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A review on habitats selection by Afghan Pika (*Ochotona rufescens*): Case study: the Lashgardar protected area in Hamadan Province

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ABSTRACT

Lashgardar Protected Area is a montainous landscape in the southen Hamadan Province which includes various mammals. However, biological and ecological conditons of such speceis have remained still unknown. The present study aims to examine the habitat selection by Afghan Pika (*Ochotona rufescens*) in Lashgardar Protected Area in two scales including landscape and home rangeof species since 2010 to 2011. Two methods of Anthropy Maximum (MAXENT) and Binary Logical Regression were used to model Pika's habitat in these two scales. Information layers in the landscape scale include slope classes, aspect, roads, villages and land coverage. The environmental variables considered and measured in the home range scale include topographic parameters (slope, aspect, and elevation over sea), percentage of vegetation, and percentage of bare soil and percent of rocky coverage (gravel, stone pieces, and cliff). The sampling was done by a random transect method with cropping of 80 peieces of sampling including 41 points of presence and 39 points of absence. The models indicated that Pikas of this region reside in rockyareas so far from roads and villages, and they chooseinterconnected rifts and holes between cliffson foothlills and steep valleys (more than 30%) as their favorite habitat. The results from the present study indictaed that cliff factor is a key to the presence of Pikas, which not only acts as a shelter against hunters and preadtors, butalso helps the establishment of body temprature balance of Pikas.

Key words: Habitat Selection; Pika (*Ochotona rufescens*);Logical Regression; Environmental Variables; Lashgardar Protected Area.

INTRODUCTION

Construction and protection of protected areas, in terms of biodiversity and ecosystems preservation and ecological processes play fundamental roles in maintaining the continuity of life and achieving sustainable utilization.One of these areas isLashgardar Protected Area in Hamadan Province with vast mountainous regionsas one main habitat of Afghan Pika in Iran (Fig. 1). Pikas are small mammals from the family of Lagomorpha that usually live in highlands and mountains and are severely sensitive to cold weather and damp microclimate, and fundamentally they cannot live and reproduce in other conditions (Verts and Carraway 1998; Smith and Weston 1990). Evidence suggests that contemporary Pikahas originated from Ochotonidaefamily and it has been divided into different types at early Miocene era. At that time Pikas found throughout North America, Asia, and Africa. Current distribution of Pikas include Holo-Arctic which covers North America, Europe and Asia (Gray, 1842). Only one species of the family named Afghan Pika or Klard or *Ochotona rufescens* has been reported in the Middle East. Afghan Pika lives in mountainous regions of Afghanistan, Pakistan, Armenia, Turkey and Iran (Hoffman et al. 2005; Smith et al. 1990). Reproduction rate of this species is high and the

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number of babies ranges from 5 to 7 and even sometimes over 11. Their breeding season extends from mid-April to late September, and during this time femalesmay labor up to 5 times (Smith et al. 1990; Nowak 1999). Because of high potential to reproduce, Pikascan be considered as pests to crops (Smith et al. 1990). Pikas are one of the most important members of their native ecosystem, and by collecting and feeding of different plant species play an important role in their distributionand also can be used as bait for many carnivores (Nowak 1999). In Iran this species is a prey for some endangered species such as the leopard. In TondouehNational Park, remains of Pika have been observed in leopard feces (Ziaei 2008). Afghan Pika is the only species of Pika which is used in laboratories in France and Japan and this may pose a threat to wild populations of this species in the future (Smith and Weston 1990; Smith et al. 1990). Also by expanding agricultural areas and fruit gardens surrounding the habitats of Pika, this species has been regarded as a pest of agricultural products and strictly controlledand this pose a threat to the population of Pikas (Smith et al. 1990). In Iran, due to predators, population of Pikas has increased, and lack of sufficient hay in meadows by improper livestock grazing has led to the excessive incursion of this speciesinto agricultural gardens and lands. Also,in some areas of Iran such as Kerman, it has become a pest (Ziaei 2008). So being aware of habitat condition of this species can provide guidance population management and conservation status of this species.

Although in other countries many studies have been conducted on different species of Pika, unfortunately few studies conducted on Pika and its distribution in Iran (Khaki Sahneh et al. 2011; Nouri 2010).Due to the lack of information on the habitat and ecology of this species in Iran, this study will attempt to model and to determine the utility and habitat preferences of Afghan Pika (*Ochotona rufescens*) in LashgardarProtected Area; so by identifying and emphasizing onpotentially desirable habitats in the region, the study provideeffective conservation and management plans..

MATERIALS AND METHOD

The study area

Lashgardar Protected Areaby an area of 15550.84 is located in Hamadan Province between 34″, 51' and 480 to and 49°, 16', 53″eastern longitude and 34°, 09', 17″ to 34°, 19' and 58″northern latitude in 8 km of east southern of Malayer city (Fig. 1). The areais located in low regions of 1750 meters and lands over 2928 meters high. Lashgardaris composed of two large mountain ranges with rocky streaks includingthe SardehMountainin a north-south directionlocated in the northwest region of the area.The most distinguished heights of this area include KalehGhandi, TakhtBaneh, KalDarvazeh and KouhSardeh by an elevation of 2850 as the highest mountain of the area. The second part consists of AhangaranMountain with an elevation of 2832 m, and also elevations known as Holarson and Kaleh Bid by an elevation of 2605 m in southern Lashgardar. In March 1990 the area was declared as a protected area. The best way to access the area is by a road located in the south of Malayer. The road passes through the Jourabvillage on its way to the east and then reaches the Aznaveleh checkpoint located in the border region.The road is paved and extends from the western edge of the area and after crossing the Jouzan Village finds its direction toward the east. Other pathways into the region are soil type. Another way which enables access to the northern partsis a road which has been split in eastern Malayer. After 4 km and possing through the Aznav village, this way reachesto the area at its northern boundary and it passes exactly on the northern border of the area. The climate of the area is semi-arid and its rainfall regime is of the type of Mediterranean. Average annual temperature is 11.2 ° C and average annual rainfall in the district is 316 mm. The most important mammals found in the region include wild goat, ram and ewe which the elevated regions of the area are a suitable place for such animals. In addition, carnivores such as wolves, foxes, jackals, hyena, badger and stone marten have been scattered in the region. Porcupine, hare and Pika also are other species of mammals found in this region which scattered in the most of the region, particularly the SardehMountin.

Sampling method

In order to facilitate sampling, the region is dividedinto two parts including Sardeh Mountain (northern part of Aznaveleh Station) and Ahangaran (southern part of Aznaveleh Station). Each of these areas has an area of about 8,000 hectares (Fig. 1). Since there was no evidence of the presence of the species in the southern part, i.e. the Ahangaranregion, this region was excluded.

Using experience and expertise of environment experts and protectors, the areas with the high probability of the presence of Pikas were identified,and within these areas using random linear transect method the sampling was done by direct observationor Pikas samples identification method (Morrison and Hik 2008; Beever et al. 2003; Smith 1974). This transects were designedt in the study area along the elevation gradient. The sampling initiation point in each section was randomly selected and transact were placed so that cover entire region under study and also different low and high regions along the way. Thus, 10 transects totalling 16 km were travelled during the fall 2010 and spring 2011. During this transects, in order to minimize spatial correlation between persons of species (Stevens and Olsen 2004, Gibbons et al. 1996). Sites within a local area are separated by at least 100m, which exceeds the largest nearest neighbour distance and home-range diameter for pika (Smith and Weston 1990) The square-type sample parts by a dimension of 50 × 50 m (Bhattacharyya et al, 2009; Smith, 1974) in terms of the presence and absence of the species or its indices were determined. In inside each plot, the coordinates of the center of the plot was recorded by GPS (Global Positioning System, Garmin72). In total, 80 sampled pieces including 41 points of presence and 39 points of absence was set to perform statistical analyses.

Analysis in landscape scale

In this scale Inductive models were generated using MaxEnt 3.3.1 software The Maxent software program(http://www.cs.princeton.edu/~schapire/maxent/) was used in this research project (Phillips et al. 2006). MaxEnt generates inductive models of probabilities of suitable habitat for a species over the landscape (Phillips et al. 2004, Phillips and Dudik 2008). Maximum Entropy (MaxEnt) is a presence only modeling software that predicts a species' potential distribution by statistically finding relationships between occurrence records and environmental variables (Phillips et al. 2004, Phillips and Dudik 2008). Model outputs from Maxent are continuous, ranging from 0 (least suitable) to 1 (most suitable).

The habitat variables studied

By studying the behavior and natural history of different species of Pika and previous studies conducted on Pika in various studied areas (Bruggeman 2010; Bhattacharyya et al. 2009, Wei-Dong and Smith, 2005, Nouri., 2010, Khaki Sahneh et al. 2011), the main parameters used as environment variables for modeling include: map of slope classes (in percent), aspect, elevation above sea level, map of roads and residential property and land cover map.

The information layers of these variables were obtained using physical resources maps of Lashgardar Protected Areaat the scale 1:1250000with resolution (100 × 100 m cells), previously prepared by the consulting engineers of catchment plan (2009) and to prepare information layersto insert the MAXENT software, Arc GIS 9.2 software was used.

The analysis in home range rank (Heady, 1998)

In this scale, the determined plots were examined.

Environmental parameters investigated

By studying the behaviour and natural history of various species of Pika which has been published in various sources (Bruggeman 2010; Bhattacharyya et al. 2009; Wei-Dong and Smith 2005), and also field observations of species in the study area, main factors as environmental variables were considered and evaluated, which include slope (in degrees), aspect (in degrees, from geographical north), altitude (in meters), percent of vegetation and bare soil, percent of Talus (2.0 to 1 m in diameter (Smith and Weston 1990)) and the percentage of rock cover (>1 m in diameter). These factors, in the field visits, were determined by the method of eye estimation and using gradiometer, compass and GPS. Based on the type of the collected data and different statistical models used in the present study, the most suitable prediction model for calcualtion based on binary data is binary logical correlation model (Pereira and Itami 1991).

The procedure is applied to model the correlation between binary dependent variable and one or more prediction environmental variable (independent). When the response variable is two-way (presence or absence of either 0 or 1) and prediction variables are quantitative and stratified, it is possible to predict the possibility of presence based on a set of dependent variables and using the Eq. 1 (Dobson 2001).

Equation1

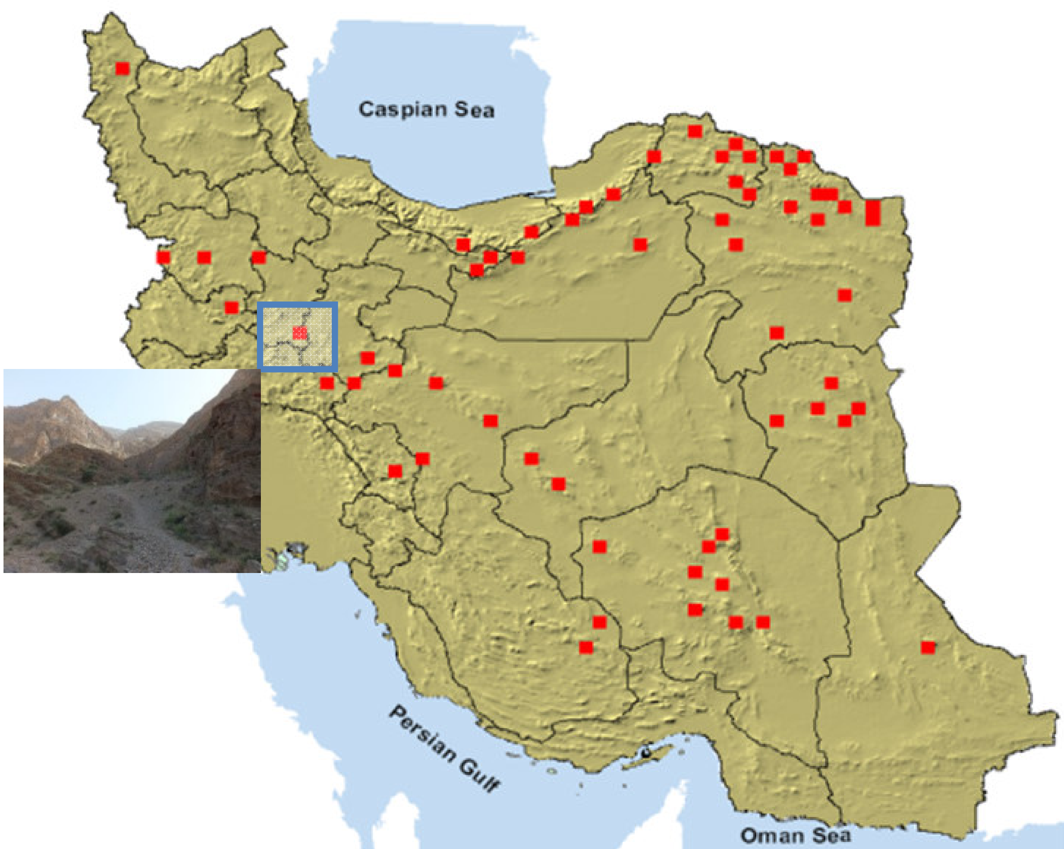
$$\mathrm{pr(x)}=\frac{\exp(\beta_0+\beta_1 x_1+\cdots+\beta_n x_n)}{1+\exp(\beta_0+\beta_1 x_1+\cdots+\beta_n x_n)}$$

x1, x2, ..., xn are independent predictor variables and nβ…, 1β,0 β are coefficients of the logistic and Pris the possibility of the presence of species (Hosmer and Lemeshow, 2000).In logistic regression, the qualitative variable namely presence-absence of species is selected as dependent variable which its relationship with environmental variables is examined through logistic regression. Since the shape of this function is sigmoid curve, andas most research confirms thenon-linear relationship between species and environmental factors, the use of this type of model fits our study. In the present study, to select the parameters influencing the presence and absence of species, the individual variables were separately inserted into the binary logical regression equation and their p values were calculated. Finally, the variables that did not establish a logical relationship (P≥5) were identified and excluded from the calculations (Bahadori, 2008). To determine the interaction between significant parameters, their correlations were calculated and out of two variables that had correlation over 0.8, one was selected. In this study, in order to select the most appropriate model Akaike Information Criterion was used. This method examines different models and so a set of variables with Akaikeh difference (ΔAIC) less than 2are entered into binary logistic regression equation as predictors (Gonzalez-varo et al 2007). And to determine the best model, Akaike weight criterion was used (Eq. 2).In this study to assess the accuracy of the model, G-test was used. In this test, the deviation of the original model is calculated using the model that all its coefficients are zero. The most appropriate model has the maximum deviation. G test has chi-square distribution with freedom degree n-1 (n equals the number of variables in the model). The null hypothesis of this test considers the logical regression slope as zero (Alizadeh 2009) and to assess how to describe data by the model (goodness of fit), the Pearson, Deviance and Hasmer-Lemen show tests were used. (P<0.05) in the test indicate that the collected data and the data predicted by the model are not consistent with each other, and the description of the model by the model is wrong (Alizadeh 2009). In this study we performed the calculation of the binary logistic regression by using software Minitab13.1 (Minitab200), and the calculation srelevant to the optimal model was done using Akaike Information Criterionin 6.0 Statistica (statsoft 2001).

Equation2

$W_i=\exp(-0.5*\Delta i)/\ \Sigma\exp(-0.5*\Delta i)$

$\Delta i = AICi - \min AIC$



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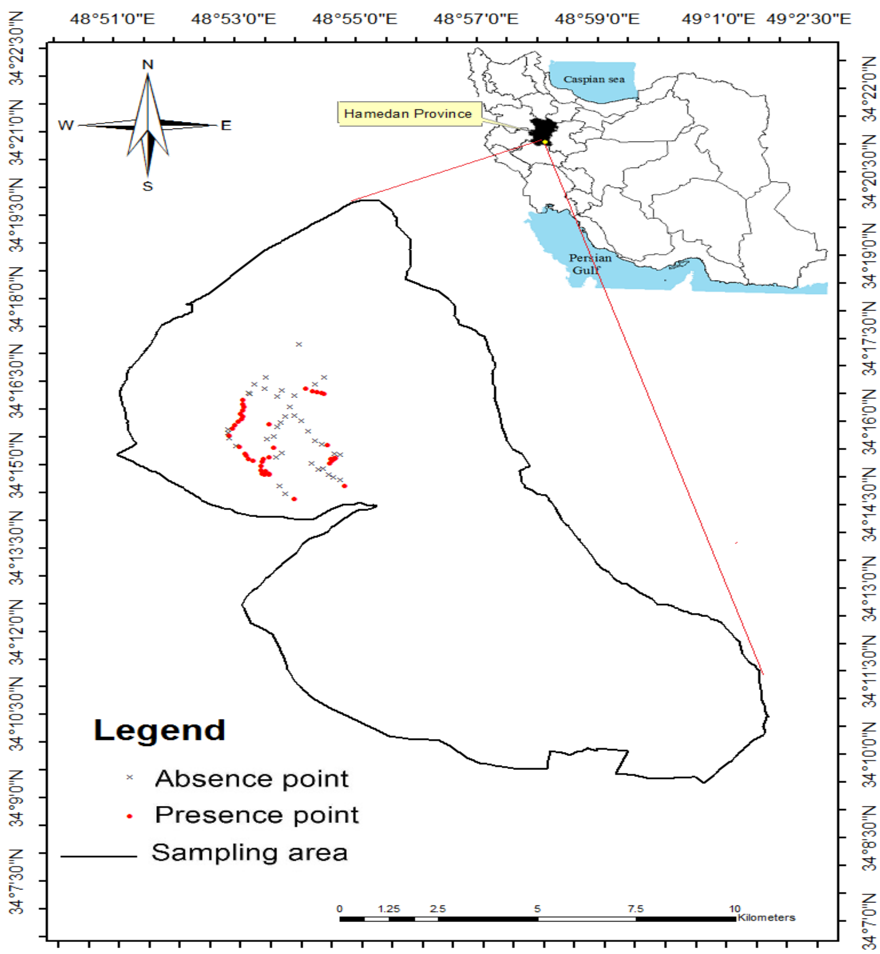


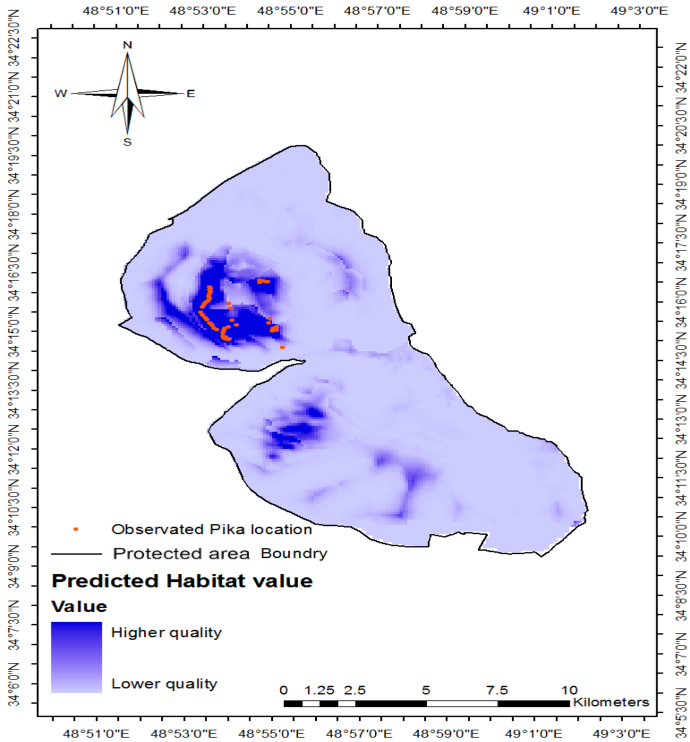
B

Fig. 1. A: *Ochotona rufescens* distribution points in Iran. **B:** Lashgardar Protected area in Zagros mountin, Iran illustrating sampling points (fall 2010 and spring 2011) **.**

RESULTS

There are various files in Maxent outlet. The Plots folder contains all the pictures of graphs, maps, and charts that Maxent creates from the run. *Ochotona rufescens*.asc incudes a prediction map by asc format which could be converted into raster file and then classified, and *Ochotona rufescens*.png which is regarded as the image of distribution prediction.
The prediction map designed by Maxent is a continuous possibility map which it was categorized into 5 classes in Arc GIS environment, and we assume that at the classes with higher ranks, the possibility of the presence of Pikas is higher (Fig2). The prediction map shows that the highest habitat suitability exists in One Vally, Chap vally, Romese in Lashgardar, and this location takes privilege of the maximum points relevant to the presence of Pikas.

The Maxent model's internal jackknife test of variable importance and Analysis of variable contributions showed that distance to road and land cover were the three most important predictors of *O. rufescens* distribution (Fig. 3; Table 1). The environmental variables that contributed the most to the model were distance to road and land cover with 54.8% and 31.5%, respectively (Table 1). And Results derived from curves showed that the probability of the presence of *O. rufescens* increase with the increase in distance to road (Fig. 4).



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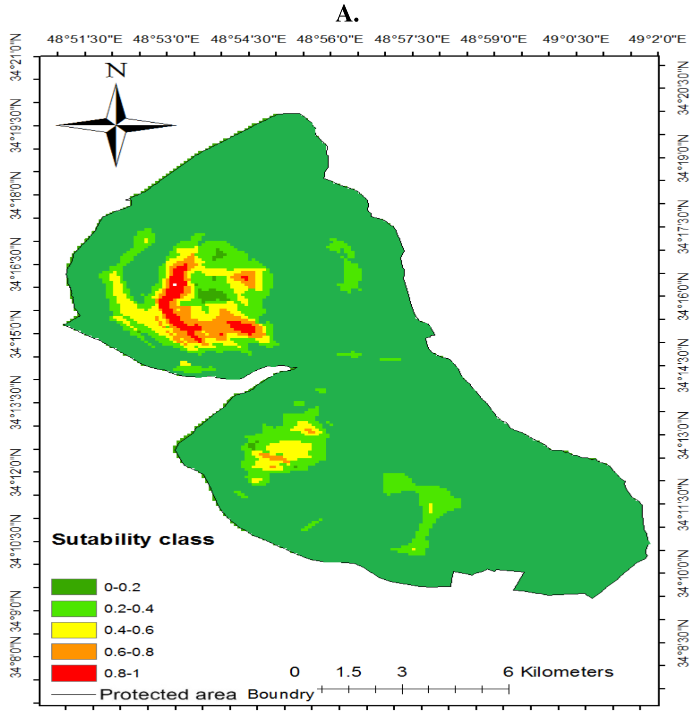

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Fig. 2. Predicted potential suitable habitat for *O. rufescenc*: Maps depicting areas in which the habitat is suitable for *O. rufescens* to succeed and present in Lashgardar protected area from the cross-validated Maxent models **a:** continuous and **b:** reclassified into 5 equal-sized probability classes.

Table 1: Selected environmental variables and their percent contribution in Maxent model for *o.rufescenc* species in Lashgardar Protected area

No.	Environmental variable	Percent contribution	Source/Reference
1	Dis-road	54.8	**Generated in GIS**
2	Land cover	31.5	**Generated in GIS**
3	elevation	4.8	**Generated in GIS**
4	aspect	4.4	**Generated in GIS**
5	slope	2.8	**Generated in GIS**
6	Dis-village	1.8	**Generated in GIS**

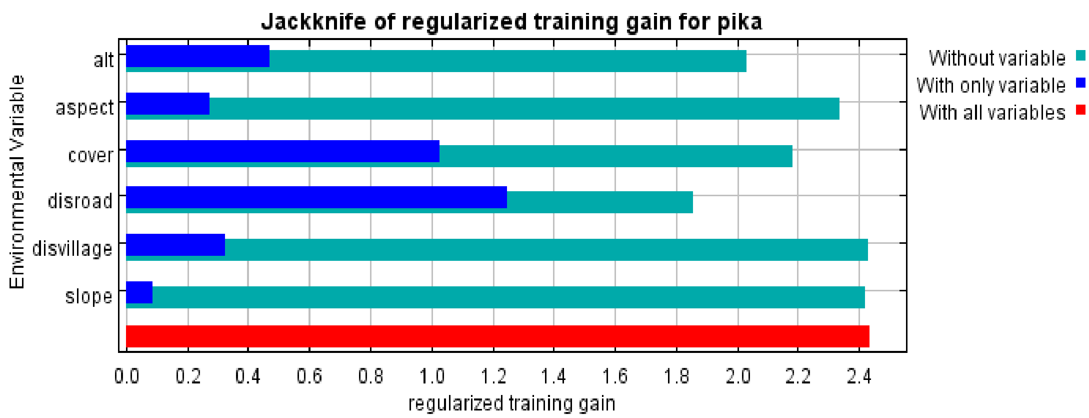

Fig. 3. Results of jackknife evaluations of relative importance of predictor variables for *O.rufescenc* Maxent model.

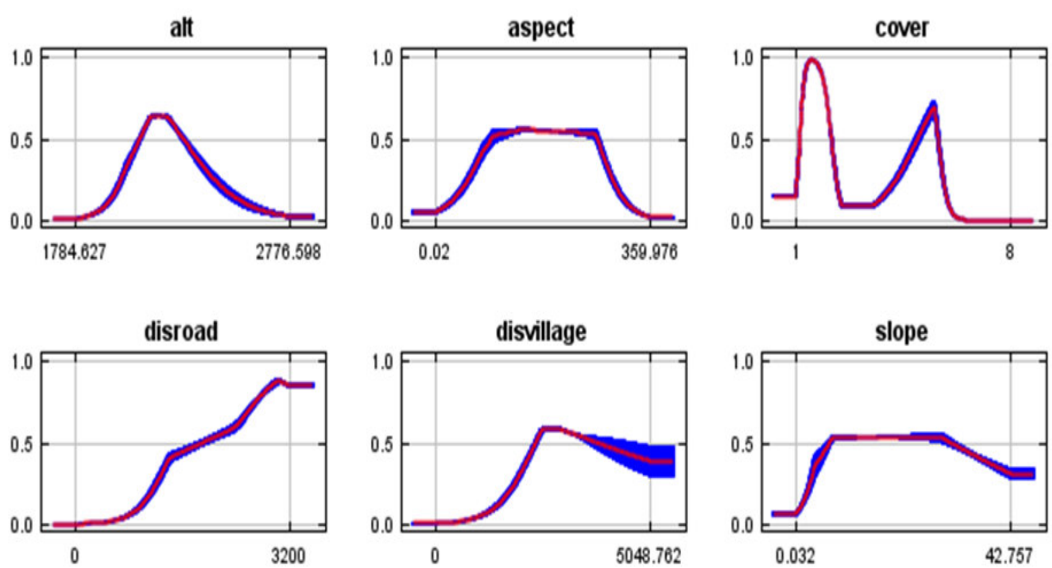

Fig 4: Response curves affect the Maxent prediction of *O. rufescens*. These curves are generated for the most important variables and show the mean response of the cross-validated models with 10 replicate runs (red) and the mean±one standard deviation (blue).

Area under (ROC) Curve

Areas under the curve (AUC) values are used to evaluate model performance by measuring the threshold independent relationship between the proportions of pixels correctly and incorrectly. Typical AUC values range from 0.5(random prediction) to 1.0 (perfect prediction ability), meaning that the closer to 1.0 the better the model is at distinguishing presence correctly classified (Pearson 2007). Swets (1988) provided a guide outlining AUC values and model performance. AUC values ranging from 0.9-1.0 are excellent, 0.8-0.9 is good, 07-0.8 is fair, 0.6-0.7 is poor, and 0.5-0.6 indicates model failure**.** The average test AUC for the replicate runs is 0.962, and the standard deviation is 0.026.

Home range scale

In order to select the variables influencing the presence and absence of the species, the individual variables were separately entered into the binary logical regressions in Minitab 14 software and their P values were calculated (Table 2). And the variables that did not make the logical connection (P>0.05) indicated that they had no effect on the presence of the species and so they were eliminated. Then, to investigate the significant interaction between the parameters, their correlation in the software Minitab14 was calculated and of both variables with a correlation of higher than 0.8 a variable was selected. The matrix results showed that the variables namely the percentage of vegetation + bare soil and the percentage of cliff cover had a correlation over 0.8, which as cliff cover was of utmost importance in the lives of Pikas, so it was chosen (Bhattacharyya et al, 2009; Bruggeman, 2010).

The final variables that were selected for modeling were as follows: altitude, slope, aspect, percent of Talus and rock and cliff cover. In order to select the most appropriate set of environmental variables to predict the presence of the species in the habitat, Akaike Information Criterion was used in the Statistica software.

So environmental variables were entered in Akaike Information Index and then 3 sets of variables entered into the regression with the Akaike difference (ΔAIC) less than 2 were selected as the predictors of the model (Table 2).

The log-likelihood of the models was calculated using G-statistic. This tests whether all coefficients associated with the model variables are equal to zero versus not being equal to zero. This value is especially useful when the P-value is>0.05. The log-likelihood of the four models (range= -4.560 to -13.127), G (range= 66.537- 83.672), and P-value (all P= 0.00) were similar. Thus,there is sufficient evidence that at least one of the coefficients is different from zero, given the accepted α level is 0.05.

Goodness-of-fit Tests

We performed Pearson, Deviance, and Hosmer-Lemenshow tests to verify how well the models describe the data. The Deviance, Pearson and Hosmer-Lemenshow tests had large P-values, indicating there is a good fit of the data in the models (Table 3).

DISCUSSION AND CONCLUSIONS

Landscape scale

In line with the objectives of the study, the results indicate that the parameters of the distance from the road and land cover are the most important factors that determine the landscape-scale distribution in the study area (Table 1 and Figure 2).

According to the Afghan Pikas habitat suitability map (Figure 3) and environmental variables map for studying the area 5), in terms of land cover, this species selected the lands with rocky protrusions and low density vegetation as its ideal habitat.

The results from Table 1 and Jackknife test results (Table 1) show that the most important factors in the landscape scale include distance from roads, land cover and elevation. Secondary to these variables are geographical aspect, slope and distance to the next village. In fact, the most important factor in choosing Afghan Pikas habitat in landscape scale in the study area is distance to the road. The results are in consistency with those of Asmus Hersey and colleagues (2008) on the American Pika. Also, using ecological niche factor analysis (ENFA), Nouri (2011) modeled Pika habitat suitability in the Lashgardar Protected Area and concluded that the most important factor in determining Pikas' habitat suitability is the distance from the road and village and then slope, respectively (Nouri, 2010).

The results showed that the probability of the presence of Pikas increases with distance from the road. High scores for the variables including distance from the road and land cover and altitudein (table1) suggest that distance from roads and land cover are very significant variables for Pikas. This can be due to Pikas' special habitat requirements and their sensitivity to temperature conditions (MacArthur and Wang, 1974; Smith, 1974) which it will be covered in the succeeding parts. Also in a study by Hasani and Varasteh (2013) in Golestan National Park the land cover factor played a major role in the spread of Pikas. The results showed that the habitat chosen by Pikas in Golestan National Park were areas with cliff and stone cover and slopes 5 to 21 degrees.

Pikas have a small displacement power, so coverage factors can play a major role in their survival. Due to their specific physical structure and their sensitivity to temperature, Pikas require cliffs to reduce fishing pressure and thermal protection (Bunnell & Johnson 1974; Bruggeman 2010, MacArthur & Wang, 1974; Wei-Dong and Smith 2005). In fact Pikas use cliffs as nests and an asylum against the hunters (Bunnell and Johnson, 1974), and due to their bodily high metabolism, they use cool shades between cliffs as a help to achieve behavioural adaptability to regulate their body temperature (MacArthur & Wang 1974).

During the observations and visits on the area during the study, in the highlands without any cliff cover, as there was the threats of hunting birds such as eagles and starlingtwo factors namely altitude and aspect lost their importance and then Pikas or their traces were not observed.

According to the results obtained in this study and other studies about Pikas (9, 10, 11, and 21) as well as the project ever done in the study area (3&6) on Pikas, it seems that one of the key factors in the selection of habitat structure by Afghan Pikas was land cover structure.

It could be concluded that on the landscape scale, Pikas select their habitat (landscape) in rocky hillsides with highslopes (slope of 30 to 60 and more than 60%) and severe mechanical damages,areas with zone surface erosion and dissolution of tree branch water channel on the eastern and southern slopes.

Home range scale

The three best selected models were identified among all models using AIC (i.e., ΔAIC < 2) (Table 2). Because the Model 1 has a higher Akaike weight than the Models 2 & 3,it is more capable of predicting the presence of the species in the region. As a result, this model is used to interpret the distribution of species in the region. The final equation for modeling the selected habitat of Afghan Pika in the Lashgardar Protected Area is as follows:

$$Y_i = -48.7683 + 1.11588 \cdot SLOPE + 0.46122 \cdot ASPECT + 0.29248 \cdot Talus + 0.46012 \cdot ROCK$$

Based on the above model, some of environmental parameters such as slope, aspect, rocky and gravel cover positively influence the presence of the species. Although practically all environmental factors have an interaction, in the present study, the impact of environmental factors on the distribution of Pikas can be categorized into two categories as follows. Based on the type of impact that includes parameters having a direct impact on the presence of the species (slope, cliff and gravel coverage), and the parameters by an indirect effect on the presence of the species (aspect). In addition, another type of classification is based on the type of parameters which include stopography (slope, aspect, elevation) and the parameters of the coverage or the resources required (Bruggeman 2010) which consists of cliff and gravel covers.

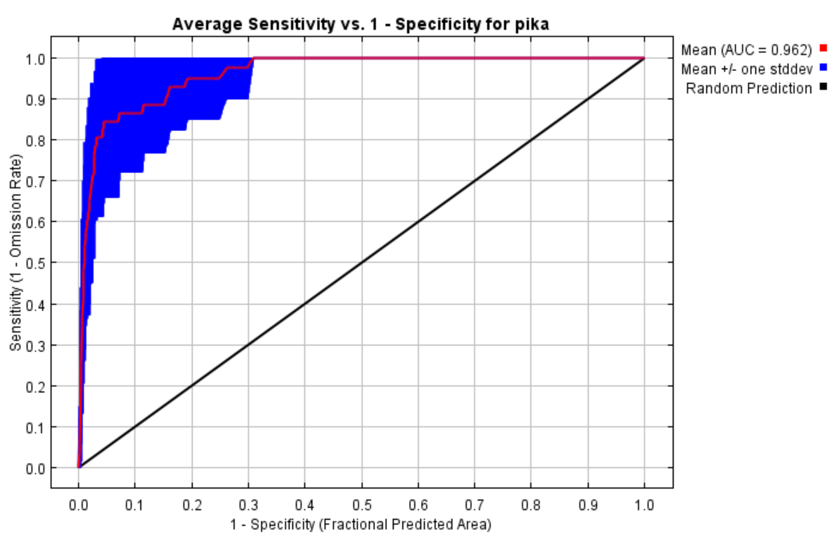

Fig 5. Area under the (ROC) Curve.

Table 2. Generalized linear models of the presence/absence of *o.rufescenc* against five environmental variables. Models were ranked in each case by best AIC from to worst fitting model, and only models with DAIC , 2 are listed. We included the standardized coefficients, allowing assessment of relative importance for each variable included in each model.

	Predictors in model									
Model	**slope**	**rock**	**talus**	**aspect**	**Altitude**	**df**	**AIC**	**ΔAIC**	**P**	w_i
1	1.11588*	0.4601 *	0.29248*	0.461221*		7	23.28096	0	0.000	0.4280
2	0.38589*	0.1211 *				2	23.47640	0.19544	0.000	0.3882
3	1.11141*	0.4622**	0.29369*	0.436472*	-0.0008*	8	24.97278	1.69182	0.000	0.1837

** P <, 0.005.
* P ,< 0.05.

Table 3. Goodness-of-fit tests of the presence/absence records to verify how well the models describe the data.

	Method	**X2**	**df**	**P**
Model 1	Pearson	9.53672	63	**1.000**
	Deviance	9.12017	63	**1.000**
	Hosmer-Lemeshow	0.39982	9	**1.000**
Model 2	Pearson	12.8594	62	**1.000**
	Deviance	11.9312	62	**1.000**
	Hosmer-Lemeshow	1.2405	8	**0.996**
Model 3	Pearson	9.42451	62	**1.000**
	Deviance	9.10738	62	**1.000**
	Hosmer-Lemeshow	0.46110	8	**1.000**

According to the results of statistical analysis on the home range scale, the final variables influencing the distribution of the species in Lashgardar Protected Area in terms of their importance to the presence of species, according to the slope of the regression coefficients include slope, rocky cover, aspect and Talus (Table 1). In this study, according to the area under study and the studies done on Pikas, cliff (stones with more than 1 m in diameter) and pebbles were considered as small stones less than 2.0 cm in diameter (Bruggeman 2010).

The results obtained from the regression analysis and the observations made at the time of the study indicate that the two variables namely cliff cover and slope have a positive correlation with the presence of the species, i.e. by an increase in the amount of these two factors the probability of the presence of Pikas will be increased.

Furthermore, according to the results from the analyses done and AkaikeWeight Criterion, these two variables have been placed in a separate model ranked second out of three models, indicating the significance of these two variables (Table 2) and these two parameters are effective on the presence of the species in the area, and given the higher coefficient of the slope (1.11588) the slope factor is the first necessary factor to the presence of the species in the area. Also, the parameters namely the percentage of pebbles and stone positively influence the presence of the species in the area, i.e. higher amount of these factors in the region, the higher probability of the presence of Pikas. Therefore, it could be inferred that Pika lives in cliff and gravel slopes. This is totally consistent with morphology and ecology of the species. In fact, Pikas,unlike other members of its type such as the rabbits, have very short legs covered with bristled fins.

As a result, due to the reduction in hunting pressure, Pikachoosessteepcliff areas. In practice, the observations made during the study confirmed the above indications. This result is in agreement with the observations by Ricankovaon Alpine Pika and the studies done by Wei-Dong and Smith (2005) on Ili Pika.

Both species choose cliff and gravel slopes with rifts and gaps as their ideal habitat (Wei-Dong & Smith 2005; Ricankova, pers. Comm.) Bunnell and colleagues in 1974 reported that cliffs'physical properties such as size and availability influence the abundance and distribution of American Pikas. The results of this study also confirmed that the size and quantity ofcliffs has the same impact on the distribution of Afghan Pika as American Pika.

Since Pika constantly demand a territory (Peacock 1997), and since each person has its own territory (Smith & Weston 1990), the percentage of cliff cover as a necessary resource for AfhanPikacan reduce hunting pressure and create more territory and so positively impact the abundance of the species. This issue is in agreement withthe study results of Franken and Hik (2004), However, in the present study, the investigations were made in the plots rather than habitat patches.

Pikas use cliff both as nest and shelter against predators (Bunnell et al, 1974). In addition, they use it as a refuge against high temperatures in summer and winter (Bruggeman 2010).

Relationship between the presence of species and gravel and rock is another habitat characteristic that is relevant to the issue of shelter for Pika. The point that must be considered is that in addition to the presence of rocks, rifts between rocks can bealso effective on Pikas.This issue has been shown in the model with positive coefficient of pebble and rock amount. Due to their specific physical structure and their sensitivity to temperature (Beever et al. 2003; MacDonald & Brown 1992; MacArhur & Wang 1974; Wei-Dong & Smith 2005), Pikasneed the cliffs to reduce fishing pressure and thermal protection ((Bunnell et al. 1974; Bruggeman 2010; Wei-Dong & Smith 2005).

Pikas have a high metabolic rate so that while resting, their body temperature has only a distance of 3 ^{0}Cfrom extending and critical border (MacArthur & Wang 1973, MacArthur & Wang 1974; Smith 1974). Due to lower control ofPikain regulating body temperature, Pikas use behavioral adaptations in warm seasonsin order to regulate body temperature. One of these adaptations is use of shade and cool rifts between cliffs to lower body temperature (MacArthur & Wang 1974; Smith 1974). So, in order to feed and find baits, they must be close to cliffs. In fact, Pikas are often observed around their nests attempting to utilize sun heat (Ziaei 2008). So when they distance themselves from their refuge which is interconnected cliffs and rifts, there must be another refuge to enable them to displace longer and to feed on more varied and abundant plants. So when the rift between the cliffs is so much, there must be a small cliff or some pebbles to enable Pikas to easier find a shelter (which in the present study, the positive coefficent of gravel and talus this issue). As it was said earlier, Pikas are not so much capable of displacement due to thier short legs and abundant fins of thier foot. Also, Pikas have some problems with regulating their body temperature in heating seasons. Therefore, Afghan Pika does not prefer habitatswithout gravel and rock, and the places where the distance between the cliffsis so limited.

Based on the results from the present study and other studies done on Pikas (Bhattacharyya et al. 2009; Wei-Dong & Smith 2005; Bunnell et al. 1974; Bruggeman 2010), it could be seen that one main factor in habitat selection by Pikas is land cover structure. So the size of the sample must indicate Pika's habitats vegetation characteristics. Therefore, species home range scale was used to reflect the requirements of the species. As a result, as there is no evidence of the size of the Afghan Pika home range, to resolve such problem and to determine the size of the sampling plot, the home range scale of other species of Pika and the size of the plots used in other Pikas habitat studies were applied; so, the size of the plots in the present study was set 50*50m.

In this study, according to the final model and other models (Table 2) the variables including elevation over sea level and aspect were secondary to the distribution of species (Table 4). According to the Model 3, altitude parameter has a negative correlation with the presence of species. In fact, the role of elevation is indirect due to the effect of other parameters.

The most important role of elevation can be adjusting the temperature in the altitudes; these results are in agreement with the results of Beever and colleagues in 2003.

Since Pikas are known as mammalian herbivores that attempt to collect heaps of plants (Dearing 1996, Richardson 2010) and may choose different plant species at different stages in their development based on the quantity of nitrogen (Morrison et al. 2004; Morrison & Hik 2008), so they prefer to choose elevated areas due to the diversity of plant species.

Another parameter effective on Afghan Pika in the present study is aspect. The results indicate that the aspects namely southwestern, western and northwestern are the preferred ones for the Afghan Pika in the Afgahn Pika Station.

The research results from Franken and Hik (2004) revealed that the parameter namely aspectinfluences the new colony site selection and retention of Pikas in the area, so that the location of new colonies sites was more toward southwest rather than northeast.

Increased elevation and distance from the geographic north (west and southwest directions) cause more lasting snow and the snow melting slower than the lower elevations and slopes facing north. Snow cover can be used as an insulation for protection against the extreme coldness of winter in mountainous regions and protect underlying vegetation from frost. In addition, in the spring, as snow in high elevation areas melts slower than low elevation areas, various watery plants are grown and Pikas are become more inclined to move toward high elevation areas. The point that should be addressed here is that the parameters namely elevation and aspect are less important than other parameters. This indicates that these two variables are secondary to the variables including slope, cliff and gravel cover and these variables indirectly affect the presence of the species. The results from the study also confirm the issue. During the visits which took place in the area, Pikas were absent mostly in the places including highlands permanently exposed to sunlight (northern and eastern aspects) without sufficient rates of rocky coveror spaces between cliffs (no rock or gravel), and areas without high slopes such as edges and peaks; this justifies the negative coefficient of the parameter of altitude in the Model 3.

In total, according to the results of statistical analysis and observations that were made during the period of study, the habitat chosen by Afghan Pika in the area under study were valleys and cliffs with multiple interconnected rifts and gaps. Notably, Pika avoids open areas without steep near roads and residential areas. This result indicates that habitat selection criteria by Afghan Pika are the same asthose of Alpine Pika,American Pika and Ili Pika(Wei-Dong & Smith 2005; Smith & Weston 1990; Bruggeman 2010 Bunnell et al. 1974; Beever et al. 2003;Ricankova, *pers. Comm*). In fact, the cliff is the key factor for Afghan Pikabecause it actsfor them as a shelter against predators, especially hunting birds and an important device for regulating and lowering body temperature. It should be noted that the effect of each parameter on the Pikais relative and depends on the effect and amount of other parameters.

REFERENCES

Aliabadian M, Darvish J and Kiabi B. 1996. Study of intraspecific variation of pika (Ochontona rufescsns Gray 1842) in Khorasan province (Ochontonidae- lagomorgha) Iranian J Biol 3 (3 & 4): 286- 303.

Alizadeh Shabani A, Mcarthur L and Abdollahian M. 2009. Comparing different environmental variables in predictive models of bird distribution. Russian Ecol 40:537–542.

AsmusHersey K, Maxfield BDK, Labrum K, Wright A and Bunnel, K. 2008. The Status of the American Pika in Utah- Draft Report. Utah Division of Wildlife resourse.s alt Lake city,Utah.

Bahadori Khosroshahi F, Alizadeh Shabani A, Kaboli M, Karami M, Shariati Najafabadi M and Ahmadi-Mamaqani Y. 2011. A Probabilistic Model for Presence of

Eurasian Nuthatch (Sitta europaea) in the Alborz Mountains, Northern Iran. The Wilson J Ornithol 123(4):741-747.

Bahadori F. 2008. Habitat sutability modeling of Eurasian Nutatatch(Sittaeuropaea) at Northern Alborz, Iran., MS Thesis, University of Tehran, Iran, 92p.

Beever EA, Brussard PF and Berger J. 2003. Patterns of apparent extirpation among isolated populations of pikas (*Ochotona princeps*) in the Great Basin. J Mammalogy; 84:37-54.

Bhattacharyya S, Adhikari BS and Gopal SR. 2009. Abundance of royle's pika (*Ochtona royle*i) along altitudinal gradient inuttarkhand, western himalaya Hystrix It. J. Mamm. (n.s.); 20(2):111-119.

Bruggeman JB. 2010. Pilot study on factors Affecting Pika population In the north cascades ecosystem Beartooth Wildlife Research, LLC700 Ninth Street. Final report. California Press, Berkeley.

Bunnell SD and Johnson DR. 1974. Physical factors affecting pika density and dispersal. J Mammalogy; 55(4): 866-869.

Franken RJ and Hik DS. 2004. Influence of habitat quality, patch size and connectivity oncolonization and extinction dynamics of collared pikas Ochotona collaris. J Animal Ecol 73:889-896.

Gray JE. 1842. Descriptions of some new Genera and fifty unrecorded species of Mammalia. Ann. Mag. Nat. Hist., series 1, 10:255-267.

Guisan A and Zimmermam NE. 2000. Predictive habitat distribution models in ecology. Ecological Modelling; 135:147–186.

Heady LT. 1998. Home range, habitat, and activity patterns of pygmy rabbits (*Brachylagus idahoensis)* in southeast Idaho. M.S. Thesis, Idaho State University, Pocatello, ID. 72 pp.

Hoffman R, Smith A, Wilson D and Reeder D. 2005. Mammal Species of the World, third edition. John Hopkins University Press: John Hopkins University Press.

MacArthur RA and Wang LCH. 1973. Physiology of thermoregulation in the pika, Ochotonaprinceps. Canadian J Zool 51:11-16.

MacDonald K and Brown J. 1992. Using montane mammals to model extinctions due to global change. Conservation Biology 6: 409-415.

Minitab Statistical Software. 2000. MINITAB. Version13.1. Minitab, Pennsylvania State University, University Park, USA. www.minitab.com.

Morrison SF and Hik DS. 2008. When? Where? And for howlong? Census design considerations for an alpine lagomorph, the collared pika (Ochotona collaris). Pp. 103–113 in Lagomorph biology: evolution, ecology, and conservation (P. C. Alves, N. Ferrand, and K. Hacklander, eds.). Springer-Verlag, Berlin, Germany.

Nouri Z. 2010; Modeling of Pika habitat suitability by ENFA method (case study: Lashkar Protected Area in Hamadan), MA Thesis, Islamic Azad University of Lahijan, P. 54.

Nowak R. 1999. Walker's Mammals of the World, Sixth Edition. Baltimore and London: The John Hopkins University Press.

Ognev S.I. 1940.Mammals of the USSR and adjacent countries(Mammals of eastern Europe and northern Asia). Vol. IV: Rodents. "Nauka," Moscow-Leningrad.

Peacock MM. 1997. Determining natal dispersal patterns in a population of North American pikas (*Ochotona princeps*) using direct mark-resight and indirect genetic methods. Behavioral Ecology 8:340-350.

Pearson RG, Raxworthy CJ, Nakamura M and Peterson AT. 2007. Predicting species distributions from small numbers of occurrence records: a test case using cryptic geckos in Madagascar. J Biogeography 34: 102-117.

Pereira JMC and Itami RM. 1991. GIS-based habitat modeling using logistic multiple regression: a study of the Mt. Graham Red Squirrel. Photogramm. Eng. Remote Sen; 57, 1475–1486.

Phillips SJ, Anderson RP and Schapire RE. 2006. Maximum entropy modelling of species geographic distributions. Ecological Modeling, 190: 231–259.

Phillips SJ and Dudik M. 2008. Modeling of species distributions with Maxent: new extensions and a comprehensive evaluation. Ecography 31:161-175.

Phillips SJ, Anderson RP and Schapire RE. 2006. Maximum entropy modeling of species geographic distributions. Ecological Modelling 190: 231-259.

Ricankova, Vera. Personal Communication.

Smith A and Weston M. 1990. Ochotona princeps. Mammalian Species; 352: 1-8.

Smith, A. T. 1974. The distribution and dispersal of pikas: Influences of behavior and climate. Ecology; 55:1368-1376.

Smith AT, Formozov NA, Hoffmann RS, Changlin Z and Erbajeva MA. 1990. Chapter 3: The Pikas. In: J. A. Chapman and J. C. Flux (eds), Rabbits, Hares and Pikas: Status Survey and Conservation Action Plan, pp.

14-60. The World Conservation Union, Gland, Switzerland.

Stevens DL and Olsen AR. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association; 99:262–278.

Swets JA. 1988. Measuring the accuracy of diagnostic systems. Science 240, pp. 1285–1293.

Tarh Abriz Counselling Engineers. 2009. Detailed feasibility studies of Lashkar Prottected Area in Hamadan (Physical Resources), Environemnt Organization.

Verts BJ and Carraway LN. 1998. Land mammals of Oregon. University of California Press, Berkeley.

Wei-Dong L and Smith A. 2005. Dramatic decline of the threatened Ili pika(Ochotona Iliensis) in Xinjiang, China. Oryx 39: 30-34. Western Regional Climate Center.

Ziaei H. 2008. A desert guide on Iran Mammals; Environemnt Foudation; Tehran, P. 219.