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FOOD PROVISIONING BY ISLAND FOXES, *UROCYON LITTORALIS*, TO CONSPECIFICS CAUGHT IN TRAPS

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ABSTRACT—Prey items were found outside of welded-wire cage traps containing island fox pups (*Urocyon littoralis*) on 24 occasions and outside of traps containing adult foxes on 11 occasions. Prey items included mice, lizards, and birds. Island fox pups were observed foraging with adults and were caught with adults in the same trap on 22 occasions. We believe fox pups receive extended parental care and were provisioned while in the traps.

RESUMEN—En 24 ocasiones se encontraron restos de presas afuera de trampas jaulas-de alambre soldado, en cuyo interior habían cachorros de zorros isleños (*Urocyon littoralis*) atrapados. Asimismo, en otras 11 ocasiones se encontraron estos mismos tipos de presas afuera de trampas que contenían zorros adultos atrapados. Los citados restos incluían presas tales como ratones, lagartijas y aves. Los cachorros de zorros isleños han sido observados buscando alimentos junto con los adultos y en 22 ocasiones fueron atrapados juntos en la misma trampa. Creemos que los cachorros reciben cuidado de los padres por un prolongado período de tiempo y que los adultos se encargan de alimentar a los cachorros mientras estos permanecen en las trampas.

Prolonged periods of parental dependency are common in behaviorally advanced carnivore species within the Canidae, Felidae, Viveridae, and Hyaenidae (Gittleman, 1989). Many of these species carry prey back to the den for their young, or regurgitate food to their young at the den site (Mech, 1970; Moehlman, 1979; Hill, 1980; Rasmussen and Tilson, 1984; Holekamp and Smale, 1990). This behavior, also known as provisioning, could have arisen because lactation is energetically less efficient than the direct transfer of solid food (Holekamp and Smale, 1990). Furthermore, levels of metabolizable energy can increase to 1.5 to 3.5 times basal levels during peak lactation and may be accompanied by a 20% weight loss (Oftedal and Gittleman, 1989). In female carnivores such severe energetic demands can be sustained only for a short period. Therefore, provisioning of young at a den or rendezvous site may be necessary until offspring are sufficiently developed to escape predators and to accompany a single adult or a pack when foraging.

Island foxes (*Urocyon littoralis*) are the smallest North American canid. During summer, females and males on San Clemente Island average 1.6 kg (SE = 0.24 kg, n = 155) and 1.9 kg (SE = 0.25, n = 146), respectively, and feed primarily on insects, fruits, and small mammals (Laughrin, 1977; Collins, 1980; Moore and Collins 1995). From an energetic standpoint, rodents, birds, and reptiles may be the only food items that small canids can transport effectively back to the den for dependent pups (Lindstrom, 1994). We report on instances of presumed attempts to provision island fox pups and adults after their capture in box traps.

MATERIALS AND METHODS—From 1988 through 1996 demography of island fox was studied on the California Channel Islands (Roemer et al., 1994). Another study conducted on San Clemente Island, involving effects of feral cats (*Felis catus*) on populations of small mammals and reptiles, occurred from 1992 through 1994 and included numerous captures of island foxes. The study populations inhabit San Miguel, San Clemente, and Santa Cruz Islands, which are 37 km^2, 157 km^2, and 249 km^2, respectively. Trapping efforts were conducted on a

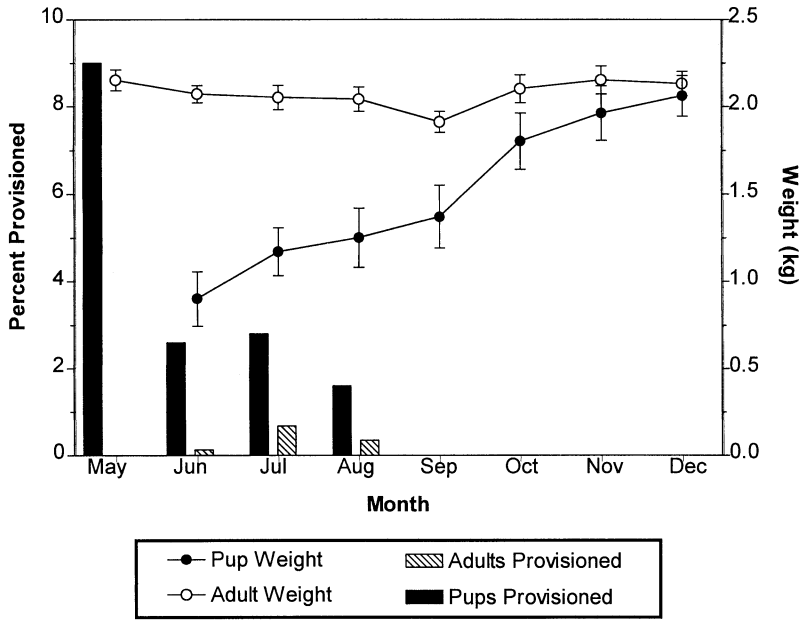

FIG. 1.—Mean weight of island fox pups in relation to mean weight of adult foxes and percentage of captures in which provisioning occurred per age class per month. Adult and pup weights are shown with standard error bars, and all weight data are from Santa Cruz Island, California.

year-round basis, but the greatest effort was focused from June through August, when island fox pups were making excursions from their dens. Single door, welded-wire cage traps (Tomahawk, Wisconsin) measuring 23 by 23 by 66 cm were placed in grid configurations or as transects along roads or canyons, baited with dry cat food and a fruit scent, checked each morning, and then reset. Pups were differentiated from adults by mass and the presence of deciduous teeth.

Chi-square analysis was used to test for the effects of season on the occurrence of prey found outside of traps. Seasons were based on the developmental period of pups and are defined as the pup dependency period, May (when pups first venture from dens) through August (when they approach adult mass), and the non-dependency period, September through April.

On three days during July 1996, we provided food (peanuts, raisins, bread and jam) for a pair of foxes with two pups to determine if the adults would provision the pups. After presenting the food, we recorded the behavior of both the adults and pups.

RESULTS—On 24 occasions one or more prey items were found within ca. 10 cm of traps containing island fox pups (2.1% of 1,135 pup captures). Either deer mice (*Peromyscus maniculatus*) or introduced house mice (*Mus musculus*) were found in 21 instances and birds were found on the remaining three occasions. Two prey items were found seven times and three prey items were found once. In an additional 11 cases, prey were found outside traps containing adult foxes (six female, four male, and one undetermined). In 10 of the 11 cases the prey items were mice, and the remaining case included two island night lizards (*Xantusia riversiana*).

Prey were found outside of traps containing pups only during the period prior to pups attaining adult mass (Fig. 1), which corresponds to the pup dependency period. Nineteen provisioning events were recorded between the months of May and August during 8,302 trap nights over nine years of trapping on San Clemente Island and four years of trapping on Santa Cruz Island. Provisioning was never observed during the non-dependency period, which included an additional 2,501 trap nights on these two islands ($\chi^2 = 5.1$; $P < 0.05$). In addition, we have observations of pups accompanying foraging adults on 10 occasions, and have captured pups with their presumed parents in the same trap on 22 occasions (15 with

adult males, 7 with adult females) during the pup dependency period. Rate of provisioning was dependent on age class, with adults being provisoned significantly less frequently than pups ($\chi^2 = 32.3$, $P < 0.001$).

On 24 July, we offered 10 raisins, each provided individually, to an adult female accompanied by a single pup. She consumed all of the raisins and was then offered a large piece of bread covered with jam. The female moved off 5 m, then transferred the piece of bread to the pup which he promptly consumed. On 25 July the female and an adult male visited camp with two pups, and in five offerings of jam-covered bread the female transferred each to one of the pups. The adult male ran off and consumed the first bread he was offered, but transferred the second to the closest pup and the third to the adult female. Later we observed the female enter a bush carrying the piece of bread she had received from the male, and after a few moments exited the bush without the piece of bread and being followed by a pup. Although we had not witnessed a transfer, we believe that the female sought out and transferred the bread to the pup. Finally, on 27 July the adult male visited our camp accompanied by a single pup. On this occasion we offered 12 peanuts to the male and the pup in such a way that the food items were approximately equidistant from each individual. Both individuals appeared to compete for these items and the adult male procured 11 of the 12 peanuts. These observations appear to suggest that adult foxes will provision pups with large but not small food items.

The possible provisioning of a pup was observed on 8 June 1994 at a trap on San Clemente Island. An adult female fox was present outside a trap containing a pup, holding a dead bird in her mouth. Another dead bird, a Gambel's quail chick (*Callipepla gambelii*), was already present outside the trap. Upon release the pup and adult nuzzled and then moved a short distance away. The adult then returned to the trap, inspected it, picked up the bird she had previously been carrying, and departed the area with the bird.

DISCUSSION—Provisioning has been reported for numerous large canids and parental care is common in the Canidae (Moehlman, 1989; Packard et al., 1992; Thomson, 1992). In large canids, prey items are carried back to the den, or food is either given directly to or regurgitated for the pups. Wolf pups (*Canis lupus*) old enough to leave the area of their dens have been reported with adults at rendezvous sites where they were provisioned (Mech, 1970). Provisioning at or near den sites has been reported for several small to medium-sized North American canids, including the red fox (*Vulpes vulpes*—Zabel and Taggart, 1989), kit fox (*Vulpes macrotis*—Egoscue, 1962), swift fox (*Vulpes velox*—Uresk and Sharps, 1986) and arctic fox (*Alopex lagopus*—Garrott et al., 1983). However, we have found no reports of any canid species providing food to pups or mates caught in traps.

The occurrence of food items outside of traps containing adult foxes could be a result of mate provisioning. The observation of food transfer from an adult male to an adult female supports the idea that mate provisioning occurs, and the placement of food outside traps would only be an extension of that behavior.

The following points appear to support our hypothesis that prey had been brought to trapped foxes: 1) prey items were found outside traps only during the dependency period when fox pups averaged less than 70% adult mass, 2) fox pups were observed accompanying foraging adults, and were caught simultaneously with their presumed parents, 3) multiple prey items (2 to 3) were found outside traps containing pups, and given the size of the combined prey compared to a pup's gape, it is unlikely they could physically carry them, and 4) adult foxes were observed transferring food to pups in an artificial situation, and were also observed with food outside of a trap containing a pup. Therefore, we believe the presence of prey items found outside traps containing pups represents instances of provisioning and further suggests that island foxes exhibit extended biparental care, a behavior common to other canids.

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