Journal of Wildlife and Biodiversity 3(1): 58-65 (2019)

by Arak University, Iran (http://jwb.araku.ac.ir/)

DOI: 10.22120/jwb.2019.98454.1041

Research Article

Seasonal changes in the distribution of suitable habitats for the Persian goitered Gazelle (*Gazella subgutturosa*) in Isfahan province

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Received: 26 November 2018 / Revised: 25 December 2018 / Accepted: 5 February 2019 / Published online: 9 February 2019. Ministry of Sciences, Research and Technology, Arak University, Iran.

Abstract

Persian Goitered gazelle (*Gazella subgutturosa*) is one of the globally and locally threatened bovines inhabiting in the plains of Iran. There are many studies conducted on the habitat suitability modeling for the species in Iran, however, seasonal variations in the distribution of suitable habitat has not been yet evaluated. To this aim, we used independent species presence data which were collected in the field surveys as well as those which was reported by the game guards during spring 2017 to winter 2018. Maximum entropy modeling approach (MaxEnt)) was applied to relate the habitat suitability of the species in each season to the potential environmental variables in the presence points. The outputs of the model indicated that elevation is the most important variable contributing to the habitat suitability of the species in each season. Moreover, the distribution of suitable habitats in autumn differs drastically from other seasons. The current protected area network of Isfahan province indicates the lowest efficiency regarding the conservation of suitable habitats in the fall which is very critical as the mating event will occure. Isfahan mostly encompass the suitable habitats for spring and the least situated suitable habitats belong to autumn. Based on our findings, we suggest that the current boundaries of protected area network in Isfahan should be reconsidered and redesigned to cover the year round suitable habitats for the species.

Keywords: Goitered gazelle, habitat suitability modeling, protected area's network, seasonal dispersal.

Introduction

The Persian gazelle or goitered gazelle, *Gazella subgutturosa* (Gueldenstaedt, 1780), distributed from the Arabian Peninsula through Mongolia's arid and semi-arid habitats (Karami et al. 2002, Ziaei 2008). Gazelles inhabits a wide range of semi-desert, steppe, bush land and woodland habitats in Iran. In the past, the species had a wide distribution in plain areas of the country, however, due to poaching and habitat destruction it has become extirpated in the most parts of the protected and non-protected areas (Ziaei 2008). Moreover, this gazelle is listed as a vulnerable species under the criterion A2 because of ongoing population declines. The decline is estimated to have exceeded around 30% in the recent 14 years (three generations) (IUCN 2017). Different aspects of the species characteristics including morphology, taxonomy and population ecology have been already investigated by different researchers (e.g. Sempere *et al*. 2001, Karami *et al*. 2002, Akbari *et al*. 2002, Farhadinia *et al*. 2008, Amininasab and Akbari 2011). Habitat suitability modeling indicates promising achievements in deciding management options for such a threatened species (e.g. Shams-Esfandabad *et al*. 2010, Goshtasb *et al*., 2012).

Recent studies (Hosseini *et al*. 2016, Khosravi *et al*. 2016, Ansari 2017) have been conducted to investigate the distribution of the suitable habitats in the vicinity of the Isfahan province throughout the year. Such kind of investigations also have been carried out in other regions like year round habitat suitability modeling in Bamoo National Park (Hassanvand *et al*. 2018), and during the autumn and winter in the same area (Nowzari *et al*. 2007). From other studies about the species habitat preferences, the investigations where had been carried out in Sorkhe-Hesar Nationl Park (Ashouri Rad *et al*. 2018) and Golestan National Park (Bagherirad *et al*., 2016) can be mentioned which these two studies have been done during the autumn and throughout the year respectively. In this study we developed species distribution models for each season using the Maximum Entropy (MaxEnt) algorithm to assess the potential current distribution and conservation status of Gazelles in Isfahan province.

Material and methods

Study area

Isfahan province with and area of 10682446 ha is situated in central Iran. There are 17 protected areas located inside or at the boundary of the province with different level of conservation from protected areas to national parks.

Species occurrence data

Species occurrence consisted of point data collected through field surveys and from records kept by the Iranian Department of the Environment from spring 2017 to summer 2018. The coordinates of all the occurrence points were recorded using a hand-held multichannel Global Positioning System (GPS) receiver. Before applying the model, all the occurrence data were divided to 4 seasons: Spring (from April to June) which coincides with the breeding season of the species. Summer (From July to September) which is the most hottest and dry season, autumn (from October to December) which is the rutting season for the Gazelles and finally winter (January-March) which is under harsh and cold conditions.

Environmental data

We selected 11 uncorrelated environmental variables representing the topographic and anthropogenic conditions of the study area. Projections, grid cell size, and spatial extent were manipulated to ensure consistency across all layers using Arc GIS 10.4. All maps were projected to universal transverse Mercator (UTM, Zone 39 N) with a grid cell size of 50×50 m. We developed topographic maps such as digital elevation model, slope and aspect by using a topographic map with the scale of 1:50000. We extracted the situation of anthropogenic factors such as gardens, farms, villages and human settlements by recording the coordinates in the field or by using google earth software. Finally, land cover map of the province was applied to extract precise location of roads, rocky terrains and bare lands. For all of the anthropogenic factors distance to the nearest feature was calculated by applying Euclidean distance function in Arc map (Ver. 10.4). Moreover, Pearson correlation coefficient was used to test for correlation among environmental variables to detect highly correlated variables ($r>0.7$). However, none of the variables were highly correlated.

Habitat suitability modeling

We applied MaxEnt modeling approach using presence-only data to predict suitable habitats for the species. For each season four MaxEnt models were run with the following settings: Auto features (feature types are automatically selected depending on the training sample size), perform jackknife tests, logistic output format, and random test percentage = 25, regularization multiplier =1, maximum iterations = 1000, convergence threshold = 0.0001 and maximum number of background points =10000) (Phillipes *et al*. 2006). We computed the area under the curve (AUC) for receiver operating characteristic curve (ROC)

to assess model discriminatory power for different seasons (Englar *et al*. 2004).

To extract suitable habitats from the predicted continuous surfaces of mean probabilities of occurrence in four replications, we used the threshold which maximizes the sensitivity plus specificity for test data. The resulted classified maps were overlaid on current protected area network inside the study area to calculate the percentage of suitable habitats already under conservation.

Results

During field surveys and review of the game guards' reports, 76 independent observations in spring, 77 observations in summer, 66 observations in autumn and 73 observations in winter were recorded. For all seasonal models, the AUC for ROC showed high discriminant power (Table 1).

Table 1. AUC for ROC curves of the selected model for each season

Model	AUC±SD
Spring	0.94 ± 0.02
Summer	0.95 ± 0.01
Autumn	0.98 ± 0.01
Winter	0.092 ± 0.02

Table 2. Percent contribution of the environmental variables in the seasonal models

Variable	Percent contribution			
	Spring	Summer	Autumn	Winter
Elevation	49.3	47.6	18.9	39
Slope	0.6	0.4	2	0.7
East- western aspect	0.9	0.9	1	1.3
North – southern aspect	0.9	1.4	0.3	2.3
Distance to the human settlements	10.8	2.2	32.5	6.5
Distance to the villages	0.5	2.3	1	0.8
Distance to the roads	0.3	1	0.7	2.2
Distance to the farms	3.6	6.9	1.1	7.8
Distance to the gardens	14.5	19.5	2.6	25.4
Distance to the bare lands	9.5	13.3	18.5	10.8
Distance to the rocky terrains	9.1	4.5	21.4	3.2

The produced response curves (fig. 2) showed that with the increase of elevation from 1000 m above the sea level (asl), habitat suitability increases in all seasons. However, in autumn and winter the suitability increases only to the elevation of 1600 m asl in contrast with spring and summer which suitability increases to the elevation of 1800 m asl. Gazelles preferred areas near farms in all seasons except winter which suitability goes higher with the increase of the distance from the neighborhood farms. In all seasons Gazelles showed tendency toward bare lands. Moreover, Gazelles preferred areas far from gardens except in autumn which the areas near gardens had higher suitability. In spring, summer and winter Gazelles were more distributed near the rocky terrains however they avoided these areas in their mating season in autumn. Gazelles avoid roads more in summer and autumn. Except for autumn, in other seasons Gazelles tend to areas quite far from the human settlements.

Distribution of the preferred seasonal habitat indicate that the Isfahan province encompass more suitable habitats in spring and winter and the lowest located seasonal habitat is in autumn. Distribution of the suitable habitats inside the protected area network shows that in the best case only 24% of habitats are currently under conservation and the amount of the overlap between the autumn suitable habitats and protected areas drop up to only 5% (Fig. 3). Finally, the pattern of the suitable habitats distribution across the province in each season indicates that the most isolation of these areas refered back to those of autumn season (Fig.4).

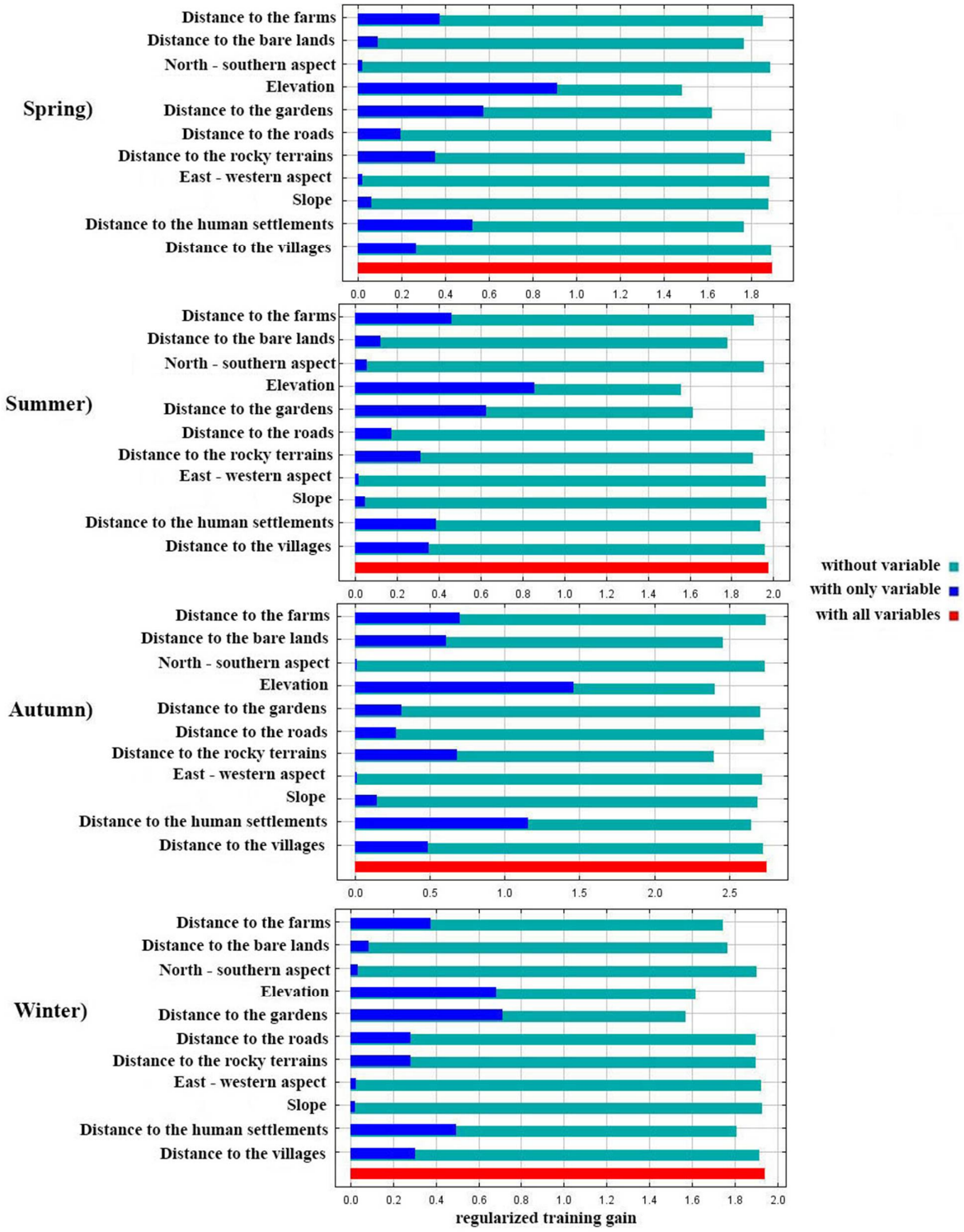

Figure 1. Jackknife test results for importance of predictive variables in the species seasonal habitat suitability model

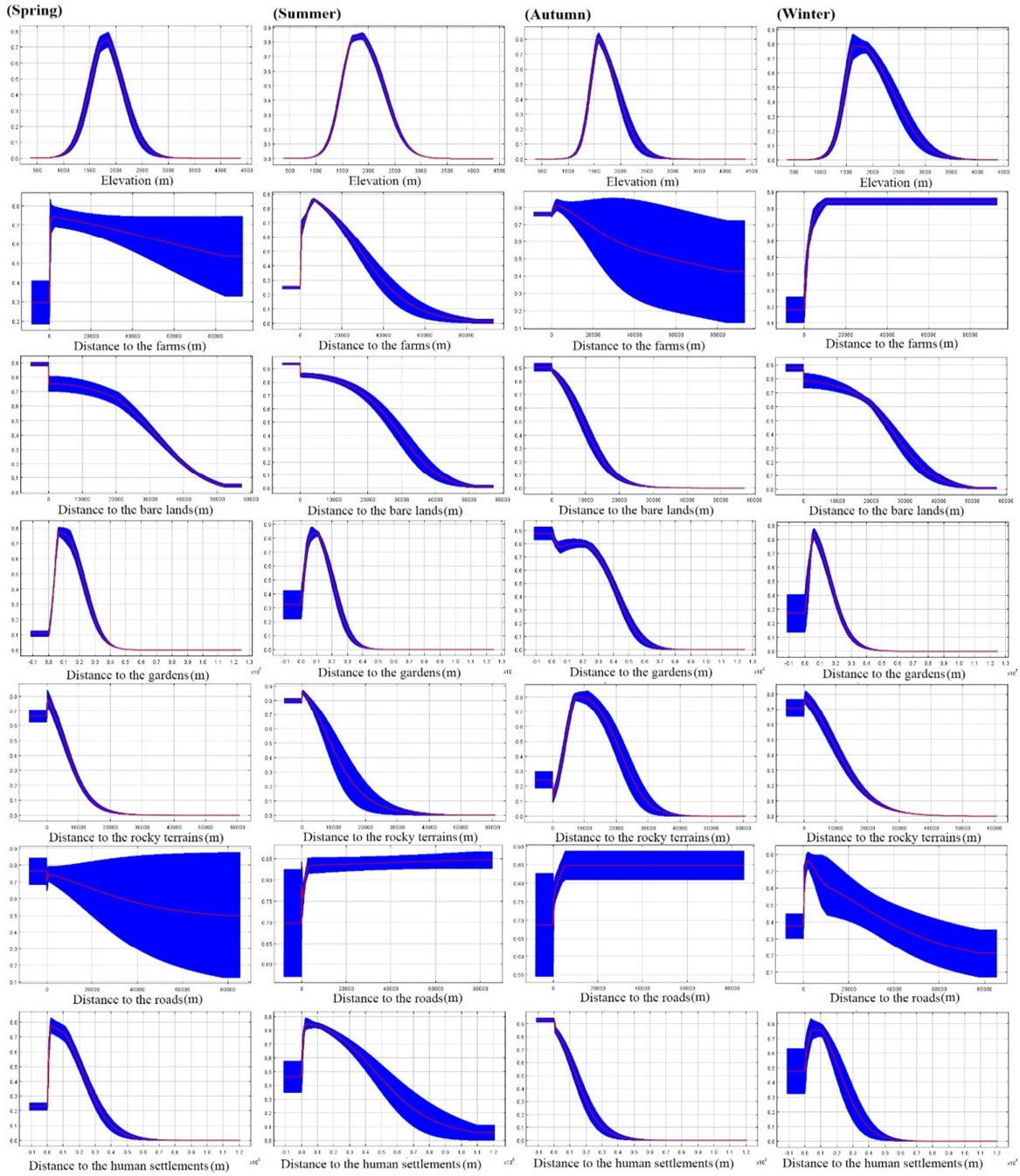

Figure 2. Response curves for important each the most important environmental variables

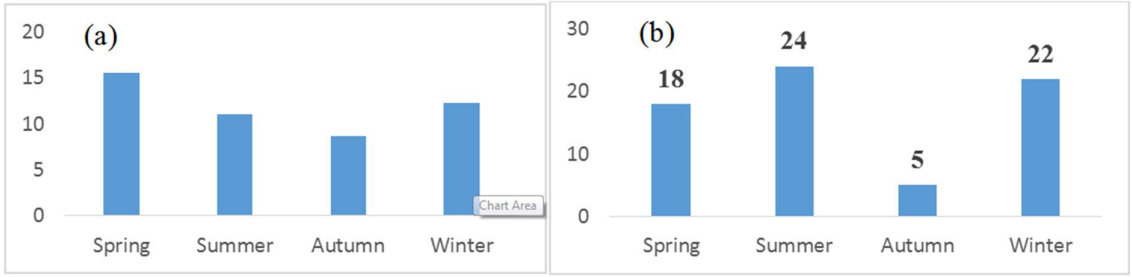

Figure 3. Suitable habitats for Goitered Gazelle throughout the province (a) and the percentage of the suitable habitat where covered by the protected area's network (b).

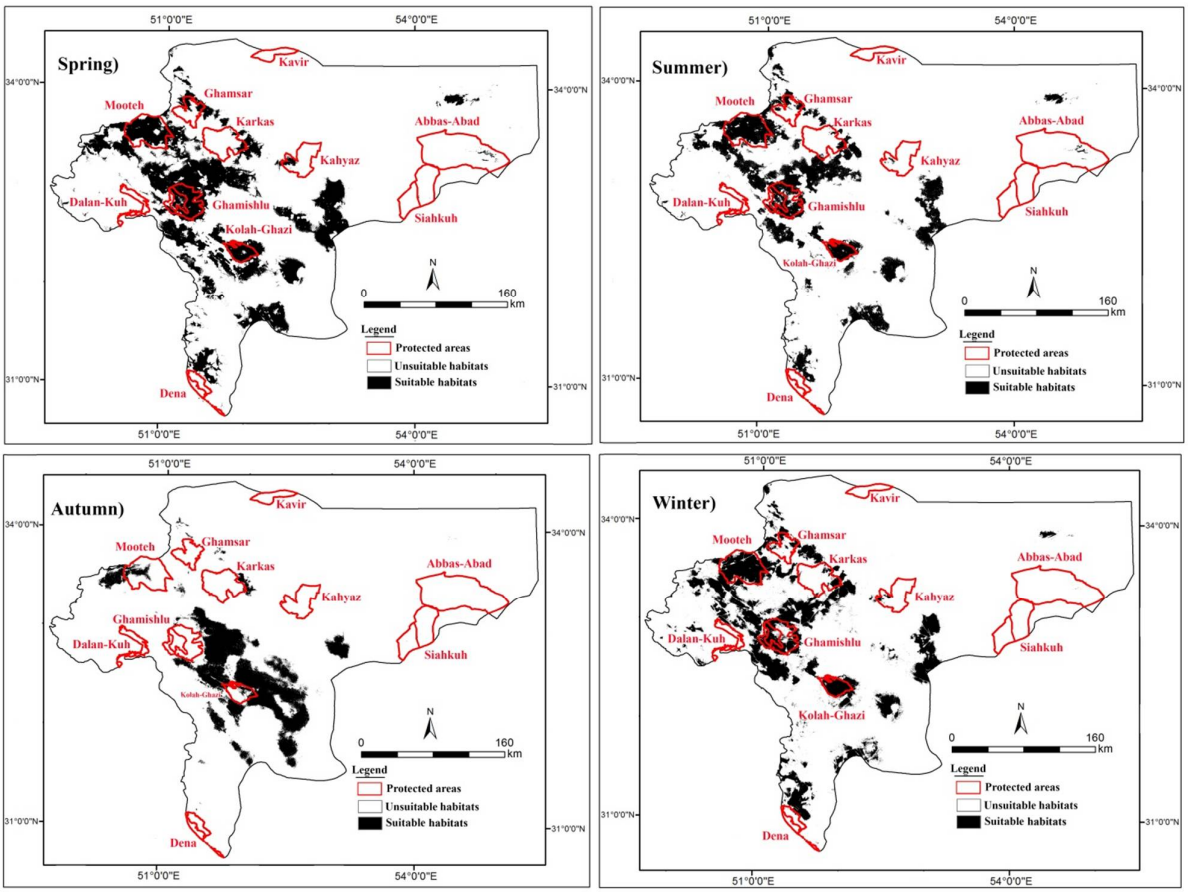

Figure 4. Distribution of the suitable habitats for goitered Gazelle among the Isfahan province protected areas for each season.

Discussion

As our results indicate, the elevation factor can be regarded as one of the most important predictive variables of the species habitat suitability in the study area, which is alsready confirmed by Khosravi *et al.* (2016). Meanwhile Hasanvand *et al.* (2018) resulted that Gazelles' habitat preferences reach to the highest level at the elevation of 1700 masl and then decreases while the suitability threshold for this factor already reported as much as 1600 m (Hosseini *et al.* 2016). In our study Gazelles preferre areas with height of 1600-1800 m. The species prefers lowest elevations in autumn and winter. Ashouri-Rad et al. (2018) found out that this species avoid from the gardens and roads but during the autumn can be found near the farms the same as what we found in the study area. The most probable reason can be related to the food resources (Karami *et al.* 2012, Ziaei 2008). Roads acted as a negative factor in habitat suitability for Gazelles in the study area which is in concordance with findings of other study carried out especially on the impacts of transportation infrastructures on habitat suitability of the Gazelles in Ghamishloo Wildlife Refuge in the same study area (Makki *et al.* 2013). Our findings proved the seasonal changes in distribution of the suitable habitats for Gazelles (Karami *et al.* 2012, IUCN 2018). This implies the need for a new approach by the department of the environment to consider seasonal differences of the species habitat use in their conservation program. Most of the changes happens in autumn which coincide with mating season of the Gazelles (Karami *et al.* 2012). Some researches (Ziaei 2008, Xia *et al.* 2010) suggested that breeding cycle activities such as rutting activity and reproduction may affect the

level of the vigilance. This may be the reason for higher tolerance of the Gazelles to the human settlements and the areas far from the rocky terrains in the autumn. Our study was based on anthropogenic and topographic characteristics of the habitats. However, Nowzari *et al*. (2016) and Bagherirrad *et al*. (2014) evaluated the habitat use of the Gazelles based on vegetation parameters. The combination of all of these parameters may lead to better understanding of ecology of the species and can be recommended for the further studies.

Conclusion

The results of the study indicates the importance of the redesigning protected areas current boundaries in the province as more suitable areas in different seasons are poorly conserved by the current network especially during the autumn. However, this investigation was limited to Isfahan province, there are some borderland habitats for the Gazelles between Isfahan and Markazi province. There is a need to another research to consider distribution of seasonal habitats between these two provinces simultaneously.

References

Amininasab M., Akbari A. 2011. Prediction of goitered gazelle (*Gazella subgutturosa*) population in Mond protected area with Contest model by RAMAS ECOLAB software (Booshehr province, Iran). Middle-East Journal of Scientific Research 8(1): 30-33.

Ansari A. 2017. Habitat evaluation for Persian gazelle in the southern half of Markazi province, Iran. Journal of Wildlife and Biodiversity 1(1): 19-23.

Akbari H, Behrouzi rad B, Kiabi BH. 2002. Habitat evaluation of Persian gazelle in Kalmand Protected Area. Environment Journal 46:113-118. [In Persian]

Ashouri-Rad A., Rahimi R., Shams-Esfandabad B. 2018. Modeling habitat suitability for goitered gazelle (*Gazella subgutturosa*) in Sorkheh Hesar national park. Journal of Environmental Science and Technology 19(4):194-207.

Elham Bagherirad M., Norhayati A., Amirkhani M., Maimon A., Mesdaghi M., Kabudi A. 2014. Seasonal Habitat Use of Persian Gazelles (*Gazella subgutturosa subgutturosa*) based on Vegetation Parameters at Golestan National Park, Iran, Arid Land Research and Management 28(4): 464-484, DOI: 10.1080/15324982.2013.868379

Engler R., Guisan A., Rechsteiner L. 2004. An improved approach for predicting the distribution of rare and endangered species from occurrence and pseudo-absence data. Journal of Applied Ecology 41:263-274.

Farhadinia M.S., Shams-Esfandabad B., Karami M., Zavarei F.H., Absalan H., Nezami B. Goitered Gazelle *Gazelle subgutturosa* Guldenstaedt, 1780: its habitat preference and conservation needs in Miandasht Wildlife Refuge, northeastern Iran.2009. Zoology in the Middle East 46:9-18.

Goshtasb H., Shams-Esfandabad B., Ataii F., Mozafari A. 2012. Habitat suitability modeling for wild boar (*Sus scrofa*) in Eastern Alamt, Qazvin province. Journal of Natural Environment, Iranian Journal of Natural Resources 65(2): 247-258.

Hassanvand A., Radnezhad H., Martynova-Van K.A., Loni A., Sadeghi M., Zaremanesh H. 2018. Potential distribution of Persian gazelle (*Gazella subgutturosa subgutturosa*) in Bamoo national park, Shiraz, Iran: A presence-only model approach. Applied Ecology and Environmental Research 16(1):305-319.

Hosseini G., Shams-Esfandabad B., Alizadeh-Shabani A. 2016. Habitat suitability for Persian gazelle (*Gazella subgutturosa*) in Haftad Qolleh Protected Area, Markazi province in central Iran. . Journal of Natural Environment, Iranian Journal of Natural Resources 69(4): 965-979.

IUCN. 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 09 October 2018.

IUCN SSC Antelope Specialist Group. 2017. *Gazella subgutturosa*. The IUCN Red List. http://www.iucnredlist.org. Downloaded on 04 November 2018.

Karami M., Hemami M.R., Groves C.P. 2002. Taxonomic, distribution and ecological data on Gazelles in Iran. Zoology in the Middle East 26:29-36.

Karami M., Ghadirian T., Faizolahi k. 2012. Atlas of Mammals of Iran. Department of Environment of Iran-University of Tehran.

Khosravi R., Hemami M.R., Malekian M., Flint A.L, Flint L.E. 2016. MaxEnt modeling for predicting potential distribution of goitered gazelle in central Iran: the effects of extent and grain size on performance of the model. Turkish Journal of Zoology 40:574-585.

Makki T., Fakheran S., Moradi H., Iravani M., Senn J. 2013. Landscape – scale impacts of transportation on spatial dynamics of two vulnerable ungulate species in Ghamishloo Wildlife Refuge, Iran. Ecological Indicators 31:6-14.

Nowzari H., Behrouzi Rad B., Hemami M. 2007. Habitat use by Persian gazelle (*Gazella subgutturosa subgutturosa*) in Bamoo national park during autumn and winter. Acta Zoológica Mexicana 23(1): 109-121.

Phillips S.J., Anderson R.P., Schapire R.E. 2006. Maximum entropy modeling of species geographic distributions. Ecological Modelling 190:231-259.

Sempere A.J., Brown N., Pereladova O.B., Bahloul K., Lacroix A., Soldatova N. 2001. Comparative analysis of reproductive cycles in female Persian gazelle (*Gazella subgutturosa subgutturosa*) (central Asia) and sand gazelle (*Gazella subgutturosa marica*) (Arabian Peninsula). General and Comparative Endocrinology 121, 57-65.

Shams-Esfandabad B., karami M., Hemami M., Riazi B., Sadough M. 2010. Habitat associations of wild goat in central Iran: implications for conservation. European Journal of Wildlife Research 56: 883-894.

Xia C., Xu W., Yang W., Blank D., Qiao J., Liu W. 2011. Seasonal and sexual variation in vigilance behavior of goitered gazelle (*Gazella subgutturosa*) in western China. Journal of Ethology 29:443–451.

Ziaie H., 2008. A field guide to mammals of Iran, 2nd ed. Wildlife Center Publication, Tehran, Iran.432 pp. [In Persian].