Wintering of White Storks in Mediterranean France

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Abstract.—The establishment of regular wintering of the White Stork (*Ciconia ciconia*) in southern France has been documented by regular census data and individual identification of banded birds. The number of wintering storks rose from eight in 1996-1997 to 172 in 2003-2004. Most records (87%) came from the Montpellier region (43°34'N, 3°54'E). The birds mainly originated from western Germany, eastern France and western Switzerland and about half were probably immature. Compared to storks observed on autumn and spring migration, first-winter birds were under-represented. We discuss the factors likely to explain the settlement of this new wintering area: its location on the migration route of the increasing northwest European stork population, the presence of a rubbish dump and adverse effects of wintering in Africa. *Received 7 April 2004, accepted 22 July 2004.*

Key words.—Age dependence, White Stork, *Ciconia ciconia*, evolution, migration, rubbish dump, wintering.

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In the 1970s, after a severe decline in the White Stork (*Ciconia ciconia*) population in northwest Europe, reintroduction programs were undertaken in several countries. Most storks reared in captivity were sedentary but the fledglings reared by these birds migrated normally to the traditional wintering areas in the Sahelian zone, in eastern and southern Africa (Bairlein 1991; Jenni *et al.* 1991; Michard *et al.* 1997; Schaub *et al.* 2004). During the 1970-80s, only a few wild individuals wintered in northern latitudes (Schierer 1991). But since the late 1980s, the number of wild storks wintering in Europe increased dramatically (Barbraud and Barbraud 1991; Tortosa *et al.* 1995; Schulz 1998; Chartier 2001; Kayser *et al.* 2003; Schaub *et al.* 2004). Yet, few data are available to document the age-distribution and geographical origin of these individuals. It has been suggested that most wintering birds would be local breeders (Tortosa *et al.* 1995) and few would be first- and second-winter immature storks (Tortosa *et al.* 1995; Michard *et al.* 1997).

This paper documents the settlement of a White Stork regular wintering ground in the Montpellier region (43°34'N, 3°54'E) in Mediterranean France.

METHODS

Most White Storks wintering in the Mediterranean region of France occur within the Reserve du Méjean, Lattes (Department of Hérault, 43°34'N, 3°54'E). Land cover within or close to the Reserve includes pastures, reed beds, freshwater marshes, coastal lagoons and market gardens. In addition, the Reserve is approximately 2 km east of the large Montpellier rubbish dump that covers an area of around 0.5 km^2.

From 1996 onwards, storks wintering on the Reserve were counted once a month between 09.00 h and 12.00 h. From 1 October to 6 December 2002, re-sightings of individually-marked birds were recorded at different times of the day during 14 additional visits, each lasting from 30 min to 4 h, giving a total observation time of around 20 h.

The number of banded birds wintering in the Reserve in 2002-2003 was estimated using a capture-mark-recapture model for estimating population size (software CAPTURE; White *et al.* 1978). Estimated values are given with standard deviations.

The age and origin distribution of the over-wintering storks were compared to those of the White Storks that crossed the area during spring and autumn between 1990 and 2002 (data provided by the Natural History Museum of Paris). Among the 85 migrating White Storks that were identified during this period near Montpellier (Departments of Hérault and Gard), 60 were found dead or injured (46 were first-winter birds found electrocuted, killed by power-line collision, or drowned). The proportion of first-winter juveniles among the 60 storks found dead or injured was probably higher than the actual proportion present among the migrating birds. To reduce this bias, the age distribution of the wintering storks was compared to that of migrating storks that were either recorded alive (N = 24) or

shot (N = 7). Birds recorded in spring before 1 May were considered to belong to the same age category as birds recorded in autumn of the preceding year. The over-representation of first-winter storks might also give a biased estimation of the origin distribution if the age distribution (and thus the proportion of first-winter storks) varies from one country to another. We assumed this bias to be small since Dutch, western German, Swiss and eastern French breeding pairs had similar fledging successes and survival rates (Bairlein 1991), so we used the whole data set for the comparison of origin distributions: eight birds originated from the Netherlands, 19 from Germany, 23 from Switzerland and 35 from France (mainly eastern France). A second comparison was made with a wintering group in southern Spain whose age distribution is known, to check whether age distribution differed between the two sites (Tortosa *et al.* 1995).

RESULTS

Before the 1990s, only casual cases of wintering White Storks had been reported in southern France (Schierer 1991). The first winter record in the vicinity of the Reserve was of eight storks in 1996-1997; this figure most likely included the local breeding pair. Since then, the winter numbers in the region have increased exponentially to 172 individuals in 2003-2004 (including 150 inside the Reserve, Fig. 1). In 2002-2003, 70-80 individuals were recorded each day from October to January: 67 on 5 October, 74 on 19 October, 83 on 26 November, 78 on 6 December and 75 on 15 January.

Forty banded storks were recorded in 2002-2003 on the Reserve but four birds with German metal bands could not be individually identified. Therefore, country of origin and age are known for 40 and 36 storks respectively (all identified storks were banded as chicks, Figs. 2 and 3). On average, each banded stork was observed on 2.6 ± 1.6 visits (range: 1-9, N = 14 visits).

All individuals identified in October were also recorded in November or December. Furthermore, the test for population closure (software CloseTest, Stanley and Burnham 1999), which tested for the absence of death or emigration/immigration events during the study period, was not significant ($\chi^2_3 = 6.95$, n.s.). This indicates that few birds joined or left the group between October and December. Thus, a model for a closed population, which best described the re-sighting data, was implemented. The selected model was M(t), which indicates that re-sighting probability varied among visits but not among individuals (range: 0.02-0.51; White *et al.* 1978). The estimated number of marked birds was 41.0 ± 1.2 (95% confidence interval: 41-46): most of the banded individuals wintering on the Reserve were identified in 2002-2003.

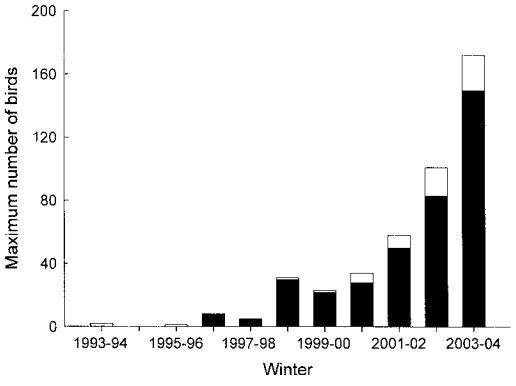

Figure 1. Numbers of White Storks wintering in southern France from 1993 to 2004 (black area, birds wintering at the Lattes Reserve; white area, birds wintering outside the Reserve). Data from Lattes Reserve, Groupe de Recherche et d'Information sur les Vertébrés et l'Environement, Association des Amis des Marais du Vigueirat and Biological Station of the Tour du Valat.

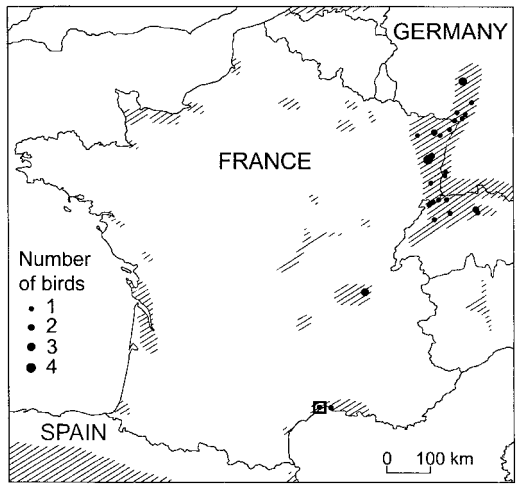

Figure 2. Birthplaces (black dots) of 36 banded White Storks wintering at the Lattes Reserve (indicated by the open square) in 2002-2003. Breeding areas of the northwestern European population shown in gray (from Araújo and Biber 1997; Chartier 2001). Most pairs breeding along the English Channel Atlantic coast migrate along the Atlantic coast (C. Barbraud and A Chartier, unpubl. data) and those breeding in central Europe initially migrate SE by the Bosphorus Straights (Araújo and Biber 1997).

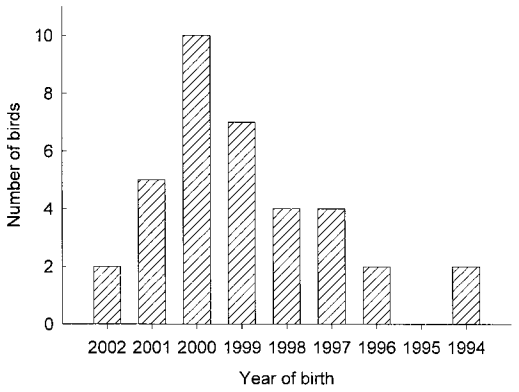

Figure 3. Year of birth for the 36 banded White Storks wintering at the Lattes Reserve in 2002-2003. Chicks born in 2002 were first-winter juveniles at the time.

Nineteen individuals had hatched in France: 14 in Alsace (northeast), three in Dombes (east), one in Camargue (southeast) and one at the study site. Thirteen originated from Germany (at least nine from western Germany) and eight from Switzerland (Fig. 2). The distance from birthplace ranged from 0 to 686 km (N = 36, mean: 580 ± 164 km). No individual known to breed in southern France was recorded in the wintering group during this study; however, most breeders in the Camargue region are recorded in winter at their nests (Kayser *et al.* 2003). Mean age was 3.0 years (N = 36, range: 0-8 years, Fig. 3). Considering that respectively 10%, 50% and 100% of the two-year old, three-year old and older storks probably bred in summer 2002 (Kanyamibwa and Lebreton 1991), 20 of the 36 wintering individuals (56%) were probably still immature.

The wintering storks at Montpellier can be considered as a random sample of the storks migrating through the area when considering the origin of birds (data provided by the Natural History Museum of Paris, χ^2_3 = 5.66, n.s.) but not when considering age distribution (two-sample Kolmogorov-Smirnov test, D = 0.49, P < 0.001): only 6% of the 36 wintering storks were first-winter birds, while they represent 55% of the migrating individuals (data provided by the Natural History Museum of Paris). On the other hand, the proportion of first- and second-winter individuals among the banded birds was not statistically different from that reported by Tortosa *et al.* (1995) for wintering storks in southern Spain (7/36 vs 7/63, Fisher's exact test, n.s.).

DISCUSSION

The dramatic increase in the number of wintering White Storks in Mediterranean France (mainly in the Reserve of Lattes, Fig. 1) probably results from the combination of three factors: (1) the location of the site along a traditional migration route for the increasing northwest European population of the White Stork, (2) the proximity of a rubbish dump, and (3) a strong selective pressure not to migrate to Africa and/or to stay close to their (potential) breeding grounds.

Contrary to other studies referring to the wintering of storks in Europe (Barbraud and Barbraud 1991; Tortosa *et al.* 1995, Chartier 2001; Schaub *et al.* 2004), local breeders represented only a minority of the wintering individuals (5% vs 92% in southern Spain, Tortosa *et al.* 1995). Thirty-one (86%) of the 36 banded White Storks whose birthplace was precisely known originated from a clearly identified and rather small area encompassing eastern France, western Switzerland and western Germany (Fig. 2). In these countries, White Stork numbers have increased substantially during the last 20 years (Schulz 1996); this probably explains why the group of wintering storks established itself so rapidly. With regard to their geographical origin, the wintering storks represent a random sampling of the individuals identified in the area during autumn and spring migrations (data provided by the Natural History Museum of Paris).

Most birds foraged at the Montpellier rubbish dump two km west of the Reserve. Refuse dumps provide an abundant food resource (Blanco 1996; Tortosa *et al.* 1003) and have probably played a major role in shortening the migration of European White Storks. However, the closure of open rubbish dumps on a European scale may soon reduce this trend.

Recent observations in Europe suggest that most first-winter individuals are probably still migrating to Africa (Barbraud *et al.*

1999; Tortosa *et al.* 1995), while an increasing number of adults are wintering in Europe, on or close to their breeding grounds (Barbraud and Barbraud 1991; Tortosa *et al.* 1995; Chartier 2001; Kayser *et al.* 2003; Schaub *et al.* 2004). In western France, the survival of young birds is positively correlated with the rainfall in Western Africa, but adult survival is not (Barbraud *et al.* 1999). Very few first-winter individuals wintered in the Reserve compared to the proportion they represent in migration flocks. The same conclusion was also made for White Storks wintering in southern Spain (Tortosa *et al.* 1995). Wintering close to breeding sites represents a selective advantage because it reduces both the energy expenditure and the risk of mortality during migration. In Switzerland for example, resident storks enjoy a better survival rate than migratory individuals, while there is no difference in survival between resident young and resident adult storks (Schaub *et al.* 2004). Additionally, wintering close to breeding grounds may favor early occupation of the breeding sites.

It might be expected that both selective factors (i.e., not migrating to Africa, staying closer to their breeding grounds) will continue or even increase over the next few decades in western Europe for two reasons. First, climatic conditions prevailing in western Africa could become worse following current climate change (International Panel on Climate Change 2001). Second, density-dependent regulation has already been observed among French and Swiss breeding storks (Barbraud *et al.* 1999; Schaub *et al.* 2004); individuals will have to compete more for access to good territories and as long as the population continues to increase, early-arriving birds may be at an advantage. Thus, the number of wintering White Storks in southern France will probably continue to increase. This is also likely to be the case elsewhere in Europe.

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