

# THE ECOLOGY OF THE PEREGRINE FALCON IN ITALY: FIRST RESULTS FROM FIVE SAMPLE AREAS

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## ABSTRACT

This paper describes a national 'Peregrine Project', inaugurated in Italy in 1981 in order to obtain data on the ecology of the Peregrine Falcon in five sample areas. The resulting data are presented in terms of habitat, population density, breeding rates, diet and mortality. The problems of the species' conservation in Italy are also discussed.

## INTRODUCTION

Increasing robberies of Peregrines (*Falco peregrinus*) and their eggs during recent years and the almost complete lack of information on their distribution and numbers in Italy resulted in a national 'Peregrine Project', launched in 1981 by LIPU (the Italian League for the Protection of Birds), the main non-governmental organization in the field of bird preservation in Italy. The objective was to provide scientific data on the ecology of the Peregrine in five sample areas, as background for a national conservation programme on this species.

## TAXONOMIC PROBLEMS

The Peregrine is a cosmopolitan species (Voous 1962), of which 17 subspecies have been described (Glutz *et al.* 1971). Two of these breed in Italy: the nominate form (*F. p. peregrinus*) is confined to the north, whilst the Mediterranean form *F. p. brookei* breeds in central and southern Italy and the islands. According to Glutz *et al.* (1971), the two should come together in the central-northern part of the country, but Moltoni & Brichetti (1978) and Brichetti (1978) stressed the lack of breeding records for the nominate race in northern Italy. Following Vaurie (1961, 1965), Brichetti put the northern boundary of *F. p. brookei* along a hypothetical line from the Tyrrhenian coast (Arcipelago Toscano) northwards to the Tuscan Apennines, reaching Ancona on the Adriatic. According to Mingozi (1981) and Fasce, the Peregrines breeding in the Western Alps and Liguria should belong to *F. p. peregrinus*. Since there are no distinct geographical barriers which might produce a clear boundary between the two subspecies, we suppose a gradual

change in morphological characters along a north-south gradient, associated perhaps with temperature. This hypothesis should be checked by a critical re-evaluation of skins preserved in Italy and abroad, and also by modern field techniques.

## SAMPLE AREAS

The study areas for the population study included most of the representative Peregrine habitats in Italy, with the exception of the central and eastern Alps and the central and southern Apennines. Each sample area was covered by independent groups or single ornithologists, all with considerable experience in raptor research.

**(1) Western Alps (Liguria, Piemonte and Valle d'Aosta).** The total area comprised about 34,000km<sup>2</sup>. Due to their geological formation, consisting mainly of granites and schists, the Western Alps provide few nesting places for the Peregrine. Fasce (Genova) and Mingozi, responsible for this area, began their surveys in 1979 and have covered about 75 percent of the available habitat.

**(2) Northern Apennines (Emilia-Romagna).** About 4000km<sup>2</sup>, ranging along an altitudinal gradient from 100m to 1000m above sea level. The N. Apennines are relatively uniform, with sedimentary rocks offering a great number of potential breeding sites for cliff-nesting raptors. Chiavetta (Bologna), who carried out the 1981 survey, has been working since 1971 on the ecology of the Peregrine and Lanner Falcon (*Falco biarmicus*) and has covered about 80 percent of the suitable habitat.

**(3) Latium (Lazio).** 25km of calcareous sea-cliffs of the mainland, and also of some smaller islands of the Pontian Archipelago. Saracino (Latina) was responsible for the 1981 survey, carried out with the working group of the local LIPU section. They were able to cover about 70 percent of the available habitat.

**(4) Sicily.** From 1978 to 1981 a study was made of the Peregrine in Western Sicily (excluding the southernmost parts of Palermo province), including some calcareous areas of Messina and Syracuse provinces as well as some small adjacent islands—an area of roughly 6000km<sup>2</sup>. The 1981 research was co-ordinated by Falcone (Bagheria) and Massa (Palermo), with a coverage of about 80 percent.

**(5) Sardinia.** The sample areas comprise calcareous, basaltic and limestone sea-cliffs along the western, eastern and southern coast, plus several small islands, altogether totalling about 260km<sup>2</sup>; and 7000km<sup>2</sup> in the east-central, southern and northwestern part of the island. Schenk (Cagliari), working since 1971 on the Peregrine in Sardinia, conducted the 1981 survey and was overall co-ordinator of the project; he obtained coverage of about 90 percent of the coastal areas and 75 percent of the inland areas.

## RESULTS

### Distribution and numbers

The Peregrine in Italy is confined to hilly and mountain areas where it nests on crags and sea-cliffs. The species is absent only from the Po valley and several of

the larger plains, e.g. the Sardinian Campidano. In parts of the Apennines and in Sicily it occupies the same habitat as the Lanner Falcon, but it is not known whether the two species compete (Bonora & Chiavetta 1975; Chiavetta 1976). Similarly, little is known of the relationship between the Peregrine and the Eagle Owl (*Bubo bubo*) in large parts of the Alps and Apennines.

**Western Alps.** In this area, Fasce and Mingozzi estimated the presence of 15–18 pairs of Peregrine, suggesting a total population in the Italian Alps of 40–50 pairs.

**Northern Apennines.** Here Chiavetta estimated a population of nine breeding pairs in the sample area of about 4000km<sup>2</sup>. According to the same author (1981), the total Apennine population could reach 100 pairs approximately (cf. Mirabelli 1979).

**Latium.** The census in this rather limited sample area produced six confirmed breeding pairs (Saracino).

**Sicily.** In the 6000km<sup>2</sup> of the sample areas, Massa and Falcone confirmed 70 occupied sites and extrapolated on this basis the presence of about 90 pairs, estimating the total Sicilian population at about 150 breeding pairs.

**Sardinia.** In the 7000km<sup>2</sup> of the inland sample areas and along the 260km of sea-cliffs, Schenk found 96 breeding pairs, suggesting a total population of 130–160 breeding pairs (Schenk 1977, 1981).

Few data are available for regions not covered along the Tyrrhenian and Adriatic coasts for several small islands (Tremi, Arcipelago Toscano, Capraia and others). An estimate of 30–40 pairs seems reasonable (cf. Moltoni & Di Carlo 1970; Moltoni 1975; Spina 1978).

Figures are summarized in *Table 1* on the number of confirmed, probable and possible breeding pairs in these five areas, and an estimate is given of the population for the whole country. The combined sample areas cover about 51,700km<sup>2</sup>, where the presence of 192 pairs has been confirmed, and the total

*Table 1:* Breeding pairs of Peregrines in Italy, 1981.

Sample	Number of confirmed pairs in sample area	Number of confirmed, probable and possible pairs in sample area	Number of possible pairs outside sample areas	Number of possible pairs in whole region
Western Alps	13	(15–18)	—	—
Central and eastern Alps	—	—	(25–32)	—
Italian Alps	—	—	—	(40–50)
Northern Apennines	7	(9)	—	—
Total Apennines	—	—	(91)	(100)
Latium Area	6	(8)	—	(8)
Sicily	70	(90)	(60)	(150)
Sardinia	96	(115–137)	(15–23)	(130–160)
Coastal areas and small islands not included in census	—	—	(30–40)	(30–40)
Italy	192	(237–262)	(221–246)	(458–506)

could reach 237–262 pairs. For the remaining areas we estimate another 221–246 breeding pairs, so that the total Italian population could be tentatively placed in the range of 458–506 pairs. Despite possible errors, this estimate is considerably higher than that of 250–270 pairs given by Chiavetta (1981). The difference can be partly ascribed to a certain recovery of numbers in some areas (Northern Apennines), but mainly to a previous underestimate of the numbers in Sicily and Sardinia, these being the most important strongholds of the Peregrine in Italy.

### Habitat

In Italy the species nests at altitudes ranging from sea-level to 1300m; exceptionally it has been found breeding at 2000m (Western Alps). One essential requirement is a sufficient number of cliffs with suitable ledges and cavities, but occasionally old stick nests of Raven (*Corvus corax*) and Golden Eagle (*Aquila chrysaetos*) have been used. Nearly all sites are on cliff faces with easy access from the air and a wide view of the surrounding landscape. Other requirements are a relatively undisturbed, partly open environment, and an abundance of prey species (mainly medium- and small-sized birds).

**Western Alps.** The altitude of 12 sites varied between 700m and *c.* 2000m above sea level, with an average of about 1050m. All were situated on ledges or in cavities in cliffs about 100m high and not necessarily vertical. The 2000m site seems to be the highest recorded in Europe (Fasce). Most eyries were found in the upper half of the cliff, only exceptionally in the lower half.

**Northern Apennines.** The altitude of the 11 occupied sites in the area varied between 300m and 800m above sea level. The nests were in cliffs of 20m–200m. Of all 23 known sites (partly outside the study area), 18 (78.5%) were in cavities and 5 (21.5%) on narrow ledges.

**Latium.** In the coastal zone five sites were found at an average height of 28m, ranging between 11m and 60m above sea level. All nests were in the upper third of the cliff, 15–60m high. Four sites were in cavities (80%) and one on a ledge (20%).

**Sicily.** Of 70 recorded sites, 22 (31.4%) were defined as coastal and 48 (68.6%) as inland. The altitude of 61 classified eyries varied between 50m and 1145m above sea level, with an average of 580m. They were found in the upper third of the cliff in 80 percent of all observed cases, in the central part in 15 percent, and in lower positions in 5 percent, but always under an overhang. Overall, 83 percent of the nests were in cavities in calcareous cliff faces; 17 percent were on narrow ledges.

**Sardinia.** The average altitude of 45 coastal sites was about 110m above sea level, varying between 20m and about 580m. Seventeen inland sites varied between 350m and 1300m above sea level, with an average of about 735m. All were in the upper half of the cliffs. Of the 62 classified sites, 48 (77.4%) were in cavities, 10 (16.1%) on ledges and 4 (6.5%) in old Raven's nests.

Summarizing 175 known sites, 100 (57%) were inland and 75 (43%) coastal. Among sea-cliff eyries, Sardinian sites totalled 45 (60%) followed by Sicily with 29 percent, Latium with 8.3 percent and Liguria with the remaining 2.7 percent. On the other hand, 49 percent of all inland sites were found in Sicily, followed by the Northern Apennines (23%), Sardinia (17%) and the Western Alps (12%). Their average altitude was as high as 1050m in the Western Alps and as low as 28m



and 110m in Latium and Sardinia respectively (sea-cliffs). These differences seemed to depend on the relative abundance of suitable cliffs and prey species. None of the Western Alps nesting-cliffs was lower than 100m, in contrast to all other inland areas, which apparently had a higher human impact on the habitat. Site characteristics were relatively uniform in all five areas. About 80 percent of all eyries were situated in small- and medium-sized cavities, 20 percent on ledges, nearly all in the upper half of the cliff face.

### Density

In *Table 2*, density figures are expressed as linear distances between occupied sites and as pair density per unit area. This is reported separately for certain pairs only and for certain plus uncertain pairs in four of the five areas, extended in Sicily and Sardinia to the whole region, where the degree of coverage has also been taken into account. In the national context, density values in the Western Alps should be considered very low, in the Northern Apennines medium, in Sardinia high and in Sicily particularly high, especially considering the presence of the sympatric Lanner Falcon.

### Breeding rates

**Western Alps.** Of 21 territorial pairs, 12 (57%) reared young. The fledging rate (mean number reared per successful pair) was 2.58, the highest found in the five sample areas, whilst productivity (mean number of young per territorial pair) was 1.48. Of twelve successful broods recorded, five contained two young and seven contained three young. Of the nine non-breeding pairs, three were composed of an adult male and an immature female, which might account for their not breeding. For the other six pairs, no possible causes for breeding failure were found but robbery and other human factors could be excluded. The Peregrine population of the Western Alps was thus characterized by a low breeding density, perhaps near carrying capacity of suitable habitats, by a sub-optimal population structure and by little (if any) human disturbance.

**Northern Apennines.** Of 37 territorial pairs, 19 (51%) reared young successfully. The fledging rate was 2.32 and productivity very low at 1.19. Of nineteen broods recorded, three pairs produced one young; eight pairs two young; seven pairs three young, and one pair four young. Of eighteen unsuccessful pairs, five hatched young which were taken by poachers, while seven failed to lay or laid infertile eggs. The causes of failure of the remaining six pairs were unknown.

The population of this region was thus characterized by a medium breeding density, probably below carrying capacity of the area, by a medium fledging rate and low productivity, mainly caused by human interference (robberies) and probably by competition with other predators, although pesticide contamination could not be excluded.

**Latium.** This small population was studied only in 1981. Of six territorial pairs, only three reared young. The fledging rate was 2.33 and overall productivity was low at 1.17; both figures were identical with the Northern Apennine ones. Of the three successful broods recorded, two pairs reared two young, and one pair reared three young. One of the unsuccessful pairs was composed of an adult male and an immature female, one other pair laid at least two eggs, while the failure of the third could probably be attributed to natural predators or human disturbance. In judging this population, based on very few data, robberies and other human interference should be considered as possible limiting factors.

Table 2: Density of Peregrines in Italy (1971–81).

Region	Linear distance between neighbouring sites (km)			Minimum area per pair in sample area (km <sup>2</sup> )	Possible area per pair in sample area (km <sup>2</sup> )	Possible density in whole region (km <sup>2</sup> per pair)
	Minimum	Average	Maximum			
Western Alps (34,000km <sup>2</sup> )	5.7	—	71.0	2.615 (n = 13)	1.890 (n = 18)	—
Northern Apennines (4000km <sup>2</sup> )	10.5	—	29.0	571 (n = 7)	444 (n = 9)	—
Sicily (6,000km <sup>2</sup> in sample area) (25,708km <sup>2</sup> in whole island)	2.0	—	5.0	86 (n = 70)	67 (n = 90)	171 (n = 150)
Sardinia (260km <sup>2</sup> sea-cliffs)	1.5	4.0	—	4.1 (n = 63)	3.5 (n = 75)	—
Sardinia (7,000km <sup>2</sup> in sample area) (24,090km <sup>2</sup> in whole island)	2.2	4.0	5.0	212 (n = 33)	175 (n = 40)	185–151 (n = 130–160)

Note: Gaps indicate inadequate data.

Table 3: Breeding rates of Peregrine Falcon in Italy, 1971–81.

Parameter	Western Alps	Northern Apennines	Latium	Sicily	Sardinia	Overall Italy
Number of pairs controlled	21	37	6	56	32	152
Number (percentage) of pairs that reared young	12 (57%)	19 (51%)	3 (50%)	51 (91%)	23 (72%)	108 (71%)
Number of chicks taking flight	31	44	7	115	55	252
Mean number of young per pair	1.48	1.19	1.17	2.05	2.72	1.66
Mean brood size in surveyed nests	2.58	2.32	2.33	2.25	2.39	2.33

Table 4: Breeding rates of Peregrines in Italy, Great Britain, France and Spain (1939–81).

Parameter	Sicily (1978–81)	Italy (including Sicily) (1971–81)	England (1939–40) <sub>1</sub>	Scotland (1964–71) <sub>2</sub>	Central France (1974–77) <sub>3</sub>	Spain–Pyrenees (1979) <sub>4</sub>
No. of territorial pairs	56	152	34	125	118	14
No. (%) of pairs which reared young	51 (91%)	108 (71%)	24 (71%)	70 (56%)	85 (72%)	7 (50%)
No. of young fledged	115	252	(58)	(168)	210	22
Mean no. of young per pair	2.05	1.66	1.71	1.34	1.78	1.57
Mean brood size in surveyed nests	2.25	2.33	2.42	2.40	2.47	3.14

Notes: 1. Data reported by Ryves (1948) in Newton (1979).

2. Data reported by Weir, in Brown (1976), quoted by Newton (1979).

3 and 4. Data reported by AWU, Meyburg (1981), Newsletter no. 4, World Working Group of Birds of Prey and Owls, ICBP.

**Sicily.** The productivity of 2.05 and the percentage of successful breeding pairs at 91% (51 out of 56 pairs) were the highest values recorded. 2.25 reared young per successful pair was the lowest rate assessed, although it is only three percent below the national average of 2.33 (*Table 3*). Of fifty-one broods recorded, four pairs produced one young; thirty-one pairs produced two young, fourteen pairs produced three young and two pairs produced four young. The high percentage of pairs that produced only one or two young (68.6%) seemed to be associated with high breeding density and intraspecific competition, possibly due to food shortage. Of five unsuccessful pairs, only one nest was robbed by poachers, whilst the causes of failure of the other four pairs are unknown.

The Sicilian population was thus characterized by a particularly high breeding density, high productivity and a medium fledging rate. Poaching and other human disturbance seem limited and intra-specific competition was thought to be the main critical factor.

**Sardinia.** Of 32 territorial pairs, 31 (97%) laid eggs, 28 (88%) hatched young and only 23 (72%) successfully reared young. This last value was considerably higher than the figures for the Western Alps, Northern Apennines and Latium areas. The Sardinian fledging rate was relatively high at 2.39, as was productivity at 1.72.

Of twenty-three successful broods recorded, six contained one young; six contained two young; seven contained three young, and four contained four young. Of twenty-eight pairs which hatched young, five produced one young, seven produced two young, ten produced three young and six hatched four young, showing a mean brood-size of 2.61. Of the pairs, 57.1 percent produced three or four young, suggesting a relatively high fertility of the population and a sufficient food supply.

Of the four pairs without hatching success, three laid eggs ( $1 \times 2$ ,  $1 \times 3$  eggs, and one with eggshells in the nest) and the causes of failure were attributed in two cases to human disturbance and in one case perhaps to broken eggs due to pesticide contamination. The remaining pair (2 adults) failed to lay.

Of 73 young hatched by 28 pairs, 17 were robbed by poachers (totally or partially plundered nests) and one young died at an early stage, giving a survival of hatched young of 75 percent. Without depredation of young, the fledging rate would have been 2.57 (equalling the Western Alps value), and productivity (mean number of young reared per territorial pair) 2.25—theoretically the highest value in the five sample areas.

The Sardinian Peregrine population, particularly the coastal one (91% of the territorial pairs controlled), was thus characterized by a high breeding density, a sufficient food supply and a normal fertility. The success rate, however, was considerably reduced by robberies of young falcons and other human disturbance. Only one pair seemed to be affected by pesticide contamination. Both the fledging rate and productivity were amongst the highest in the five sample areas.

## SYNTHESIS OF SAMPLE AREAS AND COMPARISON WITH OTHER EUROPEAN POPULATIONS

The essential parameters concerning breeding rates in the five sample areas are summarized in *Table 3*, which also shows values for the whole of Italy, based on the results obtained in the various regions.

Of 152 territorial pairs under observation during 1971–81, 108 (71%) reared

young successfully, varying from 50 percent in Latium to 91 percent in Sicily. The mean fledging rate was 2.33, varying from 2.25 in Sicily to 2.58 in the Western Alps. Mean productivity was 1.66, varying from 1.17 in Latium to 2.05 in Sicily, and was correlated with the percentage of successful pairs. Robberies were frequent in the N. Apennines and Sardinia and seemed, together with other human disturbances, the main factors limiting the breeding success in these regional populations.

Breeding data from Sicily, and the mean Italian values, are compared in *Table 4*, together with figures obtained from elsewhere in Europe. The English figures are from Peregrines not affected by pesticides and show few differences from the Italian ones. Productivity was only three percent higher in England than in Italy, while productivity in Sicily exceeded that in England by 20 percent. These figures allow us to exclude the possibility that the Italian and Sicilian populations are significantly affected by pesticides.

This judgement is supported by comparisons with other populations outside Italy, where productivity varies from 1.57 (Pyrenees) to 1.78 (central France) and fledging rate from 2.47 (central France) to 3.14 (Pyrenees), but where active site surveillance has helped to reduce human interference.

Finally, a productivity of 2.05 in Sicily is among the highest recorded for Peregrines anywhere.

## FOOD

Information on food of the Peregrine in Italy was available only from Sicily and Sardinia. These data were mainly from the breeding period and were based on analyses of prey remains from different sites. Some data were from direct hunting observations outside the breeding habitat and for other than the breeding season.

**Sicily.** Falcone & Seminara (1981) analysed 271 prey items from 7 nests, 117 pellets (cf. Massa 1981), and included 11 direct hunting attacks. Some 227 prey items of at least 38 bird species were identified, totalling about 21,756g. The mean weight of a single prey species was 95.8g, ranging in size from 12g (Sardinian Warbler) to 300g (Rock Dove, Barn Owl and Montagu's Harrier). It seems that the Barn Owl and Montagu's Harrier were recorded for the first time among the prey species of the Peregrine (Newton 1979). Starling, Goldfinch and Rock Dove were the most frequent prey, representing 41 percent of the total, while 31.7 percent of the prey-biomass was formed by Rock Dove, followed by Starling (13.2%), Waterhen (6.4%) and Magpie (5.5%).

**Sardinia.** Results from prey analyses of six Sardinian coastal sites during the nestling period (April–May) are shown in *Table 6*, which also contains five direct observations of successful hunting attacks. 107 birds of 24 species were recorded, giving a total biomass of about 12,668g and an average weight of 118.4g, varying from 12g (Sardinian Warbler) to 450g (Little Egret).

The most frequent prey species was the Rock Dove (17.8%), followed by Hoopoe (15%), Turtle Dove (11.2%), Quail and Common Swift (each with 7.5%). Of the total prey biomass 45 percent was formed by the Rock Dove, underlining the importance of this species for coastal Peregrines in Sardinia; another 15.2 percent of the biomass was formed by the Turtle Dove, followed in descending order by Hoopoe (8.8%) and Quail (7.6%). About 78.5 percent of the 107 prey items, corresponding to 53.6 percent of prey by weight, were from 19 migratory species which follow the Sardinian coasts in spring. Only 22 (20.7%)

Table 5: Prey items of Peregrines in Sicily (1978–80). from Falcone &amp; Seminara (1981).

Species	Number	Average weight (g)	Biomass (g)	Percentage	
				Numerical	Biomass
<i>Sturnus vulgaris</i>	36	80	2,880	15.9	13.2
<i>Carduelis carduelis</i>	34	20	680	15.0	3.1
<i>Columba livia</i>	23	300	6,900	10.1	31.7
<i>Sturnus unicolor</i>	13	80	1,040	5.7	4.8
<i>Carduelis chloris</i>	13	30	390	5.7	1.8
<i>Fringilla coelebs</i>	9	25	225	4.0	1.0
<i>Passer hispaniolensis</i>	9	25	225	4.0	1.0
<i>Emberiza cirrus</i>	9	25	225	4.0	1.0
<i>Oriolus oriolus</i>	8	75	600	3.5	2.8
<i>Pica pica</i>	6	200	1,200	2.6	5.5
<i>Gallinula chloropus</i>	5	280	1,400	2.2	6.4
<i>Cuculus canorus</i>	5	100	500	2.2	2.3
<i>Apus apus</i>	5	45	225	2.2	1.0
<i>Falco tinnunculus</i>	4	200	800	1.8	3.7
<i>Corvus monedula</i>	4	230	920	1.8	4.2
<i>Turdus philomelos</i>	4	70	280	1.8	1.3
<i>Acanthis cannabina</i>	4	20	80	1.8	0.4
<i>Streptopelia turtur</i>	3	160	480	1.3	2.2
<i>Upupa epops</i>	3	70	210	1.3	1.0
<i>Turdus merula</i>	3	100	300	1.3	1.4
<i>Phoenicurus ochruros</i>	3	15	45	1.3	0.2
<i>Luscinia megarhynchos</i>	3	20	60	1.3	0.3
<i>Emberiza calandra</i>	3	50	150	1.3	0.7
<i>Tyto alba</i>	2	300	600	0.9	2.8
<i>Otus scops</i>	2	75	150	0.9	0.6
<i>Galerida cristata</i>	2	40	80	0.9	0.4
<i>Circus pygargus</i>	1	300	300	0.4	1.4
<i>Tringa nebularia</i>	1	150	150	0.4	0.7
<i>Tringa glareola</i>	1	60	60	0.4	0.3
<i>Sterna hirundo</i>	1	125	125	0.4	0.6
<i>Chlidonias niger</i>	1	60	60	0.4	0.3
<i>Pyrhocorax pyrrhocorax</i>	1	270	300	0.4	1.4
<i>Monticola solitarius</i>	1	80	80	0.4	0.4
<i>Erithacus rubecula</i>	1	16	16	0.4	0.07
<i>Oenanthe oenanthe</i>	1	25	25	0.4	0.1
<i>Phoenicurus phoenicurus</i>	1	18	18	0.4	0.08
<i>Sylvia melanocephala</i>	1	12	12	0.4	0.06
<i>Alauda arvensis</i>	1	40	40	0.4	0.2
38 species	227	—	21,756	99.9%	100.1%

Notes: 44 unidentified prey items.

Average weight of prey: 95.8g.

prey items (but forming 47.7% of food biomass) belonged to 4 species which bred inside a semi-circle (radius 1km) around the eyrie, while the remaining prey items (0.9%) could belong to either migratory or breeding species.

Although rather limited, these figures show the dependence of the coastal Peregrines during the nesting period on various migratory birds and also on Rock Dove, which breed in the same habitat as the falcons. The correspondence between spring migration across the Mediterranean and the breeding cycle of coastal Peregrines may represent an adaptation similar to that of Eleonora's Falcon (*Falco eleonora*), which raises young on autumn migrants (Walter 1979).

Table 7 gives some post-breeding and winter prey items of the Peregrine taken from prey analyses and direct hunting observations in two southern Sardinian

Table 6: Prey items of Peregrines during the nesting period in Sardinia (1975–81).  
Key: b = breeding species; m = migratory species

Species and status	Number	Average weight (g)	Biomass (g)	Percentage	
				Numerical	Biomass
<i>Columba livia</i> (b)	19	300	5,700	17.8	45.0
<i>Upupa epops</i> (m)	16	70	1,120	15.0	8.8
<i>Streptopelia turtur</i> (m)	12	160	1,920	11.2	15.2
<i>Coturnix coturnix</i> (m)	8	120	960	7.5	7.6
<i>Apus apus</i> (m)	8	45	360	7.5	2.8
<i>Turdus philomelos</i> (m)	7	70	490	6.5	3.9
<i>Caprimulgus europaeus</i> (m)	5	80	400	4.7	3.2
<i>Hirundo rustica</i> (m)	5	20	100	4.7	0.8
<i>Oenanthe oenanthe</i> (m)	4	25	100	3.7	0.8
<i>Lanius collurio</i> (m)	3	30	90	2.8	0.7
<i>Jynx torquilla</i> (m)	3	40	120	2.8	0.9
<i>Oriolus oriolus</i> (m)	3	75	225	2.8	1.8
<i>Saxicola rubetra</i> (m)	2	18	36	1.9	0.3
<i>Carduelis chloris</i> (m)	2	30	60	1.9	0.5
<i>Egretta garzetta</i> (m)	1	450	450	0.9	3.6
<i>Ixobrychus minutus</i> (m)	1	120	120	0.9	0.9
<i>Cuculus canorus</i>	1	100	100	0.9	0.8
<i>Otus scops</i> (m)	1	75	75	0.9	0.6
<i>Melanocorypha calandra</i> (m/6)	1	65	65	0.9	0.5
<i>Alauda arvensis</i> (m)	1	40	40	0.9	0.3
<i>Luscinia megarhynchos</i> (m)	1	20	20	0.9	0.16
<i>Sylvia melanocephala</i> (b)	1	12	12	0.9	0.09
<i>Monticola solitarius</i> (b)	1	80	80	0.9	0.6
<i>Emberiza cirrus</i> (b)	1	25	25	0.9	0.2
24 species	107	—	12,668g	99.8%	100.05%

Notes: 3 unidentified *Passeres*.

Average weight of prey: 118.4g.

Table 7: Prey items of the Peregrine during the post-breeding and winter period in Sardinia (1971–81).

Species	Number	Average weight (g)	(g)	Percentage	
				Numerical	Biomass
<i>Sturnus vulgaris</i>	21	80	1,680	58.3	34.6
<i>Larus ridibundus</i>	2	260	520	5.6	10.7
<i>Sterna hirundo</i>	2	125	250	5.6	5.1
<i>Sterna albifrons</i>	2	45	90	5.6	1.9
<i>Anas clypeata</i>	1	800	800	2.8	16.5
<i>Pluvialis apricaria</i>	1	180	180	2.8	3.7
<i>Tringa totanus</i>	1	120	120	2.8	2.5
<i>Tringa glareola</i>	1	60	60	2.8	1.2
<i>Larus argentatus</i>	1	1,000	1,000	2.8	20.6
<i>Larus minutus</i>	1	110	110	2.8	2.3
<i>Pipistrellus pipistrellus</i>	3	15	45	8.3	0.9
11 species	36	—	4,855g	100.2	100.0

Average weight of prey item: 134.9g.

wetlands near Cagliari. Between October and March, two or three Peregrines regularly hunted Starlings, when tens of thousands of these birds approached their roosts in the reed-beds of the 'Stagno di Molentargius'. All three *Pipistrellus pipistrellus* were taken by an adult male in December and February at dusk at an altitude of 10–15m above the water surface.

## MORTALITY AND POPULATION STABILITY

The primary population parameters that influence density and numbers of any bird species are natality (breeding rate), mortality, immigration and emigration (Krebs 1972). Neglecting immigration and emigration, breeding success and mortality would mainly affect the numbers of the Peregrine in Italy. Unfortunately there are no figures available on mortality estimates in Italy calculated from ring-recoveries. The mortality rates for adult Peregrines reported from Sweden, the United States, Finland and Germany (Newton 1979) vary between 19 percent (Finland) and 32 percent (USA), with an average value of 26 percent. These rates should apply also to Italian populations which are not seriously affected by pesticides.

With the knowledge of the annual mortality of adults, the age of first breeding (which normally occurs in the second year), and the productivity observed in the five Italian sub-populations, we can calculate the possible annual mortality of young during their first year of life that still guarantees a stable population. Mebs (1971) provides the following formula:

$$(1) \quad f = \frac{2m}{(1 - q)(1 - m)}$$

where

$f$  = productivity (mean number of young reared per territorial pair)

$m$  = average mortality rate of adults

$q$  = average mortality rate of young during their first year of life.

Consequently the first year mortality is

$$(2) \quad q = 1 - \frac{2m}{f(1 - m)}$$

Maximum possible mortality rates of young Peregrines without causing a decline of numbers of territorial pairs would be 0.53 (53%) in the Western Alps, 0.41 (41%) in the Northern Apennines, 0.40 (40%) in the Latium area, 0.66 (66%) in Sicily, 0.59 (59%) in Sardinia, giving an Italian average of 0.58 or 58 percent. If these values are exceeded, the populations decline. If mortality is lower and the number of breeding pairs is limited by the varying capacity of the environment, some of the surplus birds will presumably emigrate to areas where Peregrine densities are below the carrying capacity of the available habitats. This upper limit of maximum possible mortality rates of young Italian Peregrines is considerably lower than the mortality rates derived from ring-recoveries in the United States (0.70), Finland (0.71) and Germany (0.70), where the populations have suffered a strong decline in recent decades (cf. Newton 1979; Mebs 1971). If Italian mortality rates were close to these values, the number of breeding pairs, with the exclusion of the Sicily population, would also decline.

Taking as a reference the number of pairs which reared young, and not the number of territorial pairs, including then the fledging rate in substitution of



productivity in formula (2), we obtain for the young Italian Peregrines the following maximum possible mortality rates that guarantee stability of the present population: 0.73 (73%) in the Western Alps, 0.70 (70%) in the Northern Apennines, 0.70 (70%) in the Latium area, 0.69 (69%) in Sicily, 0.71 (71%) in Sardinia and 0.70 (70%) as the overall average for Italy. These figures correspond perfectly to those reported for Finland and the United States (Newton 1979) and to those supposed by Mebs (1971) for Germany.

The theoretically-obtained Italian values should be verified in the near future by real mortality estimates from population studies, including ringing programmes, at least in certain sample areas (Sicily, Sardinia).

## CONSERVATION

With the enactment of the new national hunting law early in 1979, the Peregrine and all other birds of prey were legally protected. Some Regional Governments had accorded protection previously (Emilia-Romagna, Piemonte, Sardinia), but none before 1974. Penalties for poachers of Peregrines have increased appreciably, for example in Sardinia to five million Lire (about 6000 US dollars), though as yet surveillance is still insufficient. Unfortunately there are no, or very few, protected areas of habitat for this species, due to the lack of national or regional laws concerning natural reserves and parks. Robberies of young falcons and eggs by Italian poachers and falconers coming from abroad are frequent, especially in the Northern and Southern Apennines, Sicily (outside sample areas) and Sardinia. According to Hepp (1982), at least 200 Peregrines and their eggs were illegally imported from Italy into the Federal Republic of Germany in 1981. In the same year twelve young Sardinian Peregrines were confiscated from an Italian poacher in the first anti-poaching action realized by LIPU and the 'Guardia di Finanza' of Genova, and seven of these were successfully reintroduced into the eyries of wild Peregrines. Since the Peregrine is considered the most sought-after bird of prey in Europe and the Middle East, with an increasing black market, its conservation and management will be effective only if organized in an international framework which should be possible at least within the European Community, with the participation of governmental and qualified non-governmental conservation organizations. The legal and technical background for such a programme is given by 'Directive n. 409/1979' of the EEC and the Washington Convention. At the Italian level, it would be useful to organize a national Peregrine Working Group with the objectives of monitoring population parameters and coordinating site-surveillance to increase the number of successful breeding pairs, which in four (Western Alps, Northern Apennines, Latium, Sardinia) of the five sample areas reached only 59.4 percent of all territorial pairs, due to robberies and other human disturbance.

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