Waterbirds around the world

A global overview of the conservation, management and research of the world's waterbird flyways

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Cover photography: Whooper Swans *Cygnus cygnus* arriving at Martin Mere, England. Photo: Paul Marshall. (www.paulmarshallphotography.com)

Metapopulation networks as tools for research and conservation: the Greater Flamingo *Phoenicopterus roseus* in the Mediterranean and West Africa

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Observations in the 1990s of Greater Flamingos *Phoenicopterus roseus* banded as chicks in France and breeding in Spain and Italy, suggested that the French population was not closed. Rather, flamingos breeding at different colonies of the western Mediterranean were part of a metapopulation, i.e. important exchanges of breeding waterbirds occur among colonies. To enhance understanding of the population dynamics of this species and to propose sound conservation planning, a network was developed of partners working on flamingos at their main breeding sites.

The Greater Flamingo network was initiated in 2002 through a workshop uniting French, Italian, Spanish and Turkish partners, with Mauritania joining the network in 2003. The broad objective of the network is to study environmental and individual factors influencing juvenile and adult dispersal in order to provide sound conservation planning at an appropriate scale. The network core is a database of 400 000 resightings of more than 30 000 flamingos banded in four countries (France, Spain, Italy, Turkey) and eight colonies. The database is in four languages (French, Spanish, Italian, English) with life histories in five languages (including Turkish). Resighting efforts are coordinated over critical time-periods according to a standardized seasonal sampling scheme.

The Greater Flamingo network surveys a total of 19 breeding sites in five countries (France, Spain, Italy, Turkey and Mauritania). Of these sites, 36% are in active salinas and their existence relies on continued salt production together with appropriate island and water management. The main threat for other sites is water shortage, due to conflicts between agricultural and environmental requirements.

In the western Mediterranean, the number of Flamingo colonies has increased in the last decade, as well as an overall increase of the breeding population and numbers of chicks fledged. This increase probably resulted from the dispersal of juveniles and adults born at the large colonies of Salins de Giraud (Camargue, France) and Fuente de Piedra (Andalucia, Spain) where breeding has occurred every year for 25 and eight years respectively.

We made the hypothesis that the distribution of breeding flamingos among colonies of the western Mediterranean was despotic, following an age-related behavioural dominance where old experienced birds breed at large and long-established colonies (Salin de Giraud, France and Fuente de Piedra, Spain) and younger birds breed at small and recently-established colonies (Rendon *et al*. 2001).

We tested the prediction that flamingos hatched at the major breeding sites of Salin de Giraud and Fuente de Piedra would breed younger at the smaller colonies i.e. Saline di Comacchio, Italy (<1 000 pairs), Salinas de la Trinitat, Spain (<2 000) and Molentargius, Sardinia (<7 000)) than at Salin de Giraud and Fuente de Piedra.

The breeding status of banded flamingos was assessed from a hide. The following categories of birds were considered as breeders (i) flamingos incubating an egg, (ii) flamingos incubating more than 48 hr on a nest, (iii) flamingos with a chick on a nest or (iv) flamingos feeding a chick.

Flamingos hatched at Fuente de Piedra and then breeding at Salinas de la Trinitat were the same age as those breeding at Salins de Giraud (G-test, $G = 3.8$, $df = 2$, $P = 0.14$).

Flamingos hatched at Salin de Giraud and breeding at Salinas de la Trinitat tended to grow older with time ($G = 16.5$, $df = 9$, $P = 0.056$) which could be a consequence of an ageing pool of breeders. Contrary to predictions, these flamingos were no younger than those breeding at Fuente de Piedra (all paired G-tests non significant). At Molentargius, no temporal trend could be detected and French flamingos were no younger than those breeding at Fuente de Piedra (all paired χ^2 tests non significant). Finally, at Saline di Comacchio, French flamingos observed breeding in 2002 were younger than those at Fuente de Piedra ($G = 74.7$, $df = 3$, $P < 0.001$). In 2003, only nine French flamingos were observed breeding at Comacchio, yet the trend was the same as that observed in 2002 ($G = 30.9$, $df = 3$, $P < 0.001$).

Our results suggest that the smallest colonies, such as Saline di Comacchio, could allow early recruitment of Greater Flamingos into the overall breeding population. This implies that small breeding sites could play a critical role in the metapopulation dynamics of the Greater Flamingos and should thus be included in conservation planning.

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