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Problem

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ABSTRACT: Coyote attacks on humans and pets have increased within the past 5 years in California. We discuss documented occurrences of coyote aggression and attacks on people, using data from USDA Wildlife Services, the California Department of Fish & Game, and other sources. Forty-eight such attacks on children and adults were verified from 1998 through 2003, compared to 41 attacks during the period 1988 through 1997; most incidents occurred in Southern California near the suburban-wildland interface. Attack incidents are typically preceded by a sequence of increasingly bold coyote behaviors, including: nighttime coyote attacks on pets; sightings of coyotes in neighborhoods at night; sightings of coyotes in morning and evening; attacks on pets during daylight hours; attacks on pets on leashes and chasing of joggers and bicyclists; and finally, mid-day sightings of coyotes in and around children's play areas. In suburban areas, coyotes can lose their fear of humans as a result of coming to rely on ample food resources including increased numbers of rabbits and rodents, household refuse, pet food, available water from ponds and landscape irrigation run-off, and even intentional feeding of coyotes by residents. The safe environment provided by a wildlife-loving general public, who rarely display aggression toward coyotes, is also thought to be a major contributing factor. The termination or reduction of predator management programs adjacent to some urban areas has also served to contribute to coyotes' loss of fear of humans and to a dependency on resources in the suburban environment. Corrective action can be effective if implemented before coyote attacks on pets become common. However, if environmental modification and changes in human behavior toward coyotes are delayed, then removal of offending predators by traps or shooting is required in order to resolve the threat to human safety. We note the failure of various non-lethal harassment techniques to correct the problem in situations where coyotes have become habituated to human-provided food resources. Coyote attacks on humans in suburbia are preventable, but the long-term solution of this conflict requires public education, changes in residents' behavior, and in some situations, the means to effectively remove individual offending animals.

KEY WORDS: *Canis latrans*, coyote, coyote behavior, coyote-human attacks, human safety, urban coyote

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INTRODUCTION

Coyote (*Canis latrans*) attacks on humans, once thought to be rare, have increased in frequency over the past decade. In expanding suburban areas such as those found in several counties in Southern California, residential developments are often near steep, brushy wildland areas. Coyotes inhabiting such wildlands are drawn into suburban landscaped environments that can support an abundance of rodents and rabbits, and where they can utilize water sources, pet food, household refuse, and even house cats and small dogs as prey.

Our observations indicate that in the absence of harassment by residents, coyotes can lose their fear of people and come to associate humans with this safe, resource-rich environment. This problem is exacerbated by people who intentionally feed coyotes. In such situations, some coyotes have begun to act aggressively toward humans, chasing joggers and bicyclists,

confronting people walking their dogs, and stalking small children.

We queried representatives of various federal, state, county, and city agencies as well as private wildlife control companies about coyote attacks on humans occurring in Southern California during the past 3 decades, giving particular attention to localities where such attacks previously had been verified (see Howell 1982, Baker and Timm 1998). From the information gathered, we now list 89 coyote attacks in California (incidents when one or more coyotes made physical contact with a child or adult, or attacked a pet while in close proximity to its owner) (Table 1). In 56 of these attacks, one or more persons suffered an injury. In 77 additional encounters (not listed), coyotes stalked children, chased individuals, or aggressively threatened adults. In 35 incidents (not all listed), where coyotes stalked or attacked small children, the possibility of serious or fatal injury seems likely if the child had not been rescued. Because no single agency maintains data on such attacks, and some agencies and organizations are reluctant to discuss such incidents, we do not have data

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Table 1. Coyote attacks in California, 1978 - 2003, listed chronologically.

<u>Date</u>	<u>Location</u>	<u>Attack Details</u>
May 1978	Pasadena	5-yr-old girl bitten on left leg while in driveway of home.
May 1979	Pasadena	2-yr-old girl attacked by coyote while eating cookies on front porch; grabbed by throat and cheek.
June 1979	Pasadena	Adult male bitten on heel while picking up newspaper from front yard.
July 1979	Pasadena	17-yr-old female's leg lacerated by coyotes while attempting to save dog being attacked.
July 1979	Pasadena	Coyote bit adult male on legs while jogging; climbed tree to escape.
Aug. 1979	La Verne	Coyote grabbed 5-yr-old girl and attempted to drag her into bushes. Suffered deep bites on neck, head, and legs before saved by father and a neighbor.
July 1980	Agoura Hills	13-month-old girl grabbed and dragged off by coyote. Suffered puncture wounds to midsection before being saved by mother.
Aug. 1981	Glendale	3-yr-old girl killed in front yard by coyote; massive bleeding and broken neck.
Aug. 1988	Oceanside	4-yr-old boy nipped and bruised by coyote while playing in yard. (Morning)
Aug. 1988	Oceanside	8-yr-old girl approached by coyote while roller-skating after she had fallen. Coyote tugged at her skate, and was scared off by two women who threw rocks. (Morning)
Aug. 1988	Oceanside	Coyote grabbed 3-yr-old girl by the leg and pulled her down, then bit her on head and neck. Coyote chased off by mother and neighbors. (7 PM)
Oct. 1988	San Diego	Adult female bitten by coyote in back yard while talking on phone. (Daytime)
June 1990	Reds Meadow	5-yr-old girl attacked and bitten in head while in sleeping bag at campground. (3 AM)
June 1990	Reds Meadow	One person bitten on foot through sleeping bag; one bitten on hand; same campground as above.
Sept. 1991	Laguna Niguel	Man chased, and his poodle was ripped from his arms; poodle taken by coyote.
Mar. 1992	San Marcos	Adult female attacked and bitten on face while rescuing pit bull pup from attack in her yard.
Apr. 1992	Fallbrook	Grove worker bitten by coyote.
May 1992	San Clemente	5-yr-old girl attacked and bitten several times on her back, climbed swing set to get away; mother chased off coyote. (Daytime)
Oct. 1992	Fallbrook	10-yr-old boy attacked and bitten on head while asleep on back porch of residence. (4 AM)
Oct. 1994	Griffith Park	Man with no shirt or shoes bitten by coyote. (5 PM)
Mar. 1995	Griffith Park	Man with no shirt bitten by coyote. (Noon)
Mar. 1995	Griffith Park	Coyote stalked and then knocked down 5-yr-old girl twice; mother rescued child. (Daytime)
June 1995	Griffith Park	Woman in shorts, barefoot, preparing food, bitten by coyote. (Daytime)
June 1995	Laguna Niguel	Man attacked while lying on chaise lounge, stargazing bitten on bare foot. (Night)
June 1995	Laguna Niguel	Man bitten on bare foot while getting newspaper from yard. (Mid-morning)
June 1995	UC Riverside	Three boys chased; 7-yr-old bitten. (Late afternoon)
July 1995	Griffith Park	Man bitten by coyote while sleeping on lawn. (2:45 PM)
July 1995	Griffith Park	Man bitten by coyote while sleeping on lawn. (4 PM)
July 1995	Griffith Park	Coyote was chased away once; then returned to attack 15-mo-old girl in jumpsuit; child suffered bites to leg. (4 PM)
Sept. 1995	Fullerton	3-yr-old girl attacked in yard, bitten on face, head, and thigh. (6:30 PM)
Nov. 1995	UC Riverside	Children chased while playing; 3-yr-old boy bitten.
June 1996	Los Altos	Coyote grabbed 3-yr-old boy by hand and dragged him toward bushes; treated for bites on scalp and hand. 15-yr-old brother scared coyote away. (8 PM)
Jan. 1997	San Juan Capistrano	Two women attacked; one bitten twice on left ankle and pulled to ground. Both yelled, used alarm device, and swung handbag.
Jan. 1997	San Juan Capistrano	Coyote attacked adult female, grabbed lunch pail and ran.
Jan. 1997	San Juan Capistrano	Coyote charged adult female, took purse containing lunch.

Table 1. (continued)

<u>Date</u>	<u>Location</u>	<u>Attack Details</u>
Jan. 1997	San Juan Capistrano	Coyote charged adult female and took purse.
Jan. 1997	San Juan Capistrano	Coyote attacked man, bit shoe, no injury. Coyote refused to retreat. (Before daylight)
Jan. 1997	San Juan Capistrano	Coyote jumped on back of man, biting his backpack. Was knocked off and retreated.
Feb. 1997	So. Lake Tahoe	Man attacked and bitten on hand while feeding coyote. (Late morning)
Feb. 1997	So. Lake Tahoe	4-yr-old girl in yard attacked and severely bitten; heavy snowsuit protected all but face. Father rescued child. Coyote stayed in unfenced yard until shot by police. (Late morning)
Sept. 1997	Pomona	Man was stalked, then attacked by two coyotes, and bitten on ankle. (Early evening, daylight)
Nov. 1998	San Mateo County	Coyote approached group of 4 women hikers and bit woman on buttocks.
Nov. 1998	San Mateo County	Coyote approached 3 women hikers, grabbed one by pant her leg, let go, attempted to attack again.
Spring 1999	So. Lake Tahoe area	Two adults bitten by coyotes.
Spring 1999	So. Lake Tahoe area	Woman bitten by coyote in parking lot of motel.
May 1999	Canyon Country	Coyote attacked dog in yard, and would not cease attack; man scratched in melee. (Night)
Aug. 1999	Green Valley Lake	Coyotes attacked woman and her dogs in yard; one dog bitten. Woman and dogs escaped to vehicle; coyotes jumped aggressively on car and scratched it. (8:30 AM)
Aug. 1999	San Antonio Heights	Three coyotes attacked and killed dog being walked on leash by elderly man.
Oct. 1999	Ventura County	Six coyotes attacked man on bicycle with his dog; dog bitten.
Nov. 1999	Hollywood Hills	Coyote attacked and killed pet dog in man's presence; coyote would not leave. (Morning)
Feb. 2000	Calimesa	Adult male attacked in back yard by coyote while attempting to rescue dog; suffered cuts, scrapes, and bruises. (9 PM)
May 2000	La Mesa	3-yr-old boy bitten on his side; treated for 4 puncture wounds. (7 PM)
49 May 2000	Dublin area	Coyote killed small dog while woman was taking it for walk.
Oct. 2000	Oildale	Pair of coyotes treed woman's pet cat, then turned aggressively on her.
April 2001	Pomona	54-year-old woman fought, using an axe handle, with a large coyote that had attacked small poodle in back yard. Received bite on leg, and despite her efforts, the coyote killed the poodle and jumped over fence carrying the carcass. (4:30 PM)
June 2001	Frazier Park	22-yr-old female camp counselor sleeping in open awakened by coyote sniffing and pawing at her head. (2 AM)
June 2001	Northridge	7-year-old girl attacked and seriously injured by a coyote, despite mother's attempts to fight off the coyote. (7 PM)
July 2001	Thousand Oaks	Five coyotes attacked large dog in yard, and aggressively threatened residents attempting to rescue dog; would not leave area despite two visits by sheriff.
July 2001	Irvine	3-yr-old boy bitten by coyote in leg while playing in yard; attack interrupted by father, who was 10-20 ft. away at time of bite. (8:15 PM)
July 2001	Tustin	Coyote bit woman.
July 2001	Encinitas	Coyote attacked and took dog, while it was being walked on leash by woman. (4 PM)
Aug. 2001	Hollywood Hills	Coyotes bit man 8 times as he was defending his dog against their attack. (11:50 PM)
Aug. 2001	Irvine	Woman walking poodle on leash bitten by coyote while attempting to remove dog from coyote's mouth. (4:30 PM)
Aug. 2001	Chatsworth	Two coyotes came into yard and took pet cat out of hands of 19-mo-old toddler.
Sept. 2001	Agoura	Woman attacked by coyote when she attempted to stop its attack on her small dog. (7:15 AM)
Sept. 2001	Lancaster	Man walking encountered 4 coyotes, which crouched, circling him, attempting to attack. Fought off with walking stick, hitting one square across the face. (Morning)
Oct. 2001	San Clemente	Coyote attacked children on schoolyard; 8-yr-old girl bitten on back of neck and scratched; 7-yr-old boy bitten on back and arm. Third student attacked but coyote bit backpack. (12:15 PM)
Nov. 2001	San Diego	8-yr-old girl bitten in leg by coyote that family had been feeding at their apartment. (1:30 PM)
Nov. 2001	La Habra Heights	Coyote on golf course ran up to woman, jumped on her back, and bit her on right forearm. (Daytime).
Dec. 2001	San Gabriel	Coyote bit 3-yr-old girl in head; grabbed her shoulder in an attempt to drag her off. Father chased coyote off. (7:30 PM)

Table 1. (continued)

<u>Date</u>	<u>Location</u>	<u>Attack Details</u>
May 2002	Anza Borrego St. Park	Coyote bit boy in sleeping bag on the head.
May 2002	Los Angeles	Coyote attacked man walking his dog.
July 2002	Woodland Hills	Adult female attacked by coyote, bitten on arm. (6 AM)
July 2002	Woodland Hills	Adult male bitten on boot by coyote when he inadvertently came upon it between car and garage.
July 2002	Canoga Park	Woman walking 2 large dogs accosted by 3 coyotes; fell backward and fended coyotes off.
July 2002	Carlsbad	Woman walking Labrador retriever accosted by 8-10 coyotes, which bit at her legs and pants after she tripped and fell; her dog fought off the coyotes until she could escape. (10 PM)
Aug. 2002	Mission Hills	Coyote approached couple walking dog, attempting to snatch dog out of man's arms; left only after being kicked. (4 AM)
Nov. 2002	Carbon Canyon	Coyote came into trailer park and took dog in presence of its owner. (3 PM)
Nov. 2002	Woodland Hills	Coyote scaled 6-ft. wall into yard, attacked and killed small dog in presence of owner; in melee, woman kicked coyote, then fell and fractured her elbow and was attacked and scratched by coyote. (1 PM)
Dec. 2002	East Highland	Utility worker attacked by coyote, which tore his trousers. (Evening)
Dec. 2002	East Highland	Coyote attacked adult male. (Evening)
Feb. 2003	Lake View Terrace	Jogger bitten (tooth scrape on ankle) by coyote after jogging past neighborhood coyote feeding station.
May 2003	Woodland Hills	Coyote acted aggressively toward man after he intervened during its attack on his dog.
May 2003	Highland	Coyote came into neighbor's garage after 2-yr-old girl, biting her on arm. (10 PM)
May 2003	Woodland Hills	Coyote came into residence to attack small pet dogs. (2 PM)
July 2003	Granada Hills	Boy walking family's 2 dogs attacked by 3 coyotes; one dog was killed and the other injured; rescued by father.
July 2003	Alta Loma	Coyote grabbed her small dog while woman was walking it; she was able to rescue it.
Aug. 2003	Apple Valley	4-yr-old boy attacked on golf course; bitten on face and neck; saved by father. (Late afternoon)
Nov. 2003	Claremont	Man and his dog attacked by 3-4 coyotes; he defended himself, hitting several coyotes with his walking stick. (8 AM)

on all attacks that have occurred.

We also questioned representatives of agencies and private firms about the results of their corrective and preventive actions taken in relation to coyote attacks. We summarize and discuss this information as a contribution toward improved strategies to deal with this wildlife-human conflict.

THE CHANGING SUBURBAN ENVIRONMENT

Urban sprawl throughout Southern California, now extending across valleys and flat lands adjacent to mountain slopes and arroyos thickly vegetated with chaparral and mountain scrub, provides miles of habitat edge between residential developments and wildlands. Driven by new landscape ordinances, increased affluence, and desire to create lush and attractive landscapes in new developments, humans have now created (within as few as 6 years) rich landscapes that are more attractive to rodents, rabbits, and other wildlife (Baker 1984). These new habitats, as well as landscaped freeway rights-of-way, may develop significant populations of rabbits (*Sylvilagus* spp.), pocket gophers (*Thomomys bottae*), ground squirrels (*Spermophilus beecheyi*), meadow voles (*Microtus* spp.), and commensal rodents (*Rattus* spp. and *Mus musculus*). Such areas serve as corridors for coyote movement within suburban areas, and they are sufficiently rich in resources to serve as permanent coyote habitat.

URBAN COYOTE ECOLOGY

Coyotes in wildland environments typically feed on numerous small mammals, birds, reptiles, arthropods, fruit, seeds, other plant materials, and carrion (Bond 1939, Sperry 1941, Young and Jackson 1951, Ferrel et al. 1953). Many investigators have concluded that coyotes are omnivorous feeders and opportunistic predators (Van Vuren and Thompson 1982), varying their diet with seasonal availability but perhaps relying on learned behaviors. While rodents and rabbits are typically main components of a coyote's diet, local food habits often reflect the composition of the local prey base (Fichter et al. 1955, Knowlton 1964).

Suburban coyotes consume many human-related foods as partial substitutes for natural food items. Recent studies of suburban coyotes (MacCracken 1982, Wirtz et al. 1982, Shargo 1988, McClure et al. 1995) confirm that these animals rely heavily on food items present in the suburban landscape (e.g., "garbage," chicken, rabbit, melons, avocado, zucchini).

Analyses of coyote scats collected near Claremont, California revealed that coyotes relied heavily on "pets" and rabbits in winter and spring (Wirtz et al. 1982); similarly, in Malibu, domestic cat was found in 13.6% of coyote scats (Shargo 1988). Historian and storyteller J. Frank Dobie quotes early naturalist Vernon Bailey as having said that coyotes take "special delight" in killing domestic cats (Dobie 1949:71). At one location in Southern California near the site of a coyote attack, coyotes were relying on a feral cat colony as a food source. Over time, the coyotes killed most of the cats and then continued to eat the cat food placed daily at the

colony site by citizens who were maintaining the cat colony (Baker and Timm 1998).

Complaints of coyote attacks and predation on pets received by USDA-Wildlife Services, mainly from suburban areas in California, have increased during the last decade. Such reports rose from 17 incidents in Federal Fiscal Year (FY) 1991 to 149 incidents in FY1997 and 281 incidents in FY2003. These attacks were reported from nearly all of some 39 counties having cooperative programs with USDA Wildlife Services. Recent newspaper reports of coyote attacks on pets have also come from Las Vegas, Nevada; Tulsa, Oklahoma; St. Louis, Missouri; Eastham, Massachusetts; and Greenwich, Connecticut. Officials in the Vancouver, B.C. Ministry of Environment, Lands and Parks documented a 315% increase in coyote complaints from 1985 to 1995 (City of Vancouver 1995). Coyote attacks on pets reported in Texas rose more than 4-fold during the last decade (66 attacks in FY1994 vs. 284 attacks in FY2003) (Gary L. Nunley, pers. commun., 2004).

Food abundance regulates coyote numbers by influencing population density as well as reproduction, survival, dispersal, and space-use patterns (Gier 1968, Todd and Keith 1983, Gese et al. 1996, Knowlton et al. 1999). Where resources are plentiful, coyote territories and home ranges are significantly smaller than where resources are scarce. Male coyotes in the wild generally have home ranges from 8.1 to 16.1 square miles (21 to 41.6 km²) and females 3.1 to 3.9 square miles (8 to 10 km²) (Gipson and Sealander 1972, Chesness and Bremicker 1974), although home ranges of dominant, territorial coyotes on a northern California sheep ranch have been measured at 1.2 to 2.9 square miles (3.0 to 7.4 km²) with an average of 1.9 square miles (5.0 km²) in what was regarded as a food-rich rangeland environment (Neale et al. 1996, Sacks 1996). Estimates of coyote densities throughout the West and Midwest are typically 0.2 to 1.5 coyotes per square mile (0.5 - 3.9/km²) but with occasionally 5 to 10 coyotes per square mile (13 - 26/km²) reported (USFWS 1978). Suburban coyotes in Southern California were found to occupy home ranges of only 0.25 to 0.56 square mile (0.64 - 1.44 km²) (Shargo 1988). This suggests that suburban environments are extraordinarily rich in resources for coyotes, leading to high densities. Following the lethal attack on a 3-year-old girl in Glendale in August 1981, authorities removed 55 coyotes from within one-half mile (0.8 km) of the attack site over a period of 80 days (Howell 1982).

CHANGES IN COYOTE BEHAVIOR

Young and Jackson (1951:69) relate a 1947 report from Yellowstone National Park in which park staff described two coyotes habituated to tourists. They noted that while in the past, park visitors "were lucky to even see a glimpse" of a coyote, now these two animals were extensively observed begging for food and posing for pictures, causing tourist traffic jams along the main park highway... an occurrence "until now unheard of in Yellowstone's colorful history." Parker (1995) describes two instances in which coyotes bit visitors to Cape Breton Highlands National Park in Nova Scotia, Canada. In both

cases, he noted that the coyotes responsible had grown accustomed to tourists feeding them, even though such feeding is strictly prohibited.

The typical activity pattern of coyotes in the absence of human harassment seems to be largely crepuscular and diurnal, but when predator control activities are undertaken, coyotes shift their activity mainly to nighttime to avoid humans (Kitchen et al. 2000). Conversely, a lack of human harassment coupled with a resource-rich environment that encourages coyotes to associate food with humans can result in coyotes losing their “normal” wariness of humans. Howell (1982:21) stated that this sort of environment, which had developed in hillside residential areas of Los Angeles County, produced “abnormal numbers of bold coyotes.” At that time, he noted it was not unusual for joggers, newspaper delivery persons, and other early risers to observe 1 to 6 coyotes daily in such residential areas. By the late 1990s, Baker noted that coyotes in this area commonly could be observed feeding in late mornings and afternoons, and residents saw coyotes in yards, on streets (Figure 1), and on parks and golf courses throughout the day (Baker and Timm 1998). More recently, coyotes have been observed during mid-day on school grounds. Such behavioral changes appear to be directly associated with increased attacks on humans.



Figure 1. An urban coyote strolls through West Hills, a suburb of Los Angeles, California, in July 2002.

Based on an analysis of coyote attacks previously described, there is a predictable sequence of observed changes in coyote behavior that indicates an increasing risk to human safety (Baker and Timm 1998). We now define these changes, in order of their usual pattern of occurrence, as follows:

- 1) An increase in observing coyotes on streets and in yards at night
- 2) An increase in coyotes approaching adults and/or taking pets at night
- 3) Early morning and late afternoon daylight observance of coyotes on streets and in parks and yards
- 4) Daylight observance of coyotes chasing or taking pets

- 5) Coyotes attacking and taking pets on leash or in close proximity to their owners; coyotes chasing joggers, bicyclists, and other adults
- 6) Coyotes seen in and around children’s play areas, school grounds, and parks in mid-day
- 7) Coyotes acting aggressively toward adults during mid-day.

Carbyn (1989) analyzed 10 attacks on humans documented in Canadian and U.S. national parks from 1960 through 1988, concluding that they were predatory in nature; that is, the coyotes, having lost their fear of humans, regarded small children as prey. This opinion has been shared by others who have investigated such attacks (see Baker and Timm 1998). Carbyn noted that of the 4 most serious attacks, all were on children and 3 occurred during the season when pups were whelped or were being fed. He speculated that the coyotes’ boldness was related to food stress. He also noted the occurrence of additional aggressive responses to humans, at various seasons, that did not fit this pattern (e.g., chasing cars and biting at tires, slashing tents, and nipping at campers in sleeping bags), concluding that there may not have been a common basis for these additional aberrant behaviors. The motive for attacks by coyotes is not always hunger (Connolly et al. 1976) or protection of dens. Movement, particularly escape behavior, is a key stimulus for eliciting orientation and attack (Lehner 1976); children’s play and running behavior, particularly when running away from a coyote, may provide a strong stimulus for attack.

AN INCREASING PROBLEM

As far as we know, the first reported coyote attacks on humans in California not involving rabies-induced aggression occurred in the late 1970s, and we document a total of 89 attacks in the state between that time and December 2003. Approximately 79% of these have occurred in the last 10 years, indicating that this problem is increasing (Table 1, Figure 2). Of the persons suffering injury, more than half (55%) have been adults.

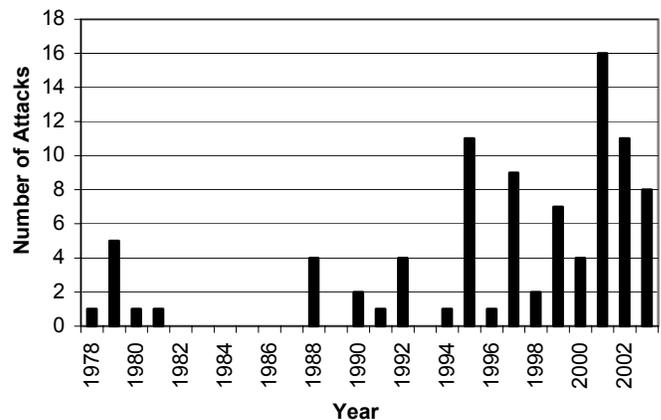


Figure 2. Coyote attacks on humans in California by year, 1978 - 2003.

Of the attacks on children and adults listed in Table 1, 63% occurred during the season when adult coyotes would most likely be provisioning pups or experiencing increased food demands because of the female's gestation (March through August), while 37% of attacks occurred during the other 6 months of the year (September through February). When only those attacks directed against children (≤ 10 years of age) are considered, 72% occurred during the reproductive season. This lends support to Carbyn's (1989) hypothesis that such attacks may be related to food demands. Alternatively, this seasonality in attacks could be related to other behaviors associated with territoriality, reproduction, and defense of den sites and/or pups.

While most of the coyote attacks on humans in California have occurred in Southern California (counties of Los Angeles, Orange, San Diego, San Bernardino, and Riverside), we list similar attacks that have occurred in Alameda, El Dorado, Kern, Madera, San Mateo, and Ventura Counties. In recent years, coyote attacks are also reported from Stateline, Nevada; Oro Valley, Scottsdale, and Lake Havasu City, Arizona; Durango, Colorado; Eminence, New York; Sandwich, Massachusetts; Vancouver, British Columbia; and Cape Breton, Nova Scotia. Loven (1995) described the way in which coyotes are adapting to the excellent habitat found in many suburban areas throughout Texas, and he noted the recent marked increase in suburban coyote complaints received by offices of the Texas Animal Damage Control Service.

In addition to the human safety issue, coyotes' presence in close association with humans can represent a potential health risk to people and their pets. Rabies, if it were to become established in suburban coyote populations, could easily put humans and domestic animals at risk. An episode of rabies in 16 dogs in Los Angeles in 1921 was suspected to have originated with coyotes or other wildlife. Another rabies outbreak in 1959 - 60 in the border areas of Mexicali Valley, Baja Calif., and Imperial Valley, California is described by Coccozza and Alba (1962). Many newborn calves were lost, and there were multiple coyote attacks on humans, cattle, and dogs. Between 1950 and 1995, 28 coyotes were confirmed positive for rabies in California (Ryan 1997). Coyotes also carry the dog tapeworm *Echinococcus granulosus*, which can cause hydatid cyst disease in humans. Further, coyotes can serve as reservoirs for the canine heartworm *Dirofilaria immitis*, which is spread to dogs by mosquito vectors (Sacks 1998), as well as serving as hosts for the mite *Sarcoptes scabiei* that causes sarcoptic mange in canids.

DISCUSSION AND MANAGEMENT IMPLICATIONS

Several factors may have led to the recent increases in predator attacks on humans in North America. Among them are human population growth, suburban sprawl, and protection of predator species that were once harassed and suppressed by hunters, trappers, and landowners. The number of incidents between humans and coyotes in Southern California seems to be related to the human population (or some function that correlates with human population); counties with larger populations have

experienced the greatest number of coyote attacks (Table 2).

Table 2. Coyote attacks on humans in Southern California by county versus human population and land area.

County (number of attacks)	Human population (million) ^a	Land area mi ² (km ²)
Los Angeles (36)	9.52	4,752 (12,308)
Orange (15)	2.85	948 (2,455)
San Diego (12)	2.81	4,526 (11,722)
San Bernardino (9)	1.71	20,150 (52,189)
Riverside (3)	1.55	7,303 (18,915)

^a 2000 U.S. Census

Southern California's residential developments in recent years have extended dramatically into landscapes that provide considerably more "edge" between brushy wildlands and the suburbs. This habitat change, which can enrich carrying capacity for coyotes, is partly responsible for growing predator populations in close proximity to humans. One estimate suggests that more than 5,000 coyotes live within the city limits of Los Angeles (Ryan 1997), an area of 469 square miles (1,216 km²), for an average of 10.7 coyotes per square mile (4.1/km²).

Reduced coyote control efforts by federal and/or county agencies, as well as by landowners, may have led to increased coyote attacks in two ways: local coyote numbers are no longer suppressed, and coyotes' fear of humans is no longer reinforced by lethal control efforts (i.e., shooting and trapping). Coyote control programs, viewed largely by citizens as agricultural or rural services, have declined as Southern California became increasingly urbanized and political and financial support for control programs waned. Concurrently, sport hunting and target shooting activities in this region have declined as well, severely restricted by municipal, county, and/or state ordinances. These factors have further contributed to coyotes' loss of wariness.

Changes in predator management have paralleled a marked change in our society's attitudes toward large predators. Once nearly exterminated from much of their native ranges within the U.S., many large predators (e.g., wolves, *Canis lupus*; mountain lions, *Felis concolor*; alligators, *Alligator mississippiensis*), now afforded nearly complete protection, have seen significant population growth and range expansion. The recent increase in attacks on humans is not unique to coyotes: half of the 20th Century's 14 known deaths from mountain lion attack in North America occurred in the 1990s. There were 110 attacks on humans by alligators in the U.S. between 1990 and 1995, compared to 78 alligator attacks in the 1980s and only 5 recorded alligator attacks between 1830 and 1969 (Lowy 2001). More strikingly, during the past 5 years, several towns and cities in coastal Queensland, Australia, have seen a sharp increase in large packs of dingoes (*Canis lupus dingo*) roaming their suburbs, attracted to these localities by abundant food sources. This has been accompanied by attacks on pets and humans, including a fatal attack in April 2001 on a 9-year-old boy near a tourist campground on Fraser Island

(Fleming et al. 2001, Roberts 2001, Rural Management Partners 2003).

Lethal Control

Lethal removal of problem coyotes by use of either leghold traps or shooting has proven to be effective in solving problems when coyotes lose their fear of humans and begin to behave aggressively (Baker and Timm 1998). Number 3 Victor Soft Catch[®] or other padded leghold traps, when used by experienced trappers, can be quite effective. Pan tension devices can prevent capture of smaller species. When modified with double swivels, shock springs, and a short (12 to 16-inch; 30 to 40-cm) chain, the risk of injury to captured animals is minimal. Twice-daily trap checks in suburban areas will decrease stress on captured animals as well as permit prompt release of any non-targets; captured coyotes typically are humanely euthanized at the site of capture. Frequent trap checking also reduces the opportunity for someone to approach a trapped coyote. Such traps can be used in California, under the provisions of the 1998 anti-trap initiative, only when a public health or safety emergency exists. The initiative thus limits the use of padded leghold traps in preventing attacks on humans.

Shooting coyotes has limited feasibility in urban and suburban areas, and it must always be coordinated with local law enforcement agencies. Only experienced personnel should be involved in control measures where shooting is used. Several varmint-type rifles and shotguns can be effective. Night-vision equipment, infrared illumination or laser sights, sound suppressors on rifles, and safer types of ammunition can make shooting operations more efficient and less disturbing in residential areas.

Of all available techniques used to date, trapping has had the greatest observed effect of re-instilling a fear of humans into the local coyote population (Baker and Timm 1998). Where 2 to 5 coyotes are trapped in a problem locality, the remaining coyotes will often disperse, although this is partially dependent on the size of the area, the number of coyote family units resident, and the existing level of wariness in the animals. At locations where leghold trapping has been used successfully, coyote problems typically have not reoccurred for at least 2 years and usually longer. Presumably the use of other capture devices, such as the Collarum[®] and foot snares, would have a similar effect. There have also been some observations that shooting to remove problem coyotes can correct bold behaviors in other problem coyotes present in the immediate area (Ronald A. Thompson, memo to Western Regional Director USDA APHIS Animal Damage Control: July 10, 1990).

Despite the demonstrated efficacy of lethal control measures in such situations, municipalities are often reluctant to authorize use of traps or shooting because of fear of adverse media coverage or litigation by animal welfare groups. Loven (1995) noted that in many cases in Texas, the tools needed to solve coyote problems in urban areas were not allowed by local authorities. Segments of the public that oppose lethal predator control have erroneously claimed that removal of coyotes

subsequently leads to higher coyote populations. Knowlton et al. (1999) state that following removals, populations return to pre-control levels, which are largely controlled by food resources.

Non-Lethal Control and Education

Public education efforts to inform citizens about wildlife and habitat are an integral part of programs designed to prevent coyote-human conflicts. Suburban residents need to have a basic understanding of the problem and of its root causes, and only then will there be sufficient public support for taking the actions necessary to prevent most suburban coyote attacks. An effective educational program, combined with use of lethal removal only as a last resort, was very effective in solving coyote-human conflicts in Glendale, California (Baker and Timm 1998).

Educational materials should discuss how residents can avoid attracting all wildlife (not just coyotes, but also their prey) into their yards and the importance of maintaining a fear of humans in wild animals. Neighborhood sanitation, in terms of keeping food sources and water unavailable to coyotes, is very important. Specifically, residents need to understand that coyotes will use pet food, improperly stored household refuse, various fruits and seeds accessible from gardens and fallen from backyard trees, and compost piles as food sources. Backyard bird feeders may attract rodents and rabbits, as will certain kinds of lush landscaping, which in turn attract coyotes. Tall or thick vegetation needs to be cleared, wherever possible, to prevent coyotes from using it for cover near residences. Small pets need to be kept indoors, or in well-fenced kennels when they are outdoors. Exclusion methods using fencing can be helpful in dissuading coyotes, as well as rabbits and other prey, from coming into yards, garden areas, or other attractive sites. Where coyotes have already begun to be a problem, educational materials should include information on how to react when approached or attacked by a coyote.

Bounds and Shaw (1994) reported, from a survey of 188 U.S. National Parks, that where "aggressive" coyotes were present, feeding of coyotes by visitors was significantly more commonplace than in parks that did not have aggressive coyotes. In general, intentional feeding of coyotes has often been practiced at locations where subsequent coyote attacks occurred. Therefore it is critical that cities and municipalities develop statutes that prohibit intentional feeding of mammalian wildlife and require adequate sanitation for bird feeders. Many towns have developed such ordinances, but they are difficult to enforce. Some also require that refuse containers have lids that fasten securely, have devices to prevent their being tipped over, and some prohibit placement of refuse containers at the curb before the morning of collection. Neighborhood and homeowner association informational meetings can be helpful in changing attitudes toward predators through peer pressure and shared vigilance. Well-meaning individuals must come to understand that intentional feeding of coyotes dooms them to subsequent lethal control ("a fed coyote is a dead coyote"). People should be informed that feeding also puts neighborhood

children and pets at risk of serious injury or death, as well as increasing risks to humans and pets from coyote-vector diseases. Where bold coyotes are accustomed to being fed or to finding ample food in a neighborhood, abrupt removal of those food sources may actually result in aggression toward people or an increased likelihood of attacks on pets or small children. In such instances, it may be prudent for the coyotes to be removed prior to making food unavailable.

Residents can reduce their vulnerability to coyote attack by carrying a walking stick or a canister of pepper spray as a defensive measure, particularly when walking pets. Daily routines and walking routes should be altered, as coyotes will learn and take advantage of people's routines. Exercising pets in mid-day may be safer than in early morning or late evening when coyotes are sometimes most active.

Hazing and Aversive Conditioning

Some educational materials recommend that people harass or attempt to scare coyotes away from residential area by such techniques as shouting, acting aggressively and waving your arms, throwing rocks, and so forth (USDA 2002). Other techniques such as shooting starter pistols, pellet guns, and blasting air horns have been used with varying degrees of success in the early stages of coyotes' adaptation to suburban settings. It is generally recognized that while some non-lethal approaches to controlling predator damage work well, they may be applicable only to certain situations and some may be of only temporary effectiveness (GAO 2001). Various methods of hazing coyotes may, when combined with modifications to the environment, reduce the chance that coyotes will lose their wariness of humans. However, once coyotes have begun acting boldly or aggressively around humans, it is unlikely that any attempts at hazing can be applied with sufficient consistency or intensity to reverse the coyotes' habituation. In these circumstances, removal of the offending animal(s) is probably the only effective strategy.

Carbyn (1989) has suggested that coyotes' loss of fear of humans in national parks and urban areas is linked to predators' association of humans with food at campgrounds, and therefore is analogous to habituation by bears (*Ursidae*) to human-provided food sources (Gilbert 1989, Herrero 2002). McCullough (1982) has noted that over time bears and other wild animals can habituate to stimuli (e.g., attempts at hazing) in the absence of a punishment. That is, the animal will, after repeated exposure to the stimulus, cease responses that are inappropriate or not adaptive (i.e., the animal will not expend time and energy in escape behavior). This concept would seem to apply to coyotes: "Bears can make complex evaluations of benefits and risks. For example instead of simply fleeing from an encounter [with a human], a bear may back off and wait and, by persistence, obtain the food reward. Thus persistence and a variety of strategies for obtaining food in the face of risks are learned because they are rewarded. Indeed, ingenuity is fostered. In the absence of punishment, the bear becomes habituated to the human, and its declining perception of risk leads to a greater frequency of

obtaining the reward, a self-reinforcing process" (McCullough 1982:29).

McCullough goes on to state that when habituated bears become a problem, negative conditioning is needed: "...successful negative conditioning must involve fear, perhaps pain..." However, "...it would be difficult to punish bears severely enough to overcome behavior positively reinforced for long periods of time... Bears in long contact with humans are likely to remain incorrigible and will likely have to be removed in most cases" (McCullough 1982:31). While Jonkel (1994) describes successful efforts in Montana to re-instill fear of humans into problem grizzly bears (*Ursus horribilis*), the cost of such treatments— involving capture, treatment, and release— can reach \$6,000 per animal and therefore would be prohibitive to apply to suburban coyotes.

Preventing Future Attacks

While it can be argued that, at present, risk of human injury as a result of coyote attack is very small in comparison to risk of dog bite, it is also true that humans have tremendous exposure to dogs. One estimate states there are 665,000 domestic dogs (*Canis familiaris*) within the City of Los Angeles (Wolf 2003), as compared to perhaps 5,000 coyotes (Ryan 1997). It is impossible to prevent all dog attacks because dogs live in close association with humans including children, but we believe it may be possible through management to reduce coyote attacks in suburban areas to nearly zero. We maintain that feasible management strategies can substantially reduce risk of suburban coyote attacks on both humans and pets, and they should be applied before the problems get out of hand. When it is possible to prevent the pain, suffering, and potential tragedy associated with such attacks, we believe this should be done.

As coyotes continue to adapt to suburban environments, and as their populations continue to expand and increase throughout North America, coyote attacks on humans can be expected to occur and to increase. To reverse this trend, authorities and citizens must act responsibly to correct coyote behavior problems before they escalate into public health and safety risks for children and adults. It is our experience that when appropriate preventive actions are taken before coyotes establish feeding patterns in suburban neighborhoods, further problems can be avoided. However, this requires aggressive use of scare devices and hazing, as well as correction of many environmental factors that have attracted coyotes into the neighborhood.

Once attacks on pets have become frequent, or if other neighborhood or public use area food sources have been used by coyotes for an extended period of time (i.e., for several months or more), lethal control techniques will likely be required to prevent continued attacks on pets or future attacks on children or adults. Following use of padded leghold traps (or other capture devices) and/or shooting, educational efforts must be emphasized in order to change the neighborhood habitat factors that have precipitated the problem, so as to prevent its reoccurrence. Such proactive coyote management to prevent human safety risks typically cannot be carried out until

residents understand the problem and its causes, as well as understand the predictable consequences of inaction. Sadly, such understanding is sometimes not achieved until after an attack has occurred.

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Figure 1 by Troy Boswell, Dept. of Animal Regulation, City of Los Angeles.

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