Scientific Reports in Life Sciences 2021, 2 (1): 40-51

DOI: http://dx.doi.org/ 10.22034/srls.2021.242070

Research Article

Suitable areas for conservation of biodiversity (case study: wintering habitat of Asian houbara bustard, *Chlamydotis macqueenii* in Sistan, Iran)

Malihe Erfani*, Soraya Eperham

Department of Environmental Sciences, Faculty of Natural Resources, University of Zabol, Iran
**Corresponding email: maliheerfani@uoz.ac.ir*

Received: 12 November 2020 / Revised: 25 January 2021 / Accepted: 29 January 2021 / Published online: 4 Februry 2021.

How to cite: Erfani, M., Eperham, S. (2021). Suitable areas for conservation of biodiversity (case study: wintering habitat of Asian houbara bustard (*Chlamydotis macqueenii*) in Sistan, Iran), Scientific Reports in Life Sciences 2(1), 40-51**. 10.22034/srls.2021.242070**

Abstract

Numerous published research in habitat suitability of various flora and fauna species show that habitat conservation is the most important component of biodiversity conservation. Among wildlife species, some are more important due to the declining population and known ecological importance. In fact, these species can be used as an indicator to consider new places or modify conservation areas' boundaries. The complexity of allocating land for conservation increases when species become more dependent on artificial and semi-artificial lands, due to the destruction of natural habitats. The present study was conducted to investigate the suitability habitat of Asian houbara bustard as a rare species that faced a sharp decline in population in recent decades in part of its wintering habitat in Sistan. The method for assessing habitat suitability was Maxent. The results showed that the most important environmental variables were the distance from human settlements and agricultural lands. This species has a strong tendency to human-made areas. Although part of its suitable habitat overlaps with protected areas, conservation of this species has not been adequate so far, and a sharp decline was seen in its population in recent years. The results of this study emphasize the need to take management measures to reduce the conflict of interest between humans and this bird and increase public participation in the conservation of this species.

Keywords: Environmental variables, modeling, wildlife management

Introduction

Defining the distribution or probability of a species present is a critical issue in ecology and species conservation, prioritizing areas for conservation of species or reintroduction of species (Thorn *et al*., 2009), estimating the population size of species (Long *et al*., 2008) as well as the distribution of species in climatic changes conditions and providing a basis for conducting field studies (Anderson *et al*., 2009).

Asian houbara bustard (*Chlamydotis macqueenii)* belongs to Gruiformes order and Otididae family that has a rather scarce but widely distributed in Iran. It is a migratory bird that lives in vegetated deserts around Iran's central deserts. It is also a fairly common winter visitor to southern lowlands of Khuzestan to Sistan-Baluchestan, southern Fars, Hormozgan, north-eastern Khorasan, and Mazandaran (Kaboli *et al*. 2012). This species has been listed as Vulnerable (VU) in the IUCN red list and listed in CITES Appendix I. Also, this species categorized as endangered species in Iran. The most important factors internationally threatening this species include hunting, habitat loss and degradation caused by tourism facilities, vehicle accidents, military exercises, overgrazing, sand extraction, power-lines, and road development (Aghaniajafi-Zadeh *et al*., 2010). Also, collision with power lines, predation by mammals, and illegal hunting has a significant effect on this species' mortality rate (Kaboli *et al*. 2012).

Despite the conservation importance of this species at the international and national levels, a few studies have been done on this species, some of which are mentioned in the following:

Erfani (2011) Studied the wintering habitat of Houbara Bustard using the habitat suitability index method (HIS) in Sistan. She considered various habitat factors such as slope, exposure, plant cover, percent of plant species, soil conditions, water resources, human threats, distance to human settlements that Influence this species to classify different wintering habitats of this species in Sistan. Results of on study that performed by Pakniat *et al*. (2016) showed the most influential variables for the distribution of this species were the topographic diversity, slope, total annual rainfall, the average temperature of the coldest season, distance from agricultural lands and the distance to moderate and poor rangeland cover in Fars province. Yousefi *et al*. (2017) studied the habitat suitability of the wintering population of Asian houbara bustard on a large scale using macro-scale environmental variables and their results indicate that annual precipitation, slope and distance to croplands were the most important variables for predicting

Houbara occurrence. They showed various patches in central, western and eastern Iran are the most suitable habitats for the Houbara. Ahmadi Sani (2017) studied the current distribution and habitat suitability of the great bustard (*Otis tarda*) as another vulnerable species of Otididae family in Iran. The results of the mentioned study indicated that great bustard tends to live in marginal habitats.

There are only a few scientific reports about the distribution, breeding and wintering habitats of Asian houbara bustard in Iran, therefore in this research, we considered the suitability of the wintering habitats of this species in Sistan.

Material and methods

Study area

Sistan is a flat basin located in the east of the Iranian plateau (figure 2) composed of alluvium of the old and current Helmand river delta, and Hamoon lakes are situated in its lowest parts, which has dried up in recent decades. In this region, the only permanent sources of surface water are Chahnimeh lakes. The vegetation of Sistan consists of desert and semi-desert plants. The flora of the rangelands of the Sistan region consists of 8 plant families and about 29 species. The climate of Sistan is desert, hot and dry, with a minimum temperature of 7 degrees in January and a maximum temperature of over 45 degrees in July. The average of annual rainfall is 65 mm that does not have a uniform distribution throughout the year and most occur in winter. There are two protected areas consist of Hamoun Wildlife Sanctuary and Shiloh Protected Area in this region. Sistan has five cities, including Zabol, Zahak, Nimroz, Hamoun, and Hyrmand, and 18 rural districts with about 669 villages (Erfani *et al*., 2020).

The present points of the Asian houbara bustard

Asian houbara bustard prefers arid steppes, open plains of deserts and semi-deserts, sand dunes, and stony or rocky regions with sparse bushes (Kaboli *et al*., 2012). It arrives in the last month of autumn (December) and stays until early spring in Sistan. Sometimes some of them separate from their flock and stay until early summer that is seen recently in summer 2018 in Lorg-e-Bagh of Sistan.

The fieldwork to obtain the present points of this species performed in the areas that percent of these spices had been previously reported such as Hamoon Wetland, Rig Bash Delbar, and Lorg Bagh Koh-Khaje and etc., and the study period was 2017-2018. Due to the sharp decrease in the population of this bird, only 17 presence points were obtaind. Our observation showed that there is the highest number of

this bird in Lorg-e-Bagh area. This bird has been seen in groups of 30 birds in the past decades, but today is seen in groups with an average 5-10 birds.

Environmental variables

This study's environmental variables consisted of the vegetation index (NDVI), distance from the road, barren lands, agricultural lands, urban and rural settlements, roads, water resources, and rivers. Urban and rural settlements, roads, and rivers were extracted from the topographic shapefile of Iran National Cartographic Center (NCC) with a scale of 1: 25000. The spatial resolution (pixel size) of all layers of environmental variables was 100*100 meters. Pearson correlation was used to ensure no correlation higher than 0.70 between each pair of variables.

Habitat suitability modeling

In this study, the Maximum Entropy Method (MaxEnt Model) was used to create a probability distribution map of Asian houbara bustard related to the mentioned environmental variables. This modeling performed using MaxEnt software version 3.3.3k s (http://www.cs.princeton.edu/~schapire/maxent). The maximum entropy approach compares the ecological attributes of percentage points to the whole area and reports the range of habitat suitability between zero and one. As zero is the worst and one is the most suitable habitat (Phillips *et al*., 2006). The model's performance evaluation and predictability were assessed by examining the value of the area under the receiver operating characteristic (ROC) curve (AUC). The model with the AUC value between 0.5–0.7 is not good. AUC between 0.7–0.9 indicates the model has reasonable performance, and the model has high performance if AUC is higher than 0.9 (Peterson *et al*., 2011). Environmental variable response curves were obtained for univariate models and the Jackknife method was calculated to evaluate the variable environmental importance. The threshold values of equal training sensitivity and specificity (ETSS) and maximum training sensitivity plus specificity (MTSS) were used to classify the suitable and unsuitable areas for Asian houbara bustard.

Results

Figure 1 shows the predictability of the model through AUC value for habitat suitability of Asian houbara bustard—completely random prediction with AUC of 0.5 shows by the black line. The average test AUC for the replicate runs is 0.723 (red line), and the standard deviation is 0.140 (blue area). As

shown in this figure, the curve obtained for the model is far from the line representing a completely random model indicating the model has good predictability (Peterson *et al*., 2011).

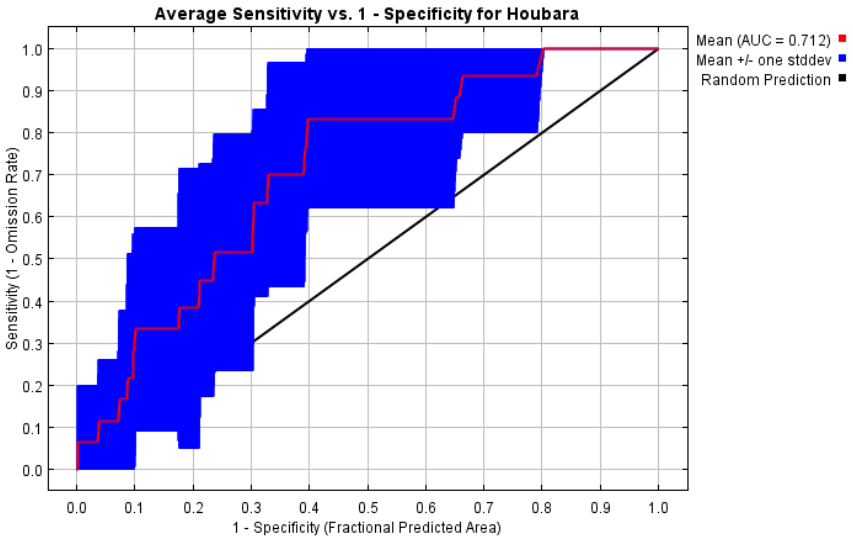


Figure 1: ROC curve for the habitat suitability model of Asian houbara bustard

The probability range of habitat suitability is between 0 and 1, that 1 indicating a highest suitability and zero is the lowest suitability (figure 2).

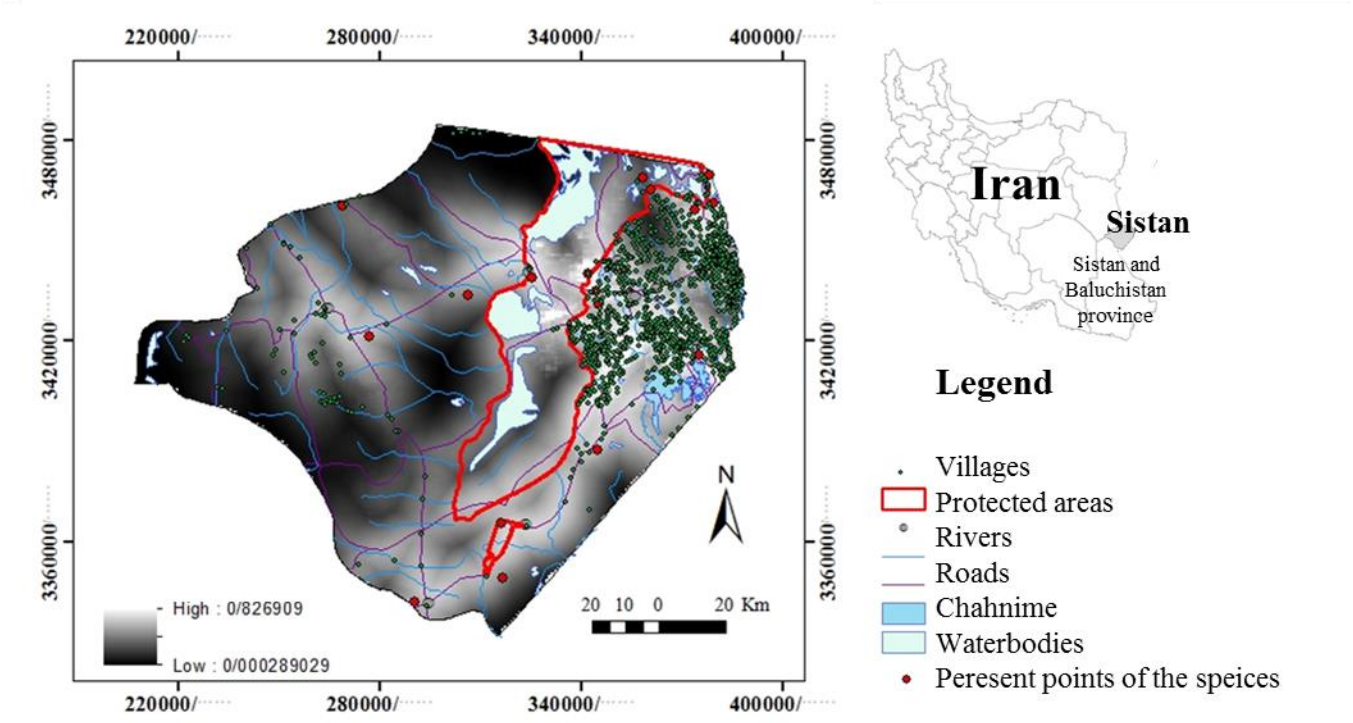


Figure 2: Habitat suitability of Asian Houbara Bustard

Figures 3 to 9 show the response of species habitat suitability to environmental variables. The vertical axis of these curves is logarithmic and each curve represents the effect of each variable on Maxent prediction. The curves show the mean response of the 5 replicates Maxent runs (red) and the mean +/- one standard deviation (blue, two shades for categorical variables).

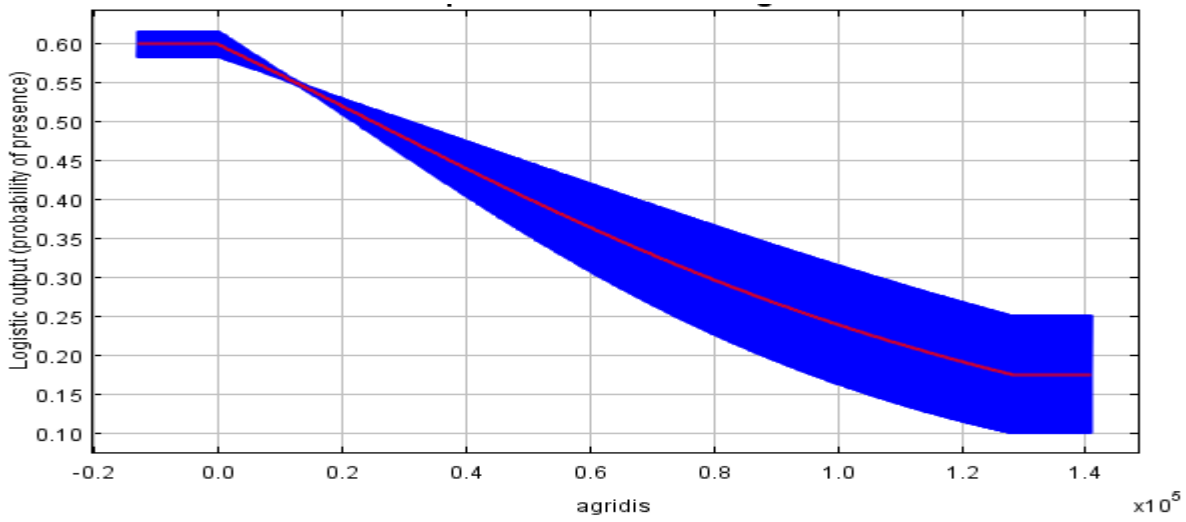


Figure 3: The response curve for distance from the agricultural land

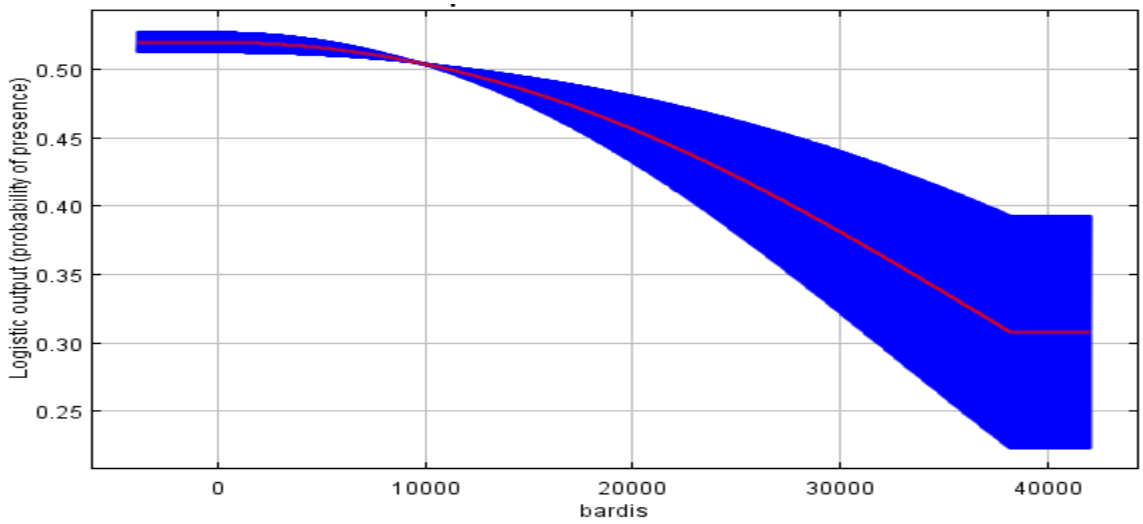


Figure 4: The response curve for distance from the barren lands

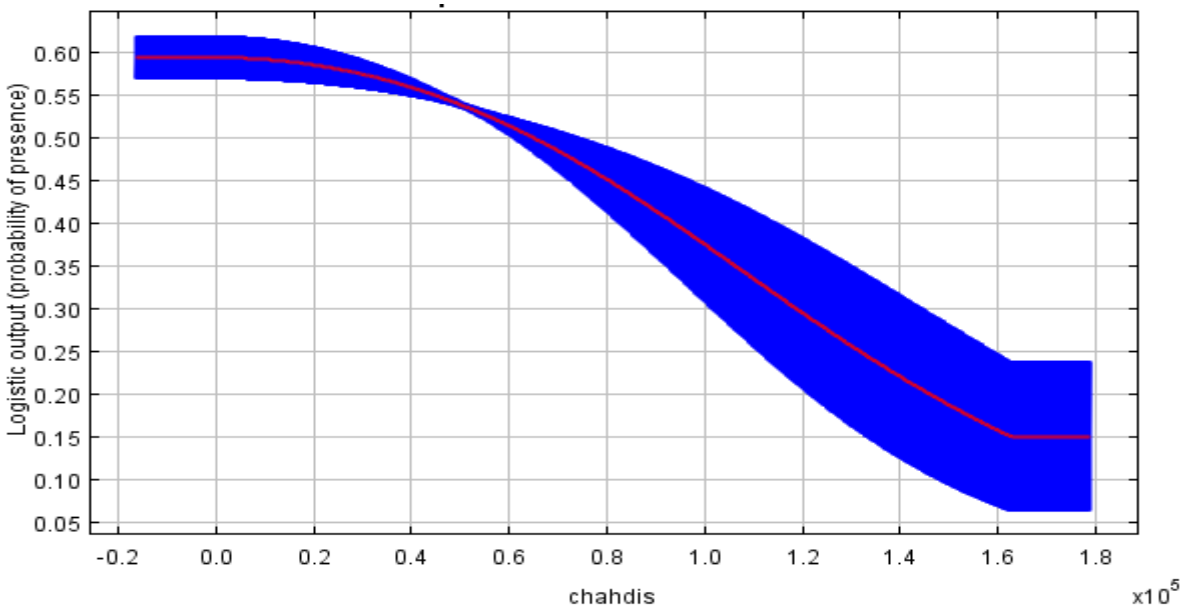


Figure 5: The response curve for distance from the water resources (Chahnimeh)

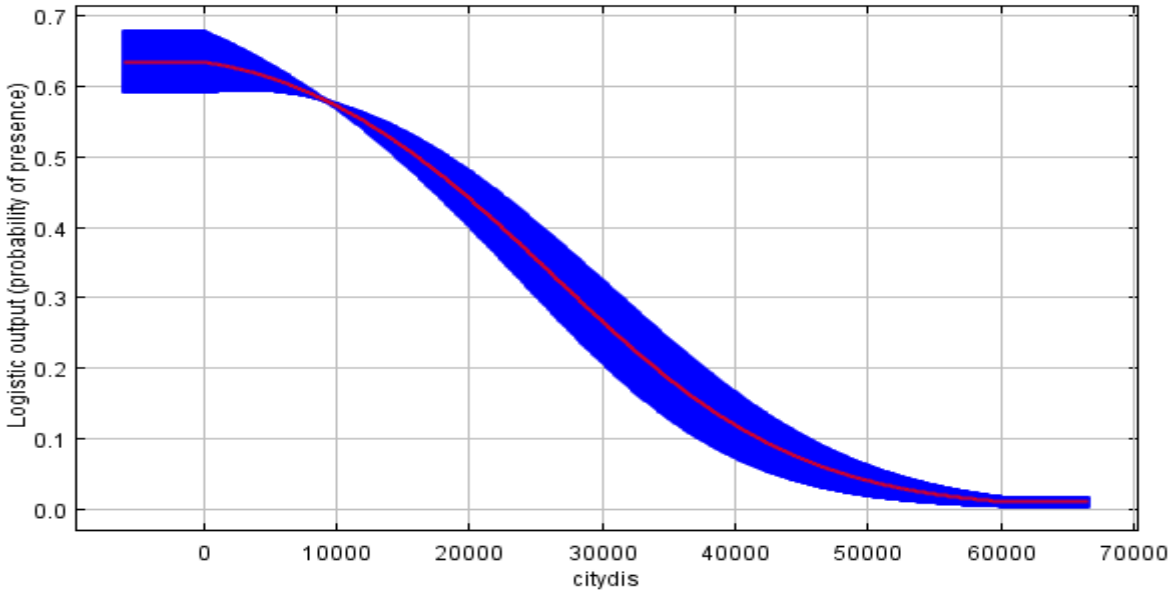


Figure 6: The response curve for distance from the cities

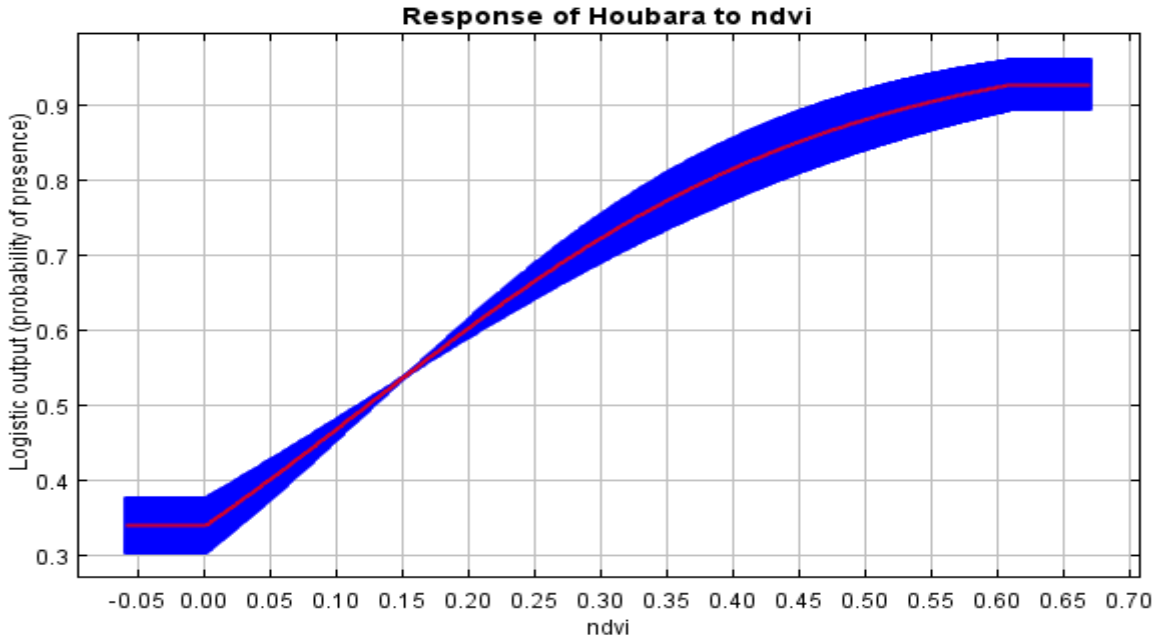


Figure 7: The response curve for NDVI

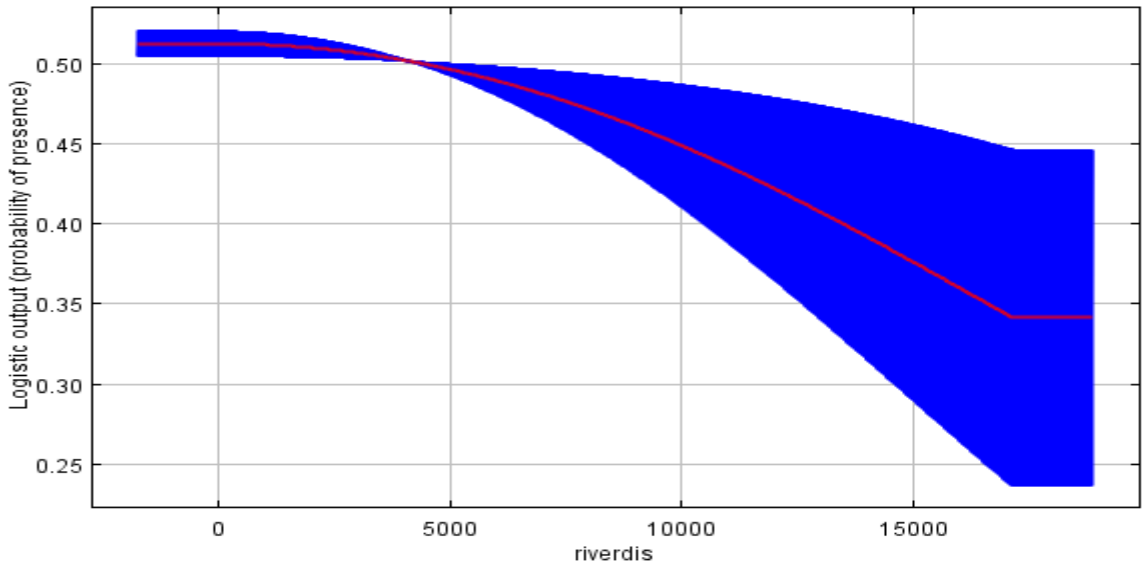


Figure 8: The response curve for distance from the rivers

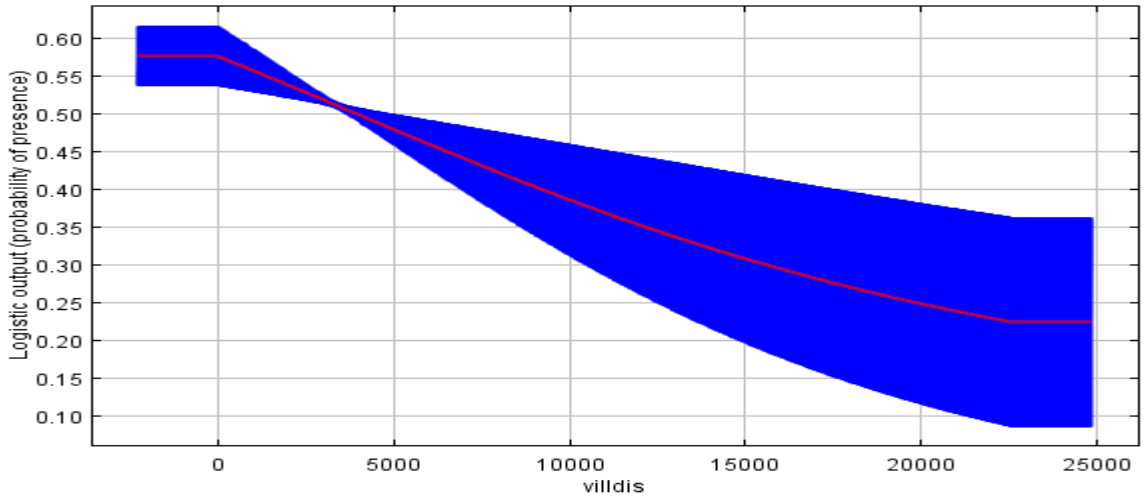


Figure 9: The response curve for distance from villages

The results of the Jackknife test are shown in Figure 10. The Jackknife test performed for sensitivity analysis and to determine the relative weight of the variables (variable importance) affecting the suitability of the habitat of Asian houbara bustard.

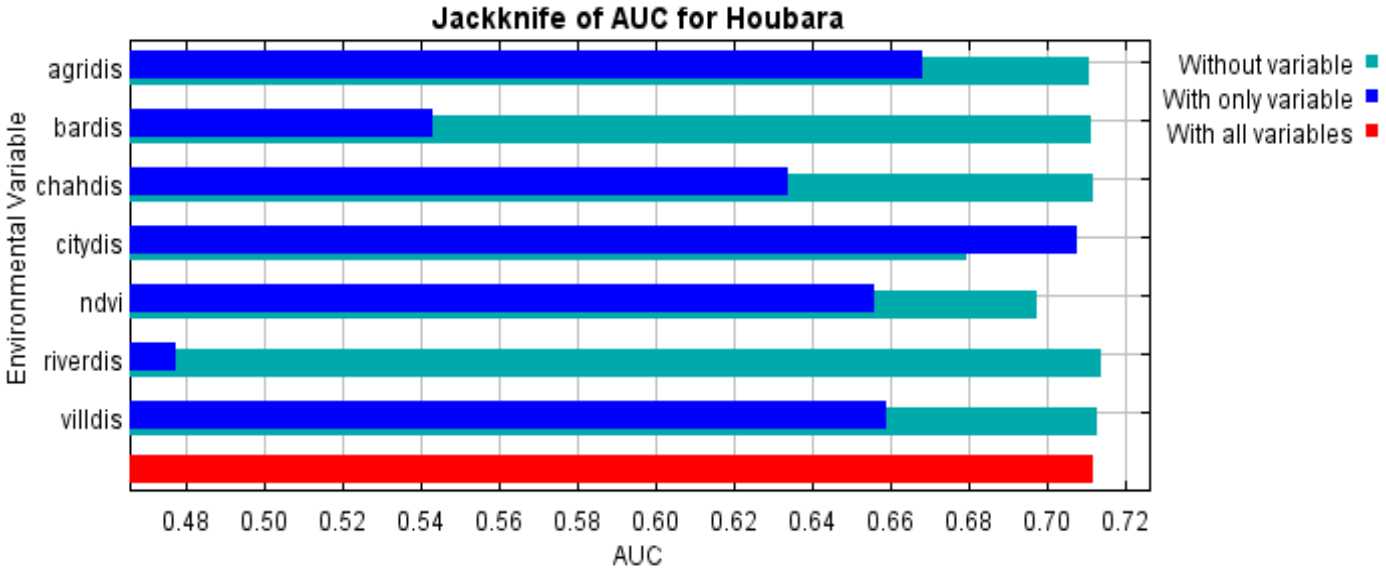
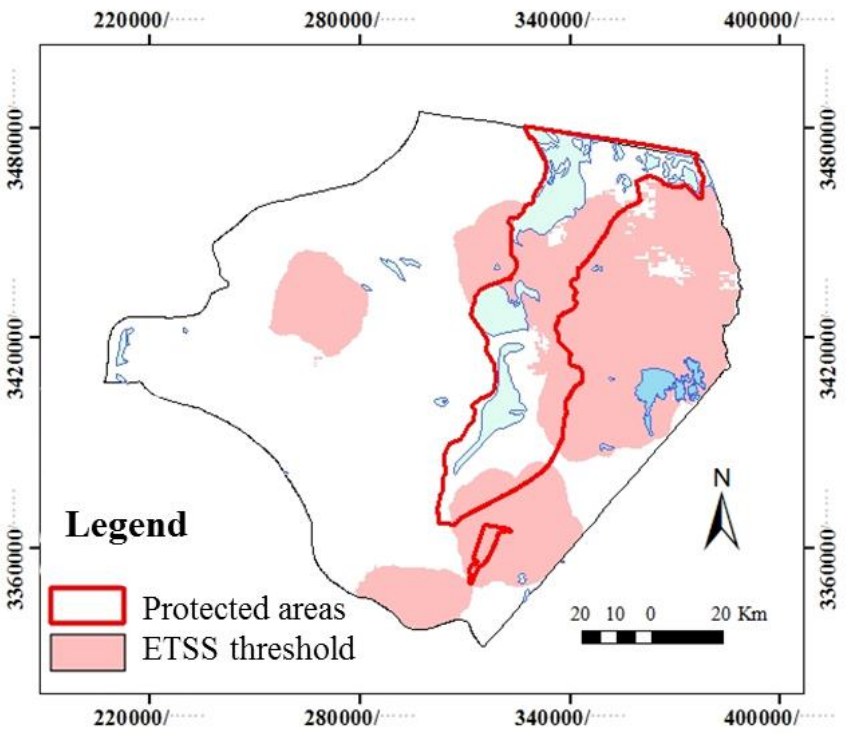


Figure 10: The results of the jackknife test

The mean thresholds of ETSS and MTSS were 0.459 and 0.338, respectively. Based on these thresholds, the habitat suitability map was classified into two suitable and unsuitable classes (Figure 11). According to thresholds ETSS and MTSS, suitable area obtained 6234.29 and 7025.63 square kilometers, respectively (figure 11).

(A)



(B)

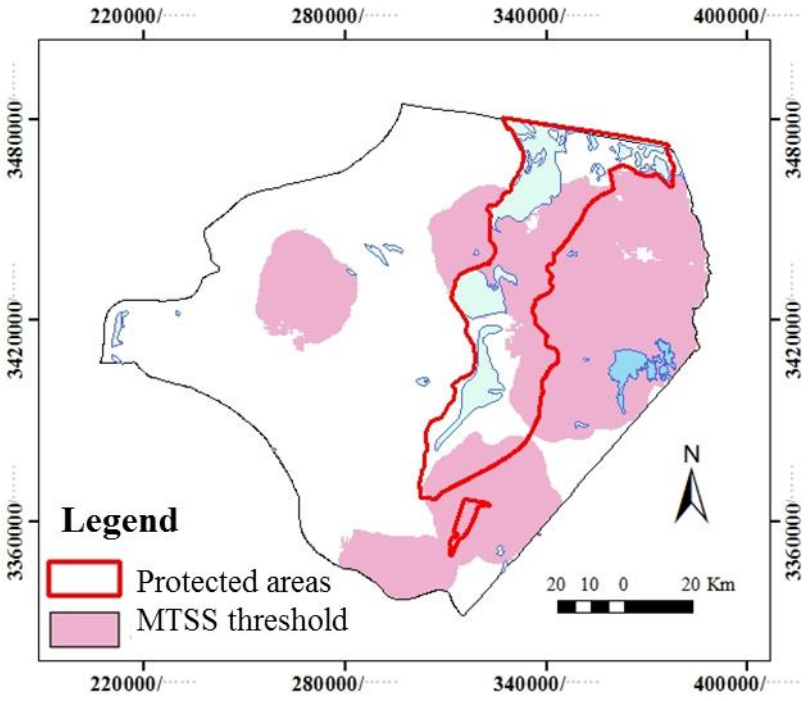


Figure 11: Suitable area according to ETSS (A) and MTSS (B) thresholds

Discussion

The results of model evaluation based on the area below the ROC curve showed that the model has a good prediction for habitat suitability of Asian houbara bustard (Fig. 1) and, therefore, the results of modeling are reasonable. The Jackknife test showed that distance from agricultural land, distance from city and distance from the village have the highest effect on habitat suitability of Asian houbara bustard (Figure 10), and in all cases except NDVI, with increasing distance, habitat suitability decreases (Figures 3 to 6 and 7-8). This shows that although this species avoids approaching humans, with the drying up of Hamoon Wetland and the destruction of a large part of its natural habitat, its dependency on agricultural land, which is closer to cities and villages, becomes more. According to the classified suitability map (figure 11), most suitable areas occur outside the protected areas, which is consistent with the results of Pakniat *et al*. (2011)'s study in Fars province.

The illegal hunting number of Asian houbara bustard in the year 2018 was 20 cases that the most of them reported from the areas completely outside the city and villages, such as around Saberi hamoon, near the political border between Iran and Afghanistan, and around Koh-Khaje. Almost all of these areas is management as protected areas that illegal hunting occurring in them indicates the inefficiency of management to protect this species.

The results of this study emphasize reducing the conflict between humans and this bird and increasing public participation in the conservation of this species, also undertaking conservation both inside and outside of protected areas.

Acknowledgments

This work was funded by the University of Zabol under Grant Number UOZ-GR-9718-68.

References

Aghaniajafi-Zadeh S.H., Hemami M.R., Karami M., Dolman P.M. 0202. Wintering habitat use byhoubara bustard (Chlamydotis macquenii) in steps of Harat central Iran. Journal of Arid Environment 77: 219-217.

Ahmadi Sani, N. 2017. A survey on current distribution and habitat suitability of the Great Bustard in West Azerbaijan, Iran. Journal of Wildlife and Biodiversity 1(2): 88-93.

Anderson B.J., Akçakaya H.R., Araújo M.B., Fordham D.A., Martinez-Meyer E., Thuiller W., Brook B.W. 2009. Dynamics of range margins for metapopulations under climate change. Proceedings of the Royal Society of London Series B - Biological Sciences 276: 1415–1420.

Erfani, M. 2011. Study of Houbara Bustard (Chlamydotis undulate) wintering habitat by using Habitat Suitability Index Method (HIS) in Sistan, International Conference on Indigenous Knowlege for Biodiversity Conservation. International Center for Science, High Technology and Environmental Sciences, Kerman (2011-12-14).

Erfani M., Farashi A., Alizadeh M. 2020. Simulating the state of jungle cat (Felis chaus Schreber, 1777) using cross-impact analysis in Sistan, Iran. Modeling Earth Systems and Environment https://doi.org/10.1007/s40808-020-00980-x

Kaboli M., Aliabadian M., Tohidifar M., Hashemi A. 2012. Atlas of Birds of Iran, Tehran: Department of Environment of Iran.

Long R.A., MacKay P., Ray J.C., Zielinski W.J. 2008. Noninvasive Survey Methods for Carnivores. USA, Washington DC: Island Press,

Pakniat D., Hemami M., Maleki S., Tohidi M., Julaie L. 2016. Habitat Suitability Modelling of Wintering Populations of Asian Houbara bustard Chlamydotis macqueenii in Fars. Journal of Animal Environment 8(3): 19-28.

Peterson A. T., Soberon J., Pearson R. G., Anderson R. P., MartinezMeyer E., Nakamura M., Araújo, M. B. 2011. Ecological niches and geographic distributions. Princeton, NJ: Princeton University Press. https://doi.org/10.23943/princeton/9780691136868.001.0001

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

Thorn J.S., Nijman V., Smith D., Nekaris KAI. 2009. Ecological niche modelling as a technique for assessing threats and setting conservation priorities for Asian slow lorises (Primates: Nycticebus). Diversity and Distributions 15:289–298.

Yousefi M., Ahmadi M., Nourani E., Rezaei A., Kafash A., Khani A. *et al*. 2017. Habitat suitability and impacts of climate change on the distribution of wintering population of Asian Houbara Bustard Chlamydotis macqueenii in Iran. Bird Conservation International 27(2):294-304.