ANALYSIS OF SAN JOAQUIN KIT FOX ELEMENT DATA WITH THE CALIFORNIA DIVERSITY DATABASE: A CASE FOR DATA RELIABILITY

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Abstract: Our analyses of the kit fox sighting elements in the California Natural Diversity Database and other data suggest the possible misidentification of coyote pups as kit fox. During the summer months, coyote pups look remarkably similar to adult kit foxes; both have black-tipped tails and large ears relative to the body size. As coyote pups grow, there is a period of time where the pup weight approximates that of an adult kit fox. With an average weight increase of about 0.31 kg/week, coyote pups are ~2 kg during June, July, and August. During this time, juvenile coyotes superficially resemble kit foxes during spotlighting sessions, and it may be challenging for biologists to differentiate coyote pups from kit foxes at a time when both are present on the landscape.

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The California Natural Diversity Database (database) was first conceptualized and developed in 1979 by The Nature Conservancy (now overseen by NatureServe; Csuti 1982, Bittman 2001). Since its inception, the Habitat Conservation Division of the California Department of Fish and Game has maintained the database (Bittman 2001, Brooks and Matchett 2002). Its main purpose is to be a repository of data concerning endangered, threatened, and special concern plant and animal species (Bittman 2001, Brooks and Matchett 2002). Ultimately, the information stored in the database will allow for better management of special status species by providing accurate and useful landscape and natural history information, which will lead to the delisting of species upon recovery.

The database only records physical sightings of plants and animals in areas that are surveyed, collectively known as *elements*. The database does not record surveys that suggest absence of a particular sensitive species, and no inference can be made regarding the presence of species on lands that have never been surveyed (Bittman 2001). It is critical that the database consists of the highest possible quality information on location, distribution, habitat conditions, threats, and land use associated with listed and sensitive species (Bittman 2001). However, the assumption that researchers, government agency personnel, members of conservation groups, biological consultants, and individuals from the private sector accurately and positively identify target species can have important implications regarding the quality of the database. Here we provide a possible example of how misidentifications by biologists in the field can subsequently add inaccurate elements to the database.

In the case of the San Joaquin kit fox (*Vulpes macrotis mutica*) there are several common survey methodologies. These methodologies vary according to the time of year, the physical landscape, the natural history, and population of the San Joaquin kit fox being studied. The primary methodology recommended by the U. S. Fish and Wildlife Service is to conduct spotlighting surveys. Spotlighting surveys generally consist of driving along dirt or paved roads, typically beginning at sunset, although timing of initiation is determined by the target species' biology (USFWS 1999). A truck or similar vehicle with the driver and passenger simultaneously using million candlepower lights search for canid eyeshine along the route (Ralls and Eberhardt 1997, Warrick and Harris 2001). Once eyeshine is observed, the vehicle is stopped and the animal is identified using binoculars or a spotting scope (Ralls and Eberhardt 1997). A determination of the taxonomic identity of the animal must be made at that time. Often, the canid runs, hides, or otherwise flees allowing surveyors only a brief view of the animal, thereby increasing the difficulty of making these determinations and increasing the potential for misidentifications.

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Regarding the kit fox, the physical traits typically keyed out during the spotlighting session are large ears, black-tipped tail, buffy tan coat color, and a general *small canid* appearance (Morrell 1972). Eyeshine color is not a determining factor. In addition, kit foxes tend to hold their bushy tails straight out from their body while running and have a "dance-like" gait. In some cases, inexperienced researchers may mistake other canids for kit foxes during spotlight sessions. Canids potentially misidentified as kit foxes include coyote (*Canis latrans*), domestic and feral dog (*C. lupus familiaris*), gray fox (*Urocyon cinereoargenteus*), and red fox (*V. vulpes*). We will focus primarily on the coyote to demonstrate the potential for misidentifications during data collection, which is then archived in the California Natural Diversity Database.

Coyote pups are typically born in the spring during April and May, and weigh approximately 250 to 275 g (Bekoff 1977, Harrington et al. 1987, Harrison et al. 1991). Pups emerge from the den between 2 and 5 weeks of age (late May), often remaining within 20 m of the entrance (Bekoff 1977, Harrison et al. 1991). Between birth and week 8, the average weight increase is approximately 0.31 kg/week, with the pups reaching adult weight in approximately 9 months (Bekoff 1977). Harrison et al. (1991) reported that pups begin to move short distances from dens at 6 to 8 weeks old. During this time (June to July), pups begin moving to rendezvous sites up to 0.5 km from the den and at times will abandon the den site entirely (Harrison et al. 1991). By the end of July, pups move >1 km from rendezvous sites and by August are beginning their independence period (Harrison et al. 1991). By September, juvenile coyotes are engaging in longer forays from rendezvous sites and are foraging on their own (Harrison et al. 1991).

Coyote pups look remarkably similar to adult kit foxes – both have black-tipped tails and large ears relative to the body size. Mean adult kit fox weight for males is 2.2 kg and 1.9 kg for females (McGrew 1979). As coyote pups grow, there is a period of time where the pup weight approximates that of an adult kit fox. With an average weight increase of about 0.31 kg/week (Bekoff 1977), coyote pups are ~2 kg during June, July, and August, though the month varies according to whelping dates. During this time, juvenile coyotes superficially resemble kit foxes during spotlighting sessions, and it may be challenging for even experienced biologists to differentiate coyote pups from kit foxes at a time when both are present on the landscape.

METHODS

To determine if there was a surge of kit fox sightings reported by surveyors during the summer, we pooled element data on the San Joaquin kit fox from the California Natural Diversity Database and the dataset used to map the distribution of the kit fox in the Recovery Plan for Upland Species of the San Joaquin Valley, California (USFWS 1998). We excluded elements that consisted of only scat or denning data, because pinpointing the sighting to at least a particular month is critical. Scats can at best be dated to the nearest one to two months if not obviously fresh, and dens can be several months to many years old.

Four hundred and ten unique element points from 1903 to 2006 were extracted from the two datasets (USFWS 1998, CNDDB 2007). The points were simultaneously graphed along with the morphological development timelines of coyotes and kit foxes. To determine if peaks of kit fox sightings were artifacts of survey restrictions imposed by the U. S. Fish and Wildlife Service, we separated the elements into two groups based on the release of the first San Joaquin kit fox survey protocol: pre-protocol and post-protocol (USFWS 1997).

Revisions to the protocol were made in 1999; however, the revisions apply only to surveys conducted in the northern range, defined as "The western intersection of the Merced/Fresno county lines, then along the Merced/Fresno county lines to the intersection of the Merced/Madera county line and State Route 152, then east along State Route 152 to the intersection of State Route 99, and then an imaginary line directly east from that intersection" (USFWS 1999). A separate protocol drafted by the California Department of Fish and Game had been established for the southern range of the San Joaquin kit fox in 1990 (CDFG 1990). The major difference between the two protocols is that the northern range protocol does not allow surveys to be conducted between 1 November and 1 May, which coincides with the breeding season of the kit fox (USFWS 1999). The southern range protocol states that the optimum survey period for kit foxes is between 1 May and 30 September (CDFG 1990). The CDFG protocol also states that the lowest period of detectability is from December to February (CDFG 1990). To analyze if there are any notable trends between foxes reported in the northern and southern ranges, data were separated into four categories: northern range, pre-protocol; northern range, post-protocol; southern range, pre-protocol; southern range, post-protocol.

RESULTS AND DISCUSSION

There was a peak of reported kit fox sightings during the months of June, July, and August (Fig. 1 and 2). During this same time period, coyote pups are active on the landscape making exploratory movements between dens and rendezvous sites. Also during these months, the coyote pups are the approximate size, weight, and appearance of adult kit foxes. By September and October pups have gained enough weight to begin favoring the adult coyote *look* and potential misidentifications should decrease. By November coyote juveniles are at least 6 months old and begin dispersing from natal areas (Bekoff 1977).

The density of coyote populations varies from location to location and depends on local conditions (Bekoff 1977). Conservative estimates suggest that coyote densities range from 0.8 to 2.6/km^2 (Bekoff 1977, Gipson and Kamler 2002). The San Joaquin Valley alone can have as many as 25,000 coyotes at any give time, and after pups are born, this number temporally increases (Schoenherr 1992). Therefore, it is reasonable to conclude that coyotes are ubiquitous in suitable habitats and even occur in urban areas (Gehrt 2004). Conversely, kit foxes are listed as federally endangered and state-threatened, and are comparatively rare. Detecting them is difficult, especially within the northern extent of their range (Orloff et al. 1986, Sproul and Flett 1993). Current estimates place the total kit fox population at perhaps a few thousand animals range-wide (Laughrin 1970, Holing 1988, Clark et al. 2004). Ideally, before reporting kit fox sightings to the database, surveyors must be absolutely sure that they have correctly identified the animal as a kit fox.

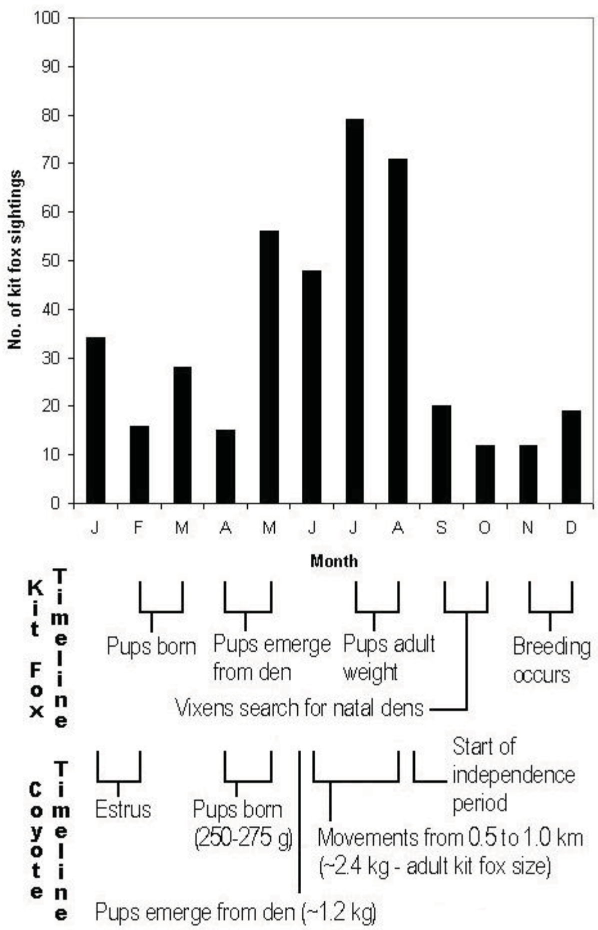

Figure 1. All sightings of the San Joaquin kit fox (*Vulpes macrotis mutica*) reported in the database and the Recovery Plan (USFWS 1998). Reproductive life history of kit fox and coyote provided to show possible explanations of observation peaks during some months. Note exploratory and independence movements of young coyotes coincide with element peak.

The only other ecological reason explaining the increase of sightings during those peak months is the possibility of dispersing juvenile kit foxes approaching adult weight (Koopman et al. 2000). Although, since 1997, the protocol has restricted when surveys can be conducted, analyzing the data prior to the implementation of the protocol also shows a peak in sightings during those months. Kit fox family groups typically split up during July or August (Morrell 1972). During a kit fox dispersal study, the peak-dispersing month was July, with most mortalities occurring during that month; mortalities were highest in June among non-dispersing juveniles (Koopman et al. 2000). According to Cypher et al. (2000), the annual mean survival rate for juveniles from 1 May to 15 February is 0.14, compared to 0.44 for adults. The low survival rate of juveniles is primarily due to fatal encounters with coyotes (Ralls and White 1995).

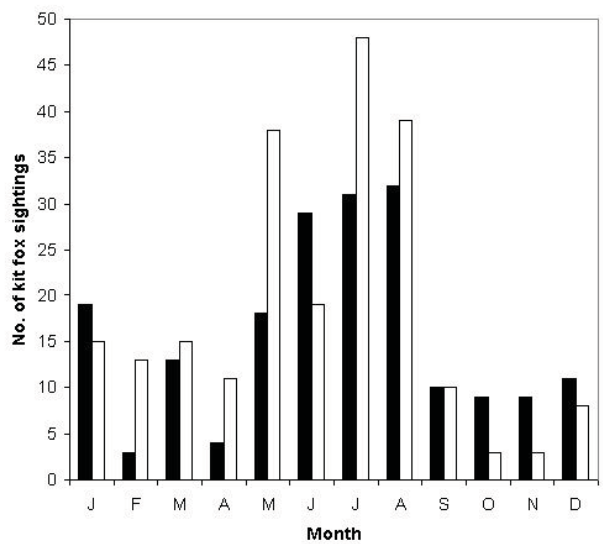

Figure 2. Reported sightings of the San Joaquin kit fox (*Vulpes macrotis mutica*) before (black bars) and after (white bars) release of the kit fox survey protocol.

Juvenile kit fox dispersal patterns may appear to explain the peaks in June, July, and August, but the high mortality rates for juveniles, coupled with the rarity of kit foxes, lead us to conclude that misidentifications may also explain the sighting peaks during these months. Although kit fox juveniles continue to disperse well into January despite high mortality rates (Koopman et al. 2000), the decrease in sightings by September may be explained by coyote juveniles having gained enough mass to no longer be mistaken for kit foxes. However, the decrease in sightings by September could also be due to fewer kit foxes from high mortality of juveniles

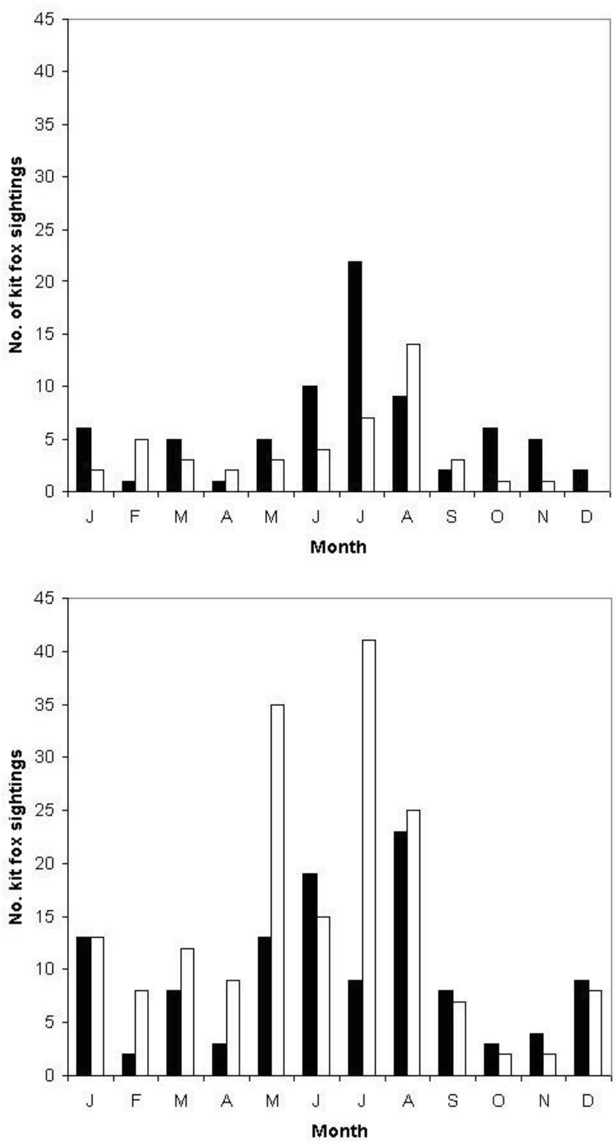

Figure 3. Comparison of Pre- (black bars) and Post-protocol (white bars) sightings of the San Joaquin kit fox (*Vulpes macrotis mutica*) in the northern (top) and southern (bottom) portions of the species' range.

during early dispersal periods. Post-protocol sightings of the San Joaquin kit fox peak in July and August in both the northern and southern range (Fig. 3). The southern range post-protocol peak in May indicate more dispersing kit fox sightings, which is expected due to a higher kit fox density in the southern range.

To determine if sighting peaks in the database were an artifact of protocol implementation, we conducted a chi-square test between number of sightings during years before and after the protocol implementation and months with protocol survey restrictions. The relative proportion of kit fox records in the database reported during and outside of the protocol survey period was not significantly different in the years preceding the implementation of the protocol than in the years following it ($\chi^2 = 0.214$, $P = 0.644$; Zar 1999). Our results indicate that the post-protocol peaks are not an artifact of the protocol, which restricts when biologists are allowed to survey. Intuitively, a protocol effect should lead to more sightings during summer months, however, before the protocol was implemented, summer months still contained observational peaks.

MANAGEMENT IMPLICATIONS

It is critical that the database is accurate and that all sightings represent true kit fox observations. the database is often the *final word* in determining the presence of special status species in any given area. Once sightings are recorded in the database, they are considered an infallible truth. Any dilution of the database with misidentifications will challenge the integrity of the database and the conservation efforts relying on it. It is possible that populations of San Joaquin kit fox may be overestimated and the distributional range more restricted than once thought if the database contains erroneous data. It is imperative that all reported kit fox sightings be evaluated, peer-reviewed, and entered into the database with the utmost scrutiny.

We cannot estimate how many kit fox records in the database are misidentifications; we can only surmise from the data that the possibility exists. Therefore, we recommend, at least for the San Joaquin kit fox, that all submitted database forms be reviewed by qualified kit fox biologists, either as an independent review committee, or as a review committee within the California Department of Fish and Game. Resource agencies should promote annual kit fox identification workshops with non-profit organizations, focusing on proper spotlighting techniques, and how to identify spotlighted canids while in the field by evaluating shape, size, gait, behavior, and other identifying characteristics. Furthermore, all biologists that will execute the survey protocol established by the U. S. Fish and Wildlife Service should practice in areas where kit foxes occur in high densities (such as the Carrizo Plain National Monument, San Luis Obispo County) and also observe coyote pups in the wild to ascertain the subtle differences between the two species. Observations of red foxes and gray foxes in the wild are also paramount.

CONCLUSIONS

Our analyses of the kit fox sighting elements in the California Natural Diversity Database and data used in the Recovery Plan suggest that some of the kit fox elements may actually be misidentifications of coyote pups. It is not our intention in writing this paper to challenge the integrity of biologists and researchers, rather we provide an educational opportunity to improve the quality of information recorded in the database that is used by resource agencies and other organizations to make informed landscape management decisions.

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