UNUSUAL PREDATORY AND CACHING BEHAVIOR OF AMERICAN KESTRELS IN CENTRAL MISSOURI

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ABSTRACT - Caching behavior of the American Kestrel (*Falco sparverius*) was studied 1981-1983 in Boone County, Missouri. Both wild prey and quarry thrown from car windows were cached. Kestrels cached food 116 times and retrieved it 77.5% of the time. Males cached food in elevated sites (at least 4 m high) 64% of the time while females did so only 20%. During spring and summer, 93% of the prey items were cached uneaten. During fall and winter, only 42% of the food cached was uneaten. When a surplus of prey was created by releasing several mice at a time, kestrels killed them while flying to their cache sites. These prey items were stored in the same cache site. Apparently, caching behavior of American Kestrels is not directly correlated with the length of time between feedings, and caching behavior operates independently of food deprivation, especially in spring and summer.

Many reptors have been observed caching prey. Mueller (1974) provided a review of food storing in several captive species. Among the falconiforms, prey caching seems to be most developed and widespread in falcons. Published records of caching include those for the Merlin (*Falco columbarius*) (Greaves 1968; Oliphant and Thompson 1976; Pitcher et al. 1982), American Kestrel (*F. sparverius*) (Pierce 1937; Tordoff 1955; Roest 1957; Stendell and Waian 1968; Balgooyen 1976; Collopy 1977), Prairie Falcon (*F. mexicanus*) (Peterson and Sitter 1975; Oliphant and Thompson 1976), Peregrine Falcon (*F. peregrinus*) (Beebe 1960; Brown and Amadon 1968; Nelson 1970; Cade 1982), Gryfalcon (*F. rusticolus*) (Jenkins 1978; Cade 1982) and many others.

STUDY AREA AND METHODS

Data reported here are from a 48 km² area in Boone County, Missouri, where farmlands are interspersed with woodlots, old fields, meadows and residential areas.

I observed kestrels from September 1981 through August 1983 using a 30x spotting scope and 9x binoculars at distances of 5-200 m. For each observation I recorded species cached, location of cache, weather conditions, time of day, and duration of caching sequence. Additional live prey was thrown from my car window to kestrels perched within 25 m of roads. The prey thrown were brown, gray, white and black House Mouse (*Mus musculus*) and House Sparrows (*Passer domesticus*) with several primaries pulled to ensure their capture by kestrels.

RESULTS AND DISCUSSION

During the 2 yr study 1210 h of observation of kestrels were made and 30 kestrels were seen caching prey a total of 116 times. They subsequently retrieved food successfully 77.5% of the time. Prey cached were 95% rodents and 5% birds. Both wild and provided prey were cached. Kestrels captured 95% of the prey thrown from car windows and cached 46 (48%). The remaining 70 (60%) prey cached consisted of 55 Prairie Vole (*Microtus ochrogaster*), 6 house mice, 3 White-footed Mouse (*Peromyscus leucopus*) 2 Western Harvest Mouse (*Reithrodontomys megalotis*), 2 House Sparrows, 1 Grasshopper Sparrow (*Ammodramus savannarum*) and 1 Eastern Meadowlark (*Sturnella magna*).

Cache sites were of 8 kinds (Table 1). Males cached prey in elevated sites significantly more

Table 1. Cache sites used by American Kestrels in Boone County, Missouri 1981-83.

	LOCATION AND HEIGHT OF CACHES								
Sex	Grass clumps (0-0.1 m)	Hollow railroad ties (0-0.1 m)	Tree roots (0-0.1 m)	Bushes (0.5-1.0 m)	Fence posts (1.0 m)	Building gutters (4.0 m)	Tree limbs and holes (4.5 m)	Tops of power poles (10.0-20.0 m)	Total
M	16	3	1	1	6	2	44	3	76
F	27	0	0	2	3	0	8	0	40

RAPTOR RESEARCH 18(3):107-110

often than did females (Table 1). Males cached prey 4 m or more above the ground 64% of the time, while females did so only 20% ($X^2 = 22.16$, $P<0.01$, df = 1).

During the breeding season kestrels have special courtship feeding ceremonies (Fox 1979; Cade 1982). Food transfer often begins as remote food passing (Nelson 1977) when the male deliberately caches prey within view of the female. When he leaves, she flies to the cache, retrieves and eats the food. I observed that all copulation and courtship activities including hitched wing-displays, food begging, courtship feeding and remote food passing occurred at elevated sites, on or near favorite plucking or hunting perches. Because males alone cache prey at these elevated sites during courtship they may be predisposed to cache in elevated sites during the rest of the year.

Partially eaten carcasses were always decapitated before being cached and only the posterior 2/3 to 1/2 of the body of the prey was placed in the cache. However, kestrels cached 78% (36 of 46) of the presented prey and 69% (48 of 70) of wild prey completely uneaten. Of all prey items cached, only28% (32 of 116) were decapitated. In contrast Stendell and Waian (1968) reported that 14 of 15 small mammals cached by a single female kestrel were decapitated and Collopy (1977) reported that 10 female kestrels decapitated 13 of 17 (76.5%) small animals cached. In Missouri kestrels cached more (58%, 27 of 48) partly-eaten prey during the fall and winter than the 7% (5 of 68) during spring and summer, which may be explained by the lack of hunger during the breeding season due to greater availability of food and warmer temperatures.

Kestrels hiding food approached the cache site furtively, then thrust, pushed, or nudged the prey into position with the beak (see Balgooyen 1976; Collopy 1977). Sometimes sites apparently were selected before the flight started, and kestrels flew directly to the cache spot. Prey was not placed in any preferential position such as belly-down (as if to take advantage of the prey's protective coloration) as reported by Balgooyen (1976) and Collopy (1977). I found items lying on back or sides as often as on the belly. Kestrels sometimes did make several attempts at repositioning prey until it was better concealed. In all cases when prey was stored on the ground in grass clumps, kestrels chose sites next to fence posts, utility poles, sign posts, or other markers. Tordoff (1955) observed that a captive kestrel which cached prey used objects nearby to memorize the location of the cache site.

When retrieving prey, kestrels flew to the cache site and if unable to find stored prey, hovered above the area or walked to adjacent grass clumps to search. In several instances kestrels appeared to give up their search when they flew to a nearby perch, only to return and resume the search. One female kestrel spent 15 min investigating grass clumps both on foot and in brief hovers before giving up.

Because my field observations were evenly distributed throughout the day, I assumed that there was no difference in the probability of observing either prey storing or retrieval (see Collopy 1977). On this assumption, I considered my caching data as a representative sample of the relative frequency of prey caching and retrieving and calculated a recovery efficiency of about 78%, similar to the 70% reported by Collopy (1977).

I observed that presenting kestrels with live prey stimulated a response that simulates the reactions of kestrels to natural prey. The typical response was to fly from the perch toward the prey within 20 sec of its detection. Kestrels then would either (1) bind to the quarry on the ground and kill it with a bite to the neck immediately (or after having flown to a nearby perch) or, (2) snatch the prey from the ground without landing and fly to a nearby perch to dispatch it with a bite to the neck.

On 6 March 1982 at 1430H I observed a female through binoculars from a distance of 100 m. The weather was 38°C, calm and clear. I approached in my car to within 25 m, threw a white mouse out the window and waited. Within 2 min the kestrel approached within 4 m of my car, hovered, and then retreated to a wire 20 m away. I then threw out 2 more mice and backed the car 25 m away. At 1440 H the kestrel again flew toward the mice but after hovering above them and looking at my car, again retreated to the wire only 15 m distance. I then presented 4 more white mice for a total of 7, all of which were conspicuous against a recently mowed lawn. At 1445 H the kestrel flew to a wire only 5 m from the mice and after hesitating for 15 or 20 sec flew down and captured a mouse. However, she immediately flew west 75 m during which flight I saw her bend over several times in midair to bite the neck of the mouse. She immediately landed on the ground and cached the prey in a grass clump at the base of a fence post. She quickly returned to capture and dispatch in flight the remaining mice in rapid succession. All 7 mice were cached in 1 or 2 grass clumps 1 m apart. None of the 7 mice were eaten at this time.

A month later at the same time of day a male took 7 mice in the same fashion, killing them midair as it flew to the cache site in a white oak tree (*Quercus alba*).

I was able to elicit the capture and caching of as many as 10 mice in sequence by both captive and wild kestrels when presenting them with prey one at a time, over 2 to 8 h periods. Nunn et al. (1976) reported that 1 wild female took 20 white mice thrown from a car window one at a time, over an hour. I found no literature reports of American Kestrels responding to a sudden increase in prey availability by mid-flight killing and caching of successive prey items uneaten.

Caching has been described as a behavorial mechanism to exploit a seasonal or daily abundance of prey, thereby maximizing food intake and dampening the effects of fluctuations in prey availability (Balgooyen 1976; Collopy 1977). My studies agree with other researchers that kestrels, like other falcons, store extra food for periods of a few hours to several days, especially when the capture of sufficient prey may be difficult (i.e., inclement weather, snow cover, or brood rearing).

Although winter food storing in kestrels may be stimulated by a "hunger drive" (see Mueller 1973, 1974) in part, my observations agree with Collopy (1977), Fox (1979) and Cade (1982) that Lorenz' (1937) model of instinctive behavior operating independently of food deprivation occurs in kestrels during the nesting season. Mueller's (1973) laboratory findings, in which the predatory behavior of kestrels was directly correlated with length of time between feedings, was not substantiated. Fifty-eight percent of the prey cached in fall and winter was partially eaten, but only 7% during the nesting season. This indicates that hunger drive does not explain caching behavior of courting males or parental food storing behavior during nesting.

When presented with a surplus of easily captured prey (both in late winter and spring) kestrels killed prey as they flew to a cache site, thus expediting capture of an ephemeral abundance of prey.

The accompanying caching of multiple prey items in the same cache or nearby appears to be yet another example of the flexible behavior of kestrels attempting to hurriedly exploit sudden surpluses in prey availability. Because I saw kestrels caching 7 prey items together in a 5-min period, I cannot support Mueller's (1973) statement that "excessive killing resulted from the falcon "forgetting" that it had cached food when it was exposed to the prey stimulus." Kestrels cache several consecutive prey items in the same spot in a period of minutes or days, and later retrieve them (Stendell and Waian 1968).

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