

## **BFA SEMINAR SERIES NO. 33**

### **The Ecology of Makgadikgadi Salt Pans, Botswana and its Flamingo Populations**

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The salt pans of the Makgadikgadi are a relic of a large and ancient lake that once covered most of contemporary northern Botswana. Today, remnants of that lake exist in the form of one of the largest salt pan complexes on earth. Two large salt flats, Ntwetwe and Sua Pans, covering approximately 16,000 km<sup>2</sup>, comprise a large inland drainage basin into which seasonal rivers flow. Depending on the annual rainfall, these predominantly dry and desolate mudflats become temporarily inundated in the rainy season, forming vast shallow saline lakes. Sua Pan is the lowest part of the complex, and receives a combined seasonal input of water from five inflowing rivers - the Nata, Semowane, Moseitse, Lepashe and Mosupe. The extent of flooding varies from year to year depending on annual rainfall. During years of above-average rainfall the pan can be converted into a vast saline lake that can last for most of, if not right through the year. On such occasions Sua Pan and the rest of the Makgadikgadi becomes one of the most important habitats for nomadic and migratory waterbirds in southern Africa.

Almost as soon as the first rains start flooding the pan, millions of microscopic algae and diatoms emerge. High salinity and the abundance of nutrients brought in by the rivers make for highly productive conditions, and very soon algal blooms start forming. Some of the algae provide food for various species of small invertebrates. Otherwise known as shrimps, small crustaceans hatch out from eggs that can lie dormant for years. One of the most primitive yet productive ecosystems on earth is, once again, rekindled.

Mysteriously, thousands of flamingos from all over southern Africa somehow sense that conditions are good on the Makgadikgadi and begin to arrive within days of flooding. As if dropped by the first heavy thunderstorms, their arrival is remarkably synchronized with the beginning of the rainy season. Two of five flamingo species worldwide occur in Africa, the Greater Flamingo (*Phoenicopterus ruber*) and the Lesser Flamingo (*Phoeniconaias minor*), both high profile species in decline in southern Africa (the Lesser Flamingo being listed as near-threatened in the IUCN Red Data List). For over 30 million years or more they have adopted a life on soda lakes, coastal saline lagoons and seasonally flooded salt pans all over Africa. Both migrate to the waters of the Makgadikgadi to take advantage of the great feeding conditions and to get yet another chance to raise their young.

During two wet seasons of field work, chemical, algae and crustacean samples were collected and analysed to reveal some of the secrets of the Makgadikgadi wetland ecosystem. Conductivity ranged between 320  $\mu\text{s}/\text{cm}$  and 125,800  $\mu\text{s}/\text{cm}$  with variable increase among three basins over the flood cycle. High proportions of  $\text{HCO}_3^-$  &  $\text{CO}_3^{2-}$ ,  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  in initial flood waters changed quickly to NaCl - dominated waters as the lake dried out. Sua Pan contained, however, less K, Mg and  $\text{SO}_4$  and more  $\text{HCO}_3^-$  than over 80% of records from salt pans elsewhere in southern Africa. Maximum pH values were recorded during initial flooding, but generally ranged between 8.6 and 10.1 and increased with salinity. Nutrient concentrations were among the highest recorded in any African lake. Changes in algae and crustacean community composition and a reduction in species richness occurred along a north-middle-south basin salinity gradient and as the lakes dried out in each basin. Algae comprised predominantly filamentous cyanobacteria *Anabaena* and *Oscillatoria*, occurring across wide salinity ranges, while *Navicula*, *Cyclotella* and *Nitzschia* were among the most wide-ranging and abundant diatoms. Other

diatoms, *Cymbella*, *Pinnularia* and *Fragillaria*, a *Cryptomonas* species and chlorophyceae from the genera *Chlorella*, *Chlorococcum* and *Scenedesmus* occurred in low salinities. Crustaceans comprised mainly *Branchinella spinosa*, *Moina belli*, *Lovenula africana* and *Limnocythere tudoranceai* and each occurred across a wide range of salinity. Others (*Branchinella ornata*, *Leptestheria striatoconcha* and *Daphnia barbata*) were abundant only at low salinities. Maximum salinity ranges among crustaceans were higher than those recorded for the same species in East African soda lakes. Long-term changes in salinity on Sua Pan as a result of an existing salt brine extraction plant may impact on biodiversity and require appropriate management.

On Sua Pan, the diet of Greater Flamingo predominantly comprised crustaceans. Fairy shrimp, of the genus *Branchinella*, various species of seed shrimp or ostracods and water fleas of the genus *Moina* and *Daphnia* also contributed to their diet. Crustaceans that occur at Sua are, in fact, unique to wetland ecosystems in southern Africa, and are akin to crustacean communities in the soda lakes of East Africa owing to the chemical make up of its waters. Abundance among the main shrimp crustaceans were among the highest estimates recorded in any lake in Africa.

Lesser Flamingo, on the other hand, specialise in feeding on microscopic algae and diatoms, which they filter with unbelievable precision. Cyanobacteria of the genus *Anabaena* and *Oscillatoria* and diatoms *Navicula* and *Nitzschia* contributed the majority of food at Sua. High concentrations of soluble nutrients (phosphorus and nitrogen) contributed to high abundance among the algae communities, providing a plentiful food source for Lesser Flamingos. With an abundance of food, and the time required to find it therefore reduced, flamingos take the opportunity to reproduce.

There are only three major breeding sites for flamingos in the whole of Africa - Lake Natron in East Africa, Etosha Pan in Namibia, and Sua Pan. A vulnerable breeding regime combined with their high sensitivity to disturbance has contributed to low breeding success by both species in the past. Sua Pan exemplifies many of the characteristics of a prime breeding spot. Along with a plentiful food supply, the pan also provides good nest building material on a site that is completely isolated and undisturbed by land predators. Numbers breeding on Sua Pan often exceed total estimates for southern Africa, estimated to be approximately 47,000 Greater and 26,000 Lesser Flamingos. These additional birds may be coming from East Africa.

Aerial surveys of flamingo breeding colonies on Sua were conducted during three contrasting breeding seasons between October 1998 and July 2001. Rainfall during the rainy seasons of 1998-1999, 1999-2000 and 2000-2001 was 442, 851 and 348 mm, respectively, and had a major effect on breeding success. In January 1999, 16,430 pairs of Lesser Flamingos were recorded breeding, but the number of chicks that survived to fledging was unknown owing to the rapid drying of the pan in late March 1999. No Greater Flamingo breeding was seen that season. Exceptional flooding during 1999-2000 produced highly favourable breeding conditions, with numbers of Greater and Lesser Flamingos breeding estimated to be 23,869 and 64,287 pairs respectively, the highest ever recorded on Sua Pan. Chick survival rate was high and an estimated 18,498 Greater Flamingo chicks and 30,646 Lesser Flamingo chicks fledged. Reduced rainfall in the 2000-2001 wet season resulted in poor breeding conditions, with the total number of adults on the colonies estimated to be 651 pairs of Greater Flamingos and 19,340 pairs of Lesser Flamingos. Rapid drying of the pan in 2000-2001 forced many chicks to walk for over 50 km to the last remaining water in the north of the pan, with an estimated 3000 Lesser Flamingo chicks surviving.

The origin and migration routes of these flamingos were, until recently, poorly understood. In July 2001, the first satellite-tracking project on flamingos in southern Africa was carried out at Makgadikgadi in an attempt to uncover some of the mystery behind flamingo migration. The movements of three Lesser and two Greater Flamingos was monitored after an exceptional breeding

season, using, respectively, 80 gm and 30 gm PTT satellite telemetry devices. Following their departure in February 2002, a highly dispersed movement was observed over a 6 month period, with destinations including sites in Namibia, South Africa and Mozambique. Despite previous observations of flamingos occasionally flying over land by day, migration was recorded only during night-time transmission periods, supporting the theory that flamingos migrate at night. Lesser and Greater Flamingo flight speeds were also estimated at respectively, 60 and 65 km/hr. Although none of the tagged birds flew to East Africa, the study could not discount the possibilities of migratory connections with East African populations, which would account for the excess numbers on Makgadikgadi during exceptional rainfall years.

The results show that flamingos are highly scattered and movement can be nomadic, incorporating visits to many smaller wetlands. As well as highlighting the importance of Makgadikgadi as a breeding site for southern African flamingos, this satellite tracking project also emphasises the need for the protection and proper management of small wetlands in the sub-continent.

Flamingos are an excellent flagship species for promoting conservation awareness and interest in their environment. The protection and conservation of flamingos has far-reaching effects on the conservation of their delicately balanced ecosystem at Makgadikgadi. A number of measures have been taken to protect flamingos at Sua Pan, and have resulted in the protection of other birds and wildlife in the area in addition to a greater overall awareness and understanding of this natural resource and its inhabitants. The reaction is by no means complete and indeed it needs to be continuous. Graham McCulloch, in collaboration with national institutions and local industry and tourism, is continuing research and conservation efforts at Sua Pan and hopes to set up a long-term monitoring and conservation plan that will contribute to the sustainable utilisation of this important wetland ecosystem in the future and help protect the habitat integrity of one of Botswana's most precious birds.

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