The wildcat *Felis silvestris* in northern Turkey: assessment of status using camera trapping

Özgün Emre Can, İrfan Kandemir and İnci Togan

Abstract The wildcat *Felis silvestris* is a protected species in Turkey but the lack of information on its status is an obstacle to conservation initiatives. To assess the status of the species we interviewed local forestry and wildlife personnel and conducted field surveys in selected sites in northern, eastern and western Turkey during 2000–2007. In January–May 2006 we surveyed for the wildcat using 16 passive infrared-trigged camera traps in Yaylacık Research Forest, a 50-km² forest patch in Yenice Forest in northern Turkey. A total sampling effort of 1,200 camera trap days over 40 km² yielded photo-captures of eight individual wildcats over five sampling occasions. Using the software *MARK* to estimate population size the closed capture–recapture model M_0, which assumes a constant capture probability among all occasions and individuals, best fitted the capture history data. The wildcat population size in Yaylacık Research Forest was estimated to be 11 (confidence interval 9–23). Yenice Forest is probably one of the most important areas for the long-term conservation of the wildcat as it is the largest intact forest habitat in Turkey with little human presence, and without human settlements, and with a high diversity of prey species. However, it has been a major logging area and is not protected. The future of Yenice Forest and its wildcat population could be secured by granting this region a protection status and enforcing environmental legislation.

Keywords Camera trap, conservation, *Felis silvestris*, Turkey, wildcat, Yenice Forest

Introduction

Despite the high diversity of carnivores in Turkey information about them is limited and there is almost no monitoring of carnivores or other large mammals (Can & Togan, 2004). Poor knowledge of species ranges and population status hinder conservation initiatives for carnivores (Holloway & Swift, 1967; Huş, 1974; Turan, 1984).

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Wildcats occur throughout parts of Eurasia and Africa (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; Bashta & Potish, 2005; Heltai et al., 2006), and are generally associated with forests (Macdonald & Barrett, 1993; Sunquist & Sunquist, 2002). They take mostly small prey (rodents and birds) but also catch larger species such as hares (*Lepus* spp.) and young deer (*Cervus* spp.; Sunquist & Sunquist, 2002). Wildcats are solitary and males and females associate only for mating (Sunquist & Sunquist, 2002), which occurs mostly from mid February to late March, with the young born in April or May (Macdonald & Barrett, 1993; Sunquist & Sunquist, 2002). The major threats to wildcats are persecution by humans and hybridization with domestic cats (Macdonald & Barrett, 1993; Beaumont et al., 2001; Randi et al., 2001; Sunquist & Sunquist, 2002). Hybridization may threaten (Pierpaoli et al., 2003) and even have caused the extinction of some local wildcat populations (Yamaguchi et al., 2004).

Although categorized globally on the IUCN Red List as Least Concern (Driscoll & Nowell, 2009) the European wildcat is listed as a Strictly Protected Fauna Species in Annex II of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), which was ratified by the Turkish Government on 2 May 1984 (Council of Europe, 2008). The species is protected by law in Turkey and any form of hunting or killing is prohibited (Turkish Ministry of Environment and Forestry, 2008).

The objectives of the study reported here were to evaluate the available information on the wildcat and its current status in Turkey, to examine the activity patterns and population size of the wildcat in one particularly important site, the Yaylacık Research Forest, using camera trapping, and to provide baseline data to promote further research on the wildcat in Turkey.

Study area

The camera-trapping survey was conducted in the c. 50 km² Yaylacık Research Forest which lies within the c. 750 km² Yenice Forest in northern Turkey (Fig. 1a), an area with an intact large mammal fauna of global importance (Morrison et al., 2007). Elevations are 100–2,000 m, most of the mean annual precipitation of 1,200 mm falls in the spring, and the mean number of days per year with snow is 25 (Can & Togan, 2009). Tree species include spruce *Picea orientalis,* the Balkan maple *Acer hyrcanum*, beech *Fagus orientalis*, Caucasian fir *Abies nordmanniana*, common ash *Fraxinus excelsior,*

European hornbeam *Carpinus betulus*, Istranca oak *Quercus hartwissiana*, Norway maple *Acer platanoides*, *Quercus petraea*, Scots pine *Pinus sylvestris*, Turkey oak *Quercus cerris* and yew *Taxus baccata* (Lise, 2005; Can & Togan, 2009). As the entrance to the Yenice Forest is controlled by the forestry service and no recreational activities are allowed, human densities are low throughout the year.

Methods

Countrywide survey

We firstly reviewed the available literature on the wildcat in Turkey, which was summarized in part by Kumerloeve (1967) and Turan (1984). We used the most recent forest inventory data and forest map (Turkish Ministry of Environment and Forestry, 2006) to assess potentially suitable habitats for the wildcat. We then conducted a countrywide questionnaire survey, with questionnaires disseminated to 331 local forestry stations, to collect information on the occurrence of the wildcat in the Taurus and South-east Anatolia regions (Fig. 1a). The questionnaire included questions on the occurrence of the wildcat and other mammalian species, habitats, and major threats to habitats and wildlife in general. The distributions of wildcat prey species were identified from Kryštufek &

Vohralik (2001, 2005). We then, in 2000–2007, made opportunistic visits to selected sites in 21 provinces (Fig. 1b) throughout Turkey to meet local forestry personnel, people and hunters and to collect further information. We visited forest sites to evaluate habitat suitability for wildcats and to document any presence signs (tracks, prey remains and scats) of the species.

Camera-trap survey

During January–May 2006 we conducted five sessions of camera trapping in the Yaylacık Research Forest, which lies within Yenice Forest (Fig. 1a), using 12 CamTrakker (CamTrakker, Georgia, USA) and four DeerCam (DeerCam, Park Falls, USA) passive infrared camera traps. We divided the 50-km² study area into fifty 1-km² cells using a 1:50,000 map provided by the Central Anatolia Forestry Research Institute of the Turkish Ministry of Forestry. In each session we set up camera traps in an area of 8 km² for 15 days, and then moved the traps to the next 8-km² area for 15 days, and so on until we had surveyed 40 km² (Karanth & Nichols, 2002; Karanth et al., 2004). The average distance between camera traps in each session was c. 1 km. The total survey effort was 1,200 camera trap days.

We placed the camera traps to maximize the total number of photo-captures (Karanth & Nichols, 2002; Holden et al., 2003; Wallace et al., 2003; Karanth et al.,
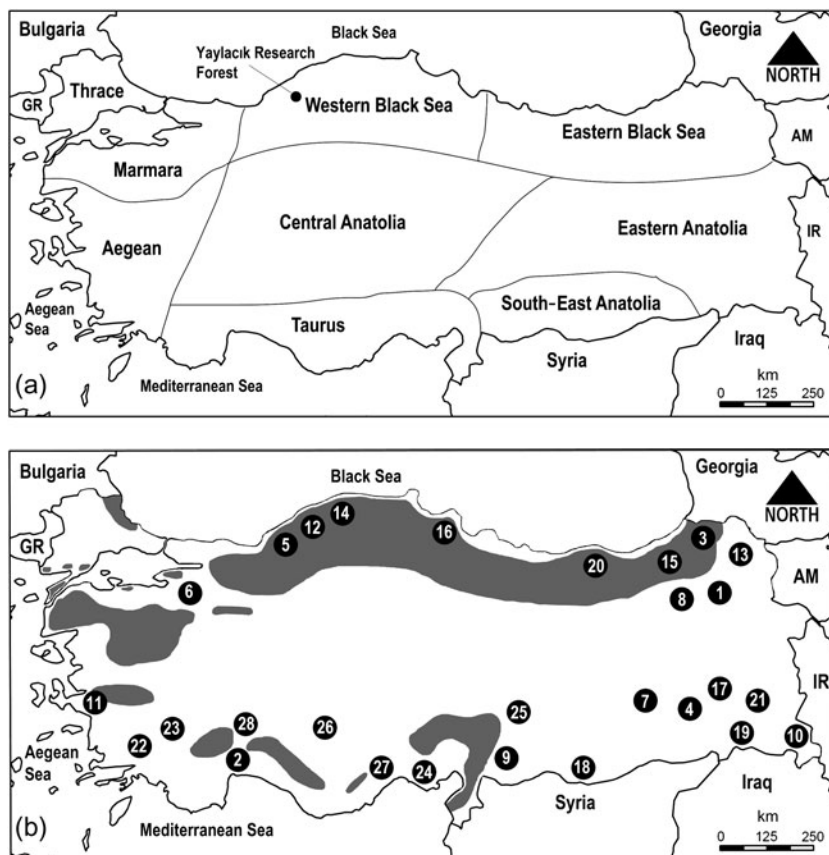

FIG. 1 (a) The regions of Turkey and the camera-trapping survey site, Yaylacık Research Forest in Yenice Forest. (b) Range map of the wildcat in Turkey (shaded areas, based on historical data, interviews and field visits; see text for details) and locations of the provinces in which we visited forest sites to search for signs of the wildcat: 1, Ağrı; 2, Antalya; 3, Artvin; 4, Bitlis; 5, Bolu; 6, Bursa; 7, Diyarbakır; 8, Erzurum; 9, Gaziantep; 10, Hakkari; 11, İzmir; 12, Karabük; 13, Kars; 14, Kastamonu; 15, Rize; 16, Samsun; 17, Siirt; 18, Şanlıurfa; 19, Şırnak; 20, Trabzon; 21, Van. Other provinces mentioned in the text are: 22, Muğla; 23, Denizli; 24, Adana; 25, Kahramanmaraş; 26, Konya; 27, Mersin; 28, Isparta.

TABLE 1 Major habitats, distribution, relative abundance and prey species of the wildcat *Felis silvestris* in Turkey (Fig. 1).

Region	Major habitats	Distribution	Abundance	Prey species (rodents & insectivores)
Thrace	Mesic deciduous & mixed forests of oak *Quercus* spp., beech *Fagus orientalis* & spruce *Picea orientalis*	Mainly confined to Kırklareli (Yıldız Mountains)	Uncommon	European red squirrel *Sciurus vulgaris*, dormouse *Glis glis*, forest dormouse *Dryomis nitedula*, water vole *Arvicola terrestris*, European pine vole *Microtus subterraneus*, Eastern hedgehog *Erinaceus concolor*, pygmy shrew *Sorex minutes*, common shrew *Sorex araneus*, Miller's water shrew *Neomys anomalus*, common mole *Talpa europea*
Marmara & Aegean	Mesic deciduous & mixed forests of *Quercus* spp., *F. orientalis* & *P. orientalis*, Mediterranean maquis & woodland oak *Quercus calliprinos*, *Quercus cerris* & pine *Pinus brutia* & *Pinus nigra*	Mainly confined to Adapazarı, Balıkesir, Bilecik, Bursa, Çanakkale & Burdur & doubtful in Denizli, Manisa, Muğla & Uşak	Uncommon	Caucasian squirrel *Sciurus anomalus*, *D. nitedula*, *E. concolor*
Taurus	Mediterranean maquis & woodland oak *Q. calliprinos*, *Q. cerris* & pine *P. brutia*, *P. nigra*	Distribution is mainly confined to Antalya, Isparta, Adana, Osmaniye & Kahramanmaraş	Rare	*S. anomalus*, *D. nitedula*, *E. concolor*
Western Black Sea Mountains	Mesic deciduous & mixed forests of *Quercus* spp., *F. orientalis* & *P. orientalis*	Distribution is mainly confined to Amasya, Bartın, Bolu Düzce, Eskişehir, Karabük, Kastamonu, Samsun, Sinop, Ordu & Zonguldak	Common	*S. anomalus*, *G. glis*, hazel dormouse *Muscardinus avellanarius*, *D. nitedula*, bank vole *Clethrionomys glareolus*, *A. terrestris*, *M. subterraneus*, *E. concolor*, Caucasian pygmy shrew *Sorex volnuchini*, *N. anomalus*, Transcaucasian water shrew *Neomys teres*, Levant mole *Talpa levantis*, blind mole *Talpa caeca*
Eastern Black Sea Mountains	Mesic deciduous & mixed forests of *Quercus* spp., *F. orientalis* & *P. orientalis*	Distribution is mainly confined to Artvin, Trabzon & Giresun	Common	*S. anomalus*, *G. glis*, *M. avellanarius*, *D. nitedula*, *C. glareolus*, *A. terrestris*, Major's pine vole *Microtus majori*, Robert's snow vole *Chionomys roberti*, *E. concolor*, *S. volnuchini*, Radde's shrew *Sorex raddei*, *N. teres*, *T. levantis*
Eastern Anatolia	Anatolian Artemisia steppe, mosaic of Artemisia steppe & oak woodland	Bitlis, Bingöl, Hakkari, Muş & Siirt	Very rare or extinct	*D. nitedula*, *E. concolor*, *A. terrestris*
Central & South-East Anatolia	Anatolian Artemisia steppe	Not found		

2004; Maffei et al., 2004; Silver, 2004; Wegge et al., 2004) and recorded their locations with a global positioning system. The camera traps were set for a 3-minute delay between photographs and 24-hour operation. Each camera trap was attached to a tree with padlocks, to prevent theft. Camera-trap performance was checked with test shots at the beginning of each session. After each session all films and batteries were replaced.

Individual camera-trapped wildcats were identified by general physical appearance and the unique patterns of tail rings. Assuming that timing of wildcat captures reflects their activity pattern, we grouped photographs into 6-hour intervals (Kawanishi, 2002; Maffei et al., 2005; Azlan & Sharma, 2006; Bitetti et al., 2006; Dillon & Kelly, 2007).

We constructed a capture history matrix of 1s (captures) and 0s (non-captures) of individual wildcats across the five

sampling occasions. The software *MARK* was used to estimate the wildcat population size using the assumption of population closure (White & Burnham, 1999). *MARK* offers four main population size estimators: model M_o (capture probabilities of individuals are constant regardless of time, behaviour or heterogeneity in captures), model M_h (capture probabilities of individuals are intrinsically heterogeneous), model M_b (capture probabilities depend on animal behaviour, and model M_t (capture probabilities are time specific). There are also four complex models (M_{bh}, M_{th}, M_{tb} and M_{tbh}) that incorporate the effects of heterogeneity, trap response and time in various combinations. To select the best-fit model and assess its parameters we used the model selection function of *MARK*, which scores the models between 0 (the poorest model) and 1 (the best model). We used a χ^2 goodness-of-fit test (Daniel, 1999) to determine the relationship between wildcat captures and location of camera traps on forest roads, trails and slopes.

Results

Countrywide survey

According to the questionnaire results and the information available in the literature the wildcat is present in the Thrace, Marmara, Aegean, Taurus, Western and Eastern Black Sea Mountains and Eastern Anatolia regions of Turkey (Fig. 1b). The Western and Eastern Black Sea Mountains are the most suitable regions for wildcats given the extent of suitable habitat and the diversity of prey (Table 1). Thrace has a diversity of suitable prey species.

The prime wildcat habitats in Turkey are characterized by mesic deciduous and mixed forests of oaks *Quercus* spp., beech *F. orientalis* and spruce *P. orientalis* in northern Turkey. We did not document presence of the wildcat at the sites we visited in Ağrı, Bitlis, Hakkari, Kars, Şanlıurfa, Siirt, Şırnak and Van. The questionnaire study conducted in the Taurus region provided information on the occurrence of the species in southern Turkey. All the respondents of the questionnaire survey from Muğla (n = 45) and Denizli (n = 34) stated that the wildcat is not present there. According to the questionnaire responses (n = 252) from Adana, Antalya, Kahramanmaraş, Konya, Mersin and Isparta the wildcat is present in these provinces. The distribution map (Fig. 1b) was produced by synthesizing the results of the field visits, questionnaire responses and the forest map of Turkey.

Camera-trap survey

The camera-trap survey documented the wildcat in the Yaylacık Research Forest (Plate 1). We obtained 402 records of animals of which 22 were of wildcats and 13 were appropriate for individual recognition. Relative abundance

PLATE 1 Camera-trap photograph of a wildcat in Yaylacık Research Forest (Fig. 1a).

of wildcats was 18.3 per 1,000 camera-trap days. Eight different individual wildcats were identified from 12 camera-trap records (Table 2) across the five camera-trap sessions, i.e. an average of 150 camera-trap days were required to document the presence of an individual. The assumption of population closure, checked with *MARK*, was not violated ($\chi^2 = 4.41354$, df = 2, P = 0.11006). The model selection algorithm selected the null model M_o as the best fit. The estimated population size was $11.00 \pm SE$ 2.97 (95% confidence interval 9–23). The distribution of the 80 camera-trap stations on forest roads, trails and slopes is given in Table 3. Captures of wildcats did not differ significantly across these location types ($\chi^2 = 0.491$, P > 0.05). Activity patterns of wildcats in the Yaylacık Research Forest were equally diurnal (06.00–18.00, 50.4%) and nocturnal (18.00–06.00, 49.6%; Fig. 2).

Discussion

Kumerloeve (1967) provided the first information on the occurrence of the wildcat throughout Turkey. Turan (1984) later modified the map of Kumerloeve (1967), showing

TABLE 2 The capture history of eight individual wildcats camera-trapped in the Yaylacık Research Forest across five sampling occasions (see text for details).

Individual	Capture history
wc1	01000
wc2	00101
wc3	00110
wc4	00001
wc5	00001
wc6	00011
wc7	00101
wc8	00100

TABLE 3 Number of camera-trap stations, camera-trap nights and wildcat captures on forest roads, trails and slopes.

	Forest roads	Trails	Slopes	Total
No. of camera-trap stations	31	30	19	80
No. of camera-trap nights	465	460	285	1,200
No. of captures (capture rate per 100 camera-trap nights)	5 (1.08)	11 (2.39)	5 (1.75)	21 (1.75)

a greater range for the wildcat. Reviewing the available information we conclude that the current range of the species is much narrower than previously believed. We failed to document the presence of wildcats in the provinces of Ağrı, Diyarbakır, Gaziantep, İzmir, Kars, Şanlıurfa, Şırnak and Van, from where the species has probably vanished since Kumerloeve (1967) drew his map. Turan (1984) suggested that the wildcat occurred in the Marmara, Aegean and Taurus regions but we conclude that its current day distribution is limited there. In the Taurus region most forests are conifer and maquis, inappropriate for wildcats, and thus the species range is mainly confined to the Kahramanmaraş region, which contains the largest area of deciduous forest. We believe that the presence of wildcats in Erzurum, Bitlis, Siirt and Hakkari is doubtful because we did not document the species in the sites we visited. However, wildcat signs are difficult to find and may be confused with other species such as foxes *Vulpes vulpes*, jungle cats *Felis chaus* and martens *Martes* sp. If present in eastern Turkey the wildcat population there is isolated from that in other parts of the country and would be a priority region for conservation of the species.

Most of the prime wildcat habitat is in northern Turkey, including Thrace, and there is a need for conservation initiatives in this region. In the Marmara, Aegean and Taurus regions the wildcat population is heavily fragmented, possibly consisting of several isolated subpopulations, and the issue of connectivity deserves further research.

Although wildcats are normally crepuscular and nocturnal (Macdonald & Barrett, 1993) in the Yaylacık Research Forest they are also diurnal (although our sample size of 22 photo-captures is small). Human-related land-use types such as roads can affect the behaviour of wildcats (Klar et al., 2008) but photo-capture rates in Yaylacık Research Forest did not differ between forest roads, trails and slopes.

The Yenice Forest (750 km²), which includes the Yaylacık Research Forest (50 km²) and two small protected areas (c. 12 km²), is one of the largest intact forests in Turkey but it does not have a protection status. Considering the size of the area, the general absence of human disturbance and the availability of prey species, Yenice Forest probably holds one of the largest wildcat populations in the country and may be one of the most important areas for conservation of the species. However, some sites within Yenice Forest have been logged, generating income for the state and local communities (Lise, 2005). The Yaylacık Research Forest is meant to be used only for research purposes but selective logging is currently allowed during some part of the year to mitigate the pressure from local communities for the use of forest resources (Can & Togan, 2009). Nevertheless, the remoteness and intactness of the region reduces the risk of hybridization with the domestic cat *Felis cattus*, which is a main concern in most parts of Europe (Beaumont et al., 2001; Pierpaoli et al., 2003; Yamaguchi et al., 2004). The future of Yenice Forest will only be secured if it is given a protection status and the appropriate environmental legislation is enforced.

Political pressure from local communities to utilize parts of Yenice Forest is increasing (Can & Togan, 2009) and the Ministry of Environment and Forestry General Directorate of Forestry is considering selective cutting in some parts of Yaylacık Research Forest. We have presented our findings to the relevant authorities and urge the Turkish Ministry of Environment and Forestry authorities to reconsider any future logging in Yaylacık Research Forest. We recommend that the Turkish nature conservation organizations, particularly WWF Turkey, which identified Yenice Forest as a global forest hotspot, focus their attention on this region.
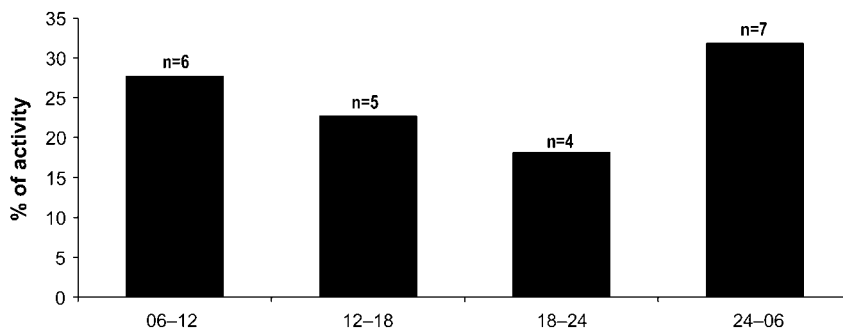

FIG. 2 The activity pattern of wildcats camera-trapped in Yaylacık Research Forest, summarized in 6-hour periods.

Acknowledgements

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Biographical sketches

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