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THE STATUS, POPULATION STRUCTURE, AND BREEDING DATES OF THE AFRICAN LAMMERGEIER *Gypaetus barbatus meridionalis*

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Abstract

The African Lammergeier (*Gypaetus barbatus meridionalis*), occurring in mountainous country from Yemen south through Ethiopia and East Africa to Lesotho and adjacent parts of South Africa, is listed as threatened in the ICBP *Red Book* (Fisher, Simon, and Vincent 1969). The authors state that the African Lammergeier is common only in the northern and southern parts of its range but is locally abundant only in Ethiopia. They imply that the nominate North African race *G.b. barbatus* is less threatened. This paper attempts to clarify the status and some other facts about the African Lammergeier and to demonstrate that the race is not at present threatened because of its abundance in Ethiopia.

Methods

Between 1963 and 1975 the number of Lammergeiers seen in Ethiopia (and whether they were immature or adult) was recorded and summarized in my field notebooks and diaries. One can usually determine whether a Lammergeier is adult or immature at 400-500 m with the naked eye in good light and at up to 4-5 km with x12 binoculars. The conspicuous white heads of adults show up clearly. In 1975 it also became clear that the immatures could be subdivided into different age groups, described later; but since this was not done between 1965 and 1974, no adequate quantitative data on the various age groups are available for those years. Of 527 Lammergeiers recorded in Ethiopia, however, only 49, 9.3 percent, could not be identified as adult or immature. Most of them were seen at very long range or against the sky as I traveled fast in a car. Samples from mountain areas include fewer unidentified individuals (15/234 or 6.4 percent) because in these areas I was usually on foot or muleback and could take longer to identify distant individuals.

Of the counts I made in towns where I spent several days, only the highest thorough count has been included, since observation shows that the same individuals visit the same areas daily. A good count in any town can usually be made between 0900 and 1000 h, when Lammergeiers are searching for food but have not yet soared to great height. Different individuals can be recognized by molt or minor plumage differences. In mountain areas, when several days were spent at one camp, I avoided counting birds in the same area twice. Although there is still some risk of double-counting, errors have thus been minimized.

Data from Ethiopia were compared with a small sample from Spain for 1955 and one from Lesotho for 1973, giving a comparative sighting rate per day as a crude index of relative abundance. These have been supplemented from published data, numerous personal observations in East Africa, correspondence with other observers, and the East African Natural History Society's and the South African Ornithological Society's nest record card schemes.

Status and Numbers

Good recent data from Yemen are lacking. Nothing is recorded in Meinertzhagen (1954) regarding this area. It seems likely that the Lammergeier may still be fairly common in mountainous parts of Yemen, since land-use methods have probably altered little, and accordingly there is no obvious reason why the status of the Lammergeier should have changed. In the rest of the race's range numbers are assessed as follows:

1. *Ethiopia:* Common, locally abundant (more than 10 seen daily in preferred habitat). Most numerous around towns and villages, but also numerous in high mountains in northwest Ethiopia, e.g. Semien Mountains. Daily sightings varied from none to a maximum of 23 in one day at Gondar in 1965. In 150 days on which Lammergeiers could have been seen, 527 were recorded, an average of 3.5/day overall. The average sighting rate in towns and inhabited areas, 4.4/day, is higher than in thinly inhabited or uninhabited mountain areas, 2.8/day. However, the latter figure is biased by a long expedition through the Bale and Arussi mountains in southeast Ethiopia in 1966, where in a total of 54 recorded days only 87 were seen, an average of 1.6/day. The species is much less common there than in the Semien Mountains, where in 24 days 134 were seen, 5.6/day, an even higher average rate than in towns and villages in the same general region. The overall sighting rate of 3.5/day may be compared with 10 in 15 days in Spain, 1955, 0.66/day; and 8, perhaps 10, in 10 days in Lesotho in 1973, 0.8-1.0/day.

There is thus no question that the Lammergeier is relatively common in Ethiopia, perhaps more so than anywhere else in the world except Tibet (Schaefer 1938). Total numbers cannot be estimated on present available evidence. However, it occurs over about three-fourths of the main Ethiopian highland massifs that total about 475,000 km^2 but is absent or scarce in the forested southwest. Normally it is common only above 1800 m in elevation but occasionally occurs lower (in the deserts of the Awash Valley down to 300 m), though it is not known to breed at these lower elevations. Four known nesting sites range from about 2500-3700 m, but it also probably nests below 2000 m.

No thorough surveys have been possible to establish the home range of a pair. In one area, two known nest sites are approximately 3.5 km apart, suggesting a range per pair of 12-15 km^2. However, Lammergeiers nesting relatively close together along cliffs in gorges probably travel many miles daily over flat plateaus lacking any nesting sites, so that average home ranges in practice would probably be much larger. Assuming however that the home range per adult pair averages 100 km^2 (a density certainly exceeded locally), there could then be about 4750 pairs in Ethiopia, and since 22.6 percent of the population is immature, perhaps 11-12,000 birds altogether. If this estimate is even approximately correct, the African Lammergeier is not a threatened race.

2. *East Africa:* In Kenya the African Lammergeier is widespread but uncommon or rare in high mountain ranges and on isolated peaks. Recorded from Mt. Marsabit (North, pers. comm.); Mt. Kulal, more than 3 birds (P. Saw, in litt.); Matthews and Ndotos ranges, certainly 4-6 pairs, and Muruanisigar, Turkana (G. H. H. Brown, in litt.); Ololokwi (Ol Donyo Sabachi) north of Archer's Post (unpub. data and North, pers. comm.); north of Kapenguria in western Pokot District (T. Barnley, in litt.); Cherangani Hills, more than 1 pair; Mt. Elgon, at least 2 pairs; Mt. Kenya, possibly 5

pairs; Ngobit (unpub. data and R. Hook, pers. comm.); along the Rift Valley from near Naivasha to near Ngong (North 1944, and unpub. data); Ol Donyo Orok and east of Chyulu Hills (Van Someren 1939); and even at Maungu, at only 800-900 m (Hopson, pers. comm.). These records suggest that although the species is much rarer in Kenya than in Ethiopia or even Lesotho, the Kenya population may be about 20-30 pairs.

In Tanzania it is recorded from Mt. Longido, Kilimanjaro, Mawenzi, and Mt. Meru, perhaps 10 pairs (G. H. H. Brown, and unpub. data); the Crater Highlands, at least 5 pairs (unpub. data, and Fuggles-Couchman and Elliott 1946). Its most southerly outpost is probably Mt. Hanang (Fuggles-Couchman 1953). There may be another 20-25 pairs in the mountains of northern Tanzania.

In Uganda it occurs on Mount Elgon; in northern Acholi; Karamoja (Mt. Moroto and probably Mt. Kadam); Ruwenzori; but not on Nyamlagira; in Zaire (Pitman, in litt., quoting Haddow, Bere, and personal records). There must be at least 5, possibly 10 pairs in Uganda. The total East African population therefore is probably at least 50-60 pairs. Although rare, it is apparently not threatened, as the population appears stable.

3. *Southern Africa:* There is a complete gap in the range from Mt. Hanang in northern Tanzania to the Orange Free State, Natal, and Lesotho. In Lesotho Rudebeck (1961) found Lammergeiers quite common, and there it has recently been studied in detail at the nest (Guy and Tomlinson, in prep.). At least one breeding pair is known in the Golden Gate National Park in the Orange Free State (Newman 1969); and it occurs along the Drakensberg escarpment; in Natal in Giants Castle Game Reserve; and almost certainly in east Griqualand, northern Cape Province, since I saw one within 1.5 km of the border between east Griqualand and Lesotho in November 1973.

In Lesotho, in 10 days spent in suitable areas, I saw certainly 8, probably 10 different individuals, of which 7-9 were adults and 1 an immature. Rudebeck (1961) saw 21 including 17 identified adults and 2 immatures. My own sightings, averaging 0.8-1.0/day (without making any special effort to find the birds), are about a quarter of the average sighting rate in Ethiopia, indicating that the Lammergeier is much less common in Lesotho than in Ethiopia. However, my average sighting rate per day is apparently at least as high as Rudebeck's, suggesting no marked recent decrease. It is also about the same as the average sighting rate per day of the Golden Eagle *Aquila chrysaetos* in northwest Sutherland in 1967, in an area surveyed in detail on foot, where the known density of Golden Eagles is one pair per 4600 ha (11,400 acres) (Brown 1967). Even supposing that a pair of Lesotho Lammergeiers requires about three times the range of a pair of Golden Eagles (150 km^2), there could still be about 100 pairs in 15,000 km^2 of mountainous Lesotho suited to Lammergeiers. The total southern African population may thus be about 120 pairs, rather than the 20-25 pairs sometimes casually mentioned for South Africa as a whole.

Thus, the total population of *G.b. meridionalis* might be about 12,000 birds in Africa, with an unknown, but probably large, population in Yemen. Most of the African birds live in Ethiopia, with small groups totaling not more than 200 pairs in East and South Africa. Even in East and South Africa the small populations appear stable and are not obviously threatened or declining (Brown 1977, Kemp & Kemp 1977). Although the African Lammergeier is thus not apparently threatened with extinction in any part of its range, it should nevertheless receive complete protection as a magnificent and completely harmless bird.

Population Structure

Between 1965 and 1975, inclusive, I have recorded 527 Lammergeiers in Ethiopia, probably about 80 percent of those seen. After 1965 almost all have been recorded. Of the 478 identified individuals 370 (77.4 percent) were adults, and 108 (22.6 percent) were immatures. Forty-nine (9.3 percent of the total) could not be identified. These figures compare with 31 percent immatures in the Bateleur *Terathopius ecaudatus* (Brown and Cade 1972) and 16-24 percent in the African Fish Eagle *Haliaeetus vocifer* (Brown and Cade 1972, Brown and Hopcraft 1973). The proportion of immatures in the Ethiopian population appears much higher than in Lesotho (3/27 or 11 percent) (my figures and Rudebeck 1961); and in the small sample from Spain (1/10 or 10 percent) in 1955.

In Ethiopia high mountain areas with sparse or moderately dense populations of peasant farmers and graziers are mainly occupied by adult Lammergeiers, whereas immatures and subadults tend to congregate around village and town rubbish dumps. Table 1 shows that in 84 days spent in mountains, I saw 188 adults (85.8 percent of identified birds) and 31 immatures (14.2 percent). In towns and predominantly inhabited areas on the plateau 182 adults (70.4 percent) and 77 immatures (29.6 percent) were seen in 66 days. Counts made only in mountains or around towns and villages would thus give a misleading picture of the population structure.

The Ethiopian Lammergeier appears nearly twice as common in and near towns and villages as in mountain areas, but the mountain sample is biased by the results of one long expedition in Bale and Arussi, in which only 83, including 62 adults and 13 immatures, were seen in 52 days. In Bale and Arussi, in 54 days (some results stolen in 1973) 87 Lammergeiers were seen, averaging 1.6/day, whereas in four trips to Semien, totaling 24 days, 134 were seen, or 5.6/day. The proportion of immatures seen in the Bale Mountains, 13/78 or 16.67 percent, is also higher than in Semien, 13/128 or 10.16 percent. This might be because in Semien large towns and villages are closer to the main mountain massif than in Bale so that immatures could more easily move there. However, it seems likely that, as in some other large birds of prey (e.g., Gargett 1975), immature Lammergeiers are unable to remain in the breeding ranges and must subsist in areas not occupied by breeding adults. In Ethiopia, the fact that immatures can readily find scraps of meat, skin, and bones around any village rubbish dump or slaughterhouse may improve survival and help to explain the apparently higher proportion of immatures in the Ethiopian than in the Lesotho or Spanish populations.

No detailed description of the molt from first immature to adult plumage in the Lammergeier seems to be available, while the visible plumage characters are complicated by the known cosmetic habits of the birds. However, according to Glutz von Blotzheim et al. (1971), the Lammergeier assumes adult plumage in about 5 years. The first immature plumage has the head blackish brown, and pale edges to the feathers of the back and wing coverts sometimes produce a pale patch on the upper back. In the later subadult plumages the pale edges disappear on the upper side, and pale or white feathers molt in on the breast and belly. The course of the plumage changes, presumably based on observation of captive birds, is, however, not described accurately.

In wild Ethiopian birds at least three phases of immature plumage are distinguishable:

1. Presumed juvenile; head and neck blackish brown, contrasting with a paler dull brown breast and belly; upper side dark brown with pale or whitish streaks some-

times coalescing; this probably would correspond to the first immature plumage as described by Glutz von Blotzheim et al. (1971).

2. Presumed immature; head and neck remain blackish brown, but the pale streaks disappear from the back and upper wing coverts, which are more uniform paler brown; breast and belly more rufous brown.

3. Subadult; in what is assumed to be an immediate subadult plumage approaching maturity, white feathers grow in on crown and cheeks; the head is now clearly separated from a still paler, more rufous, breast and belly by a dark chestnut neck-ring; sclerotic eye ring bright red, iris whitish, as in adult.

Phases 1 and 2 look very similar from below; and as relatively few Lammergeiers can normally be viewed from above, they have been lumped in a small sample since 1974 when an attempt was made to separate age groups of immatures. Among 22 identified immatures, 20 were in phase 1 or 2 and only 2 in phase 3. This small sample suggests that only about 1 immature in 10 survives to adulthood. Certainly, very few individuals in the distinctive phase 3 are seen.

If Lammergeiers assume adult plumage in about 5 years, like the African Fish Eagle, and as suggested by Glutz von Blotzheim et al. (1971), then, on the basis of theoretical mortality rates of 50 percent in the first year and 20 percent per year thereafter (Brown and Cade 1972) and a breeding rate of 0.55 young/pair/annum (see below), adult Lammergeiers must live 13.7 years as adults and 18.7 years altogether to maintain a stable population. However, Lammergeiers might actually take longer to reach maturity, as suggested by recent molt studies of Griffon Vultures *Gyps* spp. by Houston (1975). Griffons apparently take at least 7 years to attain adult plumage, completing a primary wing molt in 3 years. He quotes Menzbier (1894) to the effect that Lammergeiers take 2 years to complete a body molt but only 1 to complete a wing molt; if so, they would perhaps mature more quickly than Griffons. If, however, their rate of assuming adult plumage is similar to that of Griffons and the Bateleur *Terathopius ecaudatus* (Brown and Cade 1972), then, again using the theoretical mortality rates for the Bateleur (50 percent in year 1 and 10 percent per annum thereafter), adults must live for 14.3 years as adults and 21 years altogether. Available figures for age-classes of immatures, which cannot in any case be correlated with good molt studies in captive birds, do not currently permit any better approximations.

Adult plumage is normally rather rich pale rufous below, but the coloration is caused by a powdering of iron oxide (see e.g., Jackson & Sclater 1938, Berthold 1967). Adults are sometimes seen with pure white undersides, and zoo captives usually become pure white. In the Crater Highlands, Tanzania, in October 1957, one of a pair seen in Olmoti Crater was pure white, the other rufous. At Makalle, Tigrai, Ethiopia, in September 1975, several adults were pure white below; but by late October all adults seen had become rufous. Thiollay (1968) saw many individuals with pure white undersides in Corsica in July and August and, in April 1966, a pair of which one was white, the other rufous. These observations suggest that the rufous color of breast and belly can easily be lost or washed off, though normally maintained by cosmetic activities. The fact that all adults at Makalle in September 1975 were pure white, just after an unusually heavy rainy season, suggests that in a prolonged period of wet weather the rufous color may be more easily lost than at other times.

Breeding Dates

Yemen: There are apparently no published records (Meinertzhagen 1954). Ethiopia:

six good egg-date records (1,C1; 1,C2) include four in October and two in November. Laying thus occurs at the end of the main rainy season in north and west Ethiopia, but the single November record for the Bale Mountains in the southeast is during a subsidiary rainfall peak.

In Kenya, R. Hook took an egg on May 8 (Meinertzhagen 1944), which may have been laid in April. A pair in the Njorowa Gorge at Naivasha has laid (in three definite records) once in January, once in April, and once in early May; other observers' reports suggest that this pair has laid about April-May, at the height of the rains; young are flying by November. In Uganda Pitman records an egg from north Acholi in January (East Africa Nat. His. Soc. nest record cards). There appear no certain egg dates from Tanzania, but immatures have been seen on Kilimanjaro and Mt. Meru (G. H. H. Brown, in litt.).

The few available records from East Africa and Ethiopia suggest that, in countries where the entire protracted breeding season (at least 180-200 days from nest building to independence of the young) can be completed in dry weather, egg laying occurs early in the dry season; but that in the intertropical convergence zone (where two three-month rainy and dry seasons alternately annually), the Lammergeier is as likely to lay in the rains.

Two recent Lesotho records are for May (Guy, pers. comm.). A pair photographed by Barnes and others near Mokhotlong in Lesotho laid in June (Barnes, pers. comm., Pearse 1974). Two South African nest record cards for eggs are in July and August, and one for young in September (South African Orn. Soc. Nest record card scheme). A pair was incubating in Golden Gate National Park on 21 June (Newman 1969) and had a chick in the same nest in September (Steyn 1970). These records all suggest peak laying in South Africa about June, in the depths of winter, and are compatible with records of midwinter laying, in January or even December, in southern Spain (Glutz von Blotzheim et al. 1971).

Breeding Frequency and Success

The scanty data available on the subject of breeding frequency and success do not suggest that the Lammergeier is an unusually infrequent breeder or, consequently, unusually long-lived. One Ethiopian pair observed for four consecutive years bred in two years and in two other years frequented the usual breeding site and apparently had no alternate. Another pair bred in 1973, but not in 1974 or 1975. The Naivasha pair in Kenya were reputed to have reared young annually from 1964-69, but not in 1970, though they again bred successfully in 1971. They certainly succeeded in 1964, 1969, and 1971, but definitely did not breed in 1970. After 1972 they were much disturbed by rock-climbers and did not breed but may have succeeded again in 1975. Thus, in 7 pair years in Ethiopia young were reared in 3, 0.43/pair/annum; and in 4 years in Kenya one pair reared three young, 0.75/pair/annum. Combined, the breeding success of these three pairs is 0.55/pair/annum. This record is similar to that of a number of large eagles (e.g., Gargett 1970, Brown and Hopcraft 1973) and better than some large solitary vultures, e.g., the Lappet-faced Vulture *Torgos tracheliotus* (Pennycuick 1976), but is far lower than the breeding success of the strongly colonial Rüppell's Griffon (*Gyps rueppellii*) in Serengeti (Houston 1976) in which success per occupied nest approaches 100 percent. In this case, however, the number of non-breeding pairs could not be assessed. Taken in conjunction with the proportion of immatures in the total population, the rather inadequate data on breeding success do not suggest that the Lammergeier is exceptionally long-lived, but further data are needed.

In 1963 one Ethiopian egg was taken for electrophoretic analysis. In 1964 the same site was again used and had a downy chick; but Ethiopians threw burning brands into the nest and destroyed it. The site was never used again up to 1971, though the adults remained in the vicinity, suggesting that a catastrophe may inhibit breeding for several years.

Reasons for Abundance or Relative Scarcity

The Lammergeier is often apparently commensal with rather primitive pastoral cultures, where large populations of domestic stock are maintained under hard mountain-range conditions and consequently subject, with inadequate veterinary services or none at all, to high death rates. In Ethiopia, the Lammergeier is commensal with man, feeding on scraps of meat and carrion as well as bones, and, in Tibet, following the plough in spring to obtain grubs from the spread manure (Schaefer 1938). The Lammergeier disappears or becomes rare in areas where efficient stock-keeping and modern sanitation prevail, e.g., in Switzerland. Even in Ethiopia it is commoner in inhabited mountain ranges such as Semien than in the almost uninhabited Bale Mountains. In East Africa the Lammergeier must compete for bones with very much more powerful or numerous predators and scavengers such as the Griffon Vultures *Gyps rueppellii,* and *Gyps africanus*; spotted hyenas *Crocuta crocuta*; or jackals *Canis* spp. Lammergeiers cannot successfully contest prey with domestic dogs on rubbish dumps, or with *Gyps rueppellii* at a carcass.

The Ethiopian highlands support about 15 million cattle, at least 25 million sheep and goats, and 3 million equines, all with high death rates from disease, accident, or starvation. Here too the Lammergeier must compete with jackals and spotted hyenas for the available bone supply but, being diurnal, often has the first chance after larger flesh-eating vultures have stripped a carcass. Moreover, it is not wholly dependent on bones. Near villages and towns adults and immatures readily obtain their requirements from discarded scraps of meat, skin, and bone. An adult has been seen to walk clumsily three times in succession into a patch of dense bush to feed on the body of a dead gelada baboon *Theropithecus gelada,* in each case taking a cropload about 1 km away to a nest containing a large young bird and returning for more soon after regurgitating the food on the nest edge. However, Lammergeiers do undoubtedly feed on bones to a large extent and are often seen dropping them (Brown 1970). I have also seen the process in Spain in 1955, and there are several good records from India (e.g., Lowther 1947). Occasionally, they may also kill their own prey (Newman 1969).

In Ethiopia, religious beliefs forbidding good Christians and Muslims to eat animals not correctly slaughtered probably contribute to the abundance of food available to Lammergeiers and other scavenging birds. Probably similar beliefs would apply in Yemen. In Lesotho, on the other hand, no such religious taboos prevent hungry herdboys from eating an animal which has died; this could be a contributory factor in the relative rarity of the Lammergeier in Lesotho compared to Ethiopia, though conditions are otherwise rather similar (Guy, pers. comm.). However, the difference could also be due to less favorable climatic conditions, notably a severe winter. Even in East Africa Lammergeiers seem commoner in mountain ranges inhabited by pastoralists such as the Maasai than in uninhabited massifs; but they are so uncommon that their members cannot be assessed quantitatively.

Scavenging and carrion-eating birds commensal with man are considerably more abundant in Ethiopia than in East Africa. In counts summarized for thinly inhabited

East African grasslands (Brown 1970) scavengers and carrion-eating raptors made up 55.7 percent by numbers and 75.7 percent by biomass among 32 species of birds of prey; vultures (excluding very rare Lammergeiers) comprise 59.4 percent of the biomass. In densely inhabited Ethiopian highlands and lowlands scavengers and carrion-eaters generally make up more than 80 percent by number and more than 90 percent of the biomass, though roadside counts tend to become biased when the roads pass through frequent villages where such birds congregate. For instance in 6 days, 5-10 May 1970, between Addis Ababa and Dessie in northern Ethiopia, of 462 individuals of 16 species of birds of prey, 387 (83.8 percent) were scavengers or carrion-eaters, equivalent to 93.2 percent of the biomass. They included 18 Lammergeiers seen on 5 days (one spent in lowlands with no Lammergeiers), representative of the general average sighting rate, 3.6/day. Lammergeiers made up 4.65 percent by number of scavengers, 7.0 percent of the whole biomass, and 7.52 percent of the scavenger biomass. About 15 percent of an average sheep consists of bones so that, allowing for some competition with other bone eaters and the fact that Lammergeiers do not eat all bones, such figures are not incompatible with the available bone supply. The major part of any carcass is made up of soft flesh and intestines, eaten by the large vultures.

The large numbers of scavenging and carrion-eating birds commensal with man have also been noted by Galushin (1971) in New Delhi, and a similar predominance of scavengers and carrion eaters has been recorded in a variety of biotopes in South America (Reichholf 1974). The usefulness of such scavenging birds as sanitary squads in the tropics has recently been stressed by Pomeroy (1975).

The main threat to the continued abundance of the African Lammergeier is not direct persecution, from which it suffers little in either Ethiopia or East Africa (though it is to some extent persecuted in Lesotho); nor is it, as suggested by Fisher, Simon, and Vincent (1969), indiscriminate poisoning, which seems to have little serious effect even in South Africa. Rather, it may in time be threatened by improvements in stock-keeping methods, disease control, better sanitation, and consequent reduction in the present readily available supply of food in its range. Such a situation is still remote in its main stronghold, Ethiopia.

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Table 1. Lammergeier counts: Ethiopia, 1965-75.

Year/Month	Predominantly densely populated areas with towns/villages						Predominantly mountain areas without towns/villages			
	Days obs.	Adults	Imms.	Unid.	Total	Days obs.	Adults	Imms.	Unid.	Total
1961	10	39	15	7	61	9	24	3	3	30
1966 January to April	2	2	1	0	3	52	62	13	8	83
1966 May	4	8	6	0	14	2	4	1	0	5
1969	1	1	—	—	1	—	—	—	—	—
1970 June	6	16	8	0	24	—	—	—	—	—
1971 June	2	5	2	1	8	4	29	4	3	36
October to December	2	6	1	2	9	7	28	3	0	31
1974 January to March	4	29	15	9	53	4	34	3	0	37
September	4	17	11	7	35	—	—	—	—	—
October and November	25	47	14	8	69	2	3	0	1	4
1975 September to November	6	12	4	—	16	4	4	4	0	8
Total	66	182	77	34	293	84	188	31	15	234
Percent		70.4	29.6				85.8	14.2		
Spain, 1955							15	9	1	10
Lesotho 1973						10	7(9)	1	8(10)	

Total days observation		150
Adults	Identified	370 = 77.4%
Immatures	Identified	108 = 22.6%
Unidentified		49 = 9.3% (of total)
Total		527
Identified		478

Nos. seen/day: Overall 3.5: In towns, etc. 4.4: In mountains 2.8
In Bale Mts.: 87 in 54 days = 1.6/day
In Semien Mts.: 134 in 24 days = 5.6/day

(Most town sightings and inhabited areas in North and West rather than South and East Ethiopia)

DIET VALUES AND THE FOOD CONSUMPTION OF NEW ZEALAND FALCONS

by
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Abstract

Five diets were fed to two captive New Zealand Falcons over 12–14-day periods. The smaller male consumed 10.6–15.3 percent by body weight compared to the female's consumption of 8.2–13.0 percent. It was found that 100 g of whole mice were equivalent to 120 g of whole small birds, 132 g of lean hare muscle, 150 g of whole day-old turkey chicks, 151 g of rabbit meat, or 226 g of whole rabbit.

Introduction

The diet of the New Zealand Falcon (*Falco novaeseelandiae*) includes small-to-medium-sized birds and introduced mammals such as European hare (*Lepus europeaus*), rabbit (*Oryctolagus cuniculus*), and house mouse (*Mus musculus*). In order to estimate the annual toll taken by a pair of falcons on the prey animals within their hunting range, the food requirements of the falcons must be found.

Ambient temperature, size of raptor, its exercise, molt, reproduction, fat reserves, and diet types all affect the nutritional requirements. Fevold and Craighead (1958) found that the ratio of food consumed by three captive Golden Eagle (*Aquila chrysaetos*), expressed as a percent of their mean body weight, varied inversely with respect to both the mean body weight of the individual bird and the environmental temperature. They found that exercise did not increase food requirements to a great extent. Although a fat raptor can maintain body weight for some time by living on fat reserves (Mavrogordato 1960:46), metabolic drains such as molt and egg production will increase food requirements by an unknown extent.

Craighead and Craighead (1969) and Fevold and Craighead (op cit) did not place much emphasis on the type of food fed. But different diets, as pointed out by Beebe and Webster (1964:252) have different food values, and so the measurement of consumption of an artificial diet, such as beef (Wing and Wing 1939), cannot directly be used to make assumptions on natural food consumption.

By reducing other variables to a minimum, the following experiment was designed to investigate further how different diets affect food requirements. There has been no intent to imply that the chemical requirements of the falcons have been supplied as attempted by Bird and Ho (1976).

Method

Two captive nonreproductive, nonmolting juvenile New Zealand Falcons, a large male from North Canterbury and a small female from the Tararuas, North Island, were studied during the autumn and spring of 1976. These two periods provided temperatures midway between summer and winter temperatures. The falcons were maintained at slightly above their falconry 'flying weight' and with little or no fat reserves so that changes in food intake resulted in corresponding fluctuations in body weight. The two individual falcons were known, from measurements of six captive falcons, to have normal appetites. During the day the falcons were tethered to block perches outdoors, and at night or during extremes of bad weather they were tethered indoors in an unheated room. The door of the room was left open during the day, and the maximum and minimum temperatures of the room were taken daily. The falcons were not exercised during the experimental periods but were flown in between periods to keep them reasonably fit. Five diets were fed to the falcons, each diet for a 12–14-day period. The diets were lean hare muscle, whole rabbit, whole day-old domestic turkey chick, whole mouse, and whole small (10–90 g) birds. The turkey chicks were intended to represent fledgling small birds taken in the wild; to what extent this approximation is correct is unknown. Owing to supply difficulties all food was stored deep-frozen and thawed to room temperature before feeding. This procedure may have lowered the food value slightly.

Food was thrown to the falcons near their blocks, and they were allowed to feed undisturbed; there were no noticeable differences between captive and wild feeding behaviors. When a whole prey animal had to be divided to reduce it to the correct meal weight, the remaining portion was fed to the same falcon on the next day in order to maintain a balanced whole animal diet.

Each diet was given 2–3 days before the experimental period began in order to prevent possible carry-over from the previous diet. One meal per day was given in precalculated amounts, weighed immediately before feeding. The falcons ate all parts of all meals, except 1–2 g of plucked feathers from small birds and larger items from the rabbit diet. I did not collect small bird remains, but rabbit remains were collected, weighed, and subtracted from the meal weight. The extent to which the falcons utilized a whole rabbit carcass is shown in table 1.

Table 1. Utilization of whole rabbit by falcons.

	Weight (g)	% of body weight
Rejected gut	250	16.7
Rejected skin, bones, etc.	224	15.0
Pellets	24	1.6
Consumed meat	998	66.7
Total rabbit	1496	100.0

Pellets, while having no value nutritionally, were probably essential to maintain long-term digestive "tone," and therefore pellet weight was not subtracted from meal weight.

The falcons and their food were weighed on a single beam balance accurate to 1 g. They were kept within 5 g of their set weight throughout the experimental period and finished each diet period at exactly the same weight at the same time of day as at the start.

Results

The results are shown in table 2. Mean temperature varied by 3.5°C between different diet periods, and this variation could affect comparisons because food requirements increase inversely with temperature. Craighead and Craighead (op. cit.) found that for a male Cooper's Hawk (*Accipiter cooperii*) weighing about 300 g the food requirements increased by approximately 1 percent of the body weight for each 4.6°C drop in temperature, within normal annual temperature fluctuations. Therefore in order to make comparisons between diets, the food consumptions of the falcons were corrected on this scale to 10°C.

Discussion

The proportion of each meal that was later ejected as a pellet was much the same with each diet, except for lean hare muscle. Indigestible material was greatest in the whole bird diet but probably caused only a slight increase in meal weight.

Mean food values werė expressed as equivalents to 100 g of whole mouse, which had the highest food value. Food values correlated well between the two falcons but would have been more accurate if it had been possible to arrange longer experimental periods.

If the weight of whole rabbit is considered (table 1) rather than just the weight consumed, the 221 g of whole rabbit are equivalent to 100 g of whole mouse.

As expected, the smaller male had a consistently higher (mean = 13.5) percent body weight food requirement than the female (mean =11.1 percent). Different diet types altered the food requirements considerably although possibly less than most writers on falconry suggest. Woodford's (1960:127) claim that Woodpigeon (*Columba palumbus*) has twice the food value of rabbit is probably too generous unless considered as whole animal values.

Three steps are involved in estimating the annual toll of a pair of falcons:

1. Estimate percentages of different prey take in a sample.
2. Estimate biomass represented by estimate 1.
3. Estimate effect of such variables as temperature, metabolic demands, and food types.

This study indicates that food type alone can alter these estimates by a factor of more than 100 percent.

I would like to thank Dr. J. Warham and Dr. C. M. White for critically reading this paper.

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Table 2. Diet values and food consumption of two New Zealand Falcons.

	Rabbit	Whole chick	Hare muscle	Whole birds	Whole mouse
Month of diet period	June	July	June	Oct.	Oct.
Number of days	14	13	12	14	14
Mean ambient temperature (°C)	9.3	8.0	10.2	11.5	11.1
Male					
Maintained body weight (g)	293	293	293	293	293
Mean daily food consumption (g)	45.5	45.6	38.7	37.8	30.6
% body wt. consumed/day	15.5	15.6	13.2	12.9	10.4
% body wt. consumed at 10°C	15.3	15.2	13.2	13.2	10.6
Food consumption (g/day) at 10°C	44.8	44.5	38.7	38.7	31.1
Wt. food (g) equivalent to 100 g mouse	144	143	124	124	100
Female					
Maintained body weight (g)	424	424	424	424	424
Mean daily food consumption (g)	55.4	56.9	48.6	39.7	34.0
% body wt. consumed/day	13.1	13.4	11.5	9.4	8.0
% body wt. consumed at 10°C	13.0	13.0	11.5	9.7	8.2
Food consumption (g/day) at 10°C	55.1	55.1	48.8	41.1	35.2
Wt. food (g) equivalent to 100 g mouse	157	157	139	117	100
Mean wt. (g) equivalent to 100 g mouse	151±6	150±7	132±7	120±4	100

A ROADSIDE RAPTOR CENSUS IN THE EASTERN GREAT BASIN–1973-1974

by
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Abstract

Roadside raptor surveys were conducted throughout a 12-month period in the eastern Great Basin of Utah. An index of relative abundance was calculated for each species of diurnal raptor present. Communal Bald Eagle roosts were checked routinely and numbers of eagles recorded.

Bald Eagle numbers appear to be stable, but the numbers of Golden Eagles and Ferruginous Hawks have declined since 1968. This decline is probably due to a drop in jackrabbit numbers. The available data do not allow the development of trends for the other raptor species.

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Introduction

From May 15, 1973, to May 15, 1974, periodic counts were made of birds of prey in the semiarid valleys west of Provo, Utah. This area of approximately 932 square kilometers is typically cold desert habitat.

Two principle routes, extending through portions of Utah and Tooele counties, in the west central portion of the state, were followed (Woffinden 1975). The first was approximately 119 km long, involving a total observation area of approximately 590 hectares (a linear strip 119 km long and 0.5 km wide). The second route was a westerly extension of the first, being approximately 77 km in length and including an additional 370 hectares of area.

Both routes had numerous utility poles along them, and they were direct routes to wintering Bald Eagle (*Haliaeetus leucocephalus*) communal roosts (Edwards 1969).

Raptor counts were often peripheral to other activities and were made at different times during the day throughout the 12-month period. A total of 71 counts were conducted. Weather conditions were recorded with each survey. Binoculars and a 20–45X spotting scope were used for identification, sexing, and aging of raptors.

Bald Eagle communal roosts were checked throughout the winter months of the survey period. The total number of birds observed, as well as the numbers of adults and juveniles, was recorded.

An index of relative abundance was calculated as follows:

$$\frac{\text{Total number of a species observed}}{\text{Total number of km traveled}} \times 1{,}000 = \text{index.}$$

For example, 145 Golden Eagles (*Aquila chrysaetos*) were observed as 12,720 kilometers were traveled, which would yield an index of 11.4 (145/12,720 × 1,000).

In addition to this index, the population size of each species of raptor was estimated using the Bounded Count Method described by Overton (1969).

Acknowledgments

We are grateful to personnel and graduate students of the Department of Zoology, Brigham Young University, for their help in the survey. We thank Eugene Knoder and the National Audubon Society for partial funding of the study.

Results

A total of approximately 12,720 km was driven while making the counts. In all, 1,275 raptors were observed, 1 for every 10.0 km traveled (table 1).

Bald Eagles and Rough-legged Hawks (*Buteo lagopus*) had the greatest frequency indices of any of the raptor species even though they were only winter visitors to the area (table 1). Both adult and juvenile Bald Eagles were first observed on October 30, 1973, and were last seen on April 5, 1975 (fig. 1). Peak numbers were observed in mid-January, with a total of 80 individuals (62 mature, 18 juvenile) being observed during one complete census. During the census period, 330 mature and 141 juvenile Bald Eagles were observed for a mature:juvenile ratio of nearly 3:1.

Rough-legged Hawks (*Buteo lagopus*) were first observed in the study area on October 30, 1973, and were last seen on March 30, 1974.

Age could be determined for only 66 of the 145 Golden Eagles observed. The number of adult individuals was only slightly greater than juveniles (35 adult, 31 juvenile) in this resident species.

Ferruginous Hawks (*Buteo regalis*) were first observed in the study area on July 24, 1973, and last observed March 6, 1974. A number of pairs nested in the census area during the spring and summer of 1973 and 1974 (Woffinden 1975).

It was possible to accurately sex only 10 Kestrels (*Falco sparverius*). Seven of this total were males. Of the 78 Marsh Hawks (*Circus cyaneus*) for which sex could be determined, 43 were males.

The results of the analysis to determine the population size of the various raptor species by using the Bounded Count Method (Overton 1969) are summarized in table 1.

Discussion

As man has altered natural habitats, various raptor species have declined in numbers (Hickey 1969). Population trends of this nature cannot be accurately assessed without quantitative data from prior years. Additionally, in many instances, wildlife and resource managers are not aware of the number and species of nongame animals that inhabit the lands for which they are responsible. It is hoped that the data presented here will help fill these types of voids for the eastern Great Basin.

Bald Eagles had the greatest relative abundance index of any of the raptors discussed (45.0). This figure increases greatly (to 996.0) if an index is calculated including only the kilometers traveled during the approximate five-month period when Bald Eagles were present in the study area. Southern's (1963, 1964) population estimates of Bald Eagles wintering in his study area in Illinois show an adult:juvenile age ratio agreeing with that observed in this study. Johnson and Enderson (1972) saw only 6 individuals during their winter surveys in Colorado.

The Bald Eagle is an important winter visitor to Utah. Its communal roosting sites should be protected and maintained wherever possible. Some of these sites are on public land, while others are on private property. Fortunately, the private land owners involved provide protection for the eagles. Data from previous years of this ongoing study indicate that the number of Bald Eagles in the study area is stable.

The number of Golden Eagles appears to have decreased, however (Murphy 1975). This decrease is believed to have been a response to a decline in numbers of the black-tailed jackrabbit (*Lepus californicus*), on which the eagles are largely dependent for food. Even though the total number of nesting Golden Eagles has decreased recently, the production of nesting pairs is not significantly less than normal (Murphy 1975).

This is not the case with the Ferruginous Hawk (Woffinden 1975). A drastic decline in numbers and a significant drop in production of nesting pairs have been observed recently (Woffinden 1975). This decline is apparently a response to a drop in jackrabbit numbers, and it may well be that the decline in jackrabbits as well as the raptors that utilize them for food is simply a periodic fluctuation.

Lack of previously collected data does not allow us to suggest trends in the other raptors discussed, but it is hoped that the data presented in this paper may aid in the establishment of future trends.

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Table 1
Frequency of raptor sightings, relative abundance indices, and population estimates of raptors in the eastern Great Basin, 1973–74.

Species	Number observed	Km traveled per individual	Index of relative abundance	Population size (Bounded Count)	Confidence[1] interval
Bald Eagle (*Haliaeetus leucocephalus*)	573	22.1 (13.8)*	45.0	115	80–745
Rough-legged Hawk (*Buteo lagopus*)	173	73.5 (45.7)	13.0	30	26–102
Golden Eagle (*Aquila chrysaetos*)	145	87.7 (54.5)	11.4	13	11–49
Ferruginous Hawk (*Buteo regalis*)	136	93.5 (58.1)	10.7	10	9–28
Marsh Hawk (*Circus cyaneus*)	127	100.2 (62.2)	10.0	7	6–15
Sparrow Hawk (*Falco sparverius*)	40	318.0 (197.5)	3.1	7	5–43
Swainson's Hawk (*Buteo swainsoni*)	32	397.5 (246.9)	2.5	6	5–24
Red-tailed Hawk (*Buteo jamaicensis*)	28	454.3 (282.2)	2.2	5	4–23
Prairie Falcon (*Falco mexicanus*)	17	798.3 (464.8)	1.3	4	3–22
Burrowing Owl (*Speotyto cunicularia*)	3	4240.1 (2633.6)	0.2	3	2–21
Merlin (*Falco columbarius*)	2	6360.1 (3950.4)	0.2	1	1–20
Turkey Vulture (*Cathartes aura*)	1	12720.1 (7900.7)	0.1	1	1–20

*Miles traveled per individual
[1]Alpha = 0.05

Johnson, D., and J. H. Enderson. 1972. Roadside raptor census in Colorado—Winter 1971–72. Wilson Bulletin 84(4):489–490.

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REVERSING FEMALE DOMINANCE IN BREEDING RAPTORS

by
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In past years we have had trouble with female aggression in Merlins (*Falco columbarius*). This aggression seems to occur only at certain times of year and becomes most pronounced (in our cases) around the equinoxes. The females become very aggressive and chase and attack their mates. In one of our cases the male was killed from a pair which had successfully raised four young the year before. Other cases of aggression with Merlins have come to our attention (Fyfe, Adamson pers. comm.).

In all cases mentioned above the aggression did not appear to be due to imprinting, but rather to the birds' high-strung temperament, and possibly because they were confined to pens where the male could not readily escape. The females seem to become highly territorial and do not even permit the presence of their mates in their territory.

We discussed methods of reversing or repressing this aggression and finally decided to clip the wing tips of the females in the spring before putting them into the breeding chambers with the males. The males are kept in the breeding pens the year round, but the females are removed in September or October and are kept out until the following April.

The wings were clipped to a rounded shape, like an accipiter's wing, with a pair of scissors. The birds could fly and reach any part of the pen but were severely handicapped.

We clipped one female this spring just prior to putting her in the breeding pen. She flew up to a perch and remained there in a frozen position for forty minutes. Meantime the male was flying round the pen. Finally he flew over near the female and caused her to duck to avoid being hit. After forty minutes the female moved, but there was no further aggression, and courtship and copulation followed shortly after. The male seemed to have asserted his dominance and seemed to court more aggressively thereafter.

This method could possibly be used on imprinted birds with good results where imprinting could possibly be reversed.

TECHNIQUES USEFUL FOR DETERMINING RAPTOR PREY-SPECIES ABUNDANCE*

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Abstract

A workshop was held by the Raptor Research Foundation on October 27 and 28, 1976, in Ithaca, New York, to develop standardized data collection and analytical methods for raptor studies. Applications of the methods will ensure compatibility and facilitate year-to-year and area-to-area comparisons valuable in environmental assessment and raptor population trend monitoring.

We have focused on one of the workshop topics, that of methods appropriate for measuring prey-species abundance. Emphasis is on techniques used in western grasslands. The selection and use of the particular techniques described in this paper will depend on the level of quantification desired, the habitat type, and the availability of research time and money. Long-term studies should include methods that will provide quantified data, i.e., density (number of individuals per unit area). Such data will enable calculation of prey exploitation rates and prey densities, parameters important to our understanding of raptor population dynamics.

Invertebrates

Sample Counts

Petrusewicz, K., and A. Macfadyen. 1970. Productivity of terrestrial animals, principles and methods. *IBP Handbook 13*. Blackwell Scientific Publications, Oxford. This technique is based on counts of all individuals of the species or group of species considered in a sample from a small but representative area. The size of the sample plot depends on the mobility and abundance of the species. Sample plots 1 m^2 work well for Coleoptera and Orthoptera. Data obtainable: density.

Catch-Mark-Recatch

See above reference. Capture, mark, and release a number of individuals at the same site. Later capture again using the same method in the same area and find the marked individuals. The population can then be determined by the Lincoln Index: $N = (b)a/a'$. This technique is useful for large, easily captured insects, particularly beetles. Data obtainable: relative density.

Quick Trap and Vacuum Sampler

1. Turnbull, A., and C. Nicholls. 1966. A "quick trap" for area sampling of arthropods in grassland communities. *J. Econ. Entomol.* 59:1100-1104. A trap that can be set down quickly over the sample area to contain the flying insects present is used. Material is removed by means of a D-Vac vacuum insect net. Berlese funnels are used to separate micro-invertebrates from the debris. Widely used in grassland studies. Data obtainable: density.

*This work was done for the U.S. Energy Research and Development Administration under contract EY-76C061830.

2. Ahearn, G. A. 1971. Ecological factors affecting sampling of desert Tenebrionid beetles. *Amer. Midl. Natur.* 86:385-406. Discusses the influence of climatic conditions, activity, population size, surface illumination, trap density, and trap spacing on the use of the pitfall trapping technique in evaluating population size of ground-dwelling beetles. Data obtainable: relative abundance.

3. Greenslade, P. J. M. 1964. Pitfall trapping as a method for studying populations of Carabidae. *J. Anim. Ecol.* 33:301-310. Reviews pitfall trapping as a sampling method for Carabidae. Considers the effects of population size, locomotor activity, species' susceptibility to trapping, and habitat on the total catch. Data obtainable: relative abundance.

Malaise Trap

1. Mathews, R. W., and J. R. Matthews. 1971. The Malaise trap: its utility and potential for sampling insect populations. *Mich. Entomol.* 4:117-122. This method is based upon the observation that most flying insects that hit an obstacle respond by flying or crawling upward and thus into captivity. These traps are easy to use, can be placed in almost any habitat at any height, and are cheap to construct, or they can be purchased ready-made. Data obtainable: relative abundance.

2. Townes, H. 1972. A light-weight Malaise trap. *Entomol. News* 83:239-247.

Ocular Census Method

1. Bhatnager, K. E., and R. E. Pfadt. 1973. Growth, density, and biomass of grasshoppers in the shortgrass and mixed-grass association. *U.S. IBP Grassland Biome Tech. Rept. No. 225.* Colorado State Univ., Ft. Collins, CO. This method permits an estimate of the density of large-sized insects by traversing an area and counting the number of individuals in small sample areas (30.5 cm^2). A large number of sample points can be gathered in a short while, but the method applies only to large, easily recognized species (grasshoppers, beetles, etc.). Data obtainable: density.

Vertebrates (Reptiles and Amphibians)

Transect Lines

Fitzgerald, G. J., and J. R. Rider. 1974. Seasonal activity of the toad *Bufo americanus* in southern Quebec as revealed by a sand-transect technique. *Can. J. Zool.* 52(1):1-5. A covered sand transect was used to collect data on toad movements. The transect was 225 m long and 46 cm wide. Tracks are recorded and then erased at least twice a day. This technique is useful to measure trends in reptile and amphibian populations. Data obtainable: trend data.

Drift Fence

Gibbons, J. W., and D. H. Bennett. 1974. *Determination of anuran terrestrial activity patterns by a drift fence method.* Copeia No. 1, pp. 236-243. Hardware cloth, 0.64-cm mesh and 61 cm high, was used for fencing. "The fence was placed in an 8-10-cm deep ditch, later filled with soil. Metal stakes alongside the fence added extra support. Metal buckets (diameter 35 cm; depth 41 cm) were placed at 20-m intervals in paired holes on opposite sides of the fence so the mouth of each can was at ground level flush with the fence." Amphibians were directed along the fencing and became entrapped in sunken buckets. This technique is widely used for amphibians. Data obtainable: relative abundance.

Mark-Recapture

Rose, F. L., and D. Armentrout. 1974. Population estimates of *Ambystoma tigrinum* inhabiting two playa lakes. *J. Anim. Ecol.* 43:671-679. Neotenic salamanders were collected with a 12.2 m x 1.8 m bag sein. Each animal was toe clipped, and its initial and subsequent dates of capture were determined. Population size was estimated by six different methods: Lincoln-Peterson (Southwood 1966); Bailey triple catch (Bailey 1952); Schnabel (Ricker 1958); Schumacher-Eschmeyer (1943); Jolly (Southwood 1966); and Leslie (1952). This technique was used on aquatic organisms, but the principles also apply to terrestrial organisms. Data obtainable: density.

Grid Trapping

1. Bellis, E. D. 1964. A summer six-lined racerunner (*Cnemidophorus sexlineatus*) population in South Carolina. *Herpetologica* 20(1):9-16. Wire-screen funnel traps (108 cm long; with a 15-cm diameter receiving cylinder at each end and a cone with a small opening at the apex with a 38-cm base resting on the ground) were used to capture lizards. Each cone was somewhat flattened where it contacted the ground, thus providing a broad receiver for the lizards. The cylinders were covered with vegetation to protect lizards from excessive sunlight. Traps were systematically moved about within quadrants to assure that all habitats were well trapped. Traps were not baited; their success depended on movements of lizards in normal activity. Lizards were individually marked by toe amputation and small blotches of poster paint on their dorsa. Data obtainable: density.

2. Rickard, W. H. 1968. Field observations on the altitudinal distribution of the side-blotched lizard. *Northwest Sci.* 42(4):161-164. Five can traps arranged in a line with 3-m spacing between were used to capture lizards and insects. Data obtainable: relative abundance; this method can also be used to determine density when coupled with a grid arrangement of traps, the mark-recapture technique, and assessment lines.

Birds

Line Transect Methods

1. Kendeigh, S. C. 1944. Measurement of bird populations. *Ecol. Monogr.* 14:67-106. A simple tally of individuals detected per unit of effort. Data obtainable: relative abundance and species diversity.

2. Rickard, W. H. 1964. Bird surveys in cottonwood-willow communities in winter. *Murrelet* 45(2):22-25. A simple tally of individuals detected while walking along an established path. Data obtainable: relative abundance and species diversity.

3. Jarvinen, O., and R. A. Vaisanen. 1974. Estimating relative densities of breeding birds by the line transect method. *Oikos* 26(3):316-322. This method considers transect belts of two different widths. "In the line transect censuses of breeding birds, all observations are registered. Observations made within 25 m of the transect, about 20% of total, constitute the 'main belt' records while 'survey belt' records refer to all observations. This study shows how observations outside the main belt can be utilized to estimate densities of different species." Data obtainable: relative abundance and species diversity.

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Mammals

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BARBED WIRE IMPALES ANOTHER GREAT HORNED OWL

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At 0900 on 24 May 1976, accompanied by K. Quackenbush, I found an adult Great Horned Owl (*Bubo virginianus*) impaled by both wings on the top wire of a five-strand, barbed-wire fence (fig. 1). The fence was on semiarid rangeland, predominantly mesquite (*Prosopis glandulesa*) and retama (*Parkinsonia aculeata*), near a small water tank, approximately 20 km NNE of Laredo, Texas.

The bird was alert and active when found. A set of barbs was entangled in the skin of each wing. Closer examination showed that the bird had injured its right eye, probably on a barb, during its attempt to get free. A small patch of skin was lost on each wing when the barbs were removed, but no bleeding occurred.

Because the owl was active and did not appear seriously injured, we released it, whereupon it hopped along the ground for 18 m, perched briefly on a small tree, and then flew 90 m to a mesquite tree. We did not observe it further.

The owl was apparently flying with wings extended when it hit the barbed wire with enough force that it made two complete turns around the wire and became firmly entangled on the barbs.

Edeburn (*Wilson Bull.* 85:478, 1973) found a Great Horned Owl impaled by one wing on a barbed-wire fence in Pennsylvania, and McCarthy (*Wilson Bull.* 85:477-478, 1973) found one impaled by one eye on a barbed-wire fence in Missouri. Fitzner (*Raptor Research* 9:55-57, 1975) found a Great Horned Owl and a Short-eared Owl (*Asio flammeus*) impaled, each by one wing, on a barbed-wire fence in Washington.

In all instances the impaled owls appeared to have hit the wire forcefully as if they either did not see it or did not perceive it as a hazard to their flight.

Figure 1. Great Horned Owl impaled on barbed wire fence.

REINTRODUCTION OF CAPTIVE-BRED PRAIRIE FALCONS IN CALIFORNIA–1976

by
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In recent years there has been an increase in raptor captive-breeding programs throughout the country. However, there have been very few attempts to reintroduce captive-bred birds of prey into the wild (Olendorff and Stoddart 1974). Fyfe (Olendorff and Stoddart 1974) and Cade et al. (1974, 1975) have successfully reintroduced captive-bred Prairie Falcon (*Falco mexicanus*) nestlings in Canada and Colorado, respectively. The successful reintroduction of two captive-bred female Prairie Falcons during the summer of 1976 reported herein is the first such project in the State of California.

During the spring of 1976, Gary A. Beeman of LaFayette, California, raised twelve Prairie Falcons in captivity. Two were donated to Robert Malette of the California Department of Fish and Game for release. On 9 June 1976 Carl Thelander and Brian Walton of that Department placed the two female falcons in an eyrie located near Newell, California. The birds were approximately 13–14 days of age. Each was banded on the right leg with a Fish and Wildlife Service band. I was assigned by the California Department of Fish and Game to observe them.

The eyrie was occupied at that time by one naturally bred female nestling of approximately the same age. Both adult falcons were also present. The nest cliff has in the past supported two pairs of Prairie Falcons (Wenzel pers. comm.), but only one adult pair occupied the site in 1976. Other raptors nesting on the surrounding cliffs included a pair of Red-tailed Hawks (*Buteo jamaicensis*) and a pair of Golden Eagles (*Aquila chrysaetos*).

Follow-up observations showed that the reintroduced nestlings were accepted by the parent falcons. Direct and indirect feeding of the young by the adults was noted on several occasions. The wild-bred female and one of the female captive-bred nestlings fledged on 1 July 1796. The other captive-bred female fledged two days later. After fledging the young falcons stayed close to the nest cliff for two week as their flying and hunting abilities improved. At my last observation, two of the young falcons were observed foraging for themselves.

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Olendorff, R. R., and J. W. Stoddart, Jr. 1974. The potential for management of raptor populations in western grasslands. In *Management of Raptors*, Proc. Conf. Raptor Conserv., Tech. *Raptor Res. Rep. No. 2* pp 44–88.

Cade, T. J., et al. 1974. Introductions to wild begin. *Peregrine Fund Newslett.* 2:1–3.

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BOOK REVIEW

British Birds of Prey. 1976. Leslie Brown
Collins New Naturalist Series £6.

Leslie Brown will be best known to American ornithologists as the coauthor of *Eagles, Hawks, and Falcons of the World* in which he shared the honors with Dean Amadon. This new book concentrates on the species that breed within the British Isles. It is not just another book, but the definitive work on the subject.

Mr. Brown has amassed a vast wealth of data from a wide variety of sources, much of it hitherto unpublished. Typical of his many interesting observations is that a buzzard is able to see a grasshopper—against a background of its own color—at a distance of 110 yards, a visual acuity four times greater than that of man.

The book runs to nearly four hundred pages, all crammed with absorbing information. There are chapters on all the British breeding species, classification, food habits, territory, conservation, pesticides (Mr. Brown, agriculturalist, is able to make a more accurate assessment than most), and one headed "Some burning issues." No punches are pulled; the facts are dealt with fairly and squarely! Fortunately for us, he takes a remarkably tolerant view of falconry. The real enemy is not so much pesticides, but greed and stupidity; the wilful destruction of raptors by gamekeepers, often with the connivance of their masters; pigeon fanciers; and the wanton desires of phoney falconers and 'hawkkeepers,' plus the unwitting thoughtlessness of man, "twitchers" in particular. A twitcher is Mr. Brown's word for a tally-hunter.

The discriminative reader will spot a slight discrepancy between the age given for the Sun Life Peregrine of Montreal, the figure quoted is 12 years, not 17 (as in Hickey), but this is a trivial matter in a book of such magnitude. Anyone studying the birds of prey will find it an indispensable source of reference and an extremly good value at £6.

R. B. Treleaven.

INFORMATION ON ACCIPITERS REQUESTED

At present I am preparing a manuscript on the biology and current population status of the three North America accipiters, the Sharp-shinned Hawk, Cooper's Hawk, and Goshawk. Upon completion this paper will be published through the Bureau of Land Management as a technical note in the Habitat Management Series.

I am requesting information about current research projects on accipiters in North America. Data on the regional status of the three species is also needed. Any information which you could provide would be greatly appreciated. All communications and data will be acknowledged appropriately in the paper.

Thank you very much. Address all correspondences to Stephen Jones, Department of Zoology, Brigham Young University, Provo, Utah 84602.

BOOK REVIEW

Collected Papers in Avian Paleontology Honoring the 90th Birthday of Alexander Wetmore. 1976. Storrs L. Olson, ed. Smithsonian Contr. to Paleontology, no. 27, 211 pp.

There is considerable of interest in this volume for the student of raptors. Most exciting is a paper by O. Arredondo on "The great predatory birds of the Pleistocene of Cuba." Giant fossil Barn Owls (*Tytonidae*) have been known for some time from various West Indian islands. Now we learn that in Cuba at that time there were two such Barn Owls, a vulture as large as the Andean Condor (*Vultur*), an eagle bigger than a Golden Eagle, and, perhaps most remarkable, a strigine owl bigger than any living species; it is thought to have stood about a meter tall! It is most remarkable because the wing bones show that it must have been flightless or nearly so. Apparently some of the mammals that swarmed in the West Indies at that time must have been as clumsy as today's "guinea pigs," a relative of some of them.

Another paper describes the oldest known fossil owl. From the Paleocene of Colorado, it seems to have been somewhat intermediate between the present families Strigidae and Tytonidae. An osprey from the Miocene of California is assigned to a separate species but may have been ancestral to the living one.

Dean Amadon

BALD EAGLE LITERATURE WANTED

The National Wildlife Federation's Raptor Information Center is creating a computer-based, working (i.e., keyworded) bibliography on the Bald Eagle. An attempt is being made to include all existing literature, both published and unpublished. Information on extant bibliographies and sources of unpublished literature (reports, theses, disserations, etc.) is especially being sought. If you have pertinent articles that you wish to be included, please send them to: Mr. Bill Clark, Director, Raptor Information Center, National Wildlife Federation, 1412-16th Street, N.W., Washington, D.C., 20036. Thank you.

PEREGRINES BEAT ALL ODDS IN MORRO ROCK STRUGGLE

(News Release, Department of Fish and Game, 9 July 1977)

Somewhere in the air surrounding Morro Rock, a fledgling Peregrine Falcon is learning the "tricks of the trade" from its foster mother.

It may not seem like much, but for biologists at the Department of Fish and Game it is cause for celebration. It is the culmination of an intense but troubled effort to salvage one of only ten active peregrine nesting sites known in the state. The Peregrine Falcon is an endangered species.

"I consider it a great success, because without man's efforts that young peregrine would not be there today," said Robert D. Mallette, associate wildlife manager-biologist and the department's expert on raptors. "And the information we've learned from this operation will help us in our future efforts to increase the peregrine population in California."

Morro Rock in San Luis Obispo County is an ecological reserve, because for years a single pair of Peregrine Falcons has nested on its rocky ledges. The site is so critical that in recent years a human guard has been hired to protect the nesting site from other human intrusion. The guard was paid with funds from the California Non-game Wildlife Conservation Program.

It was the guard, a young biologist named Merlyn Felton, who first noticed the troubles which would plague this year's nesting attempt. The female peregrine at Morro Rock stopped incubating the egg early in May. No one knew why, but it was assumed the egg had gone bad, and it appeared doubtful a new Peregrine Falcon would fly off Morro Rock this year.

But Mallette decided to try something never attempted on the West Coast before, to plant in the nest peregrine chicks hatched in captivity and allow the adult peregrines to raise them. The young peregrines were from eggs hatched at captive breeding facilities at Cornell University in Ithaca, New York.

While arrangements were being made to bring the chicks to California, the peregrine nest on Morro Rock was filled with a pair of young Prairie Falcons, which were incubated and fed almost at once by the adult peregrines. The Prairie Falcon is a close relative of the peregrine.

"We put the Prairie Falcons in the nest to try to keep the nesting instincts alive in the adults," Mallette said. When the peregrines were placed in the nest a few days later, the Prairie Falcons were removed and placed with their own kind.

The adult peregrines also readily assumed the care of the two foster peregrine chicks, Mallette said. As is the custom, the female would sit at the nest while the male, also called a tiercel, captured food on the wing and brought it to the nest. The agile peregrine has been clocked at 180 miles per hour while diving on prey.

For about a week it appeared the bird transplant project would be an unqualified success. But within a matter of days two events took place which would once again alter the scope of the attempt to salvage the Morro Rock nesting operation.

First, the adult male disappeared. Then one of the chicks died in the nest. The cause of the death is unknown, but the loss of a chick is not unusual among raptors.

Later, the tiercel was found dead on Morro Rock. Pellets were found in its wings, but the body was so decomposed laboratory technicians have been unable to determine an exact cause of death.

The death of the male Peregrine Falcon presented a difficult problem to Mallette and Felton. If the female had to leave the nest for food, it would leave the remaining chick unprotected at the nest. So a scheme was devised which allowed Felton to assume the role of the food gatherer.

In a blind not far away from the peregrine nest, Felton did his best to imitate the call of the male peregrine coming in with food. The call alerted the female, which customarily meets the male in mid-air for a food exchange. But in this case, Felton merely released a pigeon or other prey species from the blind. It flew by the nest and was quickly snared by the female falcon.

The unorthodox feeding method worked, and the surviving foster chick fledged on schedule about a month after it was hatched more than 3,000 miles away. Felton reports it keeps a close eye on its mother and is learning how to catch prey on its own.

It also appears Felton has been relieved of his duty of providing food for the Peregrine Falcons. On his last visit to the nest, he discovered a new tiercel had somehow found the nesting territory and had taken over the role of the provider.

"We don't have any idea what turned him on to taking the place of the first tiercel, but we're sure happy to see him," Mallette smiled. "We've got a complete family group once again. Next year there will, in all probability, be a mated pair on Morro Rock."

ABSTRACTS OF THESES

As previously indicated (*Raptor Res.* 10[2]; 49), we will publish abstracts of theses and dissertations, retroactive to 1974. Be sure to include the complete citation (author's full name, year, title, university, pages).

A SURVEY AND ANALYSIS OF BALD EAGLE NESTING IN WESTERN WASHINGTON

Through extensive aerial surveys of the western Washington marine coastline, 218 Bald Eagle nests were located in 1975; 114 (52 percent) were occupied. Of 100 active nests, 63 percent were successful, producing 86 young for an average of 1.37 young per successful nest. One hundred forty-four nesting territories were defined, of which the 114 occupied represented 79 percent. Territories are felt to provide a more accurate measurement of habitat utilization and population status than nest numbers alone. Only 54 territories (38 percent) contained alternate nests. Analysis of 40 nest-site parameters showed proximity to open water, large nest trees with sturdy branching at sufficient height, and stand heterogeneity, both vertically (crown dominance) and horizontally (crown cover), to be the most important factors in site selection. General characteristics associated with most nests are privately owned land within 200 yards of shore, open but irregular salt water coast, predominantly coniferous stands, greater than 40 percent crown density, continuous stands often near openings, Douglas fir nest trees with Sitka spruce common on the Olympic Peninsula, nest trees usually codominant with other large trees in uneven stands, live trees less than 25 percent dead and often with broken tops, moderate to dense foliage over nests, moderate to light foliage surrounding nests, nests within top 20 feet of nest trees, and disc-shaped nests 5 feet across and 2 feet deep. Of the nests, 89 percent had at least one of ten categories of human activity within 1 mile and 74 percent within .5 mile. A tabulation of field observations on nests with a disturbance less than .25 mile away resulted in an average distance from productive nests of 130 yards and from unproductive nests an average of 80 yards. The Forest Service 5-chain (110-yard) protection zone was substantiated. Stepwise discriminant analyses were used with nest-site parameters to test their value in discriminating between occupied and inactive sites, and successful and unsuccessful nests. The technique showed promise for future evaluations of potential Bald Eagle nesting habitat.

Grubb, Teryl G. 1976. A survey and analysis of Bald Eagle nesting in western Washington. M.S. thesis. University of Washington, Seattle. 86 pp.

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BREEDING ECOLOGY OF THE FERRUGINOUS HAWK IN NORTHERN UTAH AND SOUTHERN IDAHO

Forty-three and 54 Ferruginous Hawk (*Buteo regalis*) pairs were found occupying territories in northern Utah and southeastern Idaho during 1972 and 1973, respectively. Of these, 38 and 27 nesting pairs laid eggs. Nesting success was 77.1 percent in 1972 and 74.6 percent in 1973. For successful nests, an average of 2.9 and 2.6 young hatched and 2.7 and 2.3 young fledged during the respective years. This population is reproductively comparable to others in Utah and Colorado. Analysis of prey items collected from the nests indicated that black-tailed jackrabbits (*Lepus californicus*) constitute 86 percent of the biomass (by weight) of three major prey species consumed by Ferruginous Hawks in this area. Jackrabbit density may be a major determinant of the number of young produced in a given year. Weight gained by nestlings showed a marked sexual dimorphism. Female fledglings weighed up to 1.43 times as much as males. Criteria were developed for sexing Ferruginous Hawks by measuring the diameter of the hallux. Mortality of 17 birds from the study area was recorded, of which 47 percent were immature birds. A total of 108 fledglings were banded and marked with color-coded patagial wing markers. Band reports of five (10 percent) of these birds were received. Utah juniper (*Juniperus osteosperma*) provided nest sites for 96.0 percent of the nests, and 3 percent were built on the ground. Plant community types were determined at 63 nesting sites from aerial photographs. Dominant vegetation around nest sites were desert shrub types and crested wheatgrass (*Agropyron cristatum*) seedings. The possible impact of land management practices on Ferruginous Hawks is discussed.

Howard, Richard P. 1975. Breeding ecology of the Ferruginous Hawk in northern Utah and southern Idaho. M.S. thesis, Utah State University, Logan, 70 pp.

THE BIOENERGETICS OF THE BARN OWL (*TYTO ALBA*)

The bioenergetics of the Barn Owl (*Tyto alba*) was investigated to gain information on a larger raptor and a representative of family Tytonidae. Measurements of oxygen consumption from 0°C to 37°C, body temperature, insulation, and existence energy are presented.

The relationship between standard metabolic rate and body weight in owls was reevaluated. Results show that the SMR for the Barn Owl is slightly lower than for other strigiform species and much lower than predicted values based on weight for other nonpasserines. Insulation values were lower than those for other owls. It is suggested that *T. alba* has apparently made up for this inability to conserve energy over a broad temperature spectrum by the use of man-made and natural shelters.

Metabolized energy of wild Barn Owls was estimated to be 7.3 times greater than existence energy of captives, and 11.2 times greater than SMR.

Johnson, Wayne Douglas. 1974. The bioenergetics of the Barn Owl (*Tyto alba*). M.A. thesis. California State University, Long Beach. 55 pp.

WINTER ECOLOGY AND EFFECTS OF HUMAN BEHAVIOR ON BALD EAGLES IN THE NOOKSACK RIVER VALLEY, WASHINGTON

An ecological and behavioral study was conducted during the autumns and winters of 1974–75 and 1975–76 on a population of Bald Eagles (*Haliaeetus leucocephalus*) on the Nooksack River, Washington. Eagles congregate on the Nooksack during winter to feed on spawned-out salmon (*Oncorphynchus* spp.). The largest aggregations were observed along gravel bars and sloughs where salmon carcasses were most abundant. Peak numbers of 91 and 105 were recorded for two seasons. Subadult eagles arrived on the Nooksack later than adults, but departure patterns were similar. Subadults comprised 35 percent of the population. Preferred perch trees were characteristically tall and close to the feeding grounds, providing unobstructed panoramas of the river. Deciduous trees were used primarily as perching sites; whereas coniferous trees were used for roosting. Four roosting sites were located. Human activity was found to adversely affect eagle distribution and behavior. A significant displacement of eagles to areas low in human activity was observed. Human activity was especially prevalent and disturbing on the feeding grounds. Human activities confine the population to a smaller area which may increase intraspecific strife for food resources. Sensitivity to disturbance increases with age. The mean flight (flushing) distance of adults was 196 meters, but 99 meters for subadults ($n = 300$). This differential tolerance to disturbances may affect the accuracy of ground censuses. The effects of disturbance are lessened by the presence of vegetation buffer zones which conceal activities. Habituation of eagles to human activity seems to occur. Management recommendations for wintering grounds are presented.

Stalmaster, Mark Victor. 1976. Winter ecology and effects of human activity on Bald Eagles in the Nooksack River valley, Washington. M.S. Thesis. Western Washington State College, Bellingham. 100 pp.

BEHAVIORAL ECOLOGY OF COASTAL PEREGRINES (Falco peregrinus Pealei)

A long-term study, 1968-75, of Peregrine Falcons at Langara Island, British Columbia, produced much information on the behavior and ecology of this population.

An ethogram summarizes descriptions and functions of 43 behavior patterns in courtship, 32 in territorial advertisement and defense, and 15 in self, nest, and food defense.

Males are more active in courtship, territorial advertisement, and defense. Mainly same-sex intruders are chased, but males also evict females. Nine hypotheses of sexual-size dimorphism are considered. I conclude that aerial combat with dangerous weapons selects for smaller males, better combatants; the proportion of aerial to ground fighting sets the lower limit to the size of males.

The annual schedule of courtship, incubation, nestling, fledgling, and dispersal phases is described.

Seasonal changes in courtship are not proximate causes of egg laying. Photoperiod is an early timer for laying. Ambient temperature is a "final" timer initiating rapid follicle growth ca. two weeks before egg 1 is laid. Early egg laying gives juveniles more experience before autumn-winter hardships.

Productivity over eight years averaged 1.76 fledglings per territorial pair, and 2.32 per successful pair. Average breeding spans were: males, 6.0 years; females, 3.5 years (survival rates: 0.85, 0.75). A first-year survival rate of ca. 0.45-0.55 and a floating population at least 50 percent of the size of the breeding population were estimated.

The Langara falcons declined from ca. 21-23 pairs in the early 1950s to 5-6 pairs in 1968-75. This decline paralleled a seabird decline, apparently throughout the Queen Charlotte Islands. Falcons amalgamate territories by means of pseudopolyandry; an orderly population decline results, toward a new "equilibrium" with the prey base.

Peregrines occupy type A, B-A, and B territories, from 0.3-0.5 km to ca. 15 km in diameter. Individuals establish and adjust territory size in relation to available food. They harvest on a conservative sustained-yield basis. The result is the "natural conservation" of V. C. Wynne-Edwards, but the cause is individual selection.

Peregrines demonstrate Bergmann's Rule. Larger birds live in cooler climates and have higher mortality rates and larger clutch sizes. Clutch size offsets natural mortality and provides a floating population of optimum size.

Peregrines evolve a strategy which does not produce the most fledglings at independence (e.g., D. Lack), but which balances the survival of parents and the number and quality of fledglings. Smaller broods will produce young with better survival rates and competitive abilities. When balanced with quantity and combined with philopatry, this strategy tends to increase genetic fitness.

Nelson, R. W. 1977. Behavioral Ecology of Coastal Peregrines (*Falco peregrinus pealei*). Ph.D. dissertation. University of Calgary, Calgary, Alberta. xxi + 490 pp. May.

UTILIZATION OF NEST BOXES BY BIRDS IN THREE VEGETATIONAL COMMUNITIES WITH SPECIAL REFERENCE TO THE AMERICAN KESTREL (*FALCO SPARVERIUS*)

This study was designed to determine if, by providing artificial nest sites, a raptorial predator could be attracted into an area where suitable sites are limited. The American Kestrel (*Falco sparverius*) was a common species in the area and nest boxes designed for their use were placed in three vegetational types in western Utah and eastern Nevada. Seventy boxes were available in 1975 and 110 in 1976. Kestrels nested both years in the salt-desert shrub community but were absent from the pinyon-juniper and riparian areas. Four other bird species nested in the latter two areas, however.

In 1975 the nesting success was affected by severe weather including unseasonable cold and snow. In 1976 interaction with and predation by rodents affected utilization and success. Other factors such as existing hole-nesting populations, size, construction, and placement of the box also affect the rate of occupancy and number of boxes used.

Laurence B. McArthur. 1977. Utilization of Nest Boxes by Birds in Three Vegetational Communities with Special Reference to the American Kestrel (*Falco Sparverius*). M.S. thesis. Brigham Young University, Provo, Utah. 42 pp. April.

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