

ECONOMICAL VERSUS ECOLOGICAL DEVELOPMENT: A CASE STUDY OF WHITE STORKS ON A CATTLE FARM

Pablo VERGARA* ¹, José Ignacio AGUIRRE** and Juan Antonio FARGALLO*

SUMMARY.—*Economical versus ecological development: a case study with white storks in a cattle farm.*

Aims: Wildlife and humans compete for natural resources generating conflicts that sometimes translate into financial loss. In this study, the economical costs of the upkeep of a white stork *Ciconia ciconia* colony at a cattle farm over a six-year period were evaluated. Furthermore, the effect of ash lopping in nest site selection and the efficacy of nest removal in controlling the population of this species was analysed.

Location: The ash dehesa studied was located in the Northern area of the Madrid province, in both Soto del Real and Manzanares el Real localities (40° 44' N, 3° 49' E), from 1999 to 2004.

Methods: Estimation was made of the economical cost of white stork colony maintenance by estimating the total weight of branches and bud shoots on the ashes. The tree type (lopped or unlopped) was noted to determine nest site selection where new nests were established in the subsequent year after lopping. Finally, it was recorded if removed nests (by the Regional Government as a method of population control) were less like to rebuilt in function of previous breeding success (failed or not).

Results: Storks mainly selected lopped trees as nest sites. To avoid the increase of white stork pairs in the colony, lopping was not carried out in subsequent years, causing economical losses to landowners (a minimum of 13,902.33 € in six years). In addition, due to the high nest-site fidelity in this species, the total number of nests in the colony was not reduced by nest removal. Nests that contained a pair that failed in their reproductive attempt were less likely to be rebuilt in the consecutive breeding season. The results showed that selective nest removal (removal of nests which failed the previous year) might be a more effective method for population control than nest removal methods used to date.

Conclusions: Due to the low total economic cost of colony maintenance, it is proposed that economical compensation by the regional government to the farm owners will be a more effective management measure than nest removal.

Key words: ash, *Ciconia ciconia*, lopping, nest removal, nest-site fidelity, wild species on private property.

RESUMEN.—*Desarrollo económico o ecológico: estudio con cigüeñas blancas en una granja de ganado.*

Objetivos: La fauna salvaje y los humanos compiten por los recursos naturales generando conflictos que en algunos casos pueden traducirse en pérdidas económicas. En este estudio, se evalúan los costes económicos del mantenimiento de una colonia de cigüeña blanca *Ciconia ciconia* en una granja de ganado durante un periodo de seis años. Además se analiza el efecto de la poda de los fresnos en la selección de los lugares de nidificación y la eficacia de la retirada de nidos como medida de control de la población en esta especie.

* Departamento de Ecología Evolutiva, Museo Nacional de Ciencias Naturales (CSIC), José Gutiérrez Abascal 2, Madrid, E-28006 Spain.

** Departamento de Zoología y Antropología Física, Facultad de Biología, Universidad Complutense de Madrid, calle José Antonio Novais, 2, E-28040 Madrid, Spain.

¹ Corresponding autor: vergara@mncn.csic.es

Localidad: Dehesa de fresnos situada en la zona norte de la Comunidad de Madrid, entre las localidades de Soto del Real y Manzanares el Real (40° 44' N, 3° 49' E), de 1999 a 2004.

Métodos: Se estimó el coste económico del mantenimiento de la colonia de cigüeña blanca mediante la estimación del peso total de las ramas y los sarmientos de los fresnos. Para determinar la selección de los lugares de nidificación se anotó el tipo de árbol (podado o no podado) en los que se construyeron los nidos en los años posteriores a la poda. Finalmente se anotaron sí los nidos retirados (por el Gobierno Regional como método de control de la población) fueron vueltos a construir en función del éxito reproductor (fracaso o no) de la temporada precedente.

Resultados: Las cigüeñas seleccionaron principalmente los árboles podados para construir sus nidos. Para evitar el incremento de parejas en la colonia, no se podó en los años siguientes, produciendo unas pérdidas económicas para los propietarios (un mínimo de 13,902.33 € en seis años). Por otro lado, debido a la alta fidelidad al nido en esta especie, la retirada de nidos no redujo el número total de nidos de la colonia. La probabilidad de que un nido se construyese de nuevo, fue menor en los nidos que contenían una pareja que falló en la reproducción. Nuestros resultados muestran que la retirada selectiva de nidos (retirar los nidos de los individuos que fallaron en la temporada anterior) podría ser un método más efectivo para el control de la población que los métodos de retirada de nidos realizados hasta la fecha.

Conclusiones: Debido a que el coste económico total de mantenimiento de la colonia es bajo, proponemos la compensación económica por parte del gobierno regional a los propietarios de la granja podría ser una manera más efectiva de gestión que la retirada de nidos.

Palabras clave: fresno, *Ciconia ciconia*, poda, retirada de nidos, fidelidad al nido, especies salvajes en propiedad privada.

INTRODUCTION

Wildlife and humans compete for natural resources generating conflicts that sometimes translate into financial cost. Wildlife management by public administrations considers the use of economic aid as a measure to diminish these conflicts. For this reason local and regional governments require studies evaluating the economic costs produced by wildlife for application to policy decisions. In Spain, there are several known cases of conflicts generated by wild species on private property. One example is the damage to cattle caused by the grey wolf *Canis lupus* in Northern Spain (Blanco *et al.*, 2002; Talegón, 2004). Another is the conflict between the brown bear *Ursus arctos* and honey collectors and fruit cultivators in the Cantabrian Mountain Range (BOPA, 2002; Naves and Fernández-Gil, 2002). In both cases, regional governments allocated part of their public funds to mitigate the effect of these species on the affected local economies. The purpose of such compensatory funds is to lib-

erate farmers, ranchers and other stakeholders from the responsibility of the conservation of wild species (BOPA, 2002).

One case not yet completely evaluated is that of the white stork *Ciconia ciconia*. The white stork builds large nests in anthropogenic habitats causing recognised damage to power lines and buildings. The heavy nests placed on the poles, as well as the excrement of nestlings and adults deposited on pylons, cause short-circuits of power lines, constituting an important economic and operational problem for power companies (Navazo and Lazo, 1999; Negro, 1999; Infante and Peris, 2003). In addition, building structures, primarily the tiles, undergo substantial deterioration. In some regions, the importance of such problems has necessitated the implementation of economic aid to building owners (BOLR, 2003, 2004). Nest construction in trees has not been considered a problem due to it being a local phenomenon and to date no measures for management plans for this species have been taken. However, in the Madrid province 25 % of the population breeds

on farms whose landowners suffer from the maintenance of large stork colonies (*pers. obs.*).

The white stork has been considered a vulnerable species with unfavorable conservation status in Europe (SPEC 2; Tucker and Heath, 1994). In Spain, it was categorized as "Of Special Interest" at the national scale (BOE, 1990) and "Vulnerable" at a regional scale for the Madrid province (BOCM, 1992). However, the current situation of the species has improved greatly both in Spain (Martí, 1999, 2003) and in the Madrid province (Aguirre and Atienza, 2002). One of the primary factors influencing this recovery has been the increased presence of rubbish dumps that provide the storks a constant food source (Martinez, 1995). Due to the increase in population numbers, the white stork has been removed from the most recent list of threatened vertebrates in Spain (Madroño *et al.*, 2004), which renders it a non-priority in recovery plans of threatened species. Nonetheless, in the Madrid province the white stork has recently benefited from the white stork Recovery Plan (BOCM, 1991). For this reason, a study of the potential economic burden on property owners for the maintenance of large colonies would be useful to environmental administrators in devising more realistic management measures in the recovery plan.

Trees used by the white storks as nest sites are primarily located in *dehesas*. The *dehesa* is a traditional Spanish forest-use system in which timber harvesting, cattle rearing and agricultural activities are carried out in the same area (Pardo and Gil, 2005). Ashes *Fraxinus* spp. are the dominant tree species making up *dehesas* in the Sierra de Guadarrama (Spanish Central Range). Ashes reduce pasture drying and bud shoots (annual branches) represent a reliable source of supplementary food for cattle once the pasture is totally consumed (Ceballos y Fenández de Cordoba and Ruiz de la Torre, 1971). Ash branches are sold as firewood and bud shoots are used for feeding cattle. Farmers traditionally lop the ashes leaving only the trunk (Ceballos y Fenández de Cor-

doba and Ruiz de la Torre, 1971). Lopped ashes constitute an optimal support for white stork nests, especially in the Madrid province (Aguirre and Atienza, 2002). The conflict in the *dehesas* of the Sierra de Guadarrama (Madrid) emerges from the fact that ashes with nests cannot be lopped in order to protect the storks and additionally, lopping of ashes without nests is not advisable in this region in order to avoid the installation of new stork pairs. Landowners complain about the regional government regulations. The government was aware of this conflict, and hence promoted measures to minimize this problem, such as removing stork nests outside of the breeding season. A realistic evaluation of the economical losses and the efficacy of nest removal could mediate in this conflict.

In this study, the economical cost resulting from the maintenance of a white stork colony installed in a private *dehesa* was analysed. The cost for the farmers was determined in terms of firewood sale and cattle feeding. In addition, it was studied whether the installation of nests on ashes results in the death and fall of the tree, which would increase the economic cost for the farmers. Furthermore, the effect of ash lopping in nest site selection and its importance in the increase of the white stork population in the Madrid province was analysed. Finally, the efficacy of nest removal in controlling the population of this species was analysed.

MATERIAL AND METHODS

The ash *dehesa* studied was located in the northern area of the Madrid province, in the localities of Soto del Real and Manzanares el Real (40° 44' N, 3° 49' E). The farm is located in the Cuenca Alta del Manzanares Regional Park (CAMRP). Using an aerial photograph of the *dehesa*, all trees (559) were mapped and numbered for subsequent identification. In December 1999, farmers lopped 115 ashes (20% of the ashes in the *dehesa*). Notes were taken

of the tree type (lopped or unlopped) where new nests were established in the subsequent year (2000) and all fallen trees from 1999 to 2004.

Economic cost

To determine the economic cost of white stork colony maintenance, the total weight of branches and bud shoots remaining on the ashes was estimated. To these weights the current price of firewood (0.08 €/kg) was applied in the case of branches and the price of grass bought for cattle feeding (0.15 €/kg) corresponding to the weight of bud shoots that farmers could not give to the cattle. Prices were provided by the Spanish Ministry of Agriculture, Fishing and Food (2004). To estimate firewood weight, measurements were carried out by direct counting on 28 randomly selected ashes of the number of branches and bud shoots, the average diameter of the base of such branches and the average length of the branches. Using these values, the branch volume was calculated considering the branch as a truncated cone: $\frac{1}{3} * \pi * H * (R^2 + rR + r^2)$, where H is the branch length, R is the radius at the base of the branch and r is the radius at the end of the branch. For all branches r was considered as 0.5 cm. The weight was calculated using the density value 0.75 gr/cm³ (Mazzocchi, 1953). The volume of bud shoots (considered as circular cones) was also calculated assuming that length and diameter were 50 and 1 cm, respectively. Density of wood for bud shoots was estimated as in the branches (0.75 gr/cm³). Trees without nests were randomly selected by introducing tree codes (numbers) into a Microsoft Excel sheet and randomly assigning them numbers by using the random function and selecting the first 28. To be conservative, the economic losses were calculated, assuming that ashes had matured a minimum of six years before being lopped had been measured (1999 was the

last year in which it is certain that no lopping was conducted). Although it is possible that several of these selected ashes were lopped previously, since ashes from the dehesa are lopped every ten years, the results are not greatly underestimated.

Nest removal

Due to the increase in pair numbers in the colony (see results), managers of the CAM-RP ordered a total or partial nest removal on 60 trees each winter of 2000, 2001 and 2003 resulting in a total of 180 nests removed during those years. The removed nests were recorded during February 2002 and 2004. Visits to the colony were made at the end of the breeding season (May-June) in order to determine the total number of nests in the colony, breeding outcome (defined as a binary variable where "0" was assigned to nests with no chicks produced, and "1" to nests with at least one chick produced) and to record the trees in which a nest was rebuilt after removal. Nests removed in 2002 were from different trees in 2004. The efficacy of nest removal was analysed by comparing the breeding outcome of the previous year in rebuilt and non-rebuilt nests. Although this species has high rates of nest-site fidelity, nest-switching is more likely in storks that failed in breeding in the previous year (Vergara *et al.*, 2006). We used STATISTICA (StatSoft, 1999) in all of the analyses. All tests are two-tailed.

RESULTS

Colony increase and nest placement

The white stork colony in the dehesa studied increased considerably over the last 16 years from one pair in 1989 to 168 in 2004. A total of 206 nests placed in 203 trees were monitored during the study period (Fig. 1). All the

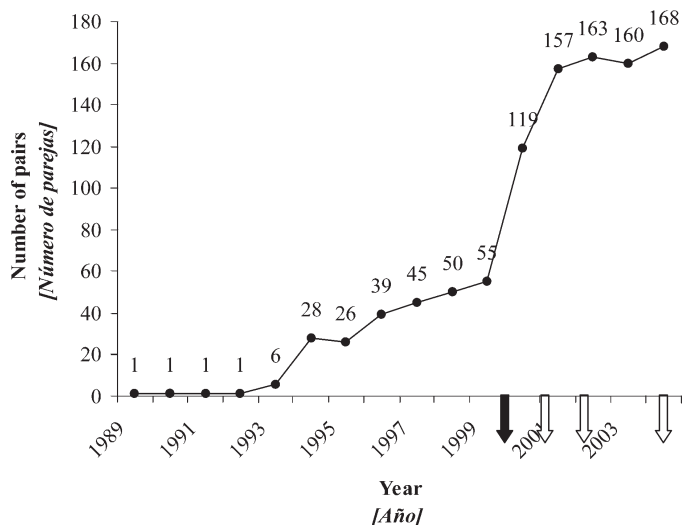


FIG. 1.—Evolution in the number of pairs breeding at the colony. Lopping and nest removal episodes are indicated with black and white arrows, respectively. Source of data previous to 1999, A. González and CAMRP staff (personal communication).

[Evolución en el número de parejas reproductoras de la colonia. Los episodios de poda y retirada de nidos se indican con flechas negras y blancas respectivamente. Los datos previos a 1999 proceden de A. González y del personal del CAMRP (comunicación personal).]

nests (64) built in the subsequent year to lopping activities (1999) were placed in lopped ashes. This indicates that lopped trees were positively selected against unlopped trees ($\chi^2_1 = 279.04$, $P < 0.001$). Average tree use for placing the nest in the dehesa over the study period was 36.31 % (203 out of 559). Between 1999 and 2004, 17 (8.86 %) trees holding a nest fell while only three (0.84 %) of the trees without nests fell ($\chi^2_1 = 21.26$, $P < 0.001$).

Economic cost

Average weight of firewood obtained from each tree in 2004 was 321.98 kg which means an economical benefit of 24.14 €/tree/6-yr. The weight of bud shoots was 4.91 kg/tree, which means an economical benefit of 0.73 €/tree/6-yr. Consequently, if there were 559 trees on the farm in 1999, the minimum

economic benefit in terms of firewood and bud shoot sales that could be produced on the farm in six years will be 13,494.26 € and 408.07 €, respectively. The minimum total economic cost resulting from storks on the farm will be 13,902.33 €/6-yr.

Nest removal

A mean of 88.3 % of nests removed on the orders of the regional administration were newly rebuilt (Table 1). During the three breeding seasons in which nests were eliminated, the average number of nests in the colony increased (Fig. 1). There are significant differences between rebuilt nests in breeding success in the previous season, hence destruction of nests was more effective in those nests that failed in breeding during the previous season than in those that succeeded ($\chi^2_1 = 4.87$, $P = 0.027$, $n = 38$).

TABLE 1

Number of removed nests and constructed again on each visit. In parentheses the percentage is given of rebuilt nests from total of removed nests.

[Número de nidos retirados y vueltos a construir en cada visita. Entre paréntesis se indica el porcentaje de nidos reconstruidos del total de nidos retirados.]

	Year [Año]		
	2001	2002	2004
Removed nests [Nidos retirados]	60	60	60
Removed and constructed again (February) [Retirados y contruidos de nuevo (febrero)]	Not measured [No medido]	46 (76.7 %)	34 (56.7 %)
Removed and constructed again (June) [Retirados y contruidos de nuevo (junio)]	52 (86.7 %)	53 (88.4 %)	54 (90 %)

DISCUSSION

Tree selection and nest placement

The stork colony studied increased notably from 1989 to 2004. The highest increases were observed in the years 2000 and 2001 (64 and 38 new nests respectively, Fig. 1). This drastic increase coincided with intensive lopping activities carried out in the dehesa during December 1999, since 100 % of the new nests in the year 2000 were placed on lopped ashes. These results confirm that storks choose lopped trees to install their nests.

Large differences in fallen trees with and without nests must be carefully considered. It is true that more trees holding nests fall, however storks positively select trees with fewer branches. Birds will install their nest on a tree as soon as the tree becomes old and starts losing branches or is lopped. It is not clear from this study that nests directly cause the death of the tree. Such tree death is primarily caused by age, lack of humidity, freezing (Anic *et al.*, 1999; Bobinac and Vuckovic, 1999; Madera and Uradnicek, 2001) or lightning which is quite common in the study area (*pers. obs.*).

Economic cost

Upkeep of a white stork colony imposes several economic costs on the owner, which translate into the loss of income from firewood sales. The results showed that lopped trees are selected preferentially by storks (as mentioned above), and if the aim is to control the number of pairs in this colony, lopping should no longer be carried out in the future. Consequently, the loss of possible firewood and bud shoot sales from trees on the farm must be included in the economic costs of the colony.

Nest removal

The low numbers of trees with removed nests during the February visits in 2002 and 2004 (7.7 and 14 %, respectively) must be due to the fact that by the time nests were checked most of them had already been rebuilt. Most of the arrivals to the colony occur during the months of December and January (Vergara *et al.*, 2004, 2007), so birds have enough time to rebuild their nests. Nest removal has proven an ineffective method since most of the nests have

been rebuilt and pair numbers have consistently increased. Fairly inefficient results have been obtained under similar situations (Navazo and Lazo, 1999). The high nest-site fidelity rate of white storks (Barbraud *et al.*, 1999; Prieto, 2002) results in birds occupying the same nests as in previous years. One of the main factors affecting nest fidelity in this species (Vergara *et al.*, 2006) and other species (Blums *et al.*, 2002; Hoover, 2003) is the breeding success or failure during the previous season, which could explain results concerning rebuilt nests according to breeding failure or success during the previous year. Naturally, if a pair fails to breed, it is most likely that nest switching will occur independently of the removal or maintenance of the nest. Removed nests may also belong to young pairs, which are still developing their breeding skills and show more intense nest switching tendencies (Schulz, 1998; Vergara *et al.*, 2006). Nest removal must therefore be aimed at nests in which young pairs have bred or intended to breed. Measures such as nest removal do not reduce colony growth, which has increased steadily since the study began (Fig. 1). Lopping could be an important causal factor affecting colony growth since more nest substrates are available. The increase observed one and two years just after lopping has never been observed again in the colony (Fig. 1), although some other unknown factors not measured in this study, could also affect it.

No growth of the colony in the coming years is predicted since there is no available substrate (Fig. 1). The importance of this farm from an environmental and economical point of view could make it an appropriate case for implementing measurements focused on sustainable development which aims at a compromise between farming and stork reproduction in a way similar to already existing economic-ecological models (Johst *et al.*, 2001, 2002). Due to the fact that the total cost of colony maintenance is low (a minimum of 13902.33 €/6-yr.), economical compensations by the CAMPR to the farm owners will likely consti-

tute more effective management measures than nest removals.

ACKNOWLEDGEMENTS.—Mr. L. Herrero, owner of the farm and farm workers Emilio and Goyo, allowed us to enter their property and provided information along with A. Sanz and D. Díaz from the park office and A. González from the park rangers (CAMRP). M. Fernández-Cruz helped during fieldwork. E. Banda, J.C. Atienza, and two anonymous referees substantially improved the manuscript. Sara Young revised the English.

BIBLIOGRAPHY

- AGUIRRE, J. I. and ATIENZA, J. C. 2002. Censo de la población reproductora de Cigüeña Blanca (*Ciconia ciconia*) en la Comunidad de Madrid. Año 2001. In: A. Bermejo, J. De la Puente and J. Seoane (Eds.): *Anuario Ornitológico de Madrid 2001*, pp. 114-125. SEO-Monticola. Madrid.
- ANIC, I., PERNAR, N. and SELETKOVIC, Z. 1999. Narrow-leaved ash (*Fraxinus angustifolia* Vahl) in the structure of floodplain forests of Croatian Posavina. *Ekologia Bratislava*, 18: 69-81.
- BARBRAUD, C., BARBRAUD, J. C. and BARBRAUD, M. 1999. Population dynamics of the White Stork *Ciconia ciconia* in western France. *Ibis*, 141: 469-479.
- BLANCO, J. C., SAENZ DE BURUAGA, M. and LLANEZA, L. 2002. *Canis lupus* Linnaeus, 1758. In: L. J. Palomo and J. Gisbert (Eds.) *Atlas de los Mamíferos terrestres de España*, pp. 234-237. Dirección General de Conservación de la Naturaleza-SECEM-SECEMU. Madrid.
- BLUMS, P., NICHOLS, J. D. and HINES, J. E. 2002. Sources of variation in survival and breeding site fidelity in three species of European ducks. *Journal of Animal Ecology*, 71: 438-450.
- BOBINAC, M. and VUCKOVIC, M. 1999. Relationship of some exogenous factors to the variability of diameter increment of narrow-leaved ash (*Fraxinus angustifolia* Vahl) future trees on an ecologically optimal site. *Ekologia Bratislava*, 18: 31-38.
- BOCM. 1991. Ley 2/91 de 14 de febrero, para la Protección y Regulación de la Fauna y Flora

- Silvestres de la Comunidad de Madrid. Boletín Oficial de la Comunidad de Madrid nº.54, 5 de marzo de 1991.
- BOCM. 1992. Decreto 18/92, de 26 de marzo, por el que se aprueba el Catálogo Regional de Especies Amenazadas de fauna y flora silvestres y se crea la categoría de árboles singulares. Boletín Oficial de la Comunidad de Madrid nº.85, 9 de abril de 1992.
- BOE. 1989. Ley 4/1989, de 27 de Marzo, de Conservación de los Espacios Naturales y de la Flora y Fauna Silvestres. Boletín Oficial del Estado nº. 74, 28 de marzo de 1989.
- BOE. 1990. Real Decreto 439/1990, de 30 de marzo de 1990, por el que se regula el Catálogo Nacional de Especies Amenazadas. Boletín Oficial del Estado nº. 82, 5 de abril de 1990.
- BOLR. 2003. Orden 8/2003, de 14 de abril de 2003, del Consejero de Turismo y Medio Ambiente por la que se regula el régimen de concesión de subvenciones para el mantenimiento de nidos de cigüeña común. Boletín Oficial de La Rioja. 29 de abril de 2003.
- BOLR. 2004. Resolución nº 64/2004, de 12 de febrero de 2004, de la Consejera de Turismo, Medio Ambiente y Política Territorial por la que se convoca la subvención regulada en la Orden 8/2003, de 14 de abril, de la entonces Consejería de Turismo y Medio Ambiente, por la que se regula el régimen de concesión de subvenciones para el mantenimiento de nidos de cigüeña común. Boletín Oficial de La Rioja. 26 de febrero de 2004.
- BOPA. 2002. Decreto 9/2002, de 24 de enero, por el que se revisa el Plan de Recuperación del Oso Pardo (*Ursus arctos*) en el Principado de Asturias. Boletín Oficial del Principado de Asturias nº 28, 4 de febrero de 2002.
- CEBALLOS Y FERNANDEZ DE CORDOBA, L. and RUIZ DE LA TORRE, J. 1971. *Árboles y arbustos de la España Peninsular*. Fofo. Madrid.
- HOOVER, J. P. 2003. Decision rules for site fidelity in a migratory bird, the prothonotary warbler. *Ecology*, 84: 416-430.
- INFANTE, O. and PERIS, S. 2003. Bird nesting on electric power supports in northwestern Spain. *Ecological Engineering*, 20: 321-326.
- JOHST, K., BRANDL, R. and PFEIFER, R. 2001. Foraging in a patchy and dynamic landscape: human land use and the White Stork. *Ecological Applications*, 11: 60-69.
- JOHST, K., DRECHSLER, M. and WATZOLD, F. 2002. An ecological-economic modelling procedure to design compensation payments for the efficient spatio-temporal allocation of species protection measures. *Ecological Economics*, 41: 37-49.
- MADERA, P. and URADNICEK, L. 2001. Growth response of oak (*Quercus robur* L.) and ash (*Fraxinus angustifolia* Vahl.) on changed conditions of the floodplain forest geobioecene hydrological regime. *Ekologia Bratislava*, 20: 130-142.
- MADROÑO, A., GONZÁLEZ, C. and ATIENZA, J. C. 2004. *Libro Rojo de las Aves de España*. Dirección General para la Biodiversidad-SEO/BirdLife. Madrid.
- MARTÍ, R. 1999. Results of the 5th International White Stork Census (1994) in Spain. In: H. Schulz (Ed.) *White Storks on the up? Proceedings of the International Symposium on the White Stork*. Hamburg, pp. 61-68. 1996, NABU. Bonn.
- MARTÍ, R. 2003. Cigüeña Blanca, *Ciconia ciconia*. In: R. Martí & J.C. Del Moral (Eds.) *Atlas de las Aves Reproductoras de España*, pp. 112-113. Dirección General de Conservación de la Naturaleza-Sociedad Española de Ornitología. Madrid.
- MARTÍNEZ, E. 1995. El uso de vertederos por la Cigüeña Blanca como nuevas fuentes de alimentación. In: O. Biber, P. Enggist, C. Martí and T. Salathe (Eds.) *Proceedings of the International Symposium of White Stork (Western population)*, pp. 159-162, Basel.
- MAZZOCCHI, L. 1953. *Memorial Técnico*. Dossat. Madrid.
- NAVAZO, V. and LAZO, A. 1999. La nidificación de aves en la red de transporte de electricidad en España: Evaluación, prevención y corrección de la problemática asociada. In: M. Ferrer and G. F. E. Janss (Eds.) *Aves y líneas eléctricas*, pp. 187-216. Quercus. Madrid.
- NAVES, J. and FERNÁNDEZ-GIL, A. 2002. *Ursus arctos* Linnaeus, 1758. In: L.J. Palomo & J. Gisbert (Eds.) *Atlas de los Mamíferos terrestres de España*, pp. 282-285. Dirección General de Conservación de la Naturaleza-SECEM-SECEMU. Madrid.
- NEGRO, J. J. 1999. Pasado y futuro de la investigación sobre interacciones entre la fauna y las

- líneas eléctricas. In: M. Ferrer and G.F.E. Janss (Eds.) *Aves y líneas eléctricas*, pp. 21-29. Quercus. Madrid.
- PARDO, F. and GIL, L. 2005. The impact of traditional land use on woodlands: A case study in the Spanish Central System. *Journal of Historical Geography*, 31: 390-408.
- PRIETO, J. 2002. *Las cigüeñas de Alcalá*. Escuela Taller de Medio Ambiente Albardín, Parque de los Cerros. Alcalá de Henares.
- SCHULZ, H. 1998. BWP Update. *The Journal of Birds of the Western Palearctic: White Stork*. Vol. 2, Number 2. pp. 69-105. Oxford University Press.
- STATSOFT, 1999. *STATISTICA for Windows [Computer program manual]*. StatSoft Inc. Tulsa.
- TALAGÓN, J. 2004. La Conservación del lobo en la provincia de Zamora. Apuntes para la gestión de una especie conflictiva. *Quercus*, 222: 21-27.
- TUCKER, G. M. and HEATH, M. F. 1994. *Birds in Europe. Their conservation status*. BirdLife International. BirdLife Conservation Series Nº 3. Cambridge.
- VERGARA, P., AGUIRRE, J. I., FARGALLO, J. A., AND DÁVILA, J. A. 2006. Nest-site fidelity and breeding success in the White Stork *Ciconia ciconia*. *Ibis*, 148: 672-677.
- VERGARA, P., AGUIRRE, J. I. and FERNÁNDEZ-CRUZ, M. 2004. Fidelidad a los sitios y fenología en la invernada de la Cigüeña Blanca (*Ciconia ciconia*) en la Comunidad de Madrid (1998-2002). In: J. De la Puente, J. Pérez-Tris, A. Bermejo and M. Juan (Eds.) *Anuario Ornitológico de Madrid 2003*, pp. 74-85. SEO-Monticola. Madrid.
- VERGARA, P., AGUIRRE, J. I. and FERNÁNDEZ-CRUZ, M. 2007. Arrival date, age and breeding success in white stork *Ciconia ciconia*. *Journal of Avian Biology*, 38: 573-579.

[Recibido: 28-08-06]

[Aceptado: 01-10-07]

The research interests of **Pablo Vergara** are signalling theory and migratory patterns in vertebrates. In particular, he studies the expression of ornaments in birds under sexual and social selection contexts and migratory phenology in relation to varying food abundance. **Jose Ignacio Aguirre**'s interests are focused on bird life history and reproduction, mainly on parental effects on future offspring fitness. In addition, he is currently working on the incidence of contaminants on breeding performance. The research interests of **Juan Antonio Fargallo** cover, in general, life histories, sexual selection, ecological immunology and population dynamics of vertebrates under varying environmental conditions (food and parasitism).