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Current status, distribution, and conservation of brown bear (Ursidae) and wild canids (gray wolf, golden jackal, and red fox; Canidae) in Turkey

Hüseyin AMBARLI[1,2,*], Alper ERTÜRK[3,4], Anıl SOYUMERT[3]

[1]Department of Zoology (Conservation Science Group), University of Cambridge, Cambridge, UK
[2]Department of Wildlife Ecology and Management, Faculty of Forestry, Düzce University, Düzce, Turkey
[3]Game and Wildlife Program, Araç Rafet Vergili Vocational School of Higher Education, Kastamonu University, Kastamonu, Turkey
[4]Department of Biology (Ecology Division), Faculty of Science, Hacettepe University, Beytepe, Ankara, Turkey

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Abstract: Turkey has viable populations of many carnivore species of the Western Palearctic. Among those, ursids and canids are represented by brown bear (*Ursus arctos*) and 3 canid species, gray wolf (*Canis lupus)*, golden jackal (*Canis aureus)*, and red fox (*Vulpes vulpes*), respectively. Those species occur in major ecosystems of Turkey and experience a wide range of threats, and they are at the center of human–wildlife conflicts. However, due to a limited number of studies about their ecology and taxonomy, their current distributions, population sizes, and statuses are vague. In this study, we document the 4 species' known data in terms of distribution range, population biology, phylogeography, threats and conflicts with people, and National Red List status in Turkey by reviewing the recent literature and national news about carnivores, data collection in field surveys, and interviews with local people, personnel of the Ministry of Forestry, and hunters in more than 50 provinces. Additionally, we also provide information about rabies cases in consideration with carnivore conservation. We finally recommend further studies to fill information gaps for wildlife conservation and management based on scientific evidence.

Key words: *Canis*, *Ursus*, *Vulpes*, IUCN, status, Red List, conservation, human–wildlife conflict, rabies

1. Introduction

Many extinct and extant wildlife species that originated from Asia and Africa inhabited Turkey's terrestrial and freshwater ecosystems because Turkey is situated at the crossroads of three different biogeographic regions (Şekercioğlu et al., 2011). Large carnivores probably used the Bosphorus as a migration route from Europe to Asia or vice versa before and during the last glacial maximum (LGM) in the Palearctic region (Bilgin, 2011; İbiş et al., 2014; Çilingir et al., 2015). Their distributions were mostly shaped by available refuges, preys, and caves that were also inhabited by human beings during the LGM (Stiner, 1999; Weiss and Ferrand, 2007; Bilgin, 2011). Since the LGM human activities have been altering habitats, killing and extirpating many species (Barnosky, 2008). Most large mesocarnivores are still threatened around the world due to their particular features such as large home ranges, special foraging behaviors, trophy values, and having conflicts with people (Ripple et al., 2014). In Turkey, there are 13 large mesocarnivores (Turan, 1984), but there is no IUCN Red List prepared with standardized methods to reveal threatened species and their level of endangerment.

A recent study in Europe showed that large carnivores have been recovering due to reintroductions, protection, and/or increased public awareness (Chapron et al., 2014). Turkey has also been experiencing the same phenomenon because the rural population declined from 70% to 25% in the last decade (TÜİK, 2013), many agricultural fields were abandoned and livestock numbers decreased (Ambarlı and Bilgin, 2014), and human impacts on natural areas decreased, although frequency of human–wildlife conflict generally increased (Ambarlı and Bilgin, 2008; Ambarlı, 2013). However, there is a limited number of studies on the effects of land abandonment and decline of rural human populations on the recovery level of the carnivore populations in Turkey (Ambarlı, 2015).

In Turkey, the family Canidae is represented by three species, which are the gray wolf (*Canis lupus* Linnaeus, 1758), golden or Asiatic jackal (*Canis aureus* Linnaeus, 1758), and red fox (*Vulpes vulpes* Linnaeus, 1758), whereas the only representative of Ursidae is the brown bear (*Ursus arctos* Linnaeus, 1758). All four species suffer from a lack of adequate scientific information and science-based approach for their management as they

* Correspondence: huseyinambarli@gmail.com

are intermittently allowed to be either hunted or killed by the public without reliable population estimates and information on problematic individuals. Although we know that all four of these carnivore species have currently viable populations in Turkey, there are no accurate census data or long-term monitoring programs. Under these circumstances, developing and implementing realistic and comprehensive management and conservation plans for these species is not possible for either governmental bodies or conservationists.

The statuses and distributions of the four species were vague until the last 15 years, and the information came from a limited number of studies about large mammals in general (e.g., Kumerloeve, 1975; Turan, 1984). Although there has been an increasing trend in large carnivore and mesocarnivore studies, which have mainly focused on brown bear, wolf, red fox, and large mammal inventories, there is still a huge gap in the basic ecological parameters about all carnivores, and species-based preliminary studies on golden jackals (http://tez2.yok.gov.tr).

All four species locally experienced severe declines in the past due to poisoning, poaching, fur trading, habitat degradation and isolation by construction of new roads in riverine to alpine habitats and construction of hydroelectrical power plants on almost all rivers in Turkey, and vehicle collisions (Can, 2004; Şekercioğlu et al., 2011). On the other hand, mainly due to enforcement of European Union regulations on protection of species and habitats, wolves and brown bears are protected species at the national level by Land Hunting Law 4915, except for culling of conflict-causing individuals, since 2003 (Resmi Gazete, 2003). However, the golden jackal and the red fox are game animals, and they are only protected by hunting commission decisions every year during the off-season, between 21 February and 15 August (MAK, 2015). The hunting quota per person is two foxes and one jackal in a day (MAK, 2015). There is a fee for illegally killed or poached species, changing according to commission decisions every year.

In Turkey, species-specific field studies on carnivores are still very limited; therefore, basic ecological studies are needed, such as monitoring of populations, diet, population genetics, and distribution modeling to provide baseline information for conservation of habitats and populations. For this reason, in this study, we aimed to reveal the distribution, current status under changing land-use patterns, and the aforementioned basic ecological parameters of three canids and one ursid species in Turkey by collating the information available in the literature obtained from field and laboratory studies to provide a baseline for further research and conservation of these species.

2. Materials and methods

To reveal the status quo of these carnivore species, we compiled the available information from the scientific literature in textbooks and thesis studies that are available in online searches by using their species and family names both in Turkish and English on the website of the Council of Higher Education's thesis archive (http://tez2.yok.gov.tr). Distribution ranges and population statuses of species were mostly determined by the use of data from field trips, interviews and surveys conducted throughout Turkey by the authors during their thesis studies, and gap analysis projects in the Lesser Caucasus, Anatolian Diagonal, Coastal Aegean, and Black Sea regions between 2004 and 2013. In addition, face-to-face interviews and inquiries were done with local people, local personnel of the Department of Wildlife and Department of Forestry, and members of hunting associations ($n > 250$) regarding key wildlife species in their regions. The spatial coverage of the data is 50 provinces of Turkey, with the exception of most provinces in Thrace and Southeastern Anatolia.

We accepted mean population sizes as 50 to 150 individuals for wolves and 50 to 400 for bears, jackals, and foxes in every province depending on the habitat suitability, based on detailed studies of the species by using noninvasive methods, e.g., camera traps and direct observations (Ambarlı, 2006; Ertürk, 2010; Soyumert, 2010; Ünal, 2011; Ambarlı, 2012). We used two numbers instead of a mean as it is known that canids can occur in very high or low densities in Asia (Jhala and Moehlman, 2004; Sillero-Zubiri et al., 2004). We tried to estimate the national population sizes roughly by using their current distribution coverages in terms of kilometers with known canid distributions and assigning a population size or density to each of them according to suitable current habitats (Ertürk, 2010; Soyumert, 2010; Ünal, 2011; Ambarlı, 2012).

For the species distributions, we also used another information source, the Mammals of Turkey Observation Website (http://www.tramem.org), where many academics and wildlife enthusiasts upload and review photos from field or urban areas. We also compiled information from national news archives about these species and provided the most recent distributions and threats that we came across. Finally, to determine national IUCN Red List status, we applied the IUCN criteria to the species (IUCN, 2001). We prepared distribution maps by using Google Earth (Mountain View, CA, USA) and ArcGIS ver. 10.1 (Esri, Redlands, CA, USA).

3. Results

Scientific studies about large carnivores in Turkey generally began after 2000 because of lack of interest or difficulties in studying elusive species. There were only

master theses (MSc) about red foxes (Birand, 1999) and river otters (Güven, 1999), and one diet study focused on a canid species (Brown and McDonald, 1995). However, large carnivore studies increased in the last 15 years: 6 PhD theses were done on large mammals and 2 of them focused on brown bears, and 21 MSc theses were done up to 2014 (4 of them on wolves, 4 of them on red foxes, 3 of them on brown bears, and the remaining 10 about large mammal inventories).

3.1. Brown bear

The brown bear is the largest carnivore in Turkey and its main distribution occurs in the Black Sea and Eastern Anatolia regions, covering 190,552 km^2. With the establishment of legal protection, conservation efforts, and fees for illegal hunting after the year 2003 (Resmi Gazete, 2003), brown bears apparently extended their distribution to formerly inhabited areas in the Mediterranean region (Turan, 1984), from the northern part of the district of Alanya and mountainous areas of the southern edge of Konya Province to Antalya and Muğla Provinces, close to the Aegean region (Figure 1). The brown bear has no distribution, except for some wandering individuals, in montane regions of Adana and Mersin Provinces, the eastern part of Central Anatolia (Kırıkkale, Nevşehir, Kırşehir, Yozgat, Niğde, and the Konya basin), and inner Aegean areas (İzmir, Manisa, Uşak, Denizli, Afyon). In the last decade, brown bears also extended their range of distribution in Northeastern and Eastern Anatolia with higher levels of human–bear conflicts compared to the previous decade (Ambarlı and Bilgin, 2008).

The diet of brown bears in Turkey is largely composed of plants (87.5%) rather than meat and livestock (Ambarlı, 2015). This dietary behavior and high population densities are probably the main reasons for the smallest litter sizes (1.67) in the brown bear range (Ambarlı, 2015). Mean weights are 140 kg for males (n = 6) and 101 kg for females (n = 3), and body lengths of male and female bears are 153 ± 21.95 cm and 144.33 ± 13.50 cm, respectively (Ambarlı, 2012). Due to this type of diet, lacking meat such as salmon or ungulates, their body sizes and masses are smaller than those of most other brown bears in the world (Zedrosser et al., 2011).

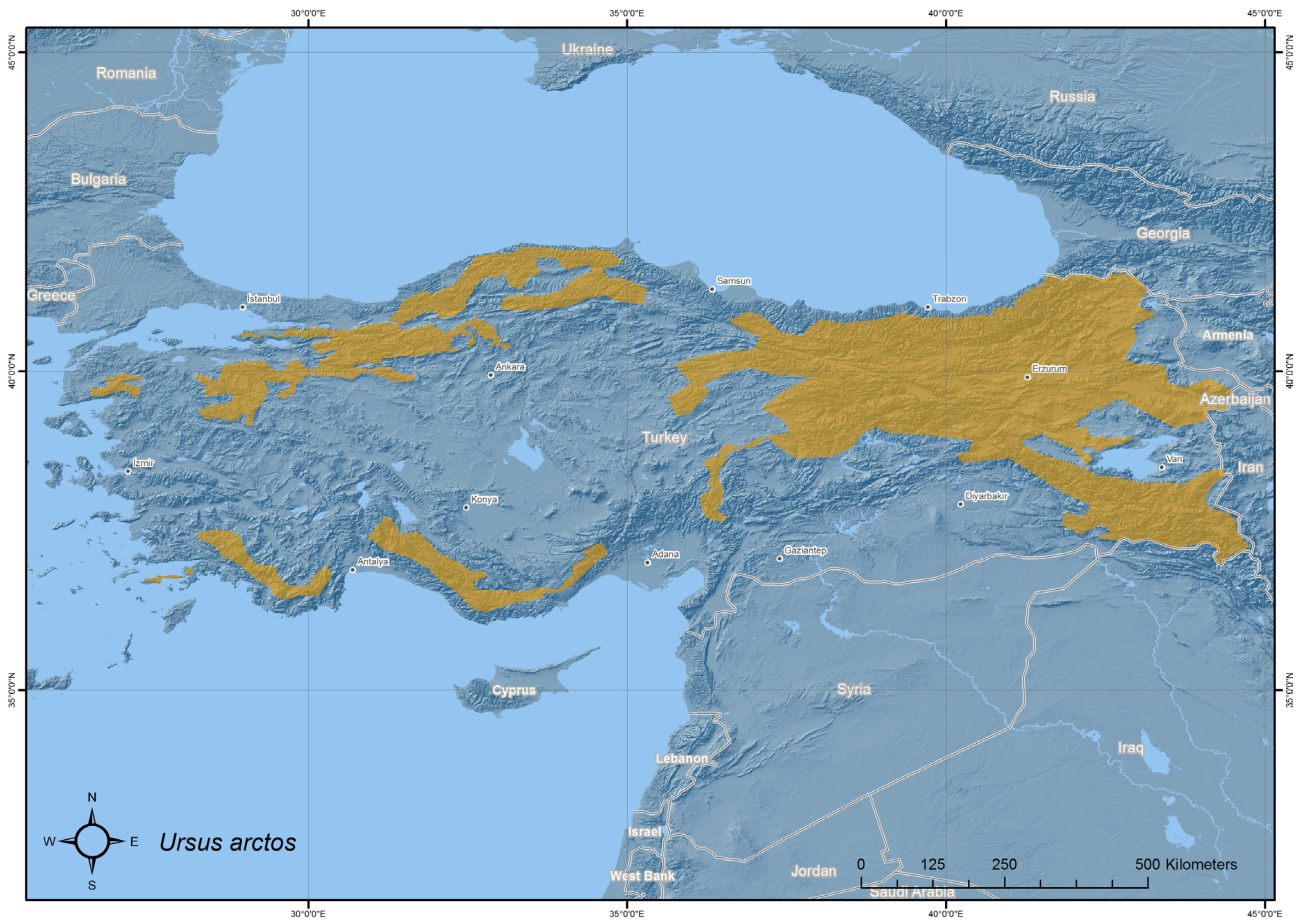

Figure 1. The distribution map of brown bear.

From the direct observations of brown bears and monitoring by noninvasive methods in Northeastern Turkey, bears are polygamous. The mating season of bears begins in mid-May; it lasts until July with a peak in early June (Ambarlı, 2015), where male brown bears mostly roam around a female and mark by rubbing trees in early spring (Ambarlı, 2010). Depending on the season and winter conditions, hibernation can be delayed or advanced, but it mostly begins in December and ends in late March or early April (Soyumert, 2010; Ambarlı, 2015). The activity patterns obtained from camera traps and GPS-GSM collars demonstrated that brown bears show predominantly crepuscular daily activity patterns (Soyumert, 2010; Ambarlı, 2014). They have the minimum home range sizes in brown bears' ranges, close to island populations: mean estimated home range sizes by 95% minimum convex polygon for females and males are 14.07 km^2 and 83.25 km^2, respectively (Ambarlı and Bilgin, 2012).

Habitats of brown bears were observed to be diverse, from lowlands near seashores to alpine pastures, mixed and evergreen coniferous forests, broad-leaved forests (covered by mostly *Quercus* and *Fagus* spp.), mixed shrublands, and open, very rugged rocky areas (Ambarlı, 2006, 2012). Although brown bears have high adaptation ability, they are vulnerable to any disturbance during hibernation and cub-rearing season in spring and early summer (Ambarlı, 2012). Subadult males and females with cubs are more prone to infanticide by male bears. There is also aggression among female bears with cubs to occupy habitats less preferred by other bears for preventing unfortunate encounters with male bears (Ambarlı, 2012). To prevent this, females with cubs change their activity pattern during mating season and become less active during the night by decreasing the movement rate and resting in very rugged areas (Ambarlı, 2014).

The first main threat to brown bears is human-caused mortality via poaching, either killing or trapping due to increasing resentment among local people for the damage to agricultural fields and humans by bears. In the last 5 years, at least 12 people were killed and 15 people were severely wounded by brown bears as a result of either human harassment and unexpected encounters or possible rabid bears' attacks (www.hurriyet.com.tr). The second major threat is the effect of construction activities on bears and their habitats. This occurs mostly due to new roads in montane regions, high pastures, and forests for various reasons, the primary of which is the building of big dams and small hydroelectrical power plants (Muluk et al., 2009), as well as for mining and tourism (Kurt and Balkız, 2011). The major threat to bear habitats is hydroelectrical power plant construction, which can cause substantial habitat fragmentation because the plants require many roads, channels, tunnels, and high-voltage electric poles passing from high altitudes and through primary wildlife habitats (Muluk et al., 2009). These are mostly the pristine habitats that bears prefer for cub-rearing and hibernation during winter (Ambarlı and Bilgin, 2012). Additionally, in 2014, a new 2600-km road construction project was initiated to connect the high pastures for alleged "eco-tourism development" in the Black Sea region, which will eventually cause massive habitat fragmentation and destruction for many wildlife refuge areas and harm vulnerable species permanently (Kurt and Balkız, 2011; WWF-Türkiye, 2015).

A recent study of mtDNA in brown bears in Turkey revealed substantial haplotype diversity, consisting of a Eurasian clade (previously known 3a haplotype), European clade (1b), Middle East clade (7a), apparently extinct clade (1c), and a new Middle East clade (7b) (Çilingir et al., 2015). This study also revealed that Syrian brown bears as a subspecies cannot represent all Southwest Asian bears because this region was inhabited many other clades and varying bear morphologies, so "Syrian brown bears" cannot be considered merely as one subspecies.

Along with these results, 7 isolated bear populations were defined in Turkey, although there may be a connection among some of these, such as the Küre Mountain population and the Northwestern Anatolia population. Between these, however, there is the fenced, 6-lane, divided E80 highway, and rural settlements and towns. It is unlikely that female bears frequently cross this fracture, but there are viaducts and underpasses near the province of Bolu where bears still may move. The Aegean population may also be connected to the Northwestern Anatolia population. There may also be 3 other small groups in the Hasan, Turkmen, and Murat Mountains, but recent documentation of females with cubs is lacking.

The total bear population size can range between 3400 and 4000 bears with respect to productivity of potential habitats. The Northeastern and Eastern Anatolia bear population is the largest bear population in terms of number (2000–2400 bears) and area (73% of the occupied area) in Turkey and it is connected to bears in the Lesser Caucasus in Georgia (Lortkipanidze, 2010). This population is unlikely to have decreased by 10% in the past 30 years. Therefore, the northeastern population is not vulnerable under criterion C and so is categorized as Least Concern (LC) (IUCN, 2001). The other six main populations in Turkey are much smaller. Based on their areas and assuming equal densities, the second largest population is the Western Black Sea population, which may have 750–800 bears. If it is connected with the Northwestern Anatolia population across Highway E80, including 300–400 bears, they may have more than 1000 bears together and then they would be categorized as Vulnerable (VU) D1. The Aegean popu-

lation is likely very small (about 100–150 individuals), but it may be connected to the Northwestern Anatolia population, so the threat category is probably Endangered (EN) D1. If all three populations are connected, covering Western and Northwestern Turkey, they can be categorized as Near Threatened (NT), but this is unlikely due to populations currently isolated by major roads and settlements in major cities in the distribution range. The other presumably isolated populations likely have less than 250 bears. The Toros and Western Toros Mountain populations are each classified as EN D, while the Datça population is Critically Endangered (CR) D1.

3.2. Gray wolf

The gray wolf is known to be one of the most adaptable carnivore species of the family Canidae and is distributed across the whole northern hemisphere, except in certain places where populations were totally extirpated (Mech and Boitani, 2007). In Turkey, the species occupies almost all types of habitats, covering about 490,666 km^2 (Figure 2), especially places where wild prey is abundant. On the other hand, the species is absent from southeastern low-altitude plains, coastal regions, the Central Aegean region, and the Central Thrace region of Turkey (Buzbaş, 2002).

The density of a gray wolf population in a given area is affected by three main factors: prey availability, source populations nearby, and human activities (Mech and Boitani, 2007). In Turkey, habitat fragmentation, poaching, and the reduction of prey availability due to illegal game hunting are restrictors of viable wolf populations in many regions (Can, 2001; Ertürk, 2010; Albayrak, 2011). In this respect, the number of wolves has probably been decreasing where habitat loss is intense and the excessive hunting of potential prey occurs, whereas numbers have probably been increasing in natural and abandoned areas with increasing wild boar numbers.

A recent diet analysis in Northeastern Turkey showed that wolves not only prey upon livestock but also have them as their main diet item (Capitani et al., 2015). However, the results of other field studies in Kastamonu, Ankara, and Artvin revealed that livestock depredation was not so intense and wolves mainly preyed on wild boars and available ungulates (unpublished data). When

Figure 2. The distribution map of gray wolf.

wolves get close to human settlements, they are blamed for depredation, and consequently human–wolf conflict is triggered (Tuğ, 2005; Ambarlı, 2013). Between 2004 and 2013, attacks on humans resulted in at least 8 deaths and 46 injured people (Ambarlı, 2013). Poisoning, poaching pups near den sites, and illegally organized drive hunts in urban areas have been reported as the major direct effects on wolf population decrease in Turkey in the past (Can, 2001). Although these illegal activities still continue in some regions, after a series of measures taken by the General Directorate of Nature Conservation and National Parks, they were noticeably reduced in the last decade.

Despite being one of the most widespread carnivore species in Turkey, the gray wolf has been investigated very scarcely in terms of scientific research. It is therefore quite difficult to estimate the nationwide population size of the species. The only rough estimate given was 5000–7000 individuals for all of Turkey (Can, 2004). However, based on direct observations in the field, relative abundances, and pack sizes (3 to 8 individuals) as detected by camera traps at different sites, the wolf populations have probably been recovering. For example, the western populations still have 1 or 2 individuals per 100 km^2, but eastern populations are believed to have 4 or 5 individuals per 100 km^2 according to recent findings (unpublished data). The estimated population size is about 6000–8000 individuals. There was no severe decline in the main population in the last decade so it can be categorized as LC according to IUCN criterion C (IUCN, 2001).

The phylogeography of populations of gray wolf is also not extensively investigated in Turkey. According to the studies on mtDNA, a different haplotype is known in Turkey, but it is not a unique one when compared to neighboring countries. The found clade is related to the populations in Poland, Estonia, Sweden, Finland, Western Russia, and Greece (Vila et al., 1999).

The wide distribution of the gray wolf brings along a necessity of generating different foraging strategies to adopt diversified prey types adapted to unique habitats in different regions. In this context, research findings show that gray wolves have a broad foraging ability on available prey. It is evident that wild boars and ungulates are the main prey for the species (Mech and Boitani, 2007). Wolves' diet also contains brown hares and ungulates belonging to the families Bovidae and Cervidae where their populations are available, similarly to Europe (Ciucci et al., 1996). It is also known that in some regions where the number of livestock is high, human–wolf conflict increases mostly in autumn (Ambarlı, 2013).

Gray wolves have a very strict hierarchy in packs, which are composed of closely relative individuals (Mech, 1991). This brings about solid territorial behavior against the other packs nearby. On the other hand, it is evident that the source populations, which demonstrate an extensive dispersal capability of wolves, are made by continuous gene flow between these adjacent packs (Mech, 1981). From this point of view, habitat continuity between adjacent packs becomes a crucial factor to ensure ongoing gene flow. However, fragmentation of forest habitats has been noted as one of the major threats that leads to the reduction of the wolf range in Turkey (Salvatori and Linnell, 2005).

Another important phenomenon that directly affects wolf populations is pack size. It is known that both prey availability and the level of habitat fragmentation directly affect the pack size (Mech, 1981; Schmidt and Mech, 1997; Aulagnier et al., 2008). Scarcity of available prey and high level of habitat fragmentation lead to small pack sizes and a high level of competition between individuals. Therefore, the territory size of a pack can vary in different conditions, which is calculated to be between 100 and 3000 km^2 (Mech and Boitani, 2007). In Turkey, eastern populations were observed in larger pack sizes and they use larger areas as their territories due to the lower habitat fragmentation and decreased human population. However, it is evident that the scarcity of wild prey caused packs to tend towards feeding at dump sites and on domestic herds (Capitani et al., 2015).

After many years of being considered a problem species in Turkey, in 2003 gray wolves were added to the protected species list made by the Central Hunting Commission, and all kinds of game hunting were forbidden except harmful individuals due to potential canine diseases such as rabies (Resmi Gazete, 2003). Living close to human settlements in Anatolia, wolves also contribute to the spread of rabies, but not as much as red foxes do. According to reports on rabies in Europe and the Mediterranean Basin, 36 wolf-caused incidences from 1980 to 2001 were recorded in Turkey (King et al., 2004). From 1991 to 2007, 10 incidences occurred (Aylan, 2008). Another widely seen disease in wolf is mange in US and European populations (Pence and Ueckermann, 2002). Although a recent study revealed wolf individuals with mange in the western Black Sea region of in Turkey (Soyumert, 2010), current scientific knowledge on this disease is limited in domestic animals. Therefore, the geographical distribution and the severity of the disease are still not known in Turkey. Interspecific interactions between carnivores have not been studied in Turkey, but the most probable areas for this kind of interaction and disease transmission are dump areas, where carnivore species may encounter each other. Intraguild predation may also occur between wolves and jackals. There are also rare cases in which a wolf pack attacked and killed the cubs of a female bear in Northeastern Turkey.

3.3. Golden (Asiatic) jackal

The golden jackal was the mesocarnivore species of least concern in Turkey and experienced severe declines in the

past due to campaigns against rabies, poisoning mainly in the Mediterranean region (Ambarlı and Bilgin, 2013), and the poaching of between 2000 and 5000 individuals for the fur industry (http://www.milliyet.com.tr/). Golden jackals mainly occur in most of the coastal regions and along river valleys that penetrate inland in Turkey at up to 1500 m above sea level, except for a small population in Hakkari inhabiting riverine habitats above 1600 m near the Iraq border (Figure 3). They are commonly present in two-thirds of the country, covering about 289,350 km^2, except for some parts of the Inner, Mediterranean, and Eastern Anatolian high plateau and mountains. They inhabit human-dominated landscapes, natural deciduous and mixed forests, woodland and shrubland at lowlands around deltas or plains, red pine forests and maquis, riverine habitats, and human-induced or degraded habitats like farmlands.

There has also been recent dispersal activity of jackal populations through riverbeds and roads to Inner, Central, and Eastern Anatolia (Ambarlı and Bilgin, 2013). Recent photographs and records from various provinces in Turkey verified the expanding distribution of golden jackals on the coasts and in inner parts of Turkey, such as in the provinces of Kocaeli, İstanbul, Kırklareli, Sakarya, Ankara, Adana, Mersin, Hatay, Gaziantep, Şanlıurfa, Hakkari, İzmir, Denizli, Muğla, Aydın, Burdur, Zonguldak, Karabük, Bolu, Artvin, Rize, Trabzon, Giresun, Ordu, Samsun, Kastamonu (http://www.tramem.org.tr), and Bartın (Soyumert, 2010). Even though a recent review about golden jackals stated unknown trends in Turkey (Arnold et al., 2012), the species has a wide distribution across the country and has an apparently increasing trend by benefiting from anthropogenic food sources, the reintroductions of pheasants and partridges (more than 100,000 in the last 5 years), and the sharp decrease in the fur trade.

They mostly produce 2 to 8 cubs from October to April depending on the latitude (Jhala and Moehlman, 2004; Lord et al., 2013). Cubs can be independent in 8 months and can breed in their first year, but the time of reproduction probably changes according to seasonality (Jhala and Moehlman, 2004; Lord et al., 2013). They live in pairs and defend their territories and care for their young (Jhala and Moehlman, 2004). Jackals are the prey of wolves

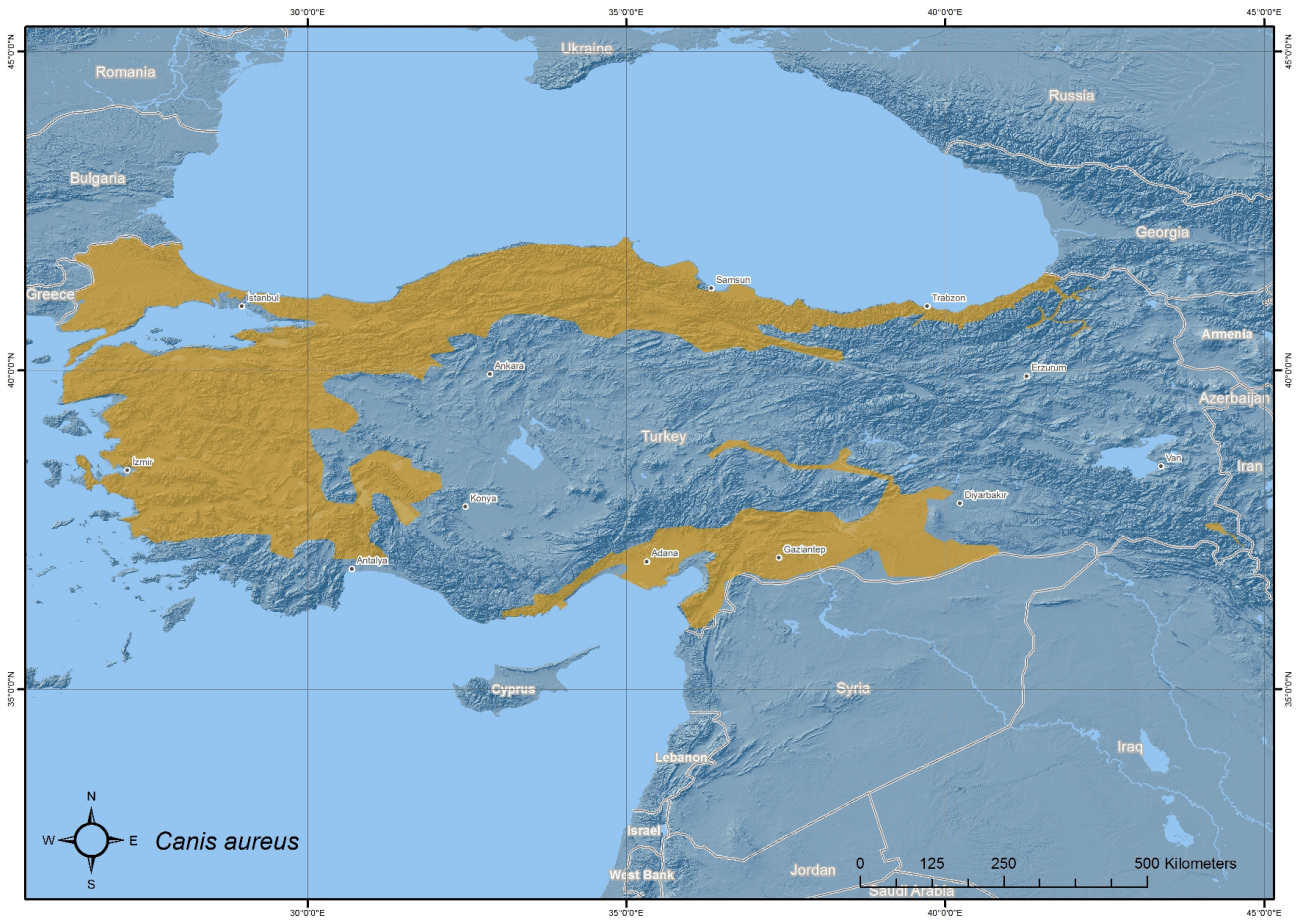

Figure 3. The distribution map of golden jackal.

and dogs and so they have antagonistic behaviors towards each other. Therefore, hybridization with other canids seems rare in nature, even though there is hybridization in the genus *Canis* (Bekoff and Gese, 2003). However, a melanistic individual was documented in 2011 for the first time in the world in Artvin, Northeastern Turkey, and this was suggested to be a result of independent mutations (Ambarlı and Bilgin, 2013). As shown in other countries, golden jackals probably come from a monophyletic mtDNA group (Zachos et al., 2009) and they have a monophyletic Y chromosome (Tez and Gürkan, 2014).

The diet mostly consists of fruits, anthropogenic foods, bird species (quail, partridge, etc.), reptiles, small mammals, and wild boar cubs in the Mediterranean region (Brown and McDonald, 1995). They also feed on carcasses, but plant materials occur in their diet more so than meat (Nadeem et al., 2012). Preliminary observations in Northeastern Turkey showed that they mostly rely on fruits during late summer and autumn, whereas they also feed at dump areas during the whole year. Detailed analysis of activity patterns showed that they may prey on brown hare, partridges, and wild goats with kids during late spring and early summer (Ambarlı and Bilgin, 2013). Their activity is mostly nocturnal with increasing twilight activities (Soyumert, 2010; Ambarlı and Bilgin, 2013). There is competition among jackals and wolves for denning sites at overlapping occurrences between 1400 and 1500 m (unpublished data).

Although human-caused mortality has a negative effect on the population status of jackals, they extended their distribution range in northern and central parts due to supplementary feedings, e.g., by the reintroduction of species from the family Phasianidae, whereas they have probably stayed at constant levels in the Mediterranean and Aegean parts of Turkey. There are also records of rabid golden jackals from the biggest city in Turkey, İstanbul (Johnson et al., 2006). The main threat in the Black Sea and Mediterranean regions is the destruction of habitats to build hydroelectrical power plants, the establishing of new roads, and the destruction of riverine habitats. In the other parts of Turkey, the main threats are overhunting in some areas and roadkill caused by collisions. The current Red List status of golden jackal according to the IUCN (2001) is LC based on criterion C because at least 12,000–16,000 individuals are present in Turkey and it has been showing an increasing trend.

3.4. Red fox

The red fox is the smallest canid species in Turkey and it has the most widespread distribution among other canids throughout Anatolia and Thrace (Figure 4). Records and studies showed that, being a habitat generalist species, the distribution of red fox covers a great variety of habitat types such as sea coasts, steppe, maquis, forest, and alpine habitats (Kütahya, 2004; Atatunç, 2007; Can, 2008; İlemin, 2010; Mengüllüoğlu, 2010; Hepcan, 2012; Soyumert and Gürkan, 2013; İbiş et al., 2014).

Beside the habitat generalist behavior, red fox is also known to have wide diversity in food consumption. Several studies confirmed the food variety of red fox including fruits, insects, small mammals, birds, and even the eggs and hatchlings of sea turtles (Birand, 1999; Ilgaz and Baran, 2001; Atatunç, 2007; Toyran et al., 2009; Akbaba, 2010). Foxes mostly scavenge on the leftovers of other species and usually follow brown bears in northeastern Turkey to find food (unpublished data).The generalist behavior of red fox leads to habitat use in a wide range of altitudes, in contrast to golden jackal and gray wolf (Soyumert, 2010). Initial genetic studies on red fox revealed a gene flow within the fox populations in Turkey (İbiş, 2009) and further studies indicated a high genetic diversity and no genetic isolation of the fox populations (İbiş et al., 2014).

Population density for red fox was calculated as 0.04 individuals per hectare in the southern part of Anatolia (Ünal, 2011). The home range of red fox in the Swiss Jura Mountains is between 0.48 and 3.06 km^2 and the distance that they move in a day was calculated as 3.9–12.0 km (Meia and Weber, 1995). Another study in France showed that the home range of red fox is 1.09 km^2 on average (Henry et al., 2005). The daily activity pattern of red fox was determined as mostly nocturnal according to a long-term camera-trapping study in the Western Black Sea region of Anatolia (Soyumert, 2010). That study revealed that 77.95% of 585 camera-trap records of red fox were obtained between 1800 and 0500 hours. Based on the same study, the annual activity pattern of red fox shows that the highest activity of red fox is in autumn and the peak of the activity is in October (Soyumert, 2010). The mating season in Southern Europe is between December and January, although it varies with latitude, and the average litter size is 5, but it differs from 1 to 13 (Nowak, 1999).

The red fox is a vector of rabies in Turkey in addition to the golden jackal. The main vector of rabies in Turkey is known to be domestic animals such as dogs, cats, and cattle, on the contrary of other European countries (Johnson et al., 2006). The lower number of rabid cases in wild species can be altered due to reducing the number of stray dogs, since the virus can adapt to a new niche (Johnson et al., 2006). Studies show a transmission of virus between dogs and red foxes (Johnson et al., 2003) and an increase in the number of rabies cases for wild red fox in Turkey since 2000 (Johnson et al., 2010).

Cases of red foxes with rabies were reported from many provinces in Western Anatolia (Johnson et al., 2003, 2006, 2010). The disease was first detected in the province of İzmir in 1999 and the records show a continuous spread of

Figure 4. The distribution map of red fox.

rabies among red fox populations towards eastern parts of Anatolia (Johnson et al., 2010). Despite recent vaccination studies for red fox (Vos et al., 2009), strict control strategies should be considered to prevent the spread of rabies among wild species in Anatolia. Red foxes with *Helicobacter* spp. (Erginsoy et al., 2004) and infected by zoonotic agents such as helminth and arthropod species (Gıcık et al., 2009) were reported from the province of Kars. Red foxes with mange were also documented based on camera-trapping records in the Western Black Sea region of Anatolia (Soyumert, 2010). The roughly estimated population size is about 16,000 to 20,000 individuals at least. Therefore, the status of red fox was defined as LC according to IUCN criterion C and the red fox population has been showing an increasing trend (IUCN, 2001).

4. Discussion

The primary concerns of this study were describing the four species' occurrences, estimated population sizes, national IUCN Red List statuses, and basic ecological parameters, which were missing in Turkey. Due to likely increasing trends in all populations of canids and the brown bears, except for some local populations in the Mediterranean and Western Anatolia regions, all four carnivore species' national statuses are defined as LC according to the IUCN criteria. However, increasing recent pressure on wildlife habitats due to the building of new roads mostly in the Black Sea, Mediterranean, and Eastern regions of Anatolia and habitat fragmentations, large dam constructions, and increasing mortality rates of "conflict-causing" species (e.g., bears or wolves) may change the species' statuses in the future. Recently killed bears and wolves by poaching, trapping, and vehicle collisions around the country showed that human-caused mortality is still the most significant factor, similar to other parts of the world (Servheen et al., 1999; Sillero-Zubiri et al., 2004). Integrating wildlife damages in agricultural areas into the TARSİM insurance schemes, similar to the recent insurance applications for bear-damaged beehives and wolf-damaged livestock, can decrease most of these illegal kills. Preventive measures such as electric fences around beehives were also widely accepted by beekeepers in the last 5 years, as suggested before (Ambarlı and Bilgin, 2008) and demonstrated by researchers (Kurt and Balkız, 2011). Due to increasing

trends in fatal attacks on humans by bears, local people in the hot spots of human–bear conflicts should be allowed to carry and use bear-deterrent sprays including capsicum, which is the most widespread solution for preventing bear-caused fatal attacks and wounds (Ambarlı and Bilgin, 2008).

All four carnivore species are prone to kinds of conflict with human beings as a result of different overlapping interests or antipredator campaigns, but many studies demonstrated that killing "problem" individuals is not a solution for remedying conflicts (Treves and Karanth, 2003). Another reason for increasing carnivore conflicts in Turkey is that natural ungulate populations are very scarce (e.g., extirpated red deer (*Cervus elaphus*) populations in Eastern and Northeastern Anatolia, endangered fallow deer (*Dama dama*) and Anatolian mouflon (*Ovis orientalis*)), dispersed, or very local, so carnivores cannot find enough prey species in the wild. Therefore, bears in Turkey have probably been changing or adapting their dietary behavior to feed on mostly plants (Ambarlı, 2015) due to extremely decreased or extinct ungulate populations. Open dump sites in the main distribution ranges of wild carnivores, where feral dogs and other carnivore species congregate, should be converted to exclosures by using electric fences or barriers because these areas are the most important cause of the spread of rabies and increasing human–wildlife conflicts in the region.

In the last decade, the Department of Wildlife initiated a project on the reintroduction of wild ungulates to former habitats that should be continued along with wild fruit tree plantations in forest patches to provide enough prey base for carnivore species. These precautions will probably decrease conflicts by providing natural prey in the near future and will help to protect both peoples' and wild carnivores' lives. Further ecological studies and social outreach programs beginning from primary school to university are also required to raise awareness about the importance of wild carnivores and ungulates in terrestrial ecosystems. In addition, the vaccination program of wild canids against rabies (Johnson et al., 2010) should be expanded, and Eastern Anatolia should be covered in the near future. Studying wild carnivores also requires good collaboration with veterinary scientists, but unfortunately the number of wildlife veterinarians interested in carnivore field studies was very limited in the past decade.

Recent genetic studies of wild carnivores in Turkey documented highly diverse haplotypes for bears, jackals, and foxes (İbiş, 2013; İbiş et al., 2014; Çilingir et al., 2015) that are very important to document phylogeographic relationships of these species because Anatolia had several refuge areas during the LGM and played an important role in their evolution.

Finally, the Department of Wildlife in the General Directorate of Nature Conservation and Natural Parks (Turkish abbreviation: DKMP) has initiated collaborative work with universities and NGOs during recent years to develop management and conservation plans based on reliable scientific data (DKMP, 2015; http://www.milliparklar.gov.tr/AnaSayfa/yabanHayatiDairesi). These management and/or conservation plans for the brown bears and three canids may give rise to a fund of knowledge and hopefully more viable populations of carnivores if they are implemented in all provinces and district directorates by adapting these plans to their routine practices. Further scientific research is also required on all four species' ecological parameters, population biology, zoonotic diseases, interspecific interactions, and social aspects of human–wildlife conflicts and conservation.

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