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ATYPICAL NESTING HABITAT OF THE PEREGRINE FALCON (*Falco peregrinus*) IN VICTORIA, AUSTRALIA

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ABSTRACT.—Nesting of the Peregrine Falcon (*Falco peregrinus*) in disused stone quarries is not unusual, but occupancy of actively worked quarries represents a departure from typical nesting behavior. In Victoria, Australia, seven of 11 stone quarries occupied were actively working quarries. In one case the eyrie was 50 m from quarrying operations, rock crushing equipment and machinery. In 1982 Peregrines occupied a hydroelectric dam within 3 yrs of its completion. They also occupied a gravel loading silo in use and nested about 20 m above a truck loading area. Such exploitation of seemingly "unsuitable" or "disturbed" sites could be expected in an expanding Peregrine population containing a high percentage of younger inexperienced adults. In Victoria the population is stable and some quarries have been occupied in excess of 20 yrs. We suggest such quarry use in Australia reflects a large, numerically healthy falcon population with a large vulnerable food supply in areas otherwise limited in natural nesting sites.

The Peregrine Falcon (*Falco peregrinus*) can and does naturally nest in close proximity to human activity (i.e. urban building, bridges, etc.). Such situations depart from the normally isolated and remote cliff sites characteristic of the species (Hickey 1969). Indeed, with the reintroduction of the Peregrine in the eastern United States, use of bridges has become frequent (Cade and Dague 1985). Overall, however, such nestings are uncommon. One of the more commonly used man-made structures is the stone quarry and in fact it should be, as a quarry is nothing other than a man-made cliff or rock face. Many quarries provide new nesting habitat in regions where otherwise no nesting substratum exists and most quarry use is of disused quarries. Fischer (1973) indicated that disused quarries along the Main, Necker and Weser rivers in the Unstrut Valley, Germany, opened up an entirely new area for nesting. Likewise, Ratcliffe (1980) documented that many quarries in Britain provide new crags for nesting in regions where none otherwise existed. We suggest that quarry use in Victoria functioned in the same fashion and is related to food supply.

We currently know of 11 quarry eyries among more than 79 natural cliff sites studied (see Pruett-Jones et al. 1981; White et al. 1981). Of these 11 quarries, seven are being excavated continuously. Herein, we describe five of these sites. The structure of worked quarries was similar in all regards to those in disuse.

METHODS

Studies on Peregrines in Victoria (ca. 227 300 km^2) started in 1975, continued through 1984, and thereafter occurred as opportunity presented (see Emison et al. 1988). No attempt was made to examine intensively all known stone quarries in Victoria. Rather, disused quarries were examined as they were found or reported; working quarries were examined when a report of falcons was received at the Arthur Rylah Institute (Victoria has an extensive bird watching community; between 1977 and 1981 nearly 800 observers reported data and the Peregrine research program received attention in the public media). Each quarry examined was visited on foot and frequently the "high walls" were climbed. Absence of suitable nesting ledges was usually noted. Measurements of prey density were not made in a systematic manner, but impressions of prey density near eyries were casually noted. Comparisons between Peregrine distribution and the distribution of four major prey groups (Rock Dove [*Columba livia*], Galah [*Cacatua roseicapilla*], rosellas [*Playtcercus* sp.], and European Starling [*Sturnus vulgaris*]) were made using the Atlas of Victoria Birds (Emison et al. 1987). For the Atlas the state was divided into blocks of 10 min (ca. 18 km) of E. Lat. by 10 min (ca. 15 km) of S. Long. of area, resulting in 918 blocks in Victoria. Bird species occurrence was recorded for each block during the Atlas period (1973–1986) which gave distribution and an index of frequency.

Figure 1. Site number 1—panoramic view of quarry. Note gravel loader in left center of photo; arrow indicates eyrie location.

RESULTS

The Eyries. The only thing most quarry eyries had in common was their placement on high walls. Each site had particular features of interest and it is instructive to describe a sample to present a clear picture of the variables at these sites.

a) Site #1 is in the largest active stone quarry in Victoria (ca. 80 ha) (Fig. 1). The quarry started operation in 1929 and Peregrines began nesting there at least in the early 1960s (Max Parker, pers. comm.). Pairs have used five or six different walls depending on where quarrying occurred but normally selected less disturbed areas. Falcons were so accustomed to quarrying operation that on one occasion we saw a Peregrine chase a Feral Pigeon past the office building and toward a 10 m high gravel loader in operation filling vehicles. The pigeon flew into dust generated by the loader and seemed to slam with total abandon into the loader and fell to the ground between two vehicles. The Peregrine landed on the roof of the vibrating loader amidst rising dust. Unable to locate the pigeon, the falcon left within about one min but at no time seemed disturbed by the commotion.

b) Site #2 is a very small, active quarry (30 × 75 m) in the shape of a quarter circle. While we do not have a history of falcon use of the site, in 1977 and 1978 nesting occurred about 50 m from a section of the quarry being worked (Fig. 2).

c) Site #3 is about the same dimensions as #2 but more U-shaped and located about 12 km in a straight line from #2. We have no history of use of the quarry. The quarry is inactive and serves as a firing range on weekends for a local rifle and pistol club. In 1977 a Peregrine eyrie was located opposite and at a 90° angle from the targets and about 60 m from bench rests and the area housing shooters. On 29 October 1977 we were at the site when shooting started at 1300 H. The female left her perch beside

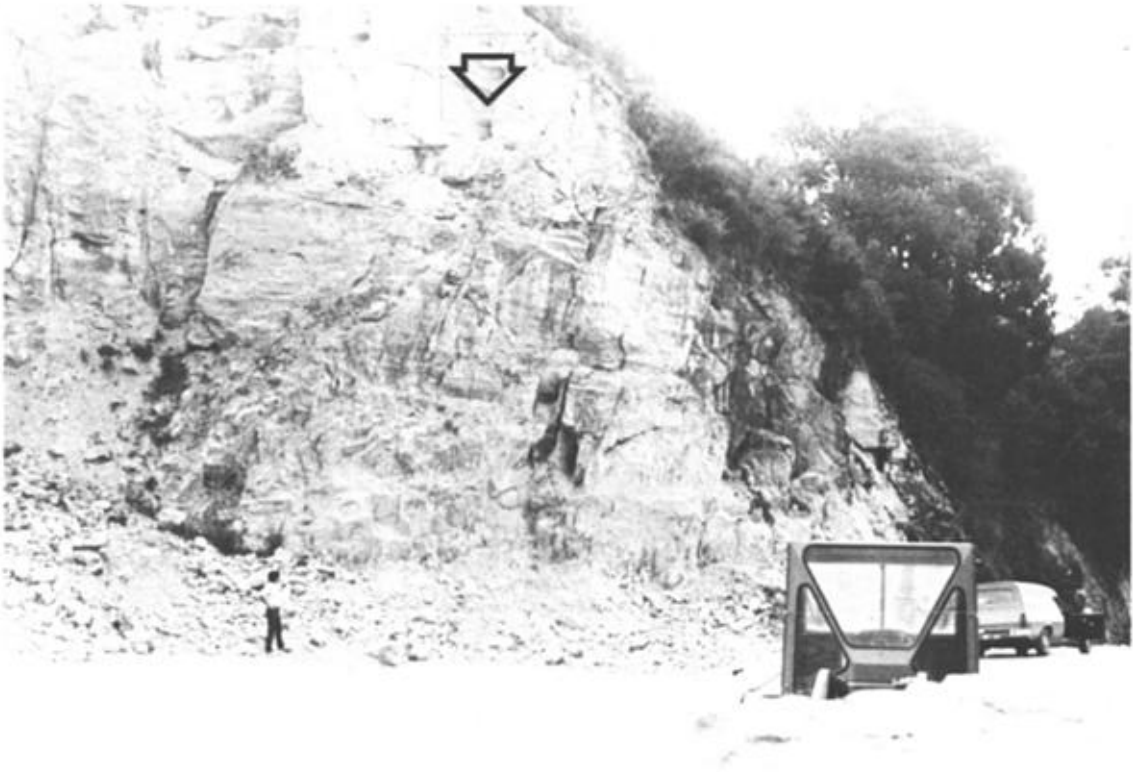

Figure 2. Site number 2—arrow indicates eyrie location. Work is being done about 50 m to the left of the eyrie.

a single 3½ wk old nestling when shooting started, screamed a few times and perched in a tree about 100 m away. She remained perched until the shooting was over. We were told by locals that the female laid eggs and started incubation after weekend shooting had already started.

d) Site #4 is dug as a long, shallow pit into otherwise level ground (Fig. 3) rather than into a hillside as with most quarries. Vertical faces of high walls are about 15 m high and face each other about 150 m apart. The long axis is about 350 m. The eyrie was actually below the level of surrounding land. As desired rock was removed, the quarry was filled in at one end and new ground was opened at the other end. The quarry was in essence moving in one direction. Filled areas were then reclaimed and replanted. As new high walls were created, the falcons moved and the actual wall used for nesting seemed to depend upon which one was being mined during egg laying. The wall used in 1978 was opened in 1976 (Peter Shanahan, pers. comm.). The quarry represented the only vertical rock faces within a 13 km radius, and the closest rock face is another quarry in the city of Geelong. Workmen frequently watched the pair cooperatively hunting above the quarry pursuing flocks of Feral Pigeons (about 15–30 individuals) or Common Starling flocks of ≥ 100 individuals (John Russell, pers. comm.). Although four young fledged in 1977 (four young is an unusually high number of young in Victoria), success of the pair was apparently not good because of the open and unsheltered nature of nesting ledges. In 1978 water gathered on the nesting ledge and eggs were in a pool of mud when checked. The pair may have been younger adults as the quarry had been used <5 yrs by Peregrines in 1978.

In 1986 and 1987 a pair of Peregrines fledged young from a nest on top of a 30 m gravel loading silo (Fig. 4) located at this quarry. The silo had a covered conveyor belt housing that, because of its

Figure 3. Site number 4—panoramic view of quarry. Arrow indicates eyrie location.

position, left a gap of about 0.3 m high covering 6 m^2. This platform, 20 m above the trucks, provided a nest scrape made in powdery dust from years of operation.

e) Site #5 has one main face of limestone 150 m long and 35 m high with only one suitable nesting ledge, a cut about 25 m from the ground. This ledge was used for at least 20 yrs (Neville Holland, pers. comm.) and during 8 yrs of monitoring by us, 17 young fledged. The quarry has been continuously worked and the eyrie was only 50 m from heavy machinery and a rock crusher. The falcons showed no concern as long as humans did not approach the eyrie too closely in a direct manner.

f) Dam Site. Like quarries, dams form cliff-like structures that have been used by nesting falcons. In Zambia, for example, where the Peregrine is a scarce breeder at best, nesting has occurred on a buttress of the Kariba Dam wall (Osborne and Colebrook-Robjent 1980). A dam 35 km from Melbourne was completed in 1979. The front wall of the dam rises about 95 m high at the highest point, whereas the back of the dam wall rose about 10 m above the water's surface during years of average rainfall. Peregrines nested on the back wall in 1982. A "draw-off" structure protruded over the water surface and where the structure met the dam wall proper a conical "pot-hole" of 1.3 m^3 was formed that provided the nesting ledge. The eyrie was within 20 m of a service road and car park used by reservoir staff. A service walkway along the "draw-off" structure passed directly over top of the eyrie and within 0.6 m. While this site was only successful in raising two young in 1982, there were signs of falcon presence at the dam in subsequent years.

Assessment of Prey. While we have no direct measure of prey density or vulnerability we have attempted to derive an index based on species occurrence. The four major bird prey groups made up, on average, 62% (of 65 species) of prey. Pigeons were found in 72% (av.) of the Peregrine eyries, Galahs in 54%, rosellas in 29%, and starlings in 65% (see Pruett-Jones et al. 1981). Of the 84 blocks in which Peregrines were recorded breeding in the Atlas period (Emison et al. 1987), starlings and Galahs occurred in 82 (the block in which either species did not occur was different), rosellas in 74, and while pigeons were not seen in about 15 blocks where Peregrines bred they nonetheless were found in eyries as food. Domestic pigeons are released by the thousands in racing contests and thus occur throughout Victoria during these races. Lost pigeons from

these races are seen in unlikely places nearly any time of the year.

As an indication of distribution (commonness?) of these major prey species Galahs were seen in about 84% of the blocks within Victoria and were present in about 50% of the state in any given month except February. Starlings were seen in about 91% of the blocks and present in over 60% of the state in any given month. The most widespread bird in Victoria, by comparison, is the Australian Magpie (*Gymnorhina tibicen*) reported in about 98% of the blocks within nearly 85% of the state in any given month. By contrast, two raptors, the Peregrine and the relatively widespread and abundant Australian Kestrel (*Falco cenchroides*), have values that are 38% and 83% of the blocks and about 5% and 35% of Victoria in any given month, respectively.

As a relative index of density, Galahs are reported on 48% of the bird lists in blocks where they occur. Comparative values are 60% of lists for the starlings and 7% of lists for the Peregrines. The proportion of Galahs to starlings in reporting rates was the same as the proportion found as prey in eyries.

DISCUSSION

In regions of high Peregrine population pressure younger breeding members, usually part of the "floating population," may use nest sites that older established pairs would not. In Britain where there are currently about 1100 pairs in the 229 900 km^2 region, about 25 disused quarries have been used and 11 of these are in areas where no other suitable cliffs exist (Ratcliffe 1980). However, in 1979 in a departure from the occupancy of disused quarries, one British eyrie was in an unused portion of a quarry where work was underway and a second eyrie was above an excavation site in progress (Ratcliffe 1980). Similarly, in the German Democratic Republic, where the Peregrine population is currently (1986) in a rapid recolonization phase, an actively worked quarry was recently occupied by nesting Peregrines (H. Richter, via D. J. Brimm, pers. comm.). We also know of a site in Alaska where in 1980 a presumably younger pair of adults successfully nested on a cliff so near a road construction site that concussion of dynamite blasting was seen to ruffle feathers on the perched male. The falcons moved onto the cliff, that over the past 30 yrs had only been used by the Golden Eagle (*Aquila chrysaetos*), after construction had already started (D. Roseneau, pers. comm.). We presume the Peregrines were first-time nesters from the "floater" population as the nearest known historical sites more than 20 km away were also occupied.

Figure 4. Gravel loading silo site—arrow indicates eyrie location on silo.

Expansion of Peregrines into new situations and their use of more "unorthodox" nesting sites is seemingly related to, among other things, an abundant food supply that can be adequately exploited. Ratcliffe (1980) did not have a direct measure of the food base but suggested that the expansion of Peregrines in Britain into new areas and their use of cliffs for nesting heretofore unoccupied by falcons was a function of the combination of an expanding population (many young entering into the adult cohort so density dependent) and abundant food supplies (so density independent with domestic pigeons as a dominant part of that food supply). Nelson and Myres (1976) suggested that the reverse also happens and interpreted the reduction of Peregrines in the Queen Charlotte Islands, Canada, to be a function, in part, of reduced prey. Certainly the

reintroduction of Peregrines back into North America has been as successful as it has by initially selecting sites with abundant food supplies nearby (e.g., erecting towers in marshes).

Like European quarries at least two of those we have discussed (Site 1 and Site 4) provide new habitat in regions where no other naturally occurring rock faces exist within 15–20 km. The rapid occupancy by Peregrines of recently exposed rock faces at some quarries in Victoria suggests that a large population of "floating," non-breeding birds is present. Of further interest is that quarries in general, and quarries in active operation especially, became occupied while other areas of Victoria with seemingly excellent natural rock faces were unused. This suggested that not only was there a numerically healthy surplus population of Peregrines available to exploit these quarters but that those quarries occupied were in areas of a high food base that helped to override the negative effect of disturbance and thus provided the proper set of conditions consisting of an essential balance between nesting and foraging habitat. In essence quarries provided something that nesting on natural cliffs did not (we have several examples of eggs being laid annually and subsequently broken because no adequate ledges exist on particular cliffs). Rapid occupancy of the dam site once it was completed corroborates this notion. We suggest that the Peregrine population in Victoria may be near saturation and that unoccupied natural cliffs in areas distant from the nearest used eyrie have some biotic deficiency such as lack of a nearby exploitable food supply. We are not yet able to explain why all seemingly optimal environments are not exploited at the same frequency. For example, Peregrines do not nest in cities in Victoria where there is an abundance of nesting locations and an enormous food supply, especially Feral Pigeons. This becomes even more of an enigma because where cliffs or quarries are not available, Peregrines in Victoria use trees for nest sites (see White et al. 1981). We were interested in the fact that of the data presented by Ratcliffe (1980) about 2.5% of the eyries in Britain were in quarries, while in Victoria nearly 14% were in quarries. Having seen many sub-optimal eyries in Britain, we wonder why more quarries there are not used. Use of quarries in Victoria becomes more interesting when one realizes that Britain and Victoria have similar land area, but about 10 times more cliff eyries are known in Britain than in Victoria. We are impressed by the fact that more than half of the quarries used by Peregrines in Victoria are in continual operation.

The fact that a few disused quarries in Victoria with seemingly adequate ledges and food supply nearby are unoccupied by falcons while some in operation are used is also something that we are not fully able to explain. However, we can suggest that at least the following conditions may be responsible. 1) Local food supplies may be efficiently exploited only from certain quarries. 2) Peregrine population pressure is such that what we would categorize as "marginal" habitat (in the sense that disturbances are frequent and severe) becomes used in spite of less desirable conditions because an abundant food supply more than compensates for the disturbance factor. 3) There is some association of biotic and abiotic factors in concert at quarries that we have not been able to identify. 4) Falcons that occupy such sites are more tolerant of disturbances than the norm of the species. If the latter is the case it would be interesting to determine if such tolerance is a heritable factor or learned because of previous experiences early in their lives.

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The 1987 Annual Meeting of The Raptor Research Foundation, Inc.—More than 400 were in attendance at the 21st annual meeting of The Raptor Research Foundation, Inc., held on 28–31 October 1987 in Boise, Idaho. The scientific program included 74 paper presentations and 18 poster presentations. Gary Duke was elected as the Foundation's new President, succeeding Jeffrey L. Lincer, while Richard J. Clark, James E. Fraser and Jim Fitzpatrick will continue as Vice President, Secretary, and Treasurer, respectively. Newly elected directors included Bernd Meyburg, Keith Bildstein, and Jeffrey L. Lincer. Thomas Hamer of Western Washington University was presented with the William C. Andersen Memorial Award for 1987 for the best student paper presentation. The paper was co-authored by Fred Samson. The Leslie H. Brown Memorial Award for 1987 was presented to Geoff and Hilary Welch for their raptor research and conservation efforts in Djibouti. The Stephen R. Tully Grant for 1987 was awarded to Kelly F. Hogan for a study of Prairie Falcon foraging ecology in the Chihuahuan Desert. The 22nd annual meeting of the Foundation will be held on 26–29 October 1988 at the Crowne Plaza Holiday Inn Metrodome in Minneapolis, Minnesota.