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The provision of supplementary fresh water improves the breeding success of the globally threatened Northern Bald Ibis *Geronticus eremita*

KEN W. SMITH,[1] ALI AGHNAJ,[2,3] MOHAMMED EL BEKKAY,[2] WIDADE OUBROU,[2] MOHAMMED RIBI,[2] MARIA JIMENEZ ARMESTO[4] & CHRISTOPHER G. R. BOWDEN[1]*

[1] *Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire, SG19 2DL, UK*

[2] *Souss-Massa National Park, Eaux et Forêts, BP107, Inezgane, Morocco*

[3] *App. 2, Im. Boularrabe, Q. Masrour I, rue de Rabat, Temara, Morocco*

[4] *Sociedad Española de Ornitologia, Melquides Biencinto 34, ES-28053 Madrid, Spain*

The Northern Bald Ibis *Geronticus eremita* is a globally threatened species with its main remaining world population breeding in an area of sea cliffs and coastal semi-desert steppe near Agadir in southern Morocco. Between 1998 and 2002, we showed experimentally that the small-scale provision of fresh water near the breeding colonies led to an increase in the productivity of the birds. The increase was greatest in years with low natural rainfall but was positive in all years tested. The supplementary fresh water appears to help buffer productivity against the impacts of low rainfall and its provision is now part of the ongoing conservation measures for this species.

Keywords: Agadir, clutch size, fledged young, Morocco, rainfall.

The Northern Bald Ibis *Geronticus eremita* is a globally threatened species (BirdLife International 2000) feeding in semi-desert and dry steppe areas and nesting on cliffs and, in the past, buildings. It has been in serious decline throughout most of recorded history, having been lost from the Alps, most of the Middle East and North Africa (Hirsch 1979, Pegoraro 1996, Pegoraro & Foger 1999). The last known breeding colony in the Middle East was, until recently, thought to be at Birecik in southeast Turkey where feral birds are still maintained, although the wild migrating birds became extinct there in 1989 (Akcakaya 1990, Arihan 1998, 1999, Nurettin 2007). The wild population in the Middle East, of which the Turkish birds were part, was thought to be extinct until, in 2002, a small number of birds were found to be breeding in Syria at a traditional site (Serra *et al*. 2004, Serra & Peske 2007). However, the bulk of the world's wild Northern Bald Ibis population now occupies a small coastal strip in southern Morocco in the region of Agadir. A total population of over 300 birds breeds on sea cliffs and forages on coastal steppe areas, mainly within the Parc National de Souss Massa (PNSM; Bowden 1998, Bowden & Aghnaj 1999, Bowden *et al*. 2003, El Bekkay *et al*. 2007, El Bekkay & Oubrou 2007, Bowden *et al*. in press).

In the 1970s, Northern Bald Ibises bred at a number of colonies in Morocco both on the coast and in the mountains and lowlands inland. At the time, Robin (1973) showed that the breeding success fluctuated markedly from one year to the next, particularly at inland sites in the plains. At inland colonies, it appears that in dry years the conditions could be so poor that birds either missed breeding altogether or had low success. The effect was less marked for colonies on the coast and in the Atlas Mountains, but Robin (1973) did not determine the mechanism driving the productivity variation. A direct impact of limited fresh water on the settling patterns and breeding decisions of the Ibis was possible, as well as low rainfall leading to poor vegetation cover and hence low prey availability. Although there are large annual fluctuations in the numbers of young fledged per nesting pair for the Agadir birds (Bowden *et al*. 2003), these are not so marked as those reported by Robin (1973) and, taken over the whole Agadir region, do not appear to be strongly correlated with immediate annual rainfall patterns.

*Corresponding author.
Email: chris.bowden@rspb.org.uk

Coastal fogs are a regular feature of the Agadir region and it has been suggested that they may to some extent buffer the breeding Ibis against the adverse effects of dry years (Bowden *et al.* 2003).

The main breeding colonies in the PNSM are at least 17 km from any sources of open fresh water and it is not clear how the birds meet their water needs during the breeding season. The observation that Northern Bald Ibises sometimes congregate around wells and stock watering areas in the villages in the PNSM suggested that they may experience water shortages. In 1998 it was therefore decided to conduct an experimental trial of the impact on breeding performance of providing a supplementary source of fresh water near the breeding colonies. Bowden *et al.* (2003) reported some initial results of this trial. In this paper, we describe the results of the full trial and the subsequent impact on the Northern Bald Ibis population of providing 'water points' at all breeding colonies within PNSM.

METHODS

Northern Bald Ibis bred at four distinct sea cliff colonies within PNSM during the course of the study (Fig. 1). In 1998, 2000, 2001 and 2002, supplementary fresh water was provided at one or two of the colonies with the treatments being switched after years 1 and 3 (Table 1). We endeavoured to ensure that in each year a reasonable number of pairs had access to water and a reasonable number did not, but we had no direct control over how many pairs occupied each colony in each year. In 1999, two water points were established and virtually all birds had access to supplementary water.

Water was provided on an extremely small scale. Within a few hundred metres of the focal colony a small (0.5–1.0 m diameter) shallow cement bowl was constructed *in situ* (Fig. 2a). The cross-section of the bowl was designed to allow access to the Ibis with their long beaks whilst largely preventing gulls (mainly Yellow-legged Gull *Larus cachinnans*) from reaching the water, or at least not being able to empty the bowl. This both reduced direct competition between the two species and the potential for disease transmission between them. Each water point was located someway down the steep sandy slope adjacent to the breeding cliff so that it was inaccessible to domestic stock (mainly Goats *Capra hircus* and Sheep *Ovis aries* but occasionally Camels *Camelus dromedarius*) which would have quickly consumed any available fresh water in more accessible sites. To reduce any possibilities of contamination and disease transmission, the water points were filled with fresh water at the beginning of each day and emptied at the end. Water points were established from the date of the first egg laying in the colony and maintained until the last young had fledged. This was normally from mid February until the end of May/early June.

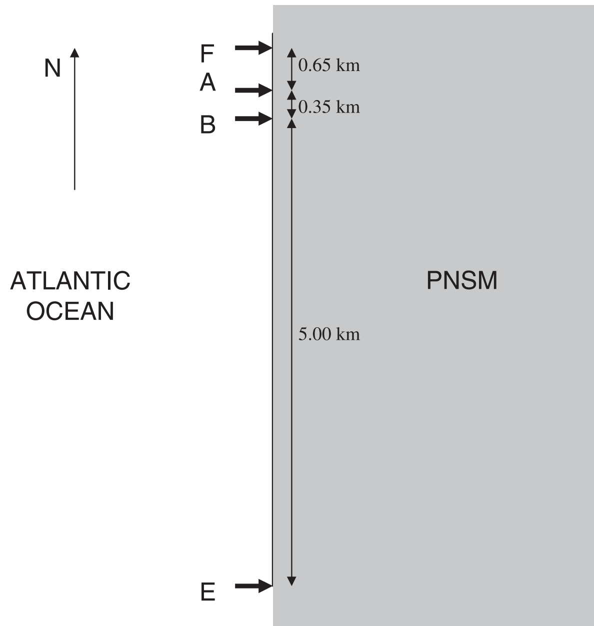

Figure 1. A schematic map showing the relative locations of the Bald Ibis colonies.

Table 1. The colonies (and numbers of nests in parentheses) with and without water points from 1998 to 2002.

Year	With access to water point	Without access to water point
1998	A(12), B(8), F(2)	E(13)
1999	A(11), B(8), F(2), E(10)	–
2000	E(13)	A(10), B(9), F(3)
2001	E(14)	A(11), B(7), F(6)
2002	A(11), B(6), F(8)	E(15)

None of the Northern Bald Ibis was individually marked so it was not possible to be certain of the origin of the birds using each water point. A schematic map showing the relative locations of each colony along the sea cliff indicating those colonies where water points were provided is shown in Figure 1. One water point was at colony B and, for these analyses, it was assumed that birds from colony A (350 m

Figure 2. (a) A water point showing the depth and central 'island' to limit access to Yellow-legged Gulls. (b) Northern Bald Ibis around one of the early water points with a Yellow-legged Gull in attendance. Photos by Chris Bowden/RSPB.

away) and F (1000 m away) had access to this water. Water was also provided at colony E, some 5.0 km south of colony B. It was assumed that only birds from colony E used this water point. We cannot be certain that birds from colony F actually used the water point at B but in grouping it with A and B our analyses are conservative in that if the birds from F were not using the water point, the strength and significance of any effects would be reduced.

The breeding performance of the Ibis was monitored by the wardens using standard procedures. Each day they recorded the contents of all the nests and any events of significance from remote vantage points using a telescope (Bowden *et al*. 2003). In the analyses, we have used data on clutch size, number of young fledged and nest failures for each nest. Because the contents of the nests were not always fully visible from the remote vantage points, the data on clutch size are less complete than those for the numbers of young fledged. There were a few instances of birds losing their eggs during laying or early in incubation and subsequently replacing them. In these cases only data for the replacement clutch were used in the analyses.

Generalized Linear Models (GLMs) were used to examine the impacts of year, local rainfall, water point treatment and colony on the breeding parameters. The distributions of clutch size and the number of young from successful nests did not differ significantly from normal and were analysed using Gaussian errors and identity link function. The numbers of young from all nests (including failures) were analysed with Poisson errors and log-link function as this was a good representation of the distribution of the data. Year, colony and the presence of a water point were included as categorical variables. Monthly rainfall data from the Agadir al Massira weather station were used in the analysis, split into two periods; the winter (November to January) and the breeding period (February to June). As year and rainfall were entirely confounded in the data, we chose to build the models using the ecologically more interesting rainfall variables. A step-up procedure was adopted with the variables which accounted for the most significant change in deviance included in the model until no further variables were significant at the $P < 0.05$ level. At each stage the difference in deviance between the models was treated as Chi-squared with the appropriate degrees of freedom. After each stage, the significance of all the variables was tested using type 3 contrasts and only those that were still significant at the $P < 0.05$ level were retained. All statistical analyses were carried out in SAS (SAS Institute 2001).

RESULTS

The sequence of the provision of water points at the colonies is summarized in Table 1. In each case, the birds found and used the water points within days of their establishment (Fig. 2b) and were frequently seen bathing and drinking at them.

Table 2 summarizes all the available breeding data. Clutch size ($n = 62$) varied significantly with year ($\chi^2 = 22.06$, df 4, $P < 0.0001$) and winter rainfall ($\chi^2 = 16.24$, df 1, $P < 0.0001$), but there were no significant effects of water point treatment ($\chi^2 = 0.39$, df 1, $P = 0.53$), colony ($\chi^2 = 7.70$, df 3, $P = 0.057$) or breeding season rainfall ($\chi^2 = 2.28$, df 1, $P < 0.13$). The multivariate model retained winter rainfall (negative) and colony as significant variables (Table 3). There were significant univariate effects of year, water point, winter rainfall and

Table 2. The breeding parameters for nests with and without access to water points from 1998 to 2002. Means are presented ± se(*n*).

(a) With access to water point

Year	No. of nests	Mean clutch size	Failed during incubation	Failed at hatch	Failed with young	Failed unknown time	Total failures	Mean no. of fledged young	Mean number of fledged young from successful nests
1998	22	2.44 ± 0.18 (9)	2	0	0	1	3	1.64 ± 0.21 (22)	1.89 ± 0.17 (19)
1999	31	3.07 ± 0.12 (15)	2	0	2	0	4	2.10 ± 0.18 (31)	2.41 ± 0.11 (27)
2000	13	3.00 ± 0.00 (4)	0	0	0	0	0	2.15 ± 0.19 (13)	2.15 ± 0.19 (13)
2001	14	2.75 ± 0.25 (4)	0	0	2	0	2	1.00 ± 0.15 (14)	1.16 ± 0.11 (12)
2002	25	2.67 ± 0.21 (6)	0	0	1	1	2	1.20 ± 0.12 (25)	1.30 ± 0.10 (23)
Total	105		4	0	5	2	11		

(b) Without access to water point

	No. of nests	Mean clutch size	Failed during incubation	Failed at hatch	Failed with young	Failed unknown time	Total failures	Mean no. of fledged young	Mean number of fledged young from successful nests
1998	13	1.00 ± – (1)	1	0	1	0	2	1.45 ± 0.28 (11)	1.78 ± 0.22 (9)
1999	0								
2000	22	3.50 ± 0.19 (8)	4	2	1	0	7	1.55 ± 0.24 (22)	2.27 ± 0.12 (15)
2001	24	2.80 ± 0.20 (10)	2	1	12	0	15	0.37 ± 0.10 (24)	1.00 ± 0.00 (7)
2002	15	2.60 ± 0.24 (5)	0	0	4	0	4	1.00 ± 0.20 (15)	1.36 ± 0.15 (11)
Total	74		7	3	18	0	28		

Table 3. Summary of the GLM of clutch size. The models assumed Gaussian errors with identity link function. Variables are listed in the order of their entry into the models.

Variable	Coefficient	se	χ^2	df	*P*
Intercept	2.955	0.249			
Winter rainfall	–0.0068	0.0014	20.11	1	< 0.0001
Colony	–	–	11.57	3	0.009

breeding season rainfall on the numbers of young fledged from all nests including failures (year $\chi^2_4 = 37.33$, $P < 0.0001$; water point $\chi^2_1 = 12.20$, $P = 0.0005$; winter rainfall $\chi^2_1 = 4.90$, $P = 0.025$; breeding season rainfall $\chi^2_1 = 9.32$, $P = 0.0023$; $n = 177$) but no significant effect of colony ($\chi^2_3 = 0.94$, $P = 0.81$). The multivariate model retained water point treatment, breeding season rainfall (positive) and winter rainfall (negative) as significant variables (Table 4). Although there was considerable annual variation, in all years the mean number of young fledged from nests with access to water points was higher than for those without.

The numbers of young fledged from successful nests ($n = 138$) varied significantly univariately with year ($\chi^2_4 = 83.14$, $P < 0.001$) and winter rainfall ($\chi^2_1 = 8.75$, $P = 0.003$), but not between water point treatments ($\chi^2_1 = 1.43$, $P = 0.23$), breeding season rainfall ($\chi^2_1 = 2.35$, $P = 0.13$) or colony ($\chi^2_3 = 0.88$, $P = 0.83$). The multivariate model (Table 5) retained winter rainfall (negative) and

Table 4. Summary of the GLM of $\log_e$ (number of young fledged from all nests). The models assumed Poisson errors with a log link function. Variables are listed in the order of their entry into the models.

Variable	Coefficient	se	χ^2	df	*P*
Intercept	0.413	0.192			
Water point (0/1)	–0.357	0.146	6.24	1	0.012
Breeding rainfall	0.0035	0.0016	5.15	1	0.023
Winter rainfall	–0.0033	0.0014	5.32	1	0.021

Table 5. Summary of the GLM of the number of young fledged from successful nests. The models assumed Gaussian errors with identity link function. Variables are listed in the order of their entry into the models.

Variable	Coefficient	se	χ^2	df	*P*
Intercept	1.879	0.155			
Winter rainfall	–0.0042	0.0013	10.55	1	0.001
Breeding rainfall	0.0028	0.0013	4.15	1	0.042

breeding season rainfall (positive). Thus, the number of nest failures rather than the number of young in successful nests appears to drive the observed difference in productivity between the water point treatments. This is perhaps not surprising given that in most cases the birds only successfully raise one or two young, so a single additional loss can result in total nest failure.

Table 2 also gives the figures for the failures at all the stages of the nesting cycle. Comparing overall failures with and without water points, there were significantly fewer failures during incubation and hatching for nests with access to water points compared with those without (4/105 nest failures with water points, 10/74 without; $\chi^2_1 = 5.51$, $P = 0.019$ with Yates correction). The effect was even more marked during the chick-rearing period (5/101 nest failures with water points, 18/64 without; $\chi^2_1 = 18.44$, $P < 0.001$ with Yates correction).

DISCUSSION

There is clearly considerable annual variation in the productivity of Northern Bald Ibis but our experimental approach has demonstrated a positive impact of the provision of water points over and above this variation in all years. The degree of improvement depended on the year, ranging from +13.1% in 1998 to +170% in 2001. It was greatest in 2001 when the breeding success at colonies without water points was at its lowest.

As we have no individually marked birds we are unable to say for certain which birds from which colonies visited the water points. We know that Northern Bald Ibis regularly commute for 10 km or more to their foraging areas and so would be well able to exploit a water point even if it was 5 km from their breeding colony. However, our analytical approach is conservative in that if birds from colonies without the water point treatments were exploiting the water points at other colonies this would simply act to reduce the magnitude of our observed effects. Our positive results suggest that, if such mixing does occur, it is limited.

Winter rainfall has a negative impact on clutch size which appears to affect all the subsequent breeding parameters. One possible explanation is that in PNSM the pattern of cultivation is linked closely to the winter rainfall. In years of high rainfall there is more cultivation of winter cereals, whereas in low rainfall years more land is left fallow. *Acanthodactylus* lizards, one of the favoured prey items for the Ibis, occur in significantly higher numbers in fallow with cultivated areas (Bowden *et al.* in press), which may provide the link to clutch size. The positive relationships with breeding season rainfall were as expected if this were to lead to better breeding season foraging conditions. Although the two rainfall variables account for some of the inter-annual variation in the breeding parameters, the fact that year alone was always the most highly significant variable in univariate tests, shows that a large degree of the annual variation remains unaccounted for.

Since 2003 the deployment of water points near the breeding colonies has become part of the ongoing conservation effort for the Northern Bald Ibis in the PNSM (El Bekkay *et al.* 2007). Since the adoption of water points, the overall breeding success has been high. The mean (± se) productivity at all colonies without access to water points between 1992 and 2002 was 0.97 ± 0.12 ($n = 10$) young/nest, compared with 1.68 ± 0.13 ($n = 10$) for all colonies with access to water between 1998 and 2007 ($t_{18} = 3.93$, $P = 0.001$; Bowden *et al.* 1997, El Bekkay *et al.* 2007). Although not all of this improvement can necessarily be attributed to the impact of the water points (for instance other measures such as protection from disturbance and discouragement of potential nest predators have also been deployed over the period), the water points are clearly a major factor. This has resulted in higher numbers of birds in the post breeding and winter periods, with the highest count of 528 in autumn 2004. However, it remains to be seen whether and how quickly this works through to the breeding population. Even in zoo populations, Northern Bald Ibis do not attempt to breed until their third or fourth year (Pegoraro 1996) and deferred maturity may be even more marked in the wild population (Hirsch 1979). Nevertheless, from 1992 to 2007 the number of breeding pairs in the PNSM increased from 39 to 50 and there was a large increase at the associated colony outside the PNSM north of Agadir at Tamri (Bowden *et al.* 2003) such that the total Moroccan breeding population more than doubled from 48 nesting pairs in 1992 to 105 in 2007.

We have not been able to collect any data that would help to explain the mechanisms that may be involved in the improvement in productivity. There are a number of possibilities. The supplementary water may allow the adults to forage over a wider area unconstrained by the need to access fresh water during the day. This may allow them to exploit areas of high prey availability which would otherwise not be accessible. It may be that the water points simply remove the need for the adults to spend time obtaining water. Oued Massa, the nearest major source of fresh water, is some 20 km from the breeding colonies (Fox *et al.* 2001), so a single round trip would take the birds at least an hour or so, which could be a significant factor in their daily time budget. It is possible that, by improving their time budgets, the water points allow the adults to be more attentive at the nest and so reduce the effects of depredation and intra-specific disputes. Bowden *et al.* (2003) showed that predation and interference from other Ibis were both significant causes of nest failure and the loss of eggs and young. A final possibility is that the ready supply of water allows the birds to exploit a wider prey base as they are less concerned about the water content of their prey, particularly that brought to the young. Faecal analysis has shown that the diet of adult Ibis is dominated by lizards *Acanthodactylus* spp., beetles (mainly *Tenebrionidae*) and invertebrate larvae (Bowden & Aghnaj 1999, Bowden *et al.* in press). There are no data on the diet brought to the young but, as they are unable to drink for themselves, the water content of the food regurgitated to them by the adults may be particularly important in maintaining their hydration. We cannot be sure which of these mechanisms is most important, but the fact that water points have a positive impact during both incubation and chick rearing suggests that the mechanism is not simply related to food and foraging but is more likely to be acting via the time constraints involved in finding water in relation to nest attentiveness and foraging time of the birds.

The only safe undisturbed nesting sites for Northern Bald Ibis in the PNSM are currently a considerable distance from any reliable natural sources of fresh water. The provision of safe nesting cliffs nearer to reliable fresh water supplies could be a potentially more sustainable long-term option than providing and maintaining artificial water points. Oued Massa is a relatively reliable source of fresh water (Fox *et al.* 2001), but unfortunately there are no obvious and safe nesting sites nearby. Neither, as yet, do we have any proven way of encouraging wild birds to make use of artificially provided nest sites, although Udo Hirsch was successful in encouraging the birds at Birecik to use artificially created nest sites (Hirsch 1979).

In May 1996 there was a serious mortality incident in PNSM in which 38 Northern Bald Ibis either died or disappeared (Touti *et al.* 1999). Although the cause of the incident was never established a number of the sick and dying birds were found around a small pool of dirty stagnant water in the south of PNSM. These events provided the impetus for exploring the possibility of providing clean safe water to the birds, which then led to the testing of the water points. Therefore an additional advantage of the water points is that they may reduce the exposure of the birds to unsafe drinking and bathing areas elsewhere.

Particular thanks to the park wardens who have implemented the creation and daily filling of the water points, in particular to Mohammed El Gadrouri who first noticed how often the birds were visiting local wells and Abdallah Essamir. Jorge Fernandez-Orueta played an important role during the implementation of the project and Dieter Hoffmann has been extremely supportive throughout the whole programme. The Moroccan Eaux et Forets Administration and Royal Society for the Protection of Birds gave the necessary support to carry out the work.

REFERENCES

Akcakaya, H.R. 1990. Bald Ibis *Geronticus eremita* population in Turkey: an evaluation of the captive breeding programme for reintroduction. *Biol. Conserv.* **51**: 225–237.

Arihan, O. 1998. Recent information on the occurrence of the Northern Bald Ibis *Geronticus eremita* in Turkey. *Turna* **1**: 10–15.

Arihan, O. 1999. Northern Bald Ibis in Turkey: experiences from captive breeding and re-introduction programs. In Boehm, C. (ed.) *Northern Bald Ibis Geronticus eremita, 2nd EEP Studbook 1999*: 27–35. Innsbruck: Alpenzoo.

BirdLife International. 2000. *Threatened Birds of the World*. Barcelona & Cambridge, UK: Lynx Edicions and BirdLife International.

Bowden, C. & Aghnaj, A. 1999. Conserving the last remaining wild Northern Bald Ibis population in Morocco. In Boehm, C. (ed.) *Northern Bald Ibis Geronticus eremita, 2nd EEP Studbook 1999*: 21–26. Innsbruck: Alpenzoo.

Bowden, C.G.R., Smith, K.W., Aghnaj, A. & Ratcliffe, N. 1997. Conservation of the Bald Ibis in the Souss-Massa National Park. Unpublished report. Sandy, UK: Royal Society for the Protection of Birds.

Bowden, C. 1998. Last chance for the Northern Bald Ibis. *World Birdwatch* **20**: 12–16.

Bowden, C.G.R., Aghnaj, A., Smith, K.W. & Ribi, M. 2003. The status and recent breeding performance of the critically endangered Northern Bald Ibis *Geronticus eremita* on the Atlantic coast of Morocco. *Ibis* **145**: 419–431.

Bowden, C.G.R., Smith, K.W., El Bekkay, M., Oubrou, W., Aghnaj, A. & Jimenez-Armesto, M. In press. Contribution of research to conservation action for the Northern Bald Ibis *Geronticus eremita* in Morocco. *Bird Conserv. Int.*

El Bekkay, M. & Oubrou, W. 2007. Northern Bald Ibis conservation project in Souss Massa region. In Boehm, C., Bowden, C.G.R., Jordan, M. & King, C. (eds) *Northern Bald Ibis Conservation and Reintroduction Workshop, Vejer, 2006*: 32–35. Sandy: RSPB.

El Bekkay, M., Oubrou, W., Ribi, M., Smith, K. & Bowden, C. 2007. Un programme de conservation pour L'Ibis Chauve (*Geronticus eremita*) au Maroc. *Ostrich* **78**: 155–157.

Fox, H.R., Wilby, R.L. & Moore, H.M. 2001. The impact of river regulation and climate change on the barred estuary of Oued Massa, southern Morocco. *Regulated Rivers* **17**: 235–250.
Hirsch, U. 1979. Studies of West Palearctic birds. 183 Bald Ibis. *Br. Birds* **72**: 313–325.
Nurettin, O. 2007. Northern Bald Ibis project at the Birecik breeding centre. In Boehm, C., Bowden, C.G.R., Jordan, M. & King, C. (eds) *Northern Bald Ibis Conservation and Reintroduction Workshop, Vejer, 2006*: 47–49. Sandy: RSPB.
Pegoraro, K. 1996. *Der Waldrapp. Vom Ibis, den Man fur einen Raben Hielt*. Wiesbaden: AULA-Verl.
Pegoraro, K. & Foger, M. 1999. The Northern Bald Ibis in Europe: an historical review. In Boehm, C. (ed.) *Northern Bald Ibis Geronticus eremita, 2nd EEP Studbook 1999*: 10–20. Innsbruck: Alpenzoo.
Robin, P. 1973. Comportement des colonies de *Geronticus eremita* dans le sud marocain, lors des périodes de sécheresse. *Bonn. Zool. Beitr.* **24**: 317–322.
SAS Institute Inc. 2001. *SAS 8.02*. Cary, NC: SAS Institute Inc.
Serra, G. & Peske, L. 2007. Northern Bald Ibis conservation efforts in Syria 2002–2006: results and lessons learned. In Boehm, C., Bowden, C.G.R., Jordan, M. & King, C. (eds) *Northern Bald Ibis Conservation and Reintroduction Workshop, Vejer, 2006*: 36–42. Sandy: RSPB.
Serra, G., Abdallah, M., Assaed, A., Abdallah, A., Al Gaim, G., Fayad, T. & Williamson, D. 2004. Discovery of a relict breeding colony of Northern Bald Ibis *Geronticus eremita* in Syria. *Oryx* **38**: 106–108.
Touti, J., Oumellouk, F., Bowden, C.G.R, Kirkwood, J.K. & Smith, K.W. 1999. Mortality incident in Northern Bald Ibis *Geronticus eremita* in Morocco in May 1996. *Oryx* **33**: 160–167.

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