



Past and current distribution of the purple swamphen *Porphyrio porphyrio* L. in the Iberian Peninsula

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The past and current status of purple swamphen *Porphyrio porphyrio* in Europe is reviewed, with particular reference to the Iberian Peninsula and the possible causes of the decline and subsequent recovery of the species in Spain.

The main cause of decline has been the loss of habitat, namely wetlands with suitable vegetation cover and water levels. This forced the purple swamphen to concentrate in a few areas, increasing the risks from hunting or other disturbances. Recently, the effective protection of the species and the areas used by it, environmental changes such as the introduction of new farms and the creation of artificial wetlands (reservoirs) may have facilitated its expansion up the Guadalquivir river.

Investigations in the Paraje Natural del Alto Guadalquivir (Jaén province, Andalusia, South Spain) have shown a significant increase in the population of the species in this area from 1983 to 1990.

INTRODUCTION

In the Iberian Peninsula several bird species are threatened with extinction, for example the Iberian imperial eagle *Aquila adalberti* (Meyburg, 1975; ICONA, 1986); bearded vulture *Gypaëtus barbatus* (Hiraldo *et al.*, 1979; ICONA, 1986); ruddy shelduck *Tadorna ferruginea* and crested coot *Fulica cristata* (ICONA, 1986). The status of other species, however, lends new hope for their conservation, for example the white-headed duck *Oxyura leucocephala* (Dolz & Gómez, 1988; Amat & Raya, 1989) and the purple swamphen *Porphyrio porphyrio* (Hidalgo, 1973; Sánchez-Lafuente & Muñoz-Cobo, 1989, 1990). This last species is strictly protected in Europe (Parslow & Everett, 1981; ICONA, 1986), as in this part of its range it is still threatened.

This paper summarizes most of the published information relating to the distribution of the pur-

ple swamphen in the western Palaearctic and attempts to outline its current status in the Iberian Peninsula. We also analyse some of the factors which may have contributed to its decline in Spain and others which may now be facilitating its expansion (ICONA, 1986).

MATERIALS AND METHODS

In order to determine the past and present distribution of the purple swamphen in Europe, we carried out an extensive literature search and sought additional information by personal contact with ornithologists. Five maps were constructed showing the different stages of the distribution of the species in the Iberian Peninsula.

To calculate density values in the wetlands where the species occurs we considered census data, nesting data and published sources.

Seventy-two censuses were carried out between January 1983 and December 1990 on a natural population of the purple swamphen in the Paraje

Natural del Alto Guadalquivir (Jaén province, Andalusia, southern Spain), totalling about 300 hours of observation and 1513 birds recorded during the eight years. Censuses were made from elevated points covering most of the reservoir extent, at similar times of the day, by the same observers and during the same periods, in order to avoid differences caused by sampling effort. We also considered nesting data for 1990 in the same areas and, finally, published information from other Andalusian wetlands.

RESULTS

Distribution of the purple swamphen in Europe

In Europe, the purple swamphen has been associated with the Mediterranean and Atlantic basins (Cramp & Simmons, 1980; Bauer *et al.*, 1982; Ferrer *et al.*, 1986), where the climate was suitable.

We first summarize the status of the purple swamphen in European countries other than Spain and Portugal to highlight the importance of the Iberian Peninsula for the species in Europe.

Greece. Possible breeding in the south in the 19th century (Cramp & Simmons, 1980; Bauer *et al.*, 1982).

France. Occurrence always accidental. Cited in the Rousillon in 1856, in Saint Hippolyte in 1879 (Ferrer *et al.*, 1986) and in the Midi in the 19th century (Mocci Demartis, 1972). Not common in the Camargue by 1937 (Hughes, 1937). Last observation in 1969 (Hafner, 1970; Howette, 1972).

Italy. Recorded from inland areas as well as on certain islands. Data about shooting are available from Romany (until 1912) and Lombardy (until 1955) (Mocci Demartis, 1972). Extremely abundant in Sicily until 1850, then decreasing to become 'still quite common' in 1900 (Voous, 1960). Last breeding proved in 1943, but probably also in 1954 (Cramp & Simmons, 1980). It was considered to be scarce in the 1970s (Mocci Demartis, 1972) but no breeding data are available. Sardinia has the only stable Italian population (Mocci Demartis, 1972; Cramp & Simmons, 1980), the size of which was estimated to be 50–100 pairs in 1974 (Cramp & Simmons, 1980), 245–285 pairs in 1980 (Parslow & Everett, 1981) and 300 pairs in 1983 (Mocci Demartis, 1983).

Elsewhere cited as vagrant or escaped from captivity in Russia, Czechoslovakia, Germany, Austria, Hungary, Netherlands, Poland, Norway, Belgium and Yugoslavia (Cramp & Simmons, 1980; Bauer *et al.*, 1982).

Distribution of the purple swamphen in the Iberian Peninsula

Portugal

According to Vaurie (1965) and Mocci Demartis (1972) the species bred in northern Portugal, and Mocci Demartis (1972), Vicente and Bugalho (1974) and Cramp and Simmons (1980) also considered it to have bred in the south. Tait (1924, in Sala de Castellarnau, 1957) considered the species to be extinct all over the country at that time. Today its occurrence is certain in the Algarve, where there is a small breeding colony (Ramos, 1989).

Spain

The purple swamphen always had a wide distribution in Spain, which suffered a stepwise decline until it became restricted to several areas in the south of the country (Cramp & Simmons, 1980; Torres & Raya, 1982; Amat *et al.*, 1985; Sánchez-Lafuente & Muñoz-Cobo, 1989). Its distribution can be summarised as follows.

Catalonia. Known to breed in the delta of the Ebro river in the 16th century (Maluquer Sostres, 1971; Cramp & Simmons, 1980). According to X. Ferrer (pers. comm.), the species no longer bred as long ago as the 1930s. Since the 1940s it has been considered an accidental species (Ferrer, 1977). The few individuals seen might come from Sardinia, Andalusia, North Africa or have escaped from private collections (Ferrer *et al.*, 1986).

Aragón. Data exist on individuals shot in the valley of river Ebro in the 1950s. This species certainly occurred in the Gallocanta lagoon until 1965 (Aragües & Lucientes, 1980).

Balearic Islands. Considered by Reyes Prosper (1986) as not common in the islands at the end of the 19th century, and by Ferrer *et al.* (1986) and Muntaner and Congost (1979) as extinct in Mallorca by 1914 and in Minorca before 1930. There are only occasional references after the 1940s (Ferrer *et al.*, 1986).

Valencia. Common from the 16th century until becoming nearly extinct in the late 19th century (see Ferrer *et al.*, 1986).

Andalusia. A traditional area for the species in the Iberian Peninsula (Vielliard, 1974; Cramp & Simmons, 1980). Nowadays, Andalusian wetlands are the most important areas for the species in Europe, where its last populations on the continent are concentrated.

Figure 1(A–E) shows the changes in the distribution of the purple swamphen in the Iberian Peninsula in five periods. The species began to decline in the first years of this century and reached a minimal distribution during the 1950–1960s. Subsequently the population has expanded up the Guadalquivir river.

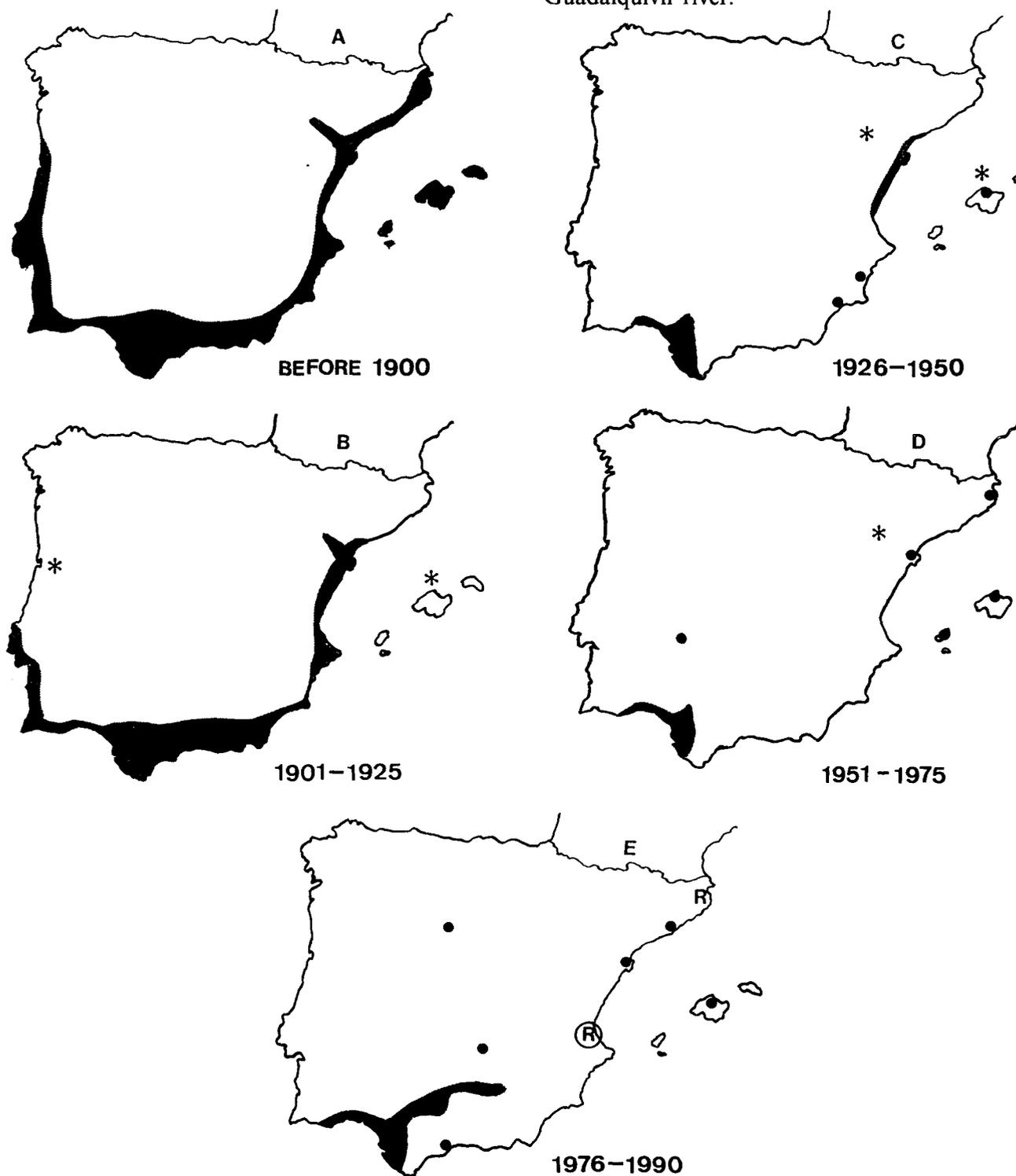


Fig. 1. Distribution of the purple swamphen in the Iberian Peninsula in five periods. (A) before 1900; (B) 1901–1925; (C) 1926–1950; (D) 1951–1975; (E) 1976–1990.

*, uncertain presence; ●, single observations; R, reintroduction in 1989; Ⓡ, birds caged from 1988 to attempt reintroduction. See Appendix 1 for data sources.

Current situation of the purple swamphen in the Iberian Peninsula (Fig. 1(E))

It is difficult to determine the whole extent of the area currently suitable for the purple swamphen in the Iberian Peninsula, as it extends over a great number of endorheic lagoons, and also occurs in areas around and on the river Guadalquivir and reservoirs. Some are not suitable in their entirety (for instance, the 50 720 ha of Doñana National Park or the 54 200 ha of the Doñana Environment Natural Park). Only several sites within these areas are used, where the vegetation cover and water depth are appropriate. Other wetlands are sporadically occupied, mainly those that undergo summer droughts — this being a natural event in the annual cycle of many lagoons in southern Spain, not caused by human activity. When such droughts occur birds tend to leave these wetlands and move to others which are still flooded. The species may at the present time occur all over the river Guadalquivir and areas nearby (lagoons, marshes or tributaries) where vegetation cover and water depth are suitable. The extent of this suitable habitat is unknown.

Most available data come from areas where the species is known to occur and where the land is protected by law or periodically patrolled (approximately 4035.25 ha). Half of this area consists of natural and half artificial wetlands (Fig. 2). The following account concerns only this area (Table 1).

A very conservative estimate of the total population comes from the published 1982–1990 census data of the protected or continuously patrolled areas (Ena & Purroy, 1982; Amat, 1984 *a,b*; Amat *et al.*, 1985; Arenas *et al.*, 1986; Gómez & Dolz, 1987; Sánchez-Lafuente & Muñoz-Cobo, 1989, 1990; J. M. Fernández-Palacios, pers. comm.). Based on these sources we have estimated the average density in two different types of habitats (Table 1).

Reservoirs are much larger than lagoons and more difficult to census, so that density values in these areas may be underestimated. Our data for the reservoir of Doña Aldonza, in our main study site in the Upper Guadalquivir, provides a more detailed analysis. Within this reservoir there is an isolated 60-ha area where birds are very easy to see along the shore.

Censuses carried out in this area between 1983 and 1990 have yielded a maximum average of 20.66 birds per month, in 1988, making a density of 0.37 birds/ha — similar to the value obtained for the lagoons (see Table 1).

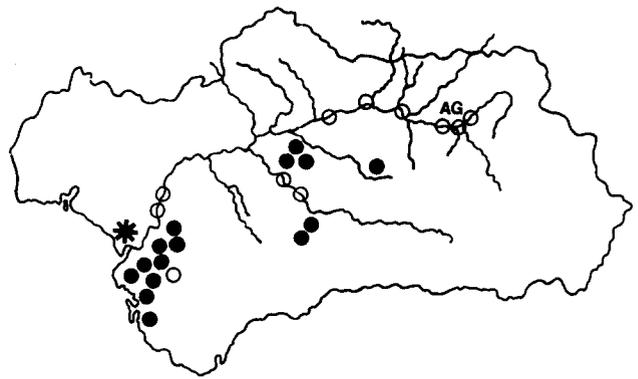


Fig. 2. Approximate situation of the known areas where the purple swamphen occurs in Andalusia (southern Spain). AG, the situation of the study site in Jaén (Paraje Natural del Alto Guadalquivir); ●, natural areas (endorheic systems with one or more lagoons); ○, artificial areas (reservoirs, channels, etc.); *, Doñana National Park and Doñana Environment Natural Park.

Nesting data in this wetland support these estimates. In Doña Aldonza, the purple swamphen starts to breed in the first week of February and the season extends until early October (Sánchez-Lafuente, unpublished data). Taking into account the incubation period and development of chicks, we considered that only those nests found between early February and late April were first-clutch nests. In this period we found 14 nests with first clutches. As communal breeding has not been proved in the Alto Guadalquivir this makes a minimum of 28 breeding birds in the 60 ha area, having a density value of 0.41 birds/ha.

Using these data the population in the protected and patrolled areas would vary between 1200 and 1700 birds. This estimation *does not include* those areas mentioned above for which no data are

Table 1. Protected areas for the purple swamphen in Andalusia, showing their average density

Protected areas	Area (ha)	Average density (birds/ha)
Endorheic lagoons ^a	1280.25	0.39
Reservoirs ^a	2755.00	0.13
Total ^a	4035.25	0.30
Total with new value for reservoirs ^b		0.37
Total with new value for reservoirs ^c		0.41

Note: 'corrected' density values for reservoirs, based on census and nesting data.

^a From published data (see text).

^b From our census data.

^c From our nesting data.

available (on the Guadalquivir river main stream, tributaries, marshes, rice fields and Doñana National Park and its surroundings).

DISCUSSION

Population decline

Although the decline of other waterfowl species generally during the 20th century has been due to habitat destruction and excessive hunting (Bernis, 1964; Mocci Demartis, 1972; Ankney *et al.*, 1987; Eddleman *et al.*, 1988) no overall census data are available for the purple swamphen in Spain.

Many authors (Valverde, 1960; Hidalgo, 1973; Rodríguez & Hiraldo, 1975; Bauer *et al.*, 1982; Cramp & Simmons, 1980; Craig, 1980; Ferrer *et al.*, 1986) have defined the habitat preference of the purple swamphen as wetlands with abundant emergent plant cover and stable water levels. Valverde (1960) stated that, in Andalusia, the species was mostly found in wetlands with reed-mace *Typha dominguensis* and reed *Phragmites communis*, but it can also be found in areas of *Scirpus* and *Schoenoplectus* where water levels are high (J. A. Amat, pers. comm.).

This type of habitat has been systematically destroyed in the Iberian Peninsula, as elsewhere in Europe. Many wetlands in Spain were drained following the Cambó Law of 1918 (Cardelús, 1984), as they were considered unhealthy (Bernis, 1964; Menanteau, 1984; Senra, 1984). Years later, this excuse was still used in order to obtain more land for agriculture (Mocci Demartis, 1972; Menanteau, 1984; Senra, 1984). Also, many wetlands have been contaminated with industrial and urban pollution (Mocci Demartis, 1972; Bernis, 1964; Parslow & Everett, 1981; Senra, 1984; ICONA, 1986).

In addition, the purple swamphen is unable to move long distances by flying (Craig, 1974, 1979), so that isolated wetlands can be considered as 'islands' for the species and are difficult to colonise. These have become reduced in extent by habitat degradation, preventing the dispersal of individuals or expansion of range because of the lack of suitable peripheral habitat (Hunter, 1987). As extinction probability is related to area (Gilpin, 1987), this contraction in area could affect the purple swamphen by reducing its breeding success (Craig, 1980).

Hunting also had a serious impact on the purple swamphen. Confined to a few areas, it was at greater risk and birds were shot intensively and illegally

(Barrena *et al.*, 1984; J. A. Amat, pers. comm.). Hunters also mistake this species for the commoner coot *Fulica atra* and moorhen *Gallinula chloropus*.

By the 1950s–1960s the species was restricted to just a few areas in the south of the Iberian Peninsula around the marismas of the Guadalquivir and a small site on the Guadalquivir river, above Seville (Valverde, 1960).

Expansion

It is difficult to determine the precise causes of range extension of any species (Bonham & Robertson, 1975), but in the case of the purple swamphen it could have been brought about by environmental changes and effective protection (J. A. Amat, pers. comm.).

The environment may be affected by natural changes, but also as a result of man's activities (Bournaud *et al.*, 1982; Menanteau, 1984). After the Spanish Civil war, rice *Oryza sativa* and other crops were introduced along the banks of the Guadalquivir river and, in order to maintain the appropriate water levels in the rice fields, it was necessary to dig wide channels, which favoured the presence of *Typha* and *Phragmites*. Apart from the potential as a feeding resource (Rodríguez & Hiraldo, 1975), it is possible for rice fields to become refuges where large numbers of birds can concentrate when summer droughts affect nearby wetlands.

New reservoirs were also created along the Guadalquivir river and tributaries. However, these will not become suitable habitats until siltation, caused mainly by run-off from agricultural land, has encouraged emergent vegetation (mainly *Typha*). The population increase seems to be associated with the development of this plant (Hidalgo, 1973), so that the occurrence of reservoirs with these conditions may be considered as a favourable change in the natural habitat of the species. Similar effects have been produced in our study site in Jaén with the penduline tit *Remiz pendulinus* (Valera *et al.*, 1990). These reservoirs, as permanent wetlands, could promote the expansion of southern populations during juvenile dispersal of the purple swamphen (Hidalgo, 1973; Craig, 1979) or floaters (Hunter, 1987). Figure 3 shows its significant increase in the reservoirs of the Alto Guadalquivir from 1983 (Spearman Rank Correlation, $p < 0.02$).

Strict protection of the purple swamphen and its habitat in Europe has definitely helped the ex-

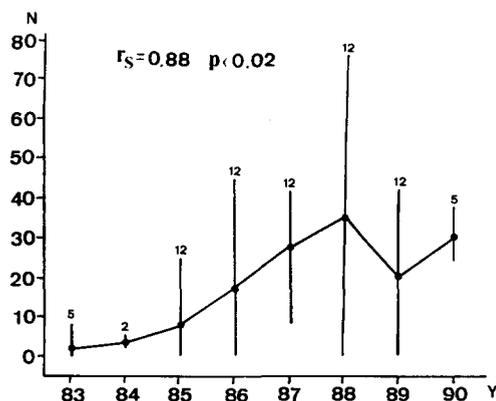


Fig. 3. Birds censused (N) in the Paraje Natural del Alto Guadalquivir (Jaén) from 1983 to 1990 (Y). Vertical lines indicate range values, numbers above the lines indicate the number of months censused each year; ●, average number of birds per year; r_s , Spearman rank correlation.

pansion. The species has been protected in Spain since September 1973 and most wetlands in which it occurs are nowadays also protected (the most recent in 1989). Today it is abundant all over the marismas of the Guadalquivir, even in areas where it was rare 30 years before (Valverde, 1960), in many lagoons of southern Spain (Amat, 1984a; Amat *et al.*, 1985; J. M. Fernández-Palacios, pers. comm.), and it has also reached northern areas along the Guadalquivir river and tributaries (Torres & Raya, 1982; Sánchez-Lafuente *et al.*, 1987).

Attempts have also been made to reintroduce the species to areas where it disappeared long ago, e.g. Catalonia (J. Sargatal, pers. comm.) and Valencia (J. C. Dolz, pers. comm.) (Fig. 1(e)). In Catalonia (Aiguamolls de l'Empordà Natural Park, Girona) about 30 individuals from the Doñana National Park were liberated in 1989 in a 60-ha area, carrying colour leg bands and radio-transmitters to record their movements. As far as is known, some attempted to breed in 1990 (J. Sargatal, pers. comm.). In Valencia (l'Albufera Natural Park) 25 birds, also from Doñana National Park, were caged in 1988 to encourage breeding in captivity. If successful, birds will be liberated on the main lagoon (J. C. Dolz, pers. comm.).

FINAL CONSIDERATIONS

The purple swamphen and its habitat are both still vulnerable today in Spain. In spite of the protection, birds are illegally shot in many places in the south, and may be offered for sale in public markets (Rodríguez & Hiraldo, 1975).

The habitat may also be burnt or cut and affected by pollution or water loss through human activity. Figure 3 shows a marked decline in the number of birds recorded in our study site from early 1989, when massive destruction of marsh vegetation occurred (two of the three reservoirs of the Alto Guadalquivir were completely burned). At the same time farmers have dug several channels, without permission, to extract water from Doña Aldonza reservoir. As a consequence, many areas in the reservoir were dry for many months. In 1990, when the vegetation recovered and water levels were higher, we recorded a fresh increase in birds.

The lack of continuity in its habitat can prevent the species from colonising other potentially suitable areas (Hunter, 1987). In the wetlands where birds are being reintroduced, appropriate conditions exist to promote breeding and establishment. However, it is unlikely that it will reach these areas by natural expansion, as they are too far from inhabited wetlands.

The importance of habitat continuity can be demonstrated by the advance of the species along the river Guadalquivir using its reservoirs. Future conservation of the purple swamphen has to take into account not only the protection and monitoring of the areas where the species live, but also of the routes that it uses to move among these areas. Vulnerability of many wetlands might be reduced by maintaining suitable water levels, allowing siltation to take place (in the case of reservoirs) and by excluding human disturbance.

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REFERENCES

- Amat, J. A. (1984a). Las poblaciones de aves acuáticas en la lagunas andaluzas. Composición y diversidad durante un ciclo anual. *Ardeola*, **31**, 61–80.

- Amat, J. A. (1984b). Ecología de las lagunas andaluzas. In *Las Zonas Húmedas en Andalucía, Monografías MOPU, Direcc. Gen. Medio Ambiente*, Sevilla, pp. 101–17.
- Amat, J. A. & Raya, C. (1989). La malvasía. *La Garcilla*, **75**, 8–11.
- Amat, J. A., Diaz, C., Herrera, C. M., Jordano, P., Obeso, J. R. & Soriguer, R. C. (1985). *Criterios de Valoración de Zonas Húmedas de Importancia Nacional y Regional en Función de las Aves Acuáticas. Monografías ICONA*, No. 35, Madrid.
- Ankney, C. D., Dennis, D. G. & Bailey, R. C. (1987). Increasing mallards, decreasing American black ducks: coincidence or cause and effect? *J. Wildl. Manage.*, **51**, 523–9.
- Arenas, R., Ayala, J. M. & Ordoñez, F. (1986). Aves acuáticas de las zonas húmedas del sur de Córdoba. *Oxyura*, **3**, 141–6.
- Bonham, P. F. & Robertson, J. C. M. (1975). The spread of cetti's warbler in north-west Europe. *Brit. Birds*, **68**, 393–408.
- Bournard, M., Ledant, J. P., Broyer, J. & Richoux, M. (1982). L'espace étang dans ses rapports avec l'avifaune en période de nidification. *Bull. Ecol.*, **13**, 125–44.
- Cardelús, B. (1984). Legislación española sobre zonas húmedas. In *Las Zonas Húmedas en Andalucía. Monografías MOPU, Direcc. Gen. Medio Ambiente*, Sevilla, pp. 5–12.
- Craig, J. L. (1974). The pukeko. *N.Z. Nat. Heritage*, **1**, 416–9.
- Craig, J. L. (1979). Habitat variation in the social organisation of a communal gallinule, the pukeko (*Porphyrio porphyrio melanotus*). *Behav. Ecol. Sociobiol.*, **5**, 331–58.
- Craig, J. L. (1980). Breeding success of a communal gallinule. *Behav. Ecol. Sociobiol.*, **6**, 289–95.
- Dolz, J. C. & Gomez, J. A. (1988). Las anátidas y fochas invernantes en España. In *Invernada de Aves en la Península Ibérica. Monografías SEO*, No. 1, Madrid, pp. 55–69.
- Eddleman, W. R., Knopf, F. L., Meanley, B., Reid, F. A. & Zembal, R. (1988). Conservation of North American railids. *Wilson Bull.*, **100**, 458–75.
- Gilpin, M. E. (1987). Spatial structure and population vulnerability. In *Viable Populations for Conservation*, ed. M. E. Soulé. Cambridge University Press, Cambridge, pp. 125–39.
- Hafner, H. (1970). Cômpte rendu ornithologique pour les années 1968 et 1969. Station Biologique de la Tour de Valat. *Terre et Vie*, **117**, 575.
- Hidalgo, J. (1973). El calamón común. *Vida Silvestre*, **5**, 44–8.
- Hiraldó, F., Delibes, M. & Calderon, J. (1979). *El Quebrantahuesos (Gypaëtus barbatus)*. *Monografías ICONA*, No. 22, Madrid.
- Howette, C. (1972). Nouvelles acquisitions faunistiques de la Camargue. *Alauda*, **40**, 343–52.
- Hughes, A. (1937). Contribution a l'étude des oiseaux de Gard, de la Camargue et de la Lozère. *Alauda, Ser. III*, **2**, 172.
- Hunter, L. (1987). Acquisition of territories by floaters in cooperatively breeding purple gallinules. *Anim. Behav.*, **35**, 402–10.
- ICONA (1986). *Lista Roja de los Vertebrados de España*. ICONA, Madrid.
- Johnson, D. H. & Shaffer, T. L. (1987). Are mallards declining in North America? *Wildl. Soc. Bull.*, **15**, 340–5.
- Menanteau, L. (1984). Evolución histórica y consecuencias morfológicas de la intervención humana en las zonas húmedas: el caso de las marismas del Guadalquivir. In *Las Zonas Húmedas en Andalucía, Monografías MOPU, Direcc. Gen. Medio Ambiente*, Sevilla, pp. 43–75.
- Meyburg, B. U. (1975). On the biology of the Spanish imperial eagle *Aquila heliaca adalberti*. *Ardeola*, **21**, 254–83.
- Mocci Demartis, A. (1972). Le statut de la poule sultane *Porphyrio porphyrio* L.) en Sardaigne. *Bull. Aves*, **9**, 187–97.
- Mocci Demartis, A. (1983). Rapporto e risultati della conferenza sulla convenzione per le zone umide d'importanza internazionale (Cagliari, 24–29 novembre, 1980) e riflessioni sugli stagni della Sardegna. *Alytes*, **1**, 21–40.
- Parslow, J. L. F. & Everett, M. J. (1981). *Oiseaux ayant Besoin d'une Protection Spéciale en Europe*. Council of Europe, Strasbourg.
- Ramos, J. A. (1989). *Ecología e conservação do caímao comum, Porphyrio porphyrio, com especial referência ao Ludo, Parque Natural da Ria Formosa*. University of Algarve, Faro.
- Sánchez-Lafuente, A. M. & Muñoz-Cobo, J. (1989). Introducción a la ornitofauna de las zonas húmedas de Jaén. *Bol. Inst. Est. Cienc.*, **138**, 99–116.
- Sánchez-Lafuente, A. M. & Muñoz-Cobo, J. (1990). Avifauna de las zonas húmedas del Alto Guadalquivir (Jaén). *Oxyura*, **5**, 45–59.
- Sánchez-Lafuente, A. M., Muñoz-Cobo, J., Rey, P. & Valera, F. (1987). Sobre los nuevos núcleos de calamón *Porphyrio porphyrio* L. en Jaén. *IX Jornadas Ornitológicas Españolas*, Madrid.
- Valera, F., Rey, P., Sánchez-Lafuente, A. M. & Muñoz-Cobo, J. (1990). The situation of penduline tit *Remiz pendulinus* in Southern Europe: a new stage of its expansion. *J. Ornithol.*, **131**, 413–20.
- Valverde, J. A. (1960). Vertebrados de las marismas del Guadalquivir. *Archivos del Instituto de Aclimatación*, **9**, CSIC Almería.
- Valverde, J. A. (1967). *Estructura de una comunidad de vertebrados terrestres, Monografías Est. Biol. Doñana*, No. 1, Sevilla.
- Voous, K. H. (1960). *Atlas of European Birds*. Nelson, London.

APPENDIX

Sources of information on which the maps in Fig. 1(A–E) were compiled

- Alba, E. (1982). Noticiario ornitológico. *Ardeola*, **29**, 175–93.
- Albert, J. A. (1973). Notas ornitológicas breves. *Ardeola*, **19**, 18.
- Arevalo, J. (1887). *Aves de España. Mem. Real. Academia Ciencias*, **11**, 1–471.
- Barrera, M., Camacho, J., Cañavate, J. P. & Roth, J. C. (1984). Estudio ecológico y problemática actual del Brazo del Este. In *Las Zonas Húmedas en Andalucía, Monografías MOPU, Direcc. Gen. Medio Ambiente*, Sevilla, pp. 161–75.
- Bauer, K. M., Glutz, U. N. & Bezzel, E. (1982). *Handbuch der Vögel Mitteleuropas* (11 vols). Akademische Verlagsgesellschaft, Wiesbaden.
- Bernis, F. (1964). *Información española sobre anátidas y fochas. Epoca Invernal*. Sociedad Española de Ornitología, Madrid.
- Blasco, F. & Lopez, M. (1989). Noticiario ornitológico. *Ardeola*, **36**, 245.
- Cramp, S. & Simmons, K. E. L. (1980). *The Birds of the Western Palearctic*, Vol. II. Oxford University Press, Oxford.
- Chapman, A. & Buck, W. J. (1978). *Unexplored Spain*. Incafo (first published London, 1910), Madrid.
- Ferrer, X., Vilalta, A. & Muntaner, J. (1986). *Ocells. Historia Natural dels Països Catalans*, Vol. 12, Enciclopedia Catalana, Barcelona.

- Generalitat Valenciana (1988). Proyecto de reintroducción del Calamón en el Parque Natural de l'Albufera. Servicio Protección Recursos Naturales, Valencia.
- Gil Lletguet, A. (1945). *Sinopsis de las aves de España y Portugal*, Madrid.
- Irby, L. H. (1895). *The Ornithology of the Strait of Gibraltar*, 2nd edn. London.
- Muntaner, J. & Congost, J. (1979). *Avifauna de Menorca. Treballs del Museu de Zoologia*, No. 1, Barcelona.
- Jourdain, F. C. R. (1936). The birds of Southern Spain. *Ibis*, **1936**, 725–63.
- Lebreton, P. (1870). Nôtes d'ornithologie andalouse. *Bull. Soc. Linn. Lyon*, **4**, 139–47.
- Lopez-Soeane, V. (1861). Catálogo de las aves observadas en Andalucía. *Rev. Progr. Cien. Exp. Fís. y Nat.*, **1861**, 1–62.
- Mayol, J. (1981). *Els Aucells de les Balears*. Moll, Palma de Mallorca.
- Molina, F. & Pardo, J. R. (1986). *Situación Actual de las Zonas Húmedas Andaluzas*. Agencia de Medio Ambiente, Sevilla.
- Ramos, J. A. (1989). *Ecologia e conservação do caímao comum, Porphyrio porphyrio, com especial referência ao Ludo, Parque Natural da Ria Formosa*. University of Algarve, Faro.
- Reyes, P. (1986). *Catálogo de aves de España, Portugal e Islas Baleares*. (Facsimile edition, original Madrid, 1886), Badajoz.
- Ristow, D. (1961). Notas de un viaje por España en Marzo–Abril 1961. *Ardeola*, **7**, 200.
- Sacarrao, G. F. & Soares, A. A. (1979). Nomes portugueses para as aves da Europa, com anotações. *Arq. Mus. Bocage*, **2**, No. 23. Facultad Ciencias Lisboa, Lisboa.
- Sala de Castellarnau, P. I. (1957). Aves que se extinguen. *Ardeola*, **3**, 350–1.
- Sánchez Garcia, J. (1885). *Catálogo de los mamíferos y aves observadas en la provincia de Granada*. Real Sociedad Economía Granada, Granada.
- Sánchez-Lafuente, A. M. & Muñoz-Cobo, J. (1989). Introducción a la ornitofauna de las zonas húmedas de Jaén. *Bol. Inst. Est. Gienn*, **138**, 99–116.
- Santaeufemia, F. J. & Torres, R. (1985). Noticiario ornitológico. *Ardeola*, **32**, 409–24.
- Saunders, H. (1871). The birds of Southern Spain. *Ibis*, Ser. **III**, **1**, 205–25.
- Soler, J. P. (1955). Captura de un calamón común *Porphyrio porphyrio* en Cataluña. *Ardeola*, **2**, 184.
- Soler, F. X. P. (1962). Algunas capturas interesantes en Cataluña, Levante y Baleares. *Ardeola*, **8**, 241.
- Suarez, F. (1969). Captura de un *Porphyrio porphyrio* en Badajoz. *Ardeola*, **15**, 136.
- Torres, J. A. & Arenas, R. (1986). Zonas húmedas del sur de la provincia de Córdoba. In *Guía de las Zonas Húmedas de la Península Ibérica y Baleares*. FAT, Madrid, pp. 207–226.
- Torres, J. A. & Raya, C. (1982). Zonas húmedas del sur de la provincia de Córdoba: descripción y avifauna. *Bol. Est. Cent. Ecol.*, **11**, 43–8.
- Trigo, E. (1960). Notas sobre capturas de aves raras o interesantes. *Ardeola*, **6**, 367–9.
- Valverde, J. A. (1960). Vertebrados de las marismas del Guadalquivir. *Archivos del Instituto de Aclimatación*, **9**, CSIC, Almería.
- Vaurie, C. (1965). *The Birds of the Palearctic Fauna. Non-passerines*. Witherby, London.
- Vicente, R. O. & Bugalho, J. F. (1974). Observações de ave caímao *Porphyrio porphyrio* no Algarve. *Cyanopica*, **4**, 10.