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DISTRIBUTION AND REPRODUCTIVE SUCCESS OF PEREGRINE FALCONS (*Falco peregrinus anatum*) IN CALIFORNIA DURING 1975 AND 1976

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ABSTRACT

Forty-two known or suspected active peregrine falcon nesting locations were visited in California during 1975 and 1976. Peregrines were present at nine locations in 1975 and thirteen locations in 1976. In 1975, seven pairs fledged fourteen young, or 2.0 young per pair. In 1976, nine pairs fledged fourteen young, or 1.6 young per pair. These data are considered normal fledgling production rates for peregrines. The known active eyries are widely dispersed throughout the state. They are considered to represent a remnant population which has undergone a severe decline since the mid-1940's. This decline is attributed to the use of chlorinated hydrocarbon pesticides (DDT) and loss of habitat through urbanization, agricultural practices, and watershed management programs.

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RECOMMENDATIONS

As a result of this study of known active peregrine falcon nesting locations in California, it is recommended that the Department of Fish and Game:

1. Make a yearly check of eyrie utilization in March and April of each year.

2. Make a yearly check of fledglings produced in May and June at the active eyries.

3. Place under protective surveillance those eyries threatened by human disturbance and/or harassment. This automatically includes all eyries protected to date. New eyrie locations should be evaluated to determine whether such surveillance is necessary.

4. Protect suitable nesting habitat from destruction and disturbance for future natural expansion of the population and/or reintroduction.

INTRODUCTION

Bond (1946) reported on the status of the peregrine falcon in western North America for the years prior to World War II. He gave no indication of a population decline in progress and considered the peregrine a common nesting species throughout California except in the arid desert regions.

Herman (et al 1970; 1971) supplemented Bond's data with nesting reports for the two decades following World War II. They concluded that a previously stable peregrine population in California, estimated to be 100 nesting pairs, declined to less than 10 known pairs by 1969. This alarming reduction greatly exceeded any possible effects attributable to shooting, egg collecting, and the capture of peregrines for falconry.

Evidence of population declines similar to the one documented in California appeared simultaneously over most of the cosmopolitan range of the peregrine falcon (Hickey ed., 1969). Ratcliffe (1967) reported the production of thin-shelled eggs in the failing population of peregrines in Great Britain. This discovery led to intensive investigations, disclosing a contamination of the food chain of global proportions. Chlorinated hydrocarbon residues introduced into the environment as pesticides and industrial wastes shortly after World War II were the primary sources of the contamination. These pollutants cause the production of abnormally thin-shelled eggs (Porter and Wiemeyer, 1969) resulting in the reproductive failure of several species of raptorial and fish-eating birds (Hickey and Anderson, 1968). Peakall (1974) analyzed peregrine eggs collected on the central coast of California for the presence of DDE, the principal chlorinated hydrocarbon compound believed responsible for subnormal eggshell thickness. Eggs collected prior to the time when extensive uses were made of chlorinated hydrocarbons (pre-1947) showed no trace of DDE. However, eggs collected subsequent to 1947 revealed DDE present in concentrations sufficient to account for eggshell thinning. Earlier, Hickey and Anderson (1968) reported a constant eggshell thickness and index of shell weight until the mid-1940's. Their measurements revealed thin-shelled eggs were first collected in California in 1947 and that most California peregrine falcon eggs collected after 1947 were significantly thinner than pre-1947 eggs (Anderson and Hickey, 1972).

Bond (1946) predicted an eventual, regional reduction in the peregrine falcon population of western North America resulting from the expansion of human development into once remote areas. But the nature and extent of the decline which characterized the two decades following this forecast greatly exceeded the prediction. The decline resulted in the near extinction of peregrines at rates greatly exceeding the destruction of peregrine habitat, and in vast areas beyond those predicted by Bond. However, his predicted human-related limiting factors may indeed be regulating the remnant peregrine population in California.

This study was conducted to: 1) sample the peregrine falcon fledgling production in California during 1975 and 1976 and 2) provide management and protection recommendations for the conservation of nesting peregrines in California.

METHODS

Thirty and thirty-nine peregrine falcon nesting territories were visited during the period of February to July in 1975 and 1976, respectively. One additional location is known to be active but the exact location is known only to a cooperator. Table 1 indicates those locations visited either one, or both years. This sample is not intended to represent the approximately 200 historical peregrine falcon nesting locations in California, but instead, reflects a summary of the known and suspected peregrine nesting activity since 1969.

To minimize disturbance, observations of nesting areas were made from a reasonable distance using a spotting scope or binoculars. Later, apparently vacant nesting cliffs were approached closely in an attempt to verify the absence of peregrines. One eyrie was entered in 1975 and 1976 following apparent nesting failure.

Data on clutch size and hatching success are difficult to obtain unless each active eyrie is entered. Restrictions placed on possible disturbance prevented taking these data. However, cooperators provided these data for two nesting attempts in 1975. Clutch size data was obtained at two eyries in 1976 which can be looked into without climbing into the eyrie. Counts of the number of young fledged per eyrie were made at all locations where pairs of peregrines were observed.

A qualitative examination of the physical features at each active eyrie provided data for use in recommendations regarding protection and management. However, existing land uses in relation to peregrine nesting ecology are difficult, if not impossible, to interpret. In some cases, the interpretations given here are based on observations made prior to this study which provide a broader base from which to make recommendations.

Nesting territories are discussed by using identification numbers within regions which are designated by letters. This is necessary to prevent revealing specific locations. For convenience, the regional designations follow those used by Herman et al (1970). However, the eyrie numbers within regions do not correspond between the two studies.

North Coast (NC):	Along the coast from the Oregon border 42° N lat, south to 38° N at the entrance to San Francisco Bay.
Mid-Coast (MC):	Along the coast from 38° N lat south to 34° N, near the line separating Ventura and Los Angeles counties, and including the Channel Islands.
Southern Coast (SC):	Along the coast from the 34° N lat south to the Mexican border, 32° 30' N.
North Interior (NI):	All areas inland (not coastal) south of the Oregon border, 42° N lat, south to 38° N lat, and east to 2,000 m (6,096 ft) elevation on the west side of the Sierra Nevada.

South Interior (SI): All areas inland south of the 38° N lat south to the Mexican border and east to 2,000 m (6,096 ft) elevation on the west slope of the Sierra Nevada.

Montane (M): From the 2,000 m (6,096 ft) elevation on the west slope of the Sierra Nevada to the Nevada border.

RESULTS

Nesting Territories

Peregrine falcons were present at nine locations in 1975 and at thirteen locations in 1976 (Table 1). Both years, one additional location was suspected as being active. Several observers noted an adult female peregrine on three different days in the vicinity of NC6. In 1976, a lone adult male peregrine was seen one day near SI8 (B. Walton, pers. comm.) but could not be located on several visits later. These were the only unpaired adult peregrines observed between March and July of 1975 and 1976.

A suspected pair reported at MC5 in 1975 consisted of an adult male and an immature female. There was no evidence to indicate that eggs or young were produced. In 1976, a pair of adult peregrines nested on a coastal cliff approximately 2.4 km (1.5 miles) north of the 1975 observations. Local observers indicated that peregrines had nested here in 1974 and 1975, and probably earlier. Therefore, I suspect that the 1975 observation was an adult male from an active eyrie and an unpaired immature, possibly fledged from this eyrie in 1974. The appearance of immature peregrines at active eyries (MC2, 1972 and 1974-76; SI2, 1976) probably is common and related to the resident nature of peregrines in California (Cade, 1960; Thelander, MS in preparation).

Location NI12 reportedly has fledged young in recent years, including 1975. In 1976 a pair apparently hatched eggs but the adult male was found injured and unable to fly. This eyrie did not fledge young in 1976.

Pairs of peregrines were seen at three other locations in 1976: two early in the season (MC6 and SI4) and one late (NI13). It could not be determined if these pairs attempted to nest. The pairs at SI4 and MC6 were seen once each and the cliffs were later observed to be inactive. However, alternate cliffs in each of these areas may have been utilized.

Reproduction

Clutch size is known for four nesting attempts; two each for 1975 and 1976. Three eggs were laid at both MC2 and NI5 in 1975. Incubation was initiated at each location. Two young hatched at MC2 and the fate of the third egg is unknown. Two eggs disappeared at NI5 and the third egg was collected after the adults abandoned the nesting ledge. It contained a two-thirds developed embryo. Later, I entered the nesting ledge and found a large quantity of eggshell fragments in the scrape. In 1976, this pair apparently did not lay eggs. Also four eggs were laid at SI2 in 1976.

Table 1. Peregrine activity observed at 42 known or suspected nesting locations in California during 1975 and 1976.

Location	Inactive		Pair		Single		Location	Inactive		Pair		Single	
	1975	1976	1975	1976	1975	1976		1975	1976	1975	1976	1975	1976
NI 1	X	NV					SI 1	X	X				
2	X	X					2			X	X		
3	X			X			3	X	X				
4			X	X			4	X			X		
5			X	X			5	X	X				
6	X	X					6		X	X			
7	X	X					7	NV	X				
8			X	X			8	NV					X
9			X	X			9	NV	X				
10	X	X					10	NV	X				
11	NV			S			NC 1	X	X				
12			X	X			2	X	X				
13	NV			X			3	X	X				
14	NV	X					4	X	X				
15	NV	X					5	X	X				
16	NV	X					6		X			X	
MC 1	X	X					7	X	X				
2			X	X			8	X	X				
3	X	X					M 1	X	NV				
4	X	X					2	NV	X				
5			X	X									
6	NV			X									

NV = no visit S = suspected

Table 2 shows fledging success for both years. These are minimum figures since the 1975 counts at NI9 and S16 and the 1976 count at MC5 were made after the young had fledged. It is possible that additional young fledged. In 1976 at NI8 two young fledged but one was later killed by a red-tailed hawk (Buteo jamaicensis) (Ed Gheen, pers. comm.).

In 1975, seven pairs of adult peregrines fledged 14 young, or 2.0 young per pair. Nine of the 12 pairs observed in 1976 are considered resident at their cliffs and to have attempted to nest. They fledged 14 young, or 1.6 young per pair. Reproduction by the three observed and one suspected pairs (MC6, S14, NI13, and NIII) could not be determined; probably they did not lay eggs.

The fledging success data for 1975 and 1976 contrast sharply with the recent decades of documented nesting failures. Such failures are still prevalent in the declining peregrine population in the Rocky Mountain region where reduced hatchability and thin-shelled eggs resulting from pesticide contamination are still evident. In 1973, 14 pairs of peregrines fledged only three young in this area (Enderson and Craig, 1974).

Table 2. Peregrine falcon fledgling production at ten locations in California in 1975-76.

Location	Number of Young Fledged	
	1975	1976
MC2	2	2
MC5	Unk.	2
S12	4	4
S16	2	Inact.
NI3	Inact.	0
NI4	2	2
NI5	0	0
NI8	2	2
NI9	2	2
NI12	Unk.	0
Total	14	14

Unk. = known to be active but fledging data not available.
Inact. = area definitely checked and no peregrines observed.

Distribution

Clearly, the post-1947 decline of the peregrine falcon breeding population is not limited to certain geographical areas in California. Instead, peregrines were greatly reduced in number throughout the biotic communities they once inhabited. Historical data on approximately 200 nesting locations indicate that nearly 65% of the known eyries are insular, coastal, or inland less than 80 km (50 miles). The remainder are generally associated with large bodies of standing water or river canyons typical of the Great Basin region, the Sierra Nevada, and the Cascade Mountain Ranges (Bond, unpublished data; Herman et al 1970).

The distribution of those peregrine eyries active in 1975 and 1976 indicates the existence of a widely dispersed, remnant population. During the years of severe reproductive failure, a small percentage of young were produced annually in some regions, but at levels insufficient to maintain a stable population. This has apparently resulted in the extinction of nesting peregrines in vast areas once supporting peregrines (e.g., Channel Islands, Ventura, Los Angeles, Riverside, Orange, and San Diego counties).

During 1975 and 1976, only four coastal locations (NC6, MC2, MC5, MC6) had peregrines present. The Channel Islands were not visited. Of these coastal sites, three pairs were observed and two produced young; at the fourth site a single adult peregrine was observed near an historical eyrie several times in 1975. The coastline between the northernmost (NC6) and southernmost (MC2) eyries had approximately 12-15 active pairs until the late 1940's (Thelander, MS in preparation). The four sites active in 1975 and 1976 were also utilized at that time with some regularity.

Combining the Southern and Northern Interior regions of the Coast Range Mountains, eight of the nine inland pairs of peregrines observed are represented in Figure 1. The distances between these known pairs are given to demonstrate the dispersed nature of the locations. A ninth interior location (NI9) is in the Cascade Mountains of northeastern California. Approximately 800 km (500 miles) separates the two extremes in Figure 1. The closest distance between locations is approximately 40 km (25 miles) and the mean distance between nearest neighbors (known) is 96 km (60 miles).

Protection Efforts

Active peregrine nesting locations considered vulnerable to human disturbance and harassment were provided protection by placing surveillance teams on 24-hour, continuous observation duty at each location. The role of the teams was primarily one of enforcement of existing laws aimed at protecting peregrines. However, the observers also aided in obtaining ecological data for several nesting attempts.

The agencies responsible for employing surveillance teams were: California Department of Fish and Game, Bureau of Land Management, U. S. Forest Service, and U. S. Fish and Wildlife Service. Three eyries were provided with surveillance in 1975 (MC2, SI2, NI8) and seven were watched in 1976 (MC2, SI2, NI3, NI4, NI5, NI8, NI9). At the 10 nesting attempts protected there were no reported incidents of major human disturbance or threat to the fledglings. However, hikers were encountered at three of the locations and asked to leave the area.

The teams were placed at each location just prior to suspected hatching dates and remained in place until the young peregrines fledged. Protection in 1976 at N13 and N15 was directed at obtaining ecological data since it appeared that the pairs at these locations did not lay eggs, but remained in the vicinity of the nesting cliffs.

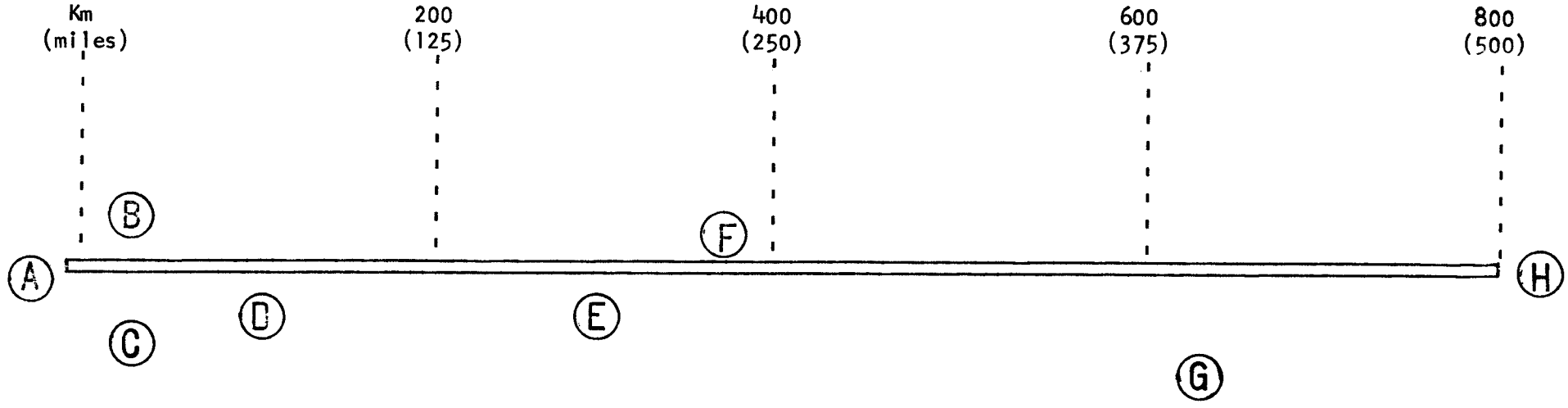

Figure 1. Demonstration of relative distances between eight locations where pairs of peregrine falcons were observed in 1975 and/or 1976 in the Coast Range Mountains of California.

DISCUSSION

Cade (1960) made three assumptions which are basic to any population study of peregrines: (1) an accurate census of the population of a given area is dependent upon knowing the location of eyries, (2) population trends can be recognized by recording the historical use of these sites and (3) the degree of permanancy is not equal for all eyries and the utilization of cliffs may occur after long periods of vacancy. Each assumption has proven very important to achieving an understanding of the current status of the peregrine falcon in California.

Knowledge of Eyrie Locations

The diversity and size of California complicate efforts to obtain an accurate census throughout the state. The result has been a high degree of accuracy in areas with suitable access and with adequate historical information on the peregrine distribution (i.e., the three coastal regions). But in areas where little background information is available and access is poor, the accuracy is decreased significantly. This is true for the Northern Interior region and the Cascade Mountains and Sierra Nevada sections of the Montane and Southern Interior regions. I suspect that nesting peregrines occur in these areas today in numbers equal to, if not exceeding, those of the Coast Mountain Ranges. Bond (1946) noted the magnificent cliffs in these areas, and how few had ever been reported to be occupied by breeding peregrines. However, since peregrines are known to nest in these biotic communities and, generally, peregrines are by nature difficult to locate, one is led to the conclusion that peregrines exist in these rugged areas but have yet to be located. Until they are, a census of nesting peregrines throughout California is little more than speculation and we must depend upon regional surveys which cover no more than 50% of the available nesting habitat in California.

Historical Use and Population Trends

The historical record of peregrines nesting in California is extensive when compared to other western states. Most records are of one, or only a few years of peregrine utilization at each eyrie. Some were active regularly and many were not. Evaluation of population trends is dependent upon knowledge of which eyries are ephemeral and which are long-term "first class" eyries (see Hickey, 1942). In areas with many years of historical data, there is commonly a ratio of approximately four cliffs occupied only occasionally, to each eyrie occupied nearly every year and rarely failing to fledge young.

From the historical data which are available, it appears that two major decimating factors emerged around 1945 which faced peregrine populations. The first factor was the loss of both nesting and wintering habitat through agricultural practices, urbanization and watershed management programs. The second was the wide use of chlorinated hydrocarbon pesticides (primarily DDT) which affected the peregrines physiologically and ultimately reduced their reproductive potential (Hickey and Anderson, 1972). Each factor affected the peregrines independently and to a different degree. The cumulative effect has been devastating. Alone, habitat loss would have reduced the populations in some localized areas, but would have left the majority of California's peregrines at their pre-1945 population levels and normal reproductive success would have continued throughout the unaffected range. However, vast areas of peregrine

habitat were severely affected by pesticide contamination of the food chain. These residues, only 10 years after their introduction to the food chain, showed evidence of their potential to eliminate the peregrines from all areas for which historical data are available. Eggs were found broken in nesting ledges (R. Quigley; T. Cade, pers. comm.), many pairs failed to reproduce but remained at the nesting cliffs (S. K. Carnie, unpubl. notes), and eyries were vacated in alarming numbers.

The cumulative effect of these two factors is the localized extinction of peregrines with little possibility for re-utilization of those areas affected by habitat encroachment and extensive reduction of the population throughout its range resulting from pesticide pollution. It is hoped that the deleterious effects of the second factor may someday be controlled and then eliminated.

The encouraging reproduction figures for 1975 and 1976, in contrast to previous decades of documented nesting failures, indicate that the peregrine population may increase since a moratorium in the use of the primary pollutants has been implemented. Habitat alteration and loss continues. To what extent a return to normal reproduction can contribute to an increase in breeding pairs is unknown.

The number of breeding pairs of peregrines in California is critically low. This is consistent with the conclusion of a 1970 survey (Herman, 1971). The location of previously unreported active nesting territories during 1975 and 1976 probably does not reflect an increase in breeding pairs, but rather a more detailed survey of the previously suspected remnant population. There is no evidence that pairs were or were not present at most of these cliffs historically.

Another important factor limiting the prediction of trends is the small population from which one obtains reproductive data. An eyrie which fledged three young in 1970 (NI5) is the location where three eggs failed to hatch in 1975 and where no eggs were laid in 1976. However, an eyrie with a lone adult present in 1970 (MC2) fledged two young in 1975. After the suspected loss of an adult female at a site in the winter of 1975, a pair was again present in 1976 and two young fledged (MC2). These findings emphasize the need for long-range, continued monitoring of the peregrine population in order to adequately assess population trends.

Utilization of Vacant Cliffs

The degree of permanancy of pairs of peregrines at eyrie sites is known to vary for nesting cliffs. However, the third assumption also states that utilization of cliffs may occur after long periods of vacancy. This assumption is directly related to the question of whether a population recovery can occur.

In 1976, a pair of adult peregrines occupied a cliff (NI3) which has not been active since 1970, when four young fledged. This is the only recent record of a vacated eyrie being reoccupied in California. Ratcliffe (1972) noted that in areas of Great Britain where some degree of population recovery has taken place, the reoccupying peregrines have taken over the deserted traditional nesting cliffs, and no completely new breeding places are known. Also, in Colorado, a pair of peregrines occupied an eyrie in 1974 where no pair had occurred since 1965 (J. Enderson, pers. comm.). It should be noted, however, that occasional

short periods of vacancy are not uncommon to those eyries for which long histories are available.

SUMMARY

In conclusion, the status of the peregrine falcon in California remains precarious; but a degree of optimism may be based on the encouraging reproduction observed in 1975 and 1976. A recovery of the present remnant population to pre-DDT levels is improbable due to the loss of habitat for both peregrines and their prey species which has occurred in the interim. The future for peregrines is dependent upon many factors. Of primary importance is the reduction of pollution residue levels to those which will permit normal reproduction. Secondly, land use policies must provide for ecological requirements needed for peregrine nesting and wintering habitat. Until these factors can be controlled, peregrines remain critically endangered and near extinction in California.

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