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PRELIMINARY DATA ON THE DISTRIBUTION OF FREE-RANGING DOGS (*CANIS FAMILIARIS* L.) IN NP VITOSHA, BULGARIA

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Abstract: Free-ranging dogs often leave the urbanized areas and stray into nearby mountainous habitats, even entering protected areas. This causes problems for the wildlife due to either direct predation or disturbance. Our camera trap survey (July 2013 - November 2014) in NP Vitosha, Bulgaria resulted in a total of 199 independent registrations of free-ranging dogs in 81 locations. In this preliminary study, we present the distribution, habitat selection, and distance from settlements and activity of free ranging dogs in Vitosha NP. The free-ranging dogs in Vitosha are predominantly diurnal, and show preference towards coniferous and mixed forests, mostly closed. Their distribution and activity patterns are influenced by human presence, which is due to the fact that they at least partially rely on human-sourced food. Some data for observations of wild animals influenced by dogs is also discussed.

INTRODUCTION

The presence of dogs without an owner or with an owner but uncontrolled (**free-ranging dogs**) is generally recognized to be a significant problem both for humans and wild animals. They are known or called by different names.

Unrestrained domestic dogs that roam outside their owner's property can become free-ranging or even feral (Nesbitt, 1975). Many researchers consider different definitions of the terms "free-ranging" and "feral" dogs. In this paper we accept the definitions proposed by Boitani et al. (1995). A free-ranging dog

has a social relationship with humans, but is able to roam freely with or without the owner's knowledge. Feral dogs, on the other hand, can be considered wild because they can live with very little or no interaction with humans. There are a large number of studies documenting the negative effects of feral dogs on wildlife. This is especially concerning when endangered species and protected areas are affected (Young et al, 2011; Hughes and Macdonald, 2013).

Some of the rural dogs might pose a different set of environmental pressures than feral or wild dogs, or even free-ranging farm dogs (Vanak and Gompper, 2009a). There is an interesting physical and behavioural difference between typical village dogs and other more feral free-ranging dogs. For example, village dogs tend to be smaller and occur more often alone or in pairs (Coppinger and Coppinger, 2002).

The behaviour and ecological impact on wild animals of the feral, free-ranging dogs are poorly studied – there are few studies on the topic (Manor and Saltz, 2004; Vanak and Gompper, 2009b; Young et al., 2011; Gehlot and Jakher, 2015; Farris et al., 2015; Kumar and Paliwal, 2015) mainly in tropical countries where they cause significant impact on ungulates and other animals. Hughes and Macdonald (2013) published a review of the interactions between dogs and wildlife covering the impact of the dogs in 29 different countries

In Bulgaria there are no published scientific papers on the feeding habits, habitat preferences or behaviour of the free-ranging dogs. During a wild cat (*Felis silvestris*) camera trap survey, we identified a significant presence of free-ranging dogs on the territory of Nature Park Vitosha. As the areas of the camera trap survey were relatively far from inhabited buildings in the park, most of these dogs fit within the description of typical feral dogs. The aim of this study is to provide a preliminary data of the dogs' current spatial distribution, habitat preference and activity patterns, which would serve future studies and management actions.

MATERIALS AND METHODS

Study area

The study was conducted in Nature Park Vitosha Mt., Bulgaria (mean altitude is 1500 m.a.s.l. reaching 2290 m.a.s.l. at the mountain's highest peak – Cherni Vrah). Nature Park Vitosha is in close proximity to the capital city of Bulgaria – Sofia. There are numerous villages bordering the park, as well as a large number of hiking trails through the mountain. Over the last few decades free-ranging dogs have inhabited the city and the neighbouring settlements, in many cases straying away from humans in search of food. The protected area within a short distance hosts abundant wildlife, including rodents and ungulates, which can easily fall prey to packs of dogs. The combination of all these factors is a prerequisite for the invasion of free-ranging dogs on the premises of the Nature Park.

GIS map layers containing information on the habitat characteristics, as well

as the human settlements and inhabited buildings near or within the Nature Park were obtained from the Nature park database.

Camera trap locations

30 camera traps (Ltl Acorn 5210) were deployed in the field (between 2013 and 2014) according to a predetermined grid (Kilshaw and Macdonald, 2011) with a cell width of 600 m (Fig.1). The camera traps were set up on animal trails in suitable habitats (predominantly forests) for detecting middle-sized and large mammals. The study area was divided into 6 zones and the camera traps were left in the field for 22-35 days in each zone before being moved to the next. The camera traps remained in zone 6 for 108 days to gather data for the winter period.

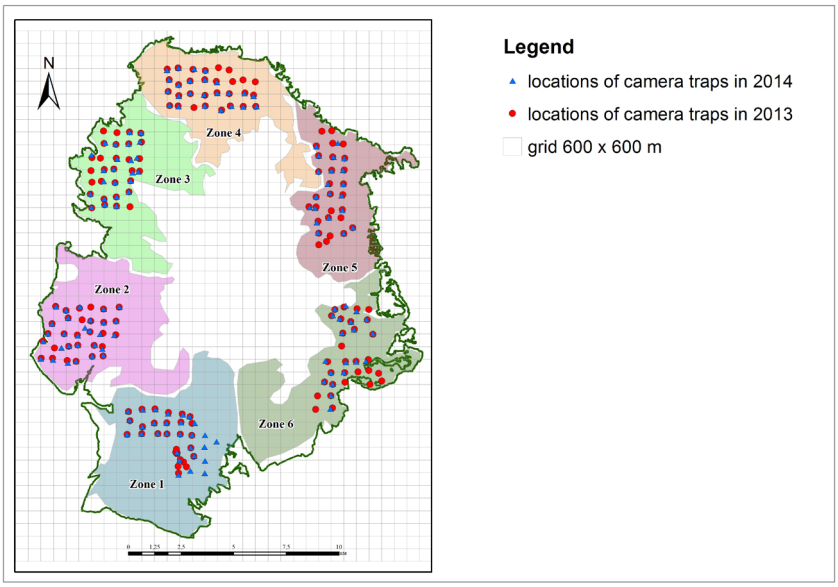


Figure 1. Map of the camera traps locations in Nature Park Vitosha

The camera traps were set to record 3 photos and a video, printing the time, date, temperature and moon phase on the photo. A standard form was completed for each camera trap station, containing information on the zone number, GPS coordinates, camera trap serial number, team members, habitat characteristics, such as forest type (deciduous, coniferous or mixed), forest visibility (open, with visibility > 10 m or closed, with visibility < 10 m) and altitude.

Analysis

The resulting camera trap photos were imported and analysed through CameraBase 1.6. (Tobler, 2013), translated into Bulgarian and complemented to adapt to the needs of the study (Zlatanova, unpublished). We considered photos of prolonged stay of the same individual at a camera trap station as 1 independent event (hereafter registration) unless it was clear that two or more different individuals were captured. This was done to avoid overestimation of the abundance of the free-ranging dogs in a certain location or time period due to the activity of a single individual spending a relatively long period of time in front of the camera.

The relative preference of the dogs towards different habitat types (type and visibility of the forest and altitude) was estimated using Ivlev's Selectivity Index (D), partially modified by Jacobs (1974). The index ranges from -1 to 1, where -1 indicates strong avoidance and 1 indicates strong preference. ArcGIS v.10 (ESRI) was used to map the free-ranging dogs' registrations and determine the minimum and maximum distance to human settlements and inhabited buildings.

The general activity patterns of the dogs were analysed as the percentage of registrations occurring during the day, in twilight (within 30 min before and after sunrise and sunset) and at night. Additionally, the activity patterns were estimated in more details as the number of independent registrations per hour. These analyses were also performed for the four seasons separately.

RESULTS AND DISCUSSION

The camera traps produced a total of 395 photos/videos of feral dogs (Fig. 1a), with 199 independent registrations in 81 locations.

Figure 1a A pack of feral dogs captured by a camera trap in NP Vitosha

Humans with domestic dogs were recorded (n = 5, one registration per zone) in 5 locations in 2014 (zones 2, 3, 5 and 6). The spatial distribution and detailed numbers of these registrations are presented in Table 1 and Fig. 2

Table 1. Number of free-ranging dogs' independent registrations and the number of camera trap locations in which they are recorded during the different field seasons

Study Area	independent registrations	camera trap locations
2013 - Zone 3	12	7
2013 - Zone 4	36	14
2013 - Zone 5	32	9
2013 - Zone 6	16	6
winter 2013-2014	53	13
2014 - Zone 1	4	4
2014 - Zone 2	3	3
2014 - Zone 3	10	7
2014 - Zone 4	24	12
2014 - Zone 5	8	5
2014 - Zone 6	1	1
Total	199	**81**

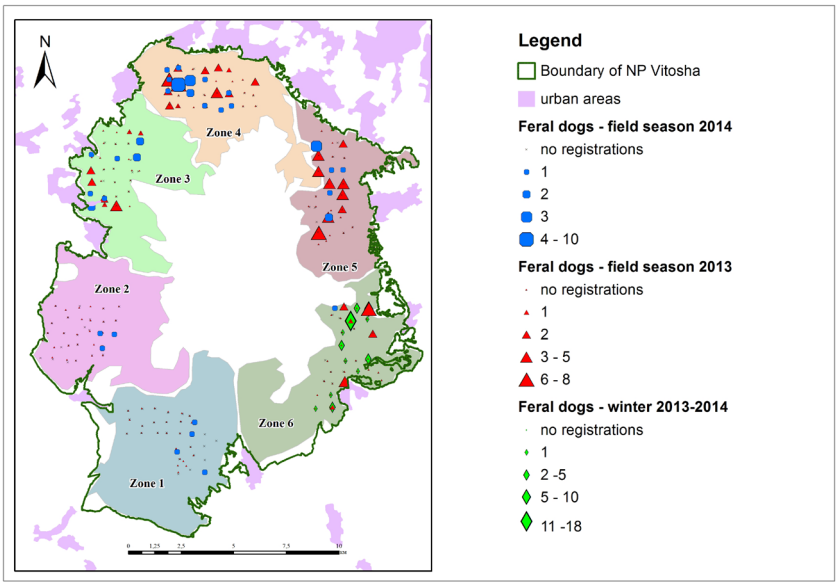


Figure 2. Distribution of the feral dogs, recorded in NP Vitosha

The distribution of these registrations is closely related to the intensive human presence (especially in Zone 4 and 5) due to recreational activities. There is a significant correlation between the human and feral dog presence (Spearman Rank Order Correlation, $p < 0,05$).

The *Selectivity index* analyses for the habitat preference show that the dogs actively avoid scattered vegetation (-1,00) and to a lesser extent deciduous forest, and show mild preference towards mixed and coniferous forests (Fig.3).

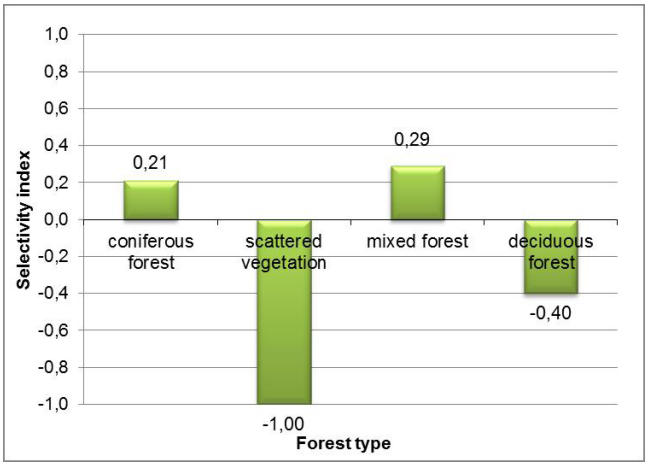


Figure 3. Forest type selection of feral dogs in Vitosha NP

There is a more pronounced difference in the habitat preferences during the separate seasons (Table 2). The dogs show clear preference (0,99 to 1) to the deciduous forests in the spring, summer and winter, while avoiding scattered vegetation in spring and winter. In the autumn there is a slight preference to coniferous (0,15) and deciduous (0,22) forests, while in winter there is complete indifference to coniferous and mixed forests (selectivity index equals 0).

Table 2. Seasonality of forest type selection in feral dogs in Vitosha NP

Season	Forest type	Selectivity index
Spring	coniferous	-0,12
	mixed	-0,36
	deciduous	**1,00**
	scattered vegetation	*-0,97*
Summer	coniferous	-0,29
	mixed	0,09
	deciduous	**1,00**
Autumn	coniferous	0,15
	mixed	-0,29
	deciduous	0,22
Winter	coniferous	0,00
	mixed	0,00
	deciduous	**0,99**
	scattered vegetation	*-0,99*

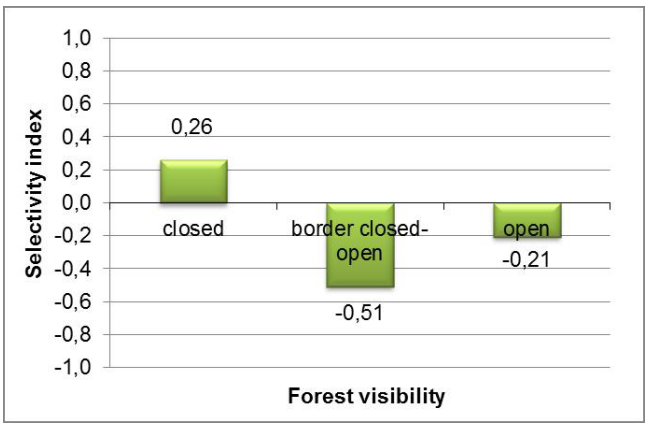


Figure 4. Forest visibility selection in dogs in NP Vitosha

As is the case with forest types, the seasonal differences in the use of forests with varying visibility are more pronounced. In spring and winter (Table 3) free-ranging dogs select more closed forests (0,70 and 0,69 respectively) while they clearly avoid the border area between open and closed forests. In the summer and autumn the preferences in respect to visibility are almost indifferent with very slight preference or avoidance (within the limit of -0,14 - 0,12 in summer and close to 0 in autumn).

Table 3. Seasonality of forest visibility selection in feral dogs in Vitosha NP

Season	Forest visibility	Selectivity index
Spring	closed	**0,70**
	border closed-open	*-0,87*
	open	-0,10
Summer	closed	0,12
	border closed-open	0,06
	open	-0,14
Autumn	closed	-0,08
	border closed-open	0,01
	open	0,08
Winter	closed	**0,69**
	border closed-open	*-0,83*
	open	-0,10

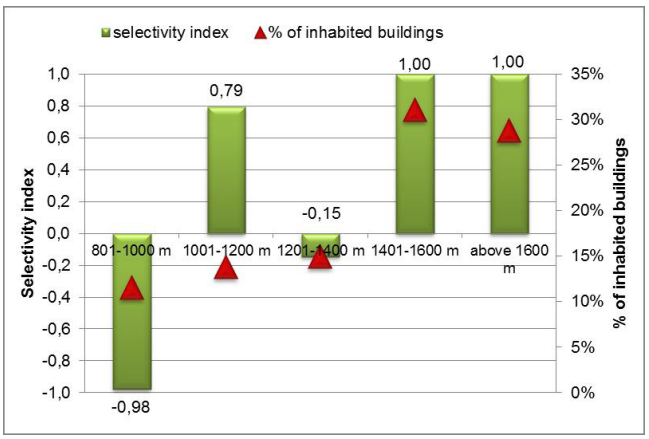


Figure 5. Altitude selection in feral dogs compared with the altitudinal distribution of inhabited buildings

Although a clearly expressed preference for altitude above 1000 m exists in dogs, there is a weak, yet unexplained avoidance of the altitude between 1200 and 1400 m. The spatial comparison between this altitude selection and distribution of inhabited buildings shows that although there is no statistical correlation between the two types of data (Pearson Product Moment Correlation, $p > 0,05$), there is, however, dependence of the dogs distribution to these buildings, especially in the altitude above 1400 m.a.s.l.

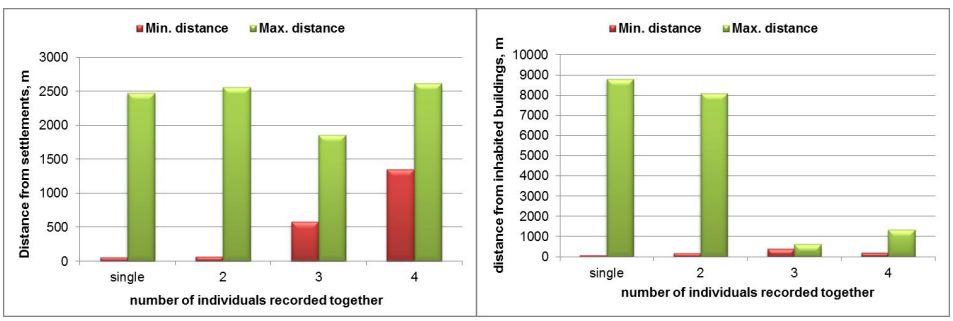
Typically, wild mammals keep at distance from human settlements. Feral dogs in Vitosha Mountain though, approach the settlements or live in the vicinity of inhabited buildings in the mountain as they still rely very much on human sources of food such as garbage dumps or food left by the tourists.

This is confirmed by the results of Frigeri et al. (2014) in Brazil, who report that the free-ranging dogs are observed in places, frequently visited by humans. The dietary analysis of the free-ranging dogs in India by Vanak & Gompper (2009) also indicates that dogs are dependent on food, provided by different means by humans.

During our study, we found that sites with 5 or more registrations of feral dogs (up to 18) range from 296 m to 2562 m in their distance from settlements, while single observations of dogs are recorded even as far as 2619 m in straight line distance. The same sites range in their distance to inhabited buildings from 94 m to 2290 m. The most frequently visited place by the dogs (18 independent registrations) is at a distance of 1664 m from villages and 2112 m from inhabited buildings.

When bigger groups of dogs (3-4 individuals) are recorded, they keep a distance of minimum 582 m (n=3) and 1356 m (n=4) from settlements (Fig. 6a) and 397 m (n=3) and 197 m (n=4) from inhabited buildings (Fig. 6b).

Single individuals keep closer to the settlements (min. 55 m; max. 2477 m) rather than to inhabited buildings (min. 91 m; max. 8785 m) probably displaced by the bigger groups. They also tend to go the farthest from human infrastructure (max. 8785 m) than the more social dogs. These results are in agreement with the findings of Font (1987) that single dogs tend to live closer to humans, while dogs forming packs are better adapted to hunt wild animals away from human settlements. Meek (1998) reports that the distance travelled by free-ranging dogs in Australia is dependent on the availability of wild prey (mainly macropods).



a) **b)**

Figure 6. Minimum and maximum distance of the recorded feral dogs to settlements (a.) and inhabited buildings (b.)

Being more independent from humans, it is expected that the feral dogs should have more nocturnal activity if they depend on a natural source of food like wild species. Yet, we found pronounced overall diurnal activity (70,9%) between 7:00 and 16:00 h. (Fig. 7) and less nocturnal activity (7,0%

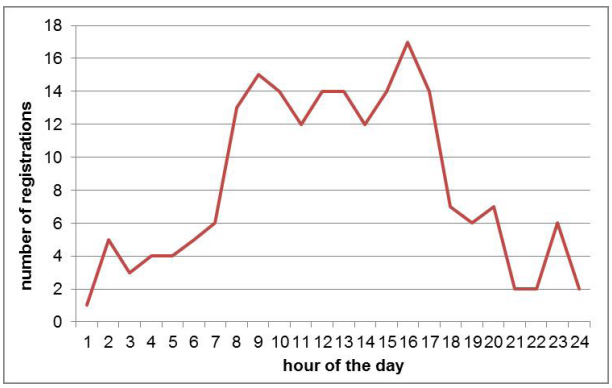


Figure 7. Hourly activity of the feral dogs

In spring the dogs are mainly diurnal. No crepuscular activity was recorded (Fig. 8), while more than one third of their activity in the winter is crepuscular. Least nocturnal activity (1,4%) is recorded in the autumn and it is more pronounced (15,4%) in summer.

These results differ from those of Font (1987) who reports a predominantly crepuscular activity with another peak around midnight in stray dogs during the autumn and winter. Frigeri et al. (2014), however, report that dogs are more likely to be detected in days and times when humans are more active in the agroforests in Brazil. This would explain the diurnal activity of the dogs in NP Vitosha, relaying partially on the food left by tourists.

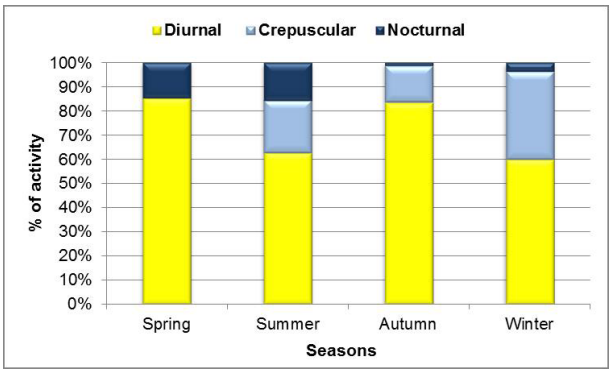


Figure 8. Seasonality of feral dogs circadian activity

The feral dogs are known to cause an impact on wild mammals in Vitosha NP. For example, in the same study, we identified that in the areas with a significant presence of feral dogs in Zone 3 and 4 no wild cats (*Felis silvestris*) were recorded. This is in agreement with the findings of Farris et al. (2015) in Madagascar, which indicate that the presence of exotic carnivores causes displacement of the native ones, especially those with crepuscular and nocturnal activity. Apart from the disturbance, feral dogs cause direct mortality on many species (see Young et al., 2011; Hughes & Macdonald, 2013 for a review on the interactions and impact of free-ranging dogs on wildlife). In the winter of 2011-2012 more than 19 roe deer were found killed by feral dogs. Feral dogs enter the adaptation confinement for the reintroduced chamois (*Rupicapra rupicapra*) every year and cause mortality on yearlings. Yet, the full scope of this influence is unknown because of the lack of systematic data collection. This calls for a further study in order to track feral dogs (by the means of GPS collars), to identify the importance and scope of this impact (either direct or indirect by disturbance).

CONCLUSIONS

The distribution and behaviour of the feral dogs in NP Vitosha points to the conclusion that they are dependent on humans, and often rely on human-sourced food. There are, however, indications that they also prey on wild animals (e.g. roe deer, chamois) and influence the distribution of native carnivores (such as the wildcat). The scope and implications of these impacts still remain largely unknown.

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