

MALE FOOD PROVISIONING AND FEMALE REPRODUCTION IN AMERICAN KESTRELS

TIMOTHY J. COONAN

While the effects of male raptor nest provisioning on clutch quality have been documented (Drent and Daan 1980; Wink et. al. 1980), the effect of provisioning on later nest success is less well established. Male provisioning ability should affect hatching and fledging success, since the female and young of many raptor species depend to a degree on the male for food delivery until fledging (Balgooyen 1976; Snyder and Wiley 1976; Newton 1978; Mueller et. al 1981; Rudolph 1982; and Village 1983).

The purpose of this study is to document the relationship between male provisioning performance and pair reproductive success, beyond clutch size, in the American Kestrel (*Falco sparverius*). Effects of differential male provisioning performance should be seen in number of young hatched and number of young fledged from each nest.

MATERIALS AND METHODS

Six kestrel pairs in wooden nestboxes (Gary and Morris 1980) were observed from the pre-hatching to fledging stage in the Coconino National Forest near Flagstaff, Arizona, in June and July 1982. The study area was primarily ecotonal within the ponderosa pine (*Pinus ponderosa*) forest of the Transition Life-zone (Lowe 1964). Stands of ponderosa pines were interspersed with more open areas of one-seed juniper (*Juniperus monosperma*), Gambel's Oak (*Quercus gambelli*), squawbush (*Rhus trilobata*), prickly pear cactus (*Opuntia* spp.), Parry rabbitbrush (*Chrysothamnus parryi*), and blue grama grass (*Bouteloua gracilis*). Elevation in the study area ranged from 2070 to 2160 m.

Observations were made with 7-15x binoculars or 20-60x spotting scope, 100 to 200 m from each nest. Nests were observed in 2 to 8 h shifts between 0800 and 1800 h. Kestrels did not forage appreciably before 0800 h, perhaps due to the inactivity of orthopterans, their principal prey.

Wind velocity can affect kestrel foraging strategies and success (Rudolph 1982; Village 1983). My observations were confined to relatively calm days, since windy days added too many variables to adequately measure its effect on provisioning.

Two hundred fifty-nine male and female provisioning trips to the nest were documented. Percent male and female provisioning and male and female prey deliveries/hr were calculated for each nest. Clutch size (determined just prior to hatching), number of young hatched and number of young fledged were recorded for each nest. Male and female prey deliveries/chick/hr were calculated for each nest.

Spearman's rank correlation procedure (Zar 1974) was used to analyze data. A significance level of 0.05 was used in all tests.

RESULTS AND DISCUSSION

Males contributed an average of 44.32% of the food deliveries to the nest from hatching to fledging. Individual males, however, varied in their contributions relative to the female (Table 1). Percent male provisioning ranged from 18.0 to 67.1%. Male prey deliveries/hr ranged from 0.60 to 2.80 and was significantly correlated with percent male provisioning ($r_s = 0.943$, $P < 0.025$). Clutch size, number of young hatched and number of young fledged were each significantly correlated with male prey deliveries/hr ($r_s = 0.843$, $P < 0.05$; $r_s = 0.843$, $P < 0.05$; $r_s = 0.929$, $P < 0.025$).

Balgooyen (1976) found that the female provided 71.1% of the food deliveries to one nest during the period after hatching when both male and female hunt. Females in this study during the same period provided an average of 54.02% of the prey deliveries ($n = 6$), though there was high individual variation in female provisioning. Female prey deliveries/hr ranged from 0.64 to 2.73 (Table 1).

Neither female prey deliveries/hr nor total prey deliveries/hr correlated significantly with number of young fledged ($r_s = 0.500$, $P > 0.10$; $r_s = 0.014$, $P > 0.25$). Spearman r_s between total prey deliveries/chick/hr and percent fledged was 0.629. While not significant ($P > 0.10$), this suggests that higher feeding rates result in higher chick survival.

Spearman's r_s between male and female prey deliveries/hr was -0.657 ($P = 0.10$), suggestive of a negative correlation. Males and females of individual pairs may adjust their prey delivery rates relative to their mate's abilities.

The individual variation in male provisioning correlated with several measures of nest reproductive success. Those males which delivered a greater number of prey/hr appeared to realize a higher immediate reproductive success of young hatched and fledged.

Other factors could account for the observed results. First, data were insufficient to evaluate quality of prey delivered by males or females. Some males may have provided relatively more vertebrates to their mates and broods than did others. The

Table 1. Male and female nest provisioning performance and female reproduction for six American Kestrel nests, northern Arizona, 1982.

NEST	PERCENT PROVISIONING		PREY DELIVERIES/HR			PREY DELIVERIES/CHICK/HR			CLUTCH SIZE	YOUNG HATCHED	YOUNG FLEDGED
	MALE	FEMALE	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL			
1	67.1	22.9	1.31	0.64	1.95	0.262	0.128	0.390	5	5	4
2	52.4	47.6	0.85	0.77	1.62	0.170	0.154	0.324	5	5	3
3	18.0	82.0	0.60	2.73	3.33	0.200	0.910	1.110	4	3	2
4	25.0	75.0	0.71	2.13	2.84	0.355	1.065	1.420	3	2	2
5	43.8	56.2	0.82	1.05	1.87	0.273	0.350	0.623	4	3	2
6	59.6	40.4	2.80	1.90	4.70	0.560	0.380	0.940	5	5	4

energetic advantage this could confer is substantial; Bird et. al. (1982) estimated 1 vole contained about 125 times more energy than 1 grasshopper.

Second, clutch size and brood size were each correlated with male prey deliveries/hr. Perhaps males adjusted their respective rates of prey delivery according to the brood size for which they had to provide. Testing for such a functional response would require comparing male delivery rates before and after hatching. Data were insufficient to evaluate this possibility. However, male prey deliveries/chick/hr was not correlated with brood size ($r_s = -0.129$, $P > 0.50$), indicating that male prey delivery rates to individual chicks were the same for large and small broods. This suggests that males respond functionally to larger broods by providing prey items at a higher rate. In contrast, female prey deliveries/hr was not significantly correlated with brood size ($r_s = 0.554$, $P > 0.10$), indicating that females do not respond functionally to larger broods by increasing their rates of prey delivery.

The variability in male and female prey delivery rates could have resulted from other factors, such as age or experience of the bird (see Newton 1979) or territory quality (Newton 1976; Rudolph 1982). A final possibility is that smaller size and lower wing-loading of some males provided them with greater energetic efficiency (Balgooyen 1976; von Schantz and Nilsson 1981). These factors were not measured.

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Department of Biology, Northern Arizona University, Flagstaff, AZ 86011. Present address: San Antonio Missions National Historical Park, 2202 Roosevelt Ave., San Antonio, TX 78210.

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