			
Laguna Purulla	100	Unknown	Three groups of nests
Laguna Llancanelo	1	Unknown	One active nest amongst a breeding colony of *Phoenicopterus chilensis*
Laguna Brava	0	0	No breeding
Chile (breeding period: December – February)			
Laguna Barros Negros, Salar de Atacama	240	0	
Laguna Puilar, Salar de Atacama	130	0	
Laguna Salada, Salar de Atacama	45	0	
Laguna Saladita, Salar de Atacama	10	0	
Salar de Pujsa	0	0	
Salar de Tara	120	80	
Salar de Coposa	0	0	
Salar de Huasco	0	0	
Salar de Maricunga	0	0	
Laguna Negro Francisco	0	0	
Nevado Tres Cruces	0	0	
Salar de Punta Negra	Unknown	0	
Salar de Surire	0	0	

Puna Flamingo *Phoenicoparrus jamesi*

Contributors: Nelson Amado, Cristian Rivera, Carlos Nassar, Sol Aguilar, Patricia Marconi and Felicity Arengo (P. Marconi y 2010), (including data from F. Moschione, C. Rodríguez, E. Derlindati, N. Cruz, E. Fra, P. Marconi, R. Clark, A. Sureda and H. Sosa).

Breeding by Puna Flamingos *Phoenicoparrus jamesi* during 2009/10 was reported at nine sites. An estimated 12,271 pairs attempted to breed producing an estimated 5,403 chicks (not including 1,812 chicks in Bolivia that were not identified to species; Table 9).

Table 9. Number of Puna Flamingo *Phoenicoparrus jamesi* breeding pairs and fledged chicks at each known site in South America in 2009/10.

Location	Nesting pairs	Chicks fledged	Comments
Argentina (breeding period: December – February)			
Laguna Vilama	0	0	No breeding
Laguna Honda	144		Active nests
Laguna Guindas	0	0	No breeding
Laguna Lina	10	14	Active nests
Laguna Santa María	0	0	No breeding
Laguna Pabellón	0	0	No breeding
Laguna Grande	1,794	45	Breeding colony recorded on 23 January, four groups of nests. One abandoned group (50 nests) found with motorcycle tracks through the colony.
Laguna Brava	0	0	No breeding
Laguna Aparejos	0	0	No breeding
Bolivia (breeding period: December – February)			
Laguna Khara		88	
Chile (breeding period: December – February)			
Salar de Pujsa	1600	550	Chicks produced for first time in several years (failed previous years)
Salar de Tara	1200	706	
Salar de Coposa	0	0	
Salar de Huasco	500	0	Intense summer rains drowned colony, eggs laid but abandoned before incubation
Laguna Negro Francisco	120	0	
Nevado Tres Cruces	0	0	
Salar de Piedra Parada	0	0	
Salar de Surire	6727	4000	

Captive populations

Rebecca Lee

The total number of captive flamingos registered worldwide with the International Species Information System (ISIS) is 16,354 (ISIS, 2010). This number, however, is probably less than half of the true number of flamingos in captivity, as many flamingos are held by non-ISIS-registered institutions and by private breeders (King, 2008). The following table summarises registered captive flamingo populations and breeding success in ISIS-registered institutions worldwide as of 4 November 2010 (Table 10).

Table 10. Numbers of ISIS-registered institutions holding each flamingo species, numbers of registered birds and numbers of chicks hatched over a 12 month period, November 2009 to November 2010.

Species	Registered institutions		Registered birds		Reported chicks (last 12 months)	
	Birds	Change since 2009	Birds	Change since 2009	Birds	Change since 2009
Caribbean Flamingo *Phoenicopterus ruber*	169	0	4,676	-68	113	-9
Greater Flamingo *Phoenicopterus roseus*	138	+7	5,084	+509	105	-19
Chilean Flamingo *Phoenicopterus chilensis*	177	+4	4,825	+139	77	+28
Lesser Flamingo *Phoeniconaias minor*	60	0	1,482	-85	18	+7
Andean Flamingo *Phoenicoparrus andinus*	1	0	26	0	0	0
Puna Flamingo *Phoenicoparrus jamesi*	1	0	1	-1	0	0
Unidentified flamingo species and hybrids	38	-1	260	+20	1	-7
Total	**N/A**		**16,354**	**+606**	**314**	**0**

Source: International Species Information System (www.isis.org; date accessed: 7 Dec 2010).
Note: Figures for numbers of birds are the number of registered birds; thus increases may indicate that institutions have registered more birds with ISIS rather than obtained new birds.

Captive Greater Flamingo *Phoenicopterus roseus* round-up at WWT Slimbridge (Photo by Richard Taylor-Jones).

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News reports

In memoriam of Dr J. Lindsay Oaks

David M. Harper (dmh@leicester.ac.uk)

It is with great sadness and heavy hearts that we inform you about the passing away of Dr. J. Lindsay Oaks of Washington State University.

Dr J. Lindsay Oaks

Lindsay was an animal health veterinarian, an Associate Professor at Washington State University, Pullman, Washington, USA. He had always been interested in birds and this took the form of involvement – from an early age – with The Peregrine Fund, based in Idaho, USA. He first became involved as a teenager in the 1970s with the captive breeding and restoration of endangered Peregrine Falcons. He subsequently qualified as a veterinarian and specialized in avian virology. He achieved distinction in the conservation world by helping discover that veterinary Diclofenac was the primary cause of mortality that drove the catastrophic decline of Gyps vultures in South Asia. He also worked with the Fund on other important issues – to discover and prevent the viral agent causing mortality in captive Aplomado Falcons, and to expose lead from spent ammunition as a potentially fatal contaminant in food consumed by California Condors.
He first became involved in Lesser Flamingos six years ago when I invited him to Lake Bogoria to address the complicated issue of the causes of occasional mass mortalities of birds there. It was clear that many of the explanations put forward to explain mortality were narrow, single-discipline approaches, such as heavy metal or cyanobacterial toxin poisoning, which did not take into account the full biological evidence and were unlikely to be real explanations. Lindsay made successive annual field visits to Bogoria with us on field research camps, carefully collecting newly dead birds every morning along the lake shore, examining the causes of death and taking samples for laboratory analysis, at the same time as making careful observations on the nature of flamingo flocks and the environmental conditions at the time. The research was initially funded by the Earthwatch Institute and the Darwin Initiative, but when the funding ran out after the end of 2008 and the research camp was maintained by our student contributions, Lindsay paid his own air fares. He was always available for consultation and he assisted several undergraduate students on each year's research camp, from Leicester, Queen Mary London and Washington State universities, with their dissertation field work. He also demonstrated his work to students from Kenyan colleges and universities visiting the reserve, to local high school pupils and interested members of the community each year when we were there.

His interests and collaborations go well beyond these accomplishments; he will be missed by many. All who worked with him benefited from his knowledge, skills and humour. A commemorative volume entitled "Contributions to the Conservation of Lake Bogoria National Reserve: Essays in Honour of Dr. J. Lindsay Oaks" is planned by those of us at Leicester, with contributions invited from all those whom he worked alongside in the six years that he came to the Lake Bogoria National Reserve every year for 2 weeks fieldwork.

"Lindsay Oaks D.V.M., Ph.D., of Pullman, WA, USA was born August 6, 1960 and passed to sleep in peace at 7:15 AM on January 15, 2011 at Holy Family Hospital in Spokane, WA". Published in Spokesman-Review from January 16 to January 17, 2011.

An obituary has been published at www.dnews.com/story/obituaries/59103/.

Unusual winter breeding by Lesser Flamingos on Sua Pan, Botswana in 2009

Graham McCulloch

2009 was an unusual year on Sua Pan, in that we had exceptional rainfall in the middle of the winter (non-breeding) season, which totalled over 200 mm (half the annual average rainfall). The pan filled up and

many flamingos arrived. They began breeding in June and it was the first time that Lesser Flamingos *Phoeniconaias minor* were recorded breeding successfully in mid-winter.

Although the total number of chicks were not counted, breeding numbers exceeded 20,000 pairs and the pan remained wet until the following rainy season, in November of the same year, suggesting chick success was high. This event, once again, highlights their opportunistic breeding nature, whenever conditions are suitable.

Positive news from Kamfers Dam

Mark Anderson

From November 2010 to February 2011, Jahn Hohne (Chairman of the Save the Flamingo Association, and MD of Ekapa Mining) and Mark Anderson (Vice Chairman of StFA, and CEO of BirdLife South Africa) have had several meetings with Mr Goolam Akharwaray, the Sol Plaatje Municipal Manager (Kimberley, South Africa).

The Homevale Waste Water Treatment Works (HWWTW) has been fixed (at a cost of c. R80 million) and it can now process 33 ML/day of sewerage water. So, we will be expecting water of a significantly improved quality flowing into Kamfers Dam.

Funding has also been obtained to repair the pipeline which will be used to pump excess, treated water away from Kamfers Dam. With water of an acceptable standard, the Municipality should be able to obtain a licence from the Department of Water Affairs to return the treated water to the Vaal Rover. It will therefore be possible to maintain the dam's water at an acceptable level (*i.e.* to prevent flooding of the flamingo breeding island and the surrounding railway lines). Funding has also been obtained to upgrade the HWWTW so that it can process an additional 15 ML/day.

A water quality expert has been employed by the Sol Plaatje Municipality and her instruction is to ensure that Kimberley receives Blue (for drinking water) and Green (for the treatment of sewerage) Drop water status.

Ekapa Mining has kindly undertaken to rebuild the flamingo breeding island and, with what we now know about island design (after our MKI version), this will be a deluxe island!

During the past summer only 10% of the island was above water, and this was initially used for breeding by *c.* 100 pairs of Lesser Flamingos and then by *c.* 160 pairs of Greater Flamingos. It is not known how many chicks fledged, especially as the island was completely flooded in January 2011 before the Greater Flamingo breeding event was completed. This past summer's breeding success was a far cry from 2007/8 when 9000 and 2008/9 when 13 000 Lesser Flamingo chicks were produced.

Mark says it was quite refreshing to listen to Goolam Akharwaray, and hear about the projects that are currently being implemented in Kimberley, his vision for the city, etc. There's hope, and there's certainly optimism (after the city almost approaching rock bottom during recent years!).

It is our opinion that the positive developments we are observing at the HWWTW and Kamfers Dam are the result of the efforts (petitions, meetings, letters, litigation, Carte Blanche and 50/50 programmes, articles in newspapers and magazines, *etc.*) of the Save the Flamingo Association, BirdLife South Africa, WESSA and the Booth family (Kamfers Dam's landowners). The Sol Plaatje Municipality eventually got the message. We may soon have one of the best functioning sewage plants in South Africa!

Conservation breakthrough in Botswana

Graham McCulloch

For many years now, conservationists have identified the Makgadikgadi salt pans, in northern Botswana as one of the most important breeding sites for Greater and Lesser Flamingo in Africa. Flamingo breeding sites are rare, but at Sua Pan (part of the Makgadikgadi pans complex), regular successful breeding events ensure the long-term viability of both species in southern Africa. Indeed, Sua Pan is one of only a few sites on the continent where Lesser Flamingo breed. An increasing number of developments and activities in the area are, however, slowly threatening the remote and inaccessible qualities that contribute to its ideal breeding conditions. Formal protection of this site has, as a result, become a matter of urgency.

Fortunately, many years of advocacy have finally paid off and, thanks to the efforts of a small group of conservationists (Tim Liversedge, Graham McCulloch and Birdlife Botswana's Pete Hancock) and the Government of Botswana, a flamingo sanctuary was established in July, 2010 to formally protect the Greater and Lesser Flamingo breeding sites on Sua Pan. The drafting of the sanctuary's regulations, only just completed, impose a strict ban on entrance into the sanctuary by land or by air, except for those conducting formally approved

Lesser Flamingos at Sua Pan, Botswana (by Graham McCulloch)

research and only under strict conditions and protocol.
The gazettement of the sanctuary is, of course, only the beginning. The regulations governing the area need to be enforced and this will be the biggest challenge. Its success in protecting the breeding sites will depend not only on the efforts of the wildlife department and its wardens in the area, but, more importantly, on the surrounding communities and their willingness to support and help enforce the regulations. To this end, the formation of the sanctuary and its regulations has included consultations with, and input from the surrounding communities.

In addition, Birdlife Botswana is currently working on a joint venture partnership among the surrounding villages in order to help them develop a larger conservation area around the edge of the pan. The area adjacent to the new sanctuary, being the remainder of the southern part of Sua Pan and its surrounding woodland, will form a sustainable development area that will form a buffer zone around the sanctuary, in which access to the pans and tourism related activities will be controlled. A management plan for the whole area is due to be developed soon, and this is being facilitated by a BirdLife Botswana UN funded project; 'Strategic Partnerships to improve the financial and operational sustainability of Protected Areas'.

Ultimately, the establishment of the flamingo sanctuary on Sua Pan is a huge achievement, providing protection and sustained inaccessibility to an increasingly exposed wilderness. More importantly, it has given renewed confidence in, and awareness of the long-term viability of Greater and Lesser Flamingo in southern Africa. In time, we hope that more similar action will provide even further protection for our flamingo populations.

The FSG and social networking

Rebecca Lee

The FSG can now be found on both Facebook and Twitter. These social networking sites allow us to connect with similar conservation groups and potential funding partners, share news, build relationships, and raise awareness of flamingo conservation as well as wetland conservation more broadly.

Since opening the accounts at the end of 2010, we now have over 330 followers on both sites, including conservation organisations around the world, tourism companies and a variety of corporate organisations that use flamingos in their names or logos. We've also been added to nine conservation-themed lists on Twitter which reach a wider audience than single accounts.

To FSG page on Facebook can be found at www.facebook.com/FlamingoSpecialistGroup and on Twitter look for @FlamingoSpecGrp. See you online!

New FSG website!

Rebecca Lee

The FSG now has a dedicated website:

www.flamingo-sg.org

The site aims to make the FSG more visible, raise awareness of flamingo conservation and provide a restricted members area. All comments and suggestions are welcome.

New FSG logo

Rebecca Lee

The FSG has a new logo! Created by Nick Cotterell from the Wildfowl & Wetlands Trust (WWT), the logo is designed to be simple, bold and representative of flamingos.

The logo can be used with or without the text 'Flamingo Specialist Group' on the left and works in black and white as well as colour. Whenever possible the FSG logo should be accompanied by the IUCN-SSC and Wetlands International logos. If you wish to use the FSG logo, please contact Rebecca Lee (rebecca.lee@wwt.org.uk) for advice.

Short reports

Seasonal variation of Andean and Chilean Flamingos in lowland wetlands of central Argentina

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Keywords: Lesser Flamingo, Phoeniconaias minor*, numbers, distribution, habitat use, Thane Creek, Mumbai, India, food abundance.*

Southern Santa Fe Province in Argentina has many shallow lakes embedded in a landscape where 70% of the area is used as grazing pastures and agricultural fields (Romano *et al.,* 2009). This region in the heart of Argentina's farm country is known as "Pampas de las Lagunas" (Pampas of the shallow lakes) (Pasotti *et al.,* 1984). Most of the lakes are moderately saline, but differ in their chemical composition (Romano *et al.,* 2008). These lakes are key lowland habitats for Andean Flamingos *Phoenicoparrus andinus*, especially during winter when some of the lakes in their primary habitats in the Andes of Argentina, Bolivia, Chile and Peru freeze (Caziani *et al.,* 2007). We have been monitoring Melincué, one of the largest lakes and a key site for flamingos in this area, since 1991 and have observed seasonal variations in the flamingo abundance there (Romano *et al.,* 2005; Romano *et al.,* 2008; Romano *et al.,* 2009). Since 2008 we have added several more lakes from the Pampas de las Lagunas complex to the winter flamingo census circuit so we can have a broader picture of flamingo abundance and distribution in the area.

This year we carried out summer and winter surveys (January and August 2010, respectively) throughout the area in order to determine seasonal differences in flamingo abundance. We visited 28 lakes in summer and 25 in winter. At each lake, we counted flamingos and noted the location of the flocks in the lake. We recorded habitat variables to correlate flamingo abundance and distribution to habitat characteristics. We recorded weather conditions and took water and sediment samples to measure physical and chemical properties and characterize plankton present. We also classified the land use of the area surrounding the lake (*e.g.* agriculture, feed-lots, *etc.*) in order to analyze possible threats to these wetlands. During winter censuses we also analysed water and sediment samples in a portable spectrofluorometer to identify and determine the abundance of different groups of algae in each lake. The water and sediment samples are currently being analysed so we will not present results of this aspect of the study in this report. Here we report solely on flamingo presence, abundance, and distribution in the Pampa de las Lagunas wetland complex in 2010.

We recorded a total of 13,756 Chilean Flamingos *Phoenicopterus chilensis* in summer and 13,333 in winter. We recorded 19 Andean Flamingos in summer and 2,587 in winter. There were also 385 flamingos that we were unable to identify to species in summer and 1,491 in winter. Finally, we recorded two Puna Flamingos *Phoenicoparrus jamesi* in winter at Melincué, constituting the first observation of this species at this site, usually considered outside the distribution range for the species.

These results show that this year there were no seasonal differences in the abundance of Chilean Flamingos in the wetlands of Pampa de las Lagunas. This pattern contrasts with what we observed in previous years for Melincué, where the abundance of

this species is markedly lower in summer than in winter (Romano *et al.,* 2005). For Melincué, the high number of flamingos observed this summer could be associated with a nesting event, which has not been observed there since 1999. It is possible that a nesting event could also have occurred in La Picasa Lake, another wetland where we observed many flamingos engaging in courtship displays during our summer survey and where breeding has been recorded in previous years.

The survey data show that Andean Flamingos were primarily present in this area during winter. This observation is consistent with previous reports from Melincué and Mar Chiquita, a large wetland to the north, in Cordoba Province (Caziani *et al.,* 2007). However, this winter there were fewer Andean Flamingos in Pampa de las Lagunas wetlands when compared with previous winter surveys (Romano *et al.,* 2009). This could not be explained by an increase in Andean Flamingos in other lowland sites we surveyed because, for example, flamingo abundance in Mar Chiquita was similar to other years (GCFA, unpublished data). These observations highlight the need to continue to survey and monitor these important habitats in both winter and summer over several years, and to broaden the survey area to cover more wetlands that may be providing winter habitat for Andean Flamingos.

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Articles

The Greater Flamingo *Phoenicopterus roseus* still breeds in Dasht-e Nawar, Afghanistan

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Abstract — Dasht-e Nawar (altitude: 3,150 m a.s.l.) located in the province of Ghazni, Afghanistan, was known since 1965 as the highest breeding site in the world for the Greater Flamingo *Phoenicopterus roseus*. Because of successive wars and civil turmoil the area could not be visited by scientists between 1979 and 2002. During the surveys we have carried out in 2007 and 2009 we confirmed for the first time since 1975 that the species still breeds in the area, with a maximum of 98 juveniles counted in August 2007. Our monitoring results and interviews of local inhabitants, however, suggest that the number of flamingos occurring in the area has decreased. In the absence of hunting and egg collection threats, the increasing diversion of inflowing waters in the main lake, for irrigation and human uses, seems to pose the greatest threat to the breeding colony of flamingos in the short term.

Keywords: Dasht-e Nawar, Ghazni, Afghanistan, breeding, Greater Flamingo, Phoenicopterus roseus, *survey, numbers, water extraction.*

Introduction

The presence of large breeding colonies of flamingos in Afghanistan was first reported by Babur the Great (1483–1530). In 1504, on his way back to Kabul from an expedition in the Indus Valley, he observed that "when within one mile of Ab-e Estada […] something of a red appearance was seen, like the ruddy crepuscule, which again by-and-by vanished […]. When we came close up we discovered that this appearance was occasioned by immense flocks of wild flamingos" (Talbot, 1909). Ab-e Estada, a large saline lake located at 32°30'N 67°55'E, provided for centuries breeding grounds for the Greater Flamingo *Phoenicopterus roseus*. Unfortunately recent accounts have suggested this is no longer the case for a variety of reasons which include a chronic shortage of inflowing water diverted for irrigation, the continuous pumping of underground waters and a considerable increase in the number of local residents, many of whom are active waterfowl and flamingo hunters (UNEP, 2003).

In 1965, German zoologists G. and J. Niethammer (cited in Klockenhoff & Madel, 1970) found another large colony of Greater Flamingos, in Dasht-e Nawar (3,150 m a.s.l.), a wetland located c. 130 km north of Ab-e Estada. Subsequently, the site was identified as the highest breeding haunt in the world for this species of flamingo, almost every year between 1969 and 1975 (Petocz & Habibi, 1975). However, after the beginning of the Soviet invasion in 1979, a long period of war started in the country and Dasht-e Nawar was no longer visited by scientists. It is only in September 2002 that a UNEP post-conflict environmental assessment mission could revisit the area. They found the lake basin dry and reported that the main lake had disappeared in summer for the past four years due to drought (UNEP, 2003). In April 2006 another mission counted up to 2,500 flamingos, but by the end of June the lake was dry and the birds had vanished, failing to breed (Petocz, 2006). These alarming reports suggested that, like in Ab-e Estada, water diversion for irrigation and human uses might no longer allow flamingos to breed successfully in Dasht-e Nawar.

Study site

Dasht-e Nawar (33°50'N 67°50'E) is located in the province of Ghazni, in Central Afghanistan (Figure 1). It is an extensive high-altitude plain enclosed in the arid Koh-e Baba mountain range, an offshoot of the Hindu Kush. The area encompasses c. 600 km² of grass-meadow plain, mudflat, brackish ponds and lakes, the largest one, Ab-e Nawar being a shallow, alkaline water lake of approximately 35 km². Water supplies come primarily from spring snow melt in the surrounding mountains and from several sources in the western part of the lake. Water level in spring is therefore almost entirely dependent on winter precipitations. Nogge (1974) believed that Ab-e Nawar water volume could typically drop from 20

million m³ to 2 million m³ between spring and fall because of evaporation.

Methods

We surveyed the area by car and foot in April and August 2007, and in July 2009. We counted flamingos between 5:30 and 10:30 in the morning using 10x binoculars, a 15/45x spotting scope and manual counters. Because flamingos gathered in only one to three large flocks it was easy to avoid duplicate counts. In August 2007 we also interviewed inhabitants of 49 households, all belonging to the predominant Hazara ethnic group, about recent history of flamingos and apparent threats in the area.

Results

In 2007, we recorded between 70 and 80 adult and immature Greater Flamingos on 28 April and 850 individuals, including 98 unfledged juveniles in one crèche, on 4 August, while we recorded on 29 July 2009 358 individuals including 20 unfledged juveniles and one adult Lesser Flamingo *Phoeniconaias minor*. Although the survey planned in summer 2008 had to be cancelled due to local insecurity, residents affirmed that large numbers of flamingos were present in the area that year. According to our questionnaire investigation, 75% of respondents considered the Greater Flamingo a salient feature of their environment and cultural patrimony, 49% of them supported that the species occurs in the area every year, but 80% of interviewees affirmed that their numbers have markedly decreased in the last 10 years or more, because of repeated droughts and chronic lack of water in the basin. Respondents mentioned that on rare occasions in the recent past, people from outside the area had attempted to capture several specimens alive.

Discussion

Thirty-two years after the last report of a breeding event (Petocz & Habibi, 1975) our surveys confirmed that the Greater Flamingo still reproduces in Dasht-e Nawar. Censuses carried out between 1969 and 1975 estimated spring/summer populations at 1,300–12,000 individuals with a maximum of 400 juveniles in 1975 (Petocz & Habibi, 1975).

Spring/summer counts between 2006 and 2009 reported population sizes of 80 to 2,500 individuals with a maximum of 98 juveniles in 2007, suggesting in concordance with inhabitant's impression that the number of flamingos breeding in the area has decreased.

In western Asia, the Greater Flamingo breeds in local and discontinuous colonies, sometimes, like in Afghanistan, at high altitudes, but always in brackish, salt-water or alkaline lakes (Cramp, 1977). Because of this highly precarious breeding habitat, the species demography is dependent on stochastic events, such

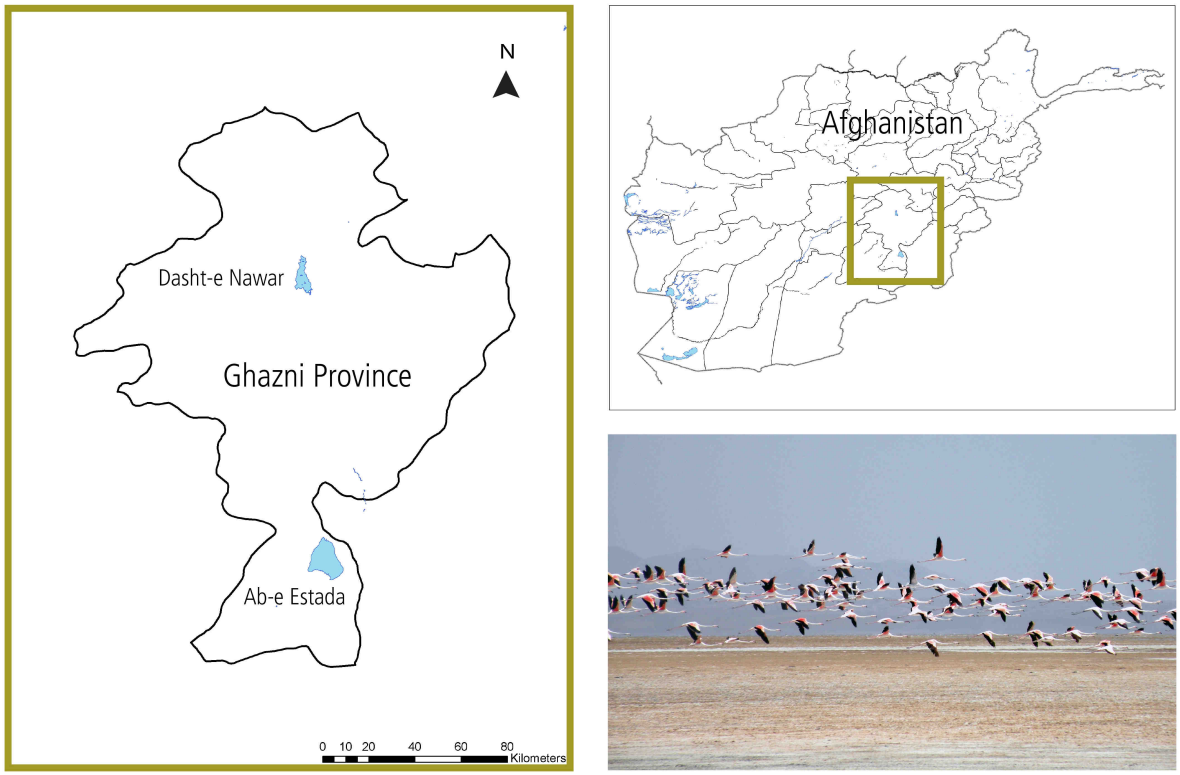

Figure 1. Maps of the location of Dasht-e Nawar and Ab-e Estada in Afghanistan. The flock of Greater Flamingos *Phoenicopterus roseus* was photographed in Dasht-e Nawar, 28 July 2009.

as fluctuations of water levels. For example, the prolonged drought in Afghanistan between 1998 and 2005 has certainly affected the breeding success of flamingos in Dasht-e Nawar, with Ab-e Nawar, the main body of water in Dasht-e-Nawar, going completely dry by the middle of summer. An additional threat to their breeding success is the increasing diversion of inflowing waters for irrigation and human uses, an indirect consequence of the large increase of the human population living around the basin since the 1970's (Petocz, 2006).

Harassment, hunting and egg collection of flamingos do not seem to be practiced by local people as Hazaras associate the pink colour of their plumage with the blood of the martyred prophet Imam Hussein (Shank & Rodenburg, 1977). Yet they heavily harvest other species of waterbirds during summer when they are in moult and unable to fly. This practice may indirectly disturb nesting flamingos. Recently, war in the country has had an unexpected effect on the flamingo colony in the area. On 18 July 2009 a F15A airplane from the US army crashed not far from the breeding site of the flamingos. When coalition forces sealed off the crash site, they disturbed the colony firing at least one rocket at it, perhaps to deter birds from flying towards helicopters. The colony was abandoned and we found dozens of dead unfledged chicks of Slender-billed Gulls *Larus genei*, Common Terns *Sterna hirundo* and Greater Flamingos when visiting the area nine days later.

Dasht-e Nawar is one of the most striking arid highlands in Central Afghanistan; it is also one of the last sizeable wetland habitats between the Amu Daryah and Helmand river basins and is therefore of exceptional international importance as a stop-over site for migrating waterbirds from Central Asia. With the alarming information that Ab-e Estada suffers excessive water drainage, Dasht-e Nawar could very well be the last breeding haven for the Greater Flamingo in Central Asian highlands.

Acknowledgements

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Modification of Dahlgren's apparatus for crop draining of flamingos

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Keywords: crop draining, Lesser Flamingo, Phoeniconaias minor*, Greater Flamingo,* Phoenicopterus roseus*, gut content, Dahlgren's apparatus.*

Introduction

The common method for collecting food samples from birds is to sacrifice them and analyze the gut content (Pullianen, 1968; Watson *et al.,* 1970; Newton *et al.,* 1974). Irrespective of the pros and cons of this method for studying dietary habits, sacrificing birds for such studies has been strongly objected (Ryan & Jackson, 1986) and considered unethical all over the world. Several non-lethal alternate methods for studying the dietary habits of birds have been developed (Duffy & Jackson, 1986; Ford *et al.*, 1982; Ryan & Jackson, 1986). Dahlgren (1982) described a method for sampling food items from the crop of Partridge *Perdix perdix*. We modified the crop-draining device described by Dahlgren (1982) to study the food habits of Lesser Flamingo *Phoeniconaias minor* and Greater Flamingo *Phoenicopterus roseus*, and successfully drained crop content of both the species without causing injury to the birds. This note aims to inform others of our successful application of the modified Dahlgren's device for crop-draining in long-necked birds like flamingos. This study was carried out at the saltpans of Bhavnagar, Gujarat, India during 5–9 May 2005.

Method

Draining the crop of flamingos has not been attempted before to our knowledge. Under the existing environmental law of India and the need to find non-lethal methods to study the crop content of flamingos, we modified Dahlgren's crop-draining device and evaluated its effectiveness for long-necked birds like flamingos.

Modified crop-drainer

The modified crop-drainer comprised two plastic syringes (50 ml capacity), one flexible plastic tube (external feeding catheter designed for the human stomach) of 1,020 mm length with 3.50 mm internal and 4.70 mm external diameter (the thick tube), one flexible thin plastic tube of 1,020 mm length with 2.50 mm external diameter (the thin tube).

The thick tube was attached to a syringe at one end and the other end was rounded and beaded to facilitate easy insertion of the tube into the oesophagus. Four perforations (with dimensions of 3.40 × 1.90 mm) were made in the last 70 mm of the tube and spaced to allow entry of food material from all directions (Figure 1). The thin tube was attached to a second syringe at one end and fused with the thick tube at the other end with synthetic material. Both the tubes were fixed to each other along their length with soft glue surgical tape.

The thick tube acted as a food suction tube while the thin tube pumped air and water into the crop in order to dilute food material and prevent shrinkage of the crop wall during suction.

Method of use

1. Two persons were required to drain the crop of a flamingo due to its large size. One person held the bird with one hand and kept its neck stretched with the other hand. The second person handled the syringes and did the actual crop draining (Figure 2).

2. The device was kept on the working table. The syringe attached to the thin tube was filled with 30 ml of drinking water and 20 ml of air. This provided sufficient air and water for three crop aspiration attempts.

3. Both of the tubes were coated with petroleum jelly.
4. The person holding the bird opened its bill by inserting one finger between the mandibles and stretched the neck to make it relatively straight.

5. The second person handling the syringes inserted the fused tubes into the oesophagus gently and slowly. The end of the tubes could be palpated during its passage down the neck until it entered the crop. The crop of a fully fed bird was bulky, filled with liquid and could be felt externally. The end of the tubes was pushed gently to the opening of the gizzard so that all of the crop content could be sucked through the four openings in the thick tube.

6. When the tubes were in place, the syringe containing water and air was tilted and its plunger depressed to add approximately 10 ml of water and a small amount of air into the crop. This inflated the crop and made it bulkier. The plunger of the syringe attached to the thick tube was pulled to aspirate the liquid crop content. When this syringe was full of crop content, it was detached and the content of the syringe was transferred to a wide-mouth plastic bottle. The syringe was re-fitted to the thick tube for a second aspiration. The quantity of the liquid sucked from the crop was equal to the water inserted each time.

7. Water-air insertion and aspiration of fluid from the crop was continued until the aspirated liquid became almost transparent without any visible particles (in the case of Greater Flamingo) or green in colour (in the case of Lesser Flamingo), which was an indication of complete cleaning of the crop.

8. The tubes were extracted from the oesophagus slowly and gently and the bird was released into a temporary enclosure.

9. When the crop content of all birds had been collected, the birds were released back into the area from where they had been trapped.

10. The crop samples were preserved for later analysis.

The crop content of seven Lesser Flamingos and two Greater Flamingos was collected without causing injury or mortality to any of the birds.

A qualitative study of the crop content was done at a later date using microscopy.

This device was able to aspirate grit in fairly large amounts from the crop of Greater Flamingos. Since both the species of flamingos feed on minute organisms (e.g. plankton), crop-draining by this modified Dahlgren's device can be used successfully as a non-lethal technique for the study of the crop content of flamingos.

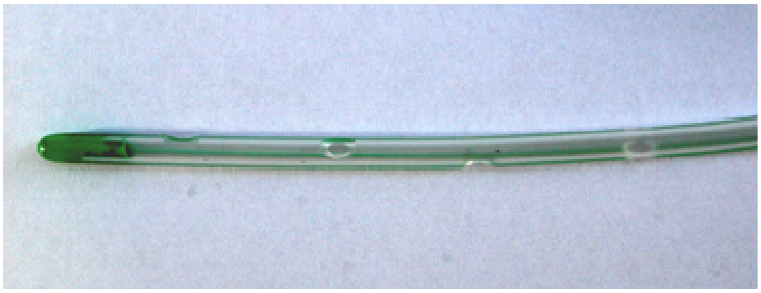

Figure 1. Rounded end and four perforations on the sides of the thick (aspirating) tube.

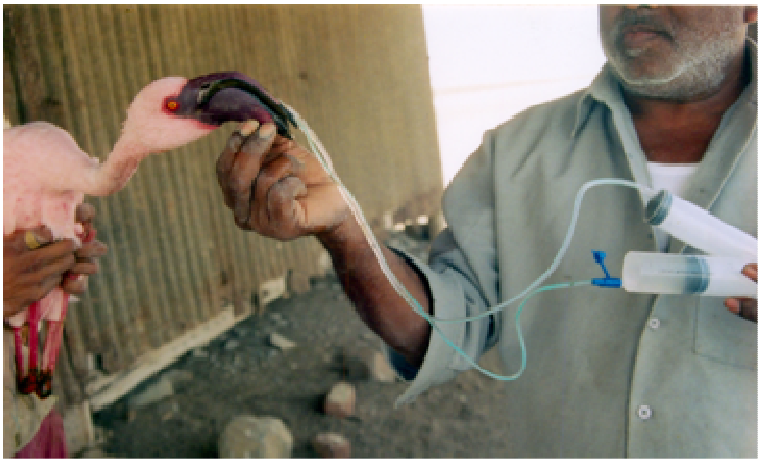

Figure 2. Crop draining of a Lesser Flamingo *Phoeniconaias minor*.

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Bela-Mowana: a lesser known nesting site of flamingos in India

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Keywords: Greater Flamingos, Phoenicopterus roseus*, Lesser Flamingos,* Phoeniconaias minor*, Rann of Kachchh, Gujarat, India, breeding, Bela-Mowana.*

Introduction

'Flamingo City' or 'Sindal bet' is a well-known nesting site for Greater Flamingos *Phoenicopterus roseus* in the Great Rann of Kachchh, Gujarat, India (Ali & Ripley, 1987), and Ali (1974) reported nesting of Lesser Flamingos *Phoeniconaias minor* at 'Flamingo City', the first breeding report from the Indian Territory. More recent publications describe other nesting sites of both flamingo species in India (Mundkur *et al*., 1989; Mundkur, 1997; Himmatsinhji, 1991; Singh *et al*., 1999; Vaishnav *et al*. 2005; Parasharya, 2006), and a detailed account of the old and new nesting sites of Lesser Flamingos in India was given by Parasharya & Tere (2006). The total number of nests in the Greater Flamingo colony at 'Flamingo City' or the mixed colony of two species at Zinzuwada site in the Little Rann of Kachchh has never exceeded 12,000 in the recent past (Tere, 2005; Parasharya & Tere, unpublished). In October 2009, however, we recorded 70,000–80,000 Lesser Flamingo chicks and a small number of Greater Flamingo chicks near Bela-Mowana in the eastern part of the Great Rann of Kachchh (Parasharya, 2009). This is the highest number of chicks ever recorded in India. Although the location of the nesting site was suspected in 2003 and old records of nesting were known (Parasharya & Tere, 2006), the actual nesting site could not be visited until 2009 due to the hostile nature of the habitat (Parasharya, 2009).

During a visit to the Kuda border outpost in October 2009, we gathered information from the Border Security Force (BSF) personnel about the presence of flamingo nests in the Rann along the road. At that time the Rann was still wet, and therefore difficult to access. We visited the site seven months later on 11 and 12 May 2010, when we believed the soil would have hardened enough that we could drive to the interior parts of Rann to search for the colony.

Observations

On 11 May 2010, we reached the Kuda border outpost at 10.00 hours and from there drove along the road leading to the international border (Figure

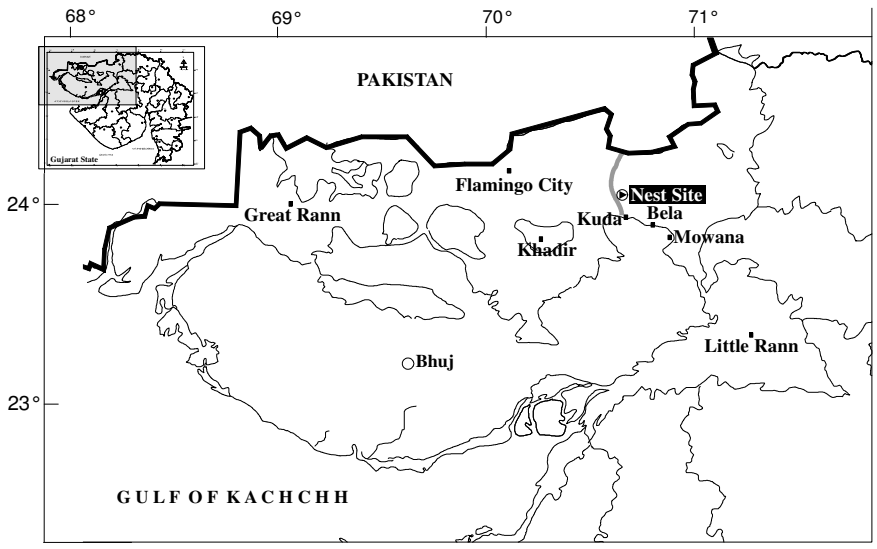

Figure 1. Location map of the nest site in the Great Rann of Kachchh.

1). After approximately 7 km, we observed the first Greater Flamingo egg beside the road. After driving another 4 km (total 11 km), clusters of nests started to appear separated by 20–50 m. Between 11 and 14 km, there were large numbers of scattered eggs and dead chicks of both flamingo species along the roadside (Figure 2). At about 14 km from Kuda, there were approximately 2000 nests in two clusters. Beyond this, on the next 0.5 km of road there were an estimated 3000–4000 nests. All the nests were on the eastern side of the road where the soil was hard and without obvious salt crystals. The western side of the road was covered with layers of salt crystals (Figure 3).

The road across the Rann is about 0.5–1.0 m above the ground (Figure 2), and is constructed by scrapping the soil from the adjacent area and spreading it on a stone bed. As a result, the area directly adjacent to the road was much deeper than 1 m. The soil was lifted from up to 60–80 m from the road on the eastern side only. It was clear that after the desertion of the nesting colony and the drying of the Rann, the road had been repaired by scrapping the soil from the eastern side of the road (Photograph 3). As a result, most of the nest platforms had been destroyed. Nests which remained intact provided evidence that here existed a nesting colony of flamingos during the previous season.

Colony size

On the following day (12 May 2010), we once again drove on the same road to make an estimate of nest density and the total area of the nesting colony. The road length along which the nests were present was measured using the vehicle's odometer (to the accuracy of 0.1 km). At 5 points along 2.5 km, the perpendicular distance from the furthest nest to the road was measured using a measuring tape. The average width of the nesting colony was 60 m. These measurements suggest that the colony may be spread over a 150,000 m² (15 hectares) area along the eastern side of the road. We estimated nest density from the area where soil scrapping was not done and the nests were intact. Nest numbers were counted from four quadrates of variable size (Table 1). Average nest density across the four quadrates was 0.72 nests/m².

Using the estimated average nest density, we estimated that the total number of nest sites in the 150,000 m² (15 hectares) nesting area would have been approximately 107,768. As there was large variation in the nest density, the total number of nests shown here may be a minimum estimate of numbers. It is possible that the road contractor may be biased towards areas having maximum nest density as the nest mounds are prominent source of dry soil. To improve this estimate of nest numbers, it is necessary to visit the nesting site while active during the monsoon and immediate post-monsoon period (September–October).

During our visit in May 2010, we found a large number of intact eggs of both the flamingo species as well as small numbers of 15–20 day old dead chicks. This indicates that some adults may have laid eggs later in the season and the chicks from these eggs may have been unable to hatch before the Rann dried up and the adults deserted the colony.

We had estimated approximately 70,000–80,000 chicks in eight crèches during October 2009 near Bela-Mowana (Parasharya, 2009). These chicks had probably hatched from the nesting colony reported here, suggesting that the hatching success of this colony in 2009 was above 74 per cent.

The running crèches moved about 25 km east along the drying edge of the water. The last source of water (less than 20 cm depth)/wet mud was available opposite Mowana on 15 October 2009. Few adults were observed with the chicks as most were feeding about 35–70 km south in the wetland around Nanda bet and other wetlands in the Little Rann of Kachchh.

Table 1. Nest densities in undisturbed areas of the Bela-Mowana nesting site.

No.	Quadrate dimensions (m)	Area (m^2)	No. nests	Nest density (nests/m^2)
1	13x11	143	220	1.54
2	10x10	100	106	1.06
3	10x10	100	138	1.38
4	24x60	1440	817	0.57
Total		**1783**	**1281**	**0.72**

Figure 2. Unhatched eggs along the roadside.

Figure 3. Nesting site on dry soil (left of photo, east side of road) and salt encrusted area (right of photo, west side of the road).

Figure 4. Top soil with nests scrapped for road repair.

Discussion

At Kuda border outpost, BSF personnel reported observing flamingo nest mounds along the nearby road during the dry season, while traveling from Kuda to the international border over the last three years.

During our visit to the site, we found eggs and chicks of both the species of flamingo indicating that this is a mixed species colony. During the count of chicks opposite Mowana in 2009, we had not been able to differentiate between the chicks of the two species, but the presence of adult Greater Flamingos was noted. Egg remains at the colony and counts of flamingos at Nanda bet and nearby wetlands in Little Rann during October 2009 suggest that Greater Flamingos may be just 10–15 per cent of the total number of flamingos breeding at this site.

The existing nesting site is along the road constructed between Kuda border outpost and the international border. It is not known whether the road was constructed through an existing nesting site or the flamingos have moved to the roadside after its construction. This is the largest nesting colony of flamingos ever recorded in the Rann of Kachchh and in India. The site is part of the Great Rann of Kachchh Sanctuary (protected area), which has been declared a 'Biosphere Reserve' by the Ministry of Environment and Forests, Government of India.

Before the road was constructed, it was impossible to reach the nesting colony. Only because of the new

road, could we document the existence of the largest nesting colony of flamingos in India. A conservation strategy should be developed by the stakeholders of the area to ensure the persistence of this flamingo colony.

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Ecology and present status of flamingos at Sambhar Salt Lake, Rajasthan, India: a critical comparison with past records

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Abstract — The present study assessed the status of the Greater Flamingo *Phoenicopterus roseus* and Lesser Flamingo *Phoeniconaias minor* populations at Sambhar Lake with comparison to 1,873 when they were first reported. Massive ecological deterioration of this important flamingo habitat and a severe reduction in the populations of both species has been witnessed in the 20th century and more recently during the current decade (2000–2010). Sambhar Lake, a Ramsar Site, is currently facing a variety of threats – both climate-related and man-made. Novel strategies for conservation management are required immediately to stop this fascinating wetland ecosystem from sliding into oblivion. This study is an earnest attempt to draw the attention of the Government of India, IUCN-SSC/Wetlands International Flamingo Specialist Group (FSG), conservation practitioners, academics, social scientists, wildlife specialists, NGOs and other responsible agencies in India and abroad to suggest ways to formulate strategies and an effective action plan to conserve this inland saline wetland.

Keywords: Greater Flamingo, Phoenicopterus roseus*, Lesser Flamingo,* Phoeniconaias minor*, Sambhar Lake, habitat degradation, climate, survey, numbers.*

Introduction

Flamingos in Rajasthan are sighted mainly at Sambhar Lake (in Jaipur district), Panchbhadra Lake (in Barmer district), Ana Sagar (in Ajmer district) and Keoladeo National Park (KNP) (Bharatpur district). Major banding studies have shown the migration of Greater Flamingos from Russia to Iran and from there to India during extremely cold weather (Cramp & Simmons, 1977). One of six Ramsar Sites in India, Sambhar Lake is considered the most significant flamingo habitat on the Indian subcontinent after the Rann of Kutchh. KNP is a World Heritage Site and one of two Ramsar Sites in Rajasthan. The status of Ramsar Site (Wetland of International Importance) was bestowed upon Sambhar Lake in March 1990. In November 2000, it was declared an Important Bird Area (IBA) (INRJ-16 and A4, A4i and A4ii codes) by BirdLife International owing to its rich aquatic avifaunal diversity, especially flamingos (Islam & Rahmani, 2004). R. M. Adam (1873) was the first to report the wonderful avifauna of Sambhar Lake.

Today, the lake is jointly owned by the state Government and Sambhar Salts Limited, and has a 7560 km² catchment area comprising dry deciduous forest with sparse thorny scrubs typical of arid and semi-arid zones. The lake basin is divided by a 5.16 km long dam between Gudha in the north and Jhapok in the south. The lake water displays a variety of colours in different seasons: dark brick-red in summers due to algae *Dunaliella salina* and *Arthrospira platensis*, while from September to November algae *Arthrospira*, *Spirulina*, *Anabaenopsis* and *Dunaliella* provide a bluish-green tinge. Examination of the available records from the past century and recent population surveys show a large decline in the numbers of flamingos and other waterbirds spending the winter at the lake. Unfortunately, the status of flamingos at Sambhar Lake was not documented after 2005, but the authors have been monitoring the general faunal diversity, conservation issues and the numbers and movements of aquatic avifauna of Sambhar Lake especially flamingos since 2006. A comparison of our data with previous investigations shows a sharp decline in the numbers of migratory birds at Sambhar Lake.

Study area

Sambhar Salt Lake is situated in Jaipur, Ajmer and Nagaur districts of Rajasthan at 26º 52' N-27º02' N, 74º54'E-75º14'E. Somewhat elliptical in shape with a maximum depth of 3m and a size of 190 km² when at full capacity, this shallow lake is a rain-fed playa which receives water in-flow of varied salinity via the four ephemeral streams (referred to as rivers) namely, Rupangarh, Mendha, Khardia and Khandel. Although, the flamingos in the area frequently change sites depending on the availability of food

and other factors such as human disturbance, their maximum population has been frequently observed on the main lake, city-bittern area, Deodhani and the saltpans of Gudha, Jhapok and Nawa village/town located in the south of the lake. It is worth-mentioning here that, the western lake is a continuous sheet of water, whereas the eastern part of the lake is mainly used for salt manufacturing (Figure 1).

Methods

The direct count method was employed to assess flamingo numbers using Nikon binoculars (10x42) and telescope (D=50mm W25). The counts were taken at least three times a year during October – April for five consecutive years (2006 – 2010). The general condition of the lake, including temperature and rainfall pattern, was also recorded as these factors are known to adversely affect populations of migratory avifauna. In addition, the available literature on flamingos of Sambhar Lake, beginning 1873, was carefully examined for comparison.

Results and discussion

During the study, which included years of high rainfall, the flamingos did not arrive at Sambhar Lake before the onset of winter (October) and left the lake by early or late March. Thus, population counts were made between October and April. A drastic reduction in the populations of both Greater and Lesser Flamingos was observed (Table 1). Greater

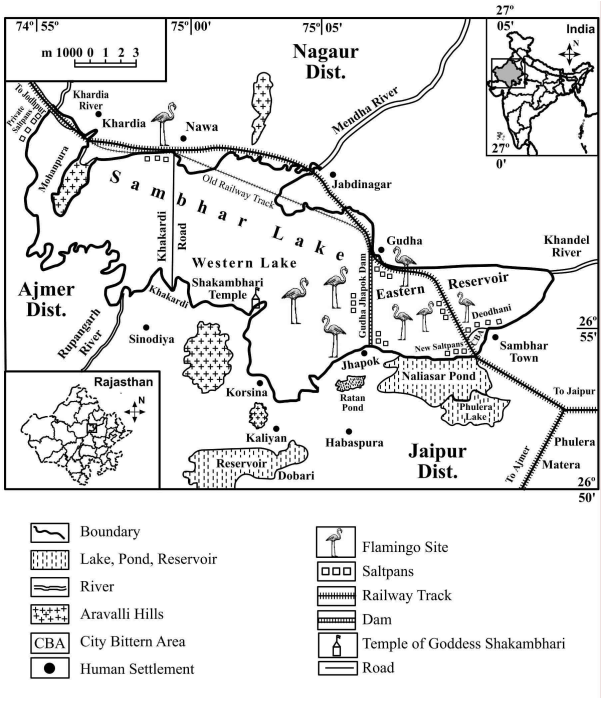

Figure 1. Location map of Sambhar Lake Rajasthan, India (Modified after Sundaram *et al.*, 1996).

Flamingos outnumbered Lesser Flamingos at all times except in October 2007 when a flock of 349 Lesser Flamingos along with 42 Greater Flamingos visited the lake for 29 days. Interestingly, one pair of Greater Flamingos and one lone Greater Flamingo visited the lake for 15 days in April 2006 and 2007, respectively, which is a significant observation considering the gregarious nature of this species. Flamingos were altogether absent during the peak summer months of (late) April to June and also from July to September.

In general, the lake faces harsh climatic conditions with average maximum and minimum temperature between 35-45°C in summer and 4-27°C in winter. There are seasonal variations in the lake size during pre and post-monsoon periods (Vijayan *et al.*, 2004). The lake has not been at full capacity for 25 years, and a wide variation in the total annual rainfall is clearly evident from records over the last century (Gopal & Sharma, 1994). The earliest available records confirm the presence of 25,000 flamingos on the lake (Adam, 1873, 1874; Hume, 1878). Thereafter, the arrival of flamingos at Sambhar Lake was recorded by many investigators (MacCann, 1939; Roonwal, 1969; Rahmani, 1997). According to Agrawal (1951), Mukherjee (1968), Alam (1981), Gole (1984) and Gopal & Sharma (1994), the number of flamingos on the lake ranged from 5,000 to 8,000. Observations from 1995–96 reported much high numbers, for example Sangha (1998) reported 18,000 Greater and 4,500 Lesser Flamingos, and Kumar (2005) reported 50,000–100,000 Greater Flamingos. Despite these usual sightings, there appears to have been an overall decline in numbers from 25,000 in the mid-1970s to 5,000 during 1951–94. This decline across the century is disturbing. During the drought years of 1939, 1987, 1988, 1989 and 2000, a completely dry lake bed resulted in no flamingos arriving at Sambhar Lake even in the month of December (Gopal & Sharma, 1994; Kumar, 2005) – evidence of the deteriorating state of the lake.

A comparison of our data with past records demonstrates that fluctuations in flamingo numbers at Sambhar Lake are largely dependent on the availability of food and rainfall. The total annual rainfall in both 2006 and 2007 was less than 100 mm leaving the lake bed completely dry (Kulshreshtha *et al.*, 2006), while in 2008 the total rainfall was over 1,200 mm resulting in continuous water supply from the main lake to the saltpans until late March in 2009 (Kulshreshtha & Sharma, 2008, 2009; Sharma & Kulshreshtha 2009). This may explain why the flamingo population was relatively small in 2006 and 2007, while large in 2008 when 3,000 birds were observed on the main lake. The area where the birds were flocking was approximately 3 to 4 km from the lake margins, which were too muddy to access. As a

Table 1. Numbers of Greater Flamingos *Phoenicopterus roseus* and Lesser Flamingos *Phoeniconaias minor* at Sambhar Lake (2006–2010).

S. No.	Month/year	No. of Greater Flamingos per site	No. of Lesser Flamingos per site
1	Feb. 2006	357 (Gudha Saltpans)	48 (Gudha Saltpans)
2	Apr. 2006	2 (City bittern Area)	None (City –bittern Area)
3	Oct. 2006	231 (City bittern Area)	14 (City bittern Area)
4	Apr. 2007	01 (City bittern Area)	None (City bittern Area)
5	Oct. 2007	42 (Deodhani Saltpans)	349 (Deodhani Saltpans)
6	Dec. 2007	110 (Deodhani Saltpans)	04 (Deodhani Saltpans)
7	Dec. 2008	2700-3000 (Main Lake); 410 adults and 338 juveniles (Deodhani Saltpans)	51 (Deodhani Saltpans)
8	Dec. 2009	159 (Deodhani Saltpans)	None (Deodhani Saltpans)

result, it was not possible to identify the species even with a good quality telescope.

Our observations confirm earlier investigations by Connor (1980) indicating that low salinity condensers and reservoirs during and after monsoon periods offer an important source of food while flamingos avoid salt works during the peak salt season from April to September.

Sambhar Lake was blessed with a total of 410 adult flamingos and 338 juveniles at Deodhani salt pans in December 2008. Interestingly, during our study, we consistently observed juveniles with the flocks. According to our observations, the Lesser Flamingos were always the first to leave the lake while the Greater Flamingos remained for two more months depending on lake conditions (Kulshreshtha & Sharma, 2010, unpublished data). This most likely due to the fact that Greater Flamingos are relatively generalised feeders and can feed on a variety of prey species, while the Lesser Flamingos are more specialised, feeding on blue green algae and diatoms and are partial to high salinity lakes (Mandakadan, 1995).
During our study period, we did not observe any breeding. Kumar (1996a), however, observed approximately 11,000 mud nests in 18 clusters in an area of more than one hectare on the southern side of the lake. This may suggest that Sambhar Lake is a suitable breeding site for flamingos, but more studies are required to find further support for this exciting possibility.

In total, we observed 52 terrestrial bird species and 46 aquatic bird species during 2006–2010. Among the winter migrants, Ruff *Philomachus pugnax* and Kentish Plover *Charadrius alexandrinus* were the most numerous, while Black-winged Stilt *Himantopus himantopus* was the most common resident.

It is unfortunate that this flamingo stop-over point on the Indo-Asian migratory flyway has seen a decline in flamingo numbers. Excessive and illegal salt extraction and the construction of 273 dams on the in-flowing rivers has resulted in a massively reduced water-level in the lake, while vehicular trespass and the formation of hundreds of clay pits has caused the siltation of the lake bed. The anthropogenic activity with the largest impact over the past five years has been the construction of a 12.4 km road from Nawa to Khakardi village in the south-west dividing the lake bed into two unequal parts, which has affected the movement of migratory birds and reduced the overall condition of the Ramsar Site (Kumar, 2005). In addition, poaching is still common around the lake. It is disappointing that despite spending large amounts of money on the 'Sambhar Wetland Conservation Project' during 2001–2010, the Forests and Wildlife Department of the Government of Rajasthan could not improve the condition of the lake.

To this end, the prioritisation of eco-sensitive zones of the lake for eco-rehabilitation has been strongly suggested (Jain, 2005). Integrated lake basin management, enforcement of existing laws and immediate efforts to bring this lake under a legal umbrella by declaring it a 'Conservation Reserve' or 'Wildlife Sanctuary' are urgent priorities to avoid Sambhar Lake vanishing as flamingo habitat.

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Population size, daily movements and nesting of the Greater Flamingo *Phoenicopterus roseus* at the Sabkhat Al-Jabboul Lake close to Aleppo, Syria

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Abstract — The Greater Flamingo *Phoenicopterus roseus* was surveyed between June 2008 and June 2009 at Al-Jabboul Lake southeast of Aleppo, Syria. Peak numbers were recorded in February (21,056) and lowest numbers in October (4,350). Up to 4,000 pairs were recorded nesting in May 2009, with 200 nests observed deserted, while others were found with chicks present in May, and later in June. Mortality of chicks was recorded with rising water levels. Known emigrants came from Italy and Iran. The main threats to the birds include hunting, collection of adults and chicks and pollution from the surrounding land. This study confirms Al-Jabboul as one of the most important sites for the Greater Flamingo in the Middle East.

Keywords: Greater Flamingo, Phoenicopterus roseus*, survey, Al-Jabboul Lake, Aleppo, Syria, numbers, breeding, water levels, Italy, Iran, migration.*

Introduction

The importance of Greater Flamingo *Phoenicopterus roseus* (locally known as Yaghnees) at Al Jabboul Lake southeast of Aleppo, Syria was first noticed early in the 1960s (Savage, 1968). Dijksen & Koning (1972) carried out mid-winter waterbird counts in December 1971 and December 1972, and informal visits by birdwatchers helped enrich the lake's species list and provide insight into the site's ornithological significance (Wester, 1998; Vandemeutter & Soors 2001; Murdoch, 2003).

The Syrian Wetland Expedition (Murdoch *et al.*, 2004) partially covered Al-Jabboul Lake and made Greater Flamingo winter counts. The expedition reached a conclusion that the lake has one of largest winter concentrations of Greater Flamingo in the Middle East and provided the first Syrian record of breeding Greater Flamingo, with 500 breeding pairs. Serra *et al.* (2006) clarified the importance of Al-Jabboul and discussed the current, future, and potential threats. None of the previous studies covers a whole year count, and none provided a detailed pattern of Greater Flamingo occurrence at Al-Jabboul.

Unfortunately, the lake and its flora and fauna are subject to a number of threats including hunting and pollution, but more importantly limited recognition of its biological importance. In an attempt to enhance its national and international profile various suggestions have been made including the development of the site for tourism with the provision of data on population numbers for its key species to inform the development of a management plan, especially those species which might act as flagship species for conservation. Until recently there have been no systematic surveys of any of the waterbird species. Thus, the main aim of this study was to carry out a number of surveys on the Greater Flamingo *Phoenicopterus roseus* to enhance the knowledge about the species for the purposes of conservation and management. This survey was made under the activities of the Swiss Agency for Development and Cooperation (SDC) through the funding of an eco-tourism project.

Study area

The area called Sabkhat al Jabboul is one of the most important wetland areas found in the Middle East (Serra *et al.*, 2006). It consists of a large (270 km^2) wetland area or lake situated within a closed basin (5,075 km^2) to the south east of Aleppo the second largest city in Syria. Due to its location, its waters are saline in many parts. During the winter, water levels rise because of heavy rains, then the lake and surrounding wetlands provide an important winter refuge for many species of waterbird and a staging post for migratory species.

A number of species also breed there during the summer (Murdoch *et al.*, 2004). Crap (1980) identified the lake as a Wetland of International Importance, Evans (1994) identified the lake as an Important Bird Area and Scott (1995) also recognised the international importance of the

wetland. The site was designated as a Ramsar Site in 1989 by fulfilling three criteria: a representative example of a natural wetland type, accommodating over 20,000 waterbirds and supporting greater than 1% of the world population of one or more species.

The lake is made up of three distinct areas of different salinity and habitat and contains up to nine permanent islands (Figure 1). Temperatures range from 2–10 °C in winter and 21–37 °C in summer. Land use around the lake varies widely but includes irrigated agriculture, sheep grazing and salt extraction.

In summer 2008, the water level was minimal. The three permanent water bodies occurred with no seasonal water. In winter, a large amount of rain water and irrigation drainage water gradually flowed into the lake, and the lake was full of water in March 2009, and that, lasted until June 2009 when the whole lake was accessible by boat.

Methods

The lake was visited on 13 separate occasions between June 2008 and June 2009. Each visit was between the 13th and 21st of each month. In summer 2008 when the water level was at its lowest, birds were counted from 30 different observation points distributed along the shoreline of the permanent water.

In early winter when the water level had risen sufficiently to allow access by boat to a few close locations, 10 additional observation points were added to cover newly formed temporal water bodies. Two boat transects were established in the north-western lake and in Hamrat Lake, to replace the point counts in these areas, while the remaining summer point counts were kept in use.

When water levels became higher enough for full access by boat, no fixed point counts were used, and all counts were carried out by boat moving from north to south through one or more of the four transects depending on the birds' distribution and water level. When the flock showed signs of alert behaviour, the boat stopped at a safe distance not to disturb the birds, and counts took place accordingly, then the boat resumed moving to the southward until the whole area was covered.

To minimise the risk of double counts in summer, birds were counted only after they flew from night roost locations in the salt water to the brackish water where they would remain until sunset. Researchers moved smoothly between observation points on the shoreline so as not to 'push' birds ahead to the next

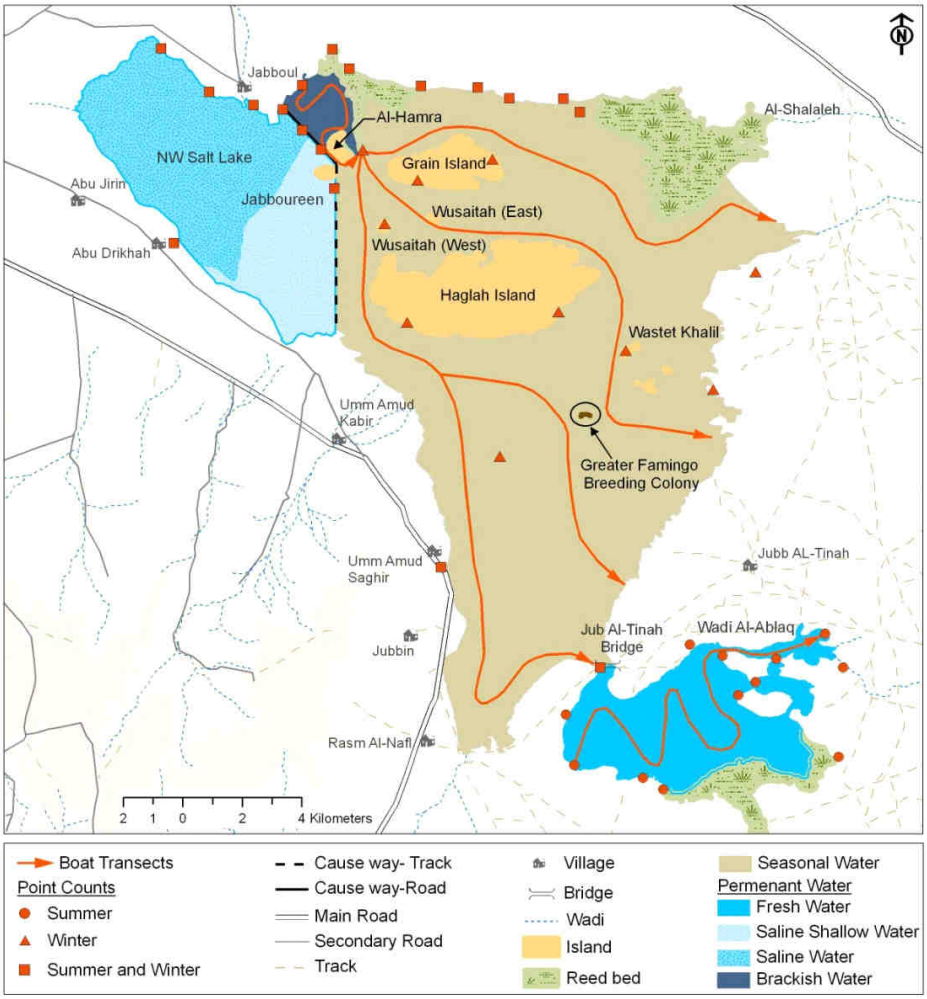

Figure 1. Seasonal and permanent water of Al-Jabboul with their classifications. Points around the shore line are those points which were used for counts in summer when the lake was dried. Points in the middle are those points that were used in early winter, in addition to shoreline

point. Reference landscape features were recorded when the count was stopped to move to the next point and when two researchers started counting large groups of flamingos.

Results

Flamingos were recorded in all months of the year. Individual monthly counts increased slowly from 4,350 in October up to a maximum of 21,056 in February (Figure. 2). From then on numbers declined to 5,000 in June.

Daily movements and links with other colonies

In terms of local movements, flamingos were seen in various parts of the lake during the day. In early morning, birds were observed feeding in the north west of the salt lake, then flew in flocks to the brackish water and continue feeding during the course of the day. At night, most roosted back in the more saline areas to the north west.

Whilst it is unknown where the majority of the birds came from, a few birds are known to have come from Italy and Iran by the recovery of rings from hunters. In 2007 one bird shot at the lake had been ringed in Italy in the same year. In 2005 and 2006, hunters recovered two birds, which had been ringed in 1989 in Iran.

Nesting birds

The previously identified breeding sites (from interviews with locals and general observations) were visited in July 2008 and found to be dry with no signs of nests or dead chicks. Flamingos were seen breeding in May 2009 on an isolated island south east of Haglah Island (Figure 1). A total of 4,000 nests were recorded on the island with 2,000 chicks, but 200 nests appeared abandoned.

One month later, the site was found surrounded by traditional staked-noose line, and a large number of chicks was captured, a lot of eggs were deserted, and the adults were disturbed but kept close to the colony. The staked-noose line was removed, and chicks were released. The number of nests was reconfirmed to be 4000 nests. Approximately 2,000 chicks were counted. Chicks were of various sizes ranging from a few days old (diamond on the peak) up to one or two week-old. Large numbers of chicks became stranded and died in rising water levels at the nesting site.

Discussion

As Serra *et al.* (2006) indicated, Greater Flamingos are difficult to count at Al-Jabboul Lake making double counts possible. The observation of daily movements of flamingos between salt and brackish water, however, provided an opportunity to perform the counts during the time the flamingo spent in the brackish water, since it was the longest period of time the birds remained at one location.

Murdoch *et al.* (2004) performed a winter count and suggested that Al-Jabboul wetland holds one of the largest flamingo populations in the Middle East. Comparing the results of this survey with the 2005 estimation of flamingos in the eastern Mediterranean (Béchet, 2005), suggests that Al-Jabboul may host a

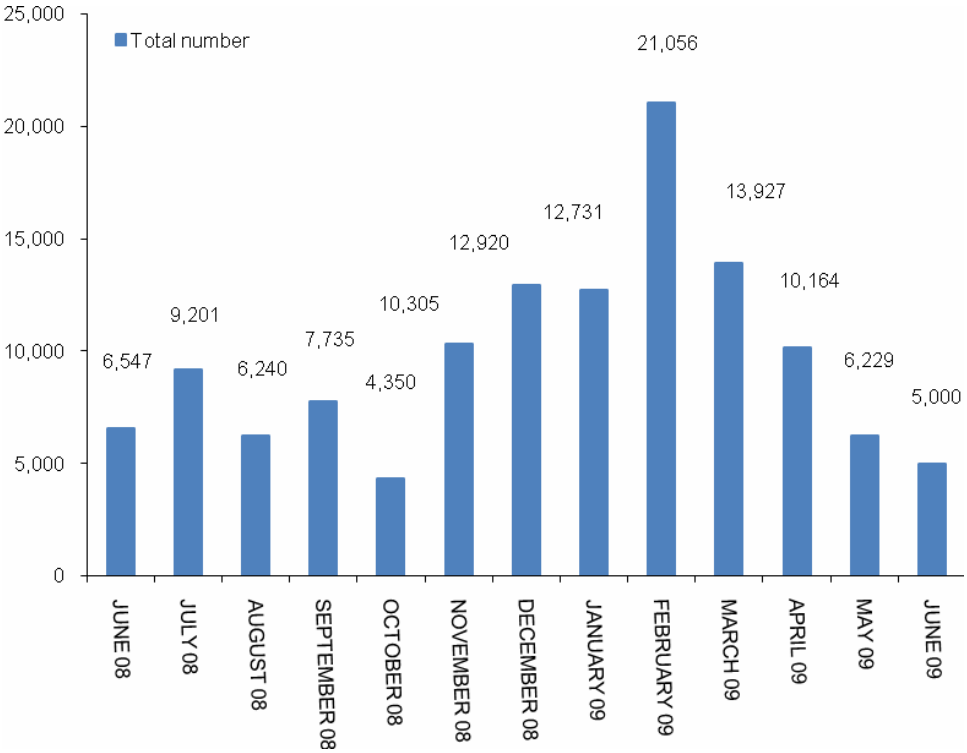

Figure 2. Numbers of Greater Flamingos *Phoenicopterus roseus* recorded at Al-Jabboul Lake between June 2008 and June 2009.

quarter of the wintering population in the region and supports the suggestion of Murdoch *et al.* (2004). However, given that there has not been a total estimate of numbers in the eastern Mediterranean since 2005, the results of this survey could not be compared with wintering numbers in the region during the study period.

The species' localised movements between the salt and brackish water is well-known to locals. The salt water of Jabboul, mainly in the northwest, contained a large amount of *Artemia salina*, one of the main food sources of the Greater Flamingo. According to locals, the Greater Flamingo flies back to the fresh water (which is brackish in reality) to wash salt from its mouth and body, to avoid salt drying on its feathers and skin. The salt water areas may also be attractive to the flamingos because of the absence of disturbance from hunters and fishermen due to low fish contents, which make it safer for the Greater Flamingo for overnight roosting.

Al-Jabboul Lake is visited by migrant Greater Flamingos from both the west and the east Mediterranean, as indicated by three ring recoveries, one from Italy and two from Iran.

The wintering population is highly dependent on water levels, which were exceptional in the year of the count (2008/09) due to the large amount of water entering the lake from irrigation and a high level of rainfall. High water levels assured the importance of the lake for Greater Flamingo.

Murdoch and Asaad documented the first flamingo breeding event for Syria in 2006 with a total of 500 pairs (Serra *et al.,* 2006). No count took place in 2007, and no breeding record occurred in 2008. In 2008, the lake had minimum seasonal water, and most of the seasonal flooded sites were dry which would have made it difficult for Greater Flamingos to find suitable nesting conditions. In 2009, the water level increased significantly, and temporal islands were formed. Greater Flamingos selected one of these islands (the island with the most difficult access and least disturbance) as their nesting site. The location of the new colony is close to the 2006 record; both are located in the south to southeastern part of Haglah Island, almost in the centre of the lake, which is the most difficult place to reach in the lake, even though it has been approached by chick collectors.

The major threats faced by Greater Flamingos at Al-Jabboul Lake are high hunting pressure and the collection of chicks, juveniles, and adults. The species is targeted by hunters all year long, although there is lower hunting pressure during summer due to the heat. Chicks and adults were collected during the breeding season to be sold as pet birds to private farms. Staked-noose lines, a traditional trapping method, were found surrounding the breeding colony and in the feeding grounds. Pollution is a growing threat; the lake receives sewage and industry discharges from the surrounding villages and factories.

The long-term future of this important site for the conservation of the Greater Flamingo depends on addressing the threats of excessive hunting, collection and growing pollution. Encouraging tourists and birdwatchers to the site would bring economic benefits to the region. For this it is essential that the wildlife is conserved or enhanced.

Acknowledgments

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Chott Merouane (Algérie): un nouveau site de reproduction du Flamant rose *Phoenicopterus roseus*

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Résumé — Le Flamant rose Phœnicopterus roseus s'est reproduit en 2010 dans le Chott Merouane (wilaya d'El-Oued, sahara septentrional algérien). L'incubation a commencée le 2 mai 2010 et s'est achevée le 17 juin 2010. Approximativement, 86% des œufs ont éclos et les poussins ont quitté les nids dés la troisième semaine du mois de juin. Suite à l'assèchement du chott vers la fin de ce mois, le Renard roux Vulpes vulpes et le Fennec Vulpes zerda ont pu consommer les œufs provoquant ainsi un taux d'échec estimé à 12%. A partir de la fin juin une crèche composée de 2 240 poussins s'est formée au centre du plan d'eau. Les poussins ont pris leur envol définitif le 2 octobre 2010.

Abstract — The Greater Flamingo *Phoenicopterus roseus* reproduced this year at Chott Merouane (wilaya d'El-Oued, Algeria northern Sahara). Incubation began on 2 May 2010 and ended 17 June 2010. Approximately, 86% of eggs hatched and the chicks left nests in the third week of June. At the end of June, after the drying out of the chott, Red Fox *Vulpes vulpes* and Fennec Fox *Vulpes zerda* were able to reach the second core of nests and consumed eggs causing a rate of failure estimated at 12%. From the end of June the crèche of 2240 chicks gathered in the center of the site. The chicks left the site on 2 October 2010.

Keywords: *Greater Flamingo,* Phoenicopterus roseus*, Chott Merouane, Algeria, breeding, predation.*

Introduction

La recherche d'éventuels sites de nidification du Flamant rose *Phœnicopterus roseus* est une des priorités des ornithologues algériens. En effet, les chotts et les sebkhas présentent des capacités d'accueil potentielles sauf que la plupart du temps, on n'attribue à ces lieux que le rôle de quartier d'hivernage pour cet échassier et pour un grand nombre d'oiseaux d'eau (Johnson & Cézilly, 2007; Houhamdi *et al.*, 2008; Smart *et al.*, 2009). Ces prospections se sont soldées par la découverte en 2003 de la colonie de Garaet Ezzemoul dans les hauts plateaux du Constantinois à l'Est du pays (Saheb *et al.*, 2006; Boulkhssaim *et al.*, 2006; Samraoui *et al.*, 2006, 2008, 2009; Boulekhssaim *et al.*, 2009) puis celle du Lac El Goléa en 2009 dans le Sud (Khelifa *et al.*, 2009; Bouzid *et al.*, 2009). Entre temps, le Flamant rose a tenté de nicher en 2009 dans d'autres zones humides notamment au niveau de la Sebkhet de Bazer-Sakra (wilaya de Sétif) et du Chott Merouane (wilaya d'El-Oued). Malheureusement les conditions climatiques et les différentes pressions anthropiques exercées sur ces milieux ont causé son échec.

A la limite septentrionale du sahara algérien, l'éco-complexe de zones humides de la Vallée de Oued Righ représente la continuité géographique du Chott Djérid et du Golf de Gabes (Tunisie) et héberge pendant toute l'année une population de Flamant rose dépassant largement le 1% international (Laferrère 1966; Isenmann & Moali 2000; Boumezbeur 2001; Houhamdi *et al.*, 2008). Dans une étude réalisée depuis juin 2004, ces échassiers sédentaires fréquentent souvent durant la période estivale les deux hydrosystèmes les plus étendus et encore en eau de toute la vallée, soit Chott Melghir et Chott Merouane et ce jusqu'à 2008.

Dans cet article nous documentons la première nidification connue du Flamant rose au Chott Merouane dans l'Est algérien. Nous détaillons les caractéristiques écologiques de la colonie (description des deux noyaux, mensurations des nids

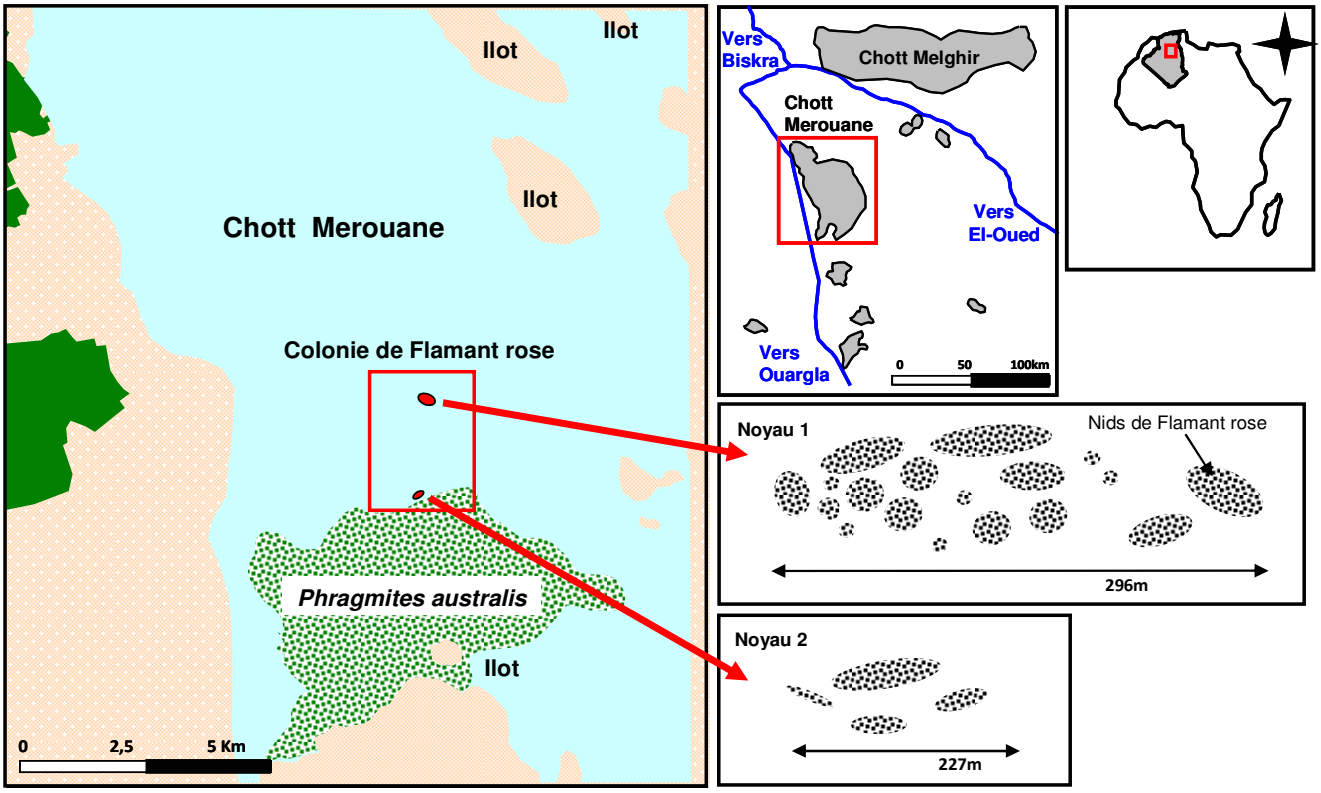

Fig.1. Situation géographique du Chott Merouane et description de la colonie des Flamants roses *Phœnicopterus roseus.*

et des œufs) et nous énumérons les différentes menaces pesant sur cette reproduction.

Description du site

La Vallée de Oued Righ circonscrite entre les wilayas de Biskra, El-Oued et Ouargla (sahara algérien) est dominée par deux types de climats, le premier aride, chaud et sec caractérisant toute la partie septentrionale et le second de type saharien s'étale sur le reste de la vallée. Cette cuvette située à la limite méridionale du Paléarctique occidental s'étend sur plus de 300 km du Sud (Touggourt) au Nord (Biskra) présentant des altitudes allant jusqu'à 41 m en dessous du niveau de la mer Méditerranée (Nouidjem 2008; Bouzegag 2008). Elle renferme neuf oasis (Chott Merouane: 305 000 ha, Lac de Oued Khrouf: 1 200ha, Chott Melghir: 523 400 ha, Chott Hamraia-1: 30 ha, Chott Hamraia-2: 52 ha, Chott Tindla: 180 ha, Lac Ayata: 25 ha, Lac Merara: 33 ha et Chott Tighdidine: 250 ha; Fig.1).

Matériel et méthodes

Nous présentons ici le suivi réalisé de 2009 à 2010 dans l'éco-complexe de zones humides de la Vallée de Oued Righ. Les effectifs de flamants ont été estimés dans deux chotts de la vallée, Chott Merouane et Chott Melghir, d'août 2009 à juillet 2010 à raison de deux sorties par mois d'une journée entière (de 7h00 à 17h00). Les dénombrements ont été effectués avec des télescopes ornithologiques. Un comptage individuel était effectué si le groupe de Flamants était proche et ne dépassait pas les 200 individus; dans le cas opposé nous réalisions des estimations visuelles, autrement dit si les oiseaux étaient très éloignés et l'effectif très élevé (Lamotte & Bourrelière, 1969; Blondel 1975; Houhamdi 2002). Après la désertion des deux noyaux de la colonie découverte sur le Chott Merouane, nous avons procédé à la mesure de certains paramètres caractérisant la biologie et l'écologie de la reproduction chez ces échassiers (superficie des deux noyaux de la colonie, mesure des nids et des œufs abandonnés).

Résultats et discussion

Phénologie et structure

Les effectifs dénombrés en 2010 avoisinent les 29 000 individus (Fig. 2). Ces derniers se distribuent dans les endroits vaseux où la hauteur d'eau ne dépasse pas 10 cm. Nous avons observé un nombre important d'immatures (1 234 au niveau de Chott Merouane et 564 au niveau de Chott Melghir) et d'individus bagués provenant de France, d'Espagne, d'Italie (254 bagues ont été lues). A partir du mois de décembre 2009, les effectifs sont plus importants dans le Chott Merouane et ce jusqu'à la fin de l'étude (juillet 2010). Au delà du mois de juin, l'augmentation des effectifs dans le Chott Merouane est liée à l'inclusion des poussins estimés à 2 240

Tableau 1. Caractéristiques des nids (valeurs extrêmes citées entre crochets).

Nids	No.	Hauteur (cm)	Diamètre externe (cm)	Diamètre interne (cm)	Distance inter-nids (cm)	Distance inter-sous-unités (m)	Profondeur de l'eau (cm)
Noyau 1	2232	23.74 [10–38]	35.66 [28–51]	25.73 [19–31]	65.95 [16–197]	17.15 [2.8–93.20]	08 [07–10]
Nouveaux nids	1860	24.62 [15–32]	36.64 [34–40]	26.38 [21–31]	43.27 [16–145]		
Anciens nids	372	21.21 [10–38]	33.92 [28–51]	21.79 [19–26]	67.33 [18–197]		
Noyau 2	372	25.33 [14–42]	34.76 [29–48]	26.54 [21–34]	64.33 [37–172]	186 [117–254]	13 [11–15]
Nouveaux nids	367	26.22 [18–42]	36.81 [38–48]	27.05 [24–34]	51.28 [42–172]		
Anciens nids	05	25.32 [14–37]	31.66 [29–43]	22.81 [21–25]	74.26 [37–148]		

NB. La profondeur de l'eau a été mesurée le 20 juin 2010.

Tableau 2. Mensuration des œufs (valeurs extrêmes citées entre crochets).

	Nombre d'œufs	Longueur (cm)	Largeur (cm)	Poids (g)
Total	15	89.21 [87–90]	54.37 [53–55]	153.21 [152.8–155.3]
Noyau 1	12	89.33 [87–90]	54.47 [53–55]	153.33 [152.8–155.3]
Noyau 2	03	88.50 [88–89]	53.50 [53–54]	153.65 [153.4–153.9]

individus issus des deux noyaux de la colonie. Les températures atteignant souvent 50°C à la mi-journée ont provoquées la réduction rapide du plan d'eau du chott et de ce fait, la crèche a été en déplacement vers le centre du chott qui est demeuré inaccessible. Il nous a été donc impossible de poursuivre l'étude durant le mois d'août.

Description de la colonie

Suite à une première tentative de nidification échouée en 2009 (observation personnelle de l'équipe), les flamants se sont installés de nouveau dans les mêmes secteurs occidentaux et sud-occidentaux du Chott Merouane en 2010. L'incubation a commencée durant la première semaine du mois de mai 2010 et s'est prolongée jusqu'à la fin de la troisième semaine du mois de juin. Du fait que les îlots du chott sont très hauts (de 9 à 113 m), l'espèce a préféré édifier sa colonie sur deux noyaux directement dans l'eau. Les deux noyaux sont distants de 1 230 m. Le premier (33° 57'318"N, 006° 03'255"E) est cependant le plus grand (Fig. 1 & 3). Il est long de 296 m et large 137 m et composé de 19 sous-unités pour un total de 2 232 nids. Les plus grandes sous-unités sont situées au niveau de la partie septentrionale du noyau et les plus proches sont construites dans la partie occidentale. La plus grande sous-unité est composée de 623 nids dont 102 datent de 2009 et 521 sont bâtis cette année. Elle est longue de 57 m et large de 21 m (Fig. 1). Le second noyau (33° 56'582"N, 006° 03'451"E) est plus petit. Il représente environ 20% de la superficie du premier (Fig. 4) et il est composé de 372 nids répartis en quatre sous-unités renfermant respectivement 171, 86, 62 et 53 nids. Ces quatre sous-unités sont très espacées et les distances qui les séparent varient de 117 m à 254 m (moyenne de 186 m). Les nids sont bâtis directement dans l'eau. Les nids récents sont plus hauts et plus larges (Tableau 1). Globalement, les cônes des nids sont légèrement plus grands que ceux de Garaet Ezzemoul (Saheb *et al.*, 2006; Samraoui *et al.*, 2006) et ceux de Sebkhet Bazer Sakra. Les mensurations des quinze œufs trouvés intacts le 20 juin au niveau des deux noyaux (12 dans le premier et 3 dans le second) sont légèrement plus petits que ceux de la littérature (Schonwette, 1967 in Cramp & Simmons, 1977; Johnson 1997; Saheb *et al.*, 2006; Tableau 2).

Enfin, sous l'effet de l'élévation brutale de la température pendant la période estivale, les régions occidentales et sud-occidentales du chott ont subi un

assèchement partiel qui a rendu possible l'intrusion de nombreux prédateurs terrestres dans le deuxième noyau très proche de la Phragmitae à Phragmites australis. Les Canidés sont les premiers prédateurs ayant accédé à la colonie, en particulier le Renard roux Vulpes vulpes (Fig. 5) et le Fennec Vulpes zerda qui ont probablement causé l'arrêt définitif de l'incubation le 17 juin 2010. Ces derniers ont consommé les œufs non éclos et les poussins incapables encore de se déplacer et de quitter le second noyau de la colonie provoquant ainsi des dégâts irréversibles. Nous avons estimé les dommages de cette journée à 12% (nombre d'œufs prédatés / nombre total des nids) Trois individus de Vautours percnoptères Neophron percnopterus et cinq individus de Goéland leucophée Larus michaellis se sont aussi joints au festin. La crèche s'est ensuite déplacée au centre du plan d'eau. Vers la fin du mois de septembre, les premiers envols des poussins ont été observés. Ces derniers ont quitté définitivement Chott Merouane en direction du nord le 2 octobre 2010.

Conclusion

La découverte de ce troisième site de reproduction en Algérie renforce le besoin de coordonner des plans de gestion afin de pérenniser la conservation de cette espèce phare des grands chotts et sebkhas nord- africaines. Un programme de lecture de bagues a aussi été initié pour déterminer l'origine des flamants nichant en Algérie et identifier le rôle des grands chotts et sebkhas nord-africain dans le recrutement de cet échassier. Au niveau du sahara algérien et principalement dans la Vallée de Oued Righ, des études préliminaires ont montré que cette espèce est sédentaire avec des effectifs dépassant pendant toute l'année le seuil de 1% prescrit dans la convention internationale de Ramsar (Bouzegag 2008; Nouidjem 2008; Houhamdi *et al.*, 2008). Il est probable que le Chott Melghir, le plus grand de la région, joue le rôle de gagnage pendant le nourrissage des poussins nés dans le Chott Merouane particulièrement pendant le mois de juin 2010. Il est cependant d'accès très difficile et demeure de ce fait inexploré.

Remerciements

L'étude de l'écologie du Flamant rose *Phœnicopterus roseus* dans l'éco-complexe de zones humides de la Vallée de Oued Righ a débuté en septembre 2006 et inscrite en tant que sujet de thèse de doctorat de M. Bensaci Ettayib. Les auteurs tiennent à remercier M. Bouzegag Brahim pour l'accueil et l'hébergement pendant la réalisation pratique de ce travail, Dr. Arnaud Béchet pour son aide matérielle et les membres très actifs de l'association scientifique «Ecologia pour la préservation des zones humides et de l'environnement» de la commune de Djamaa, wilaya d'El-Oued (Algérie).

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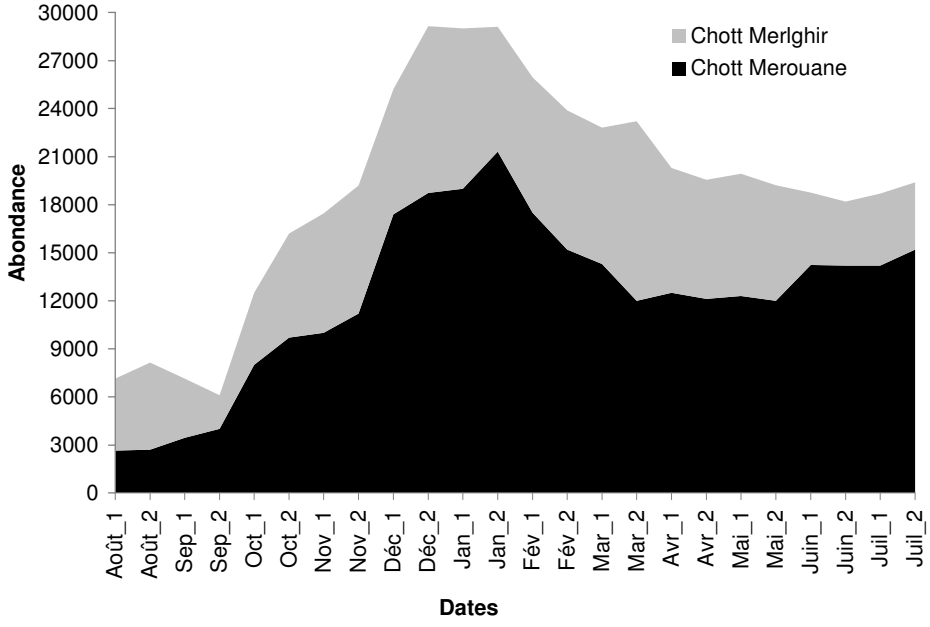

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Counting flamingos with a mobile phone – connecting all the flamingo lakes?

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Abstract — We describe a means for making a digital census of flamingos in large congregations as found in East African lakes. Comparing three cameras of increasing pixel resolution, two programs were written which calculated flamingo number from number of pixels covered, making allowance for flamingo size change from near (picture bottom) to far (picture top). Cameras with resolution of 9 megapixels (mp) produced acceptable flamingo numbers. We then tested an Android mobile phone camera against visual counts by experienced waterbird census counters. The results were 44.22% lower than visual counts but suggest that acceptable numbers will be possible with the current batch of affordable Android devices on the market (around 5 mp). A website was established, based on human crisis mapping software, to be developed as the open-access portal for all digital photographs, so that future censuses can be shared between lakes and countries.

Keywords: digital image processing, census, mobile phone, flamingo, waterbird, Android.

Introduction

Kenya has participated in the African Waterbird Census (AWB), developed and coordinated by Wetlands International, since it started in 1991, coordinated by a partnership between Nature Kenya and the National Museums Ornithology Section (formerly Department). Many wetlands are included in this census, but the most important are the chain of lakes in the floor of the Eastern (or Gregory) Rift. The northern lakes are not usually included, because of access difficulties, but five moderately sized lakes - Bogoria, Baringo, Nakuru, Elmenteita and Naivasha, together with several smaller lakes and wetlands associated with them are counted every 6 months.

Four of these lakes are tourist attractions (all except Elmenteita); two of these four (Bogoria, Nakuru) are soda lakes and their attraction is largely because of the dense congregations of Lesser Flamingos *Phoeniconaias minor* that they sometimes hold. There are believed to be 2.5 million Lesser Flamingos in East Africa (Milingwa & Baker, 2006), between Ethiopia and Tanzania and at times a million or more can be seen in Bogoria (a National Reserve), or Nakuru (a National Park).

Flamingos are censused in both of these lakes by the reserve/park staff more frequently than the AWB census, as they are also in Tanzanian protected areas. At present however, there is no sharing of these data and no central repository for a database. Such information would be highly valuable in population management, because the total number of flamingos counted in Kenya (almost all in the soda lakes mentioned above) has varied three-fold, between around half a million and 2 million. Clearly such differences indicate that the flamingos are elsewhere, rather than experiencing large population crashes. This article addresses two of these information issues - whether flamingos can be counted more often and whether information can be better shared.

The first author wrote a program for the Android mobile phone platform, which digitally counts flamingos as objects in images, taken using the camera component of the phone. This image, geolocated by inbuilt GPS, is stored alongside the manual counts of exactly the same landscape view, by a 3-person team, inputted manually. The Android phone, if connected to the Web through a sim card, can upload both images and counts to a central website.

Methodology

The investigation was carried out at Lake Bogoria, Kenya. We first compared the ability of cameras with increasing resolution to capture images of flamingos, and then compared digital counting with visual counting using the AWB Census methodology and performed by National Museum approved census counters.

The devices used were an Android mobile phone, a compact digital camera and a semi-professional digital SLR. For the first stage, identical images were taken using these three devices, of identical flamingo congregations in different locations along the eastern shore of the lake. The photographs were then stitched into a panoramic photograph using "Double Take", an image manipulation program for the Macintosh OSX and classified using a parallelepiped classification algorithm discriminating against the different colours within the image, providing a new, generalised image (Figure 1) from which flamingos could be counted (Lillesand *et al.,* 2004). The generalised image simplified the colour, so that flamingos were distinguished from other classes such as trees, sky, or water. It was then visually corrected to eliminate anomalies (see Figure 1 where 'flamingos' appear in trees). The classified image is generalised by colour, flamingos being pink with attempts made to classify other classes such as trees, sky, water etc. Due to the terrestrial nature of the photographs discrimination of other classes was made difficult with trees being commonly reflected in water.

One pre-classified photograph was then selected from which two flamingos were selected: the largest, *i.e.* closest to the lens at the bottom of the image and the smallest, *i.e.* the farthest away, towards the top of the image. A program to calculate flamingo size, in pixels, was then written, using linear interpolation of size reduction as flamingo position on the image changed with distance from near (lower) to far (upper):

$$n = y_0 + (x + x_0)\frac{(y_1 - y_0)}{(x_1 - x_0)} \qquad (1)$$

This equation was used to both calculate the depth and width of the rhomboid that represents a flamingo in the two dimensional image space. It is a two stage iterative process to calculate the dimensions of the rhomboid, where:

n is the interpolated line size in pixels.
x is the distance of the chosen pixel from the bottom of the image.
x_0 is the distance in pixels of the far flamingo from the bottom of the image.
x_1 is the distance in pixels of the near flamingo from the bottom of the image.
y_0 is interchangeably the height or width in pixels of the far flamingo.
y_1 is interchangeably the height or width in pixels of the far flamingo.

$$f = \frac{1}{x^n * y^n} \qquad (2)$$

Equation 2 calculates "Flamingo Pixel Relevance", the area of the 'virtual flamingo' in the image and provides a quotient to give the importance of one pixel in the image, which differs upon location. This is then added to the total flamingo count.

$$\sum_{(x,y)\in \mathrm{Im}age}^{\infty} f(x,y) \qquad (3)$$

Equation 3 calculates the final flamingo number from the classified image. The tuple (x; y) are pixel coordinates within the raster image, f being previously defined in equation 2. The sum of these will give the number of flamingos in the classified image.

Results

The first phase did not provide adequate results, because the mobile phone did not have adequate resolution to count any flamingos. The second phase, conducted by trained volunteers from the AWB count to provide the comparison, used an improved, more current Android mobile - Samsung i5700.

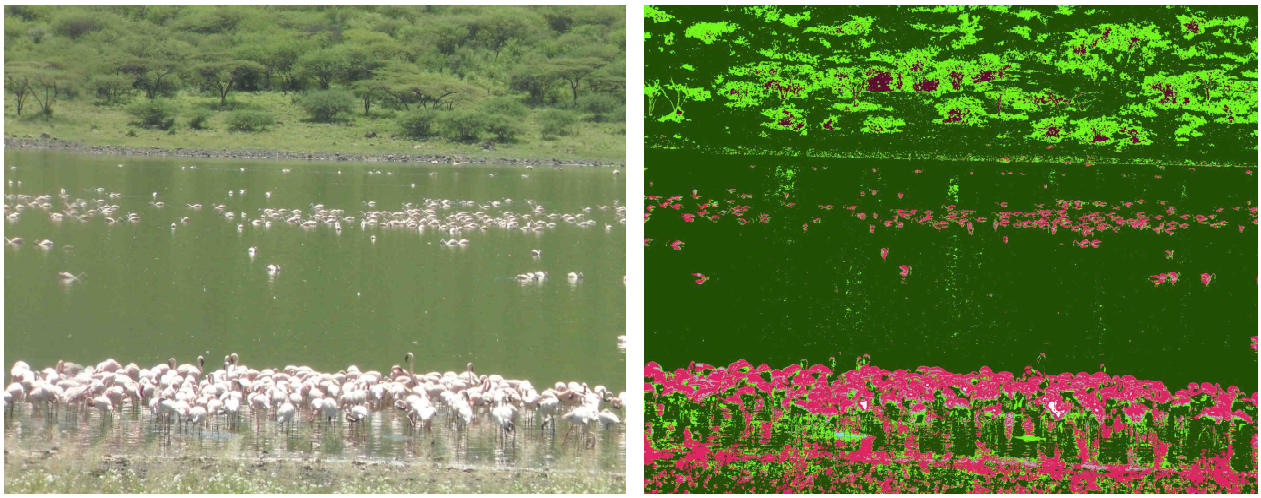

Figure 1. Comparison of the original and generalised image after classification.

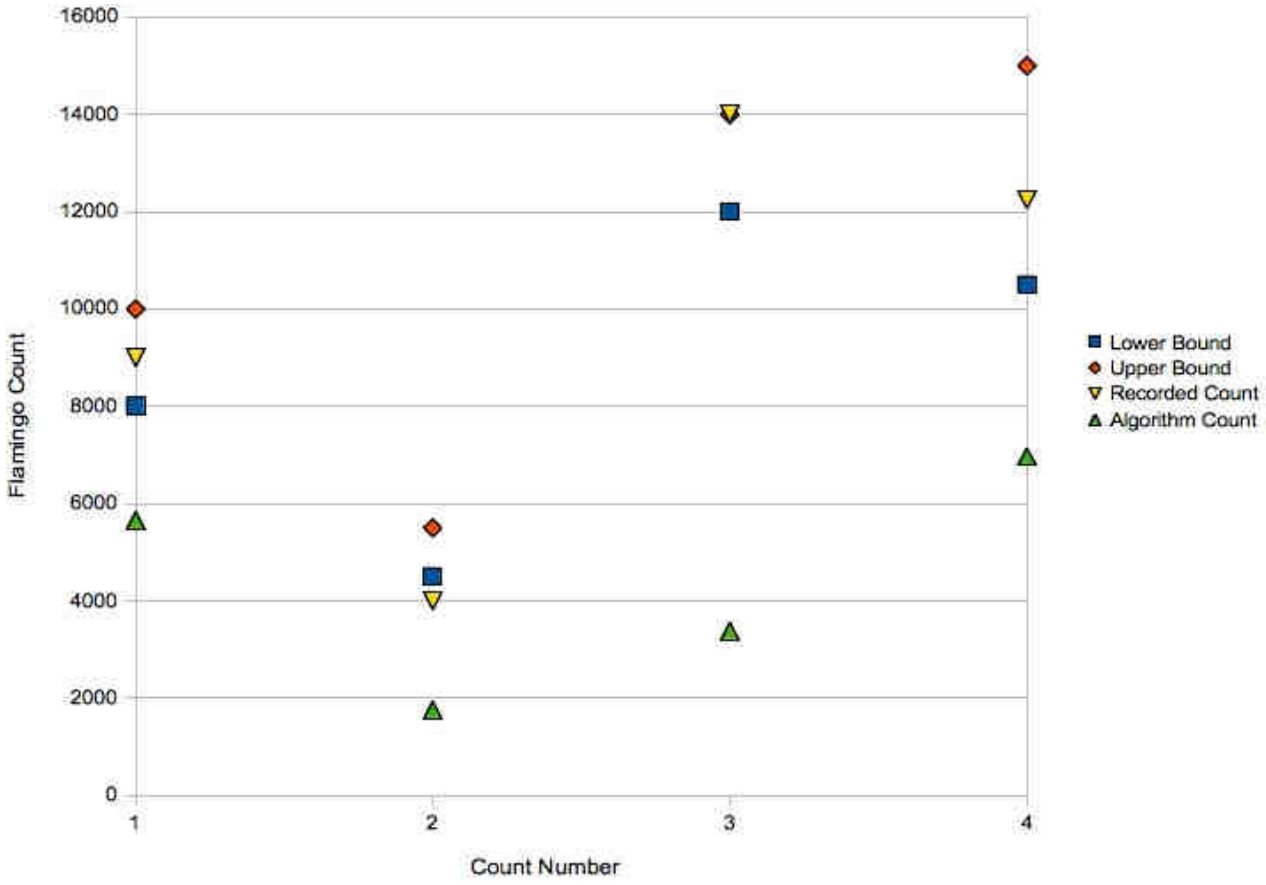

Figure 2. Comparison of algorithm counts against official counts.

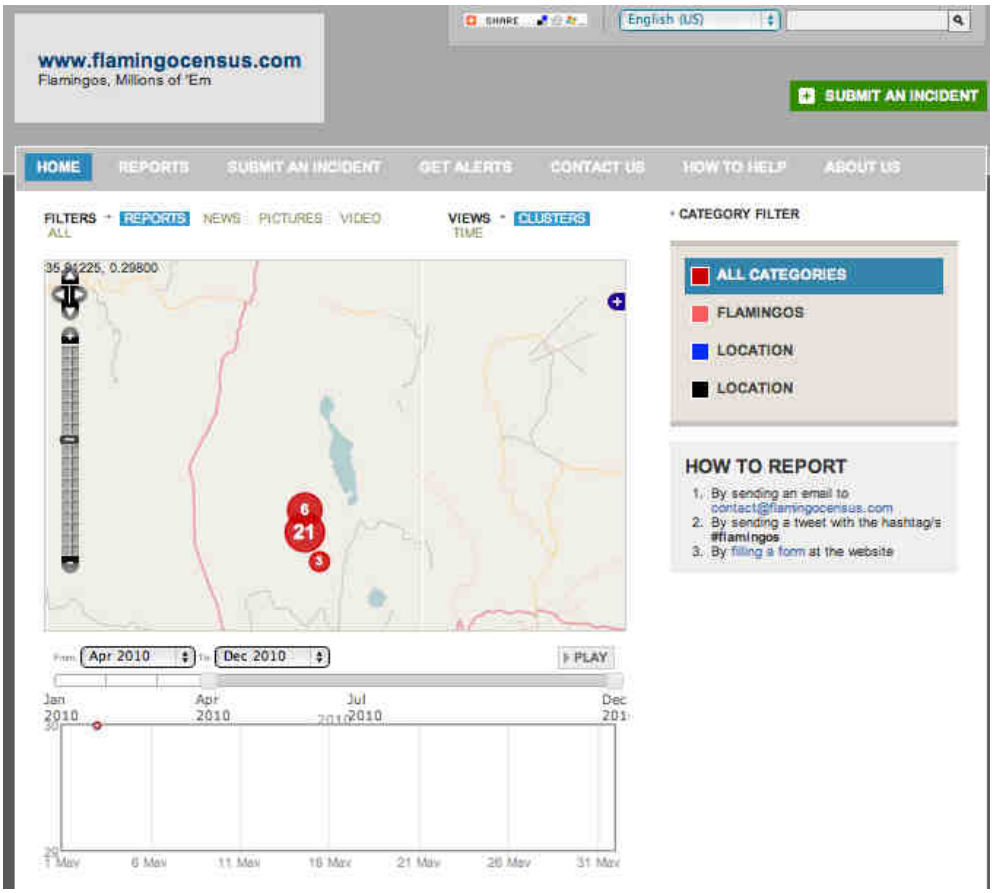

Figure 3. Ushahidi Crisis Mapping Platform.

Figure 2 shows the results for the four locations counted in the second phase (three visual counts and one digital count at each location). Despite an improvement over the first phase, the data suggest this digital method is not yet accurate enough to replace manual counts.

A website was established at the address www.flamingocensus.com, running Ushahidi software, which is commonly used in mapping human crises (Kovacic & Iliffe, 2010), but here has been employed to chart flamingo counts, (illustrated in Figure 3).

Currently the website acts as a portal to the source code and programs developed to achieve the results mentioned, alongside an interactive map of the recorded flamingo counts. The information encoded into these counts includes the latitude and longitude of the location which was used to photograph, the date and time and the device used.

Discussion

The results taken together indicate that the resolution of Android phone cameras needs to be capable of of 5 megapixel images, to take photographs of flamingos from terrestrial vantage points which can be digitally interpreted. The next generation of phones in 2011 is expected to affordably achieve this and will be tested in the Kenya lakes.

Many lakes have flamingo densities at certain locations, repeatedly visited by tourists and with lookout points used for water bird census, such as the Hot Springs in Bogoria or the "Baboon Cliffs" in Nakuru. Repeated comparison of visual with digital counts from these locations, as part of the AWB Census, could examine whether the location supports a consistent fraction of flamingos in the whole lake; if it did then information could easily be gathered by staff at frequent intervals or even by tourists on a daily basis, akin to placing location tagged photographs on Google Earth. To do this, the software for image analysis needs to be centrally available.

The work presented here is very much the first iteration of a large cycle, which will investigate both the digital recording of flamingo densities using mobile phones and the sharing of information between lakes from the 4 countries of East Africa. It opens up avenues for further research; possibly by monitoring flamingos through tourist volunteered geographical information and tracking.

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Is ground census of flamingo lakes worthwhile?

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Abstract — Flamingo numbers in Kenya are counted annually at accessible soda lakes by Nature Kenya and the National Museums of Kenya as part of the African Water Bird Census, in January, and frequently also in July. On occasions there have been over a million birds at certain lakes. The accuracy of the census has been questioned because an element of subjectivity has to be applied to group estimates when so many birds are counted. The value of the census has been questioned because counts can only be performed at lakes where easy access enables people to view all lake areas; this renders any census of East African flamingos only partial, because of other lakes within the flamingos' range, some in Kenya and some in other countries. Lakes Bogoria, Nakuru, Elmenteita and Sonachi have been counted in this way for flamingos since 1991 and Oloidien since 2006 (before that year it was a small freshwater lake, not counted separately from Naivasha). This study compared the data obtained from ground counts at the end of January 2008, with data obtained from an aerial photographic census performed over the same lakes one week later. The number of flamingos recorded in the photographic aerial census was 333,347 whereas the ground counts registered a total of 351,693. These results suggest that, in spite of the limitation of ground counts, they are a reliable method to estimate flamingo population size. It is argued that ground counts in the accessible lakes should be maintained as part of the efforts to monitor flamingos.

Keywords: Kenya, Tanzania, African Water Bird Census, census, flamingos, East Africa, Bogoria, Nakuru, Elmenteita, Sonachi, Oloidien, numbers, aerial survey, photography, ground counts.

Introduction

The Lesser Flamingo *Phoeniconaias minor* is a nomadic bird species, which travels frequently and unpredictably from lake to lake in the Eastern Rift Valley, and between salt pans and wetlands in the rest of Africa, in response to changes in environmental conditions (Childress *et al.*, 2007; Childress, Nagy & Hughes, 2008). They are known to occupy a handful of saline lakes in Kenya and Tanzania (Figure 1), and a few more in Ethiopia and Uganda (Childress, Nagy & Hughes, 2008). Those saline lakes are of high scientific interest and the human communities which live in the vicinity of some of them benefit economically from the tourism the Lesser Flamingos attract (Harper *et al.*, 2003). As tourist and conservation hotspots, African lakes and wetlands require effective regular monitoring (Bennun, 2001; Bennun *et al.*, 2005). Nevertheless ornithology still needs further development as an activity amongst Kenyans. Flamingo ground counts which rely on large numbers of volunteers are valuable as they help to spread awareness of the importance of protecting and monitoring ecosystems and they also get local people involved in the monitoring efforts (Bennun, 2001).

Flamingos are considered a Near Threatened species because of their dependence upon special environmental conditions which allow them to feed and breed (Childress, Nagy & Hughes, 2008). Given the limited specialised feeding and breeding sites available for them to do so they are at risk due to environmental change and habitat degradation and therefore require conservation.

A Darwin Initiative study on Lesser Flamingo conservation (2003-8) undertook an aerial census of all flamingo lakes (16) in Kenya and Tanzania, to ascertain if it was economically and technically feasible to carry out such a study from a light aircraft with an ordinary digital (SLR) camera. The overall study found that the digital image analysis was possible and the aerial census could be completed for less than £5,000. This paper compares aerial count data with ground count data for the five Kenyan lakes that are censused regularly as a test of ground counting efficiency.

Study area

The study included lakes Bogoria, Nakuru, Elmenteita, Sonachi and Oloidien, all endorrheic lakes in the Eastern Rift Valley with different degrees of alkalinity. Lake Bogoria is the most saline lake (conductivity up to 80 mS/cm, maximum depth 12 m, area 3,000 ha). Lake Nakuru is a shallow pan (conductivity 15–25 mS/cm, max. depth 3 m, area

3,000–5,000 ha) approximately 65 km south of Lake Bogoria. Lake Elmenteita, about 30 km south of Lake Nakuru, has a similar conductivity to Nakuru but is even more shallow (max depth 1.5 m, area up to 1,800 ha). Lake Sonachi (conductivity 16 mS/cm) is a small crater lake (180 ha) located further to the south (near the freshwater Lake Naivasha). Lake Oloidien used to be a bay of Lake Naivasha but it has been independent since 1980 with salinity slowly increasing a hundred-fold over this time to conductivity 5 mS/cm; its max depth is 5 m, and area is 510 ha (Vareschi, 1978; Owino *et al.*, 2001; Harper *et al.*, 2003; Ballot *et al.*, 2005; Childress *et al.*, 2007).

Methods

A Cessna 182 aeroplane was used to fly over the lakes. A Nikon D200 digital camera with 24–70 mm zoom lens was hand-held during the flights. Colour photographs were taken in RAW file format and copies were made from the resulting files as high resolution (300 pixels/inch) TIFF files (3884 x 2600 pixels).

Two methods were used to extract the number of flamingos from the images. Sections of photographs with scattered flamingos were copied into Photoshop and then converted into binary images to render the flamingos as black objects, which were counted in ImageTool. Flamingos that appeared flying or were too close to each other were first "tagged" in Photoshop by visual recognition. The tags were pasted onto new blank files which were then analysed with ImageTool. Images that contained high densities of flamingos were counted manually. A combination of two or three of the methods was applied to a single image whenever it was deemed necessary.

The flamingo ground counts were carried out by teams of trained volunteers led by at least one person with considerable experience in ground counts. Volunteers had been trained for a weekend prior to being used. The lakes' shorelines were divided into sections and assigned to teams which then counted the flamingos using binoculars and telescopes from vantage points along the shorelines (Owino *et al.*, 2001; Tuite, 2004). At each point, the observers in the team made individual estimates. These estimates were compared and a single estimate was agreed upon. To avoid repeatedly counting flying birds the teams did not count "birds flying in from behind" as those were considered to have been counted by the team located in that direction. The data were recorded in notebooks and then transferred to databases.

The results of the flamingo ground counts performed by the National Museums of Kenya at lakes Bogoria, Nakuru, Elmenteita, Sonachi and Oloidien at the end of January 2008 were then compared with the results of the aerial photographic census carried out in early February 2008.

Results

The ground counts (Table 1) recorded a total of 351,693 flamingos with the greatest number at Lake Nakuru (258,210). The aerial census carried out in early February recorded a total of 333,347 flamingos again with the greatest number at Lake Nakuru (258,818). Ground counts for July of that year are also included, to illustrate the large difference between censuses that often occurs.

Discussion

In January and February 2008, the majority of the flamingos were found in Lake Nakuru and the

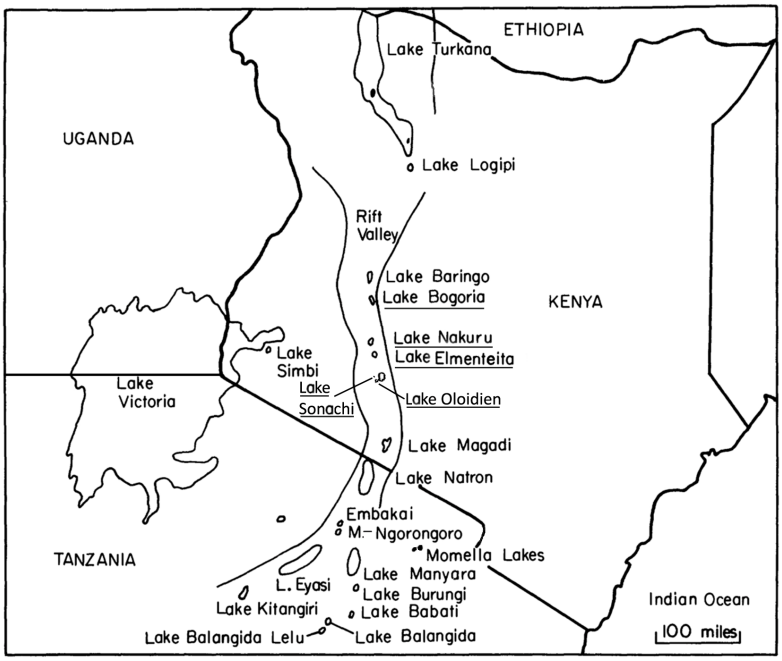

Figure 1. The saline lakes of Kenya & Tanzania (those of Uganda & Ethiopia not shown). The lakes of the present study appear underlined. Modified from Tuite (1979).

Table 1. Flamingo numbers in Kenyan saline lakes as obtained from the 2008 aerial and ground counts.

Lake	Ground count (January)	Aerial census (February)	Difference (from Aerial)	Ground count (July)
Elmenteita	6,914	1,471	+ 5,443	19,349
Nakuru	258,210	258,818	- 608	6,630
Bogoria	69,847	45,208	+ 24,639	978,582
Oloidien	16,706	27,850	- 11,144	48,062
Sonachi	16	0		1,338
Total	**351,693**	**333,347**	**+ 18,346**	**1,053,961**

counts differed by only 608 birds (0.23%). Larger percentage differences between the counts were shown on the smaller lakes, which we believe to be due to the itinerant behaviour of flamingos, moving from lakes Elmenteita and Bogoria to Nakuru and Oloidien in the week between the two counts. A satellite tracking study of birds initially from Bogoria indicates that flamingos fly short distances to nearby lakes more frequently, rather than long distances to lakes which are further away (Childress *et al.*, 2007).

Concerns over the scientific validity of flamingo ground counts centre on uncertainty about the accuracy and reliability of data collected by volunteers (Bennun *et al.*, 2005). This study has shown that there was an overall similarity between the figures obtained through ground and aerial count methods, supporting the continued use of trained volunteers for ground counts as at present.

The actual drawback of flamingo ground counts is the inability to count all of the Kenyan saline lakes by ground, especially remote lakes like Logipi. In spite of this, the results of this study confirm that the flamingo ground counts do provide adequate estimations. This highlights the importance of maintaining them as part of the monitoring programmes required by the Lesser Flamingo Action Plan. Given that the plan currently suggests a minimum of three ground counts per year (Childress, Nagy & Hughes, 2008), this paper suggests performing them with higher frequency throughout each year, along with periodic aerial surveys when money allows, to maintain quality control.

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Monitoreo mensual de tres especies de flamenco en el Monumento Nacional Laguna de los Pozuelos, Jujuy, Argentina

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Resumen — Presentamos resultados preliminares del monitoreo mensual de tres especies de flamencos (*Phoenicoparrus andinus*, *P. jamesi* y, *Phoenicopterus chilensis*) en la Laguna de los Pozuelos, ubicada a 3500 m s.n.m en la Puna de Jujuy, noroeste de Argentina. Los censos se realizaron durante 19 meses, desde febrero de 2009 a setiembre 2010. Los resultados evidencian un patrón de abundancia estacional similar al de los lagos Uru Uru y Poopó en Bolivia (Rocha *et al.,* 2006), donde las tres especies se encuentran presentes a lo largo de todo el año. Generalmente se presenta una dominancia de *P. chilensis* sobre las otras dos especies, siendo *Phoenicoparrus jamesi* la menos abundante. Se han observado notables picos de abundancia de las tres especies en el sitio para los meses de setiembre-diciembre de 2009 y este año partir de agosto 2010. En diciembre de 2009 y setiembre de 2010 se registraron abundancias correspondientes al 63% y 87%, respectivamente, de la población total estimada de *P. andinus* (Marconi *et al.,* 2010), la especie más amenazada de flamencos. También se registró un importante intento de nidificación en febrero de 2010 de *Phoenicopterus chilensis* (más de 2000 nidos activos). La colonia ubicada a unos 300 m de la orilla en zona próxima a la desembocadura del Río Santa Catalina fracasó por un aumento repentino en el nivel del agua provocado por lluvias. Otro evento de mortalidad de flamencos registrado (al menos 60 aves adultas halladas muertas en la orilla, de *Phoenicoparrus andinus* y *Phoenicopterus chilensis*) fue ocasionado por la inusual ola de frío en agosto de este año (temperaturas inferiores a -26°C).

Abstract — We present preliminary results of monthly censuses of three flamingo species, the Andean Flamingo *Phoenicoparrus andinus*, the Puna Flamingo *P. jamesi* and the Chilean Flamingo *Phoenicopterus chilensis* at Pozuelos National Monument, located at 3500 m a.s.l. in the Puna of Jujuy, northwestern Argentina. The monitoring was conducted for 19 months, from February 2009 to September 2010. The results show a pattern of seasonal abundance similar to Uru Uru and Poopó lakes in Bolivia (Rocha *et al.,* 2006), where the three species are present year round. The Chilean Flamingo is usually dominant, while the Puna Flamingo is the least abundant. Over the census period, numbers of the three species were highest between September and December 2009 and in August and September 2010. In December 2009 and September 2010, the abundances recorded were 63% and 87%, respectively, of the total estimated population of Andean Flamingo (Marconi *et al.,* 2010), the most threatened of the flamingo species. We also recorded a nesting attempt in March 2010 of Chilean Flamingos with more than 2,000 active nests. The colony, located in the lake about 300 m offshore in the area near the mouth of the Santa Catalina River, failed due to a sudden increase in water level caused by rainfall. In August 2010, unusually low temperatures (below -26°C) caused a flamingo mortality event, with at least 60 Chilean and Andean Flamingos found dead.

Keywords: Andean Flamingo, Phoenicoparrus andinus*, Puna Flamingo,* Phoenicoparrus jamesi*, Chilean Flamingo,* Phoenicopterus chilensis*, census, Argentina, nesting, mortality event.*

Introducción

El Monumento Natural Laguna de Los Pozuelos se encuentra ubicado en la provincia de Jujuy, en el noroeste de Argentina, a 3.500m s.n.m.

La laguna forma parte de una cuenca endorreica de unos 2400-km² de extensión aproximada, en la cual los ríos Santa Catalina y Cincel, en los extremos Norte y Sur, respectivamente, resultan los únicos colectores que, con régimen semipermanente, alimentan la laguna. Estos cursos sólo fluyen en sus tramos finales en el período de estiaje, y poseen caudales fluctuantes que se incrementan con la llegada de las crecidas (Igarzábal, 1991). La laguna experimenta un ciclo de recarga y desecación anual muy pronunciado, alcanzando una superficie máxima que puede superar los 90 km2 en la época de lluvias (en febrero), retrayéndose en años secos a sólo 200 ha en el sector de la desembocadura del Río Cincel en la época de estiaje (setiembre–noviembre) (Lizárraga, 2009).

En la Laguna y Lagunillas de Pozuelos se congregan aves acuáticas y endémicas de la Puna. En el cuerpo de agua mayor se encuentran las tres especies de flamencos, el Flamenco austral (*Phoenicopterus chilensis*) y los Flamencos Altoandinos: la Parina Grande (*Phoenicoparrus andinus*), actualmente clasificado como vulnerable (UICN, 2010), ya que es la especie de flamenco más rara del mundo; y la Parina Chica (*P. jamesi*), ambas consideradas en peligro a nivel nacional (AVA y SAyDS. 2008).

Metodología

La metodología del monitoreo en el sitio se fue ajustando con los censos estacionales bianuales (verano–invierno) que se realizan desde el año 2005 a la fecha (Caziani *et al.* 2007, Moschione y Sureda, 2008). Las fechas de los censos estacionales se coordinaron con el Censo Neotropical de Aves Acuáticas (CNAA) y el censo estival de flamencos del GCFA (Caziani *et al.,* 2006, 2007; Marconi *et al.,* 2008). Los censos mensuales, iniciados en febrero de 2009, se efectúan en la tercera semana de cada mes.

Laguna de los Pozuelos es difícil de relevar por su extensión y relieve plano. En las lagunas de menor tamaño se realizaron censos totales de aves acuáticas, mediante barrido con binoculares y telescopios montados sobre trípodes. En Pozuelos, se realizaron conteos por campos identificando especies y registrando nidos, juveniles, individuos anillados, e individuos hallados muertos, desde 8–10 puntos próximos a la costa, hasta al menos 20% del total estimado (Bibby *et al.,*1992 ; Rodríguez, 1996). El muestreo se realiza utilizando siempre los mismos puntos. Desde el Cerro Fantasma (22º 19' 43,3" S 66º 04' 09,4" W) se realiza un buen conteo total de flamencos, pero sin discriminar especies, y asimismo se observan los sitios de concentración de flamencos.

La metodología del censo aplicada es la más adecuada para flamencos, por el tamaño de estas aves y su distribución habitual en el cuerpo de agua, aunque ofrece una cobertura parcial para otros grupos de aves acuáticas. Sin embargo, y a los fines de la comparación de los datos previos, ha sido conveniente mantener el mismo esfuerzo de muestreo.

Resultados y Discusión

El incremento cuantitativo en el esfuerzo de muestreo con frecuencia mensual desde febrero de 2009 ha permitido un mayor conocimiento de las fluctuaciones en riqueza y abundancia de la avifauna acuática a lo largo del año, y la detección de especies raras, especialmente migratorias. Fueron registradas por primera vez varias especies de chorlos: Limnodromus griseus, Limosa fedoa, Calidris minutilla, Calidris pusilla, Charadrius wilsonia y Chlidonias niger.
Los flamencos muestran un patrón de abundancia estacional similar al observado en los lagos Uru Uru y Poopó en Bolivia (Rocha *et al.,* 2006), donde las tres especies están presentes todo el año. En particular destacan las especies altoandinas (*Phoenicoparrus* spp.) en el invierno, por su funcionamiento como hábitat complementario de los sitios altoandinos que se congelan en esta época. Generalmente, presenta una dominancia de *Phoenicopterus chilensis* sobre las otras dos especies, siendo *Phoenicoparrus jamesi* la menos abundante. Con el monitoreo mensual en Pozuelos se han observado notables picos de abundancia de flamencos en primavera, que por su ubicación constituye un sitio de latitud y altitud intermedia a los de concentración estival. Estos incrementos fueron registrados de setiembre a diciembre en 2009, y a partir del mes de agosto de 2010 (Fig. 1).

En diciembre de 2009 y setiembre de 2010 las abundancias de *P. andinus* alcanzaron el 63% y 87%, respectivamente, de la población global estimada (Valqui *et al.,* 2000; Caziani *et al.,* 2007; Marconi *et al.,* 2010).

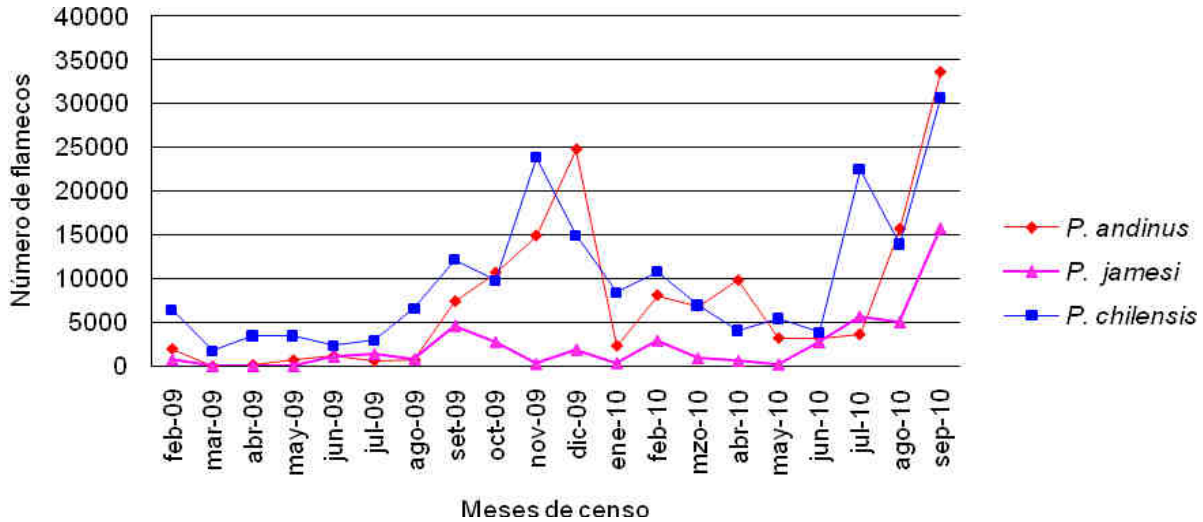

Fig. 1. Abundancias de flamencos en Pozuelos, período 2009–2010.

Desde el inicio del censo mensual se registraron 24 individuos anillados *(*20 *P.andinus* y 4 *P. jamesi),* un importante incremento en la "recaptura" de registros de avistajes, ya que en el período 2005–2008, correspondiente al censo estacional bianual, sólo hubo 6 registros de flamencos anillados. El 13/02/2009 se registró cerca de la desembocadura del Río Cincel (22°24'46,8" S, 65°59'5,9" W) un individuo anillado en Barros Negros, Salar de Atacama, por CONAF en 1988, lo que indica una longevidad comprobada de la especie en estado silvestre de 22 años.

La periferia inmediata de la Laguna de los Pozuelos es sometida a pastoreo en diversa intensidad, observándose intensificación de erosión asociada a la actividad en algunos sectores. Esta actividad de carácter parcialmente tradicional está modificando su dinámica en los últimos tiempos, ocurriendo una intensa parcelación de los campos con alambrados. En porciones más alejadas de la cuenca existe actividad minera, que en algunos casos, como el de Mina Pan de Azúcar, genera problemas agudos de contaminación. Si bien estas actividades son efectuadas fuera del área del Monumento Natural, repercuten en forma directa en el depocentro de esta cuenca endorreica.

El Monumento Natural como área de conservación no representa una unidad estructural y funcional a nivel ecosistémico ni es representativa de la diversidad biológica a escala local. Aún para las especies acuáticas, a escala local requiere complementación con las lagunillas cercanas dispuestas en un pequeño valle longitudinal al oeste de la Laguna de Pozuelos. La ampliación e inclusión del sector de Lagunillas como parte del área protegida, con cuerpos de agua de otras características, sectores de serranías, extensiones funcionales de pastizales y estepas, e incluso pequeñas comunidades de queñoa y cardonales, aumentaría considerablemente la riqueza y funcionalidad del área y su potencial de conservación.

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Fourth simultaneous flamingo census in South America: preliminary results

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Abstract — The fourth International Simultaneous Census (ISC) of flamingos in South America, conducted in 2010, included a comprehensive survey of 259 wetlands throughout the distribution range of both of the high Andes species, the Andean *Phoenicoparrus andinus* and Puna Flamingo *P. jamesi*, in Argentina, Bolivia, Chile and Peru. At each wetland we recorded total flamingo counts, other waterbird species counts, resightings of banded flamingos, and we surveyed breeding sites. Total counts were 106,001 Puna Flamingos, 38,675 Andean Flamingos, 280,752 Chilean Flamingos *Phoenicopterus chilensis*, and 8,623 unidentified flamingos. Comparing censuses of similar coverage (ISC 05 and ISC 10), numbers of Andean and Puna Flamingos are similar. In contrast, there was a marked increase in Chilean Flamingos with the inclusion of lowland wetlands, especially Mar Chiquita-Bañados del Río Dulce and Laguna Llancanelo in ISC 2010. Both high-Andes flamingo species had similar distribution to prior censuses.

Resumen — El 4to. Censo Simultáneo internacional (CSI) en 2010 incluyó un relevamiento exhaustivo de 259 humedales a través del área de distribución de las dos especies de Flamencos Altoandinos, la Parina Grande (*Phoenicoparrus andinus*) y la Parina Chica (*P. jamesi*) en Argentina, Bolivia, Chile y Perú. En todos los humedales registramos conteos totales de flamencos y de aves acuáticas, re-avistaje de individuos anillados e hicimos un relevamiento de sitios de nidificación. Los resultados totales fueron 106.001 Parinas Chicas 38.675, Parinas Grandes, 280.752 Flamencos Australes (*Phoenicopterus chilensis*), y 8.623 flamencos no identificados. Comparando censos de similar cobertura (CSI 2005 y CSI 2010), los números de Parinas Grandes y Parinas Chicas son similares. En cambio, hubo un marcado incremento del número de Flamencos Australes, debido a la inclusión en el CSI 2010 de humedales de Tierras Bajas, especialmente Mar Chiquita - Bañados del Río Dulce y Laguna Llancanelo. Ambas especies de Flamencos Altoandinos tuvieron similar patrón de distribución que en censos anteriores.

Keywords: Andean Flamingo, Phoenicoparrus andinus*, Puna Flamingo,* Phoenicoparrus jamesi*, Chilean Flamingo,* Phoenicopterus chilensis*, census, high Andes, International Simultaneous Census, ISC, Argentina, Bolivia, Chile, Peru, Grupo Conservación Flamencos Altoandinos, GCFA.*

Introduction

Range-wide simultaneous censuses for high Andes flamingos started in 1997 and were the first regional activity developed by the Grupo Conservación Flamencos Altoandinos (GCFA). Three international (comprehensive) summer censuses (1997, 1998, 2005) and two winter censuses (1998, 2000) have been conducted to date. The first series of simultaneous censuses (1997–2000) allowed the GCFA to establish a regional baseline for population numbers for both high Andean flamingo species and the conservation status of Andean wetlands. The GCFA determined that simultaneous censuses at 5-year intervals would allow establishment of population trends for the two high Andes flamingo species. The third summer census (2005) provided the necessary scientific information to identify priority wetlands for development of a Network of Wetlands of Importance for Flamingo Conservation, focusing research and conservation efforts on these key sites. Here we report preliminary results from the fourth simultaneous flamingo census carried out in 2010.

Logistics and methodology

During the 2010 simultaneous flamingo census, we visited 259 wetlands in January and February in Argentina, Bolivia, Chile and Perú, of which 60% are included in the Network of Wetlands of Importance for Flamingo Conservation (Figure 1) (Marconi 2010). Of all censuses organized by the GCFA, this one had the broadest wetland coverage, increasing number of wetlands censused by 62% and including lowland wetlands (29 lakes).

Eighty-eight people participated including biologists, park guards, and students distributed in 21 census teams. Twenty institutions including government agencies, academic institutions, national and international non-governmental organizations, and two private companies provided support or participated either directly or indirectly.

To train new technicians and plan and coordinate the 2010 Census, we held the "Training Workshop for Integrated Management of the High Andes Wetland Network and Associated Ecosystems of Argentina, Bolivia, Chile and Peru," funded by the Ramsar Convention (Ramsar, 1971) and the Wetlands for the Future Initiative. The workshop took place from 8–13 November, 2009, in Abra Pampa, Jujuy Province, Argentina, organized by Patricia Marconi with support from Fundación YUCHÁN and technical staff of the National Park Administration's (Administración de Parques Nationales, APN) Northwestern Regional Delegation and Laguna de los Pozuelos National Monument. Field training activities took place in Laguna Runtuyoc and Laguna de los Pozuelos Natural Monument. The latter is the first Ramsar site for Argentina and a priority site in the Wetland Network.

Concurrent to the workshop, the GCFA met to plan and coordinate the 2010 International Simultaneous Census (ISC 10). Outcomes were: 1) updated consensus version of the 2010 census methodology; 2) detailed workplan with census dates established, 20 operative units organized, and country

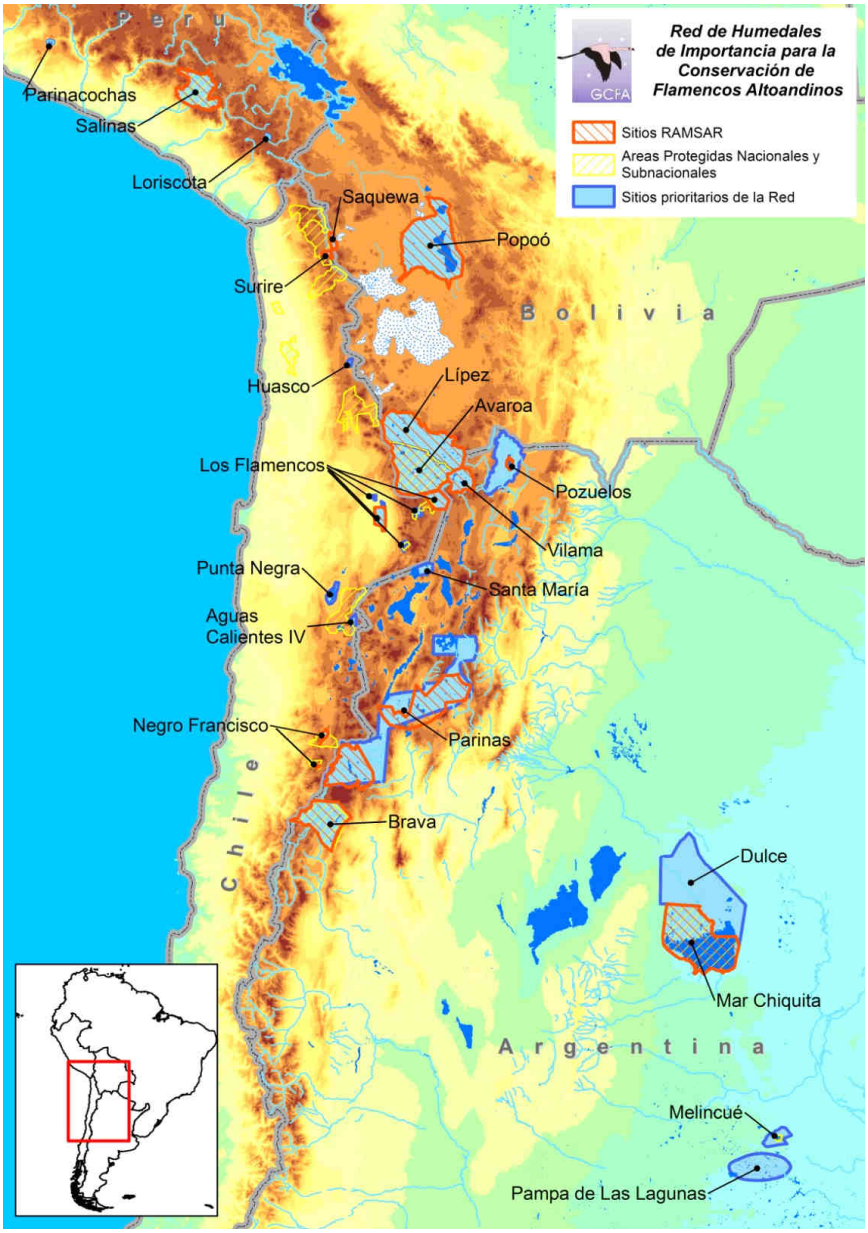

Figure 1. Network of Wetlands of Importance for Flamingo Conservation.

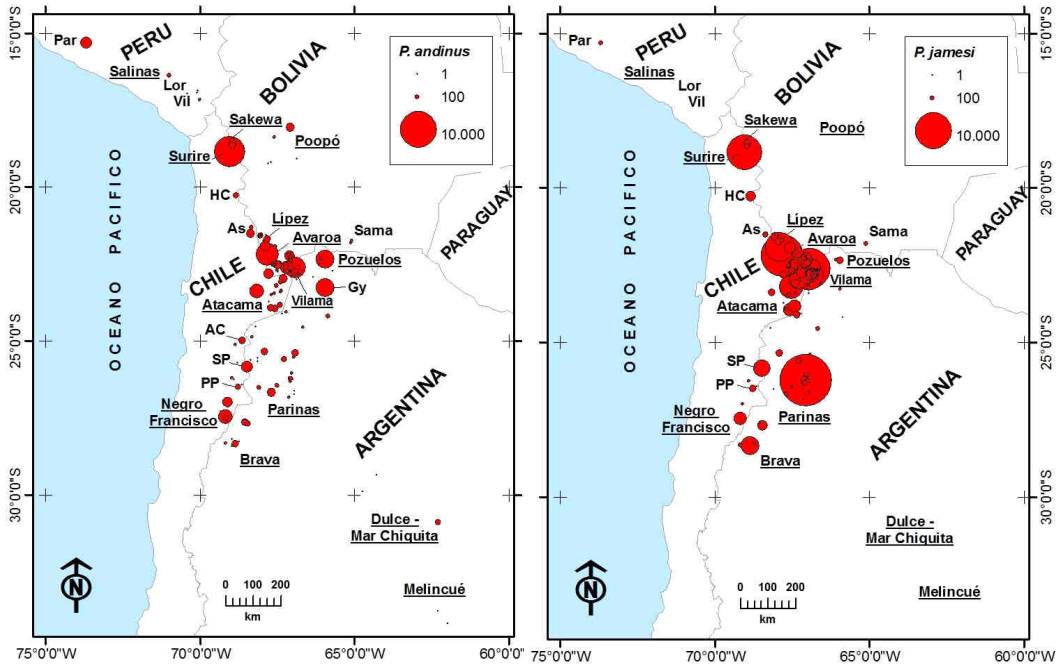

Figure 2. Andean Flamingo *Phoenicoparrus andinus* and Puna Flamingo *P. jamesi* abundance at each wetland during the fourth International Simultaneous Census, January–February 2010. Underlined sites are priority sites in the Wetland Network. Other sites are Par: Parinachochas, Lor: Loriscota, Vil: Vilacota in Peru; Sama in Bolivia; HC: Huasco-Coposa, As: Ascotán, SP: Salar de las Parinas, PP: Piedra Parada in Chile.

coordinators designated; and 3) schedule for local training workshops in each country (Marconi, 2009).

In Argentina and Chile we conducted the census during the established timeframe, between 22 January and 2 February, 2010. In Bolivia the census took place from 31 January to 8 February and in Peru from 16–24 February. The shift in starting dates in Bolivia and Peru was due to logistical difficulties. We used the census methods described in Manual de Técnicas de Monitoreo de Condiciones Ecológicas (Marconi, 2010).

Preliminary results of the flamingo census

This is a preliminary presentation of the results that the GCFA is analyzing in depth to be published in a scientific publication. Of the 259 wetlands surveyed, 60% had high Andes flamingos. Total counts were 106,001 Puna Flamingos, 38,675 Andean Flamingos, 280,752 Chilean Flamingos, and 8,623 unidentified flamingos (Table 1).

Unidentified individuals were mostly from priority sites Lagunas de Vilama, Reserva Eduardo Avaroa and Lago Poopó. Comparing censuses of similar coverage (ISC 05 and ISC 10), numbers of Andean and Puna Flamingos are similar. In contrast, there was a marked increase in Chilean Flamingos with the inclusion of lowland wetlands, especially Mar Chiquita-Bañados del Río Dulce and Laguna Llancanelo in ISC 10. Both high Andes flamingo species had similar distribution to prior censuses (Figure 2) (Caziani *et al.,* 2006, 2007).

Table 1. Global results of the International Simultaneous Census (ISC) and Simultaneous Census of Network Sites (SCN) for the three high Andes flamingo species.

	ISC 97	ISC 98	ISC 05	SCN 07	SCN 08	SCN 09	ISC 10
Puna Flamingo	47,619	64,101	105,647	70,333	79,399	80,878	106,001
Andean Flamingo	33,918	27,813	31,962	28,471	28,812	32,708	38,675
Chilean Flamingo	39,087	25,777	40,889	53,199	37,265	51,098	282,752
Phoenicopteridae	0	0	26,547	20,649	115	652	8,623
Total	120,624	117,691	205,045	172,652	145,591	165,336	436,297
Number of Wetlands	93	126	142	94	84	96	259*

ISC: International Simultaneous Census; CSR: Simultaneous Census of Network Sites.
* Includes 26 lowland wetland sites

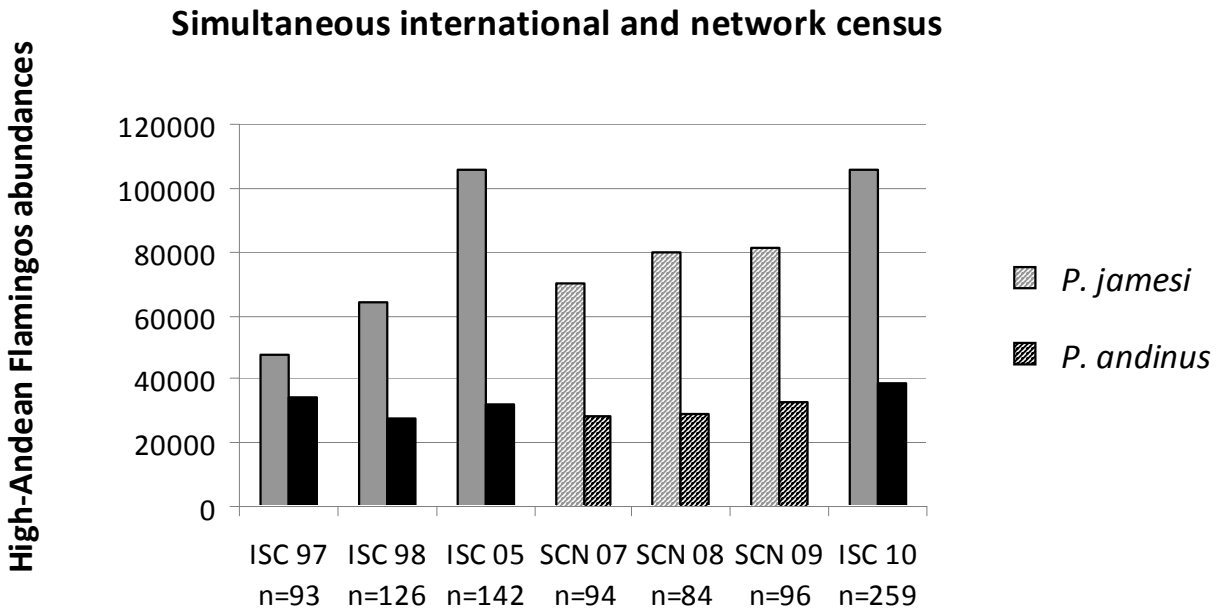

Figure 3. High Andes flamingo abundance in International Simultaneous Censuses (ISC) and Simultaneous Censuses of Network Sites (SCN).

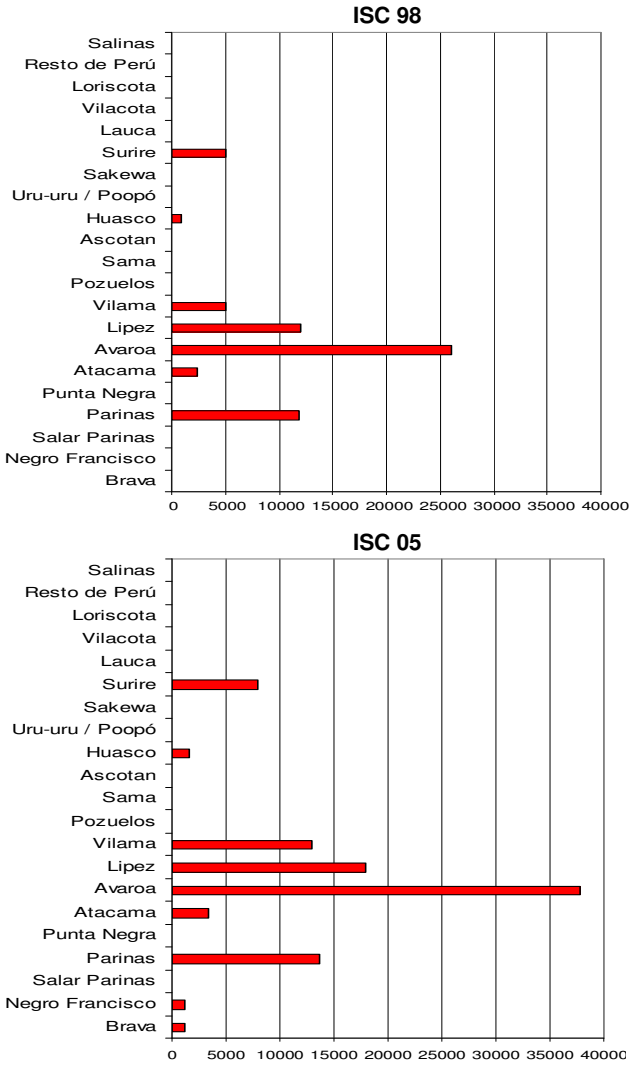

Figure 4. Comparison of Puna Flamingo *Phoenicoparrus jamesi* numbers for ISC 98 and ISC 05.

In summer 2010, Puna Flamingos were found in the high Andes wetlands, with 50% of the population at four wetlands: Laguna Grande and Lagunas de Vilama in Argentina, Laguna Colorada in Bolivia, and Salar de Surire in Chile. The Andean Flamingo had a wider distribution, with 50% of the population in five wetlands: Salar de Surire in Chile, Laguna Colorada in Bolivia and Lagunas de Vilama, Laguna Guayatayoc and Laguna de los Pozuelos in Argentina. The contribution of lowland wetlands to global population numbers is very small, with 408 Andean Flamingos in Mar Chiquita, Argentina. However, 62% of the Chilean Flamingos counted were found in Mar Chiquita.

Comparison between International Simultaneous Censuses and Simultaneous Censuses of Network Sites

With regard to Andean Flamingos, results from the ISC and SCN (Marconi *et al.,* 2007) are similar, indicating a stable population trend in the past 13 years (Figure 3).

For Puna Flamingos, we observed an increase in numbers between ISC 97 and ISC 98 due to the addition of Laguna Grande (Catamarca, Argentina) in 1998. Most of the increase observed in ISC 05 is due to the 68.24% found in the Eduardo Avaroa and Lipez sites (Figure 3). This is consistent with numbers recorded during summer censuses in Bolivia in 1999 and 2000 (Rocha, unpubl. data).

Estimates of abundance for Puna Flamingos during the summer 2007, 2008 and 2009 SCN are similar. We attribute the lowest number recorded in 2007 to the temporal offset between the censuses at Eduardo Avaroa and Lipez (conducted March–April) and the rest of the priority sites (early February) because of seasonal fluctuations when individuals begin to disperse to lower altitude sites as of March. When we compare results from ISC and SCN we conclude that the SCN consistently underestimates Puna Flamingo abundance by about 20%. Looking at Puna Flamingo numbers at each priority site in the Wetland Network (Figure 5), we observe:

- Most of the population is concentrated primarily in Eduardo Avaroa and Lípez (Bolivia), and secondly in Vilama (Argentina) (Figure 2).
- Sustained increase in Las Parinas priority site (Argentina).
- Numbers at Avaroa-Lípez (Bolivia) and Vilama (Argentina) appear to complement and compensate for each other.
- The next two sites in importance, Salar de Atacama and Salar de Surire (Chile) have strong fluctuations in abundance.

We suggest that the Avaroa-Lípez-Vilama complex represents a unit for Puna Flamingos that use the wetlands in this complex in an alternative and complementary way.

From the comparison between ISCs and SCNs we draw the following preliminary conclusions:

1. The priority sites in the Wetland Network are a **representative sample** of concentration sites for Andean and Puna Flamingos such that the results of the SCNs can be considered reasonable extrapolations of total populations, requiring considerably lower cost and effort than that required for total coverage of the summer distribution of both species. However, if we were to detect a decrease in numbers in these priority sites, an immediate assessment of other wetlands would be required to determine if this is the result of change in habitat use by both species or a decrease in global populations.

2. Both **summer ISCs and SCNs should be simultaneous**, with a maximum delay of two weeks from beginning to end. The shift in 3 months during the SCN in Bolivia in 2007 introduced error because offset counts can double count or miss individuals moving among sites. Because of the timing of the offset, this was exacerbated by the seasonal changes (Marconi *et al.,* 2007). At sites above 4,300 m asl, for example, Laguna Colorada (Avaroa site), flamingo numbers are highly seasonal due to dispersal to winter sites at a lower altitude. This would explain the apparent decrease in Puna Flamingo numbers to 9,337 at the end of March 2007 from 18,412 at the end of January 2005.

3. The contribution of lowland wetland sites to numbers of Andean Flamingos (1.05%) and Puna Flamingos (0%) does not justify the effort to census during annual summer SCNs. In contrast, results from winter ISCs (1998 and 2000) and SCNs (Romano *et al.,* 2005; Romano *et al*., 2006; Romano *et al.,* 2008; Romano *et al.,* 2009) show that winter monitoring yields essential information on distribution and habitat use of both flamingo species, but especially for Andean Flamingos.

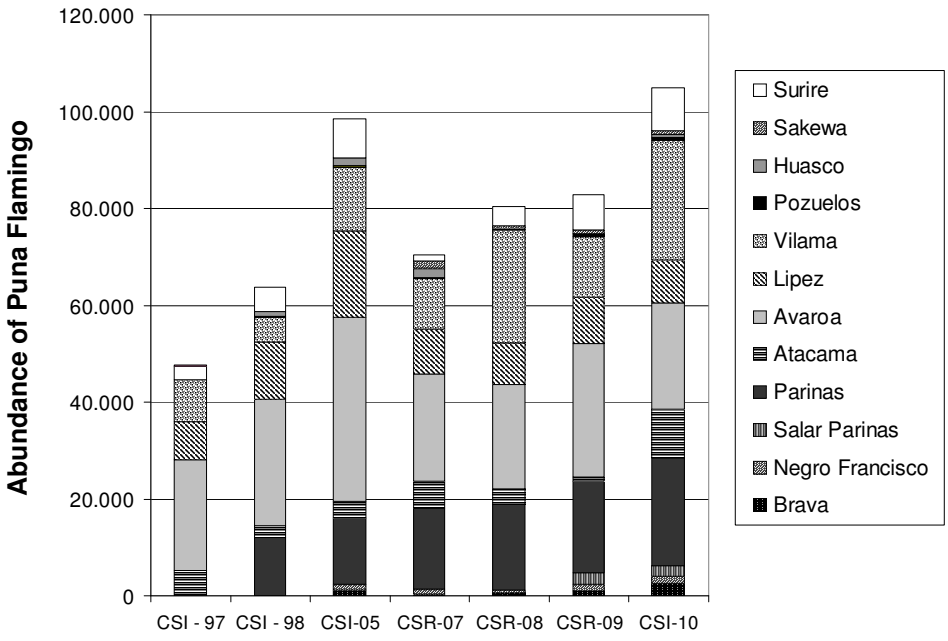

Figure 5. Puna Flamingo *Phoenicoparrus jamesi* abundance in the Wetland Network recorded during ISCs and SCNs.

We recommend continuing simultaneous annual summer censuses in high Andes priority sites of the Wetland Network (SCNs) and simultaneous winter censuses in lowland priority sites, Pozuelos (Moschione *et al.,* 2008), Poopó (Rocha *et al.,* 2006) and Saquehua, to monitor high Andes flamingo populations and their habitats.

Finally, the ISC 10 census included lowland wetland sites that have large summer concentrations of Chilean Flamingo – Mar Chiquita, Bañados del río Dulce, Salinas Grandes, Salinas de Ambargasta and Laguna Llancanelo – but it did not cover the entire distribution range of this species. However, the number recorded (282,752) is above the current estimate of 200,000 for the global population. A more accurate estimate of the Chilean Flamingo global population should be 300,000.–

Acknowledgements

We wish to thank the twenty organizations – governmental, nongovernmental, academic and international – and two mining companies for their support, and the 88 census participants, whose volunteer work made this census possible.

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Current population status, trend and distribution of Lesser Flamingo *Phoeniconaias minor* at Lake Natron, Tanzania

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Abstract — Lake Natron is considered the most important breeding site for the Lesser Flamingo *Phoeniconaias minor* in Africa and the world in general. The number of Lesser Flamingos observed at Lake Natron has increased from 25,195 in 1969 to a peak of 507,117 in 1994 and thereafter declined in subsequent years. According to the most recent survey which was conducted in August 2010 the number of Lesser Flamingo at Lake Natron was estimated to be 104,947. This report presents the current population status, trends (from 1969 to 2010) and distribution of Lesser Flamingo at Lake Natron based on data from an aerial survey conducted in August 2010. The aerial survey technique involved taking photographs of each flock of flamingos. Photographs were taken to the Conservation Information Monitoring Unit (CIMU) based in Tanzania Wildlife Research Institute (TAWIRI) headquarters for count verification and analysis. Compared to the last census (2002) the population of Lesser Flamingos increased by 2.5%. Most of the Lesser Flamingo flocks were recorded at the northern and southern parts of Lake Natron. The study recommends that more research is needed to determine the causes of decline in the population of Lesser Flamingo in the surveyed area even during the high peak season of August to November.

Keywords: Lake Natron, Lesser Flamingo, Phoeniconaias minor*, Tanzania, Africa, numbers, status, distribution, trend, aerial census.*

Introduction

Flamingos are characteristic birds of soda lakes in the East African Rift Valley where they are highly gregarious and nomadic (Britton 1980, Zimmerman *et al.,* 1996). Breeding of flamingos in this area is generally sporadic but occurring most during August to November (Brown & Root, 1957; Brown & Britton, 1980).

The Lesser Flamingo *Phoeniconaias minor* breeds mainly in the Rift Valley lakes of East Africa with three smaller breeding populations in West Africa, in southern Africa, and in India and Pakistan (BirdLife International, 2010a). Despite being the most numerous flamingo species, the 2010 IUCN Red List classifies the Lesser Flamingo as Near Threatened (IUCN Category 3.1) due to the declining population, infrequent breeding, and reduction in the number of breeding sites, some of which are threatened by anthropogenic activities (IUCN, 2010). The species is also listed under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), an international agreement aimed at the conservation of migratory waterbirds, to which Tanzania is a Contracting Party.

Besides flamingos, Lake Natron supports an estimated 100,000 individuals of other waterbirds, most of which are Palearctic migrants. Owing to its unique biodiversity importance, the Lake Natron Basin was designated Ramsar Site No. 1080 under the Ramsar Convention on 4 July 2001 (Ramsar, 2010) which covers an area of 224,781 ha.
In East Africa, Lake Natron is the main and only regular breeding site for Lesser Flamingo (Britton, 1980; Brown & Britton, 1980; Severre, 2001).

The most comprehensive surveys of flamingos in Tanzania were carried out in 1969 (Bartholomew & Pennycuick, 1973, 1994; TWCM, 1995) and 1995 (Baker, 1996). These surveys showed that the Lesser Flamingo population increased from 1969 to 1994 but declined in subsequent years.

The purpose of the present survey was to assess the current population trend and distribution of the Lesser Flamingo in Lake Natron.

Study area

Lake Natron (Figure 1), a Ramsar site situated on the floor of the eastern Rift Valley, extends 58 km south from the Kenyan boarder with a mean width of 15 km. The lake is relatively shallow with the maximum depth of only 50 cm (Hughes & Hughes, 1992). The principal inflow for the lake is the perennial Ewaso Ngiro River from the Mau escarpment in Kenya and

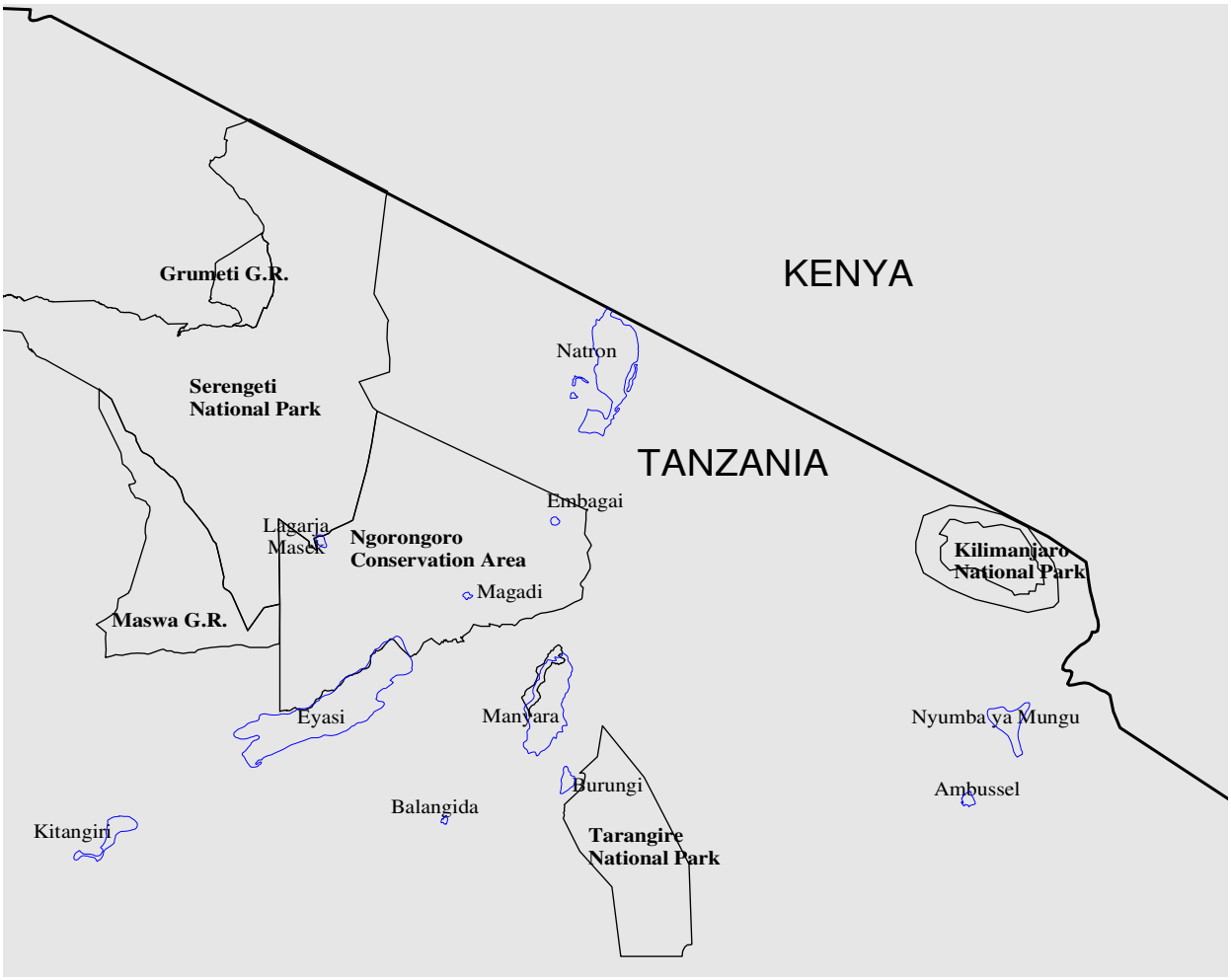

Figure 1. A map of Tanzania showing the study area (Lake Natron) and other soda lakes.

drainage from the Loita hills and Loliondo in the northwest and the Ngorongoro highlands to the south. The lake is situated at 36º 0.00' East 2º 25.00' South and its water is highly saline with chloride concentrations reaching 65,000 mg/litre (BirdLife International, 2010b).

Methods

The population of Lesser Flamingo at Lake Natron was estimated using aerial census techniques adapted from Norton-Griffiths (1978). The survey was conducted in August 2010 between 1600 and 1800 hrs using a Cessna 182 with a crew of four. The aircraft was used to circumnavigate the lake at an average altitude of 106.68 m above the lake. On sighting a flamingo flock, photographs were taken using a hand-held digital camera (Nikon DX-D5000) and the flock's position was recorded using a GPS (GARMIN-GPS map 76). Where the flock was too large to be captured on one photograph, a sequence of overlapping photographs were taken to record the flock entirely (see *e.g.* Norton-Griffiths (1978) for details of taking and recording total count photographs). Wherever flocks were small and possible to count, photographs were not taken, instead direct counts were made.

The photographs were downloaded onto a computer and opened with the Arc Map 9.2 programme. Each photograph was opened and magnified 15 times. The number of individuals per photograph/exposure and direct counts made in the field were added up to determine the total population of flamingos in the surveyed area.

Results

Current population

From 110 photographs, 103,991 Lesser Flamingos were counted and from direct counts of 13 small flocks, 956 individuals were recorded. Therefore the total population of Lesser Flamingos from aerial photographs and direct counts was 104,947 individuals.

Distribution pattern

Most of the Lesser Flamingos counted were concentrated in the northern and northeastern parts of the lake. Small numbers of individuals were counted in the southern and southwestern parts of the lake (Figure 3).

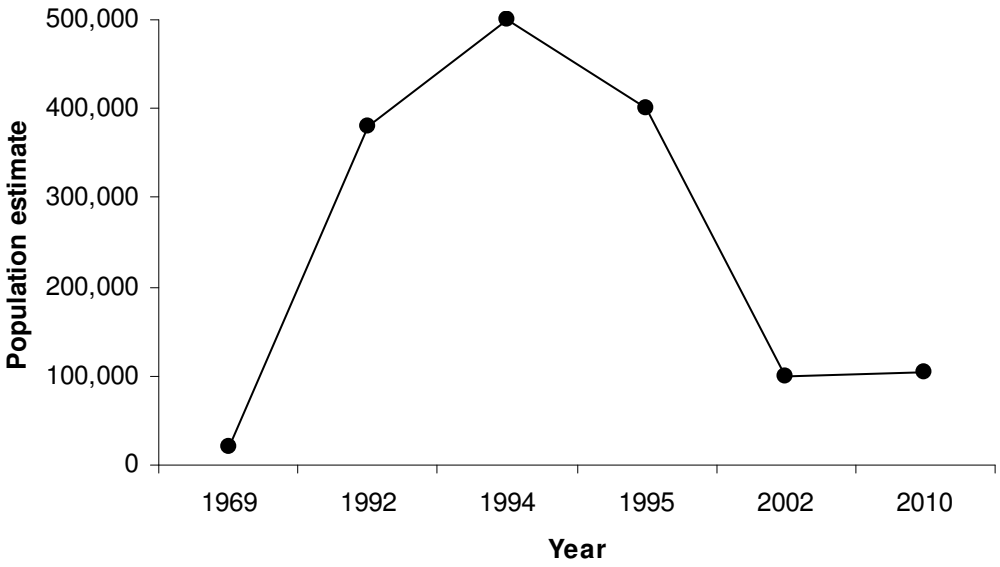

Figure 2. Population trend of Lesser Flamingo *Phoeniconaias minor* at Lake Natron, 1969–2010.

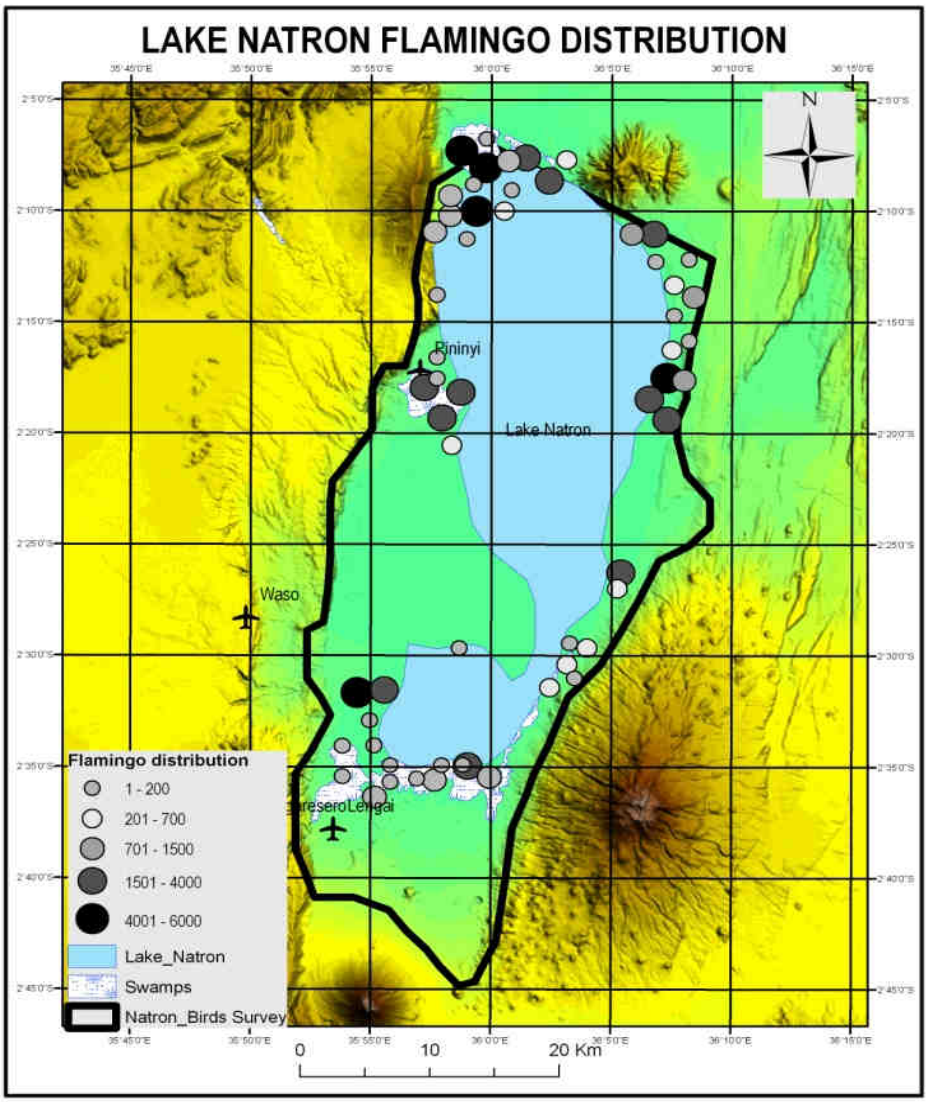

Figure 3. Distribution pattern of Lesser Flamingos at Lake Natron in August 2010.

Discussion

Past counts show an increasing trend in the population of Lesser Flamingo between 1969 and 1994 (Bartholomew & Pennycuick, 1973; TWCM, 1995; Baker, 1996). Although there has been a continuous decline since 1994, the present survey indicates an increase of 2.5% when compared to the

last survey, which was conducted in 2002 (Figure 2). The present estimate, however, remains very low compared to surveys conducted between 1992 and 1995.

The results suggest that most of the east African Lesser Flamingo population (estimated at 1.5–2.5 million; BirdLife, 2010a) was outside of Lake Natron at the time of the present survey, probably either on other soda lakes in the Rift Valley or elsewhere in Africa.

The nomadic habit of the Lesser Flamingo is demonstrated by the annual fluctuations in the total number of birds recorded between 1969 and 2010 at Lake Natron. According to Baker & Baker (2001), evidence from the ongoing monitoring of satellite-tagged Greater Flamingos *Phoenicopterus roseus* indicates that movements of these birds between several lakes can occur within a day. This suggests that flamingo movements can contribute to population fluctuations at a particular site in time and space. This could explain why there where fewer Lesser Flamingos at Lake Natron during this survey compared with other years.

According to personal observations (Fyumagwa, author of this paper) Empakai Crater is an important site for the Lesser Flamingos using Lake Natron as it harbours an abundant crop of cyanobacteria, which forms the most important part of the Lesser Flamingos' diet. It is important therefore, to survey both sites simultaneously in order to establish a clear population trend of Lesser Flamingos using Lake Natron. According to Tuite (1979) and Burgis & Symoens (1987), flamingo distribution and abundance are strongly related to food supply. Thus, it is very likely that the differences in the number of Lesser Flamingos between the soda lakes over years or between years at a single site reflect fluctuations in the availability of food supply.

In conclusion, the decline in the number of Lesser Flamingos at Lake Natron is perhaps due to a decline in food supply, which may at least in part be a result of anthropogenic activities. The study recommends that more research is needed to ascertain the causes of the decline in numbers of Lesser Flamingos at Lake Natron. Further, the study recommends that due to the nomadic behaviour of flamingos in the Rift Valley soda lakes, population estimates and distribution of flamingos should be done across all lakes concurrently. This will give a clearer depiction of flamingo abundance and trends.

Acknowledgements

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Population and habitat of the Lesser Flamingo *Phoeniconaias minor* in Thane Creek, Mumbai, India

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Abstract — We studied the population, distribution and habitat use of the Lesser Flamingo *Phoeniconaias minor* along the shore of Thane Creek between October 2006 and July 2008. During the first year of the study, Lesser Flamingos arrived in December 2006 and reached a peak of around 10,000 in May 2007. During 2007–2008, their arrival was earlier and the peak was in April, numbering about 13,000. First-year juveniles were among the earliest to arrive, representing about 40% of the population at the beginning of the season and 16% in the peak month. The arrival, departure and distribution of the flamingos were positively correlated with the abundance of food in the region. A few Lesser Flamingos were sighted at other sites along Thane Creek in 2008. We suggest further studies and reduction of disturbance to protect the flamingos and the area.

Keywords: Lesser Flamingo, Phoeniconaias minor*, numbers, distribution, habitat use, Thane Creek, Mumbai, India, food abundance.*

Introduction

The Mahul-Sewri mudflats (1,000 ha) in Thane Creek have been identified as an Important Bird Area of India (Islam & Rahmani, 2004) harbouring a large population of Lesser Flamingos *Phoeniconaias minor* (>15,000), a globally Near Threatened species (BirdLife International, 2009) and thousands of smaller waders. In 2006, Maharashtra State Road Development Corporation Ltd. (MSRDC) of Mumbai proposed a trans-harbour link (MTHL) across the Thane Creek from Sewri to Nhava and commissioned a study on the population of birds with emphasis on the flamingos and their habitat in order to take necessary steps for the protection of the birds and the area. This paper presents a summary of the study conducted from October 2006 to July 2008, excluding September 2007 to January 2008.

Study area

Sewri Bay is situated just off the wide mouth of Thane Creek and along its western border in Mumbai (Figure 1). Mahul-Sewri region (19˚01'00"N, 72˚52'60"E) has mudflats of about 4 km² flanked by mangroves on one side. The Mahul rivulet drains into this area. There are many major industrial and port-related establishments located overlooking the bay. The coastal region of Mumbai is highly polluted (Zingde & Govindan, 2000). Nhava (18˚58'20.8"N, 73˚00'22.1"E) in Navi Mumbai is located on the eastern side of the creek where the proposed MTHL bridge will join mainland Mumbai. Other areas along the shore of the creek, such as Vashi, Zasai village, Uran village, Jawaharlal Nehru Port Trust (JNPT) salt pans and Koliwada village, had mudflats and saltpans which were reported to have occasional sightings of a few flamingos and hence were surveyed during January–February and April–May 2008.

Methods

Flamingo abundance

The Mahul-Sewri region was divided into four sections: Reti Bhandar (S1), Colgate (S2), Mahul (S3) and Rama Devi (S4) (Figure 1) and counts of birds were conducted using the total count method two to three times a month during low tide from suitable vantage points. Photographic counts (with digital camera) were also made and used along with total counts. Average of the numbers was calculated for each month for abundance. Proportion of adults and juveniles was calculated from sample populations.

Invertebrate abundance

The phytoplankton, zooplankton and benthos (benthic macro-invertebrates) in the four sections of the Mahul-Sewri region were investigated during the monsoon (June– August), summer (March–May) and winter (December–February) of 2007–2008. Ten samples were collected from the flamingo areas from each section in each season. Plankton samples were collected from water using 55µm mesh plankton net and analyzed following standard methods (Hurlbert,

1986). Total biomass of plankton and density of phytoplankton and zooplankton were determined (APHA, 1995).

Mud samples were collected from the same locations at the same periods by pushing a 10.5 cm diameter PVC pipe into the substrate to a depth of 10 cm. The benthic samples were passed through a sieve of 500 μm and analyzed to find density of different groups (Holme & McIntyre, 1971).

Results

Population and distribution of flamingos in the Mahul-Sewri region

In 2006, Lesser Flamingos arrived in small groups in December. Their numbers increased slowly until March, when larger numbers began to arrive, reaching a peak of about 10,000 birds in May (Table 1). They started leaving the area in June and the last few birds (juveniles) left in July 2007. During 2007–2008, they arrived in November, and the population increased during January to March, reaching a peak of about 13,000 birds in April. Their departure was mainly in May, earlier than in the previous year, with a very few juveniles remaining in June 2008. The proportion of juveniles was >40% in the beginning of the season and decreased to 16% with the influx of huge flocks in April.

The Lesser Flamingo's distribution pattern was similar in both the years, being concentrated in the Mahul-Sewri region and occurring in low density towards Section 1 (Reti Bhandar); roosting and/or resting during high tides were near Tata Power and Tata jetty beyond Section 4 (Rama Devi). Disturbance was caused by the ship repair activities at Sewri and by tourists when they went close to the flamingos in boats. Local people catching crabs, however, did not cause much disturbance. Small construction works by Tata Power caused slight disturbance, but the birds adjusted and went back to the area after the construction was over.

Food availability for the flamingos in the Mahul-Sewri region

Total mean biomass of plankton was the highest in summer (March–May) (Figure 2). The Myxophyceae (blue-green algae) followed by Bacillariophyceae (diatoms) and Chlorophyceae (green algae) showed the highest mean percentage abundance in the three seasons. During the summer and winter (December–

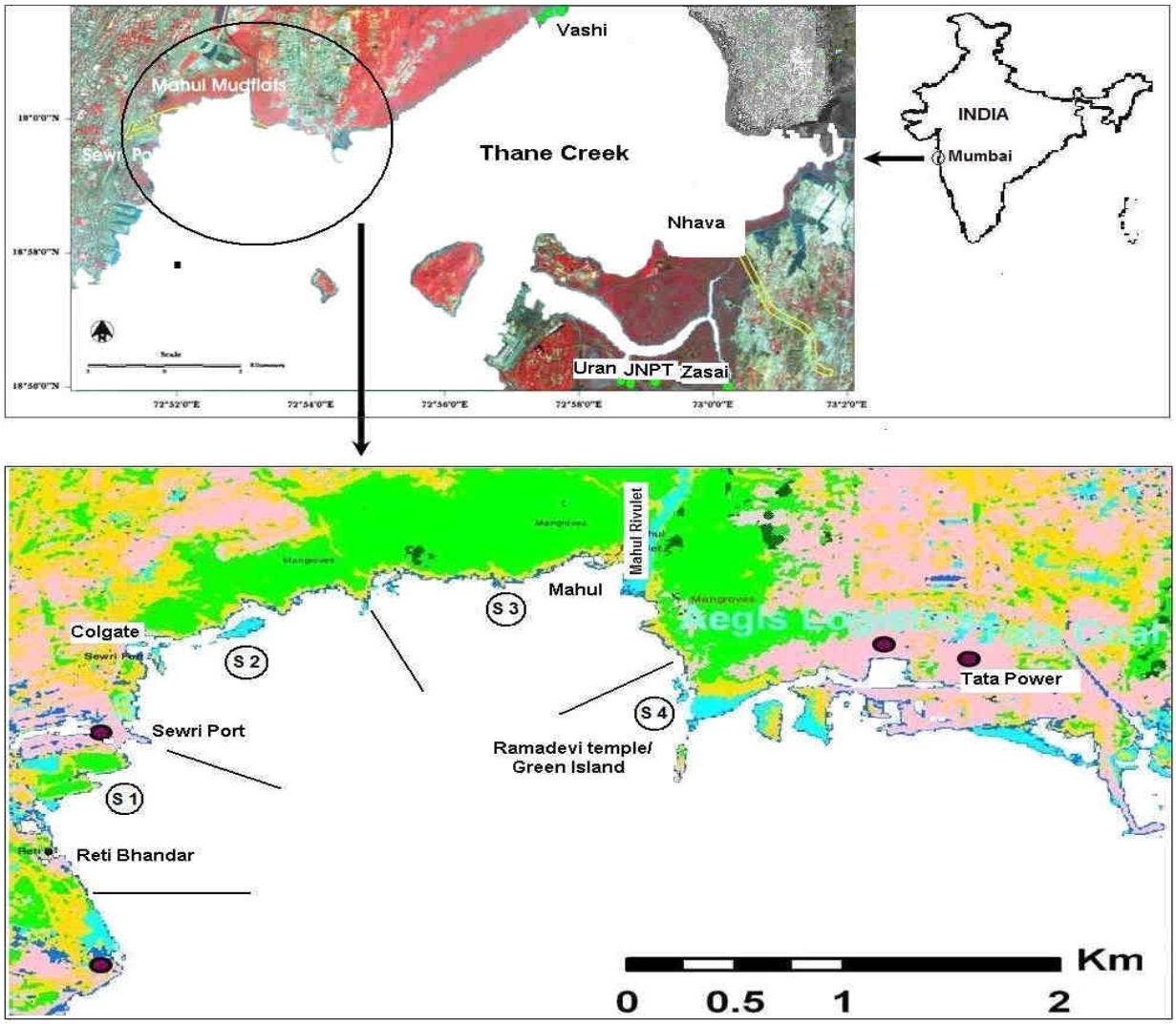

Figure 1. Map of the study area showing Thane Creek (above) and Mahul-Sewri region enlarged with sections marked (below) (Source: Vijayan *et al.* 2008).

Table 1. Abundance and flock composition of Lesser Flamingos *Phoeniconaias minor* in the Mahul-Sewri region (2006–2008).

Year	Month	Mean abundance (±SD)		Flock composition (%)	
				Adults	Juveniles/sub-adults
2006	December	46.2	(± 48.8)	60.5	39.5
2007	January	169.1	(± 44.6)	63.3	36.3
2007	February	179.6	(± 31.8)	64.0	36.0
2007	March	3,808.0	(± 3471)	84.0	16.0
2007	April	10,045.0	(± 339.4)	83.7	16.3
2007	May	10,362.5	(± 118.1)	83.1	17.1
2007	June	2,793.0	(± 2469.2)	93.5	6.5
2007	July	7.5	(±11.9)	2.0	98.0
2008	February	6,900.8	(± 2115.2)	80.8	19.2
2008	March	11,367.6	(± 2548.1)	76.8	23.2
2008	April	12,996.0	(± 227.9)	83.9	16.2
2008	May	4,528.0	(± 2057.1)	70.3	29.7
2008	June	1,276.7	(± 889.6)	81.6	18.4
2008	July	13.0	(± 1.4)	0.0	100.0

February) Myxophyceae was the dominant planktonic group followed by Bacillariophyceae. The Myxophyceae mainly consisted of ten species of *Oscillatoria* and three species of *Spirulina*. Abundance of the Lesser Flamingo in different sections and seasons was positively correlated with that of the phytoplankton (log transformed) ($r=0.78$, $p<0.05$), and with zoo plankton ($r=0.698$, $p<0.05$). Total abundance of benthos was comparatively less and it went down from winter to summer and monsoon (Figure 2).

Population and distribution of flamingos in other areas along the Thane Creek

During the present survey, Lesser Flamingos were sighted at only four other sites along Thane Creek, namely Zasai village (50–100 individuals), JNPT salt pans 1 (around 300), JNPT salt pans 2 (20–100) and Vashi mudflats near bridge (20–325). Most of the birds were juveniles/sub-adults. An incident of hunting of four flamingos at Uran was reported in December 2007.

Discussion

Numbers of Lesser Flamingo visiting the Mahul-Sewri mudflats increased from 1994 to 2003 when it was15,000 (Islam & Rahmani, 2004). The subsequent decline may be because of shifts between sites and erratic movements (Ali & Ripley, 1987), or may be as a result of the overall decline in the global population (BirdLife International 2009). A seasonal pattern of abundance was observed which was positively correlated with food abundance, weather, and water level and quality as has been shown for many species of flamingos (Arengo & Baldassarre, 2000; Tuite, 2000). Departure of flamingos was related to breeding which has been reported from Kuchchh in Gujarat, India as being erratic depending on the monsoon, but mainly from September to November (Parasharya, 2009).

Lesser Flamingos at Sewri mudflats were largely feeding on algae and diatoms and probably on insect larvae and copepods as reported by Ali and Ripley (1987) and BirdLife International (2009). In the

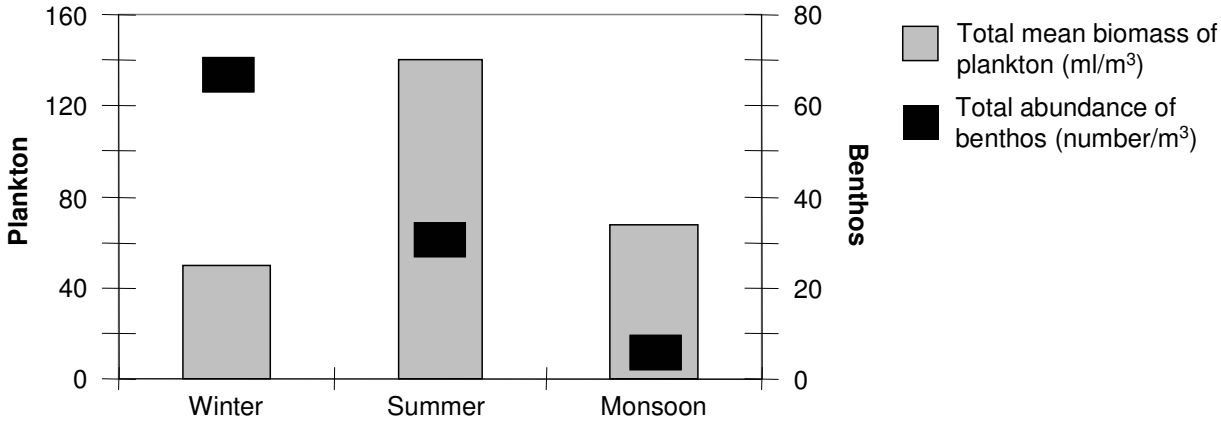

Figure 2. Mean abundance of plankton and benthos in different seasons in the Mahul-Sewri region.

breeding area in India, they mainly fed on diatoms (Parasharya & Tere, 2006). Gut contents of flamingos indicated that blue-green and red algae, diatoms, larval and adult forms of small insects, crustaceans, molluscs and small fishes make up the main diet (Ramesh & Ramachandran, 2005). Tuite (2000) found a shift in diet of the Lesser Flamingo in East Africa according to food availability.

The proportion of juveniles in the population was higher during December–March probably because the non-breeding or unsuccessful adults remained in the breeding area for feeding while the families with chicks left for new feeding grounds. This might also explain the erratic arrival of flamingos at Sewri. As more water was available at Kuchchh, Gujarat towards the end of 2006, breeding of flamingos was extended and more adults stayed back (Parasharya pers. comm.).

Disturbance was caused by the ship repair activities at Sewri and tourist boats, as observed elsewhere by Galicia and Baldassarre (1997). However, the birds adjusted to slight disturbances from the local fishermen and some construction activities by adopting local movements, as recorded in the wetland birds in Argentina (Cardoni *et al*., 2008). Tourism has to be regulated and managed in an eco-friendly way. Construction activities in this area may be restricted to the season when flamingos are not present (or not in larger flocks). Since the flamingos have the habit of moving between sites, multiple foraging sites should be available and protected in the Thane Creek. Further studies are required all along the coast of this creek including monitoring and satellite tracking of flamingos and, networking among flamingo sites within and outside the country.

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A new review of the status of the Caribbean Flamingo *Phoenicopterus ruber* in the Dominican Republic and Haiti

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Abstract — The Caribbean Flamingo *Phoenicopterus ruber* is a locally common resident of Hispaniola with numbers augmented significantly by seasonal visitors. We review the existing literature and provide new data on the status of the flamingo in the Dominican Republic and Haiti. We summarize recent counts and compare these with those provided in earlier reviews by Wiley and Wiley (1979), Ottenwalder *et al.* (1990), and Keith *et al.* (2003), and we pay particular attention to reports of flamingos nesting. We conclude with recommendations to advance the conservation and monitoring of this species.

Keywords: Caribbean Flamingo, Phoenicopterus ruber*, Hispaniola, Dominican Republic, Haiti, nesting.*

Introduction

The Caribbean Flamingo *Phoenicopterus ruber* is a locally common resident of Hispaniola, with numbers augmented significantly by seasonal visitors thought to arrive from the Bahamas Islands and Cuba. Although flamingos have been reported on Hispaniola since the arrival of the Spanish and French (Buffon, 1781), and have been most often considered to be locally common, the sites where they have occurred have suffered from habitat change and degradation, and numbers of birds have fluctuated substantially (Keith *et al.,* 2003). The species has bred on the island in the historic past (Keith *et al.,* 2003) and in relatively recent times (Wiley & Wiley, 1979), but the most recent review of the species status (Keith *et al.,* 2003) states that "there are no known active breeding sites now." This contrasts with an earlier important summary of the status of the Caribbean Flamingo in the Dominican Republic and eastern Haiti (Wiley & Wiley, 1979) that reported several nesting colonies in the Dominican Republic in the 1970s.

Because of significant local interest in the status of the Caribbean Flamingo, especially in the Dominican Republic (SEA/DVS, 1994; Espinal, 2006), and the recent formation of the Caribbean Flamingo Conservation Group, we sought to review the existing literature and provide new, more recent data on the status of the flamingo in the Dominican Republic and Haiti. We summarize recent counts and compare these with those provided in earlier reviews by Wiley and Wiley (1979), Ottenwalder *et al.* (1990), and Keith *et al.* (2003), and we pay particular attention to reports of flamingos nesting. We conclude with recommendations to advance the conservation and monitoring of this species.

Methods

Historical data on the distribution and status of the Caribbean Flamingo have been provided by Wetmore and Swales (1931), Wiley and Wiley (1979), Ottenwalder *et al.* (1990), and Keith *et al.* (2003) and are briefly summarized here. Additional data were obtained from members of the Hispaniolan Ornithological Society, national park guards, tour guides and especially from personal observations of the authors.

Results

Below we review population counts of flamingos at all key sites in the Dominican Republic, followed by a similar review of sites in Haiti. We then assess reports of breeding attempts by flamingos in both countries.

Flamingo use areas

Lago Enriquillo — This large, inland lagoon has traditionally been considered one of the most important sites for flamingos on the island. Daily counts have run from 20–30 birds to more than 600 (Wiley & Wiley, 1979), with most concentrating at the eastern end of the lake or near Isla Cabritos. Keith *et al.* (2003) reported a record of nearly 1,000 birds along the southern shore in 1996, but our records suggest a population that fluctuates between 300 and 600. Recent counts include 500 on 14 Sept 1999, 300 on 11 Jan 2002, 500 on 14 Sep 2004, 400

on 16 May 2005, 350 on 27 Sep 2006, and 500–600 on 20 Sep 2007. A series of three tropical storms and hurricanes in late-2007, with extreme amounts of rain, filled Lago Enriquillo to unprecedented levels, resulting in excessively deep water and the emigration of the entire flamingo population. These conditions are expected to persist for months if not years.

Lago del Rincón at Cabral — Also known as Laguna de Cabral, this neighbour of Lago Enriquillo is smaller, less saline, and less frequently used by flamingos. Wiley and Wiley (1979) found only seven birds there, but reported earlier counts of as many as 155. Our observations from 1998–2005 average around 80 flamingos.

Laguna de Oviedo — This lagoon on the eastern side of the Barahona Peninsula has become one of the most important sites for flamingos on the island. Wiley and Wiley (1979) reported only 19 birds here, but we have consistently found dozens of flamingos at Oviedo, including careful counts of 80 on 24 Feb 2003 and 200 on 26 Aug 2005. Many of the flamingos found at Oviedo probably move frequently among the other lagoons on the Barahona Peninsula (see below), such that these flamingos might best be considered part of a much larger super-population.

Other lagoons of the Barahona Peninsula — South of the Laguna de Oviedo, a series of coastal lagoons regularly host a large number of flamingos. These rather remote sites, including *Laguna de la Rabiza*, *El Salado de Bucán Base*, and *Laguna Salada*, are seldom censused, but Wiley and Wiley (1979) reported counts of 200–440, and we recently received a report by park guards and tour guides of as many as 2,000 flamingos regularly occurring on the Peninsula. Further to the west, the *Charcos de Cabo Rojo* have not previously been reported as a site for flamingos, but we frequently recorded 15–35 flamingos at these small lagoons, including 32 on 3 Jun 2004, 15 on 6 July 2004, 22 on 16 July 2005 and 30 on 4 Sep 2007.

Bahía de Neiba and Bahía de Ocoa — The coastal area of the Bahía de Neiba has hosted flamingos in the past. Wiley and Wiley (1979) reported the presence of "small numbers" of flamingos at sites such as *Puerto Alejandro* and the adjacent *Laguna de Neiba*. We have counted 150 flamingos at Puerto Alejandro on 15 Sep 2002 and 200 on 19 Sep 2007. Further east, Wiley and Wiley (1979) stated that local residents reported the regular presence of flamingos at *Puerto Viejo*, with Keith *et al.* (2003) reporting 325 individuals at this site. Across the Bahía de Ocoa, the *Salinas de Baní* is frequently visited by birdwatchers who regularly count approximately 70 flamingos at these salt ponds and adjacent wetlands (pers. observ.).

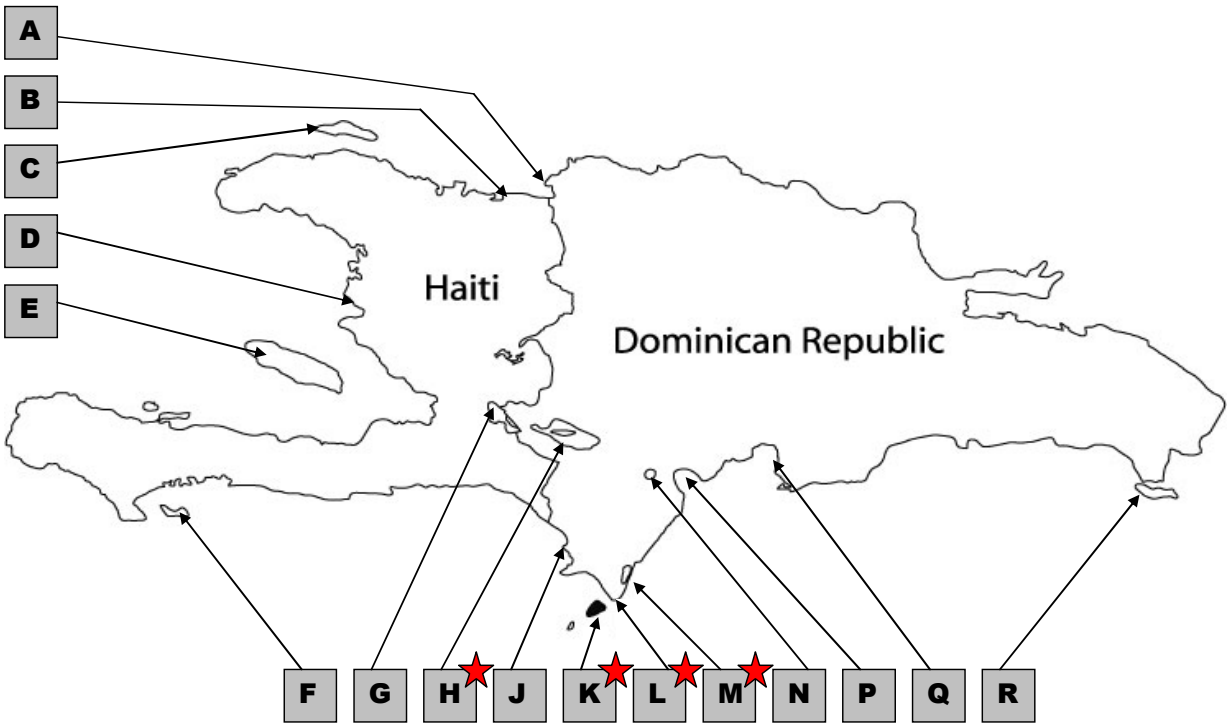

Figure 1. Caribbean Flamingo *Phoenicopterus ruber* use areas and areas where nesting has been attempted since the 1970s (starred) on Hispaniola, including (A) Monte Cristi, Manzanillo Bay and Laguna Saladilla; (B) Liberté Bay; (C) Île de la Tortue; (D) delta of the Artibonite River; (E) Île de la Gonâve; (F) Île-à-Vache; (G) Étang Saumâtre and Trou Caïman; (H) Lago Enriquillo; (J) Charcos de Cabo Rojo; (K) Isla Beata; (L) other lagoons of the Barahona Peninsula, including Laguna de la Rabiza, El Salado de Bucán Base, and Laguna Salada; (M) Laguna de Oviedo; (N) Lago del Rincón at Cabral; (P) Bahía de Neiba, including Puerto Alejandro and Laguna de Neiba; (Q) Bahía de Ocoa, including Puerto Viejo and Salinas de Baní; and (R) Isla Saona.

Laguna Baytoa — Although not previously reported by Wiley and Wiley (1979) or by Keith *et al.* (2003) as a site hosting flamingos, we found 50 birds at this lake in San Juan Province on 17 Sep 2007.

Monte Cristi – Manzanillo coast — Another concentration of flamingos is often reported at lagoons and coastal wetlands in extreme northwestern Dominican Republic. Records in Wiley and Wiley (1979) included small numbers of up to 15–20 flamingos, but Keith *et al.* (2003) added a previously unpublished report of 200–300 flamingos in the *Manzanillo Bay* area in 1951. Our more recent records include only 30 birds at the nearby *Laguna Saladilla* on 18 Oct 2003, and 60 flamingos at the same site on 21 Sep 2007.

Isla Saona — While reports exist of flamingos on Isla Saona (Wiley and Wiley, 1979; Keith *et al.,* 2003), off the southeast corner of Hispaniola, there are no recent counts of this species on the island, or any other indication that Saona is regularly used by flamingos.

Isla Beata — This island, which lies south of the Barahona Peninsula and thus quite close to one of Hispaniola's major concentrations of flamingos, is reputed to host small numbers of flamingos, especially at the lagoons and salinas on the eastern coast of the island (Wiley & Wiley, 1979). Keith *et al.* (2003) reported a high count of 100 flamingos on Beata in January 1990, but few ornithologists have since had the opportunity to visit this island where access is restricted.

In Haiti, flamingos are reported from coastal mangrove lagoons near Liberté Bay, between Grande Saline and Gonaïves, Étang Saumâtre, Trou Caïman, and on the offshore islands of Île de la Gonâve, Île-à-Vache, and Île de la Tortue. Although few data are available from Haiti (Ottenwalder *et al.*, 1990), the following accounts summarize what is known:

Liberté Bay — Flamingo populations from the Liberté Bay area are likely to correspond to those at *Manzanillo Bay* and *Laguna Saladilla* just across the border in northwestern Dominican Republic (see above). Records in Wiley and Wiley (1979) included small numbers of up to 15–20 flamingos in this area. Ottenwalder *et al.* (1990) did not find flamingos in this area, but Keith *et al.* (2003) added a previously unpublished report of 200–300 flamingos in the *Liberté Bay-Manzanillo Bay* area in 1951.

Coastal Grande Saline and Gonaïves — This region, which includes the Artibonite River delta was not reported as flamingo habitat by Wiley and Wiley (1979) who limited their report to eastern Haiti, but Ottenwalder *et al.* (1990) observed variable numbers of up to several hundred individuals on over-flights in the early 1980s, and Keith *et al.* (2003) reported as many as 1,000 flamingos in marshes in this region in January 2000.

Étang Saumâtre and *Trou Caïman* — These lagoons which, like Lago Enriquillo and Lago del Rincón at Cabral, are remnants of the marine strait that formally divided Hispaniola, have historically hosted large numbers of flamingos (Wiley & Wiley, 1979). Few recent counts exist for either of these lakes, although Wiley and Wiley (1979) reported as many as 300 flamingos at *Étang Saumâtre* in January 1976, Ottenwalder *et al.* (1990) called these lakes "one of the most important flamingo sites of Hispaniola," and we counted 75 flamingos at the western end of the same lake on 15 Sep 2005.

Haitian islands — Reports exist of flamingos from the offshore islands of *Île de la Gonâve*, *Île-à-Vache*, and *Île de la Tortue*, but we are aware of no recent counts from any of these sites. Ottenwalder *et al.* (1990), during over-flights in November 1982 and May 1983, found no flamingos on Île-à-Vache, but as many as 50 in 1982 and 1983 on both Île de la Gonâve and Île de la Tortue.

Flamingo breeding sites

Keith *et al.* (2003) reviewed the many localities where the Caribbean Flamingo was thought to have bred in the past, including Lago Enriquillo, Laguna de Oviedo and Lago Limón (Independencia Province) in the Dominican Republic. In Haiti, reports from the past of nesting flamingos have come from Gonaïves, Étang Saumâtre, and Liberté Bay. Additional accounts of nesting have come from the offshore islands of Isla Beata and Île de la Gonâve. The Caribbean Flamingo is not known to have bred in Haiti since 1928 (Ottenwalder *et al.,* 1990). The most recent breeding attempts that have been reported have all occurred in the Dominican Republic and were summarized by Wiley and Wiley (1979). These included nests at *Lago Enriquillo* in 1975 and 1977, *El Salado de Bucán Base* in 1977 and 1978, *Laguna Salada* in the same time period, and on *Isla Beata* where eggs were harvested in 1971. Since then, according to tour guides and park guards based at Laguna de Oviedo, sporadic attempts at nesting have taken place at *El Salado de Bucán Base*, including 2007. But these birds apparently do not lay eggs, or are unsuccessful in their nesting attempts because of disturbance by local fisherman. No other nesting attempts are known from the past 30 years.

Discussion

It is apparent that the number of flamingos recorded on Hispaniola fluctuates substantially from year to year. As Keith *et al.* (2003) have pointed out, the flamingo is "a strong flyer (and) this species might be

encountered at almost any favourable feeding locality along the entire coast of the island." Numbers of flamingos on the island apparently depend on breeding success at the large colony on Great Inagua, Bahamas, but other birds may also come from Cuba (Sprunt, 1975; Ottenwalder, 1991). The dependence of Hispaniolan flamingo numbers on immigration from populations from Cuba and the Bahamas (Sprunt, 1975; Wiley & Wiley, 1979; Keith *et al.,* 2003; Latta *et al.,* 2006), has been supported by band returns and the occurrence of sub-adult birds accompanying adults.

Assessing population trends of flamingos on Hispaniola is made difficult by the anecdotal nature of many early reports of flamingos, and especially by the unpredictable influx of birds from nesting sites on other islands (Keith *et al.,* 2003). Despite the loss of some traditional feeding areas, such as Lago Limón (Wiley & Wiley, 1979) and perhaps some of the Haitian sites where persecution may be high, Keith *et al.* (2003) and Latta *et al.* (2006) concluded that on balance the Caribbean Flamingo appears to have become more numerous from 1930 to the present day.

While numbers of flamingos may be generally stable or increasing, we suggest that conservationists should be most concerned with the loss of breeding colonies on Hispaniola, and the apparent continued disruption to birds attempting to nest. Ottenwalder (1988) and UNESCO (1997) have pointed out that flamingos are found only in areas with a low human density. Nesting attempts throughout the island have been disrupted by the harvesting of eggs, introduction of cattle, and burning for forage (Wiley & Wiley, 1979), so that human pressure has probably directly resulted in the reduction of flamingo range and disappearance of breeding colonies (Ottenwalder, 1988). Human disturbance is probably responsible for our observation that there have been no verified nesting attempts since Wiley and Wiley (1979) reported on several disrupted nesting colonies 30 years ago. As those authors also pointed out, "human disturbance of nesting attempts has undoubtedly prevented flamingo breeding colonies from expanding in the Dominican Republic." In addition, there is a growing threat from the capture and sale of flamingos for placement as decorative waterfowl in private lakes of wealthy individuals, and especially at resorts and hotels located in the eastern Dominican Republic.

Conservation recommendations

We recommend six critical steps be taken to help conserve and expand the Caribbean Flamingo population of Hispaniola. These steps include:
(1) Because the Hispaniolan population is derived from the breeding colonies on Inagua and Cuba, and because flamingos are known to wander widely, results from a population monitoring program on Hispaniola would be difficult if not impossible to interpret except within the context of a wider, pan-Caribbean census. We support the implementation of a Caribbean-wide census, but see little value in expending valuable time and energy systematically counting flamingos on Hispaniola only.

(2) We recommend a more regular and detailed monitoring of the nesting areas known to be recently favoured by the flamingo. This monitoring should focus on protecting nesting areas from human disturbance, and should incorporate a community education component to help encourage local people to share in the protection of this important natural resource. These areas should include Lago Enriquillo, Laguna de Oviedo, El Salado de Bucán Base, Laguna Salada, and Isla Beata. That these sites are all currently in protected areas, including Isla Cabritos National Park, Jaragua National Park, and the Jaragua-Bahoruco-Enriquillo International Biosphere Reserve, should facilitate protection and monitoring efforts.

(3) Pressure the governmental authorities responsible for these protected areas to manage them effectively so as to reduce disturbance to nesting flamingos. This should include support for, and collaboration with, national and international non-governmental organizations with a shared interest in flamingo conservation in the Dominican Republic and Haiti.

(4) Encourage governmental authorities to enforce laws prohibiting the hunting, capture, sale or possession of flamingos, and prosecute individuals and corporations responsible for this trade.

(5) Address the variety of problems facing coastal areas through holistic, interdisciplinary actions towards more sustainable development. This should result in more environmentally sound, socially equitable, and culturally appropriate development of coastal areas, as outlined for example in UNESCO (1997).

(6) Support and cooperate with international colleagues involved in flamingo conservation in the region through the Caribbean Flamingo Conservation Group.

Unfortunately we note that most of these very same conservation measures for the flamingo on Hispaniola were previously outlined by Wiley and Wiley (1979), Ottenwalder (1988), Ottenwalder *et al.* (1990), and echoed by Keith *et al.* (2003). A full 30 years after the recommendations first published by Wiley and Wiley (1979), we still have to report that the situation has not improved for the Caribbean Flamingo in the Dominican Republic and Haiti, and

that there is in fact abundant evidence that the situation has deteriorated, perhaps dramatically, at least in terms of nesting conditions. Based on data reported here, we suggest that the apparent loss of all breeding colonies, and the recent growing popularity of wild-caught flamingos in gardens and lagoons of private homes and commercial hotels and resorts, has created a situation anathema to the maintenance of healthy, reproducing populations of flamingos in the Dominican Republic and Haiti.

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The use of mirrors and artificial nest mounds to encourage breeding in Chilean Flamingos *Phoenicopterus chilensis* at Colchester Zoo

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Abstract — Breeding a bird that naturally lives in flocks, often numbering tens of thousands of individuals, is difficult in captivity as these numbers are not practical or even possible to house. In 2010, Colchester Zoo took the first step to encourage breeding in its flock of 15 Chilean Flamingo *Phoenicopterus chilensis* by installing six two-metre high mirrors along the edge of a lake in the flamingo enclosure. The purpose of the mirrors was to create the illusion of more flamingos, in effect increasing the flock size from 15 to 30. After the mirrors were installed, previously unseen behaviours were observed: courtship displays, the successful construction of four nest mounds and nest maintenance activities. The mirrors also benefited the overall welfare of the birds by increasing social stimuli and therefore stimulating a larger array of natural behaviours, and increasing flock security by creating the illusion of more individuals. Colchester Zoo plans to establish a successful breeding programme for Chilean Flamingos and to increase public awareness of flamingo conservation, thus helping to secure the future of this popular bird.

Keywords: Colchester Zoo, Chilean Flamingo, Phoenicopterus chilensis*, breeding, mirrors, captivity.*

Introduction

Flamingos are one of the most easily recognisable birds, with their long necks and legs, unusual bill shape and of course their plumage, which in the Chilean Flamingo *Phoenicopterus chilensis* is the classic pink. They are also a popular bird in zoological collections (Unger & Elston, 2009) with a registered captive population of over 3000 (ISIS 2010) and many more present in un-registered zoological and private collections.

Despite the popularity of this species, breeding success in captivity has been limited and the BIAZA Flamingo Focus Group (FFG) has determined that the species is currently not sustainable in UK collections without increased breeding or additions of birds from outside the UK (BIAZA FFG, unpublished data). To ensure the future of the Chilean Flamingo in UK collections and eliminate demand for wild-caught birds, it is vital that collections holding the species make every effort to encourage breeding and establish self-sustaining flocks.

Furthermore, with the wild population of Chilean Flamingos now numbering 200,000 compared to an estimated 500,000 in the mid 1970s (IUCN, 2010) it is vital that captive breeding becomes more successful.

The main difficulty faced when breeding flamingos in captivity is small flock size. In the wild, all six flamingo species tend to live and breed in large flocks often numbering tens of thousands of individuals (King & Stevens, 2009), feeding and performing courtship behaviours together (Unger & Elston, 2009). These flock numbers are unachievable in captivity and thus captive flocks are a lot smaller.. Studies of captive flocks have found a clear relationship between flock size and breeding success. Hosey *et al.* (2009) found that flocks of less than 21 birds will rarely breed, and Perry (2009) found that breeding success is greatly improved in flocks of 40 or more individuals.

While flock size is important, it is not, however, the only factor influencing breeding success. King (2008) identified a range of factors important for breeding, including flock security, sex ratio and enclosure design. Measures such as the provision of artificial nest mounds, decoys and mirrors have also been shown to encourage breeding (Unger & Elston, 2009).

In 2010, Colchester Zoo implemented two of these measures (mirrors and artificial nest mounds) to encourage breeding in its relatively small flock of 15 Chilean Flamingos. The following paper describes how the mirrors and nest mounds were used and their effects on the captive flock.

Materials and methods

Study flock and diet

Colchester Zoo (Maldon Road, Colchester, Essex, UK) has maintained a flock of Chilean Flamingos since 1983. When the measures described in this paper were implemented (June 2010), the flock consisted of 15 birds (nine males and six females): three from the original flock and 12 obtained from WWT Slimbridge in 2002. While some of these birds had bred successfully at other collections before entering the Colchester Zoo collection, no breeding behaviour had been observed at Colchester Zoo prior to June 2010. The flamingos were fed Mazuri© flamingo breeder: 2.5 kg (dry weight) in the morning and afternoon, increasing to 5 kg in winter.

Enclosure

The birds were maintained on a natural lake approximately 50 m long and 20 m across at its widest point and fed by a natural stream (Figure 1). The flamingos shared the lake with native wildfowl and one adult female Dalmatian Pelican *Pelecanus crispus*. Despite having free access to the flamingos' part of the lake, the pelican spent most of its time at the opposite end of the lake. There was a pump in the middle of the lake to disturb the water surface to prevent freezing. This pump was installed in spring 2010. The nesting area was a natural bay near the mouth of the stream and surrounded by trees, with a keeper path behind leading to feed bowls.

Installing mirrors

Six acrylic mirrors (2 × 0.75 m) were purchased from Primrose London (www.primrose-london.co.uk). Acrylic mirrors are 10 times stronger than glass, weigh 80% less and do not shatter. The mirrors were attached to wooden backs with waterproof glue and given wooden frames to increase strength.

The mirrors were installed in the flamingo enclosure on 7 June 2010 (Figure 1, Figure 2). Four were placed on one side of the bay area where the lake narrowed and the birds spent most of their time. The remaining two mirrors were placed directly opposite on the other side of the bay to further increase reflections.

The mirrors were secured in place by attaching wooden posts that were dug a few feet into the ground.

Constructing artificial nest mounds

Eight artificial nest mounds were constructed in the flamingo enclosure on 17 June 2010 by Colchester Zoo keepers. The mounds were made from a clay-based soil and were approximately 1 ft high and 1 ft in diameter. Two were built on the waters edge next to the four mirrors in the bay area, two were built directly in front of the mirrors, and four were built on the land area adjacent to the mirrors. The nest mounds were regularly watered to prevent drying.

Results

No breeding behaviour (courtship displays, nest building activities or egg laying) was observed prior to 7 June 2010, when the mirrors were installed. Within days of the mirrors being installed, courtship displays were observed (Figure 2) and the birds were also observed interacting with the mirrors and displaying in front of them.

On 18 June 2010 (the day after artificial nest mounds were constructed by keepers) the flamingos began nest building (Figure 2). Nest building behaviour continued until 12 July with a total of four nests successfully constructed.

Figure 1. The lake at Colchester Zoo where the flamingos were kept, taken from the mouth of the natural stream that feeds the lake (left), and three of the acrylic mirrors (2 × 0.75 m) installed around the lake in June 2010 to encourage breeding (right).

Between 12 July and 4 October 2010, nest maintenance activities were observed (Figure 2). Courtship displays and nest building activities were not observed after 12 July. No eggs were laid and none of the artificial nest mounds were used.

Discussion

Following the installation of mirrors and artificial nest mounds, previously unseen behaviours of courtship and nest building were observed. Although we cannot be certain that the breeding behaviours did not occur in coincidence to the husbandry activities, the lack of any breeding behaviour in the years before and the proximity of the birds to the mirrors and nest mounds when expressing these behaviours suggest that the mirrors and nest mounds were directly responsible for stimulating the breeding behaviour.

Although no eggs were produced, the courtship displays, nest building and nest maintenance activities are very encouraging signs for breeding success in the future. The successful construction of four complete nests and the formation of four pairs are particularly positive developments. The reason eggs were not laid is unknown. Other collections have reported that the first egg of a season is often laid by a dominant and experienced pair and this appears to trigger egg laying in the rest of the flock. Thus, providing a dummy egg to a nesting pair may encourage egg laying and will be considered as a husbandry option in the future.

Mirrors are believed to stimulate breeding behaviour by increasing perceived flock size, which better replicates breeding conditions in the wild. Mirrors may encourage these behaviours by increasing the flock's sense of security. Simply introducing new birds to a flock has led to breeding at other collections, so it may also be possible that mirrors trick the birds into believing there are new individuals in the flock.

As well as stimulating breeding behaviour which may lead to breeding success in the future, the mirrors and nest mounds have benefited the overall welfare of the flock by providing a more stimulating and naturalistic environment generally, indicated by the increased repertoire of behaviours expressed by the flamingos. If the mirrors have increased the flock's sense of security, this will also provide overall and long-term benefits for welfare. This range of benefits was achieved by the installation of just six inexpensive mirrors and the construction of eight nest mounds. These modifications to the enclosure have proved cost-effective and valuable.

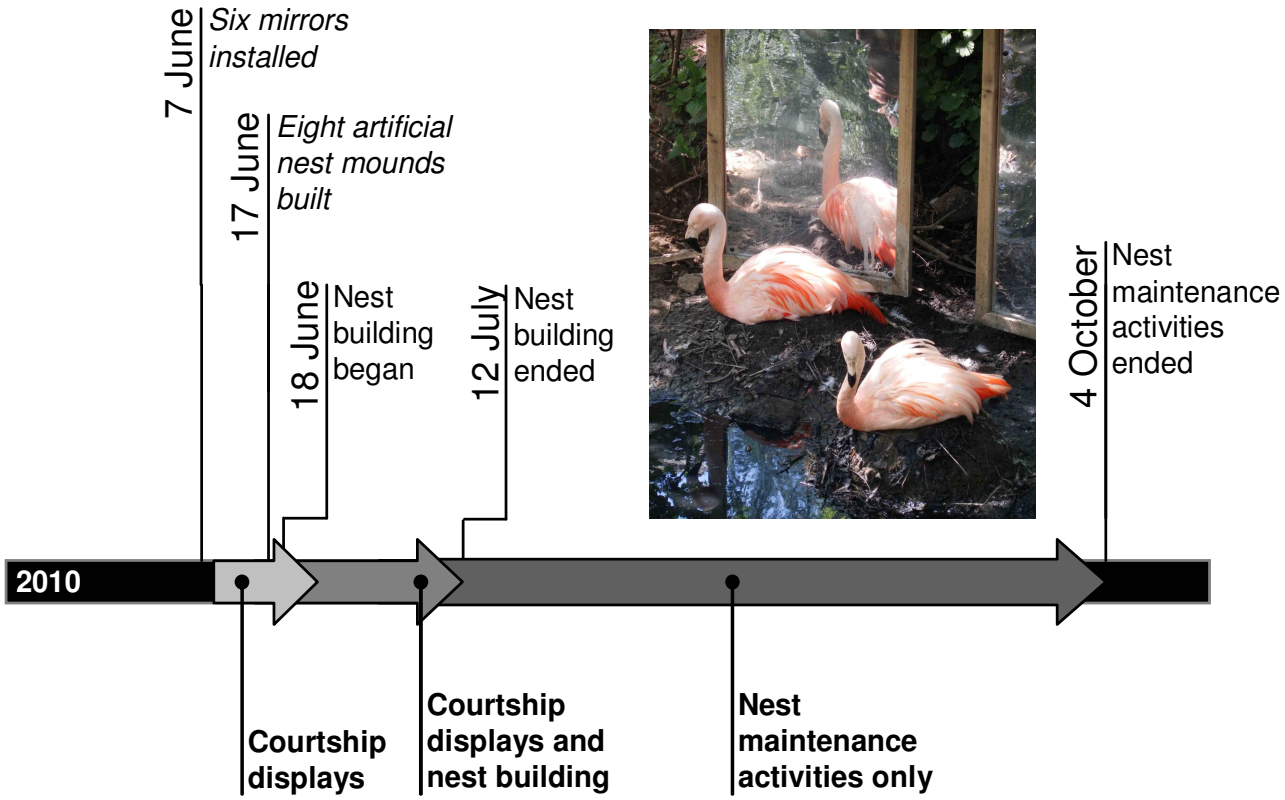

Figure 2. Timeline of breeding behaviour observed in captive Chilean Flamingos *Phoenicopterus chilensis* at Colchester Zoo in 2010 following the additions of mirrors and artificial nest mounds to their enclosure. Notice how courtship displays began shortly after mirrors were installed and nest building began shortly after artificial nest mounds were constructed. Italics indicate activities performed by keepers.

From the 3239 Chilean Flamingos in ISIS registered captive populations, only 10 eggs were reported in 2010: six in Europe and four in North America (ISIS, 2010). These figures indicate the importance of developing husbandry techniques that encourage breeding in captive Chilean Flamingos to ensure the long-term sustainability of this popular species in zoological collections and eliminate any demand for wild-caught birds.

Colchester Zoo will continue to review its management techniques and enclosure design for Chilean Flamingos to identify where improvements could be made to increase the chances of breeding in future years. It is hoped that Colchester Zoo can establish a sustainable breeding flock which will improve the overall situation for the captive Chilean Flamingo population in the UK. We also hope to increase the public awareness of the threats that face all flamingos in the wild and aid in their conservation.

Acknowledgements

I would first like to thank my Head of Section Vicky Nunn and Curator Sarah Forsyth for their advice and support as well as all the keepers who would inform me of any behaviours they saw. I would also like to thank Kerry Hunt and Nikki Brown for their help and Jennie Cook for proof reading and suggestion. Finally I would like thank the staff at WWT Slimbridge, UK for the all the advice and valuable knowledge they have passed on.

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A new nesting site for the Greater Flamingo *Phoenicopterus roseus* in the Algerian Sahara and an account of the 2010 breeding season

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Abstract — In 2010, the Greater Flamingo *Phoenicopterus roseus* made four breeding attempts at four distinct sites but with no success because of widespread drought. Noteworthy is the record of Sebkhat Safioune, a new nesting site in the Sahara, and the use of artificial nests to encourage breeding at Bazer Sakra. In August, possibly stimulated by these nests built close to the shore where nesting previously took place, Greater Flamingos built 300 new nests and initiated an attempt at incubation in the middle of the dried salt lake, before deserting the colony in mid-August.

Résumé — L'année 2010 a été marquée par la découverte d'un nouveau site de nidification du Flamant rose au Sahara et l'utilisation de nids artificiels à Bazer Sakra pour induire les flamants à se reproduire. Quatre tentatives de nidification ont eu lieu à travers l'Algérie, deux dans les Hauts Plateaux et deux au Sahara, mais elles ont toutes échoué. A Bazer Sakra au mois d'août, peut-être encouragés par la présence de nids artificiels, les flamants ont construit plus de 300 nouveaux nids mais à un endroit distinct de celui utilisé dans le passé.

Keywords: Greater Flamingo, Phoenicopterus roseus*, breeding, drought, Algeria, artificial nest site.*

Introduction

Recent findings have settled an issue that has been a problem for Algerian ornithology for a number of decades. A lack of local ornithologists and a vast arid country have presented challenges to the assessment of the true status of the Greater Flamingo *Phoenicopterus roseus* in Algeria, which has led researchers to underestimate the role of Algerian wetlands for the Greater Flamingo Mediterranean metapopulation. Over the last eight years (2003–2010), the Greater Flamingo has made a total of 17 nesting attempts in Algeria, resulting in four successful breeding events at two distinct sites (Samraoui *et al.*, 2006, 2009, 2010).

Methods

Between February and August 2010, three known Greater Flamingo nesting sites in Algeria, where nesting attempts had been confirmed in the past (Samraoui *et al.* 2010), were monitored – sites at Ezzemoul, Bazer Sakra and El Goléa (Figure 1). Beginning in April for sites north of the Sahara and at the end of February for sites in the Sahara (see Figure 1), observations were made every few days until display and nest building was initiated. Thereafter, a vigil was kept daily to provide physical protection against human disturbance. The colonies were monitored from the shores using telescopes.

Results

Despite drought conditions, the Greater Flamingo attempted to breed at all three surveyed sites. A fourth nesting site, Chott Hodna could not be investigated but a fifth site, Sebkhat Safioune – the second nesting site identified in the Algerian Sahara – was discovered unexpectedly in May.

Ezzemoul

In 2010, the salt lake complex of Oum El Bouaghi located in the northeastern Hauts Plateaux was relatively dry. In early April, Ezzemoul had less than 40 cm of water whereas Chott Tinsilt, the main feeding site, had only 10 cm of water. Prospects looked poor but on 20 April, over 1000 Greater Flamingos were in full courtship swing with 100 birds building nests on the breeding islet. The number of birds fell to 400 on 23 April with 20 nests containing incubating birds and another 200 birds building nests or displaying. Interestingly, the

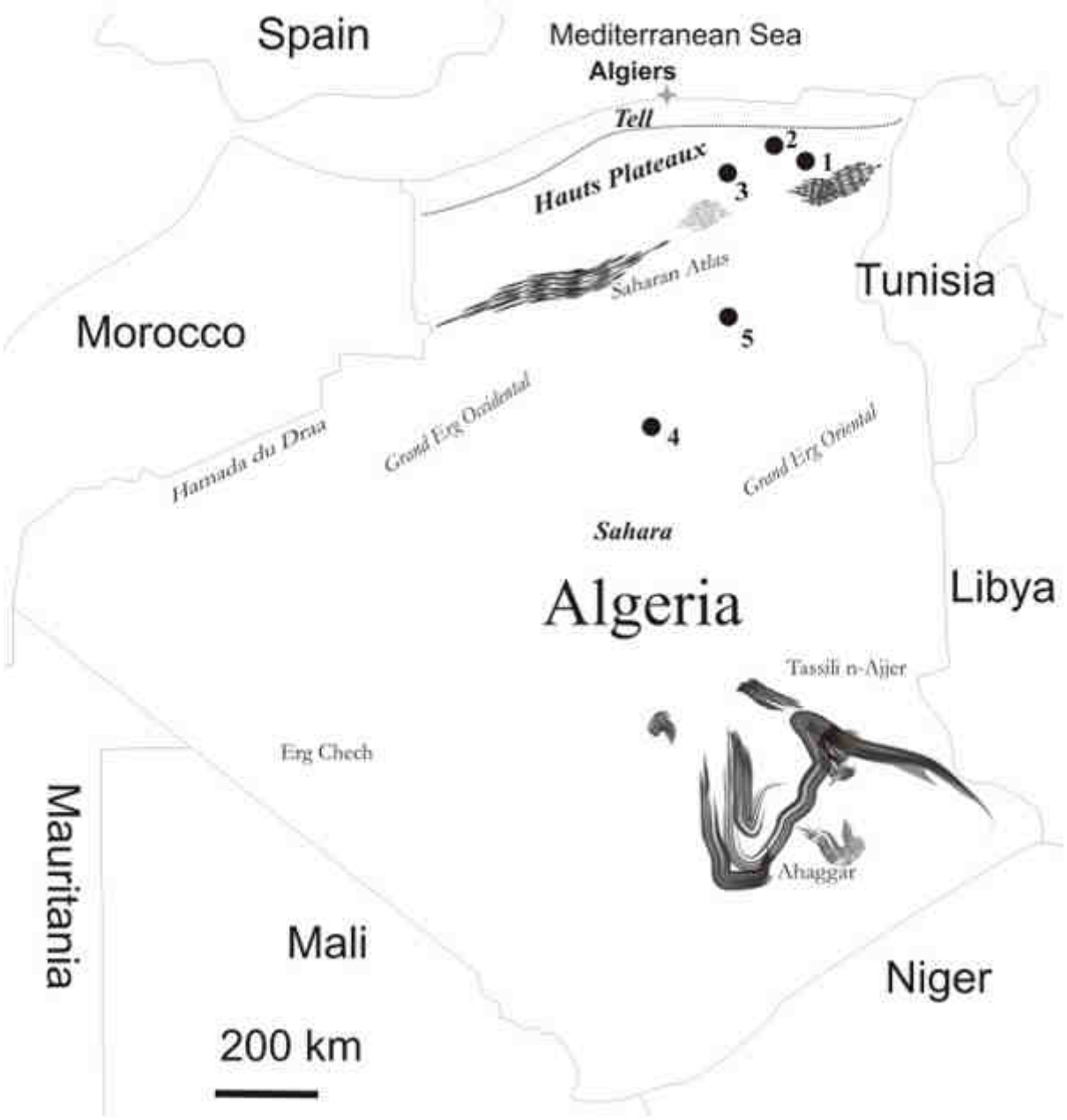

Figure1. Known Greater Flamingo *Phoenicopterus roseus* nesting sites in Algeria: Ezzemoul (1), Bazer Sakra (2), Chott Hodna (3), El Goléa (4), and Safioune (Ouargla, 5).

flamingos started nesting on the eastern side of the islet whereas in 2006 and 2009, they began on the western side. Physical protection of the site was attempted but the low water level provided access to terrestrial predators and on 24 April, the islet was found deserted with most flamingos located far from the islet. They were probably disturbed by a group of five Wild Boar *Sus scrofa* that stayed in the lagoon for a few days. From that day onwards, the number of Greater Flamingos dwindled from 600 to 60 by mid-May.

Bazer Sakra

The region of El Eulma like that of Oum El Bouaghi (Ezzemoul) is also located in the eastern Hauts Plateaux. There was little rain in 2010 and the salt lake of Bazer Sakra was holding a thin sheet (2 cm) of water at the end of April with most Greater Flamingos foraging around the main affluent which feeds the site with sewage water. On 1 May, a team of 10 people, made up of students and researchers worked for over 6 hours to build a total of 100 artificial nests using mud, buckets and spades to give them the shape of a natural nest (Figure 2). These nests were on average 12 cm high and 30 cm wide, and were located close to the shore in an area where, in the past, the Greater Flamingo nested unsuccessfully (Figure 2). Hen egg shells were scattered across these newly built nests to give them added attraction. Between May and July, the number of flamingos fluctuated between 258 and 3500 but no nesting was recorded. On 9 August, 2000

Figure 2. Artificial nests at Bazer Sakra: students building the nests (A); a view of some of the nests after construction (C); and a close-up of one of the nests (D).

flamingos were present with 62 birds aligned along a line of nests about 250 m long. A total of four nests were being used by incubating Greater Flamingos, and over the next two days, this number rose steadily to 47 and 64 with a total of 2200 flamingos present on the site (Figure 3). On 12 August, there were still a few birds incubating early in the morning but by midday, the colony was deserted . Inspection of the colony, a few days later, revealed a total of 300 nests but with no sign of eggs.

El Goléa

In early February, the water level of the salt lake was much lower than that of the previous year. On 20 February, Greater Flamingos started displaying in a distinct location far from the islet where they successfully nested in 2009. By 5 March, they had built 15 nests but the nesting area was close to the shore and within a few days was deserted, probably as a result of human disturbance or disturbance by a pair of White Storks *Ciconia ciconia*. On 26 March after returning to the previous year's nesting site, the birds, numbering 310, continued displaying courtship and nest-building behaviour. They were, however, obviously unsettled, shifting nervously between adjacent islets. An inspection of the deserted colony revealed three eggs.

Sebkhat Safioune

On 21 May, on a visit to Sebkhat Safioune (32° 19'16" North, 5° 22'6" East, alt. 129 m), a vast salt lake north of the oasis of Ouargla, which on past surveys always proved dry, we stumbled upon an unexpected colony of Greater Flamingo (Figure 3). Beginning in November 2009, the drainage water from the town of Ouargla was collected and diverted to Sebkhat Safioune. Thus, Sebkhat Safioune apparently benefited from the drainage of Chott Aïn El Beïda, a Ramsar site, and Sidi Khouiled, sites which had assumed this function, previously. There was a small colony of Greater Flamingo numbering 200 birds, three of them incubating and many more building nests on a small island located at a distance of 1600 m from shore. By June, high temperatures and sand storms led to a drop in the water level and this led to the desertion of the colony. An inspection

A

B

Figure 3. Nesting attempt at Sebkhat Safioune, in 2010 (A); a closer view of the deserted colony at Sebkhat Safioune (B).

of the empty nesting islet found 61 nests with no trace of eggs.

Discussion

Despite being unsuccessful at breeding in 2010, the Greater Flamingo seemed to have expanded its nesting range across Algeria with breeding attempts at three known nesting sites, Ezzemoul, Bazer Sakra and El Goléa (Bouzid *et al.* 2009), and one previously unknown site, Sebkhat Safioune. These breeding attempts, undertaken at an unusually late period, may be due to young, inexperienced birds "learning the trade" and they may only succeed on rare occasions.

Colonial waterbirds are known to require social stimulation to initiate and achieve successful breeding. Following the use of decoys and vocalisation playbacks as successful management tools in recovery programs of waterbird breeding colonies (Podolsky & Kress, 1989; Crozier & Gawlik, 2003), similar techniques including increase of flock size (Stevens, 1991), use of large mirrors to provide extra stimuli (Pickering & Duverge, 1992), and use of a combination of decoys, vocalization playbacks and artificial nests (O'Connell-Rodwell *et al.*, 2004) have been successfully tried on various species of flamingos both in captivity and in the wild.

Different management techniques like predator control, crop protection or the maintenance or provision of breeding islands have also been used successfully in the past in efforts to conserve the Greater Flamingo (Johnson & Cézilli, 2007). The use of artificial nests was first used in zoos to stimulate Greater Flamingos to breed (Kear & Duplaix-Hall, 1975) and the technique has been successfully replicated in the wild. For example, at Etang du Fangassier in the Camargue region of France, a mixture of nests built using mud-filled buckets and real nests transplanted from a nearby dyke was placed on an artificial island, which became the principal breeding site in France (Johnson, 1976). A modified technique of molding nests and scrapping mud to create depressions between the mounds was similarly successful at Fuente de Piedra, Spain with the nests containing scattered shells of chicken eggs being particularly attractive to flamingos (Rendon Martos & Johnson, 1996). If hydrological conditions remain the key factors that control the reproduction of the Greater Flamingo, active management may lead to successful breeding at Bazer Sakra and the colonisation of new sites in North Africa. Our first attempt at stimulating Greater Flamingos to breed at Bazer Sakra was promising; it remains to be seen whether it will succeed in the long run.

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We thank Farrah Samraoui for editing the manuscript and the Station Biologique de la Tour du Valat for free access to their library. We thank the Algerian Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (M.E.S.R.S.), Luc Hoffmann and the MAVA foundation, and D.S.F.P., King Saud University, KSA, for material support.

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Flamingo-related publications in 2010

with abstracts where available

Why do flamingos stand on one leg?

Anderson, M.J. & Williams, S.A. 2010. Zoo Biology, 29: 365–374.

Abstract — A series of observational studies of captive Caribbean flamingos *Phoenicopterus ruber* were conducted to determine why flamingos rest on one leg. While frequently asked by the general public, this basic question has remained unanswered by the scientific community. Here we suggest that the latency of flamingos to initiate forward locomotion following resting on one leg is significantly longer than following resting on two, discounting the possibility that unipedal resting reduces muscle fatigue or enhances predatory escape. Additionally, we demonstrate that flamingos do not display lateral preferences at the individual or group levels when resting on one leg, with each bird dividing its resting time across both legs. We show that while flamingos prefer resting on one leg to two regardless of location, the percentage of birds resting on one leg is significantly higher among birds standing in the water than among those on land. Finally, we demonstrate a negative relationship between temperature and the percentage of observed birds resting on one leg, such that resting on one leg decreases as temperature rises. Results strongly suggest that unipedal resting aids flamingos in thermoregulation.

Preferred neck-resting position predicts aggression in Caribbean Flamingos (*Phoenicopterus ruber*)

Anderson, M.J., Williams, S.A. & Bono, A.J. 2010. Laterality, 15: 629–638.

Abstract — When flamingos rest, they typically lay their heads along their backs. In order to achieve this positioning they curve their necks to either the right or left of their midline. Previously we have shown both individual and flock-level laterality of preferred neck-resting direction, with most birds preferring to rest their necks to their right (Anderson, Williams, O'Brien, 2009). As laterality has been shown to play a role in social cohesion (e.g., Rogers Workman, 1989) and aggression (e.g., Vallortigara, Cozzutti, Tommasi, Rogers, 2001), here we attempted to determine whether a flamingo's preferred neck-resting direction could be used to predict involvement in aggressive encounters. Results replicated the earlier flock-level preference for neck resting towards the right, and indicated that those flamingos preferring the left were more likely to be involved in aggressive encounters.

Experience-dependent natal philopatry of breeding Greater Flamingos

Balkiz, O., Bechet, A., Rouan, L., Choquet, R., Germain, C., Amat, J.A., Rendon-Martos, M., Baccetti, N., Nissardi, S., Ozesmi, U. & Pradel, R. 2010. Journal of Animal Ecology, 79: 1045–1056.

Abstract — 1. Contrary to the generally high level of natal philopatry (i.e. likelihood that individuals breed at their natal colony) found in first-breeding colonial birds, little is known of natal philopatry later in life. Most hypotheses advanced to explain natal philopatry are valid at all ages. However, for young and inexperienced birds, the benefits of natal philopatry may be counterbalanced by the costs of intraspecific competition at the natal colony making dispersal temporarily advantageous. In turn, experience may increase competitive ability and make natal philopatry advantageous again.
2. We evaluated this hypothesis on the large-scale dispersal of greater flamingos *Phoenicopterus roseus* breeding among three colonies comprising > 85% of the Western Mediterranean metapopulation. The Camargue (France) and Fuente de Piedra (Spain) are large and saturated colonies while Molentargius (Sardinia) is a recent and growing colony.
3. We used a 20-year capture-mark-resighting dataset of 4900 flamingos ringed as chicks in Camargue and Fuente de Piedra and breeding at the three colonies. We assessed the effects of natal colony and breeding experience (firsttime observed breeders versus confirmed experienced breeders) on dispersal using multistate capture-recapture models. Dispersal to an unobservable state accounted for temporary emigration.
4. Fidelity was higher at the natal colony (> 84%) than elsewhere. Fidelity increased with experience in the two large colonies (Camargue and Fuente de Piedra) suggesting a large-scale experience-related despotic distribution. Breeding dispersal was significant (up to 61% and 52% for first-time breeders and experienced breeders, respectively) so that colony dynamics is affected by exchanges with other colonies. Except for Fuente-born breeders leaving Molentargius, dispersal to the natal colony was higher than to any other colonies.
5. Survival was not higher at the natal colony. Inexperienced birds likely had lower breeding success at the Camargue and skipped reproduction after having emigrated to the other large colony but not to Molentargius. Breeding at Molentargius could allow avoiding queuing (and non-breeding) at the large colonies while gaining experience and competitive ability for future attempts.
6. Natal philopatry appears as an important driver of large-scale breeding dispersal in the Greater flamingo. The fitness advantage of natal philopatry is likely experience-dependent and mediated by the variations of intraspecific competition.

Age-specific variation of resistance to oxidative stress in the Greater Flamingo (*Phoenicopterus ruber roseus*)

Devevey, G., Bruyndonckx, N. von Houwald, F., Studer-Thiersch, A. & Christe, P. 2010. Journal of Ornithology, 151: 251–254.

Abstract — Birds exhibit exceptional longevity and are thus regarded as a convenient model to study the intrinsic mechanisms of aging. The oxidative stress theory of aging suggests that individuals age because molecules, cells, tissues, organs, and, ultimately, animals accumulate

oxidative damage over time. Accumulation of damage progressively reduces the level of antioxidant defences that are expected to decline with age. To test this theory, we measured the resistance of red blood cells to free radical attack in a captive population of greater flamingo (*Phoenicopterus ruber roseus*) of known age ranging from 0.3 to 45 years. We observed a convex relationship with young adults (12–20 years old) having greater resistance to oxidative stress than immature flamingos (5 months old) and old flamingos (30–45 years old). Our results suggest that the antioxidant detoxifying system must go through a maturation process before being completely functional. It then declines in older adults, supporting the oxidative theory of aging. Oxidative stress could hence play a significant role in shaping the pattern of senescence in a very long-lived bird species.

Classification and prevalence of foot lesions in captive flamingos (Phoenicopteridae)

Nielsen, A.M.W., Nielsen, S.S., King, C.E. & Bertelsen, M.F. 2010. Journal of Zoo and Wildlife Medicine, 41: 44–49.

Abstract — Foot lesions can compromise the health and welfare of captive birds. In this study, we estimated the prevalence of foot lesions in captive flamingos (Phoenicopteridae). The study was based on photos of 1,495 pairs of foot soles from 854 flamingos in 18 European and two Texan (USA) zoological collections. Methodology for evaluating flamingo feet lesions was developed for this project because no suitable method had been reported in the literature. Four types of foot lesions were identified: hyperkeratoses, fissures, nodular lesions, and papillomatous growths. Seven areas on each foot received a severity score from 0 to 2 for each type of lesion (0 = no lesion, 1 = mild to moderate lesion, 2 = severe lesion). The prevalence of birds with lesions (scores 1 or 2) were 100%, 87%, 17%, and 46% for hyperkeratosis, fissures, nodular lesions, and papillomatous growths, respectively. Birds with severe lesions (score 2) constituted 67%, 46%, 4%, and 12% for hyperkeratosis, fissures, nodular lesions, and papillomatous growths, respectively. Hyperkeratosis and nodular lesions were most prevalent on the base of the foot and the proximal portion of the digits, likely reflecting those areas bearing the most weight. The second and fourth digits were most affected with fissures and papillomatous lesions; these areas of the foot appear to be where the most flexion occurs during ambulation. The study demonstrates that foot lesions are highly prevalent and widely distributed in the study population, indicating that they are an extensive problem in captive flamingos.

First Lesser Flamingo *Phoeniconaias minor* equipped with a satellite transmitter in West Africa

Salewski, V., Wikelski, M. & Childress, B. 2010.Malibus, 32: 60–63.

No abstract available.

Habitat of flamingos

Pattanaik, C., Prasad, S.N. & Vijayan, L. 2010. Current Science, 99: 559–559.

No abstract available.

The breeding of the Greater Flamingo *Phoenicopterus roseus* in Algeria (2003-2009)

Samraoui, F.,Boulkhssaim, M.,Bouzid, A., Baaziz, N. Ouldjaoui, A. & Samraoui, B. 2010. Alauda, 78: 15–25.

Abstract — The breeding of the Greater Flamingo *Phoenicopterus roseus* in Algeria (2003-2009). For years, the Greater Flamingo *Phoenicopterus roseus* has been considered as a wintering species in Algeria, present in relatively small numbers. It has, over the last 7 years (2003-2009), nested regularly at Sebkha Ezzemoul in the north-eastern Hauts Plateaux. This period witnessed thirteen nesting attempts by the species at three distinct sites and 4 successful breeding events totalling over 15000 fledging chicks. Breeding failures were linked to disturbance mainly caused by human intrusion and, to a lesser extent, to drought. Conservation efforts have been deployed aiming at protecting the colony and the connectivity of key wetlands in the area.

First report of Andean Flamingo (*Phoenicoparrus andinus*) breeding in Llancanelo Lagoon, Mendoza, Argentina

Sosa, H & Martín, S. 2010. Nótulas Faunísticas, 42: 1–3.

Abstract — Presence of Andean Flamingo was observed in Laguna Llancanelo, Mendoza, Argentina. The individuals were breeding in the same colony of young of Chilean Flamingo. This would be the first appointment of this species for Llancanelo and the Mendoza province.

Grebes and flamingos: standards of evidence, adjudication of disputes, and societal politics in avian systematics

Livezey, B.C. 2010. Cladistics, 26: 1–11.

Abstract — The recent proposal of a sister-group relationship between the Neoavian grebes (Podicipedidae) and flamingos (Phoenicopteridae) is chronicled, and morphological evidence claimed to be supportive of the grouping is examined. The hypothesis arose from an exiguous amalgam of molecular inferences, advanced in part by a pervasive, unsupported superiority conferred upon sequence data, and adopted by several societal committees on avian classification. Morphological characters marshalled specifically to support the hypothesis were found to be erroneous, and associated phylogenetic analyses, where given, were ambiguous. A combined analysis of large data sets for morphology and RAG-1 sequences found flamingos and grebes to be sister groups but with reduced support. This example illustrates problems attending the synthesis of contradictory evidence and evaluation of unprecedented hypotheses, and reveals the informality by which revisions are adopted. Procedures for rational synthesis of evidence are needed for progress during this challenging but promising

period of diversified phylogenetics, without which disputes will be dominated increasingly by polarized, intransigent prejudice regarding methods and data.

Avian poxvirus infection in flamingos (*Phoenicopterus roseus*) in a zoo in Japan

Terasaki, T., Kaneko, M. & Mase, M. 2010. Avian Diseases, 54: 955–957.

Abstract — Two diseased flamingos (*Phoenicopterus roseus*) with nodular lesions (pock) characteristic of poxvirus infection were found in a zoo in Japan. Avian poxvirus was isolated from the lesions (upper beak) of the affected birds and was genetically characterized by polymerase chain reaction, nucleotide sequencing, and phylogenetic analysis. Based on the phylogenetic analysis, the virus isolated from these flamingos was genetically close to those isolated from pigeons, suggesting the possibility of interspecies transmission.

New nesting colonies of Puna Flamingo (*Phoenicoparrus jamesi*) in northwest Argentina

Derlindati, E.J., Moschione, F.N. & Cruz, N.N. 2010. Nótulas Faunísticas, 56: 1–5.

Abstract — As part of the survey of priority sites for conservation of Andean flamingos, in February of 2009 we found new breeding colonies of Puna Flamingo or James flamingo (*Phoenicoparrus jamesi*) at three sites in northwest Argentina. Before this discovery, only one colony was known in this area, but the species had not been identified. The aim of this paper is to present the first appointment with nesting sites containing reproductive success *P. jamesi* chickens from Argentina. We censused a total of 533 chickens and 2,315 adults. This discovery is extremely important if we consider that this species is considered vulnerable to regional scale, and the periodic recruitment *P. jamesi* occurs in a single site with a concentration of approximately 5,000 individuals annually, so that only these three sites increased the recruitment by 10%.

A breeding island for Lesser Flamingos *Phoeniconaias minor* at Kamfers Dam, Kimberley, South Africa

Anderson, M.D. & Anderson, T.A. 2010. Bull ABC, 17: 225–228.

No abstract available.

Caribbean Flamingo resting behavior and the influence of weather variables

Bouchard, L.C. & Anderson, M.J. 2010. Journal of Ornithology. Available online from http://www.springerlink.com/content/6hh5020414633t8n/.

Abstract — This observational study of captive Caribbean Flamingos (*Phoenicopterus ruber*) sought to investigate the possible functions of unipedal and bipedal resting. In particular, this research sought to further examine the possibility that thermoregulation is a primary function of unipedal resting. Significant negative correlations were found between length of unipedal resting and average temperature, and between length of unipedal resting and average heat index, indicating that temperature is a major factor in determination of resting stance. A significant negative correlation was also obtained between length of unipedal resting and average wind chill, but as the observed wind chills did not significantly differ from the temperatures, such a finding is to be expected. These results suggest that flamingos rest on one leg for longer intervals in an attempt to conserve body heat. Further, a significant positive correlation between length of bipedal resting and average wind speed suggests that on windy days, a bipedal stance is preferred to enhance stability when resting.

Novel linear megaplasmid from Brevibacterium sp. isolated from extreme environment

Dib, J.R., Wagenknecht, M., Hill, R.T., Farias, M.E. & Meinhardt, F. 2010. Journal of Basic Microbiology, 50: 280–284.

Abstract — Brevibacterium sp. Ap13, isolated from flamingo's feces in Laguna Aparejos, a high-altitude lake located at approximately 4,200 m in the northwest of Argentina was previously found to be resistant to multiple antibiotics, and was therefore screened for plasmids that may be implicated in antibiotic resistance. Brevibacterium sp. Ap13 was found to contain two plasmids of approximately 87 and 436 kb, designated pAP13 and pAP13c, respectively. Only pAP13 was stably maintained and was extensively characterized by pulsed-field gel electrophoresis to reveal that this plasmid is linear and likely has covalently linked terminal proteins associated with its 5' ends. This is the first report of a linear plasmid in the genus Brevibacterium and may provide a new tool for genetic manipulation of this commercially important genus.

Avian collisions with power lines: a global review of causes and mitigation with a South African perspective

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Bird Conservation International, 20: 263–278.

Abstract — Many large terrestrial and wetland birds and some smaller, fast-flying species are prone to colliding with overhead wires associated with power infrastructure. A high proportion of these are threatened species and for some, collision with power lines and other man-made structures is a significant and damaging source of anthropogenic mortality. We review the existing literature on the nature, scale and impact of this problem worldwide, with particular emphasis on the South African situation, and focus on the evidence for and against various line configurations and devices proposed to mitigate the negative effects of overhead lines on bird populations. Cranes, bustards, flamingos, waterfowl, shorebirds, gamebirds and falcons are among the most frequently affected avian groups, and collision frequency is thought to be an influential factor in ongoing population declines in several species of cranes, bustards and diurnal raptors. The bulk of the research on this issue

has been done in North America, Scandinavia, southern Europe and South Africa. Few comprehensive experimental studies on ways to reduce avian collisions with power lines have been carried out, although most of these have yielded quite clear results. Mitigation options considered include reviewing the placement of proposed new lines, removing the earth-wire which is usually the highest, thinnest and most problematic component in an overhead power line configuration, or else fitting this wire with markers-brightly coloured 'aviation' balls, thickened wire coils, luminescent, shiny or hinged flashing or flapping devices. All of these options reduce bird collision frequency overall by at least 50-60%, although the efficacy of line marking may be much lower for certain species (e. g. bustards). There remains considerable uncertainty about the best-performing marking device (perhaps because performance may vary with both local conditions and the species involved in each instance), and a durable, all-purpose device, that is effective both during the day and at night, has not yet been developed. We conclude by outlining a proposed experimental evaluation of the full array of collision mitigation options, to select the best approaches for use under South African conditions.

Taphonomic controls on animal tracks at saline, alkaline Lake Bogoria, Kenya Rift Valley: impact of salt efflorescence and clay mineralogy

Scott, J.J., Renaut, R.W. & Owen, R.B. 2010. Journal of Sedimentary Research, 80: 639–665.

Abstract — The morphologies of subaerial vertebrate tracks and invertebrate traces in surficial sediments can be used in paleoenvironmental reconstructions by providing details about the initial substrate conditions (e.g., water content) and any changes experienced during trace preservation. A qualitative field study was undertaken to identify the factors affecting track taphonomy in saline lake-margin environments, supported by experiments to isolate selected factors that modify track morphology and substrate characteristics. Flamingo tracks, ubiquitous around saline, alkaline Lake Bogoria in the Kenya Rift, were the focus of field study, although other vertebrate tracks and surficial invertebrate trails and tunnels were also considered. A complex and interacting set of environmental factors were identified, such as the effect of lake-level fluctuations on substrate grain size and capillary evaporation. Several factors affect the early taphonomic modification, destruction, stabilization, and/or cementation of tracks and their associated substrates. The laboratory experiments tested the effects of pore-water salinity, clay mineralogy (e.g., swelling or non-swelling clays), drying method (e.g., solar radiation or wind), and wetting-and-drying cycles on tracks. These data were supported by statistical analyses of impression depth and planimetric area. The results show that track morphology in smectitic substrates is altered rapidly by wetting and drying, particularly if the substrates contain saline pore waters, but morphology is less affected in non-swelling clays. The degree of morphologic alteration and/or resistance to wetting and drying varies with the rate of substrate drying and the type of the resulting salt efflorescence (e.g., interstitial vs. surficial crust). These short-term, process-related taphonomic effects help to explain the morphologic variants of tracks in lake-marginal settings, and provide insights into the preserved distribution patterns of subaerial ichnofossil assemblages.

Combined hepatocellular-cholangiocarcinoma in a Lesser Flamingo (*Phoenicopterus minor*)

Van Wettere, A.J., Degernes, L.A. & Barnes, H.J. 2010. Avian Pathology, 39: 275–278.

Abstract — A case of combined hepatocellular-cholangiocarcinoma (CHCC) in an adult male lesser flamingo (*Phoenicopterus minor*) that was part of a breeding programme at a private facility is reported. Grossly, the liver was markedly enlarged with multifocal, well-circumscribed, pinpoint to 2 cm diameter pale tan nodular masses. Histologically, the hepatic parenchyma was replaced by neoplastic cells that demonstrated hepatocellular and, less frequently, biliary epithelial cell differentiation. Positive pan-cytokeratin (AE1/AE3/PCK26) immunolabelling of the neoplastic cells forming bile ducts with the scattered immunoreactivity of cells forming glandular structures within the areas of hepatocellular differentiation supported the diagnosis. No metastases were detected. CHCC is a rare neoplasm in mammals and birds. This is the first report where gross, histological, and immunohistochemical characteristics of CHCC in a bird are described, and the first report of CHCC in a lesser flamingo.

Avian longevities and their interpretation under evolutionary theories of senescence

Wasser, D.E. & Sherman, P.W. 2010. Journal of Zoology, 280: 103–155.

Abstract — We comprehensively reviewed information on maximum life spans of wild birds (based on banding recoveries) and nine ecological, physiological and behavioral variables that have been hypothesized to affect the evolution of avian life spans. Data on maximum longevities and body masses were available for 936 species, and data on all variables were available for 470 species in 40 families from 15 orders. The Phoenicopteriformes (flamingos), Psittaciformes (parrots) and Procellariiformes (petrels and shearwaters) had the longest mean maximum life spans (> 30 years), and the Passeriformes (perching birds), Podicipediformes (grebes) and Piciformes (woodpeckers) had the shortest mean maximum life spans (< 10 years). Other orders were intermediate, with the Gruiformes (cranes and rails), Anseriformes (waterfowl), Ciconiiformes (herons and egrets) and Pelecaniformes (pelicans) living a mean maximum of 20-30 years, and the Columbiformes (pigeons), Strigiformes (owls), Falconiformes (hawks), Sphenisciformes (penguins) and Charadriiformes (shorebirds) living a mean maximum of 10-20 years. Within the speciose order Passeriformes, the Corvidae (crows) had longest mean maximum life spans (> 17 years), and the Tyrannidae (flycatchers) and Parulidae (wood warblers) had the shortest mean maximum life spans (6 years). Multivariate regression analyses revealed that the independent variables together explained 80.3% of the variation in maximum longevities among 40 avian families, and 69.6% of the variation among 17 families of

Passeriformes. In the comprehensive analysis four variables significantly affected maximum longevities, namely body mass, diet, sociality and breeding insularity (mainland vs. island), whereas breeding latitude, breeding habitat, nest-site location and migratory behavior did not have significant effects. These results are consistent with evolutionary theories of senescence, which predict that morphological and behavioral attributes that reduce extrinsic mortality should select for mechanisms that postpone physical deterioration, resulting in longer life spans and extended breeding opportunities.

First Record of Palaelodus (Aves: Phoenicopteriformes) from New Zealand

Worthy, T.H., Tennyson, A.J.D., Archer, M. & Scofield, R.P. 2010. Records of the Australian Museum, 62: 77–88.

Abstract — The first record of the flamingo-like Palaelodidae (Phoenicopteriformes) is reported from the Early Miocene, St Bathans Fauna of Central Otago, New Zealand. Two distal tibiotarsi are described as a new Palaelodus species and a cranial fragment of a sternum is tentatively assigned to the same taxon. The new species is slightly smaller than *P. wilsoni* from the Late Oligocene-Early Miocene of Australia, and is distinguished from all congeners by a more robust shaft with a gradual expansion of width to the distal condyles.

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