Interspecific Interactions Among Wild Canids: Implications for the Conservation of Endangered San Joaquin Kit Foxes

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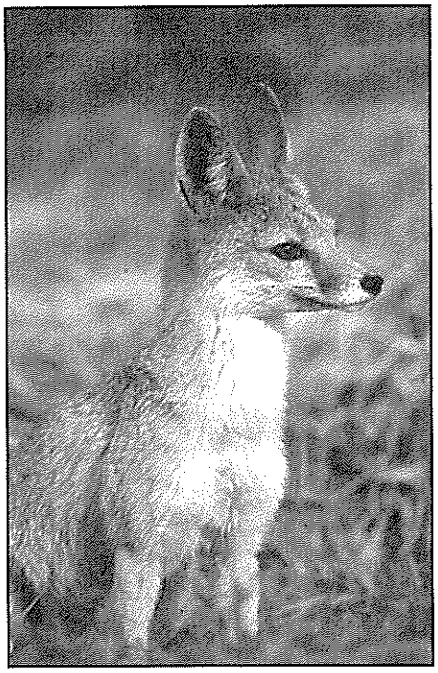
Abstract

*Interspecific interactions among wild canids have significant implications for the conservation and recovery of endangered San Joaquin kit foxes (*Vulpes macrotis mutica*). Coyotes (*Canis latrans*) and non-native red foxes (*V. vulpes*) both engage in interference and exploitative competition with kit foxes. Several behavioral and ecological adaptations of kit foxes ameliorate such competition with coyotes and facilitate their coexistence. These adaptations include habitat partitioning, food partitioning, opportunistic foraging patterns, and year-round use of multiple dens. These adaptations are less effective against red foxes due to greater food and habitat overlap, the ability to pursue kit foxes into dens, and high potential for disease transmission. Thus, non-native red foxes pose a serious threat to kit foxes. Interactions between coyotes and red foxes may benefit kit foxes. In particular, interference competition by coyotes may limit the abundance and distribution of red foxes in the San Joaquin Valley. These interactions should be considered when evaluating management options (e.g., predator control).*

Introduction

Kit foxes are relatively small canids (1.7 to 3.0 kg) that occur in arid and semi-arid habitats of the southwestern United States and northern Mexico. The San Joaquin kit fox (*Vulpes macrotis mutica*) is a genetically distinct subspecies that historically occurred in the San Joaquin, Salinas, and Cuyama Valleys of central California. The abundance and range of this taxon have been significantly reduced, primarily due to habitat loss and degradation associated with agricultural, industrial, and urban development (FWS 1998). Fur harvests, predator control programs, and rodent control programs also may have contributed to observed declines. San Joaquin kit foxes persist as a metapopulation comprising three larger "core" populations and a number of smaller "satellite" populations. Current threats include continuing habitat conversion, rodenticide use, and interspecific competition. Much of the remaining habitat is fragmented, disturbed, and subject to competing land uses such as hydrocarbon production and water banking (FWS 1998). The San Joaquin kit fox was listed as Federally Endangered in 1967 and California Threatened in 1971.

Interspecific competition from other mammalian predators is an important factor affecting the remaining San Joaquin kit fox populations (Cypher et al. in press). Coyotes (*Canis latrans*), bobcats (*Lynx rufus*), gray foxes (*Urocyon cineareoargenteus*), badgers (*Taxidea taxus*), feral cats (*Felis domesticus*), and non-native red foxes (*V. vulpes*) all engage in interference and/or exploitative competition with kit foxes. Interference competition consists of direct mortality, harass-



San Joaquin kit fox (*Vulpes macrotis mutica*). Photograph by B. Moose Peterson/WRP.

ment, and spatial exclusion. Exploitative competition consists of overlap in use of potentially limited resources such as food items and dens. Competitive interactions with coyotes and red foxes have the greatest implications for San Joaquin kit foxes. Our objectives for this paper are to summarize the competitive interactions that occur between kit foxes, coyotes, and red foxes, and to assess the potential implications of these interactions for kit fox conservation and recovery.

Competitive interactions

Coyotes engage in both interference and exploitative competition with kit foxes. Coyotes have long been recognized as a significant cause of mortality for kit foxes (Seton 1925). At various study sites throughout the range of the San Joaquin kit fox, coyotes are the primary source of kit fox mortality for which the cause of death is identifiable (Hall 1983; Briden et al. 1992; Standley et al. 1992; Ralls and White 1995; Spiegel and Disney 1996; Cypher et al. 2000). This mortality indeed appears to be the result of competition rather than predation. Coyotes commonly do not consume the kit foxes they kill (Spiegel and Disney 1996; Cypher and Spencer 1998), although over half of kit foxes killed at one location were consumed during a period of low food availability (Ralls and White 1995).

Another effect of interference competition is spatial exclusion in which the presence of one species in an area results in decreased use of that area by another species. On a regional scale, kit foxes usually are absent or less abundant in more rugged terrain (areas with average slopes >5%). Kit foxes may have more difficulty eluding predators in rugged terrain. At one study site, kit foxes were abundant in rugged terrain when regional coyote abundance was low, but kit fox numbers quickly declined in this terrain as coyote abundance increased (Warrick and Cypher 1998). On a local scale, White et al. (1994) did not detect any temporal segregation among telemetered kit foxes and coyotes, indicating that areas were being used concurrently by the two species.

With regards to exploitative competition, coyotes consume some of the same food items consumed by kit foxes. Items commonly used by both species include black-tailed hares (*Lepus californicus*), desert cottontails (*Sylvilagus audubonii*), kangaroo rats (*Dipodomys* spp.), pocket mice (*Chaetodipus californicus*, *Perognathus inornatus*), California ground squirrels (*Spermophilus beechyi*), pocket gophers (*Thomomys bottae*), grasshoppers (Acrididae), Jerusalem crickets (Gryllacrididae), and beetles (*Eleodes* spp.). Overlap in resource use varies with the relative availability of different food items (White et al. 1995; Cypher and Spencer 1998), and therefore may not be a significant factor in all areas or all years.

The overall effect of competitive interactions between coyotes and kit foxes is not clear. Declines in kit fox abundance in some areas have been associated with increases in coyote abundance (Cypher et al. 2000; White et al. 2000). Coyote predation, however, does not appear to be the primary factor driving kit fox population trends. Instead, food availability as mediated by annual environmental conditions (particularly precipitation) appears to be the primary factor influencing kit fox population dynamics (White et al. 1996; Cypher et al. 2000). Predation by coyotes potentially could have a more significant impact on kit fox populations when food availability is low or when kit fox populations are small (particularly introduced populations).

Coyotes have historically occurred throughout the range of the kit fox, and kit foxes have evolved adaptive strategies for coexisting with coyotes. One such strategy is year-round use of dens. Kit foxes may have over 100 dens scattered throughout their home range, although on average about 12 dens are used by a given fox annually (Koopman et al. 1998). These dens facilitate escape from predators (White et al. 1994; Cypher and Spencer 1998). In addition, some amount of resource partitioning occurs between coyotes and kit foxes. Although food habits overlap, coyotes take higher proportions of leporids while kit foxes usually consume higher proportions of nocturnal rodents, particularly kangaroo rats and pocket mice (White et al. 1995; Cypher and Spencer 1998). Furthermore, there is some evidence that some degree of habitat partitioning may occur with kit foxes preferring more open areas with reduced shrub cover (White et al. 1995; Warrick and Cypher 1998).

Red foxes also engage in both interference and exploitative competition with kit foxes. Historically, native red foxes only occurred at high elevations in the Sierra Nevada and Cascade ranges in California, and were not found in any portion of the range of San Joaquin kit foxes (Grinnell et al. 1937). In more recent times, red foxes from the eastern United States have been introduced into lower elevation areas of California by humans for hunting and trapping, and have escaped from fur farms (Jurek 1992; Lewis et al. 1993). These highly adaptable, non-native red foxes have spread rapidly and have colonized many regions of California, including the San Joaquin Valley. The abundance of anthropogenic water sources in the San Joaquin Valley (e.g., canals, irrigated agriculture, stock ponds, and urban areas) likely has facilitated colonization by red foxes.

Red foxes are larger (3 to 8 kg) than kit foxes, and therefore dominate in interference competition. Red foxes are known to have killed radiocollared kit foxes on at least three occasions (Ralls and White 1995; Clark 2001). In addition, red foxes may be competitively displacing kit foxes in some locations (White et al. 2000). At one location, kit foxes primarily used areas not occupied by red foxes (Clark 2001). Finally, red foxes and kit foxes are closely related taxonomically which may increase the potential for disease transmission.

Being relatively close in size to kit foxes, exploitative competition may be more intense between the two species. Considerable overlap in use of foods was documented at one location in the San Joaquin Valley (Warrick and Clark unpublished data). Red foxes will use kit fox dens, excluding use by kit foxes. Red foxes have been observed in dens formerly used by kit foxes on a number of occasions at three different locations (White et al. 2000; Cypher et al. in press; Warrick and Clark unpublished data).

Red foxes constitute a serious threat to San Joaquin kit foxes. Adaptations of kit foxes that reduce competition with coyotes are less effective against red foxes. Red foxes can enter most dens used by kit foxes, making escape and avoidance more difficult. Resource partitioning may be minimal although some degree of habitat partitioning may occur between the two species. Red foxes may have difficulty colonizing kit fox habitat lacking in nearby water sources. Most red fox observations in the San Joaquin Valley are in relatively close proximity to sources of water.

Interactions between coyotes and red foxes can affect kit foxes. The presence of both coyotes and red foxes in a given area may act in an additive manner with regards to reducing food availability for kit foxes. Thus, exploitation competition between coyotes and red foxes may detrimentally affect kit foxes.

Red fox (*Vulpes vulpes*). Photograph by B. Moose Peterson/WRP.

Interference competition between coyotes and red foxes may also benefit kit foxes. Reduced abundance of red foxes attributable to coyotes has been documented in a number of locations (Dekker 1983; Voigt and Earle 1983; Major and Sherburne 1987; Sargeant et al. 1987). This reduction is a consequence of both direct mortality and exclusion. In a study in the San Joaquin Valley of California, 11 radiocollared red foxes were recovered dead. Of the nine mortalities for which the cause of death could be identified, all nine were killed by coyotes (Clark 2001). Coyotes have been suggested as a biological control strategy for red foxes in coastal areas of California where the foxes are preying on endangered California least terns (*Sterna antillarum browni*) and California light-footed clapper rails (*Rallus longirostris levipes*) (Jurek 1992). Coyotes also have been proposed as a means of reducing red foxes in the prairie pothole region of North America, thereby reducing red fox predation on duck nests (Sargeant and Arnold 1984).

Conservation implications

Due to anthropogenic ecosystem modification, non-native red foxes are expanding their range and increasing in abundance in California (Jurek 1992; Lewis et al. 1993). As described above, this species poses a potentially serious threat to kit foxes. Implementing effective control programs for red foxes would be extremely difficult for a number of reasons. In general, predator control programs can be costly as they usually must be implemented over large areas for multiple years (sometimes indefinitely) to achieve effective control, and are not popular with the general public even when conducted for the conservation of a rare, native species (Goodrich and Buskirk 1995). Poisons can not be used due to the threat to kit foxes as well as other non-target species. Trapping red foxes without also capturing kit foxes would be difficult due to the relatively close weights of the two species. The use of many types of trapping devices was banned in California in 1998. Shooting, possibly in conjunction with predator calling, may be possible, but could be difficult and costly to implement over large areas or near human-inhabited areas where red foxes commonly occur.

Coyote control is often suggested as an action that would benefit San Joaquin kit foxes. Similar to control efforts for red foxes, coyote control can be both difficult and controversial (Cypher and Scrivner 1992; Connolly and Longhurst 1975). There may be certain situations where limited coyote control might benefit kit foxes (e.g., reintroduction sites, smaller preserves and habitat blocks during periods of low food availability). Given the potential beneficial role of coyotes in limiting non-native red foxes; however, the implementation of coyote control should be carefully considered. Any reduction or limitation of red fox abundance achieved naturally through competitive pressure from native predators could significantly benefit kit foxes and would require no effort on the part of humans. Red foxes are rarely observed in areas where coyotes are abundant, even though kit foxes persist in these areas (Ralls and White 1995; Spiegel and Disney 1996; Cypher et al. 2000).

Ultimately, the strategy with the greatest potential for effectively conserving and recovering San Joaquin kit foxes will be to conserve and properly manage large blocks of habitat that are connected by movement corridors. This will facilitate larger kit fox populations that are more robust to losses from interspecific competition, and that are able to naturally recolonize areas where local extirpations of kit foxes may have occurred. Also, the fragmentation of kit fox habitat by anthropogenic disturbances promotes increased abundance of red foxes, which negatively impacts kit foxes. The conservation of large blocks of habitat is a paramount goal of the recovery plan for San Joaquin kit foxes and a number of other rare species that occur sympatrically with kit foxes (FWS 1998).

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