

Anthropogenic and environmental determinants of Greater Flamingo *Phoenicopterus roseus* breeding numbers and productivity in the Camargue (Rhône delta, southern France)

"Predicting how bird populations may respond to climate change is a major challenge which could be addressed by understanding how past environmental processes have driven the variations of breeding population size and productivity. In inhabited regions, this issue may be complicated by the interference associated with heterogeneous levels of habitat management. Here, we have explored how several hydrological variables influenced the breeding of the Greater Flamingo *Phoenicopterus roseus* in the Camargue (Rhône delta, southern France) over a 28-year period (1974–2001). In this region, Flamingos breed in a commercial salt pan. They forage in both salt pans and adjacent brackish lagoons. We hypothesized that breeding numbers, productivity and body condition of chicks at fledging were influenced positively by water levels of the Vaccares, the main lagoon of the delta, in spring (water and food availability) and the Rhône discharge in winter (nutrient availability in the salt pans). We controlled for variations of the flooding date of the breeding salt pan by the salt company and the size of the breeding island. We first found the Vaccares water levels and Rhône discharge to be negatively correlated with the North Atlantic Oscillation (NAO). Secondly, the number of Flamingo breeding pairs with a 10-day advance of the flooding date of the breeding salt pan. Productivity was 0.46 ± 0.41 chicks per pair and could not be explained by any of the variables considered. Finally, chick body condition decreased with the number of breeding pairs and Rhône discharge. Our results show that this intensely managed system remains sensitive to large-scale climate variations, the breeding of the Greater Flamingo is affected by both climate variations and management of the salt pan, and the expected enhancement of delta productivity by high river discharge was absent, probably prevented by dykes and embankments along the river. The response of bird populations to climate variations can thus be complex in intensely managed biological systems as found in the Mediterranean. We encourage pursuing such analyses incorporating anthropogenic variables explicitly in order to expand our capacity to make inference on the future of these systems."

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