



Species at Risk: Golden Eagle Predation on Arid-Land Foxes

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The Golden Eagle (*Aquila chrysaetos*) in California typically inhabits grassland foothills with scattered oaks (*Quercus* sp.), sycamores (*Platanus racemosa*), or large gray pines (*Pinus sabiniana*), with sustainable California ground squirrel (*Spermophilus beecheyi*) and black-tailed jackrabbit (*Lepus californicus*) populations, either along the Coast Range or the Sierra Nevada (Grinnell and Miller 1944). The Golden Eagle is federally protected under the Bald Eagle Protection Act of 1962 (U.S. Fish and Wildlife Service 1978). Nearly 70% of direct and indirect Golden Eagle deaths are from accidental trauma, such as collisions with vehicles, power and transmission lines, and other structures, such as wind turbines (Kochert et al. 2002). Poisoning, electrocution, and illegal shooting also take their toll on Golden Eagles. Loss and destruction of habitat due to wildfires and human developments have caused loss of shrublands that support jackrabbits and have led to a decline in Golden Eagle populations (Kochert et al. 2002).

Also associated with these rolling grassland habitats are several carnivore species, including the federally endangered San Joaquin kit fox (*Vulpes macrotis mutica* – U. S. Fish and Wildlife Service 1998). In the literature, there are reports of predation of fox species by Golden Eagles, including Channel Island gray foxes (*Urocyon littoralis*) and the swift fox (*Vulpes velox*) of the Great Plains. If Golden Eagles are known to prey on these species, it is also likely that they prey upon the San Joaquin kit fox in California. Herein I review the literature regarding predation of arid-land foxes by Golden Eagles and its applicability to eagle-fox interactions within the Central Valley of California.

Golden Eagles are strong birds and have been known to kill ungulates, including mountain sheep (*Ovis Canadensis* – Bleich et al. 2004). One bird can carry up to 3.5 kg in flight (Kochert et al. 2002), and can easily take a coyote pup (Ingles 1965). Golden Eagles have also been known to take domestic calves (Phillips et al. 1996). Kit foxes, which weigh 2.3 kg on average, do not seem to be a challenge for this powerful raptor. However, the literature is sparse in documenting kit foxes and other arid-land fox species as prey items, either because it has not been a common research objective, or these interactions are infrequent, and when observed, are not being reported.

Golden Eagles are typically diurnal whereas kit foxes are nocturnal, providing an unexpected predator-prey interaction. In the northern range of the San Joaquin kit fox (Alameda, San Joaquin, and Contra Costa counties), a common prey item for the fox is the California ground squirrel which is a diurnal species (Orloff et al. 1986). The lack of well-distributed and abundant kanga-



roo rat (*Dipodomys* sp.) populations has likely led the kit fox to prey-shift to the ground squirrel, which makes the fox vulnerable to diurnal aerial predators (Clark et al. 2007).

The northern range of the kit fox also occurs in ideal Golden Eagle habitat. The rolling oak savannah habitat of the northern range has been reported to support the highest density of Golden Eagles in the world (Franklin et al. 1998, Hunt et al. 1998). The additional predatory pressure of Golden Eagles on kit foxes in the northern range may contribute to the currently declining San Joaquin kit fox populations in that portion of California (Clark et al. 2007), although this is conjectural. In the past, Grinnell et al. (1937) documented Golden Eagle predation on San Joaquin kit foxes in Fresno County. Arthur Oliver, a trapper interviewed by Grinnell, stated that trapped foxes were sometimes destroyed by Golden Eagles, which also

occasionally took adult free-roaming foxes.

In the 1980s, portions of the northern kit fox range were targeted for an extensive rodent poisoning campaign, which left large expanses of grassland devoid of the California ground squirrel for many years (Orloff et al. 1986). The loss of this prey item during this time period, as well as the elimination of most of the highest quality habitat for the kit fox through agricultural conversion and urbanization, led to a disruption in the demographics of the species, making a full recovery of the species in the northern range a challenge. Golden Eagles, too, depend on California ground squirrels for food, and a decline in the squirrel population would have led to prey-switching in Golden Eagles as well. It is unknown if kit foxes were frequently targeted as a prey item during this poisoning campaign.

The Channel Island gray fox has a

San Joaquin kit fox (*Vulpes macrotis mutica*). Photo by Brian Cypher, western Kern County.

similar weight range as the kit fox, and it too has fallen victim to Golden Eagle predation (Collins et al. 2009). Historically, Bald Eagles (*Haliaeetus leucocephalus*) were the primary raptor on the Channel Islands, but were reduced to a dozen or so breeding pairs by the 1950s due to DDT and thinning egg shells, and were eventually extirpated from the islands. The open niche led to the occupation of the Channel Islands by Golden Eagles, which initially fed on the non-native pig (*Sus scrofa*) which had been introduced to the islands in the 1850s; however, they quickly learned that island foxes, having no natural enemies, were easier to catch than the pig. Without the pigs, the Golden Eagles likely would not have stayed long enough to discover the easily caught island fox (Roemer et al. 2001, 2002; Coonan et al. 2005). This example illustrates that at least under certain circumstances, Golden Eagles can regulate and deplete a population of a small fox species.

Foxes of the Great Plains of the United States, such as the swift fox, have also been preyed upon by the Golden Eagle. Pfeifer and Hibbard (1970) report that Golden Eagles had eaten the rear portion of a male swift fox carcass in North Dakota; this indicates that Golden Eagles scavenge swift foxes. Another male swift fox in South Dakota was partially consumed by a Golden Eagle while still in a trap (van Ballenberghe 1975). At times, eagles have been suspected of taking swift foxes in Kansas (Chambers 1978), Wyoming (Madson 1987), and Canada (Herrero 1985), but direct evidence was not always available.

During other studies, direct predation of swift foxes has been confirmed by examining physical evidence left behind. In Canada, Herrero et al. (1991) lost two study animals due to Golden Eagles. Moehrenschrager et al. (2007) lost 13 Canadian study animals between 1995 and 1997. Their study also included kit foxes in Mexico, and one

eagle was observed on the ground attempting to reach a kit fox caught in a trap. Mollhagen et al. (1972) and Olen-dorff (1976) surmised that adult kit foxes were taken as prey by Golden Eagles in Texas and New Mexico because kit fox prey remains were found in eagle nests. In a Golden Eagle nest inventoried for prey remains in Mongolia, red fox (*Vulpes vulpes*) and corsac fox (*V. corsac*) remains were discovered (Ellis et al. 1999). The authors suggest that the take of 27 foxes by Golden Eagles is “not so much a preference for foxes, but rather that populations of more normal prey were depressed at this site” (Ellis et al. 1999).

Due to significant land conversion to agriculture and urban uses in the northern Central Valley of California, the remaining habitat suitable for San Joaquin kit fox occupation lies along the western edge of the Valley (U.S. Fish and Wildlife Service 1998); an ecotone between the Central Valley’s agricultural matrix and upland annual grassland, which is also known to support Golden Eagles. Intraguild predation and behavioral interactions between arid-land foxes and Golden Eagles are rare in the literature, likely because observing these interactions are difficult to make when foxes occur in low densities on the landscape. Moreover, these associations were likely uncommon prior to human encroachment and development of the Central Valley for two reasons. (1) Golden Eagles tend to remain in upland areas, even where grasslands are available on flatter terrain. (2) Kit foxes, prior to human conversion and settlement of the Central Valley, occurred on the valley floor in robust and sustainable densities. Therefore, these two species likely did not interact much historically. Kit foxes are now restricted to high quality Golden Eagle habitat, especially in the northern range, and eagle-fox interactions are potentially greater than they were in the past. More research on

Golden Eagle predation on imperiled foxes, such as the kit fox, swift fox, and island gray fox, is needed to determine the impacts on fox population dynamics, predation avoidance behaviors, and other ecological variables, such as prey population cycles, especially when available habitat where both species currently co-occur is becoming increasingly rare in California.

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