Brood Size of the White Stork in Greece

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Abstract.—The brood size of the White Stork (*Ciconia ciconia*) was investigated at 30 localities within the breeding range of the species in Greece in 1993, 1994 and 1995. These localities were grouped in four major habitat types: river, lake, delta and dry habitat (lacking water bodies nearby). Brood size groups of 1, 2, and 5 nestlings (less common) and 3-4 nestlings (common) for all years and major habitats were compared. No significant spatial or temporal differences in the brood sizes were found. The mean brood size of the White Stork in Greece was among the highest in Europe attributable to favorable feeding conditions associated with cultivations. *Received 30 July 2005, accepted 15 August 2006.*

Key words.—White Stork, *Ciconia ciconia*, brood size, habitat, Greece.

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White Stork (*Ciconia ciconia*) is a bird of great conservation interest. Its populations have declined considerably throughout Europe (Tucker and Heath 1994). Suggested reasons include changes in the ecological conditions in the wintering grounds in Africa but also including intensification and transformation of land use resulting in loss of suitable breeding and foraging habitats in Europe (Dallinga and Schoenmakers 1987; Goriup and Schulz 1990). Numerous monitoring programs have been established in most European and other countries and report average number of nestlings per nest (i.e., average brood size, see in Rheinwald *et al.* 1989; Biber *et al.* 1995). Breeding productivity of White Stork is greatly affected by prey and foraging habitat types (Pinowska and Pinowski 1989; Thomsen and Struwe 1994) but also by a variety of factors such as weather conditions (Thomsen and Struwe 1994; Bert and Lorenzi 1999), breeding density, competition for nest sites (Profus 1986) or interactions between nesting birds (Barbraud *et al.* 1999), and the age of the parents (Sasvari *et al.* 1999).

Greece hosted a good population of White Storks (2387 pairs in 1993, Tsachalidis and Papageorgiou 1996) but this population seems to have decreased (c. 2000 pairs in 2004, Tsachalidis in press; Tsachalidis unpubl.). Information on the breeding biology of the White Stork is scarce in Greece (Jerrentrup 1989; Goutner and Tsachalidis 1995; Tsachalidis and Goutner 2002; 2003).

The purposes of this study were to provide information on the brood size of the White Stork in Greece and to investigate spatial and temporal fluctuations in storks brood size in relation to breeding habitats.

METHODS

White Stork nests were visited as part of a project aiming in the study of biology of the species in Greece from 1993 to 1995. Field visits took place from mid-June to the beginning of July when most nestlings were fledged. The areas visited are shown in Table 1. A map and coordinates of the localities have been published elsewhere (Tsachalidis and Goutner 2002). The number of nestlings present in each nest was recorded within the framework of other research carried out, reaching the nest sites by a "cherry-picker" (Goutner and Tsachalidis 1995). All nests were visited in the localities studied, thus brood size data were representative in each area.

Four major habitat types were distinguished: rivers, lakes, deltas and dry habitats (lacking water bodies nearby). There was no indication that the pairs investigated were the same due to lack of data on individually marked birds, thus the brood size data were treated as independent. Broods were compiled in two groups, the first containing broods of 1, 2, and 5 nestlings (being less common) and another with broods of 3-4 nestlings (being commonest). Comparisons of brood-size data for areas commonly visited in all three years, was impossible through contingency tables due to small sample sizes. Thus, temporal data compared were

Table 1. Brood sizes of the White Stork in Greece from 1993 to 1995. JZm: average brood size.

			1993						1994						1995					
Major habitat types	Areas	Villages	1	2	3	4	5	JZm	1	2	3	4	5	JZm	1	2	3	4	5	JZm
Rivers																				
	Evros	Poros	—	—	—	—	—	—	—	—	—	—	—	—	0	1	2	7	3	3.92
	Strymon	Kumaria	—	—	—	—	—	—	—	—	—	—	—	—	0	2	1	1	1	3.20
		Mitrusi	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1	0	0	—
	Axios	Kimina	0	1	3	3	0	3.38	1	0	3	3	0	3.25	0	0	2	3	3	4.12
		Anatoliko	0	1	2	0	0	3.38	1	0	0	0	1	3.25	0	0	2	1	1	3.75
	Pinios	Omolio	—	—	—	—	—	—	0	1	1	4	0	3.50	0	1	1	2	1	3.60
		Girtoni	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	2	1	4.33
Lakes																				
	Kerkini	Kerkini	1	4	8	0	0	2.54	1	2	3	2	1	3.00	1	0	2	4	4	4.00
		Limnochori	0	1	1	0	4	4.17	0	0	0	2	1	4.33	0	0	1	6	3	4.20
	Koronia	Ag. Vassilios	0	0	1	0	2	4.33	0	1	2	1	2	3.67	0	0	0	1	3	4.75
		Nymphopetra	0	1	0	2	0	3.00	—	—	—	—	—	—	—	—	—	—	—	—
		Kavalari	0	1	1	3	0	3.40	0	2	1	1	2	3.50	0	0	0	3	3	4.50
	Artzan	Vafiohori	—	—	—	—	—	—	0	2	9	5	1	3.27	0	1	3	9	0	3.62
Deltas																				
	Nestos	Eratino	1	4	4	0	0	2.33	0	1	2	5	0	2.50						
		Pondolivado	0	1	3	0	0	2.75	0	0	2	1	0	3.33	0	2	8	3	1	3.21
		Ziloti	0	0	3	0	0	3.00	—	—	—	—	—	—	0	2	0	2	0	3.00
		Dekarcho	0	0	3	1	0	3.25	—	—	—	—	—	—	—	—	—	—	—	—
		Mangana	0	1	2	2	0	3.20	—	—	—	—	—	—	0	2	6	1	1	3.10
	Sperchios	M. Vrisi	—	—	—	—	—	—	0	0	2	1	0	3.33	0	0	2	0	0	3.00
		Anthili	—	—	—	—	—	—	0	0	3	5	0	3.62	2	1	2	3	1	3.00
	Amvrakikos	Aneza	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	5	0	—
		Philipiada	—	—	—	—	—	—	—	—	—	—	—	—	0	2	4	4	1	3.36
Dry habitats																				
	Drama	Megalokambos	1	2	6	0	0	2.56	0	1	2	3	1	3.57	0	0	1	5	1	4.00
		Nikotsara	0	0	2	0	0	3.00	—	—	—	—	—	—	—	—	—	—	—	—
		Nikiforos	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	1	0	—
		Mavrovatos	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	2	5.00
	Epirus	Xirolofos	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	3	2	4.40
		Krystallopigi	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	1	1	4.50
		Karvouniari	—	—	—	—	—	—	—	—	—	—	—	—	0	1	1	1	0	3.00
		Psathotopi	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	1	0	—

these of the year with the lowest average brood size and the compiled data of the rest two years—found to be similar. Two-tailed Fisher Exact Tests were used throughout. The above mentioned two brood-size groups were compared among all four major habitats and three years using a three dimensional contingency table (Zar 1984). In this analysis the table rows were brood sizes, columns were habitats and "tiers" were years. The brood size compilation allowed coping with expected values <5.

RESULTS

Brood sizes varied from one to five in all areas studied (Table 1). Average brood sizes varied from 3.2 to 4.3 in river habitats (n = 64 broods), from 2.5 to 4.8 in lakes (n = 115), from 2.3 to 3.6 in deltas (n = 102) and from 2.6 to 5.0 in dry habitats (n = 39). Brood sizes of three and four nestlings were commoner in all major habitat types whereas other brood sizes were less common graded as 5 > 2 > 1 (except brood sizes of five in delta areas) (Fig. 1).

Comparisons between broods of 1, 2, and 5 versus 3-4 nestlings in areas visited more than one year during the study, indicated that changes of brood size patterns were not significantly different through years (Fisher Exact Tests). Also, the overall comparison among brood sizes compiled as specified above for all habitats and years did not reveal a significant spatio-temporal difference (χ^2_{57} = 13.190, n.s., three dimensional contingency table).

DISCUSSION

The distribution of White Stork brood sizes in Greece indicated spatial and temporal uniformity. In a study along the river Elbe (Germany), the mean brood size was relatively stable only increasing in years of periodic flooding, attributed to an enhancement of food resources (Dziewiaty 1999). In the Marismas region of Guadalquivir, Spain, rainfall greatly affected breeding success of the White Stork leading to differences between 1979-1982 (Rubio Garcia *et al.* 1983); and in Charente-Maritime, France, breeding success reduced from 1978 to 1996 coincident with increasing density of the breeding population (Barbraud *et al.* 1999). Of the variety of factors that could affect brood size of the White Stork, abundance and type of prey are of prime importance depending on the diversity and availability of foraging habitat types (Alonso *et al.* 1991; Thomsen and Struwe 1994; Ożgo and Bogucki 1999). Prey capture and diet composition of the White Stork are affected by habitat type and characteristics such as vegetation height and farming practices (Pinowski *et al.* 1991). In Greece stork diet in all major habitats mostly consisted of insects (mainly coleopterans and orthopterans) (Tsachalidis and Goutner 2002). Orthopterans and coleopterans seem to be prey favored by the storks especially in the Balkans and around the Mediterranean (Tsachalidis and Goutner 2002) probably due to their abundance during the breeding period. Uniform diet and prey availability among sites may have contributed to similarities in brood sizes.

Although the diet of White Stork in European countries contains considerable proportions of vertebrates (Pinowska and Pinowski 1989; Mužinić and Rasajski 1992; Thomsen and Struwe 1994), the average brood size in Greece is higher being mostly similar to those in the eastern part of the region (Table 2). The drop in White Stork breeding population in Greece has been attributed to a large scale destruction of feeding habitats (Heckenroth 1999) but a recent population drop in the northern part of this region has not affected brood size (Tsachalidis in press). The factors affecting brood size of the White Stork in Greece need further investigation.

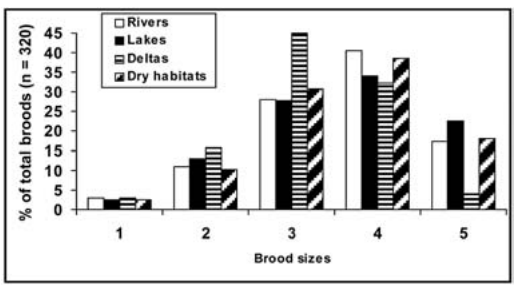

Figure. 1. Percentages of brood sizes of the White Stork in the major breeding habitat types in Greece from 1993 to 1995.

Table 2. Average brood size of the White Stork in areas of the western Palearctic. n.d.: no data. JZm: average brood size.

Country	Year	JZm	Range of JZm	Area	Reference
NW Germany	1974	2.58	1.40-3.33	NW Germany	Meybohm & Dahms 1975
Germany	1976-1980	2.80	2.60-3.00	Kalbe/Milde	Kaatz & Stachowiak 1987
NW Germany		2.41	n.d.	Oldenburg	Bairlein 1991
SW Germany	1976-1988	2.54	n.d.	Baden/Wurttenberg	Bairlein 1991
E. Germany	1994	2.70	2.40-3.20	Niederlausitz	Köhler 1999
	1995	2.20	1.80-2.70	Niederlausitz	Köhler 1999
Germany	1991,95, 96	2.40	1.80-2.80	All country	Kaatz 1999
Netherlands	1966-1980	2.47	n.d.	All country	Bairlein 1991
Netherlands	1995	1.83	n.d.	All country	Van der Have *et al.* 1999
France	1975-1988	2.65	n.d.	Alsace	Bairlein 1991
SW France	1978-1996	3.20	2.10-4.00	Brouage	Barbraud *et al.* 1999
Poland	1973-1978	2.59	n.d.	Silesia	Bairlein 1991
Estonia	1954-1961	2.92	n.d.	All country	Bairlein 1991
SE Austria	1966-1984	2.62	n.d.	Steiermark	Bairlein 1991
France	1995	2.60	2.20-2.90	All country	Duquet 1999
Denmark	1952-1996	2.72	2.18-3.83	All country	Skov 1999
Poland	1995	2.55	n.d.	All country	Guziak & Jakubiec 1999
Czech Republic	1994	3.00	n.d.	All country	Rejman 1999
	1995	2.70	n.d.	All country	Rejman 1999
Slovakia	1984	2.45	n.d.	All country	Fulin 1999
	1994	2.62	n.d.	All country	Fulin 1999
	1995	2.80	n.d.	All country	Fulin 1999
Hungary	1994	3.11	n.d.	All country	Lovászi 1999
Rumania	1994	1.74	n.d.	All country	Weber 1999
	1995	1.31	n.d.	All country	Weber 1999
Croatia	1987	3.36	2.69-3.95	Parts	Schneider 1988
Croatia	1994-95	2.63	2.15-3.92	All country	Muini 199
Bulgaria	1979-1984	2.40	1.50-2.60	All country	Michev *et al.* 1989
Bulgaria	1994-95	2.80	2.30-3.70	All country	Petrov *et al.* 1999
Lithuania	1994-95	2.50	n.d.	All country	Malinauskas & Zurba 1999
Ukraine	1994	2.71	2.00-3.41	All country	Grishchenko 1999
	1995	2.94	1.67-3.50	All country	Grishchenko 1999
Russia	1994	n.d.	2.50-2.71	Parts	Delyuk *et al.* 1999
Spain	1984	2.12	1.66-3.00	All country	Lazaro *et al.* 1986
Spain	1975-1981	2.29	1.95-2.64	All country	Chozas, 1986
SW Spain	1979-1982	2.46	1.69-3.10	Marismas	Rubio Garcia *et al.* 1983
Greece	1977-1985	n.d.	2.17-2.85	Kavala-Xanthi	Jerrentrup 1989
Greece	1993*	2.87	2.30-5.00	All country	Tsachalidis & Papageorgiou 1996
Greece	1993	3.00	2.33-4.33	Parts	This study
Greece	1994	3.41	2.50-4.33	All country	This study
Greece	1995	3.72	3.00-5.00	All country	This study
Portugal	1984	2.63	2.25-3.50	All country	Rosa *et al.* 1999
Portugal	1994	2.53	1.96-3.37	All country	Rosa *et al.* 1999
Morocco	1995	2.28	1.48-2.53	All country	El Agbani & Dakki 1999

*Questionnaire-based survey.

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