

The impact of domestic dogs (*Canis familiaris*) on wildlife welfare and conservation: a literature review.

With a situation summary from Israel.

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Introduction

The increasing human population rapidly inhabits most areas on earth, with severe implications to the natural environment. Wherever people go, they bring their domestic animals with them, the result is the introduction of a number of domestic species to new habitats all over the world. Dog (*Canis familiaris*) has accompanied man all over the world since its domestication 15,000 years ago (Savolainen et al., 2002) and today it is the most abundant canid on earth (Green and Gipson, 1994) with a great impact on the environment. The great abundance of free-ranging dogs is a rising concern to conservationists in many countries where dog predation takes toll on wildlife, hybridization with wild canids endangers rare species by disrupting their gene pool and dogs serve as reservoirs in the transmission of numerous disease, creating a health hazard effecting both wildlife and human populations.

Canis familiaris can be grouped into three distinct but often overlapping groups:

Domestic dogs- dogs that stay within the bounds of a home or the control of a human, this type of dog will have an impact on the natural environment only if it is taken to natural areas by the owner and is allowed to hunt.

Stray dogs- these dogs live near or in human habitation, utilizing human dwellings, but are under partial or no control. Stray dogs are sometimes fed by humans or may rely on rubbish dumps or on the killing of farm animals for their survival. They may also use other human facilities such as a water supply or shelter. These dogs may have significant impact on nearby natural environments because they tend to hunt for fun as packs, killing more than they need to eat and taking both large and small prey items. The human created food source or habitat modification may allow dogs to survive in areas that were previously canid free.

Feral dogs- Are the most widespread of the wild canids. They may occur wherever people were present and permitted dogs to roam free or where people abandon unwanted dogs. They are abundant all over the world in all continents, including North, Central and South America, Europe, Asia, Australia, New Zealand, Africa, and

on several ocean islands, such as the Galapagos. Feral dogs survive and reproduce independently of human intervention or assistance. Some feral dogs use human garbage for food, but others acquire their primary subsistence by hunting and scavenging like other wild canids (Green and Gipson, 1994).

The origin and domestication of dogs

Exactly when dogs arrived is still uncertain, archeological evidence is scarce but most dog fossils date back to 7,000 years ago (Kendall, 2002). Current studies suggest that Palaeolithic human were probably the first to tame dogs (*Canis familiaris*) by breeding aggression out of wolves (*Canis lupus*) in East Asia around 15,000 years ago (Savolainen et al., 2002). Savolainen et al. (2002) Compared maternally inherited mitochondrial DNA (mDNA), of 38 Eurasian wolves with that of 654 domestic dogs samples across Asia, Europe, Africa and the Arctic America to assess the number and location of dog domestications. Their findings suggest a common origin from a single gene pool for all dog populations. The genetic variation of dogs in China, Thailand, Cambodia, Tibet and Japan is much larger than in Europe, West Asia, Africa and Arctic America suggesting an East Asian origin for the domestic dog. Leonard et al. (2002) isolated mitochondrial DNA sequences from ancient dog remains from archaeological sites predating European settlement in Latin America and Alaska and showed that Native American dogs were more closely related to Eurasian dogs and wolves than were American wolves. They concluded that domestic dogs in America originated from multiple Old World lineages of dogs that accompanied late Pleistocene humans across the Bering Strait.

Hare et al. (2002) suggest that during the process of domestication, dogs have been selected for a set of social and cognitive abilities.

Dogs serve people in many important ways; guarding property and domestic livestock, assisting the blind and other disabled people, performing search and rescue missions, acting as sled animals, detecting explosives and drugs etc.

Clearly dogs are useful and important domestic animals and pets. However, without proper care and handling stray or feral dogs may become a nuisance and cause serious damage.

Dogs gone wild

Feral dogs descend from dogs that ran or were chased away, abandoned by their human owners as pups, or stray dogs that moved into a wild habitat switching from a diet based on human scraps to predation on wild animals. Like domestic dogs, feral dogs have a variety of shapes, sizes, colors, and even breeds and are difficult to distinguish in appearance from domestic dogs. However, after a few generations of uncontrolled breeding, a generalized mongrel tends to develop, often it has a German shepherd or husky-like appearance. McKnight (1964) (in: Green and Gipson, 1994) noted German shepherds, Doberman pinschers, and Collies as breeds that often become feral. In general, feral dogs mostly reflect the breeds that are locally common (Green and Gipson, 1994).

The primary feature that distinguishes feral from domestic dogs is the degree of reliance or dependence on humans, and in some respect, their behavior toward people. Scott and Causey (1973) (in: Green and Gipson, 1994) based their classification of these two types by observing the behavior of dogs while confined in cage traps. Domestic dogs usually wagged their tails or exhibited a calm disposition when a human approached, whereas most feral dogs showed highly aggressive behavior, growling, barking, and attempting to bite. Some dogs were intermediate in their behavior and couldn't be classified as either feral or domestic based solely on their reaction to humans. However, if this definition is based solely on the behavioral observation, then the definition may be circular i.e., the type of dog is defined by it's behavior and vice versa.

Dog numbers and distribution

Estimates of worldwide dog abundance are at around 500 million, with factors such as geography, climate, availability of food and shelter influencing local abundance (Wandeler et al., 1993 in: Veitch, 2000). Feral, stray and domestic dogs are now found in most parts of the world and outnumber all other canids. Veitch (2000) suggests that the presence and abundance of dogs depends on the attitude of humans in that area towards dogs in general. These attitudes are often influenced by public

perceptions of care for the natural environment, care for a harvestable resource, disease carried by dogs and the value of dogs as pets.

In many countries (e.g. Australia, New Zealand Great Britain and Germany) there are strict rules about the keeping of domestic dogs with concurrent rules allowing local authorities, farmers or hunters to impound or kill dogs which are not within a specific area or under human control (Veitch, 2002). Human dependent and free ranging dogs are rare in those countries although feral populations may exist. In Italy, where feral and free ranging populations are present, the killing of free ranging dogs is not permitted and they must be captured for retention in public kennels (Genovesi and Duprae, in press, in: Veitch, 2000). Feral and stray dogs are abundant and widely distributed throughout Hong Kong, but concentrated at the fringes of urban areas (Dahmar 2000). Many are released by owners that no longer want them as pets, and some may be escapees. Between the Agriculture Fisheries and Conservation Department and the Society for Prevention of Cruelty to Animals, more than 20,000 feral/stray dogs (on average) are captured and destroyed each year in Honk Kong. According to Dahmar (2000) in spite of this effort the population of feral/stray dogs destroyed each year in Hong Kong appears only to compensate for mortality that might otherwise occur due to diseases, starvation, or accidental death. This suggests that much larger numbers of feral and stray dogs actually exist in Hong Kong and a quick revival of dog populations.

In most of the USA there are dog control laws, but in some areas owners allow their dogs to roam (S. Sorby pers, comm, in: Veitch, 2000). Densities of free ranging dogs reported in urban areas in the US are high: 232 dogs/ km² in Baltimore, Maryland (Beck, 1973 in: Daniels and Bekoff, 1989) 154 dogs/ km² in Newark, New Jersey (Daniels, 1983 in: Daniels and Bekoff, 1989). In Ciudad Juarez, Mexico, a highly populated area, densities were 2-5 times greater (Daniels and Bekoff, 1989). This may reflect the differences in human population densities or the local crime rate, since dog owners in Ciudad Juarez believe that dogs provide adequate protection (Daniels and Bekoff, 1989).

In Zimbabwe, more than 70% of the national dog population exists in communal lands, which cover 42% of Zimbabwe's land area. It is estimated that in 1954 there were 250,000 dogs nationally (Foggin, 1988 in: Butler and du Toit, 2002), by 1994 the dog population in communal lands alone reached an estimated 1.36 million, with

an annual growth rate of 6.5% (Butler and Bingham, 2000 in: Butler and du Toit, 2002).

Social Behavior and Reproduction

Daniels and Bekoff (1989) suggest that urban and rural dogs are predominantly solitary, other studies (Beck, 1973; Daniels, 1983) indicate the same general pattern of avoidance of conspecifics. Urban and rural dogs exhibit territorial behavior restricted to the homesite (Daniels and Bekoff, 1989) probably because food is provided at this site by the owner and it is a relatively small, easily defended area. Feral dogs, on the other hand, are highly social (Daniels and Bekoff, 1989; Green and Gipson, 1994) living in constant packs year round in most cases, though some may be seasonal pack members. The advantages of pack living are enhanced vigilance resulting in greater protection against potential predators and increased ability to gain access to higher quality food resources (Daniels and Bekoff, 1989).

The nucleus of a new pack may consist of siblings that disperse together (Bekoff, 1977). Nesbitt (1975), commented on the rigid social organization of a pack of feral dogs where nonresident dogs were excluded, including females in estrus. In one instance, Nesbitt used three separate female dogs in estrus, chained in the back of a corral-type trap, as bait over a 59-day period and captured no feral dogs. He then baited the same trap with carrion, and a pack of feral dogs, including four adult males, entered the trap within a week.

Feral dogs may have rendezvous sites like wolves and travel routes to and from the gathering site may be well defined. Food scraps and other evidence of concentrated activity may be observed at gathering sites (Green and Gipson, 1994).

Female domestic dogs will mate only when in heat, or estrus, which occurs about every six months and lasts from 18 to 22 days. Giving birth occurs after a gestation period of about nine weeks. The size of the litter varies to some extent with the size of the dog: small dogs rarely bear more than two puppies, while the largest breeds average closer to ten (Dog reproduction, Colombia Encyclopedia, 2003). Feral dogs maintain two cycles of reproduction a year, unlike most nondomestic canids that have a single annual breeding cycle (Kleiman, 1968 in: Daniels and Bekoff). Gipson (1983) (in: Green and Gipson, 1994), found that only one female in a pack of feral dogs studied in Alaska gave birth during two years of study, even though other adult females were present in the pack. Daniels and Bekoff (1989) suggest that breeding by

a second female might induce it to leave and establish a new homesite temporarily. This may protect her from infanticide by the dominant female (Daniels and Bekoff, 1989). In wolves (*Canis lupus*), breeding is generally restricted to a single dominant female (Daniels and Bekoff, 1989). In the Alaska study all pups from both litters had similar color markings, suggesting that the pups had the same father, adult males of different colors were present in the pack. Gipson (1983) suggests that several members of a pack may share pup rearing, dens may be burrows dug in the ground or sheltered spots under abandoned buildings or farm machinery. Feral dogs commonly use former fox or coyote dens (Green and Gipson, 1994). In general, mortality early in life appears to be high (Daniels and Bekoff, 1989), but survival of pups born during autumn and winter has been documented, even in areas with harsh winter weather (Green and Gipson, 1994).

Range and Habitat of feral dogs

Home ranges of feral dogs vary considerably in size and are probably influenced by the availability of food. Dog packs that are primarily dependent on garbage may remain in the immediate vicinity of a dump, while packs that depend on livestock or wild game may forage over an area of 130 km² or more (Green and Gipson, 1994). In Fort Rucker Military Reservation in Dale and Coffee counties, Alabama, pack size of truly feral dogs ranged from two to six adult members (Causey and Cude, 1980). The minimum home range of packs was 0.01872km². Feral dogs are often found on lands where human access is limited, such as military reservations and large airports. The only areas that do not appear to be suitable for feral dogs are places where food and escape cover is not available or where large native carnivores, particularly wolves, are common and prey on dogs (Green and Gipson, 1994).

Dogs as predators

Domestic dogs have been introduced to the wild in many parts of the world. This return to the wild has been enhanced by the removal of wild canids and large felids and the establishment of new wild populations of prey species, poor disposal of human waste and provision of food in the form of other domestic animals (Veitch,

2002) or irresponsible disposal of dead cattle and poultry and the irresponsible disposal of unwanted dogs and pups.

Canis familiaris is not a natural predator but an introduction of a domestic species into the natural environment. The impact of feral, stray and human dependent dogs on natural environments has not been well documented and is often difficult to separate from impacts caused by other introduced pest species and human influences. In many cases the damage is a combination of a few factors, one of which is dogs.

Where human modifications such as other food sources, water or shelter are present to enhance survival of the dog population then native prey species may be reduced below sustainable levels (Veitch, 2002).

Dogs are continually introduced either intentionally or unintentionally into the natural environment and feral dog populations are sustained by a constant flow of new members that shift from the domestic and stray categories. Abandoned unwanted dogs, lost hunting dogs and unwanted pups dumped by their owners may end up as strays or feral dogs. Thus, the feral dog population is maintained and revived by dog populations from human dwellings. In Israel in 1991, during the Gulf War, a nasty phenomenon of dog abandoning by owners was widespread. People who felt that they no longer have room for a dog in the house or people who left the country on short notice abandoned dogs, often right outside the airport, and many of these unfortunate dogs became strays and feral.

When domestic dogs attack domestic animals, they may injure or kill several, but they seldom consume their victims. Rather, they leave the impression that they were involved in vicious play and not in the attempt to obtain food. For example in my neighborhood in Yehud, three domestic female dogs massacred 20 chickens and two turkeys, and left all but one uneaten. One of these female dogs once killed a couple of ducks at the National Park in Tel Aviv, often harasses and injures tortoises when stumbling upon them on nature walks and enjoys digging up mole rats (*Spalax leucodon ehrenbergi*) mounds in the yard (T. Mekhmandarov per. Comm.).

In contrast to domestic dogs, feral dogs that rely on their prey for food consume much of what they kill. Their survival, much like that of other wild canids, depends on their

ability to secure food. Feral dogs are opportunistic feeders (Green and Gipson, 1994). They can be efficient predators, preying on small and large animals, including domestic livestock or scavenging on carrion, particularly road-killed animals and disposed dead cattle, green vegetation, berries and other fruits, and refuse at garbage dumps (Green and Gipson, 1994). Most diagnostic characteristic of injuries caused by dogs are the slashing and biting of prey animals over much of their bodies (Green and Gipson, 1994).

Green and Gipson (1994) suggest that feral dogs are usually secretive and wary of people and thus, are active during dawn, dusk, and at night much like other wild canids. In Zimbabwe, free-ranging domestic dogs scavenged carcasses at any time with a peak at dawn (Butler and du Toit, 2002). Generally, dogs are both diurnal and nocturnal, which gives them a better opportunity to scavenge and hunt. As a result they have an advantage over native predators in access to prey.

There are very few comprehensive studies about the impact of domestic dog predation on wild animals. One extensive study that was carried in Zimbabwe about the interactions between free ranging domestic dogs and wild scavengers will be discussed here. Further evidence of dog damage is sporadic examples from around the world, which, put together, illustrate the extent and type of damage that is caused by domestic dogs.

In Zimbabwean communal land (rural area of traditional agropastoralism) numbers of free- ranging dogs have reached unprecedented levels (Butler and du Toit, 2002). 62% of Zimbabwe's reserve boundaries border communal lands (Butler and du Toit, 2002), hence the ecological interactions between dogs and wild animals may be significant. Butler and du Toit (2002) conducted a two-year study in order to examine the potential competitive interactions between dogs and wild scavengers on the boundary of Gokwe Communal Land and the Sengwa wildlife research area. Dogs in the study area were mostly owned but unrestricted, and bred freely whilst depending on people for their basic needs. These dogs primarily scavenge on human waste, with mammalian carrion forming the most important component of the diet, as most domestic animal fatalities were left *in situ* by their owners. In this study the vertebrate scavenging guild consisted of eight mammalian and nine avian species. Dogs were the most successful species in the vertebrate scavenger guild eating 60% of the total mass consumed. Consequently dogs probably have direct impact on wild scavengers by competing for wild carcass, especially on the periphery of the Sengwa Wildlife

Research Area. Butler and du Toit (2002) suggest that the repercussions are probably greatest for vultures (four different species in the study area: white backed (*Gyps africanus*), lappet faced (*Torgos tracheliotus*), white headed (*Trigonoceps occipitalis*) and hooded vultures (*Necrosyrtes monachus*)), which were the most successful of the wild scavengers. They propose four reasons to the superiority of dogs over vultures as scavengers: First, dogs are both diurnal and nocturnal, which gives them better opportunities to find and consume the carcasses relative to vultures, which are entirely diurnal. Second, dogs successfully repelled vultures from the carcasses probably because of their larger size. Third, Dogs consumed the carcasses, which were small, quickly and thoroughly, before the vultures detected them. And fourth, vultures were more sensitive to human disturbance than dogs, and since most human disturbance occurs during the day, this probably has significant effect on vultures. Butler and du Toit (2002) think that this situation is of great concern for the conservation of vultures, whose populations in southern Africa are already at risk owing to habitat destruction and indiscriminate poisoning. Given that the dog population's growth rate is 6.5% per annum in Zimbabwean communal lands, they assess that their ecological impacts on wild scavengers can only escalate.

In Spain, in Las Amoladeras Bird Reserve, 68-99% of lark (*Galerida theklae*) and *Calandrella rufescend*) nests were preyed upon by red foxes (*Vulpes vulpes*) and feral dogs (Yanes and Suarez, 1996). These canids were the only predators that effected larks nesting success and the impact of both species (fox and feral dogs) was similar. However there was no correlation between canid abundance and lark density. Yanes and Suarez (1996) suggested that canids selected areas where rabbit numbers are high because a positive relationship between numbers of canid tracks and rabbits was established. In terms of biomass it is unlikely that it would be worthwhile for a canid to search actively for lark nests. Nest predation by canids seems to fit the definition of incidental predation described by Vickery et al. (1992) as the fortuitous capture of an unexpected prey item when looking for the main prey, the consumption of which does not alter foraging behavior. This consumption reflects the opportunistic nature of both red foxes and dogs (Triggs et al., 1984, in: Yanes and Suarez, 1996). The indirect effect of incidental predation by canids appears to have serious consequences for lark population in the bird reserve (Yanes and Suarez, 1996). Since the foraging habits of feral dogs are opportunistic, and include the consumption of small animals, upon

which dogs stumble while foraging, the great abundance of dogs may be a serious threat to wild species in many places.

In Italy, in one day, five non-controlled dogs completely destroyed the largest flamingo colony in the country (Cagkiari, Sardinia) and the total destruction of water bird colonies caused by dogs is regularly reported in several lagoon complexes in Italy (Genovesi and Duprae in press, in: Vietch, 2002).

In the USA in Alabama during a 30-month study period, feral dogs were documented preying on small rodents such as cottontail rabbits (*Sylvilagus floridanus*) and gopher tortoises (*Gopherus polyphemus*) and feeding at landfills, garbage dumps and on all types of carrion (Causey and Cude, 1980). The dogs also regularly chased white-tailed deer (*Odocoileus virginianus*), but there was never any evidence of a kill. Causey and Cude (1980) suspect that feral dogs might be preying on white-tailed deer fawns. Rick Adams, district wildlife manager in Basalt, Colorado, says that dogs, in their domestication, have lost many of their instincts for making quick kills and instead chase and harass terrorized wildlife until the chased animal collapses in exhaustion (Wildlife Report, 1998). According to Adams, his department received reports of dogs chasing big game almost daily. During the spring fawns and elk (*Cervus elaphus*) calves are particularly vulnerable, and Adams reports a scene of a gruesome dog attack on a young fawn, which was literally torn to pieces by a domestic, unleashed dog (Wildlife Report, 1998). Glen Eyer, district wildlife manager for Archuleta County, Colorado, says that during the early winter months when the deer and elk move down from the higher elevations, they share land with local canines. One winter two dogs killed 12 elks in one day (Wildlife Report, 1998). Dogs chasing ungulates are also reported from En Gedi reserve in Israel, where dogs frequently chase Nubian ibex (*Capra ibex nubiana*) (Michael Blecher pers. comm. 2/2/03). Additionally, increased numbers of feral dogs in the coastal plains in Israel has led to the decline in numbers of mountain gazelles (*Gazella gazella*) in the area (Perry and Dmi'el, 1995).

On Kau Sai Chau the fifth largest island of Hong Kong (6.67km²), six cases of civet mortality were documented from May 1998 through May 2001, all of which were attributed to attacks by feral/stray dogs (Dahmer, 2000). Five of the civets were small Indian civets (*Viverricula indica*) and one was a masked palm civet (*Paguma larvata*), these are not abundant species on the island and all of the carcasses that were found were uneaten.

The introduction of dogs into new geographical areas, where no canids existed before, frequently has serious ecological consequences. Dogs played a significant role in the extinction of native wildlife when they were introduced onto islands that were previously free of vertebrate predators (Vietch, 2002). Feral dogs have been in the Galapagos since the first half of the 19th century (Kruuk and Snell, 1981). On the islands of Santa Cruz and Isabela in the Galapagos Feral dogs seriously threaten populations of endemic fauna such as giant tortoises (*Geochelone elephantopus*), and breeding colonies of flightless cormorants (*Nannopterum harrisi*) and blue-footed boobies (*Sula nebouxi*) (Barnett and Rudd, 1983 in: Vietch, 2002). Marine iguanas (*Amblyrhynchus cristatus*), also endemic to the Galapagos Islands, are routinely preyed upon by feral dogs. Kruuk and Snell (1981) estimate that dogs take approximately 27% of the marine iguana population per year, as well as iguanas eggs, which is more than the iguana population at this site can sustain over time.

In New Zealand, The absence of effective dog control is a major threat to adult kiwi where kiwi live close to human settlements or in areas where dogs accompany people hunting and tramping. Of a reported 194 kiwi deaths in Northland, there is documented evidence of 130 cases of feral dogs, wandering pets, farm dogs and hunting dogs killing kiwi (Forest and Birds, 2001). In one instance, in Waitangi Forest, a single free ranging dog killed an estimate of 500 kiwi (*Apteryx australis*) in a population of 900 birds in just a few month (Taborsky, 1988).

In Atherton Tableland in north Queensland, Australia, at least four Lumholz's tree-kangaroo (*Dendrolagus lumholzi*) died from attacks by domestic dogs or dingoes (Newell, 1999). This took place after a clearfelling of the tropical forest, which is the habitat of this rare arboreal marsupial. This is an example of a combination of effects, which takes toll on wild animals. Habitat distraction, which is the number one threat to wildlife all over the world (Coleman, 1997) combined with predation by the most abundant canid in the world, can be detrimental to many endangered species.

African black oystercatcher (*Haematopus moquini*) breed on the open coast of the southwestern Afrotropics (South Africa and Namibia) at the height of the summer tourist season. They are vulnerable to effects of human disturbance such as destruction of nests by people and vehicles and predation of eggs and chicks by domestic dogs (Leseberg et al., 2000).

Uncontrolled "exercising" of domestic dogs threatens coastal birds in some areas. In Santa Barbara, California, USA, dogs off leash were the main cause of disturbance to

wintering snowy plovers (*Charadrius alexandrinus*) (Lafferty, 2001a). 39% of the dogs on the Santa Barbara beach disturbed birds of different species and more than 70% of birds flew when disturbed (Lafferty, 2001b).

Feral dogs commonly kill house cats (*Felis catus*), and they may injure or kill domestic dogs (Green and Gipson, 1994).

The Dingo

The origin and specific status of domesticated animals is difficult to determine due to the crossing of different breeds and their transportation to different parts of the world, this problem is particularly acute with both dingoes and domestic dogs, which freely interbreed. The origins of the dingoes (*Canis lupus familiaris dingo*) are obscure. Dingoes belong to a group of primitive dogs inhabiting equatorial lands such as New Guinea, Borneo and the Philippines. The Indian plain wolf (*Canis lupus pallipes*) is considered to be the likely ancestor of this group (The Dingo, 2000). As there are no dingoes in Tasmania, it is assumed they arrived in Australia after the formation of Bass Strait, 10,000-11,000 years ago. The estimated time of arrival is between 3500 and 4000 years ago (Dingo Farm (a); The Dingo, 2000; Australian Conservation Foundation, 1984). The oldest reliable dingo fossil found has been carbon dated at 3450 years old at the approximate era at which rock engravings of dingoes also appear in Aboriginal art (Dingo Farm (a); The Dingo, 2000). Dingo populations are genetically distinct from the domestic breeds and hybrid dogs in Australia, the dingo can be reliably distinguished from other dog breeds by skull morphology (Corbet, 2001) and DNA testing can distinguish the purity of dingo populations (Wilton, 2001 in: Muir, 2001). The dingo is an indigenous animal under the Threatened Species Conservation Act 1995 because the dingo was “established in New South Wales before European settlement” (Muir, 2001). However, in order to understand the damage of introduced canids the early effects of dingoes on indigenous Australian wildlife as well as their effects in the present should be considered. The dingo was probably the first large placental carnivore to reach the Australian continent and its arrival may have contributed to the extinction of at least two marsupial carnivores, the Tasmanian devil (*Sarcophilus harrisii*) and the Thylacine (*Thylacinus cynocephalus*)

from mainland Australia (The Dingo 2000). The endangered species page of the Queensland museum internet site lists the following species, which are considered to be threatened by dingo predation among other factors: False Water Rat (*Xeromys myoides*), Greater Bilby (*Macrotis lagotis*) and Northern Bettong, (*Bettongia tropica*). Dingoes also prey upon the adults of the endangered Bridled nailtail wallaby (*Onychogalea fraenata*) (Fisher, 1998).

Hybridization

All species of the genus *Canis* are closely related (Wayne et al., 1997) and can interbreed and produce fertile offspring (Gray, 1954 in: Vila and Wayne, 1999). Interbreeding may present conservation problems if it threatens the genetic integrity of endangered wild canids (Vila and Wayne, 1999). There are numerous reports of domestic dogs hybridizing with rare or endemic species. For example, the Ethiopian wolf (*Canis simensis*), the world's most endangered canid (Gottelli et al., 1994), which is found only in the Ethiopian highlands with a total population less than 500 individuals is sympatric with domestic dogs and may hybridize with them. Gottelli and Sillero-Zubiri (1990) report sightings of domestic dogs mating with Ethiopian wolf and field observations of 8% out of 156 Ethiopian wolves with abnormal coat color. Microsatellite analyses of these abnormal individuals also show evidence of hybridization with dogs (Gottelli et al., 1994). Interspecific hybridization apparently occurs between male domestic dog and female Ethiopian wolves and may happen even if a receptive female has also mated with an Ethiopian wolf.

There is evidence that hybridization between domestic dogs and the accessorial species the wolf (*Canis lupus*), threatens the pure existence of some populations of the later. Wolf dog hybridization has been reported in the USSR, Italy, Portugal, Spain (reviewed in Blanco et al., 1992) and Israel (Mendelssohn and Yom-Tov, 1999). Butler (1994), suggests that the gray wolves are exposed to 'genome pollution' through contact with both feral and domestic dogs in most parts of Europe. According to Butler, researchers have recently discovered that supposedly purebred European wolf populations (*Canis lupus lupus*), a subspecies of the gray wolf (*Canis lupus*), are

in fact mainly hybrids between wolves and dogs. However, Blanco et al. (1992) suggest that hybridization takes place mainly when wolves are so scarce that individuals cannot find natural mates. Vila and Wayne (1999) suggest that the behavioral and physiological differences between domestic dogs and wolves may be sufficiently great that mating is unlikely and hybrid offspring rarely survive to reproduce in the wild. Green and Gipson (1994) suggest that non-synchronous estrus periods and pack behavior of excluding nonresident canids from membership in the pack may preclude interbreeding.

Interbreeding with domestic dogs also threatens the existence of *Canis ssp.* such as the New Guinea singing dog (*Canis hallstromi*) and the Australian dingo. The New Guinea singing dog from the Central Highlands of New Guinea is thought to have been isolated in the highlands from all other canids for about 4,000-5,000 years, which would make them one of the oldest pure strain of dogs (Koler-Matznick, 2000). The status of the wild population is unknown, but many domestic dogs have been imported into the Highlands over the last 20 years and it is feared that the wild Singers will soon become hybridized (Koler-Matznick, 2000). The Australian dingo is in danger of extinction in the wild due to hybridization with domestic dogs (Wilton, year not mentioned). Hybrids exist in all populations throughout Australia and the proportion of hybrids appears to be increasing (Corbet, 2001). In NorthEastern Victoria for example, it is estimated that only 10.8% of the canids are pure dingoes, 37.6% are feral dogs and the rest are hybrids (Dingo Farm (b)). There is also high proportion of hybrids in zoos and fauna parks (Oakman, 2001 in: Muir, 2001).

Wildlife Welfare and Public Health

Dogs, like all other animals domestic or wild are susceptible to a wide range of infectious and parasitic diseases some of which are shared with other species of wildlife and domestic livestock and some of which are shared with humans.

Although this report deals with the impact of domestic dogs on wildlife populations, their effects on human population cannot be ignored altogether and will be discussed in the second half of this section.

Domestic dogs and wildlife disease

The more contact there is between domestic animals and wild ones, the greater the risk of new infections reaching rare species. As populations of domestic dogs become larger, they form reservoirs for pathogens. Although wild animals can be susceptible to the same pathogens as domestic animals they usually live at such low densities that the disease cannot keep on going indefinitely and after an outbreak, the pathogen would disappear. Dogs may exist in very high densities so where infection was once sporadic, it becomes a persistent presence, circulating continuously, flaring up when conditions are right and re-infecting wild populations (Pain, 1997).

For example, in 1994, a sickness was sweeping through the lion's (*Panthera leo*) population in the Tanzania's Serengeti National Park, claiming lions of all ages. Before the year was out, the disease had killed a thousand lions, a third of the population, before spreading north across the border into Kenya. Blood and tissue tests revealed that the lions had died from a disease they weren't suppose to get - Canine distemper. This is a dog disease caused by a morbillivirus related to measles. Distemper is spread in fine droplets from an animal's breath and transmission requires close contact with the infected individual. Village dogs rarely get close enough to lion to pass on the virus, so there are likely to have been several intermediaries, spotted hyenas (*Crocuta crocuta*) are probably the final link in the chain, because they mix with lions at the kill (Pain, 1997; Segelken, 2002).

In 1985, the last remnant of the black footed ferret (*Mustela nigripes*) population in North America was reduced from an estimated 58 individuals in 1985 to 16 individuals in 1986 (Williams et al. 1988 in Schenck et al., year not mentioned). This catastrophic decline in numbers was attributed partly to infection by canine distemper virus that might have come from dogs and partly to losses during juvenile dispersal.

As human population increases, people are moving into more remote areas, coming closer to the refuges of endangered species. Where people go, domestic animals including dogs go as well. The Madre de Dios region of the southeastern Peru has the continent's largest population of giant otters (*Pteronura brasiliensis*), with around 200 animals. Between 60 to 70 of these are living in Manu National Park, where growing trade between forest villagers and town's people has led to an influx of dogs (Pain 1997). In 1994 Christof Schenk of the Frankfurt Zoological Society, who studies the

Manu etters found that most dogs in the forest villages carried antibodies to canine distemper and parvovirus. Both pathogens can kill otters (Schenuk et al., year not mentiond).

Canine distemper may have played a part in the extinction of the marsupial wolf (*Thylacinus*) in the early 20th century, and it pushed the black footed ferret (*Mustela nigripes*) of North America to the brink in the 1970's (Pain, 1997)

There are other killer-diseases that can be contracted from dogs. Parvovirus, is a highly contagious cause of enteritis that can take a heavy toll on puppies of wild canids (Pain, 1997). Mange is a common and rarely fatal disease but can become a killer in animals that have never been exposed to it before (Pain, 1997). During the latest episode in Fennoscandia, Denmark, mange had reduced the abundance of red fox by over 70% (Frochhammer and Asferg, 2000). Although, this episode was not necessarily related with domestic dogs, it goes to show the disastrous consequences such a disease that is carried by domestic dogs can have.

For wild canines there is also the constant threat of rabies. Rabies affects a wide range of domestic and wild animals. It is an acute viral encephalomyelitis, which is almost invariably fatal. The virus is present in the saliva of the host and may be excreted in the saliva before clinical signs appear and may lead to infection of an unsuspecting and untreated bite victim (Fekadu, 1993). The incubation period of rabies in dogs may vary from one week to several months and diagnosis by clinical signs alone is inadequate since many rabid dogs develop dumb rabies, which can easily be overlooked, and others die without showing signs of rabies (Fekadu, 1993).

In 1990 and 1991 rabies claimed more than half of the Ethiopian wolves in the Bale Mountain National Park (Pain, 1997). Rabies was also responsible for the death of African wild dogs (*Lycaon pictus*) in the Masai Mara reserve in Kenya in 1989 and in the Serengeti in 1990 (Pain, 1997).

Public health and general nuisance

Disease carried by dogs can also be transmitted to human, and may sometimes be fatal. A free roaming domestic dog may acquire a disease while wandering outside and later transmit it to its human owner. Even puppies can carry disease. Many people may not see dogs as a wild animal, and are not reluctant to go near stray or feral dogs- such field situations can be dangerous.

Dog rabies is still epizootic in most countries of the developing world and in these countries dogs are responsible for most human deaths from the disease (WHO, 1992; Fekadu, 1993). Dog rabies is also presents in first world countries.

In the US, between 1990 and 1996, 22 episodes of large-scale exposure of human to rabies in 15 states were reported to Procedure-Health departments (Rotz et al., 1998). (A large-scale exposure was defined as administration of postexposure prophylaxis (PEP) to 25 or more people after an exposure to a rabid or presumed rabid animal or littermates).10 of the 22 animals involved in these episodes were dogs.

According to the Centers for Disease Control and Prevention in the US in 1996, 111 of the 574 cases of rabies detected in domestic animals were detected in cats (Krebs et al., 1997).

In Machakos district in Kenya rabies persists endemically for over 40 years. Between 1992-1993 approximately 860 rabid dogs per 100,000 dogs were confirmed in the district (Kitala et al., 2000). The annual incidence of animal bites of humans was 234 per 100,000 people and 97% of animal bits of humans were due to dogs. The estimate of human rabies incidence per year was 25 per million people (Kitala et al., 2000).

In Sri Lanka rabies is endemic in all provinces and dogs are the main reservoir and vector of the disease (Matter, 2000). Over 96% of reported rabies cases in animals are among dogs and 95% of human rabies deaths are due to bites of rabid dogs.

Rabies is also endemic in Madagascar, with dogs as the reservoir (Rakotomalala et al., 1998). An increase of human rabies cases was reported in 1996-1997 with an estimate of at least 50 human cases in 1996.

Rabies is only one of the many diseases carried by dogs. Dogs are also reservoirs in the transmission of *Helicobacter heilmannii*, which causes gastritis in humans (Meining et al. 1998) Domestic dogs constitute the main reservoir of *Leishmania infantum* and *Leishmania chagasi*, and play a key role in the transmission to humans (Moreno and Alvar, 2002). Cohen and Gurtler (2001) found that domestic animals including dogs could cause human infection by American trypanosomiasis (Chagas disease). The disease is caused by the protozoan parasite *Trypanosoma cruzi* and is transmitted by blood-feeding triatomine bugs. It is a chronic, frequently fatal infection that is common in Latin America. Neither adequate drugs nor a vaccine is available. Cohen and Gurtler (2001) suggest that excluding domestic animals, especially

infected dogs, from bedrooms could greatly reduce the risk for human. Human and canine visceral leishmaniasis, a typical rural disease associated with precarious conditions of life (Bevilacqua et al., 2001) is a chronic parasitic infection that infects approximately 400,000 individuals annually, with a predilection towards early childhood (Grech et al., 2000). The spatial evolution of the epidemic showed that the canine cases had preceded the human cases confirming the importance of dogs as reservoir in urban areas (Bevilacqua et al., 2001). Young puppies are potential transmitters of human-pathogenic *Campylobacter spp.*, including *C. upsaliensis* (Hald and Madsen, 1997).

Disease that can be transmitted from dogs to human can also be transmitted to wild animals, but obviously incidents of disease in wildlife are reported at much lower rate than those in human. Nevertheless, the degree of dog-transmitted disease in wildlife is probably much higher than in human.

In areas where feral dogs feed at and live around garbage dumps near human dwellings where people have not hunted and trapped feral dogs, the dogs may not have developed fear of humans, and in those instances such dogs may attack people, especially children. Such situations occur most frequently around small remote towns (Green and Gipson, 1994). In the US dog bites cause an estimated 585,000 injuries resulting in the need for medical attention every year (Gershman et al., 1994). From 1979 through 1994, attacks by dogs resulted in 279 deaths of humans and during 1995-1996, at least 25 persons died as the result of dog attacks (these numbers are only of deaths caused by dogs attacks and not deaths associated with infection secondary to dog bites). 20 out of the 25 incidents (80%) occurred among children (MMWR Weekly, 1997).

In Israel, especially in big cities like Tel Aviv, although there are specific municipal by laws that require the removal of dog feces by owners, the occurrence of “dog pooh” on sidewalks, parks, and children sandboxes is still very common. In an article in Haartz Daily, Amir Ben-David (2003) expresses his fear as a parent of the fact that his two-year-old daughter plays in sandboxes where dogs or cats may have defecated. Parents in Ben-David’s neighborhood in Tel Aviv have signed petitions and put up posters urging dog owners to clean up after their dogs, but achieved nothing. According to Ben-David (2003), up to now the municipal city council did not do much to solve the situation despite the health risks to small children. Only about six-month ago the city council formed a “ green cruiser” whose duty is to force the

municipal by-law of Order and Sanitary. The first few month were dedicated to education programs and actual law enforcement began in 2003. During January 2003, supervisors gave out 25 reports, of 490 NIS each to dog owners that did not clean up after their dogs. Unfortunately, no extra precautions are taken in children's playgrounds (Ben-David, 2003). Hopefully the municipal city council will continue to enforce the law, and more importantly educate the public and encourage dog owners to be responsible for their dogs.

Dogs in Israel

Information about feral dogs in Israel is scarce and disorganized although they occur almost everywhere in Israel, apart from extreme desert areas where rainfall is less than 200mm (Y. Yom-Tov pers. comm.). Dog's impact and damage has never been studied properly and the estimates of numbers and distribution are rough and probably smaller than the factual numbers. Dr. Van Hahn (pres. Comm. 2/2/03), of the Veterinary Service in the Field (VSF) in the Ministry of Agriculture, says that approximately 135,000 dogs are vaccinated against rabies in Israel annually. The VSF estimates that this makes up for about 60% of the dogs in Israel, hence there are about 220,000 dogs in Israel today (Dr. Van Hahn pers. comm. 2/2/03).

Dr. Zvi Galin, the chief veterinarian of the Tel Aviv municipality, says the number of registered dogs in Tel Aviv is 15,000 and assesses that in addition there are about 2600 unregistered dogs in Tel Aviv. According to Dr. Andre Yaffe, the chief veterinarian of Ramat Hashron, there are 2400 registered dogs in Ramat Hasharon. The number of owned dogs in rural areas in agricultural settlements (kibbutzim and moshvim) and in and around military bases, is relatively higher, and many homes own more than one dog.

With an extremely high human population growth rate and an exhilarated development policy, Israel is one of the most densely populated countries in the world. In fact, north of Ashdod, along the coastal plain and up to the Lebanese border and west along the mountain shoulder there is a territorial continuity of human settlements with a maximum distance of 7km between settlements. This actually means that there is no point that is more than 3.5 km away from human settlement so

that even the most “remote” areas, where natural fauna and flora still exists are accessible to domestic and stray dogs, which flourish in human settlements.

The Supervision and Regulation of Dogs Act, 2002, provides that dog owner will not allow the dog to exist the yard unless it is held on a leash by a person who is capable of controlling it (section 11a). However, in most rural areas domestic pet dogs roam freely with no apparent control. In addition, the dumping of unwanted dogs in or near agricultural settlements or military bases is common practice. Consequently, the numbers of stray and feral dogs in those areas are high and maintained by a flow of new dogs from human settlements.

There is no data about the numbers of stray and feral dogs that exist in Israel, although National Reserve and National Park Authority (NRNPA) personnel report that feral dogs occur in most nature reserves throughout Israel. Two examples, one from the coastal plain of Israel and the other from En Gedi reserve demonstrate the damages of feral dogs to wildlife in Israel. The second example, also exhibits the attitude of many in the rural community regarding the controlling of their dogs.

During a three-year study (1987-1990) in the sand dunes of the coastal plain of Israel, Perry and Dmi’el (1995) observed that domestic dogs numbers increased in the study area. In several cases in the sand dunes of the coastal plains in Israel, dog tracks were found paralleling those of mountain gazelles (*Gazella gazella*), indicating a chase by feral dog packs (Perry and Dmi’el,1995). Perry and Dmi’el (1995) believe that the proliferation of dogs was a main factor in the virtual disappearance of Mountain gazelles and monitors lizards (*Varanus griseus*) from the area.

En Gedi Kibbutz borders the En Gedi Nature Reserve, a unique oasis in the dry Judea desert, home to the Nubian ibex (*Capra ibex nubiana*), rock hyraxes (*Procavia capensis syriaca*), leopard (*Panthera pardus*), Blanford’s fox (*Vulpes cana*) and a large number of unique plants. There are tens of free roaming owned dogs in the kibbutz, which are often seen inside the reserve (Avi David, Manager of En Gedi Nature Reserve, pers. comm. 1/2/03). According to Avi David dogs commonly chase rock hyraxes and Nubian ibexes. Michael Blecher, the En Gedi Reserve biologist says he can report least 3 incidents in which dogs preyed on young rock hyraxes, and says that dogs were seen chasing and attacking Nubian ibexes, but there is no proof of actual predation (Michael Blecher pers. comm. 2/2/03).

There is no apparent control of dogs in the kibbutz, and NRNPA rangers that come upon dogs inside the reserve trap them and return them to their owners (Avi David Pers. comm.).

There is very little information concerning truly feral dogs in Israel. It is very difficult to assess their numbers and the extent of their damage to wild animals. The policy of the NRNPA is that feral dogs in wild areas are considered a disturbance to the natural environment and to native wildlife. NRNPA regulations allow rangers to shoot those dogs. The usage of poisons is forbidden.

Table 1 shows the number of feral dogs that were shot in Israel between 1997 and 2001 by NRNPA rangers and authorized hunters (Nemtzu and Veksler, unpublished manuscript).

Table 1: the number of feral dogs that were shot in Israel between 1997 and 2001:

Year	1997	1998	1999	2000	2001
Number of dogs shot	2684	2148	1679	719	678

It is important to emphasize that the numbers given in table 1 are not the numbers of feral dogs in Israel, but only a small proportion of it. These data only includes the incidents of dog shooting that were reported by rangers and hunters. Not all cases are reported, and data are often lost.

The decrease in the number of dogs' shot from 1997 to 2001 is a result of the presence of less dogs in the wild due to a large scale epidemic of rabies among wild canid in Israel in 1997-1998. During 2000 and 2002, the shooting of feral dogs was outlawed for a few month each year because of public pressure from animal right movements. This explains the low numbers of dogs shot during these years. The number of dogs shot by NRNPA rangers is much smaller than the number dogs destroyed by local municipalities by municipal veterinarians each year. The data of the ministry of agriculture show that local municipalities destroy approximately 22,000 stray dogs annually (Dr. Van Hahn, pers. comm. 3/2/03).

Dog related diseases are common in Israel as in many other countries.

Table 2: The number of cases of pet-carried disease in humans in Israel between 1995-2000 (Health Ministry in Jerusalem data)

	1995	1996	1997	1998	1999	2000
Dog tapeworm	8	7	6	13	5	
Spotted fever	45	45	59	35	77	52
Leishmania	74	118	68	58	57	38

A total of 2243 rabies cases were diagnosed in Israel between 1948 and 1997. Rabies occurred in almost all parts of the country with an apparent clustering in the North (Yakobson et al., 1999). Dogs comprised 50% of the animals diagnosed as rabid over the 50-year period. However, most of the rabid dogs were identified before 1958 and were mainly urban. From the mid 1970s, sylvatic rabies supervened, and rabid foxes accounted for 49% of all diagnosed cases between 1988 and 1997, establishing that foxes are currently the main reservoir of rabies virus in Israel (Yakobson et al., 1999). Despite the implementation of rabies control measures, such as compulsory dog vaccination, elimination of stray dogs and cats and quarantine of suspected rabid animals, the prevalence of rabies in domestic animals has remained static over the past 30 years (Yakobson et al., 1999). 16 cases of rabies were detected in dogs in Israel during 2002. 3 cases of human rabies in 1996 and 1997 have highlighted the risk of virus transmission if contact occurs between peoples and unvaccinated domestic or wild animals (Yakobson et al., 1999).

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