

STATUS OF THE PEREGRINE FALCON IN THE ROCKY MOUNTAINS IN 1973

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THIS is a report on eyrie occupancy, reproductive success, eggshell condition, and chlorinated pesticide residues for Peregrine Falcons (*Falco peregrinus*) nesting mainly in the region from northern New Mexico to southern Montana in 1973. Also included is a summary of eyrie occupancy of Peregrines in the region for the period 1964–72. The purpose of our work is to determine whether this regional population is involved in the population declines reported for the species in much of the contiguous United States (Hickey 1969) and in several parts of Canada and Alaska (Cade and Fyfe 1970). Our study area was surveyed for Peregrines in 1964 (Enderson 1965), and many former eyries were unoccupied at that time. Surveys carried out in 1973 and in the interim suggest that poor reproductivity and a gradual decline in active eyries has continued.

EYRIE SURVEY

Between 1 March and 19 July 1973 we traveled over 7000 miles visiting 28 known Peregrine Falcon eyries in the central Rocky Mountain region. In addition we obtained reliable reports on the status of seven other eyries we were unable to visit. Table 1 compares the occupancy of these 35 territories with similar data gathered since 1964 by Enderson. The most thorough surveys of Peregrine territories made by Enderson were in 1964, 1965, 1969, and 1972, but Table 1 also includes information obtained retrospectively from qualified observers. Data are scanty for 1967 and 1970 when only a few usually occupied eyries were visited, and for 1966 and 1968 when much of the available information came from other workers. Not included in Table 1 are a few ambiguous reports of nesting Peregrines where the location of the eyrie is uncertain.

Of the 35 eyries visited in 1973, 14 had pairs, including three found in 1973. Thus only 11 of 32 formerly occupied eyries visited in 1973 had pairs.

Table 2 summarizes the information available on 10 territories that were observed in at least 5 years in the 1964–72 period, prior to the thorough survey in 1973. These tend to be well-established, and the majority were occupied in the years they were visited.

SURVEY OF OTHER SUITABLE HABITATS

In the period 1964–72 our fieldwork rarely disclosed new, unreported eyries. Enderson found two new territories in 1965. Most of the eyries

TABLE 1
OCCUPANCY OF PEREGRINE FALCON EYRIES 1964-73

	Year									
	64	65	66	67	68	69	70	71	72	73
Eyries with data	20	16	3	4	6	25	6	10	17	35
Pairs	9	8	2	3	3	8	5	5	10	14
Lone Adults	4	6	0	1	1	0	0	2	2	2

in the region were found by other workers. To estimate how frequently nesting Peregrines might be found if a reconnaissance of apparently ideal cliffs in suitable habitats was conducted, we visited 23 such places in 1973 where, to our knowledge, no Peregrines had ever been reported. These cliffs, not previously searched, included 19 in Colorado, 2 in New Mexico, 1 in Montana, and 1 in Wyoming. We found a pair of Peregrines on one of these, and saw what appeared to be an adult Peregrine at one of the others, but the rugged terrain prevented our confirming the sighting. At one of the other cliffs we saw an adult Peregrine wearing falconer's bells, but nesting was doubtful. Other raptors encountered in this exploration included six pairs of Prairie Falcons (*Falco mexicanus*) and two pairs of Golden Eagles (*Aquila chrysaetos*); 12 localities were unoccupied. We conclude that the number of Peregrines in the region in addition to the known eyries is probably not great and that new eyries will be found only as the result of a great deal of searching or by occasional "accidental" discovery, as were two in 1973, one of them by Craig.

REPRODUCTIVE SUCCESS

The 1973 survey disclosed very poor reproductive success with 14 pairs fledging only three young. Active eyries were usually visited prior to egg-laying and observed with a spotting telescope, and often more than

TABLE 2
OCCUPANCY OF TEN PEREGRINE EYRIES MOST STUDIED
IN THE PERIOD 1964-1972¹

	Year									
	64	65	66	67	68	69	70	71	72	
No. eyries visited	7	10	1	4	3	10	5	8	10	
No. eyries with pairs	5	6	1	3	2	6	4	4	6	
No. eyries with lone adults	2	4	0	1	1	0	0	2	2	

¹ Includes only eyries visited in at least 5 years in the period 1964-72.

TABLE 3
RESULTS OF PEREGRINE NESTING ATTEMPTS IN 1973

Eyrie	Visits	Eggs	Young	Results
1	7	3	0	Adult present 4 March; copulation, incubation 7 May; three eggs (1 spoiled) 17 May; pair inattentive 5 June (rock climbers in eyrie)
2	10	+ ²	0	Copulation 5 April; incubation 2 May; clutch broken 7 May; shell fragment and spoiled egg on new ledge 25 May
3	4	?	0	Pair absent early in season; not incubating in middle of incubation period; not present in early summer etc.
4	7	0	0	Pair seen once, lone birds on two visits; no evidence of nesting.
5	7	+ ¹	0	Copulation seen 1 March, 13 May; pair visited ledges in mid-May; incubated in mid-June in apparent re-nesting attempt; pair absent 19 July.
7	2	2	1	One nearly fledged young and one spoiled egg in late June.
8	13	3	2	Copulation 10 March and through early April; laying 11 April; chose new ledge 16 April; incubating 21 April; three eggs 19 May; two 2-week-young 5 June; young near fledging in late June; young flying early July.
9	4	+ ²	0	Probable incubation 5 May, incubation 26 May; ledge empty, female passive 31 May.
10	2	1	0	Female carried food to ledge 25 May; one spoiled egg only 31 May, female incubating.
11	2	+ ²	0	Incubation in May, ledge empty in early June.
14	2	?	?	Male on cliff 14 May, incubation possible; pair flying and perching, young unlikely 9 June.
15	2	?	0	Copulation and ledge scraping 14 May; lone adult passive 18 July, no young.
16	2	?	0	Copulation, no incubation in mid-June; male only 19 July, nest very doubtful.
17	3	?	0	Pair flying and vocal 12 April; present, possibly pair 16 June, no young 17 June.

¹ Nest ledge inaccessible.

² Number of eggs undetermined.

once in the incubation period (Table 3). Of the 14 pairs, only eight are known to have laid eggs, although five other pairs may have had clutches or small young that were lost.

We were able to rope to the ledges of five of the eight pairs known to

TABLE 4
 PEREGRINE FALCON EGG SHELL CONDITION IN 1973
 WITH PRE-1947 VALUES FOR COMPARISON

Eyrie ¹	Year	Thickness index	Thickness (mm) ²	Shell weight (g)
1	1973	1.62	0.325	3.86
2	1973	1.52	0.305	3.66
		—	0.302	—
10	1973	1.33	0.254	2.92
7	1973	1.53	0.282	3.31
		—	0.299 ³	—
8	1971	—	0.284 ³	—
		—	0.294 ³	—
7	1968	—	0.279	—
MEANS ⁴		1.50 ± 0.18	0.292 ± 0.016	3.44 ± 0.63
Alta., Saska., Montana	pre-47 ⁵	1.87 ± 0.03	0.359 ± 0.005	4.12 ± 0.09
East. U.S.	pre-47 ⁵	1.99 ± 0.01	0.375 ± 0.005	4.47 ± 0.04
Mass., N. J.	1947-50 ⁵	1.54 ± 0.09	0.310 ± 0.025	3.35 ± 0.20
Ungava	1967, 70 ⁶	—	0.291 ± 0.013	—

¹ Numbers follow Table 3.

² Shell plus shell membrane.

³ Shell membranes absent; values are for shells plus the mean membrane thickness (0.06 mm; range: 0.05-0.07) for other six shells.

⁴ Means ± 95% confidence limits.

⁵ Anderson and Hickey (1972).

⁶ Berger et al. (1970).

have laid, and other workers visited two others. Of the seven ledges two held three eggs each, one had broken eggs in its first clutch and an abandoned egg and a shell fragment in its second, one had only one spoiled egg, one had a large young and a spoiled egg, and at the remaining two ledges all of an unknown number of eggs had disappeared. Two pairs re-nested (eyries 2, 8) and re-nesting was suspected of another pair (eyrie 5).

Overall, one pair (4) probably did not lay; two pairs (3, 16) may have laid but if so, lost them in incubation; three pairs (14, 15, 17), may have laid but if so, lost eggs or small young; one unsuccessful pair (2) laid two clutches but eggs in both broke; three pairs (1, 9, 11) failed in incubation; one pair (10) had only a spoiled egg; one pair (5) probably had two clutches but lost both; and two pairs (7, 8) fledged three young from at least five eggs. Hence, at least eight pairs failed to hatch any eggs at all, and another pair probably did not hatch eggs in either of its two clutches.

EGGSHELL CONDITION

We collected three infertile eggs and one abandoned egg, each from different eyries, and also picked up fragments from another egg at two of these eyries. In addition, shell fragments are available from two eggs

TABLE 5
CHLORINATED HYDROCARBON RESIDUES IN PEREGRINE EGGS

Eyrie	Percent moisture	Percent lipid	$\mu\text{g/g}$				
			DDE		Dieldrin	PCB	
			Wet wt.	Lipid wt.	Wet wt.	Wet wt.	Lipid wt.
1	81	5.2	28	538	0.1	6.4	123
2	82	4.2	16	381	0.1	3.6	86
10	76	5.0	40	571	ND	5.9	84
7	78	7.0	48	960	ND	7.4	148
Mean \pm SE	79 \pm 1.4	5.3 \pm 0.6	33 \pm 7.0	612 \pm 123	—	5.8 \pm 0.8	110 \pm 15
Alaska ¹	—	—	—	407	—	—	—
N.W. Can. ²	—	—	17.8 \pm 10.9	—	0.8 \pm 0.7	—	—
Gr. Brit. ³	—	—	11.9	—	0.6	—	—
Alaska ⁴	—	—	27.4 \pm 13.0	469 \pm 194	—	—	—
Ungava ⁵	—	—	12.7	253	—	—	—
Alaska ⁶	—	—	—	—	—	—	—
Tundra	—	—	—	889	—	—	—
Taiga	—	—	—	673	—	—	—
Aluetian	—	—	—	167	—	—	—

¹ Calculated from Cade et al. (1968), n = 2.

² Enderson and Berger (1968), n = 5.

³ Ratcliffe (1965), n = 13.

⁴ Lincer et al. (1970), n = 3.

⁵ Berger et al. (1970), n = 10.

⁶ Cade et al. (1971), n = 19, 14, 11, respectively.

hatched in 1971 and one in 1968. We compared three measurements reflecting eggshell conditions: 1, thickness index (Ratcliffe 1967); 2, eggshell thickness; and 3, dried eggshell weight with similar data from this subspecies collected at other times (Table 4). Data from Alberta, Saskatchewan, and Montana, and from the eastern United States, provide information on shell condition prior to the widespread use of DDT; those from Massachusetts and New Jersey are from a population in the period of its rapid decline. The four intact eggs we collected average 20% less than the pre-1947 shell index from this region, 25% less than those from the eastern United States before 1947, and average about the same as that from the declining population.

PESTICIDE RESIDUE

The contents of four intact Peregrine eggs taken in 1973 were analyzed for chlorinated hydrocarbon residues by the Denver Wildlife Research Center (DWRC), Bureau of Sport Fisheries and Wildlife (BSFW), and DDE accounted for 90% of the pesticide residues present (Table 5). Extraction and cleanup utilized a method (MS) developed by J. E. Peterson, DWRC, that works particularly well for samples of 10 g or less. The

method uses an iso-octane:acetone (80:20; v:v) solvent for extraction and an iso-octane-acetonitrile liquid-liquid partition with an iso-octane:acetonitrile-water back partition for cleanup. We used 5% deactivated Florisil for final cleanup before injection into the gas chromatograph, where QF-1 and OV-1 columns were used.

DDE residue levels in the four eggs from the Rocky Mountain region are similar to those reported from Peregrines from northwest Canada and Alaska, except that eggs from Aleutian Peregrines appear to have far lower residues. Eggs from Ungava and Great Britain appear to have substantially less DDE as well, but inadequate information is available for statistical comparisons.

Risebrough et al. (1968) report 10.2 ppm PCB (wet weight) in a single Peregrine egg from Baja California, compared to a mean of 5.8 in our samples.

We know very little about the prey taken by the Peregrines we studied. Feathers of a White-throated Swift (*Aeronautes saxatalis*), a Rock Dove (*Columba livia*), and a Brewer's Blackbird (*Euphagus cyanocephalus*) were found in eyries, as were several from small unidentified passerines. We have seen nesting Peregrines kill a Clark's Nutcracker (*Nucifraga columbiana*) and a small passerine, attack Piñon Jays (*Gymnorhinus cyanocephala*), and eat a Mourning Dove (*Zenaida macroura*).

DISCUSSION

Population trends.—Demonstration that the Peregrine Falcon population in the central Rocky Mountain region has declined depends upon evidence that important numbers of well-verified historical eyries are no longer being used by the species. Such evidence is subject to error, not the least of which is the near impossibility of proving that seemingly vacant eyries were not in fact occupied for some period in the breeding season. An adjacent Peregrine population in Utah has been shown to have declined to possibly 10% of former numbers, and only two or three eyries of 29 occupied in the last several decades may be active (Porter and White 1973). Our work suggests a less severe reduction. We found 11 of 32 eyries known before 1973 still occupied by pairs in that year. Although our information is sometimes spotty, abandoned eyries seem to fall mainly in one of two groups. Eleven of the 19 vacant sites (two eyries had lone adults) appear to have been frequented by at least one adult until about the mid-1960s. In the other group are seven eyries that so far as we know have not been used for at least a decade. The remaining eyrie is apparently well used, but vacant in 1973.

All of the 11 eyries in the first group that persisted into the mid-1960s

and then became inactive are on mountains or in deep canyons. All but two were on cliffs at least 45 m high, generally deemed adequate for the species, but four of the cliffs are within a few hundred meters of places frequently used by people, such as picnic grounds. But compared to cliffs that still have Peregrines, only one could be considered poor because of casual human interference.

Compared to the cliffs with active eyries, only two in the second group appear now to be inadequate, one because of a new commercial development only 30 m below the nest ledge, and the other because of intense rock-climbing recreational activity.

Of the six eyries not visited in 1973, two are now subject to much indirect human activity, especially rock-climbing, and one is on a very low cliff (9 m) near a highway in otherwise ideal habitat. Two are along rivers on the northern plains east of the Rocky Mountains, a region where Peregrines are nearly gone (Cade and Fyfe 1970).

Thus most of the 21 eyries now vacant still seem to meet the nesting requirements of Peregrines. Even at the 14 currently active sites, casual interference by people takes place to some extent at five of them (intensely at two). From the aspect of habitat suitability, we can see no reason why many of the unused sites should remain vacant, unless a reduction in breeding adults has occurred.

What percentage of known eyries would be occupied by pairs in the absence of a decline? In Massachusetts from 1935 to 1942, Hagar (1969) found an average of about 77% of 14 eyries occupied by pairs each year, while six of the "best" eyries were always occupied. In Pennsylvania and New Jersey, annual occupancy by pairs averaged about 85% for between 12 and 20 eyries visited in the years 1939-41 (Rice 1969). In the years 1950-54 at eight eyries on the Hudson River, occupancy by pairs averaged about 80% at a time when reproductivity was poor (Herbert and Herbert 1969). Of 14 eyries under observation in the upper Mississippi River drainage in 1954-55 the rate of occupancy by pairs averaged 71% (Berger and Mueller 1969). Along the Colville River in Alaska in the mid-1950s occupancy of cliffs by pairs of Peregrines averaged 55% in a region where competition with the Gyrfalcon (*Falco rusticolus*) for cliffs probably exists and, where some of the cliffs may have been alternate sites within one territory (Cade 1960: 172). At 805 eyries in Great Britain in the period 1930-39, eyrie use by pairs averaged 85% annually with variation around that mean estimated at 7-8% (Ratcliffe 1972). It seems reasonable to conclude that at least 10%, perhaps 20%, of known eyries would not be used in any one year.

On this basis, we should have found 25-29 active territories among the

32 eyries known prior to 1973, instead of 11. Even discounting the three eyries where human disturbance would probably preclude nesting now, 22–26 active eyries would be expected had no decline occurred. We estimate a decline of Peregrines in the region on the order of 50% in the last 20–30 years. This conclusion draws strong additional support from the observation that none of 18 eyries without pairs after 1968 was occupied in 1973.

Reproduction.—In 1973, 14 pairs fledged a mean of about 0.2 young per pair, probably less than one-fifth that generally considered normal for the species (Hickey 1968: 28). So far as we know only two pairs in eight that laid were able to hatch eggs. The remaining pairs apparently did not lay, or if they did, they lost their eggs or small young.

Historical data on the production in this population is fragmentary. Six pairs fledged five young in 1964 in Colorado (Enderson 1965). Although the production of fledged young was not determined at all regional eyries with pairs in later years, we know that in 1969 four of eight pairs failed to fledge young, three pairs had 10 young, but that three, probably five, of these young were taken by people. No information is available for one pair. Hence seven pairs fledged no more than five young. In 1971 five known pairs fledged fewer than five young; in 1972 10 pairs fledged fewer than seven. Thus known pairs apparently reproduced poorly in recent years.

Eggshells and pesticides.—We have little information on pesticides and eggshell condition in this population before 1973. Enderson took a single adipose sample by biopsy from a female with young in 1967 that was analyzed for DDE by the Wisconsin Alumni Research Foundation using procedures described elsewhere (Enderson and Berger 1968). DDE amounted to 864 ppm (wet basis) in that sample, or about twice that found in similar samples from Peregrines along the Colville River, Alaska (Lincer et al. 1970), a population known to be producing thin-shelled eggs (Cade et al. 1971).

Thin eggshells have been associated with DDE or DDT-family residues in 11 species of wild North American birds (Anderson and Hickey 1972), among them the Peregrine Falcon. A regression of the thickness index plotted against the logarithm of DDE in Alaskan Peregrine eggs (Cade et al. 1971) provides a model for comparison with our data on the four Rocky Mountain Peregrine eggs. Our mean of 33 ppm (wet weight) corresponds to a thickness index of 1.47, very near our actual average index of 1.50.

The significance of thin eggshells in regard to hatching and fledging success is difficult to establish. Peregrines on the Alaskan tundra in

1967-69 laid eggs with an average thickness index of 1.48 and fledging success was between 1.26 (1967) and 0.79 (1969) young per pair (Cade et al. 1971). Since 1969 that population has been reproducing poorly (White and Cade 1971). In Ungava in 1967 and 1970 the thickness of 21 eggshells averaged 0.291 ± 0.013 mm, including eight in five eyries that were broken or cracked (Berger et al. 1970), which is nearly identical to the average for the nine eggshells we measured. Prairie Falcons with eggshell indexes below 1.45 for one egg from each clutch fledged only 0.3 young per pair in 10 eyries (Enderson and Berger 1970). If the mean index of 1.5 we found is representative of the Rocky Mountain situation, poor reproduction can be anticipated.

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SUMMARY

Peregrines are presently using only about one-third of their former eyries in the central Rocky Mountain region, and a population reduction on the order of 50% in the last few decades seems indicated. Poor reproduction, especially in 1973, is correlated with eggshells that are about 20% thinner than those from this subspecies prior to 1948. DDE levels in four eggs from 1973 average about as high as those reported from Peregrine eggs anywhere.

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