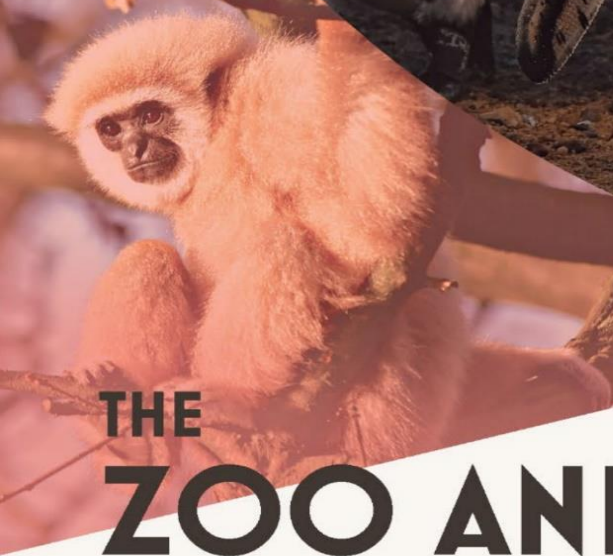


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FREE RANGING DOGS IMPACT ON WILDLIFE IN NORTH AND EAST OF TEHRAN, IRAN

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Full Paper

Abstract

In this study, the nature of wildlife-dog interactions is reviewed to highlight the lack of knowledge about the effects of free-roaming dogs on native wildlife. Observations highlighted significant evidence of predation, chasing, and attacks of wild Iranian ungulates - including Alborz wild sheep, wild goat, and Persian gazelle - by free-roaming dogs, which had a negative impact on native populations. Methods to reduce the damage caused by these dogs are rarely considered in Iran, but small changes in policy and human behaviour with respect to dogs could profoundly reduce the economic and environmental costs. Results highlight that further research examining the ecological impacts of wildlife- free-roaming dog interactions, as well as mitigation strategies stemming from policy and our society, are not just feasible but needed. Public awareness campaigns that highlight both issues caused by dogs and effective ways to avoid these problems are also a necessary step for successful conservation.

Introduction

Maintaining or restoring ecosystem health is a major conservation goal, but many immediate and long- term threats impede this goal, including habitat loss, infectious disease, and invasive species. Much attention has been paid free-roaming domestic cats (PATRONEK, 1998), but free-roaming dogs receive less notice, despite being a major problem and potential predator and competitor of native non-domestic cat species (FELDMANN, 1974). This case study documents the wildlife-dog interactions in Northern and Eastern Tehran.

In human-populated landscapes, dogs (*Canis familiaris*) are the most abundant terrestrial carnivores and can disrupt and modify ecosystems well beyond the areas occupied by people. The worldwide population of domestic dogs is estimated at ~700 million, with around 75% classified as “free-roaming” (SMITH et al., 2019). Free-roaming dogs are best described as opportunistic feeders. They often prey on small and large animals (GREEN and GIPSON et al., 1994).

Few studies have focused on population-level impacts to endemic species associated with wildlife-dog interactions. Most of these studies have found that dogs negatively affect native species. For example, domestic free-roaming dogs were shown to have a significant effect on Ethiopian wolves (*Canis simensis*) through disease transmission and hybridization (LAURENSEN et al., 1998). Others have focused on

human-related economics associated with free-roaming dogs, like human cases of rabies in Asia (KNOBEL et al., 2005). Iran is ranked third in the world regarding the number of deaths due to dog-related rabies between 2002 and 2020 with 37 deaths (Linnell et al., 2021).

Dogs may carry transmissible pathogens for diseases such as rabies, parvovirus, and canine distemper virus (CDV), which can cause significant decline of native wildlife population (WOODROFFE, 1999). They come in close contact with both humans and wildlife, resulting in the potential transmission of diseases that otherwise might not spread (SALB et al., 2008). Dogs can also act as vectors for parasite exchange among humans, livestock, and wildlife.

Although the direct killing of wildlife is most apparent, many dogs also disturb endemic species, which results in increased stress and energetically costly behaviour to wildlife. The presence of dogs also deters the use and habitation of those areas (LENTH et al., 2008) and can have deleterious effects on the breeding success of native species such as ungulates (GINGOLD et al., 1974). A study using genetic analysis to evaluate the diets of wolves (*Canis lupus*) in conflict with livestock producers suggested that free-roaming dogs consumed more livestock than wolves (ECHEGARAY and VILÀ, 2010).

Ten endangered and threatened ungulate species from Suidae, Cervidae and Bovidae families occur in Iran. The main species that we focused on during this study were the Alborz wild sheep, wild goats and Persian gazelle - these are the species mostly in conflict with free-roaming dogs.

Alborz wild sheep (*Ovis Gmelini* and *Ovis vignei*), recorded in the IUCN red list of threatened species, have relatively low populations in most of the protected areas of Tehran province. During the last 4 decades, the human population in the province doubled; while, the associated developed area expanded by 4 times. Wild sheep populations have become fragmented and their movements appear to be limited (AMADI, 2014).

Wild goats (*Capra aegagrus*) in Iran are widely distributed through mountainous areas and cliffs, deciduous forested areas of the North, and the central desert areas (HARRINGTON, 1977; ZIAIE, 2008). The species is listed as “vulnerable” (A2cde) by IUCN. The main threats to this species are poaching, competition from livestock and habitat destruction. Although wild goats are reported in 85 reserves throughout Iran (DARVISHSEFAT, 2006), illegal hunting remains a problem (ZIAIE, 2008). According to the Iranian Department of Environment (DOE) census in 2008, only 9 populations of wild goats with more than 1,000 individuals existed throughout Iran. Wild goats are distributed in relatively low to medium population density in most of the protected areas of Tehran province.

In the early 1990s, about 100,000 Persian gazelle (*Gazella subgutturosa*) occurred in Asia, but now the species is threatened in many parts of its natural range (MALLON & KINGSWOOD, 2001), which led to its IUCN classification as “vulnerable” in 2008. Hunting and habitat loss have caused a recent decline of more than 30% in many populations (IUCN, 2017). In Iran, intensified hunting and habitat destruction due to overgrazing, conversion of natural habitat into agricultural land, urbanization, road development, and mining account for the dramatic decline in deserts and plains (FADAKAR et al., 2019; MALLON and KINGSWOOD, 2001).

Methods

Between 2017 and 2020, we studied Alborz wild sheep (*Ovis Gmelini* and *Ovis vignei*), wild goats (*Capra aegagrus*) and Persian gazelle (*Gazella subgutturosa*) in the North and Northeast of Tehran (Jajrud, Varjin, Lar, Koohsefid, Khojir, Sorkhehesar, etc.) to examine the impacts of free-roaming dogs on these species. We also conducted gross necropsies on all sampled ungulates that died during the study to examine traumatic lesions and signs of diseases that could potentially be transmitted by dogs. Additionally, gross necropsies were performed on free-roaming dogs found dead within our study area to evaluate what species

they were consuming and examine pathologic lesions. Hair from prey species found in the stomach of free-roaming dogs were analysed microscopically to distinguish between wild and domestic animals and the ungulate species. An enzyme-linked immunosorbent assay (ELISA) for the detection of IgG and IgM antibodies against CDV was employed, using Biopronix ELISA kits. The pathologic investigations were analysed in relation to first-hand accounts from local people and the Iranian Department of Environment ranger's reports to summarize free-roaming dogs' influence on the studied ungulates, evidence of transmissible diseases associated with the dogs. The complete data was collected by the authors and rangers during the study period.

Results

During this study, 23 dogs killed by cars near the national parks and protected areas had Alborz wild sheep hair and bones in their stomach (Fig.1). In addition 18 dogs, killed by rangers in the area, had similar findings.

Hair identification was performed by microscopic comparison (Fig.2). The cell structure of domestic sheep hair is amorphous with a fragmented pattern, whereas the cell structure of wild sheep hair is filled lattice with a continuous pattern. Additional features of wild sheep hair are a multicellular medulla, straight margins and an invisible cortex.



Figure 1: Wild sheep hairs in the stomach of a free roaming dog killed by a car accident near Varjin.

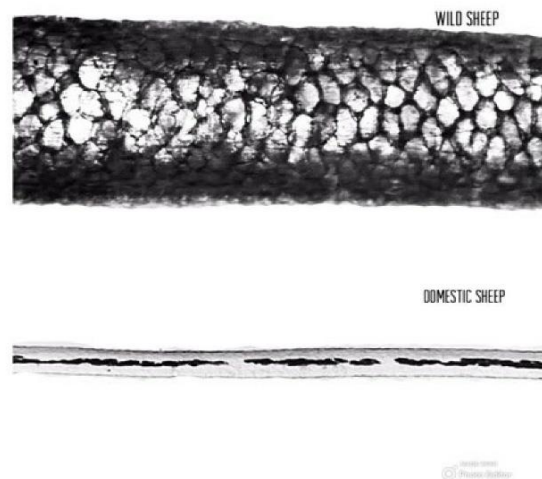


Figure 2: Comparison of microscopic findings of hair from wild and domestic sheep (Photo by: Bahareh Zahedian)

Thirty-seven wild sheep were referred to the rehabilitation centre after being chased and injured by free-roaming dogs. The dogs bit the wild sheep into different parts of their bodies and caused variable lesions. Most animals got bitten into skull (23/37) and cervical area (29/37), followed by forelimbs (15/37), hindlimbs (10/37), thoracic (4/37) and abdominal (2/37) areas. More subadult (24 cases) than adult animals (13 cases) were examined.

Dog attacks resulted in skin incisions in 31 out of 37 cases, insignificant damage to injuries of deeper tissues resulting from a combination of tearing and necrosis of muscles. In eight cases, the attacks caused wet

gangrene, and osteomyelitis in five cases. Animals found with chronic injuries also suffered from a very significant loss of body condition. In a subadult animal, a bite resulted in cervical vertebral fractures and subsequently death. In animals referred to the rehabilitation centre, other clinical findings included blindness, head tilt, head deviation and circling. In the necropsy, cysts were observed in their brains embedded in the frontal lobe of the left cerebral hemisphere and in the parietal lobe of the right cerebral hemisphere with different diameters (ranging from 2.5 to 5 cm). Coenurosis was confirmed in 18 cases with *Coenurus serialis* caused by *Taenia serialis* larva and three cases with *Coenurus cerebralis* caused by *Taenia multiceps* larva (Fig. 3). *Cysticercus tenuicollis* caused by *Taenia hydatigena* larva attached to the abdominal visceral tissues (Fig. 4) was found in 12 wild sheep and hydatid cysts caused by *Echinococcus granulosus* larva were embedded in lungs and liver tissues of 25 wild sheep (Fig. 5 and 6).



Figure 3: *Coenurus cerebralis*, caused by *Taenia multiceps* larva (Photo by: Alireza Shahrhiri Panah)

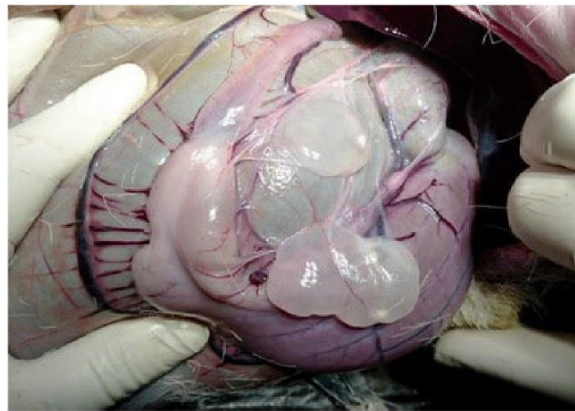


Figure 4: *Cysticercus tenuicollis*, caused by *Taenia hydatigena* larva (Photo by: Alireza Shahrhiri Panah)



Figure 5: Hydatid cysts caused by *Echinococcus granulosus* larva embedded in liver tissues (Photo by: Alireza Shahrhiri Panah)



Figure 6: *Echinococcus granulosus* protoscoleces inside hydatid cysts (Photo by: Alireza Shahrhiri Panah)

The impact of free-roaming dogs capturing wild sheep resulted in a 70% fatality rate. The rescued wild sheep could survive only in captivity because of the social behaviour changes and a high risk of disease transmission due to the rehabilitation time at the centre (Fig. 7 and 8).



Figure 7: Four-year-old male wild sheep attacked by free-roaming dogs in face (Photo by: Alireza Shahrhiri Panah)



Figure 8: Six-year-old male wild sheep attacked by free-roaming dogs in neck and the lower lip (Photo by: Alireza Shahrhiri Panah)

The necropsy of 41 dogs (killed on the road or by rangers) revealed 35 animals with gastrointestinal nematodes such as *Toxocara canis*, *Toxocara cati*, and *Toxascaris leonina*. Gastrointestinal cestodes such as *Echinococcus granulosus*, *Taenia serialis*, *Taenia multiceps*, and *Taenia hydatigena* were found in 31 dogs. 71 out of 88 dogs were positive for IgM, and 87 out of 88 positive for IgG antibodies against CDV.

Wild goats

Wild goat hair and bones were found in the stomach of seven dogs killed in road traffic accidents as well as two dogs killed by rangers. Wild goat hair is characterized by a multicellular medulla, a partially filled structure with lattice, a continuous pattern and scalloped margins. In comparison to wild goats with narrow cortex, the cortex width of the hair of domestic goats is thicker (Fig. 9). Four injured wild goats were referred to the rehabilitation centre after being chased and attacked by free-roaming dogs. Injured body parts were the cervical region and the hindlimbs (Fig. 10). These attacks resulted in a 40% fatality rate, with rescued individuals only surviving in captivity.

During this study, two wild goats were referred to the rehabilitation centre with clinical signs suspicious for Coenurosis which was confirmed by the finding of *Coenurus serialis*. Additionally, hydatid cysts were found in four wild goats.

Persian gazelles

During the study period, five Persian gazelles were referred to rehabilitation centres after being chased and attacked by free-roaming dogs. All individuals were caught by head and face, which resulted in frontal bone skull fracture (1 case), maxillary bone and nasal septum fracture (2 cases) and masseter muscle laceration (2 cases) (Fig. 11). In addition, 2 out of the 5 cases had hydatid cysts.

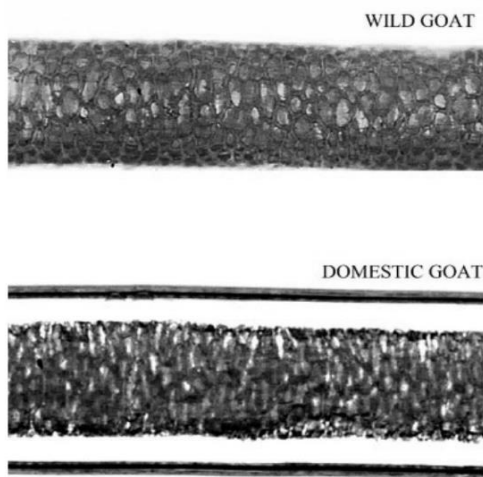


Figure 9: Microscopic structure of wild goat hair compared with domestic goat hair (Photo by: Bahareh Zahedian)



Figure 10: Less than a year-old male wild goat attacked by free-roaming dogs resulting in cervical vertebral fracture and death (Photo by: Alireza Shahrhiri Panah)



Figure 11: Three-year-old female Persian Gazelle bitten in face by free-roaming dogs (Photo by: Alireza Shahrhiri Panah)

Other Species

The necropsies of free-roaming dogs revealed wild boar (*Sus scrofa attila*) hair and bones in two of the dogs' stomach (Fig 12 and 13), Cape hare (*Lepus capensis*) hair and bones in two stomachs (Fig 14) and rodent's hair and bones in another. Wild boar hair has been identified to have a mean length of 49.08mm, being of black colour with blonde shafts and having double branched shafts (Fig.12). Cape hare hair is characterized by a multicellular medulla arranged in rows, an isolated structure and continuous pattern, straight margins and a narrow cortex width.



Figure 12: Macroscopic structure of wild boar hair (Photo by: Bahareh Zahedian)



Figure 14: Microscopic structure of hare hair (Photo by: Bahareh Zahedian)



Figure 13: Wild boar hairs in the stomach of a free-roaming dog killed by rangers in Varjin (Photo by: Iman Memarian)

Discussion

This study confirms the threat of Iranian wild ungulates by the increasing presence of free-roaming domestic dogs. Not only result wildlife-dog encounters in injuries that are often fatal, the presence of dog's faeces pose a risk because they may harbour infectious stages of endoparasites like *Toxocara* sp., *Echinococcus granulosus* or *Taenia* sp. Endoparasites were found in more than 70% of the examined free-roaming dogs. The evidence of *Coenurus serialis* has been reported previously in wild sheep (MEMARIAN et al., 2008) and wild goats (DEZFOULI et al., 2019). The findings of this study confirm that these were not single isolated cases.

Almost all free-roaming dogs have been tested positive for Canine Distemper Virus – a disease that may threatens the Iranian wild felid and canid population. There have been many reports that indicate a significant decrease in wild felid populations around the world caused by CDV (TERIO and CRAFT, 2013).

In the United States, legislation protects wildlife and prosecutes dogs' owners responsible for disturbing wildlife (TISCHLER, 2007). In Iran, incidents rarely result in prosecution and methods to reduce damage caused by dogs are rarely considered. Agencies in charge of these problems are often unable to act because they are understaffed, underfunded or afraid of extreme dog-lovers. There is an urgent need for

focused studies on the dogs' impact on endemic endangered species and an estimation of the population size of free-roaming dogs. In Iran, there is no sustainable dog management program in Iran and the number of free-roaming dogs seems to increase, resulting in an increased numbers of reports of dog bites in humans (In 2018: 15,539 cases; 2019: 16,578 cases; 2020: 19,903 cases) reported by Iranian ministry of public health (<https://dotic.ir/cat/129>). The number of people feeding free-roaming dogs is increasing, which can increase the dogs' reproduction rate. The application of scientific findings to management and public outreach programs will not only facilitate recovery and maintenance of wildlife populations globally, but also has the potential to reduce economic losses (YOUNG et al., 2011).

Implementing conservation actions to reduce wildlife-dog interactions will be challenging because of public perceptions. Public awareness campaigns that focus on the problems created by dogs and effective ways to avoid these can help citizens appreciate their role as wildlife stewards. With further research and awareness campaigns, Iran's agencies could respond more efficiently to wildlife-dog incidents and develop proper action plans.

Ideas to improve the situation exist. Shepherd dogs and livestock whom roam freely, are often not given veterinary care or reproduction control. Campaigns may be designed to teach pastoralists how to train herding dogs to not harass wildlife and protect their livestock appropriately. More benefits to livestock can be achieved by choosing better breeds, providing veterinary care, and feeding the herd, rather than allowing them to graze freely.

Developing policy that excludes free-roaming dogs from critical wildlife habitat, especially during sensitive periods for species, will allow researchers to measure the dogs' impacts. Non-invasive techniques, such as camera traps, can be used to estimate population size and monitor the population of dogs and potential prey (O'BRIEN et al., 2003). Cutting-edge genetic methods can facilitate the identification of individual predators that attack or kill prey (WILLIAMS et al., 2003), providing opportunities for selective removals and more efficient management of dogs. GPS radio collars can provide spatial information to enhance analyses of wildlife-dog interactions, similar to applications of GPS collars for wolf-ungulate interactions (ZIMMERMAN et al., 2007). Photos from camera traps and spatial details from GPS collars may also help to raise public awareness by providing visual examples of the roaming capabilities of pets. These techniques could provide much needed information about the effects of free-roaming dogs, while also providing basic biological information to test alternative hypotheses. Globally, policies aimed at reducing subsidization (e.g., changes to garbage storage) could drastically reduce the population size of free-roaming dogs at the urban-wilderness interface by removing eatable remains (YOUNG et al., 2011).

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