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CHANGES IN SITE OCCUPANCY AND NESTING PERFORMANCE OF PEREGRINE FALCONS IN COLORADO, 1963–2004

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KEY WORDS: *Peregrine Falcon*; Falco peregrinus; *occupancy rate*; *population change*; *productivity*; *reproductive success*; *Colorado.*

In 1965, Professor Joe Hickey held a conference of more than 50 people at the University of Wisconsin to review marked declines of several species of bird-eating and fish-eating raptors, particularly the Peregrine Falcon (*Falco peregrinus*; Hickey 1969). By that time, peregrines were extirpated in parts of Europe and the eastern United States and were greatly reduced in several other regions. The purpose of this paper is to compare territory occupancy and nesting performance in Colorado in the 1960s and 1970s, when the population was in decline, with falcon activities and occupancy at most of the same cliffs in 2004.

In 1964, a broad survey in the Rocky Mountain region was accomplished (Enderson 1965) and adult pairs in Colorado were present at five (33%) of 15 cliffs visited. Single peregrines were seen at two other sites, and eight were apparently vacant; only four young were seen at these sites. Another survey was done in Colorado in 1973 and the results were included in a broader regional report (Enderson and Craig 1974); eight (44%) pairs were found at 18 sites and only two young were seen. These published reports included records from only a single year. Because additional unpublished data are available for Colorado in other years during those early periods, it would be useful to include them in a wider analysis and to contrast those historical results with a recent survey that I completed in 2004.

METHODS

In the period from 1963–65, I visited cliffs in Colorado where peregrines had been reported in the literature or gleaned from correspondence with interested people, often falconers. I also visited several sites in the 1973–75 period that included most of the territories from the earlier survey plus two additional peregrine cliffs found in the interim. The sites visited in 2004 included 15 sites selected arbitrarily from those included in the earlier survey periods. In all, 21 different sites were surveyed at least once in the three periods.

In 2004, I also visited an additional 32 sites found since 1975. I did not include the latter group in the activity and occupancy comparisons between periods. The additional 32 cliffs were checked because they were logistically accessible while I visited historical sites, or were reported by other observers. They were selected without regard for past occupancy or reproductive performance

Because of small sample size in any one year, I pooled data within the first two periods. As a result, data for as many as three seasons within a period were tallied for some locations. For this analysis, reproductive performance by pairs between years at the same site was considered independent, but the validity of that notion was not tested.

A spotting scope or binoculars on a tripod or window mount were used to discover falcons on cliffs. In the two earlier periods, I usually walked the tops of the cliffs in addition to the distant viewing. Unless weather interfered, I usually searched the cliff for at least 4 hr or until peregrines were seen. Incubation, brooding, or food exchanges usually occurred in that span of time. When fresh excrement was seen, or poor weather interrupted, searching was extended or often repeated on another day. Sites were excluded from the analysis if I assessed that sampling was inadequate to determine occupancy. I believe the effectiveness of observations was generally similar between periods, except that in 1963–65 when I was less familiar with the cliffs and peregrine activities at the cliffs. Sites were usually visited once or twice to verify occupancy, and usually once to count young. This pattern did not change substantially between periods, except that in the first two periods I often checked, based on incubation behavior, to see if females had laid eggs as well.

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Table 1. Occupancy and productivity of Peregrine Falcons at 21 cliffs during three survey periods from 1963–2004 in Colorado.

	YEARS		
	1963–65	1973–75	2004
Number of cliffs checked in period	18	18	15
Number of site visits in period	34	47	15
Number of pairs	16	19	13
Occupancy (%)	47	40	87
Number of pairs with known reproductive outcome	9	19	10
Number of young recorded	11	12	21
Number of young per pair	1.2	0.7	2.1

Productivity was defined as the number of large young (ca. 30 d or older) counted for all pairs on territory. The estimate is a minimum because some young on the ledge or recently fledged may have been overlooked. When a site was not checked at the time large young should have been present, it was not included in productivity calculations.

RESULTS

In the 1963–65 period, I determined occupancy by peregrines during 34 visits at 18 nesting locations (Table 1). In that period pairs were present in 16 of 34 instances (47% occupancy). In all, productivity was determined for nine pairs and they produced 11 young (1.2 young/pair). In 1973–75, J. Craig and others assisted me in visits to 18 sites. In all, occupancy was ascertained 47 times over the 3 yr, 19 pairs were found holding territories (40% occupancy) and 12 large young were seen (0.63 young per pair). For comparison, in 2004, I visited 15 of these same sites (including 14 from the 1963–65 sample); 13 had pairs (87% occupancy). The outcome of nesting was checked for 10 pairs; 21 large nestlings or flying young were found (2.1 young per pair).

Additionally, the expanded 2004 survey included other sites discovered in the last three decades. In all, 47 sites (among about 160 places where peregrines have been reported to nest in Colorado in the last decade) were checked in 2004. Pairs were found at 45 sites (96% occupancy) and 30 pairs of which I checked for production, reared 54 large young (1.80 young/pair).

DISCUSSION

How severe was the DDT/DDE induced decline in Colorado in the 1960s and 1970s? To what extent have peregrines become reestablished at sites vacated in those earlier periods? The biology and management of peregrines in Colorado, 1973–2001, have recently been summarized (Craig and Enderson 2004). From 1994–2001, annual occupancy rate was in the range of 82–89%, probably typical of the species. However, in 1963–65 and 1973–75 occupancy rates were 47% and 40% (Table 1), respectively. If these low rates represented the general condition, the population was depressed to about one-half in the early periods compared to the last decade.

Indeed, the low occupancy rate persisted for some time. In 1977 we visited 29 sites in Colorado and 11 pairs were found and in 1985, only six (21%) of those 29 sites were occupied by pairs (Enderson et al. 1988). In 2004, 96% of the sites surveyed ($N = 47$) had pairs of falcons. Documentation of further population increase and expansion of nesting pairs will depend on colonization (and our discovery) of sites not known to have held peregrines in the past.

It is tempting to speculate on the size of the pre-DDT peregrine population in Colorado and on the potential for further increase. A coarse estimate of total pairs at recently-used cliffs can be obtained by multiplying the approximate number of cliffs used in the last decade by the mean recently observed for occupancy rate (160 cliffs $\times$ 0.85 occupancy rate = 136 pairs). Craig and Enderson (2004) also estimated that there were another 250–300 potentially useable cliffs in the state where the falcons could nest without undue crowding. Because there is much suitable habitat in Colorado, I suggest that the total population might eventually double or even triple in size The current population plus this potential projected increase could also reflect the pre-DDT population size (250–400 pairs).

Productivity in 1963–65 was 1.2 young per pair on territory, and 0.7 in 1973–75. After that time, augmentation of broods from captive stocks with 229 peregrines through 1990 obscured natural reproduction. However, in the late 1970s and early 1980s, 22 non-augmented pairs averaged 1.2 young per pair (Craig and Enderson 2004). In 1995–2001, productivity averaged 1.7 young per pair (range 1.3–2.1). The current reproductive rate of 1.8/pair seen in 2004 is a marked improvement compared to the mid-1970s.

CAMBIOS EN LA OCUPACIÓN DE SITIOS Y DESEMPEÑO EN LA NIDIFICACIÓN DE *FALCO PEREGRINUS* EN COLORADO ENTRE 1963–2004

RESUMEN.—El halcón *Falco peregrinus* desapareció de muchos de los acantilados que utilizaban para nidificar en

las Montañas Rocosas en las décadas de 1960 y 1970. En el año 2004 revisé 15 de los 21 acantilados utilizados por *Falco peregrinus* en el pasado en Colorado para determinar los cambios en la ocupación y en las tasas de productividad. En el año 2004, la tasa de ocupación por pareja fue de un 87% en comparación con un 47% y un 40% entre 1963–65 y 1973–75, respectivamente. La tasa reproductiva basada en todas las parejas con territorios fue de 2.1 juveniles/pareja, en comparación con una tasa de 1.2 y 0.7 para los períodos anteriores, respectivamente. Se estima que 136 parejas nidifican en unos 160 acantilados donde *F. peregrinus* estuvo presente en la última década, pero el número real es seguramente mayor y podría aumentar a 250–400 parejas dada la estimación de la disponibilidad de hábitat apropiado.

[Traducción del equipo editorial]

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ANALYSIS OF RESERVOIR SELECTION BY WINTERING OSPREYS (*PANDION HALIAETUS HALIAETUS*) IN ANDALUSIA, SPAIN: A POTENTIAL TOOL FOR REINTRODUCTION

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KEY WORDS: *Osprey*; Pandion haliaetus; *reintroduction*; *predictive model*; *reservoirs*; *southern Spain*; *fish production*.

The extant Mediterranean Osprey (*Pandion haliaetus haliaetus*) breeding population is largely fragmented in Morocco, Corsica, and on a few islands from the Balearic and Canary archipelagos, which support isolated-remnant populations (González et al. 1992, Thibault et al. 1996). The disappearance of the Osprey as breeding bird in the coastal region of mainland Spain was due to the loss of suitable nesting sites resulting from the development of a tourist infrastructure (González et al. 1992) and human persecution (especially by theft of eggs or chicks). Ospreys have been extinct as a breeding species in continental Spain since the 1980s (González et al. 1992). However, Ospreys still winter in some parts of Spain. Historically, Andalusia was an important breeding area for this species in Spain, and currently is an important wintering and stopover area for migrant birds (Osterloff 1977, Saurola 1994).

Reservoirs are occupied extensively by breeding Ospreys in most of their range, but they are a relatively new ecosystem in Spain. Reservoirs of 150 ha or more covered 25 500 ha (0.3% of Andalusia) during the 1960s, but now cover twice this area (MOPU 1991). Construction of artificial impoundments may have enhanced the spread of Osprey populations in other areas due to habitat creation (Van Daele and Van Daele 1982, Houghton and Rymon 1997). Reservoirs often provide foraging advantages over rivers and lakes because they are shallow and open-water areas, with reduced turbidity that improve the detectibility of prey (Vana-Miller 1987 and references therein). An

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