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Received 16 March 1995; accepted 3 June 1995

J. Raptor Res. 29(3):204–207

RECOVERY OF A RESIDENT POPULATION OF OSPREY ON CORSICA

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KEY WORDS: *Corsica*; *Mediterranean*; *osprey*; Pandion haliaetus; *population recovery*; *population size.*

Two factors have been shown to be major causes of the decline of osprey (*Pandion haliaetus*) in Europe between 1940 and 1970: (1) persecution during breeding and migration (Bijleveld 1974, Saurola 1985), and (2) extensive use of pesticides, especially organochlorines (Ratcliffe 1967, Newton 1979, Odsjö 1982). But since the 1970s, osprey numbers have increased rapidly in Europe. This has been especially well documented for the migrant northern populations (Bird et al. 1983, Dennis 1987, Poole 1989). Conversely, the literature for resident populations is scarce. Mediterranean population increases apparently were consistently lower, with stable populations reported in some areas (Thibault et al. in press.). The reasons for this difference are unknown, but patterns of recolonization and recovery might be different between resident and migrating populations (e.g., adult and juvenile survival rates, or both, may differ).

The island of Corsica has a resident population of ospreys known to occupy nearly all of its rocky coasts. The historic distribution is shown in Fig. 1a. Additionally, on the east coast which is flat and sandy at least two pairs bred in gorges several kilometers inland, and two others on off-shore rocky islets (Terrasse and Terrasse 1977, Thibault and Patrimonio 1990). The number of breeding pairs between the end of the 19th century and the 1960s is unknown because no counts were performed, but it was estimated at 40–100 pairs (Thibault and Patrimonio 1990) Here we report patterns of abundance and geographic distribution of the osprey in its population increase on Corsica from 1977–94.

STUDY AREA AND METHODS

The total osprey population on Corsica in the western Mediterranean Ocean (42°N, 9°E) has been monitored annually from 1977–94. The breeding season of this resident population is spread over 6 mo, from February to July (Thibault and Patrimonio 1991). Osprey in the Mediterranean have semi-colonial habits, breeding within 80–500 m of each other (Thibault et al. in press). Osprey in Corsica nest only on pinnacles along the rocky seacoast (Thibault and Bouvet 1983). This facilitated observing nests using telescopes (20–45×) from less than 300 m away, permitting a good view into nests. Eyries were checked at least once a month from March to August. We

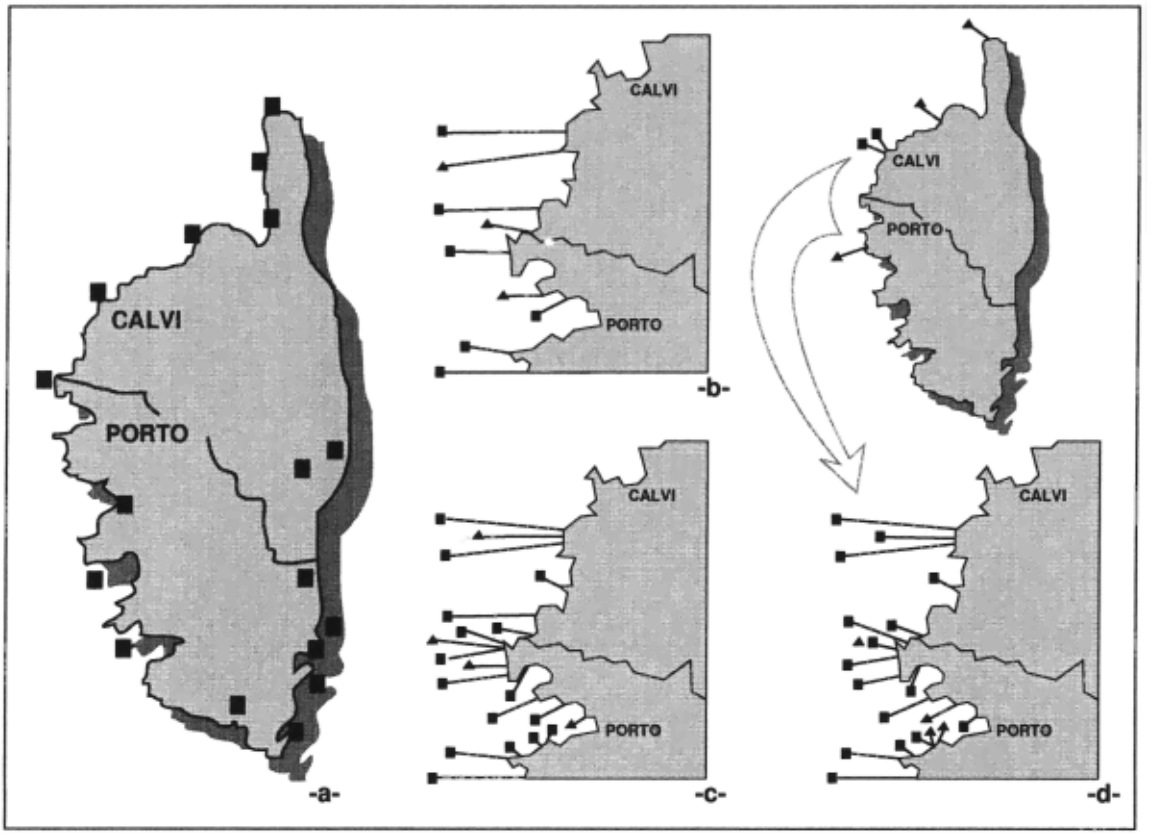

Figure 1. Distribution of the osprey on Corsica: (a) historic data from the end of the 19th century to the 1960s (squares indicate historic breeding sites [Thibault and Patrimonio 1990]), (b) distribution in 1977, (c) distribution in 1990, and (d) distribution in 1994 (squares indicate breeding pairs; triangles indicate nonbreeding pairs).

also checked sites listed in Thibault and Patrimonio (1990) that are unoccupied today, for which historic data and locations were obtained from literature or with the help of local residents. These sites were also checked regularly between 1977–94. All occupied nests were taken into account, but we distinguished between active nests (with at least one egg), and nests occupied by nonbreeding pairs (with no clutch). To calculate the population density, location of all occupied nests was plotted on 1:25 000 scale maps (Institut Géographique National, France). Distances between nests were then calculated with a curvimeter following the coastline.

RESULTS

Trends in the number of both active nests and nests occupied by nonbreeding osprey from 1977–94 are presented in Fig. 2. During this period, the number of breeding pairs increased steadily from 6–18 at the annual average growth rate of 6.7% ($r_{16} = 0.93$, $P < 0.001$).

Until 1990, the whole breeding population was confined to the region between the cities of Calvi and Porto. In 1977, six breeding pairs were spread over 90 km along the northwest coast (Fig. 1b), with a mean distance between nests of 13.9 km (SD = 6.3, range = 7–23 km, $N = 6$) and 7.5 km (SD = 2.9, range = 5–12.2 km, $N = 9$) for active and occupied nests, respectively. By 1990, the number of breeding pairs had increased to 16, but the birds were distributed within exactly the same area as in 1977 (Fig. 1c). As a result, the mean distance between nests decreased to 3.9 km (SD = 1.99, range = 2–9 km, $N = 16$) and 3.24 km (SD = 2.35, range = 1–9 km, $N = 20$) for active and occupied nests, respectively. From 1990–94, osprey distribution in Corsica increased, while the number of breeding pairs was only slightly higher. Considering only the original area, the mean distance between nests since 1990 has remained constant (3.9 km, SD = 1.99, $N = 16$ in 1990; and 3.4 km, SD = 2.5, $N = 16$ in 1994), i.e., no new pairs became established there after 1990. This suggests that the initial area was saturated by 1990. Thus, the increase in number from 1990–94 involved

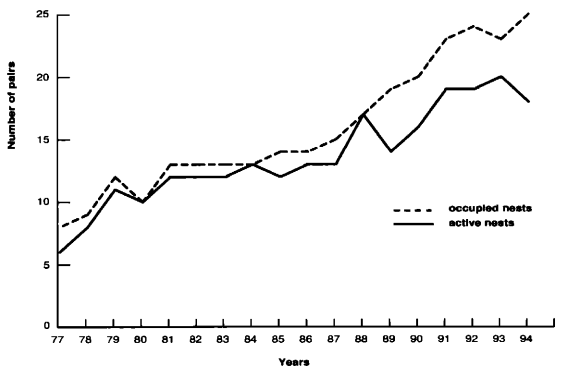

Figure 2. Trends in osprey numbers in Corsica 1977–94. Active nests were those that produced at least one egg, and occupied nests were those attended by osprey that did not lay eggs.

several pairs that recolonized former breeding sites—sites that had not been occupied for at least 20–30 yr. In 1994, a total of five pairs (two breeding and three nonbreeding) were in this situation (Fig. 1d).

DISCUSSION

The decrease of osprey on Corsica appears to have been most severe among isolated pairs—those that were distributed in areas where favorable habitats were limited and where colonies of birds did not exist. Conversely, on the northwest coast of the island, human pressure was very low and favorable habitats enabled the birds to breed at high densities. In the latter area, osprey were able to maintain a minimum number of pairs, thus preventing total disappearance from the island. Recovery of osprey populations to historic numbers is unlikely because several historic breeding sites, especially in the southeastern part of the island, are now surrounded by housing developments. Two facts in the pattern of recovery in Corsica are strikingly different from what was observed in northern European populations. First, the average annual population increase was lower in Corsica (7%, 1977–94) than in Scotland (15%, 1962–86; Dennis 1987). Second, the population remained in exactly the same area for 15 yr while numbers increased threefold before shifting to new sites. We suggest that annual population increase in Corsica is lower because new recruits were mainly local recruits. Conversely, in Scotland a Scandinavian origin for some at least of the recruits is well established (Dennis 1987). Although we cannot ascertain that the increase was entirely attributable to local recruits rather than through immigration to Corsica, banding nestlings with color bands since 1980, and field identification of adults using individual variation in the coloration of head feathers (Bretagnolle et al. 1994), strongly suggest that the new birds are mainly local recruits. The second difference may result from a combination of (1) the semi-colonial habits of the osprey (Bretagnolle and Thibault 1993), which, like other colonial birds, tends to use sites that are already being used by conspecifics (Buckley and Buckley 1980, Burger and Gochfeld 1990), and (2) the insularity of Corsica. The osprey appears to be more colonial in Corsica than in Scotland or elsewhere in northern Europe, possibly as a consequence of breeding entirely in continuous coastal habitats on Corsica, rather than on lakes (i.e., discrete habitats) as in other parts of Europe. It is also possible that nonmigratory habits of ospreys in Corsica might have further reduced natal dispersal in the population.

As a result of these differences, the increasing population of Corsican ospreys occupied the same range for nearly 15 yr, before expanding its range to other sites on the island (though these were all occupied historically) when the initial area was saturated.

RESUMEN.—Hemos estudiado la reprodución del Aguila pescadora *Pandion haliaetus* en la isla de Corcega, Mediterraneo occidental, desde 1977 hasta 1994. La antigua distribución, desde el final del siglo XIX hasta 1960, basda sobre datos historicos, demuestra que ocupaba casi todas las costas rocosas. La población estaba estimada entre 40–100 parejas. En 1977, se redujo a 6 parejas repartidas sobre 90 km de la costa Norte-Oeste. En 1990, el número de parejas reproductoras era de 16, para une distribución en los mismos limites que en 1977. Desde 1990 hasta 1994, la región parecia saturada, puesto que varias parejas habian reconquistado antiguos lugares en el norte de la isla, inocupados desde 20–30 años. Las modalidades de crecimiento de efectivos, y su distribución son discutidos en función de las especifidades de esta población residente.

[Traducción de Helena Perez]

ACKNOWLEDGMENTS

Many people helped with the fieldwork but particular thanks are due to Franck Finelli, Olivier Patrimonio, José Torre, and personnel of the Fonds d'Intervention pour les Rapaces. Patricia Howlett kindly improved the English. We are indebted to Alice Müller who drew the figures Keith L. Bildstein, Norman R. Seymour and Glenn D. Therres provided useful comments on a first draft.

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Received 26 October 1994; accepted 22 March 1995

J Raptor Res. 29(3):207–210

A COMPARISON OF TWO METHODS FOR STUDYING THE DIET OF THE PEREGRINE FALCON

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KEY WORDS: diet; *Falco peregrinus*; methodology; peregrine falcon.

A frequent difficulty in the study of raptor diets is determining how valid the results are as the result of the sampling methodology. Stomach contents, pellets, prey remains, and direct observation are the main methods applied (Marti 1987). Many studies have used just one of these methods (e.g., Bustamante 1985, Nielsen and Cade 1990, Tella 1991). Others used a combination of some of them (e.g., Restani 1991, Mañosa and Cordero 1992, Underhill-Day 1993), but biases produced by the different methods have been tested only for few species (Collopy 1983, Simmons et al. 1991, Hunt et al. 1992, Mersmann et al. 1992, Real 1991, Mañosa 1994).

The aims of this paper are (1) to compare pellet contents with uneaten prey remains in determining the diet of the peregrine falcon (*Falco peregrinus*), and (2) to develop a more accurate method to evaluate peregrines' diet by using both methods separately or in conjunction.

METHODS

The study was carried out on 7500 km^2 in the Ebro Valley, northeastern Spain (Tella 1991, 1993). Diet samples were collected from below cliffs used by 19 breeding pairs of peregrine falcons that remained in the area yearround. The collections were made between 1987 and 1993, on a regular basis throughout the year to avoid biases associated to seasonal variations in the diet (Mearns 1982, 1983). Collections were carried out by one or two people carefully searching for pellets and small remains for 45–120 min (Langvatn 1977). Each collection of prey remains and pellets from a pair on one date was considered to be a sample. Prey remains were identified using our comparison collection of bones and feathers and those from the Museum of Zoology of Barcelona. Mass of prey was estimated from the literature (Geroudet 1946–57, Cramp and Simmons 1977–83, Cramp 1985–93) and our own data from the study area.

Diet was determined separately from the number of prey items identified in pellets and from uneaten prey

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