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Reproductive success of Whiskered Tern *Chlidonias hybrida* in eastern Spain in relation to water level variation

Alvaro Ortiz, Vicente Urios

A study on the Whiskered Tern *Chlidonias hybrida* was developed between 2002 and 2009 in wetlands of eastern Spain to evaluate how water level fluctuation affects its reproductive success. This species is catalogued as Endangered in Spain and has an unfavorable conservation status in Europe. Our study, which included 716 nest in total, showed a hatching success of 54.6% (829 chicks from 1,518 eggs). Fledgling success was 25.7% (213 fledged out of 829 chicks hatched), with a breeding success of 14.0% (213 fledged from 1,518 eggs). Strong variations in water level destroyed several nests, which affected the breeding success. The total mean percentages of nest, eggs and chicks that were lost after major water level fluctuations were 61.0%, 54.6% and 46.6% respectively. Therefore, it is crucial to keep the wetlands water levels as stable as possible during the ~~breading~~ season, which should not vary more than 5 cm once the nests are established. Unfavorable climatic events, such as strong rain or hail, also caused the lost of nests, eggs and chicks, even when wetland water levels remained constant.

Reproductive success of Whiskered Tern *Chlidonias hybrida* in eastern Spain in relation to water level variation

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Reproductive success on Whiskered Tern

ABSTRACT

A study on the Whiskered Tern *Chlidonias hybrida* was developed between 2002 and 2009 in wetlands of eastern Spain to evaluate how water level fluctuation affects its reproductive success. This species is catalogued as Endangered in Spain and has an unfavorable conservation status in Europe. Our study, which included 716 nest in total, showed a hatching success of 54.6% (829 chicks from 1,518 eggs). Fledgling success was 25.7% (213 fledged out of 829 chicks hatched), with a breeding success of 14.0% (213 fledged from 1,518 eggs). Strong variations in water level destroyed several nests, which affected the breeding success. The total mean percentages of nest, eggs and chicks that were lost after major water level fluctuations were 61.0%, 54.6% and 46.6% respectively. Therefore, it is crucial to keep the wetlands water levels as stable as possible during the breading season, which should not vary more than 5 cm once the nests are established. Unfavorable climatic events, such as strong rain or hail, also caused the lost of nests, eggs and chicks, even when wetland water levels remained constant.

Keywords: migratory species, phenology, reproductive success, water variability, wetland.

Introduction

The population of Whiskered Tern *Chlidonias hybrida* (Pallas 1811), a migratory species of the family Sternidae, have declined in the Iberian Peninsula and Europe between 1970–1990 (Urios *et al.* 1991). Last decade the population was estimated to include between 35,000 and 52,000 pairs in the Western Palearctic (BirdLife 2004). Breeding populations are established in wetlands with abundance of food and specific vegetation (table 2) for nests support (Dostine and Morton 1989; Tucker and Heath 1994; Latraube 2006; Paillisson *et al.* 2006; Ortiz, not publ), and shows synchrony on the date of laying and incubation (Paillisson *et al.* 2007). Disturbance during the breeding season, either by climatic events or anthropogenic processes force the populations to move to more suitable areas for nesting, ~~as it also occurs~~ in other species of the same family (Nisbet *et al.* 1995; Stienen & Brenninkmeijer 2002; Paillisson *et al.* 2006).

The future of the species in the Iberian Peninsula appears to be uncertain due to habitat destruction (Callaghan & Villaplana 1990). In the natural wetland of Albufera of Valencia (SE Spain) nesting couples declined from 2000 to quit nesting in just one decade (1970-1980) and still do not today.

The main aim of our study was to study the phenology and reproductive success of the Whiskered Tern in relation to water~~s~~ level variability. We predicted that a strong variation of water level in a short period of time could negatively affect breeding success. This will bring new knowledge to enhance the management and conservation of the species in the wetlands where the species nests, that could serve as a model for management in other areas.

Methods

A continuous study of the breeding colonies of the Whiskered Tern in the Pego-Oliva Natural Park (Valencia Community, Spain) was ~~developed~~ between 2002 and 2009. Additional observations were made at four further wetlands in Valencia Community: Hondo de Elche-Crevillente N.P. (Alicante), Xeresa marsh (Valencia), Moro marsh (Castellón) and Almenara marsh (Castellón). Valencia Community government gave me the permissión to come in the wetlands. It was evaluated how the species behaves after water level variation, whether produced by sudden climatic changes, such as continuous rain or hail, or anthropogenic causes such as draining of the marshes to irrigate crops or channelling works near the breeding area, in relation with its ~~breading~~ success.

To take census of pairs, nests, eggs and chicks, researchers directly accessed the breeding colonies, on foot or by inflatable boat. In some cases, we could observed colonies from a distance with binoculars where vegetation was not an obstacle. To catch fledglings and adults a mist net was used at dawn. Colonies were visited once a week from April to June, more frequently in June and July (every 3-7 days), and every 7-10 days in August.

The following direct observations were made: date of arrival of pairs to the colony, the number of pairs, the number of nest, the number of eggs, the date of hatching eggs, the number of empty nests, the number of chicks, the number of chicks that were able to fly, the date of the first fledglings, and the date when the adults with fledglings left the colony. With these parameters we determined the number of chick /eggs in the nests, % hatching success of eggs, the % survival of fledglings and the productivity. Mean values are given ± SD. Nest monitoring was carried out using labelled wooden stakes, on which the number of the nest was marked.

Water level fluctuations were also recorded in the cited wetlands to study its influence on the colony and its correlation with the reproductive success. Wooden stakes calibrated in centimeters were used to observe the water level variations. In Pego-Oliva N.P. it was tried to control water level fluctuations and maintain it as stable as possible, using gates for channels that supply the entire marsh.

Results

Reproductive success (Table 1)

Our study in the Pego-Oliva N.P. during the 8 years show that the average percentage of nests (N=334) with 1 egg was 11.75 ± 10.4, with 2 eggs 47.05 ± 32.9, with 3 eggs 40.73 ± 32.3 and with 4 eggs 0.48 ± 0.9, the latter being rare. The mean annual average of clutch size was 2.31 ± 0.34 eggs/nest. Hatching success was 64.6% (540 chicks / 836 eggs). The number of young that fledged from eggs that hatched was 22.6% of chicks become fledglings (122 fledglings / 540 chicks). Total productivity over the eight years was 14.6% (122 fledgling / 836 eggs) from 414

nests.

In all wetlands studied, a total of 716 nests, 1,518 eggs, 829 chicks and 213 fledglings were counted. Total hatching success was 54.6%, fledglings success 25.7% and productivity 14.0%.

Water level fluctuations (Table 2)

The water level in the studied wetlands varied between 20 and 200 cm, which had a strong influence on the terns' reproduction. The depth average in our main area of study, the Pego-Oliva N.P., was 51.8 cm ± 18.8 cm. However, in the Almenara marsh, some nests were built in areas with a water depth of 200 cm, being anchored on the algae *Cladophora sp*., the latter attached to *Myriophyllum verticillatum*.

Two main factors affected to the water level in the studied wetlands. Firstly, at least six climatic events, including rain and/or hail, caused water level to rise. In some occasions, the rain with hail at the beginning of the summer destroyed most nests (table 2, colony 8). The increase of the water level usually causes the destruction of the nests and the abandonment by the parents when they do not rebuild them. Moreover, intense rain or hail can cause damage to the colony, even when the water level does not vary considerably (Table 2, colony 8 and 16).

Secondly, ~~human activities affected considerably to the colonies~~. The watering of crops, such as rice fields in Pego-Oliva P.N., reduces the water level in the wetland, and several nests were destroyed when this process occurred in a short period of time, which can result in the complete desiccation of the wetland, causing the abandonment of the whole colony (Table 2, colony 15). Channelling works using heavy machinery also caused the decrease of the water level in some areas which can affect the nests that are anchored on the vegetation (Table 2, colony 12). Furthermore, on some occasions, colonies were damaged by streams of water, although the water level remained more or less constant (Table 2, colony 6); this event was caused by the transfer of masses of water within the wetlands by human activities.

All these events can cause the lost of high percentages of nests, eggs and chicks, forcing the

parents to produce second clutches (Ortiz 2005) or abandon the colony, moving to a different breeding area, like Albufera of Valencia, or another wetland.

The percentage of nests, eggs and chicks lost in cases where populations did not suffer major environmental problems was 6.1%, 52.4%, and 49.2% respectively (Table 2, colony 2). However, when strong rain or hail occurred, followed by a rise of the water level in the wetland, the losses were 96.3% of nest, 86% eggs, and 85.7% of chicks (Table 2, colony 8). The average ~~of the averages~~ losses in cases where there were severe fluctuations in water levels were of 61.0% of nest, 54.6% of eggs and 46.6% of chicks.

Discussion

The mean annual average of cluth size in our study in the Pego-Oliva N.P. was 2.31 ± 0.34, n=334, being very similar to other studies in France (2.71 ± 0.49, n = 211, in 2004, 2.05 ± 0.78, n = 406, in 2005, Paillisson *et al.* 2006; and 2.35 ± 0.05, n = 207, in 2006, Paillisson *et al.* 2008). Other studies in Portugal showed averages of 2.91 (n =45) in 1993 and 2.95 (n = 39) in 1994 (Catry *et al.* 1997).

In Pego-Oliva N.P. the hatching success (64.6%) was similar to that found in other countries, such as in the Northern Territory of Australia (66% in the 1970s; Cramp 1977). However, considering all colonies studied in this work in the Valencia Community, hatching success decreased to 54.6%. In the colonies excluding the Pego-Oliva N.P. , hatching success was 42,4%, which was also influenced by climatic events and human activity (Table 2). Hatching success was strongly influenced by fluctuating external conditions (climatic and anthropogenic) in each wetland and year, varying from > 80% in years with favourable conditions to 14% in years with unfavourable conditions (Table 1).

Water level variation strongly influenced the terns' breeding success, resulting in the abandonment of the laying when variation is too pronounced (Table 2), as was reported by Catry et al. (1997) and Paillisson et al. (2006). We also observed that unfavourable climatic events, such as intense rain or hail, or streams of water caused by human activities, also had the capacity

to disrupt incubation (Table 2), as was also reported by Tomialojć (1994). During the nesting period, it is essential that the water level remains stable, without major fluctuations (less than ± 5 cm) once nests are established on the vegetation, since this could otherwise result in the destruction of nests and therefore the loss of eggs and chicks (Table 2).

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251 **Table 1.** Breeding parameters of Whiskered Tern *Chlidonias hybrida* in the studied wetlands of
252 Valencia Community, 2002-2009.

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Wetland	Year	Initial Adults no.	Pairs no.	Total Nests no.	Eggs no.	Chicks no.	Fledglings no.	Eggs / Nest no.	Hatching success (%)	Fledglings / Chicks (%)
Pego-Oliva	2002	240	112	111	191	127	18	2.1	66.5	14.2
	2003	180	67	64	151	110	32	2.6	72.8	29.1
	2004	220	102	100	260	210	35	2.7	80.8	16.7
	2005	96	43	43	65	26	6	2.1	40	23.1
	2006	120	30	27	50	7	1	1.9	14	14.3
	2007	212	38	38	34	13	6	2.3	38.2	46.2
	2008	50	10	1	2	2	2	2	100	100
	2009	160	64	30*	83	45	22	2.8	54.2	48.9
Subtotal		**1278**	**466**	**414**	**836**	**540**	**122**	–	–	–
Mean		**160**	**58**	**52**	**105**	**68**	**15**	**2.3**	**58.3**	**36.5**
Moro	2004	154	67	55	134	61	23	2.4	66.2	58.8
	2005	66	30	30	61	13	9	2	21.3	69.2
	2009	70	32	32*	47	28	16	2.4	59.6	57.1
Hondo	2004	130	55	50	154	35	8	2	22.7	22.9
Xeresa	2005	240	120	114	257	130	24	2.3	50.6	18.5
Almenara	2008	46	23	21*	29	22	11	2.4	75.9	50
Subtotal		**706**	**327**	**302**	**682**	**289**	**91**	–	–	–
Mean		**118**	**55**	**50**	**114**	**48**	**15**	**2.3**	**49.4**	**46.1**
TOTAL		**1984**	**793**	**716**	**1518**	**829**	**213**			
TOTAL MEAN		**142**	**57**	**51**	**108**	**59**	**15**	**2.3**	**53.9**	**41.3**

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255 *** Sampled, not total.**

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261 **Table 2.** Water level variations that affected the reproductives success of Whiskered Tern

262 *Chlidonias hybrida* in the Valencia Community 2002-2009.

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Colony no.	Year	Disturb Date	Wetland	Nests support *	Average water depth	Events and water level variations	Effect on the reproductive success in the colonies
1	2002	12 to 17 July	Pego	*Ph, Th, Sc, Ch*	31	Watering crops. Water level decreases from 31 to 20 cm	Loss of 71% of nests (66/93), 43.6 % of eggs (17/39) and 7.7% of chicks (2/26)
2	2003	23 June to 31 July	Pego	*Mv, Ph*	75	No negative effect seen. Water level slightly decreases from 77 to 72 cm	Loss of 6.3% of nests (4/64), 52.4% of eggs (77/147) and 49.2% of chicks (31/63)
3	2004	14 to 21 June	Pego	*Ph*, *Th, Sc*	27	Rain. Water level rises from 22 to 34 cm	Loss of 35.6% of nests (27/76), 42% of eggs (34/81) and 86.2% of chicks (75/87)
4	2004	5 to 16 July	Pego	*Mv, Ph*	63	Watering crops. Water level decreases from 65 to 52 cm	Loss of 30% of nests (3/10), 53.8% of eggs (7/13) and 66.7% of chicks (4/6)
5	2004	23 July to 11 August	Pego	*Mv, Ph*	50	Watering crops. Water level decreases from 52 to 45 cm	Loss of 37.5% of nests (3/8), 42.9% of eggs (6/14) and 35.7% of chicks (5/14)
6	2005	25 June to 6 July	Pego	Ph, Th, Sc	41	Stream of water. Water level remains constant	Loss of 86.7% of nests (13/15), 100% of eggs (18/18) and 66.7% of chicks (4/6)
7	2005	25 June to 6 July	Pego	*Mv, Cl*	75	Rain. Water level raises from 69 to 75 cm	Loss of 100% of nests (25/25), 100% of eggs (4/4) and 78.9% of chicks (15/19)
8	2006	May-June	Pego	*Ph, Th, Sc*	75	Strong rain and hail. Water level raises from 65 to 75 cm	Loss of 96,3% of nests (26/27), 86% of eggs (43/50) and 85.7% of chicks (6/7)
9	2007	22 to 28 June	Pego	*Ph*	55	Rain. Water level raises from 50 to 60 cm	Loss of 50% of nests (19/38), 20.6% of eggs (7/34) and 14.3% of chicks (1/7)
10	2008	May-June	Pego	*Ph, Th, Sc*	50	Continuous rain. Water level raises from 40 to 60 cm	Loss of 90% of nests (9/10), 90% of eggs (18/20) and 0% of chicks (0/2)
11	2009	23 June	Pego	*Ph*	22	Rain. Water	Loss of 93.3% of nests

		to 13 July				level raises from 50 to 60 cm	(28/30), 0% of eggs (0/0) and 51% of chicks (23/45)
12	2004	18 June to 10 July	Hondo	*Ph, Tg*	46	Channelling works in the natural park. Water level decreases from 65 to 35 cm	Loss of 74.2% of nests (49/66), 94.6% of eggs (124/131) and 87.5% of chicks (14/16)
13	2004	9 to 20 July	Moro	*Ph, Cl*	35	Stream of water after watering crops. Water level decreases from 40 to 30 cm	Loss of 54.5% of nests (24/44), 86.3% of eggs (69/80) and 30.4% of chicks (7/23)
14	2004	6 to 23 July	Moro	*Ph, Cl*	28	Stream of water after watering crops. Water level decreases from 35 to 26 cm	Loss of 40% of nests (2/5), 18.2% of eggs (2/11) and 0% of chicks (0/9)
15	2005	15 June to 6 July	Xeresa	*Ph*	18	Desiccation after watering crops. Water level decreases from 20 to 5 cm	Loss of 89.5% of nests (102/114), 92.6% of eggs (75/81) and 81.4 % of chicks (96/118)
16	2005	6 to 20 July	Moro	*Ph, Cl*	47	Heavy rain destroying nests. Water level remains constant	Loss of 83.3% of nests (25/30), 78.9% of eggs (45/57) and 25% of chicks (3/12)
17	2008	24 June to 17 July	Almenara	*Ph*, *Th, Cl*	27	No negative effect seen. Water level slightly decreases from 30 to 25 cm	Loss of 33.3% of nests (4/12), 7,4 % of eggs (2/27) and 30% of chicks (6/20)
18	2009	19 June to 20 July	Moro	*Th, Ph, Cl*	31	No negative effect seen. Water level slightly decreases from 35 to 30 cm	Loss of 20% of nests (4/20), 40.4% of eggs (19/47) and 42.9% of chicks (12/28)

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265 * Support (specific vegetation):

266 reed *Phragmites australis: Ph.*

267 cattail *Thypha dominguensis & T. latifolia*: Th.

268 rushes *Scirpus tabernaemontani & S. maritimus*: Sc.

269 tarays *Tamarix gallica*): Tg.

belfry of water *Myriophyllum verticillatum*: Mv.
algae *Cladophora sp: Cl.; & Chara sp*. Ch.