

## WIDE RANGING BY NESTING PEREGRINE FALCONS (*FALCO PEREGRINUS*) DETERMINED BY RADIOTELEMETRY

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**ABSTRACT.**—In 1994, 2 adult male and 3 adult female Peregrine Falcons (*Falco peregrinus*) were radio-tracked during hunting flights in the nesting season in Colorado. Based as many as 319 locations per bird, 95% harmonic mean contour home ranges varied from 358–1508 km<sup>2</sup>. All estimated ranges overlapped even though the most distant nests were separated by 28 km. About 60% of the locations were less than 8 km from nest sites, but about 20% of locations for females exceeded 23 km. Searches from aircraft verified that several hunting flights were as far as 20–43 km from nest sites and were much greater than previously reported. One female flew at least 79 km on one flight and, during another flight, the same bird flew over 19 km in 10 min, averaging 115 km/hr. Peregrine Falcons in Colorado apparently obtained prey in widely separated places with no apparent dependence on any certain area.

**KEY WORDS:** *Peregrine Falcon*; *Falco peregrinus*; *hunting flights*; *dispersion*; *flight speed*; *home range*.

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Amplio extensión por *Falco peregrinus* determinado por radiotelemetria

**RESUMEN.**—En 1994 dos machos adultos y tres hembras adultas *Falco peregrinus* fueron localizados con radio durante tiempos de cazar en el tiempo de poner en Colorado. Basado en 319 lugares por pajaro, 95% promedio harmonica contorno del campo tenia una variación de 358–1508 km<sup>2</sup>. Todo los campos estimados fueron traslapados aunque la distancia mas grande que los separo fue 28 km. Casi 60% de los lugares fueron menos de 8 km del los nidos, pero casi 20% de los lugares para hembras fue mas de 23 km. Buscando con el avion confirmo que varios tiempos de cazar fueron tan largos como 20–43 km de los nidos y fueron mas grandes que antes reportandos. Una hembra volo no menos de 79 km en un vuelo, el mismo pajaro volo arriba de 19 km en 10 minutos, promedio de 115 km/hr. *Falco peregrinus* en Colorado aparentemente cogio presa en lugares amplio separados con aparente nada de dependencia en un lugar particular.

[Traducción de Raúl De La Garza, Jr.]

The sizes of raptor home ranges and the distances they travel from nest sites to forage have long been of interest. Craighead and Craighead (1956) provided early estimates for several species based on direct observations, including those for a Prairie Falcon (*Falco mexicanus*) which was seen nearly 5 km from its nest site. Ratcliffe (1993) reviewed several reports for Peregrine Falcons (*Falco peregrinus*) and found that most prey are caught within a few kilometers of nesting areas. Nevertheless, some peregrines ranged many kilometers farther.

The available information on peregrines thus far suggests considerable variation in distances traveled and these variations seem to be site specific. Scottish peregrines, for instance, catch most prey

within 2 km of nest sites but they can range as far as 6 km away (Weir 1978). In southern Scotland, a female moved a maximum of 18 km from its nest (Mearns 1985), and in California telemetry indicated a nesting female did not range more than 8 km from its nest over several wk (Enderson and Kirven 1983). A nesting male peregrine was followed by helicopter over Alaskan tundra 14.6 km from its nest, and its home range was estimated at about 320 km<sup>2</sup> (White and Nelson 1991). Porter and White (1973) suggested peregrines in Utah may hunt over marshes up to 15 km from a nest.

Able to cover huge areas, peregrines can use nest sites far from prey concentrations allowing them to encounter a variety of habitats and prey species. Large hunting ranges would tend to deem-

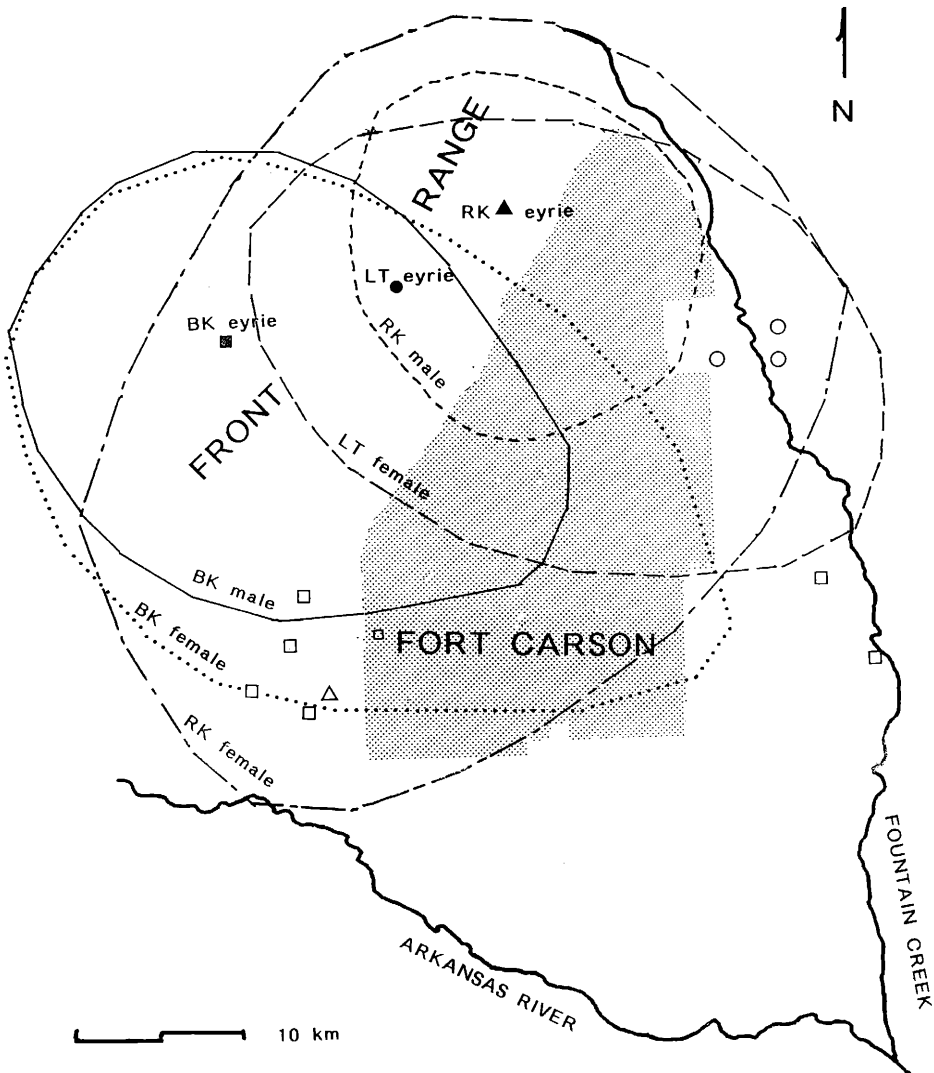


Figure 1. Distribution of harmonic mean 95% contour home ranges of adult Peregrine Falcons, May–August 1994. Open symbols are for more outlying locations verified from aircraft on different days; all were females except for the small square on Fort Carson (BK male).

phasize the significance of small local areas as food sources.

We report here on the hunting flights and ranges of five Peregrine Falcons nesting within Fort Carson Military Reservation in central Colorado in 1994. Topography allowed tracking of peregrines from ridges or mountain tops so that transmitters could be detected as far as 50 km away, allowing more complete tracking of this highly mobile species than had been possible previously.

#### STUDY AREA

We tracked five adult Peregrine Falcons that nested at three sites along the Front Range from 9–37 km southwest of Colorado Springs, Colorado (Fig. 1). The highest nest site was 2650 m above sea level. Tracking stations were distributed such that we could survey the entire plains area east of the Front Range where elevations ranged from 1510 m along Fountain Creek to the east, to as high as 2080 m near the foothills. At least six small intermittent streams, supporting riparian floras, flowed southeastward on the plains, but the largest drainages were Fountain Creek on the east and the Arkansas River

to the south. All three nests were in mountainous terrain, overlooking the plains to the east. Conifer forests and meadows predominated at higher elevations, woodlands and brushlands formed a transition with grasslands on the plains. In the mountains, water availability varied greatly depending on slope orientation, resulting in a patchy mosaic of meadow, woodland and forest.

#### METHODS

We trapped the peregrines with dho-gaza nets and a live Great Horned Owl (*Bubo virginianus*), or nooses over dummy eggs from 7 April–4 June 1994. Transmitters weighing 9 g were attached to rectrices no. 4 and 5, the last to be moulted (Beauvais et al. 1992). Five tracking stations, each with a rotating 5-element yagi antenna on a mast 4-m tall, were located on the most prominent ridges or mountain tops yielding an overview of nest sites and lowland terrain. Observations on the locations of peregrines were obtained 9 hr per d from 0600–1500 H and 0900–1800 H on alternate days, 5 d per wk. Stations were sometimes moved to improve reception.

Observers were coordinated using transceivers or cellular telephones to ensure that they took simultaneous bearings on transmitter signals. Frequent afternoon thunderstorms interrupted data gathering. Depending on topography and distance, signals were seldom obtained by more than four stations at once, and sometimes only one receiver could obtain a signal, especially when falcons were on cliffs.

We used LOCATE II software (Anonymous 1993), to estimate falcon locations for sets of three or more simultaneous bearings. Locations were accompanied by error ellipses varying directly in area with the closeness of the intercepts. We arbitrarily rejected all locations with ellipses of more than 5000 ha. If circular, an area of 5000 ha would have a radius of about 4 km, a relatively small distance compared to flight ranges of peregrines we found. We found the distributions of all estimated locations for each bird were similar for ellipse areas in categories of 1–500, 500–1000, 1000–2500 and 2500–5000 ha; estimated locations with ellipses exceeding 5000 ha were often outliers. We also used locations that we obtained using triangulations of only two bearings if the intersection of the bearings exceeded 20°. This arbitrary limit was consistent with tests made on transmitters with known locations and tended to exclude unreliable locations near the limits of transmitter reception.

Autocorrelation between consecutive locations in home range estimation was minimized by accepting only locations obtained at least 1 hr apart. We found the mean distance between two locations did not increase when the interval was 1 hr or more using samples from combined data for all birds. When the interval was 30 min, the mean distance between locations (3655 m; SE = 3775 m,  $N = 25$ ) was much less than for 1 hr (6820 m; SE = 5818 m,  $N = 25$ ) or for 1.5 hr (5547 m; SE = 5126 m,  $N = 25$ ). The home range of each individual was estimated using the harmonic mean 95% contour limit for data meeting our error and autocorrelation limits (Dixon and Chapman 1980).

In the analysis of each hunting flight, only round-trip flights with a near complete record of locations every 10–20 min were used. When sequential fixes suggested the

Table 1. Locations of instrumented breeding Peregrine Falcons by error-ellipse size, and number of two-bearing sets with intersections exceeding 20°. All locations were at least 1 hr apart.

	NUMBER OF LOCATIONS BY ELLIPSE CATEGORY (ha)				NO. OF LOCA- TIONS WITH 2	TOTAL LOCA- TIONS
	<500	1000	2500	5000	BEAR- INGS	
BK female	17	14	14	10	147	202
BK male	20	7	11	19	262	319
RK female	13	3	11	9	52	88
RK male	28	9	19	16	97	169
LT female	50	18	48	39	112	267

bird was perched, one estimated location was used. We also estimated speed of flight when the distance traveled between estimated locations was unusually great.

We also searched for instrumented peregrines five times using a fixed-wing aircraft between 12 July–27 August to verify locations that were extremely far from nesting areas. Locations of birds were estimated by signal strength during near approaches and were sometimes confirmed visually.

#### RESULTS

In all, three females and two males were instrumented and tracked (Table 1). One male (RK) was found dead on 25 July about 15 km from its nest, apparently killed by another raptor. Two pairs (BK, RK) hatched two young each but only one pair (BK) fledged young in mid-June. The breeding attempt of the third pair (LT) failed during incubation.

Harmonic mean 95% contour ranges overlapped but were skewed eastward from the nest sites (Fig. 1). The latter feature may have been due to the fact that we had better reception when we overlooked the low terrain to the east of the Front Range. Home range estimates based both on harmonic mean 95% contours and minimum convex polygons (Mohr 1947) indicated that, except for female RK, the falcons mostly utilized the canyons that contained the nest sites (Table 2). The RK female showed two centers of activity which exaggerated its harmonic mean contour but not the polygon range. Before its mate died, it centered its activity near the nest but later moved about as far as 32 km to the southeast when its mate died. The average harmonic mean contour range for males was 526 km<sup>2</sup> and for females 1116 km<sup>2</sup>, but varia-

Table 2. Home range areas of adult Peregrine Falcons in Colorado.

BIRD	AREA OF	
	HARMONIC MEAN 95% CONTOUR km <sup>2</sup>	AREA OF MINIMUM CONVEX POLYGON km <sup>2</sup>
BK female	1037	1344
BK male	694	1440
RK female	1508	1256
RK male	358	811
LT female	803	1152

tion between individuals was great. Minimum convex polygon areas were usually much larger, again with great variation.

We found that females had larger home ranges than males. About 60% of locations for males were less than 8 km from their nesting areas, and no more than 15% were more than 24 km away while females showed a tendency to forage farther from their nests (Fig. 2).

Aerial surveys of the area showed that two females traveled considerable distances to riparian habitat near Fountain Creek. The LT female was found there on three days 20–22 km from its nest and the BK female was found there twice 37 and 43 km from its nest. The latter was the farthest any bird was found from its nest. Maximum distances obtained during aerial surveys for the BK male and the RK female were 19 and 30 km, respectively.

We were able to plot 56 round-trip flights from the nest of the BK adults. Each plot included sets of locations found at 10- or 20-min intervals, except for a few longer intervals separating locations certainly parts of the same flight. Adults did not differ in average maximum distance from the nest (*t*-test, *P* = 0.69), average total distance traveled (*t*-test, *P* = 0.34) or average duration of the flights (*t*-test, *P* = 0.75). In all, 21 round-trip flights were recorded for the female, and 35 for the male (Table 3). On average, the maximum distance flown from the nest site was about 13 km. Six of the flights by the male and eight flights by the female exceeded 50 km round-trip, and one was at least

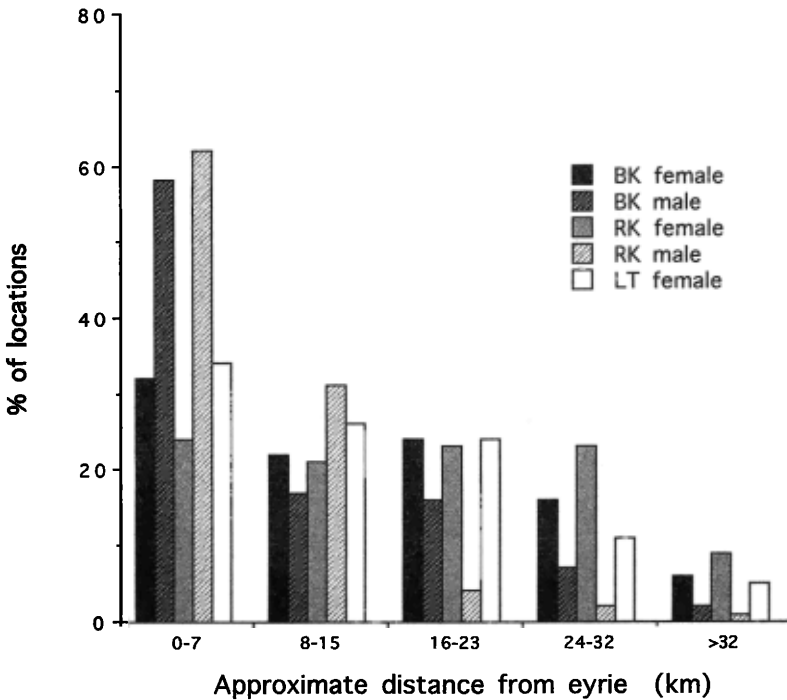


Figure 2. Percent of radiotelemetry locations by distance category from nests for three female and two male adult Peregrine Falcons. Although males made some long flights, their activities were generally closer to the nest than females.

Table 3. Summary of round-trip flights from the nest of a pair of adult Peregrine Falcons. Maximum distance was for the farthest telemetry location from the nest. Minimum total distance was the sum of straight line distances between successive locations.

	NUMBER OF FLIGHTS	AVG.	AVG. MINIMUM	AVG.
		MAXIMUM DISTANCE km (SD)	TOTAL DISTANCE km (SD)	DURATION min (SD)
Male	21	13.3 (6.4)	40.3 (24.2)	102 (56.8)
Female	35	12.6 (6.5)	34.4 (19.2)	97 (64.6)

79 km. Some flights lasted <1 hr but the average was about 100 min. The longest flight lasted 3.5 hr for the female and 4.0 hr for the male.

Hunting trips sometimes included periods with little or no movement when birds were perched or soaring, and periods where outbound or inbound flight was direct and swift. In the latter case, estimates of average flight speed were made based on the distance traveled in 10 min. We determined distances for 16 of the fastest segments for the BK male and 25 for the BK female. Distances traveled in 10 min usually did not exceed 12.4 km (Table 4) but the male flew a maximum of 17.6 km or about 105 km/hr. Twice the female was estimated to have flown 19.1 km in no more than 10 min (115 km/hr). In all three cases the birds were en-route to or from the vicinity of a reservoir 21 km from the nest area.

#### DISCUSSION

Our estimates of home ranges varying from 358–1508 km<sup>2</sup> far exceed the estimated range of 117 km<sup>2</sup> for a female Peregrine Falcon over a 2-mo period in Scotland (Mearns 1985). In fact, our maximum distance estimate between nesting and foraging areas was over twice as far as that observed in Scotland. We also found a great deal of variation in distances traveled. We felt this was probably due to vagaries in hunting success. Home range size probably reflects prey distribution and abundance, and conditions favoring soaring.

The vast home ranges of these peregrines greatly exceed those of eagles reviewed by Newton (1979). Prairie Falcon ranges have been studied more often; in Wyoming six pairs had a mean home range of 69 km<sup>2</sup> (95% contour harmonic mean) which increased to 112 km<sup>2</sup> when telemetry locations

Table 4. Observations on distances between estimated locations of adult Peregrine Falcons taken at 10-min intervals when flight was swift and direct to or from nests.

	KILOMETERS PER 10-MIN PERIOD				
	5.0–7.4	7.5–9.9	10.0–12.4	12.5–15.0	>15.0
Male	4	4	7	0	1
Female	10	4	7	2	2

within 500 m of the nest were excluded (Squires et al. 1993). Marzluff et al. (1997) has also shown that Prairie Falcons in Idaho have 95% harmonic contour home ranges averaging about 300 km<sup>2</sup>, with large individual variation. Home range estimates are likely affected by measurement methods, habitat, and prey availability and considerable variation among reports should be expected.

Our findings show that peregrines are capable of traveling great distances in short periods. The maximum we found was 19 km in 10 min, but almost half of the speeds exceeded 10 km in 10 min. Over the 3 mo, such mobility resulted in a wide-ranging pattern of foraging flights. We found little evidence that individual birds favored particular places, and foraging locations were widely distributed within the home ranges. In contrast, Prairie Falcons in Idaho were located 90% of the time in core areas including only 38% of their convex polygon home ranges (Marzluff et al. 1997).

The terrain in our study area made long, shallow high speed dives outbound from nest sites possible, and the return trips were probably made in a similar way after thermal soaring to gain altitude. We witnessed the beginning of several outbound flights but instrumented birds were actually seen only a few times. This is consistent with our impression that these peregrines hunted over ranges so vast that their activities were spread very thinly on the land. Specific areas, perhaps excepting Fountain Creek, were not especially important to the falcons, and at least, in this region, birds may not be significantly affected by local habitat change except near nest sites.

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