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Study of Activity Pattern and Visitation Frequency of Eurasian Wild Boar in Disturbed patches (Case Study: Deylaman-Dorfak Non-Hunting Area)

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Abstract: *The elimination of the trees and bushes causes disturbed patches in the forest landscapes and this can be effective on the fauna and flora. The present study deals with the activity pattern and visitation frequency of wild boars in disturbed patches of Deylaman - Dorfak non-hunting area. To do so, four disturbed patches and four closed-canopy forest environment (as the control patches) were selected and seven plots featuring 100-square-meter dimensions were taken into account and pellet groups were counted. Also, two camera traps were installed in every pair of patches (one disturbed patch and one control patch) and monitoring was carried out for five days. The results indicated that the wild boars attended the disturbed patches more than the control patch and the reason for such a preferential presence can be the food resources availability therein. On the other hand, the species activity was more of a nightly manner in the disturbed patches and it seems that this prevalent nightly activity is more due to one or several of the following factors: shortage of shelter, human interference, competition and predator - prey interactions. Therefore, the higher visitation frequency of the wild boars indicates the positive effect of the disturbed patches on this ungulate and their prevalently nocturnal activity pattern is (possibly) reflective of their negative effects. Moreover, the present study results support the creation of these disturbed patches if the forest managers especially concentrated on the protection of these patches as the important habitats of the ungulates. However, it is suggested that a proper understanding of the effects of these patches on the other species should be attained before offering any sort of management solution because unidimensional approaches in consideration of only one species and even one order can be misleading for the conservation of biodiversity in landscape-level.*

Keywords: *Disturbed Patch; Disturbance; Eurasian Wild Boar; Hyrcanian Forests; Deylaman and Dorfak Non-Hunting Area; Activity Pattern.*

INTRODUCTION

The processes of natural and man-induced disturbances like windthrow or clear-cutting of trees cause the creation of open spaces called forest gaps or disturbed patches in the forest landscape (Fischer et al, 2013) and the creation of disturbed patches leads to the shift in access to resources like food and shelter that surely affects the wild populations (Agetsuma et al, 2016). There are many studies performed regarding the effect of these patches on mammals but the ecologists have not yet reached a proper understanding of the effect of these patches on many of the species of the aforementioned order and it is currently unknown in many of the parts world..

Hyrcanian forests, as one of the most ancient forest of the world and remnants from the third geological era, (Mahmoudi, cited in E'etemad, 1994) and Deylaman-Dorfak non-hunting area, as a distinct example of such a Hyrcanian ecosystem (Dehdar Dargahi et al, 2007) have not left immune of the effects of these disturbances and their outcomes.

The wild boar (Sus scrofa) is one of the most widely distributed ungulates in the world. Due to the absence of natural predators, hunting prohibitions and high fertility rate (Firouz, 2005), this species has appeared as a pest to the agricultural products in iran Like many other countries. However, it should not be forgotten that the species plays a very important role in the shaping of the various environments (Albarella et al, 2009) and it is one of the main preys of carnivores like Persian leopard (Hamidi, 2008). On the other hand, due to the fact that there is not so far conducted a study regarding the effect of disturbed forest patches on such ungulates as wild boars in Hyrcanian forests, especially the forests in Deylaman-Dorfak non-hunting area, and the results of the present study can be effective on the decisions made by the forest managers, the present study accordingly aims at evaluation of the amount of effect these disturbed forest patches have on Eurasian wild boars in Deylaman-Dorfak non-hunting area via investigating the activity pattern and visitation frequency of these species in these patches.

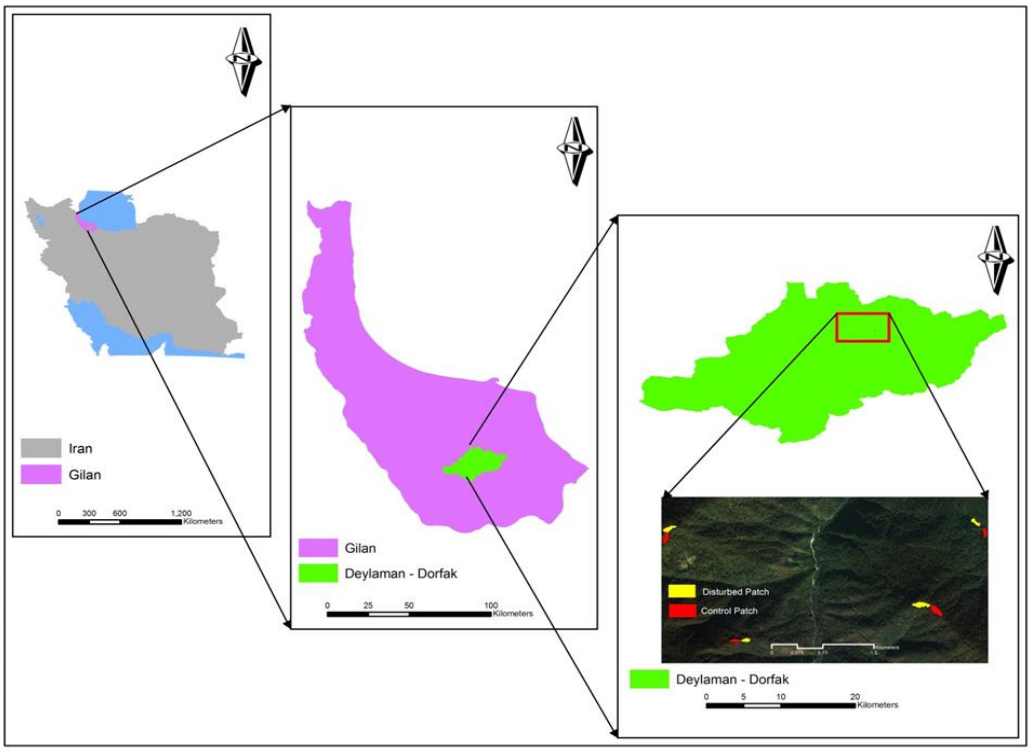

Figure 1. Location of study area

Materials and Methods

Study Area

Deylaman _ Dorfak non-hunting area, with an area equal to 44885.99 ha, is situated within a 10-km distance from the southern side of Siahkal County and it enjoys a forest, rangeland and mountainous topography. The region is known to have 26 typical mammals and 101 bird species and the average annual temperature of the region is 12.7°C and the average annual precipitation is 1173cm (Dehdar Dargahi et al, 2007).

The studied forest patches include eight patches: four disturbed patches (D) and four control patches (C, closed canopy patches) positioned between 49°50'37.40"E and 49°53'13.26" E longitudes and between 36°59'54.50"N and 37° 0'57.11"N latitudes(Table1).
Table (2) lists some non-biological characteristics of the patches.

Table 1: Patches Non-biological Features

Row	Patch Type: Disturbed(D) Control (C)	Aspect	Average Slope (Percent)	Average Height (Meter)	Perimeter (KM)	Area (ha)
1	D1,C1	West	23,20	1137,1160	0.47	1/2
2	D2,C2	Northeast	20,24	696,740	0.33	0/55
3	D3,C3	Southeast	10,19	1054,1093	0.30	0/44
4	D4,C4	Southeast	2,5	1196,1201	0.43	0/84

Table 2: Cover Percent

Row	Tree and shrub cover (percent)	Herb Cover (percent)
D1	8	100
C1	96	80
D2	10	100
C2	90	60
D3	6	100
C3	90	40
D4	5	100
C4	95	50

Table 3: Identified Tree Species

Patch Type	English name	Scientific name
Disturbed Patch	Caucasian persimmon	Diospyros lotus
	Blackthorn	Prunus spinosa
	Common medlar	mespilus germanica
	Caspian locust	Gleditsia Caspica
Control patch	Oriental beech	Fagus orientalis
	Common hornbeam	Carpinus betulus
	Caucasian Alder	Alnus subcordata

Vegetation Study

The canopy data used herein have been obtained based on visual estimation and they are recorded in proportional values (table 2). This method is based on visual estimation of the area occupied by the canopy as proposed in Paletto and Tosi (2009). The visual estimations are hypothetical and the results can vary according to Weather variations but many of the foresters utilize visual estimations in the majority of the cases of canopy calculation for their being easy and less troublesome (Huynh, 2005). Furthermore, the identification of the upperstory species was conducted based on morphological attributes and they are summarized in table (3).

Methods of Monitoring the Wild Boar Activity

- **Pellet Group Count**

To do so, seven plots with 100-square-meter dimensions were considered in each patch; the plots were chosen in the patch center as well as in 1.2- and 2.2-meter distances from the center to the internal margin of the patch. At the same time with the designing of the plots (August, 2017), the entire signs were cleaned off the

plots so as to make them ready for sampling. The selected time interval between the designing and examining of the plots was three weeks and the investigation of the signs existent in every pair of the patches (control and disturbed) was undertaken on a single day with a time interval of several hours.

- **Camera Trapping**

A camera trap(CT) was installed in every disturbed and control patch; the regions close to the natural wildlife attractions like the wildlife trails (Burton et al, 2015), especially the trails' intersections (Karanth and Nichols, 1998) as well as the regions with higher frequency of the presence signs (like dung, foot traces, soil turn over) were selected as the camera trapping stations and a camera was installed on a tree in every station within a 50-cm height from the ground level.

Data Analysis

Before analyzing the data, the number of the wild boar pellet groups and the images (figure 4) recorded in the disturbed and control patches were counted. Before being counted, the images were divided into two types of dependent and independent: the images were recounted as having recorded independent incidents when the apparent properties of the images recorded of the species clearly proved their difference and non-repetitiveness or when the time interval between two consecutive images of a species was 30 minutes or more otherwise the images were recounted as having recorded dependent incidents hence discarded from further study.

Figure 2. Samples of camera trap images

Statistical Tests

In the next stage, the normality of the obtained data was evaluated (Kolmogorov-Smirnov Test, P<0.05) and pairwise t-test was applied to compare the data following which the following indices were defined.

Visitation Frequency Index Based on CT Pictures (VFIC)/ Pellet Groups (VFIP)

The ratio of the number of recorded pellet groups of a species in the disturbed/control patches to the entire period of patch sampling (T=21) was considered as the wild boars' visitation frequency index in the control/ disturbed patches and a similar index was also defined for the images (the number of the images recorded of the wild boars in disturbed /control patches during the entire monitory period (T=5).

Time-Period Visitation Frequency Index (TVFI)

A period of 24 hours was divided into three time spans: day (08:00-16:00), night (20:00-04:00) and dusk (04:00-08:00 and 16:00-20:00). Then, the species relative activity frequency index was calculated as shown in the formula below in each of the three time spans following the lead of Liu et al (2013):

$$\boldsymbol{TVFI = N_{ni}/N_{ti} \times 100} \quad (3)$$

Day: DA; night: NA and dusk: Dui

N_{ni} denotes the collection of the images recorded of the species in every disturbed /control patch for a given time span and N_{ti} denotes the images recorded of the species in the disturbed /control patches for the entire camera trapping (T=21).

Results and Discussions

Statistical Test Results

The results of the pairwise t-test indicated that there is no significant difference between the images taken from the wild boars in disturbed and control patches (t=0.775, df=3, p=0.495), though the number of images taken was generally more in the disturbed patches than in the control ones. However, a significant difference was documented between the wild boars' dung frequencies in the disturbed and control patches (t=9.798, df=3 and p=0.002) and a higher frequency was recorded for the disturbed patches. Besides, a significant relationship was evidenced between the frequency of the images with the percentage of herbaceous canopy and the percentage of tree canopy as well as between the frequency of the recorded dungs with the percentage of the herbaceous canopy and the percentage of the tree canopy (details in table 4). On the other hand, no significant difference was figured out between the activity during dusk and nocturnal activity and diurnal activity in the disturbed patches as well as in the control patches (details in table 5).

Table 4: Paired Samples Correlations

		t	df	Sig. (2-tailed)
Pair 1	Pictures - Herbcover	-10.466	7	.000
Pair 2	Pictures - Treecover	-2.962	7	.021
Pair 3	PelletGroup - Herbcover	-10.949	7	.000
Pair 4	PelletGroup - Treecover	-2.716	7	.030

Table 5: Paired Samples Differences

Patches name			t	df	Sig. (2-tailed)
Disturbed patches	Pair 1	night.d - day.d	1.732	3	.182
	Pair 2	night.d - crepu.d	.775	3	.495
	Pair 3	day.d - crepu.d	.000	3	1.000
Control patches	Pair 1	night.c - day.c	.000	3	1.000

	Pair 2	night.c - crepu.c	The t cannot be computed because the standard error of the difference is 0.		
	Pair 3	day.c - crepu.c	.000	3	1.000

VFIC/VFIP Results

VFIP calculation proves the claim that the frequency of wild boars' visitation is higher in the entire disturbed patches than in the control patches (figure 3).
However, VFIC results indicated that wild boars have not attended the no.2 disturbed and control patches and their frequency of visitation is higher in no.4 disturbed patch than in no.3 control patch. However, the frequency of wild boars' visitation in no.1 and no.3 disturbed patches has been higher than in no.1 and no.3 control patches (figure 4).

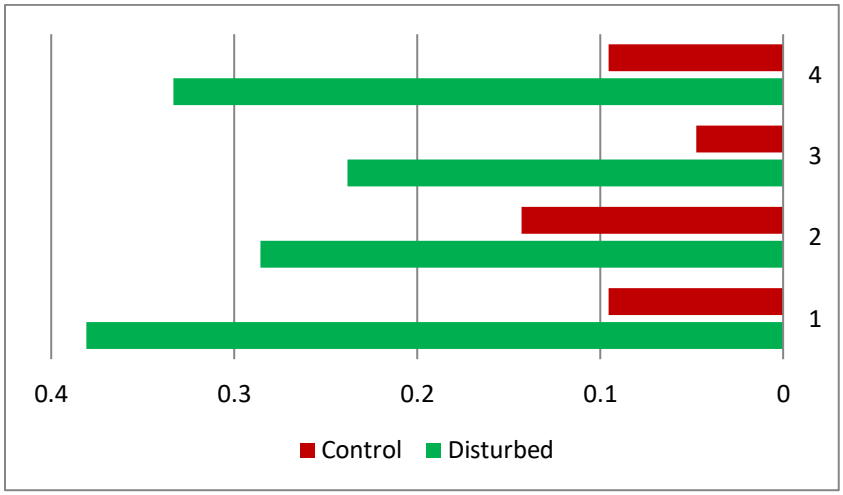

Figure 3: VFIP Results

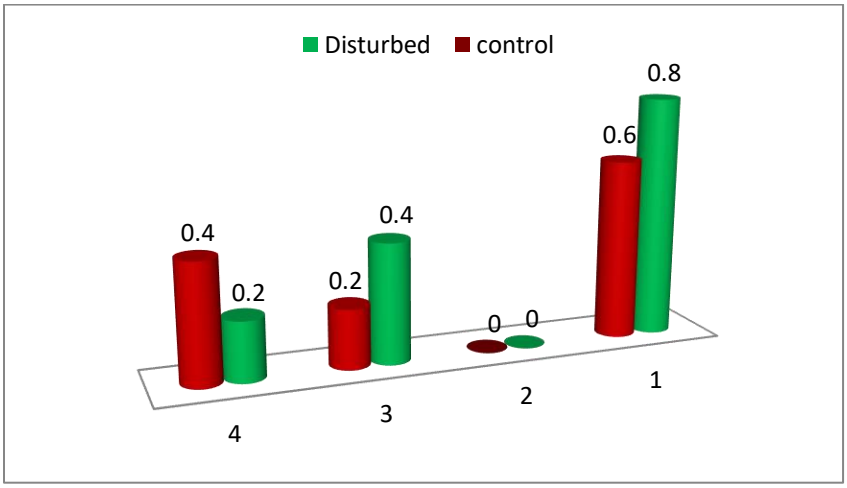

Figure 4: VFIC Results

TVFI Results

The results of TVFI indicated that the activity of the wild boar species is identical in control patches during various hours of the day and it is equal to 33.3% while activity rates of the species in the disturbed patches have been 50% and 25% and 25%, respectively, for day hours, night hours and dusk hours (figure 5).

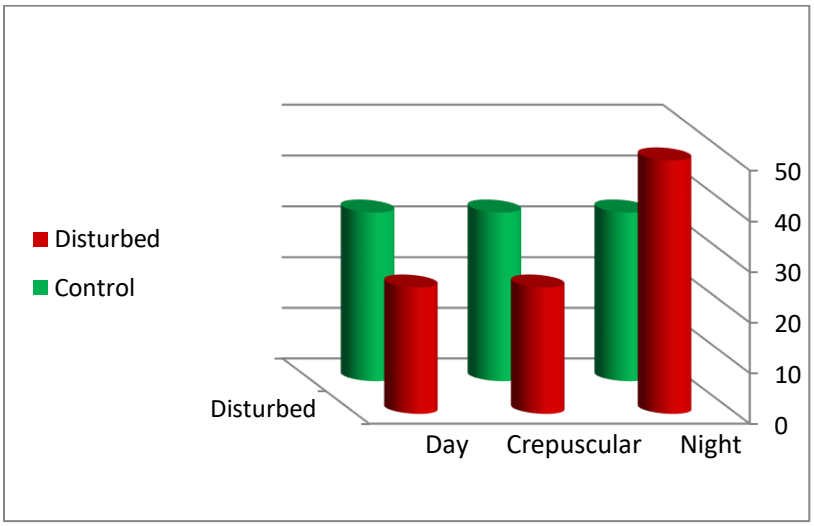

Figure 5: TVFI Results

Discussions

The present study explored the idea that how the open spaces in forest as results of the cutting or falling of trees influence the visitation frequency and pattern of wild boar activity; the data analysis indicated in general that the wild boars' visitation frequency is higher in disturbed patches than in forest regions featuring closed and dense canopy. In addition, it was found out that the activity pattern of the wild boars does not prove significant difference during various time periods studied herein, namely day, night and dusk. However, TVFI results indicated that activity pattern in the disturbed patches is more nocturnal whereas no significant difference was observed in the control patches in terms of nocturnal activity pattern.

Comparison of Methods Used to Study Wildlife

Many of the mammals are nocturnal and secretive and this subject has caused the development of indirect observation methods (Duckworth, 1998; Chiarello, 2000; Lopes, 2000 and Jachmann, 2001) such as the animal signs count and camera traping. Although the pellet defecation rate of the large ungulates is low, the present study shows that the pellet group count method gives an acceptable estimation of the wild boars' visit rates during a relatively short time. On the other hand may the relationship between presence signs and the number of individuals be complex or unknown; because the amount of the pellet left by an animal is neither always associated with its population density nor the inability in finding an sign necessarily demonstrates the inexistence of the species (Gese, 2004). On the other hand, the camera traping has resulted in a weaker estimation of the species visitation frequency and this could have come about for various reasons. Camera traping are very costly and a low number of them are naturally applied and they often simultaneously cover a lower number of plots as exercised in the present study, as well, quite unlike the methods of the animals' presence sign counting (like pellet and track). Moreover, the plots were monitored for a shorter time duration in the present study for such a reason as preventing the robbery of the cameras as well as shorter period of monitoring all the patches in the intended seasons (for the purpose of not missing the season), though the monitoring period should have been longer in order for achieving more reliable estimations (Tobler et al, 2008). On the other hand, the camera traps feature an imperfect recognition rate due to such factors as habitat characteristics and the technical properties of the camera (like detection area), the technique of using the camera (such as duration of camera traing) as well as the unknown processes of animal movement in the field of view (Burton et al, 2015). Furthermore, two types of camera traps were applied in the present study and this might have impacted the estimations because the sensitivities of various camera types differ (Rovero and Marshal, 2009). However, the method needs a shorter duration of time in contrast to the pellet group

count and it provides for a higher detection rate for an identical period of time (Bowkett et al, 2006). Besides being employed for the calculation of the relative abundance of the mammals as used in Liu et al (2013), camera traps are appropriate and reliable instruments for the investigation of the animals' activity pattern and visitation frequency as proposed in Ohashi et al (2013) whereas such a possibility is missing from many of the indirect observation methods like pellet group count.

Patch Selection and Activity Pattern of Wild Boar

The studies by Bordie et al (2015) indicate that there is no significant difference between the disturbed patches and the forest environments in terms of wild boar visitation frequency and Kuijper et al (2009) even express that the wild boars visit the closed canopy environments more frequently than the disturbed patches. Generally, various factors such as access to the resources and human interferences are effective in the habitat selection by the wild boars (Srivastava and Khan, 2009 and McClure et al, 2015). with the creation of the disturbed patches, More light reaches the soil, soil moisture and oxygenation capacity and microclimate is increased and therefore, the diversity of the herbaceous species (Kooch et al, 2011) as well as their quantities will be higher in these areas than the closed canopy areas (Kuijper et al, 2009), although their qualities are lower in these patches than the closed canopy forest regions (Molvar et al, 1993).On the other hand, the diversity of the tree species is increased after the emergence of disturbance in the forest gaps (Wright et al, 2003). These tree species were found predominantly of the fruit-bearing types in the studied disturbed patches. Therefore, the disturbed patches can be recounted as appropriate nutritional localities for the wild boar and can attract the species toward themselves.

Many studies have shown that wild boars preferentially use jungles as shelter (Olofsson et al, 2015) and, in case that the disturbed patches are taken into account as distinct habitats, they provide less shelter for ungulates like wild boar against carnivores, human disturbances and adverse weather conditions and, in this regard, closed canopy forest regions are more suitable. So, according to the foresaid cases, it seems that the factor that has more than any other caused the selection of open habitats or disturbed patches by the wild boars is the availability of food. On the other hand, the results of the present study indicated that the wild boars' activities in these preferred habitats (disturbed patches) is more of a nocturnal type whereas there is no significant difference between wild boar activity during various hours of day and night in the dense forest environments. Wild Boars are essentially more active during dusk (Oliver and Leus, 2008) but some factors like human interference (Ohashi et al, 2013), competition and predator - prey interactions (Wu et al, 2018) can change the wild boar activity towards nocturnality. On the other hand, the shortage of shelter, as well, can in turn, affect the increase in the intensity of the aforementioned factors hence the frequency of wild boar visitation during night as compared to the other hours of the day and night in the open regions can be justifying considering one or all of the aforesaid factors.

Overall Conclusion and Prospects

The higher visitation frequency of wild boars is indicative of the positive effect of the disturbed patches on these ungulates and the predominantly nocturnal activity pattern of them is, more likely, reflective of the negative effect of the disturbed patches on them. Therefore, the results of the present study support the creation of disturbed forest patches as caused by natural or Man-made factors if the forest managers particularly concentrate on the monitoring of disturbed patches as important habitats favored by ungulates. However, it is necessary to obtain a correct understanding of the effects of these patches on the other species before offering any managerial solution because a unidimensional approach considering only one species and even one order can be misleading in line with the conservation of biodiversity in the level of a landscape. So, further research can be conducted on the other species, especially the other species of mammal orders for the high sensitivity of them to the land visage variations.

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