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EXTRA ADULTS AT HARRIS' HAWK NESTS

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Although the Harris' Hawk (*Parabuteo unicinctus*) is a common resident locally in the southwestern deserts of the United States, it has received relatively little study. This paper discusses some unique aspects of the breeding behavior of this species in the Lower Sonoran Life-Zone in the Sonoran Desert as observed in Pima and Pinal counties, Arizona from 1969 to 1975. The biology and nesting behavior of this species are discussed in another paper (Mader 1975).

Most significantly, I found Harris' Hawks commonly nesting in groups of three adults (fig. 1). My observations at three such nests indicated that the extra hawk served as a helper by either feeding the chicks and (or) supplying prey at the nest. The only other hawk known to engage commonly in nest helping roles is the Galapagos Hawk (*Buteo galapagoensis*), a species endemic to the Galapagos Archipelago (de Vries 1973). Galapagos Hawks not only nest in groups of three but also occasionally in fours. Nest helpers among nonraptorial birds are well-known (Skutch 1961).

MATERIALS AND METHODS

I found Harris' Hawks in areas characterized by stands of saguaro cacti (*Carnegiea gigantea*) and palo verde trees (*Cercidium microphyllum* and *C. floridum*) with triangle bur-sage (*Franseria deltoidea*) as the predominant shrub species. Nests were found in saguaros, palo verdes, ironwoods (*Olneya tesota*), a mesquite (*Prosopis juliflora*), and a red-gum eucalyptus tree (*Eucalyptus camaldulensis*).

Nesting success of Harris' Hawk twosomes and threesomes was determined by searching for nests by car and on foot. Nests were checked by using a 7.6-m extension ladder and 1.5-m poles connected together with a mirror at the top. Nesting activities of three threesomes (height of nests ranged from 4.0 m to 5.9 m) were observed from tower blinds, ranging in height from 2.4 m to 4.8 m and placed 12.2 m to 18.6 m from the nests. Two towers were placed on higher ground than the nest site and all blinds afforded the observer a comparatively level view of the nest. Field identification and blind observations were aided by a 30× spotting scope. One of these threesomes (individuals were identified by bands and/or distinctive feathering) nested successfully three times within a 2-year period and was watched from three blinds for a total of 263 hr; 164 hr the first time, 12 hr the second, and 87 hr the third time. I observed the other two threesomes for approximately 18 and 29 hr.

Harris' Hawks were trapped from 1971 to 1974 during the months of October through February. Hawks were trapped by automobile from the road with bal-chatri traps (see Berger and Mueller 1959) baited with starlings and pigeons and sexed in the field by using comparative measurements of 73 museum specimens. There was no overlap in wing and weight measurements among 37 male and 14 female Harris' Hawks trapped in my study.

Data on rainfall were gathered from weather station records near Cortaro, Arizona.

RESULTS

I saw three adults at 23 (46%) of the 50 nests checked. Nests visited three or more times revealed more threesomes present than did those visited less often (table 1). Therefore, it is possible that a few nests ranked as twosomes were really threesomes. I visited the three threesomes that I had observed from blinds 67 times (from the incubation to fledging period). I saw three adults during 54 of my visits, indicating that on one visit an observer had an 81% chance of finding all three hawks present at a threesome. On the other hand, alarm calls by Harris' Hawks or circling flights over nests by individuals can, on a few occasions, attract other Harris' Hawks in the general vicinity, resulting in the appearance of hawks who do not include the resident twosome or threesome. Therefore, it is also possible that some nests ranked as threesomes were really twosomes.

I was unable to check some nests late in the nestling stage to see if the young had fledged. For this reason and to simplify matters for discussion, I considered a nest successful if one chick was raised to an age of at least 28 days. My observations indicated that

FIGURE 1. Three adult Harris' Hawks at a nest site in southern Arizona.

very little chick mortality occurred after 28 days of age. Table 2 summarizes nesting success of Harris' Hawk twosomes and threesomes from 1969 to 1973. Fifty-nine percent of the twosome nests were successful and 78% of the threesome nests. The difference in nesting success between twosomes and threesomes is not significant using a Z test ($z = 1.48$, $P > 0.05$).

A possible correlation was found between high rainfall early in the year and correspondingly high nesting success of Harris' Hawks (table 3). Because most of the nests were found in 1972 and 1973, only data for these two years are included in table 3. From January through May 1972, 0.43 cm of rain fell and 14.3 cm fell in the same period in 1973. Nesting success in 1972 (19 nests total) and 1973 (17 nests total) was 68% and 76%, respectively.

Sex ratios among trapped and nestling Harris' Hawks were 2.8 males to 1.0 females and 1.1 males to 1.0 females, respectively (table 4). Male and female hawks may differ in trap susceptibility.

TABLE 1. Number of adults present when an observer visited active Harris' Hawk nests.[a]

No. of visits	No. of nests visited[b]	Maximum no. of adults present during visits		
		1	2	3[c]
1	2	0	2	0
2	14	1	9	4
3	10	0	4	6
4	7	0	3	4
5	7	0	3	4
6	2	0	2	0
7	0	0	0	0
8	1	0	0	1
9	2	0	1	1
10 ≥	5	0	2	3
Totals —	50	1	26	23

[a] Only nests that were initially found with eggs appear in the table.
[b] Thirteen of the 16 nests visited once or twice failed (9 with eggs) before more visits were made.
[c] Three nests once had 4 adults when visited and another once had at least 5 adults. Later visits revealed 3 adults occupied each of these nests and a maximum of 3 adults was used.

TABLE 2. Comparative nest success in twosomes and threesomes of Harris' Hawks in southern Arizona from 1969 to 1973.

	Twosomes	Threesomes
No. nests	27	23
No. of successful nests[a]	16	18
No. chicks raised to at least 28 days	35	45
No. chicks per nest attempt	1.30	1.96
No. chicks per successful nest	2.19	2.50
No. chicks per nesting adult[b]	0.73	0.65
Successful nests as % of total	59%	78%

[a] A nest was considered successful if a chick was raised to an age of at least 28 days. Only nests that were initially found with eggs appear in the table.
[b] Figure for twosomes includes three renests, total number of adults = 48.

Sex ratios among threesomes of nesting Harris' Hawks could be determined at only three nests. In each instance the ratio was two males to one female. Eight of the nine hawks involved were previously or afterward trapped, sexed, and banded, while the sex of the remaining bird (a male) was established by its copulation with a female. Except for one instance, only adult-plumaged birds were observed in twosomes and threesomes. At other nests, although immature hawks occasionally were present during nest checks, I saw nothing to indicate that they had active roles in the care of the young. I do not know whether the adult hawks of nesting twosomes and threesomes are genetically related. At two different threesomes, I observed two males to copulate with the same female. Twosomes and threesomes laid approximately the same number of eggs per clutch (table 5). Twosomes averaged 3.00 eggs per nest and threesomes, 2.91.

Observations of three threesomes indicated that all three adults shared duties in the care of the young by either feeding them and (or) supplying prey at the nest. I could determine the individual roles of the members of a threesome at only one nest. At

TABLE 3. Nesting success of Harris' Hawks for 2 successive years in the Sonoran Desert showing monthly rainfall.

	1972	1973
Rainfall in cm from January thru May	0.43	14.30
No. nests	19	17
No. successful nests[a]	13	13
Successful nests as % of total	68%	76%
No. chicks raised to at least 28 days	33	30
No. chicks per nest attempt	1.7	1.8

[a] A nest was considered successful if a chick was raised to an age of at least 28 days. Only nests that were initially found with eggs appear in the table.

TABLE 4. Harris' Hawks captured in southern Arizona from 1971 to 1974.

	Hawks trapped[a]		Hawks sexed as nestlings	
	♂	♀	♂	♀
Adults	22	8	0	0
Immatures	9	3	51	47
Totals	31	11	51	47
No. of males per female	2.8♂:1.0♀		1.1♂:1.0♀	

[a] Excludes recaptured nestlings.

this nest (observed for 164 hr), each hawk had a specific role in the nest duties during the nestling stage. The female attended the nest, brooding the chicks, shading them on hot days, or simply perching nearby on a saguaro. One male obtained prey and fed the chicks; the other male obtained prey and gave it to either the female or the other male for feeding to the chicks.

DISCUSSION

I could not observe from blinds all the nests of Harris' Hawks that I found with three adults. Therefore, I do not know whether nest-helping is common among this species although it seems possible, if not likely, in the population I studied. If it is common, then threesomes may be more successful than twosomes for the following reasons. (1) An extra adult could probably increase prey supplies at a nest, thereby insuring greater fledgling success in low prey years. Most falconiforms hunt solitarily for prey (Lack 1968). At the observed threesomes, the adults went after prey not only singly but also together during the nestling period. Three adult Harris' Hawks hunting independently at a nest may increase prey captures, thereby providing more food at the nest, but it is also possible that group hunting by two or three hawks within a threesome may provide even more food by disproportionately increasing the success rates of capture attempts. This possibility remains to be tested critically. (2) A third hunting adult would leave more time for the primary nest-attending hawk to "guard" the nest from predators. (3) If one adult perished, the other two could probably shift their nest duties and avoid loss of the brood.

A threesome of two females and one male Red-tailed Hawk (*Buteo jamaicensis*) observed by Wiley (1975) had a clutch of four eggs. Clutches of 53 Red-tailed Hawk pairs in his study in Orange County, California, averaged 2.53 eggs per nest (Wiley, pers. comm.). It is reasonable that a nest with one fertile male and two females capable of laying might produce more eggs than would a normal breeding pair. Twosomes and threesomes of Harris' Hawks laid approximately the same number of eggs per nest (see table 5), supporting the idea that most if not all threesomes consisted of two males and one female. If indeed there are more males in a population of Harris' Hawks, it would appear most beneficial for them to serve as nest helpers supplying food rather than not to nest at all because suitable females were unavailable. If a sex ratio of one to one existed among adult Harris' Hawks in a population, it might be more advantageous to have a male or a female serve as a nest helper in high-prey habitat than it would be for that individual to nest with a single mate in poor-prey habitat where there was less chance of successfully raising chicks. Evidence strongly suggests that this type of mate selection, with regards to habitat quality, occurs in the Long-billed Marsh Wren (*Telmatodytes palustris*), a polygamous species with an even sex ratio (Verner 1964).

TABLE 5. Comparative clutch size of twosomes and threesomes of Harris' Hawks from 1969 to 1973.

	Clutch size				No. of nests	No. of eggs	Mean no. eggs per nest
	1	2	3	4			
Twosomes	2	5	11	9	27	81	3.0
Threesomes	2	6	7	8	23	67	2.9

Fry (1972) postulated that cooperative breeding in bird species and its associated phenomena may be expected in environments with irregular rainfall and food resources scattered spatially and temporally. Rainfall in the Sonoran Desert is generally biseasonal, with an annual average precipitation of 29.4 cm (at Tucson). However droughts are not uncommon. Irregular rainfall appears to affect some prey populations of Harris' Hawks. For instance, breeding of small birds in the Sonoran Desert can be stimulated by heavy rains early in the year (Marshall 1963, Hungerford 1964, Ohmart 1969). Early spring breeding by the Curve-billed Thrasher (*Toxostoma curvirostre*) appears to be related to the extent of winter rain (Smith 1971). High fledging success of birds may also be dependent upon seasonal distribution and volume of precipitation (S. M. Russell, pers. comm.). The onset of summer rains and resultant plant growth probably promotes the breeding of rabbits in the summer months in the Sonoran Desert (Hungerford et al. 1973), although I have found Cottontails (*Silvilagus auduboni*) of the spring in nests of Harris' Hawk during April and May. Of 91 prey items observed to be brought to two nests, biomass consisted of 72% mammals, 26% birds, and 2% reptiles. Cottontails alone accounted for 39% of the total biomass. If small bird and rabbit populations are partially or substantially dependent upon amount of rainfall and its arrival, nesting success of Harris' Hawks may be indirectly affected; coupled with fluctuations of small rodents, this may result in unstable and dispersed food resources.

Populations and breeding of small animals and birds that are susceptible to predation by Harris' Hawks also appear to be distributed spatially and temporally in the Sonoran Desert although published studies are lacking. Gambel's Quail (*Lophortyx gambelii*) nests from March to September (Bent 1932) as do two species of doves (Brown 1967, Stair 1970). Bendire's Thrasher (*Toxostoma bendirei*) nests from February to July (Bent 1948). The Curve-billed Thrasher has been recorded nesting in this same period of time (Smith 1971). All three species of rabbits native to the Sonoran Desert breed year-round (Hungerford et al. 1973). Harris' Hawks lay eggs from February to August and I have found juvenile bird and animal prey items in such nests in the same span of time.

To summarize, if nest-helping is common among Harris' Hawks in Arizona, it may be an adaptation that increases nesting success due to better nest attentiveness and prey procurement in a desert environ-

ment where food resources are scattered and subject to seasonal or yearly fluctuations.

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HUNTING TACTICS OF A PEREGRINE FALCON ON BLACK TURNSTONES

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At 10:37 on 8 January 1974, while I was photographing gulls at Clover Point, Victoria, British Columbia, I observed an adult male Peregrine Falcon (*Falco peregrinus pealei*) swooping on a flock of five Black Turnstones (*Arenaria melanocephala*) which were foraging together on a lawn. The weather was sunny, but cool (38°F) with a wind of 10–15 MPH from the northwest. The initial attack was unsuccessful but it did split the flock. Four turnstones flew low over the ground to nearby intertidal rocks while the other bird flew out over the water and began climbing quickly. The peregrine followed, though at a lower altitude, several times making zig-zag movements ("blocking") which probably prevented the turnstone from coming down. When about 1500 feet in the air and one-quarter mile from the shoreline, the peregrine came up level with the prey and began direct pursuit. Although the falcon was visible to the naked eye, the only glimpses of the turnstone (using 10×40 binoculars) were white flashes from its belly. At first it appeared that the turnstone was outdistancing the falcon but after a few seconds the peregrine rose slightly, arched its wings and stooped on the turnstone. It missed. Again from slightly above its prey, another stoop was unsuccessful. By then the turnstone was diving too. After a very short chase the peregrine gained altitude for several seconds, folded its wings and on a fairly long stoop caught the turnstone about 800 feet above the ocean, perhaps a third of a mile northwest of the Point. The peregrine then flew toward a log-littered beach. The episode ended at 10:41, four minutes after it began.

Cade (Univ. California Publ. Zool. 63:221–222, 1960) did not mention such hunting tactics by peregrines in Alaska and other parts of North America. Rudebeck (Oikos 2:65–88, 1950; 3:200–231, 1951), however, documented instances of European Peregrine Falcons forcing their prey up into the air for capture. As Rudebeck suggested, if the prey can stay above the peregrine, it is safe. In my observation, after two swoops the turnstone could not keep above the predator and only then did the turnstone dive towards the ground.

In addition, although it is well known that Peregrine Falcons prey heavily on shorebirds throughout the year, I have found no specific reference to their preying on Black Turnstones.

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