UNIVERSITI PUTRA MALAYSIA

MODELING REGIONAL CUMULATIVE EFFECTS OF LAND USE AND LAND COVER VARIATIONS IN RELATION TO PERSISTENCE OF THE PERSIAN LEOPARD (Panthera pardus saxicolor) IN IRAN

AREZOO SANEI

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By

AREZOO SANEI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2018

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DEDICATION

Let's not wish the leopard to exit from the gate of creation,
And we should know that life lacked something, if the worms did not exist,
And without a scratch on its bark, the law of tree would be offended,
And if there were no death, our hands would search for something else,
And we should know that before corals, a void existed in the thoughts of the seas
(Sepehri, S. 1964. The water's footsteps)

I dedicate this thesis to the king of the mountains of Iran,
the Persian leopard.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

MODELING REGIONAL CUMULATIVE EFFECTS OF LAND USE AND LAND COVER VARIATIONS IN RELATION TO PERSISTENCE OF THE PERSIAN LEOPARD (*Panthera pardus saxicolor*) IN IRAN

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AREZOO SANEI

March 2018

Chairman : **Professor Mohamed Zakaria Hussin, PhD**
Faculty : **Forestry**

Cumulative effect of land use and land cover changes on the persistence of the Persian leopard (*Panthera pardus saxicolor*) in Iran is not characterized and formulated so far. Current research is concerned with developing an innovative species and region specific methodological approach to predict cumulative effect of the land use and land cover variations on the Persian leopard persistence. The research is a countrywide practice conducted in a regional basis in Iran with three provinces selected for the relative ground validation techniques. Accordingly, three main research sections are developed to assess the data and information required for formulation of the models. In the first section the provinces are innovatively classified into five significantly dissimilar regions in terms of environmental variations based on the wide distribution of the Persian leopard in at least 30 out of 31 provinces of Iran. Sufficient well distributed leopard presence records together with 17 natural and human variables were used to develop potential habitat predictive maps in a regional basis using MaxEnt software. Variables are tested for possible correlation among them and models were evaluated for the predictive performance. The research null hypothesis regarding no significant regional variability of permutation importance of

the research variables in the best fitted predictive models, is accepted. Two landscape corridors to improve the leopard distribution pattern connectivity in a metapopulation scale are identified.

The next research section is aimed to validate the developed best fitted predictive models in the earliest section via ground validation techniques to eventually assess a threshold value indicating the minimum suitability rate for the leopard presence. In this regards, three threshold rules including equal training sensitivity and specificity, maximum training sensitivity plus specificity and minimum training presence were selected for the purpose of binary classification of the predictive maps. Accordingly, field surveys (e.g. camera trapping for 2,541 trap nights, sign surveys, interviews with local knowledgeable people) together with mapping and overlays concentrated on the errors of omission across three selected provinces in (1) North-East containing Kopet Dag Mountains, (2) North-West located in the Caucasus Ecoregion and (3) adjacent to the Persian Gulf in southernmost part of the leopard range in the country. The results indicate that the sensitivity and specificity based threshold rules show more accuracy comparing to the minimum training presence rule with notable overestimation of the suitability rates. Eventually, habitat suitability rate of 0.3 on the developed predictive maps was identified as a value to safely recognize the actual potential habitats with confirmed significance for conservation planning.

The latest section of the research is aimed to develop empirically fitted species and region specific models and relative threshold values using the findings of previous research sections to assess cumulative effects of land use and land cover variables on the regional persistence of the Persian leopard. The Principle Component Analysis and regression curve estimation were used as the main statistical techniques in this section. Two types of innovative models with relative threshold values were developed. The first type uses habitat suitability rates while the second type uses density of the land use and land cover variables. Subsequently, current status of each province in relation to the Persian leopard regional persistence is assessed. Accordingly, adjustments are required in cumulative effect of land use and land cover variables to improve the quality of two identified landscape corridors in the earliest section as their current status is significantly farther than the threshold level to ascertain regional persistent of the Persian leopard. Findings of this research support the earlier hypothesis indicating

that the leopard range in Iran is in the process of splitting to the northern and southern fragmented parts.

Research sections developed in this study contribute significantly to the current knowledge about the Persian leopard status and the conservation requirements. The developed approach provides a helpful insight to the decision makers to wisely consider wildlife friendly solutions for development activities and prevent negative cumulative effect of land use and land cover changes on leopard persistence in each region. These innovative models can be adjusted to be used for the conservation purposes in other countries of the Persian leopard range in southwest Asia. The approach can be used to develop similar species and region specific models addressing other regions and large cat species.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMODELAN KESAN KUMULATIF SERANTAU VARIASI GUNA TANAH DAN LITUP TANAH BERKAITAN DENGAN KEHADIRAN BERTERUSAN HARIMAU BINTANG PARSI (*Panthera pardus saxicolor*) DI IRAN

Oleh

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Kesan kumulatif perubahan guna tanah dan litup tanah terhadap kehadiran berterusan harimau bintang Parsi (*Panthera pardus saxicolor*) di Iran belum diciri dan dan diformulasikan setakat ini. Penyelidikan semasa mengambil berat tentang penemuan suatu pendekatan inovatif metodologi terhadap spesies dan wilayah spesifik untuk meramalkan kesan kumulatif guna tanah dan variasi litup tanah terhadap kehadiran berterusan harimau bintang Parsi. Penyelidikan ini adalah satu amalan di seluruh negara yang dijalankan berasaskan serantau di Iran dengan tiga wilayah yang dipilih untuk menjalankan teknik pengesahan tanah. Tiga bahagian penyelidikan utama dibangunkan dalam merumuskan model bagi data dan informasi yang diperlukan. Dalam bahagian pertama, wilayah-wilayah ini diklasifikasikan secara inovatif ke dalam lima wilayah yang jauh berbeza dari segi variasi alam sekitar berdasarkan luas taburan harimau bintang Parsi dalam sekurang-kurangnya 30 dari 31 wilayah Iran. Rekod kehadiran harimau yang mencukupi dengan 17 pembolehubah semulajadi dan manusia digunakan untuk membangunkan peta ramalan habitat yang berpotensi secara serantau menggunakan perisian MaxEnt. Pembolehubah

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diuji untuk menentukan kemungkinan korelasi antara mereka dan model dinilai untuk prestasi ramalan. Hipotesis nol penyelidikan iaitu ketiadaan signifikan dalam kepelbagaian permutasi serantau sebagai pembolehubah penting penyelidikan adalah model ramalan terbaik adalah diterima. Dua koridor landskap untuk meningkatkan kesalinghubungan corak taburan harimau dalam skala metapopulasi dikenalpasti.

Bahagian penyelidikan yang seterusnya bertujuan untuk mengesahkan model ramalan terbaik yang telah dibangunkan di bahagian sebelum ini melalui teknik pengesahan lapangan untuk menilai nilai ambang yang menunjukkan kadar kesesuaian minimum bagi kehadiran harimau bintang. Dalam hal ini, tiga peraturan ambang termasuk sensitiviti dan kekhususan latihan yang saksama, sensitiviti latihan maksimum bersama spesifisiti dan kehadiran latihan minimum telah dipilih untuk tujuan klasifikasi binari peta ramalan. Oleh itu, tinjauan lapangan (contohnya, pemerangkapan kamera untuk 2,541 malam perangkap, tinjauan jejak, wawancara dengan orang tempatan yang berpengetahuan) bersama-sama dengan pemetaan dan lapisan tertumpu kepada pengecualian ralat di tiga wilayah terpilih di (1) Timur Laut yang mengandungi Pergunungan Kopet Dag, (2) Barat Laut yang terletak di Caucasus Ecoregion dan (3) bersebelahan dengan Teluk Parsi di bahagian paling selatan dari populasi harimau bintang di negara ini. Hasil keputusan menunjukkan bahawa sensitiviti dan spesifisiti berasaskan peraturan ambang menunjukkan ketepatan lebih tinggi berbanding dengan kehadiran latihan minimum dengan jangkaan yang ketara mengenai kadar kesesuaian. Akhirnya, kadar kesesuaian habitat 0.3 di atas peta ramalan yang dibangunkan telah dikenal pasti sebagai nilai selamat untuk mengenali habitat potensi sebenar dengan perancangan pemuliharaan yang signifikan sahnya.

Bahagian terakhir penyelidikan ini bertujuan untuk membangunkan spesies yang terikat secara empirikal dan model khusus serantau serta nilai ambang relatif menggunakan penemuan bahagian penyelidikan terdahulu untuk menilai kesan kumulatif penggunaan tanah dan pembolehubah litup tanah atas kehadiran serantau harimau Parsi. Prinsipal Analisis Komponen dan teknik anggaran keluk regresi digunakan sebagai teknik analisis utama dalam bab ini. Dua jenis model inovatif dengan nilai ambang relatif telah dibangunkan. Jenis pertama menggunakan kadar kesesuaian habitat sementara jenis kedua menggunakan kepadatan penggunaan tanah dan pembolehubah litup tanah. Selanjutnya, status semasa setiap wilayah

berkaitan dengan kehadiran serantau harimau Parsi dinilai. Pelarasan diperlukan dalam kesan kumulatif pembolehubah guna tanah dan litup tanah untuk meningkatkan kualiti koridor landskap yang dikenal pasti di bab terawal sebagai status semasa mereka adalah jauh lebih rendah daripada tahap ambang untuk menentukan kehadiran berterusan harimau Parsi di rantau ini. Penemuan penyelidikan ini menyokong hipotesis yang lebih awal yang menunjukkan bahawa banjaran taburan harimau bintang di Iran sedang dalam proses pemisahan ke bahagian utara dan selatan yang terbahagi.

Bahagian penyelidikan yang dibangunkan dalam kajian ini menyumbang dengan ketara kepada pengetahuan semasa tentang status harimau bintang Parsi dan keperluan pemuliharaan. Model yang dibangunkan ini menyediakan pandangam yang berguna kepada pembuat keputusan untuk mempertimbangkan secara bijaksana penyelesaian mesra hidupan liar untuk aktiviti pembangunan dan mengelakkan kesan kumulatif negatif guna tanah dan perubahan litup tanah di setiap wilayah. Model-model inovatif ini boleh diselaraskan untuk digunakan untuk tujuan pemuliharaan di negara-negara selain dari kawasan harimau bintang Parsi di Asia barat daya. Pendekatan ini boleh digunakan untuk membangunkan spesies yang serupa dan model spesifik wilayah yang meliputi kawasan dan spesies kucing besar lain.

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LIST OF ABBREVIATIONS AND SYMBOLS

°	Degree
°C	Degree Centigrade
%	Percent
′	Minute
AMV	Assessed Model Value
ANOVA	Analysis of Variance
ASL	Above Sea Level
AUC	Area Under the Curve
C	City
Cl.	Climate
D	Density of the areas with habitat suitability rate of more than 0.3
DoE	Department of Environment
Dep. Var.	Dependent Variable
Dr.	Dry condition
DF	Dry Farming
Elev.	Elevation
Eq.	Equation
ENM	Ecological Niche Modeling
F	Forest
HP	Human Population
HPI	Human Poverty Index
IF	Irrigated Farming
LC	Landscape Corridor
LU/LC	Land Use and land Cover
MaxEnt	Maximum Entropy
MR	Main Road
Mnts	Mountains

MVP	Minimum Viable Population	
NHA	No Hunting Area	
NP	National Park	
PA	Protected Area	
PCA	Principle Component Analysis	
r	Correlation coefficient	
R	Range	
ROC	Receiver Operating Characteristic	
SD	Standard Deviation	
SDM	Species Distribution Modeling	
SF	Scattered Farm	
SR	Sub-Road	
Topo.	Topography	
UPM	University Putra Malaysia	
V	Village	
Veg.	Vegetation	
WR	Wildlife Refuge	

CHAPTER 1

INTRODUCTION

1.1   General overview

Fragmentation of habitats into smaller patches and loss of suitable areas and connectivity of patches in landscapes pose a serious threat to populations' viability of various large predator species (Gerber *et al.*, 2012; Johnstone *et al.*, 2010; Michalski and Peres, 2005; Meffe and Carroll, 1997). Management efforts are to provide or recreate spatial, temporal, genetic and ecological connectivity between habitat patches (Lockwood *et al.*, 2006). Physical connectivity of reasonably undisturbed areas, e.g. through the wildlife corridors in which connect at least two major habitats (McEuen, 1993; Beier and Loe, 1992), facilitate dispersal of individuals between remaining patches (Cushman and Landguth; 2012; With and King, 1999). This allows for the long term genetic interchange and re-colonizing the relative areas (Bond and Lake, 2003).

As a result of fragmentation serious declines occur in the total area of habitats and they split into smaller and more isolated patches (Saunders *et al.*, 1991; Harris, 1984). While maintaining connectivity of habitat patches in increasingly populated areas even in the same political boundary is a challenge, managing such habitats in international borderlands poses as a serious issue for many countries (De Jong *et al.*, 2010; IUCN, 2007; Bennett and Mulongoy, 2006). Changes in vegetative composition of habitats and subsequently type and quality of the food base, changes in predation and competition, demographic stochastic and reduction in genetic diversity, human-predator conflicts, increasing opportunities of poaching and increasing local extinctions are among the adverse effect of habitat fragmentations (Watson, 2005; Knaepkens *et al.*, 2004; Anderson, 1999; Noss and Cooperrider, 1994).

Even though, large predators may persist for decades in fragmented habitats (Turner and Corlett, 1996), their long term viability in these areas are threatened by various factors, e.g. effect of human disturbances, edge effects and reduction in immigration rates (Dannemann *et al.*, 2018; Niebuhr *et al.*, 2015; Levins, 1969). Thus, predicting responses of various species to habitat

fragmentation, habitat loss and reduction of habitat suitability rates caused by the land use and land cover changes is a matter of concern for conservation biologists (With and King, 1999). While each case of the land cover alternation or changes in land use could occur in a small scale, but cumulative effect of these changes may perhaps produce a significant impact leading to the actual fragmentation (see also Theobald *et al.*, 1997). Thus, understanding the responses of the species to these changes allows for identification of priority areas and further effective management planning (Moilanen *et al.*, 2005).

Considering this overview, current study is an innovative attempt to formulate a species and area specific model and a threshold level to enable managers and conservationists to predict the cumulative effect of changes in land use and land cover variables on the Persian leopard (*Panthera pardus saxicolor*) regional persistence in Iran. Three research chapters are presented in this thesis in which the first one represents countrywide distribution modelling of the Persian leopard in a regional context. The second chapter concentrates on the ground validation of the developed maps in three different provinces across the country. The third research chapter uses the outcomes of first two research chapters to develop the innovative model regarding the regional persistence of the Persian leopard in Iran.

1.2   The Persian Leopard: General introduction

1.2.1   Taxonomy

Due to the variability in habitat types and conditions (see also Sunquist and Sunquist, 2002) where the Persian leopard inhabit either in Iran or elsewhere in the west, south and central Asia, morphological features and morphometric characteristics (e.g. body size measurements, coloration, coat pattern) are also variable (Khorozyan *et al.*, 2006 Kiabi *et al.*, 2002; Sanei, 2007; Etemad, 1985; Heptner and Sludsky, 1972). Therefore, considering phenotypic variations and geographic extent, scientists had described more than one leopard subspecies exist in Iran (e.g. *P.p. dathei* Zukowsky, 1959; *P. p. sindica* Pocock, 1930; *P.p. saxicolor* Pocock, 1927). However, more recent investigates including molecular genetic studies and craniometric analysis confirmed and supported the presence of one leopard subspecies in Iran, i.e. *P.p. saxicolor* (see also Farhadinia *et al.*, 2015; Rozhnov *et al.*, 2011; Khorozyan

et al., 2006; Meijaard, 2004; Ullrich and Riffel, 1993; Uphyrkina et al., 2001; Miththapala et al., 1996).

1.2.2 Distribution pattern

While the Persian leopard range in south, west and central Asia has been limited during the past decades, the subspecies is known to be widely distributed in Iran (Sanei et al., 2016) and still extant in Turkmenistan, Armenia, Azerbaijan, Iraq, Turkey, Afghanistan, Pakistan and Russia. However, the Persian leopard presence is uncertain in Georgia, possibly extant in Uzbekistan and possibly extinct in Tajikistan (Stein et al., 2016; Lukarevsky et al., 2007; Khorozyan et al., 2005).

In Iran, historical reports denoted the leopard as a common species in mountains and hills particularly along the Alborz and Zagros mountainous chains (Joslin, 1990; Misonne, 1959; Pocock, 1930; Birulya, 1912; Blanford, 1876) except for the agriculture lands and vast plains, e.g. the deserts (Harrington and Darreshuri, 1977; Lay, 1967).

However, recent countrywide studies documented the leopard presence in 74 protected and non-protected habitats out of a total of 90 investigated sites which eventually covers all provinces except for the Hamedan (Sanei and Zakaria, 2011c; Sanei, 2004, 2007). These studies suggested that 55% of leopard presence areas are protected which is well in agreement with population guesstimates by Kiabi et al. (2002). Subsequently, Sanei et al. (2016) conducted new distribution and status assessments which then hypothesized that the leopard distribution range in Iran is in the process of splitting into the northern and the southern parts.

1.2.3 Ecology and behavior of leopard

The studies concerning the leopard ecology in Iran were handful. As such, study of territorial marking of leopards in Bamu demonstrated that most of the scrapes were claw in the winter which is known to be the mating season for the leopard in the region (Ghoddousi et al., 2008). Other reports from Sarigol NP, North Khorasan province, indicated that the mating season was from January to February (Farhadinia et al., 2009). There are also numerous records of attacks of leopard in domestic dog (Canis lupus familiaris) meant

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for feeding which was confirmed by Fadakar *et al.*, (2013) via DNA tools. However, studies of spatial ecology of the leopard in Tandureh NP, north-eastern Iran, are still on-going (Farhadinia, unpub. data).

1.2.4   Disease

On the subject of the knowledge about disease of the Persian leopard, Namroodi *et al.*, (2015) conducted a study on three leopards that died in road crashes in Golestan National Park, northern Iran to test *Toxoplasma gondii* and rabies virus infection. Even though rabies virus infection was not detected in any of them, two of the cats were infected by *T. gondii*. Subsequently, they concluded that toxoplasmosis might be a notable factor in leopard road kills. *Taxocara cati* was recorded in two other leopards (male and Female) in Golestan NP, while parasites found in the female individual was 7 times more than the male individual in the same area (Ghaemi *et al.*, 2011). *Ancylostoma tubaeforme* was recorded in a young female illegally killed in Semnan province (Youssefi *et al.*, 2010). Shistosoma spp. was recorded in one leopard faeces in Degarmanli site in Golestan NP (Persian Leopard Online Portal, unpublished records, accessed 07 August 2012). Mowlavi *et al.* (2009) detected *Trichinella britovi* in a leopard as they recovered larvae from the specimen muscles.

1.2.5   Habitat

Even though leopards are found in a variety of habitat conditions ranging from temperature of – 23.1˚ C to 49.4˚ C, they are mostly recorded in the areas with 13-18˚ C and duration of ice cover with less than 20 days/year and more than 200 mm/year of precipitation (Sanei and Zakaria, 2011c and 2008). Elevation of 1,100-1,200 m and slopes of 30-65˚ in Turan NP and PA (Mobargha, 2006) and elevation of 1,800 – 2,400 m and slopes of 20-70˚ in Kolah Ghazi NP (Omidi *et al.*, 2010) are identified as the most suitable habitats for the leopards in the above mentioned areas. Mountainous habitats, small rippling hills and rough terrain with abundant preys were found as the habitat preference for the leopard in Sarigol NP (Taghdisi *et al.*, 2013). In general, the leopard range in Iran is mostly confined to the mountainous habitats (Sanei et al., 2016). The Persian leopard is known to avoid deserts and anthropogenic landscapes, e.g. agriculture lands (Gavashelishvili and Lukarevskiy, 2008; Harrington and Darreshuri, 1977; Lay, 1967) and snow cover (Gavashelishvili and Lukarevskiy, 2008).

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1.2.6 Prey

Leopard presence range is known to have 100% of conformity with wild goat *Capra aegagrus* presence in a total of 43 study sites across Iran. In the other hand, wild sheep *Ovis Orientalis,* wild boar *Sus Scrofa* and Indian crested porcupine *Hystrix indica* were found to be present in 95%, 65% and 65% of the leopard presence habitats (Sanei *et al.*, 2011). Omidi *et al.*, (2010) identified the wild goat as a main factor for leopard presence in Kolah Ghazi NP, while, in Tandureh NP, the wild goat and the wild sheep were identified as the main leopard prey (Chalani, 2005). In Golestan NP, the wild boar together with the wild sheep and the wild goat has a main part in leopard diet (Sherbafi, 2010). Attacks on domestic dogs have been frequently recorded. For instance, an old male leopard was frequently recorded to feed on domestic dogs in a village namely Tazeh Ghaleah in northeastern Iran, close to Turkmenistan border (pers. Observ.). Such records have been made in Golestan NP using sequencing the control region of mtDNA (Fadakar *et al.*, 2013). In Sarigol NP, wild sheep followed by the wild boar and wild goat were identified as the main prey for the leopard (Taghdisi *et al.*, 2013).

1.2.7 Main threats, mortality rate and human-leopard conflicts

Habitat destruction, degradation and fragmentation are reported as the main factors threatening leopard population in the national (Sanei *et al.*, 2016; Sanei and Zakaria, 2011d) and local scale (e.g. Erfanian *et al.*, 2013; Ghoddousi *et al.*, 2010 and 2008; Sanei, 2007). A total of 71 leopard mortality have been recorded from 2007 to 2011 in which 70% (n=50) of them were as a result of intentional hunting and poisoning and 18% (n=13) because of road accidents (Sanei *et al.*, 2012). In general, least number of mortality cases have been officially recorded in Iran from 2007 to 2015 includes 152 cases while 19 additional cases are not confirmed (Sanei *et al.*, 2015). Depredation on wide range of livestock mostly including domestic sheep and goat (n=7,090) and to a lesser extent camel, cow, donkey, horse and mule (n=208 kills) have been recorded. Attacks on herding dogs are also very frequent (Sanei *et al.*, 2016). Dry condition, serious prey reduction, presence of animal husbandry and livestock in leopard habitats, low ecological awareness, aftermath of Iraq and Iran war (Sanei *et al.*, 2016; Sanei and Zakaria, 2011d) and possibly presence of landmines in trans-boundary leopard areas in the neighboring Caucasus habitats (see also WWF, 2016).

1.2.8 Importance in the Iranian culture and literature

Formerly, a total of 3 members of the genus *Panthera* inhabited in Iran. These were including the Persian lion (*Panthera leo persica*), the Caspian tiger (*Panthera tigris virgata*) and the Persian leopard (*Panthera pardus saxicolor*). However, after extinction of the lion and the tiger (about 150 and 58 years ago, accordingly; Ziaie, 2008; Firouz, 2000), the Persian leopard has been the last remaining of *Panthera* species in Iran. Thus it has a unique importance for both ecological health of natural ecosystems as well as the cultural heritage in this country.

In general, the big cats (i.e. lion, tiger and leopard) have a great influence in the Iranian literature and symbolization. For instance, since 1846 until Iran revolution in 1979, lion and the sun were the elements of the Iran's national flag. In the literature works of various Persian authors the lion, the tiger and the leopard are denoted as symbols of strength, intelligence, bravery, justice and valour. As such, poems by Ferdowsi (940–1020 CE) in the Persian epic of the kings (or Shahnameh) and Sepehri (1928 – 1980) in the modern Persian poetry, are denoted.

A famous legendary of Iran namely Rostam who is a hero in Shahnameh (epic of the kings), used to wear a kind of suit made of the leopard skin (namely Palangineh) in the battles. After his death, the suit was handed to Faramarz, his son (see also Ferdowsi, 2006). According to a folktale about the leopard and the moon, a leopard may not tolerate anything overhead. In the full moon nights, tragedy happens when the leopard tries to reach to the moon from peak of the mountain. The leopard broken pride and its injured body over the sharp cliffs after clawing at the moon with no success, vanishes the desire to reach to the moon (see also moon and the leopard by Hossein Monzavi, 1946–2003).

Among other art works, the paintings remained from 8th century Iranian kings are shown with clothes made of a leopard coat which denotes strength and bravery of the kings. Yet, some elements in the Iranian carpets are influenced by the leopard and lion symbols and signs (Hermidas, 2011). All these facts indicate that large cats and in particular the leopard which has a vast distribution in the country, had a great influence on local communities during the centuries. Yet, the leopard is recognized as the king of the mountains by Iranians (Zakaria and Sanei, 2011). However, aside from the

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historical significance of the large cats in arts, beliefs and thoughts of local communities and Iranians in general, there are various other factors affecting the actual interactions of the leopards and local communities in the current situation.

1.2.9   Protection status, law and regulations

The Persian leopard is listed as Endangered EN C2a (i) on the IUCN (International Union for Conservation of Nature) Red List of Threatened Species (IUCN, 2016). Endangered is defined as a species that is encountering a very high risk of extinction in the near future in the wild. Category C2a refers to the population estimate of less than 2,500 mature individuals and continuous decline in the number of mature individuals and severe fragmentation in population structure while no subpopulation is estimated to have more than 250 mature individuals (IUCN version 2.3 Categories and Criteria, 1994).

In CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), Persian leopard is listed in Appendix I which refers to the regulation that international trade of the species is prohibited. In the exceptional and non-commercial circumstances, e.g. scientific researches, translocation of an individual or any part of a specimen (e.g. bone, claw, teeth) is subjected to the import and export permissions from both originating and destination countries (CITES, 2012).

In the Iranian environmental conservation laws and regulations, the Persian leopard has been protected by national wildlife conservation law since 1999. The principal safety zones for leopards include national parks (NP); wildlife refuges (WR) and protected areas (PA) as well as no-hunting areas (NHA) with short-term protection for the purpose of enabling wildlife species to recover. Yet, some different kind of habitat protections (e.g. forest reserves) is executed by the Iranian forest, range and watershed management organization. These areas occasionally act as safety zones for the leopard and their prey species (see also forests and natural resources protection law enacted in January, 1942).

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In early 2016, the Persian leopard national conservation and management plan (Sanei, 2016) were finalized and endorsed by the head of the Department of Environment (DoE) of Iran. An innovative model was developed for the planning procedure to actually address extreme diversity of natural and cultural conditions as well as economic and other relative factors that eventually affect the species conservation and management (Figure 1.1). The plan includes total of 11 main chapters which has been enacted for duration of 5 years in the first phase of implementation. These chapters include:

1. Awareness raising, training and empowerment
2. Habitat
3. Media
4. Veterinary and disease
5. Rehabilitation centers
6. Trans-boundary habitats and international cooperation
7. Genetic conservation
8. Compensation and the innovative Persian leopard insurance program
9. Persian leopard national network
10. Research, evaluation and monitoring
11. Protection units and wildlife wardens

Accordingly, the Persian leopard national insurance program has been implemented partially since early 2016 to address both compensation of livestock losses and reduction in livestock-leopard conflicts. This program also includes depredations by wolf *Canis lupus* to further improve effectiveness of the plan (see also Sanei *et al.*, 2016). Relatively, amount of the penalty for each illegally hunted leopard has been upgraded from 50,000,000 Rials equivalents to 2,014.75 USD in 2014 to 800,000,000 Rials equivalent to 26,270.30 USD in 2015.

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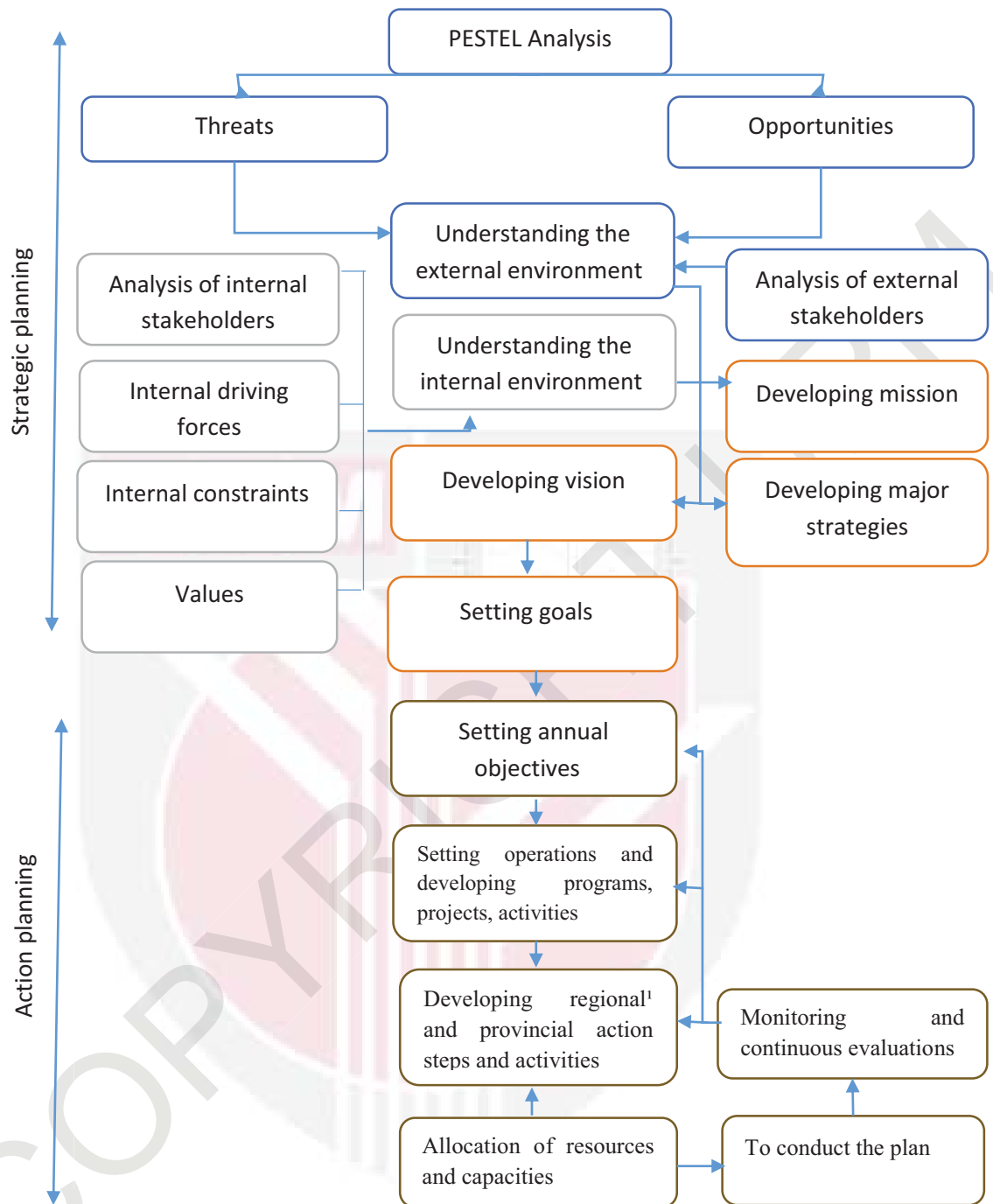
Figure 1.1 : An innovative model developed for action planning concerning conservation and management of the Persian leopard in Iran. The chart presented here, is according to the Persian leopard national conservation and management action plan in Iran.
(Sanei, 2016)

1.3   Problem statement

Various species and in particular, the territorial big cats, are vulnerable to habitat loss and fragmentation. Understanding the distribution and habitat requirements of the species together with the population estimates and the trends over time are the key parameters required for designing suitable management strategies and prioritization in allocation of the limited resources (Richmond-Coggan, 2006; Karanth, 2003; Nowell and Jackson, 1996). While developments and disappearance of vast areas of habitats particularly in developing countries is considered as a main threat to the large felids (Sanei and Zakaria, 2011a, b; Nowell *et al.*, 2007; Sunquist and Sunquist, 2001; Anderson, 1999), adequate knowledge about the key areas and a threshold level for various anthropogenic factors is essential for establishing the conservation priorities (Ariyanto, 2015; Ario, 2007; Lindenmayer and Fischer, 2006). Relatively, a possibility that the leopard distribution in Iran is in the process of splitting into a northern and the southern parts has been hypothesized in a recent study (Sanei *et al.*, 2016). This is a main concern not only for the leopard persistence in Iran, but also its presence in the neighbouring countries where the species occurrence is supported by trans-boundary movements. Thus, identification of the leopard habitats, habitat arrangements and suitability rates are the main concern for the Persian leopard conservation in Iran.

Aside from the influence of each single variable of land use (LU) and land cover (LC) and identification of the particular threat factors, no study has been done so far to assess the cumulative effect of multiple drivers of changes on the persistence of the Persian leopard in either regional or countrywide and even local scales. On the other hand, preventing the development activities across the entire country due to the wide distribution of the Persian leopard in Iran is not realistic and feasible. Yet, being a top predator as well as an umbrella species, assessing a research-based species and region specific conservation program, eventually influence conservation status of a large number of other species (e.g. brown bear, grey wolf, striped hyena, roe deer, red deer, etc.) and wide range of habitats. Yet, influencing the programs for LU/LC changes and development activities to eventually ensure existence of the adequate amount of suitable areas with enough suitability rates and proper arrangements and connectivity among them, is particularly an urgent need for leopard conservation in Iran. This would not be possible without influencing the development strategies and drawing attention of decision takers and land use managers to the research based

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solutions for nature friendly development activities. Yet, politicians' considerations about cost effective practical solutions should be noted.

Thus, identification of the habitats, their suitability rates and significance of each area in relation to the probability of leopard presence and arrangements of the other habitats in the region and assessing the cumulative influence of LU/LC variations on the local and regional leopard persistence are essentially required. Assessing regional models that explain how the changes of each single LU/LC variable is actually affecting leopard persistence in local, regional and eventually, countrywide scales in relation to the other factors in the area, is the current innovative practice dedicated to the Persian leopard conservation and management in Iran. This model enables the managers and decision takers to adjust and combine the development activities and conservation efforts in the best possible way to ensure that present status of the LU/LC is not harming the leopard persistence, followed by numerous other coexisted species, in a wide scale.

1.4   Justification and significance of the study

The range of the Persian leopard in south west Asia has been seriously restricted during the past decades (see also Sanei *et al.*, 2016; Khorozyan and Abramov, 2007; Versechagin, 1959). However, land use and land cover changes across the leopard range (Sanei and Zakaria, 2011c) resulted from human factors and natural mischances (see also Mirzaei *et al.*, 2015; Sanei and Zakaria, 2011d; Asgari *et al.*, 2008) are increasingly threatening the main population of this subspecies in Iran (see also Stein *et al.*, 2016; Kiabi *et al.*, 2002). As such, understanding the current status of this main population together with conservation requirements particularly in terms of habitat availability and connectivity while land use and land cover changes increasingly occur (e.g. Azizi and Jafari, 2016; Rezaei *et al.*, 2016; Mirzaei *et al.*, 2015), is essential.

Obtaining reliable population estimates and demographic trends for secretive, nocturnal and solitary leopards (Sergeant *et al.*, 2003; Eltringham, 1979) with the range dispersal across 30 provinces of Iran (Sanei et al., 2016; Sanei and Zakaria, 2011c), is problematic (Vold and Buffett, 2008) due to the time, financial and human resources constraints. Thus, studies concerned with population trends and demographic data such as death and birth rates (e.g. for Population Viability Analysis, Lindenmayer *et al.*, 1993) are

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problematic. However, study on the distribution patterns and relative parameters in a large scale are practically feasible and provides a reliable basis to understand the species status and dynamics over time. Previous studies demonstrated that habitat loss and fragmentation negatively influences species persistence (see also Roques and Stocia, 2007), thus, habitat suitability rate is connected to the species persistence in a region.

Relatively, models related to the land use and land cover changes have extensive variety depending on data availability, modelling goals and methodological approaches (Brown *et al.*, 2014). These models are generally used to predict the changes of land use and land cover in future or evaluate various scenarios which are also very helpful in decision making and conservation programs (Sanchez and Alonso, 2008; Turner *et al.*, 2004; Singh, 2003; Agarwal *et al.*, 2002).

However, no study is conducted so far to assess cumulative effect of land use and land cover changes on the Persian leopard. Due to the absence of such researches and an urgent need to provide research-based data for conservation practices via influencing rapid development strategies in and around leopard natural habitats, this study was carried out to develop an innovative model to further improve the Persian leopard conservation practices.

Typically, LU/LC change models investigate the relationship between the variables and historical land transitions. Afterwards, these relationships will be used for building models about land transitions in the future (Ahmed *et al.*, 2013). In general, land use and/or land cover change models have been classified into various categories such as economic (divided to non-spatial explicit and spatial explicit models) and non-economic models (Irwin and Geoghegan, 2001), empirically fitted and process simulation models (Brown *et al.*, 2004), land cover in distributional models (changes in proportion of a landscape) and spatial landscape models (location and configuration of changes; Baker, 1989), also to empirical and statistical, mathematical, spatial simulation models (Lambin, 1997). Among these categories, empirically fitted models are about description of the process on the basis of measured data during that process in specific place and time. However, process simulation is according to a general understanding about the processes and simulating the outcomes via building models in specific places (Brown *et al.*, 2004).

Accordingly, to develop empirically fitted models on the basis of the actual data for the purpose of this research, assessing the leopard potential habitats with relative suitability rates, validation of such models on the ground and relative corrections, also selection of LU/LC variables affecting habitat suitability rates together with the relative threshold level are essential. Yet, concerning notable variation of environmental factors in various provinces of Iran, identification of significantly dissimilar regions to develop regional models was considered. Thus, aside from producing the regional habitat suitability distribution maps which eventually cover the entire country, cumulative effects of LU/LC variables was also modelled on the regional basis.

1.5   Thesis statement

A major contribution of this thesis to conservation and management of the Persian leopard in Iran is formulating a predictive model and assessing the relative threshold level to address the cumulative effect of LU/LC variations on regional persistence of the Persian leopard in relation to the habitat suitability rates. However, a research question in this thesis is about the possibility that the Persian leopard potential habitats in Iran are in the process of a major fragmentation that may split the entire potential range into northern and southern parts. This question has been hypothesized by previous studies after plotting the recent presence locality of the Persian leopards in Iran (Sanei *et al.*, 2016). Relatively, modelling of the leopard potential habitat distribution across the entire country is conducted in which existence of landscape corridor/s to improve the connectivity in the metapopulation scale is studied.

In this regards, definition of key terms and assumptions are clarified in chapter 3. The overall study design is considered in a regional context to address the regional variability of environmental factors in various provinces of Iran. Thus, each region is consisted of several provinces which are found to be significantly similar in terms of the selected environmental and human factors.

In general, land cover is defined as biophysical status of the land surface and the immediate sub-surface. While land cover changes are related to either human or natural factors, the purpose of land use is generally associated with nature of the land cover. Therefore, understanding the changes in land

use is necessary to understand the changes in land cover and vice versa (Anwar, 2014).

Regional species potential distribution models are developed using MaxEnt software version 3.3.3K to assess the potential habitats for the leopard. A potential habitat in these models is considered as a habitat with some degree of suitability for the leopard persistence. This leads to the potential distribution map of the species that indicates the distribution pattern of the suitable habitats for leopard persistence. Probability of suitability is estimated by the software using environmental variables and presence records. MaxEnt also provides the permutation importance for each variable which is the measure of contribution of variables by permuting their values randomly among both species presence and environmental background training points and assessing resulting reduction in training AUC. Despite of the percentage contribution which is calculated on the basis of tracking the variables during the modelling process, then, converting the result to percentage, permutation importance is not dependent on the path that MaxEnt used to obtain the final model (Phillips, 2006).

A landscape corridor is a cluster of connecting habitats that provides opportunity for movements of individuals of the species between various areas (IUCN, 2007). This study also investigated the landscape corridors in a metapopulation scale which is consisted of connecting local populations where individuals uncommonly move from one to another across the habitats which are unsuitable for feeding and breeding (see also Nouhuys, 2016; Hanski and Gilpin, 1991). With this definition, habitat fragmentation occurs when habitats break off into the isolated patches due to the reduction of the areas of habitats (Saunders *et al.*, 1991; Harris, 1984).

1.6   Objectives

The general objective for this thesis is to formulate a model to predict regional persistence of the Persian leopard on the basis of the current potential range and cumulative effect of changes in selected land use and land cover variables. There are six specific objectives that are addressed in one of the three research chapters:

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1. To estimate potential distribution of the Persian leopard in Iran considering the extensive variability of the environmental condition (chapter 4)
2. To predict landscape corridor/s to improve distribution pattern connectivity in a metapopulation scale (chapter 4)
3. To identify the main environmental factors contributing to assess the leopard potential distribution in Iran (chapter 4)
4. To validate the best fitted leopard distribution models on the ground in selected study areas in order to assess a threshold value indicating the minimum suitability rate that can be safely used in further conservation practices (chapter 5)
5. To develop a species and region specific model for assessing cumulative effects of *priori* selected land use/land cover variables on the regional persistence of the Persian leopard with respect to the habitat suitability rates (chapter 6)
6. To propose a species specific threshold level for land use and land cover variations affecting habitat suitability rates with influence on the regional leopard persistence in Iran (chapter 6)

1.7   Hypothesis

One null hypothesis is generated for the current thesis in which is stated as follows. It should be noted that the MaxEnt investigated another null hypothesis saying that the test points prepared for the model validation are predicted no better than a random prediction. This is addressed in chapter 4.

H0: Permutation importance of the research environmental variables in the best fitted MaxEnt models does not significantly vary according to the regional differences of the environmental variables (chapter 4)

1.8   Organization of the thesis

This thesis is organized in a total of 7 chapters including three research chapters:

Chapter 1. This chapter includes a general overview to the species concerning taxonomy, distribution, ecology and behaviour, habitats, preys, main threats, mortality rates and conflicts, cultural significance and conservation laws and regulations. This chapter also illustrates the main research problems and relative justifications together with research question, main and specific objectives and the hypothesis.

Chapter 2. Second chapter is dedicated to the review of literature in three main sections of ecological concepts related to the research topic, statistical aspects of the methodologies used in this research as well as a review to the land use / land cover changes modelling. Ecological aspects reviewed in this chapter includes subjects about population viability, minimum viable population and extinction risk, also niche concept and Hutchinson's biotope-niche duality, ecological niche modelling and species distribution. Statistical reviews include Maximum Entropy, Principle Component Analysis and the curvilinear regression. A brief review is also presented to the status of the Persian leopard in South-West Asia while more details about introduction to the sub-species in Iran is provided in the first chapter.

Chapter 3. There are three research sections in which each of them includes a standalone research topic, but also the results and findings of each is much related to the others. Thus chapter 3 is dedicated to a general overview to the methodologies used in these sections. This chapter includes the conceptual frame work of the thesis as well as the definition to the key terms and assumptions.

Chapter 4, 5 and 6. These chapters include separate research topics that eventually the findings are related to each other. Classification of regions is illustrated in chapter 4. Each research chapter include its own objectives, methodologies, results and discussions. The null hypothesis is addressed in chapter 4.

Chapter 7. The last chapter includes conservation implications and relative recommendations along with the final conclusion of the thesis.

References. The references cited in the thesis, are indicated in this section.

Appendices. All materials mentioned in the text as appendix are presented in appendices.

REFERENCES

Abai, M. R., Saghafipour, A., Ladonni, H., Jesri, N., Omidi, S., & Azari-Hamidian, S. (2016). Physicochemical Characteristics of Larval Habitat Waters of Mosquitoes (Diptera: Culicidae) in Qom Province, Central Iran. *Journal of Arthropod-borne Diseases*, 10(1): 65-77.

Abai, M.R., Azari-Hamidian, S., Ladonni, H., Hakimi, M., Mashhadi-Esmail, K., Sheikhzadeh, K., Kousha, A. & Vatandoost, H. (2007). Fauna and Checklist of Mosquitoes (Diptera: Culicidae) of East Azerbaijan Province, Northwestern Iran. *Iranian Journal of Arthropod-borne Diseases*, 1(2): 27-33.

Abtahi, S. M. & Safe, A. (2012). Rain and Temprature Trends in Namak Lake Basin (Iran) During the Last Half – Century. *International Journal of Science and Nature*, 3 (1): 137 – 146.

Ahmed, B., Kamruzzaman, M., Zhu, X., Rahman, M. S., & Choi, K. (2013). Simulating Land Cover Changes and Their Impacts on Land Surface Temperature in Dhaka, Bangladesh. *Remote Sensing*, 5(11), 969e5998.

Andrén, H. (1994). Effects of Habitat Fragmentation on Birds and Mammals in Landscapes with Different Proportions of Suitable Habitat: A Review. *Oikos*, 71, 355–366.

Anderson, S. H. (1999). *Managing Our Wildlife Resources*. New Jersey: Prentice Hall.

Agarwal, C., Green, G. M., Grove, J. M., Evan, T. P., & Schweik, C. M. (2002). A Review and Assessment of Land-Use Change Models: Dynamics of Space, Time and Human Choice. USDA (Forest Services). *General Technical Report NE-297*, 7559-7564.

Akçakaya, H. R. (1992). Population Viability Analysis and Risk Assessment. In D. McCullough & R. H. Barrett (Eds.), *Wildlife 2001: Populations* (pp. 148-157). The Netherlands: Springer Science & Business Media.

Akçakaya, H. R. (2000). Viability Analyses with Habitat-based Metapopulation Models. *Population Ecology*, 42(1): 45-53.

Akhani, H. (1998). Plant Biodiversity of Golestan National Park, Iran. *Stapfia*, 54: 1-411.

Akhani, H., Djamali, M., Ghorbanalizadeh, A., & Ramezani, E. (2010). Plant Biodiversity of Hyrcanian Relict Forests, N Iran: An Overview of the Flora, Vegetation, Palaeoecology and Conservation. *Pakistan Journal of Botany*, 42(Special Issue): 231-258.

Amini Parsa, V., Yavari, A., & Nejadi, A. (2016). Spatio-Temporal Analysis of Land Use/Land Cover Pattern Changes in Arasbaran Biosphere Reserve, Iran. *Modeling Earth Systems and Environment*, 2(4): 178.

Amir-Ahmadian, B. (2002). *Comprehensive Geography of Caucasus* (pp. 538). Tehran, Iran: National Geographical Organization Publication.

Anwar, S. (2014). *Spatial Point Process Modelling of Land Use and Land Cover (LULC) Change* (Doctoral dissertation). University of Twente, Enschede, The Netherlands.

Araújo, M. B., & Williams, P. H. (2000). Selecting Areas for Species Persistence Using Occurrence Data. *Biological Conservation*, 96(3): 331-345.

Araújo, M. B., Thuiller, W., & Pearson, R. G. (2006). Climate Warming and the Decline of Amphibians and Reptiles in Europe. *Journal of Biogeography*, 33(10): 1712-1728.

Araújo, M. B., Whittaker, R. J., Ladle, R. J., & Erhard, M. (2005). Reducing Uncertainty in Projections of Extinction Risk from Climate Change. *Global Ecology and Biogeography*, 14(6): 529-538.

Araya, Y. H. (2009). *Urban Land Use Change Analysis and Modelling: A Case Study of Setubal and Sesimbra, Portugal* (Master's thesis). Institute for Geoinformatics, University of Munster, Munster, Germany.

Ario, A. (2007). *The Javan Leopard (Panthera pardus melas) Among the Human Pressures: A Preliminary Assessment for Their Habitat and Preys in Gunung Halimun-Salak National Park,* Conservation International Indonesia, Jakarta, Indonesia.

Ariyanto, A. C. (2015). *Mapping of Possible Corridors for Javan Leopard (Panthera pardus ssp. melas) between Gunung Merapi and Gunung Merbabu National*

178

Parks, Indonesia (Master's thesis). Faculty of Geo-Information and Earth Observation (ITC), University of Twente, The Netherlands.

Armandpisheh, O., Bannayan Aval, M., Khazaei, H. R., Aghaei, M., & Kafi, M. (2015). Study of Drought Stress Patterns in Khorasan Province using Climatic-Agricultural Indices. *Biological Forum*, 7(1): 920- 928.

Asakereh, H., & Razmi, R. (2012). Climatology of Precipitation in North West of Iran. *Geography and Development*, 9(25): 137-158.

Asgari, A., Rahimzadeh, F., Mohammadian, N, & Fattahi, E. (2008). Trend Analysis of Extreme Precipitation Indices over Iran. *Iran-Water Resources Research*, 3(3): 42-55.

Asghari, M., & Vafaei, R. (2015). Comparative Analysis of Climate and Morphology between Traditional Patterns and Modern Approaches: The Case of Bushehr's Traditional context. *Procedia Engineering*, 118: 590-605.

Askerov, E. K. (2002). New Data on the Leopard (*Panthera pardus* L.) in Azerbaijan and the Measures of Its Conservation. *Bilgi*, 3: 69-72.

Ayala, F. J. (1970). Competition, Coexistence and Evolution. In M. K. Hecht & W. S. Steere (Eds.), *Essays in Evolution and Genetics in Honor of Theodosis Dobzhansky* (pp. 121-158). New York: Appleton-Century-Crofts.

Azizi, A., Malakmohamadi, B., & Jafari, H. R. (2016). Land Use and Land Cover Spatiotemporal Dynamic Pattern and Predicting Changes Using Integrated CA-Markov Model. *Global Journal of Environmental Science and Management*, 2(3): 223-234.

Badaruddoza, Kumar, R., & Kaur, M. (2015). Principal Component Analysis of Cardiovascular Risk Traits in Three Generations Cohort among Indian Punjabi Population. *Journal of Advanced Research*, 6(5): 739-746.

Baker, W. L. (1989). A Review of Models of Landscape Change. *Landscape Ecology*, 2(2): 111-133.

Baldwin, R. A. (2009). Use of Maximum Entropy Modeling in Wildlife Research. *Entropy*, 11(4): 854-866.

Bannayan, M., Soler, C. T., Garcia Y. Garcia, A., Guerra, L. C., & Hoogenboom, G. (2009). Interactive Effects Of Elevated [CO_2] and Temperature on Growth and Development of A Short-And Long-Season Peanut Cultivar. *Climatic Change*, 93(3-4): 389-406.

Barve, N., Barve, V., Jiménez-Valverde, A., Lira-Noriega, A., Maher, S. P., Peterson, A. T., ... & Villalobos, F. (2011). The Crucial Role of the Accessible Area in Ecological Niche Modeling and Species Distribution Modeling. *Ecological Modelling*, 222(11): 1810-1819.

Beier, P., & Loe, S. (1992). A Checklist for Evaluating Impacts to Wildlife Movement Corridors. *Wildlife Social Bulletin*, 20: 434-440.

Bennett, G., & Mulongoy, K. J. (2006). Review of Experience with Ecological Networks, Corridors and Buffer Zones. *Secretariat of the Convention on Biological Diversity, Montreal, Technical Series*, 23: 100.

Benoit, K. (2011). Linear Regression Models with Logarithmic Transformations. *London School of Economics,* 22(1): 23-36.

Bertuzzo, E., Suweis, S., Mari, L., Maritan, A., Rodríguez-Iturbe, I., & Rinaldo, A. (2011). Spatial Effects on Species Persistence and Implications for Biodiversity. *Proceedings of the National Academy of Sciences*, 108(11): 4346-4351.

Birulya, A. A. (1912). Materials on Systematics and Geographical Distribution of Mammals. III. Carnivora Collected by N.A. Zarudny in Persia in 1896, 1898, 1900-1901, and 1903-1904. *Annals of the Zoological Museum of the Imperial Academy of Sciences*, 17: 219-280.

Balme, G. A., Hunter, L., & Slotow, R. (2007). Feeding Habitat Selection by Hunting Leopards *Panthera Pardus* in a Woodland Savanna: Prey Catchability versus Abundance. *Animal Behaviour*, 74(3): 589-598.

Blanford, W. T. (1876). *Eastern Persia: An Account of the Journeys of the Persian Boundary Commission 1870-71-72//The Zoology and Geology* (p. 516). London: Macmillan & Co.

Bobek, H. (2005). *The Historical Aspect of Iranian Natural Forests and Woodlands* (Pashaei A. A., Trans, p. 145). Tehran: Geographical Organization of Iran.

Bolker, B. M. (2008). *Ecological Models and Data in R*. Princeton, NJ: Princeton University Press.

Bond, N. R., & Lake, P. S. (2003). Local Habitat Restoration in Streams: Constraints on the Effectiveness of Restoration for Stream Biota. *Ecological Management & Restoration*, 4(3): 193-198.

Boyce, M. S., Vernier, P. R., Nielsen, S. E., & Schmiegelow, F. K. A. (2002). Evaluating Resource Selection Functions. *Ecological modelling*, 157(2): 281-300.

Boyle, J. R., Warila, J. E., Beschta, R. L., Reiter, M., Chambers, C. C., Gibson, W. P., ... & Mccomb, W. C. (1997). Cumulative Effects of Forestry Practices: An Example Framework for Evaluation from Oregon, USA. *Biomass and Bioenergy*, 13(4-5): 223-245.

Braeken, J., & Van Assen, M. A. (2017). An Empirical Kaiser Criterion. *Psychological Methods*, 22(3): 450-466.

Breitenmoser, U., Pittet, M., Avgan, B., Askerov, E., Breitenmoser-Würsten. C. & Ransom, C. (2014). *Recovery of the Leopard in Azerbaijan*. United Kingdom: Zoological Society of London.

Brotons, L., Thuiller, W., Araújo, M. B., & Hirzel, A. H. (2004). Presence-absence versus Presence-only Modelling Methods for Predicting Bird Habitat Suitability. *Ecography*, 27(4): 437-448.

Brown, D. G., Band, L. E., Green, K. O., Irwin, E. G., Jain, A., Lambin, E. F., ... & Verburg, P. H. (2014). *Advancing Land Change Modeling: Opportunities and Research Requirements*. Washington, DC: The National Research Council Press.

Brown, D. G., Walker, R., Manson, S., & Seto, K. (2004). Modeling Land Use and Land Cover Change. In G. Gutman, G. Janetos, A. C. Justice, C. O. Moran, E. F. Mustard, J. F. Rindfuss, R. R. Skole, … M. A. Cochrane (Eds.), *Land Change Science: Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface* (pp. 395-409). Dordrecht, the Netherlands: Springer.

Brown, J. D. (2009). Choosing the Right Type of Rotation in PCA and EFA. *JALT Testing and Evaluation SIG Newsletter*, 13 (3): 20-25.

Brown, J. H. (1971). Mammals on Mountaintops: Nonequilibrium Insular Biogeography. *The American Naturalist*, 105(945): 467-478.

Bryant, F. B., & Yarnold, P. R. (1995). Principal-Components Analysis and Exploratory and Confirmatory Factor Analysis. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and Understanding Multivariate Statistics* (pp. 99-136). Washington, DC: American Psychological Association.

Cayuela, L., Golicher, D. J., Newton, A., Kolb, M., de Alburquerque, F. S., Arets, E. J. M. M., & Pérez, A. M. (2009). Species Distribution Modelling in the Tropics: Problems, Potentialities and the Role of Biological Data for Effective Species Conservation. *Tropical Conservation Science*, 2: 319-352.

Chalani, M. (2005). *Analysis of Leopard Diet in Tandoureh National Park* (BSc. thesis). Azad University of Arak, Markazi, Iran.

Chhabra, A., Geist, H., Houghton, R. A., Haberl, H., Braimoh, A. K., Vlek, P. L. G., … & Lambdin, E. F. (2006). Multiple Impacts of Land-Use/Cover Change. In F. Lambin & H. J. Geist (Eds.), *Land-Use and Land-Cover Change: Local Processes and Global Impacts* (71-87). Berlin: Springer Publishers.

CITES, 2012. Appendices I, II and III valid from 25 September 2012. UNEP. Retrieved from https://www.cites.org/eng.

Cleophas, T. J., Zwinderman, A. H., Cleophas, T. F., & Cleophas, E.P. (2007). *Statistics Applied to Clinical Trials*. New York: Springer.

Colwell, R. K., & Rangel, T. F. (2009). Hutchinson's Duality: The Once and Future Niche. *Proceedings of the National Academy of Sciences*, 106(2): 19651-19658.

Comrey, A. L., & Lee H. B. (1992). *A First Course in Factor Analysis*. London: Taylor & Francis.

Comprehensive Study of Chahar Mahal and Bakhtiari Environment (1993). General DoE office of Chahar Mahal and Bakhtiari, Yasuj, Iran.

Comprehensive Study of Esfahan Environment (1993). General Doe Office of Esfahan, Esfahan, Iran.

Comprehensive Study of Hormozgan Environment (1993). General Doe Office of Hormozga, Bandar Abbas, Iran.

Comprehensive Study of Ilam Environment (1993). General Doe Office of Khorasan, Mashhad, Iran.

Comprehensive Study of Kohgiluyeh and Boyer Ahmad Environment (1993). General Doe Office of Kohgiluyeh and Boyer Ahmad, Kohgiluyeh, Iran.

Comprehensive Study of Semnan Environment (1993). General Doe Office of Semnan, Semnan, Iran.

Comprehensive Study of Sistan and Balouchestan Environment (1993). General Doe Office of Sistan and Balouchestan, Zahedan, Iran.

Craig, M. H., Sharp, B. L., Mabaso, M. L., & Kleinschmidt, I. (2007). Developing a Spatial-Statistical Model and Map of Historical Malaria Prevalence in Botswana Using a Staged Variable Selection Procedure. *International Journal of Health Geographics*, 6(1): 44.

Cramer, J. S. (2003). The Origins and Development of the Logit Model. In J. S. Cramer (Ed.), *Logit Models from Economics and Other Fields* (pp. 149-158). Cambridge, England: Cambridge University Press.

Cronin, J. T. (2003). Matrix Heterogeneity and Host-Parasitoid Interactions in Space. *Ecology*, 84(6): 1506-1516.

Cushman, S. A., & Landguth, E. L. (2012). Multi-Taxa Population Connectivity in the Northern Rocky Mountains. *Ecological Modelling*, 231: 101-112.

Dalgaard, P. (2002). *Statistics and Computing, Introductory Statistics with R* (p. 267). New York: Springer.

Dannemann, T., Boyer, D. & Miramontes, O. (2018). *Lévy Flight Movements Prevent Extinctions and Maximize Population Abundances in Fragile Lotka–*

Volterra Systems. Proceedings of the National Academy of Sciences (pp. 2-12). PNAS, USA.

De Jong, W. (2010). Forest Rehabilitation and Its Implication for Forest Transition Theory. *Biotropica*, 42(1): 3-9.

Delfan, B., Bahmani, M., Hassanzadazar, H., Saki, K., & Rafieian-Kopaei, M. (2014). Identification of Medicinal Plants Affecting on Headaches and Migraines in Lorestan Province, West of Iran. *Asian Pacific Journal of Tropical Medicine*, 7: S376-S379.

Dengler, J., Löbel, S., & Dolnik, C. (2009). Species Constancy Depends on Plot Size–A Problem for Vegetation Classification and How It Can Be Solved. *Journal of Vegetation Science*, 20(4): 754-766. Doi: 10.1111/j.1654-1103.2009.01073.x.

Department of Environment of Iran (2012). Status of the Areas under Auspice of the Department of Environment. Tehran, Iran. Unpublished Document.

Dierwechter, Y. (2017). *Urban Sustainability Through Smart Growth: Intercurrence, Planning, and Geographies of Regional Development across Greater Seattle*. Cham: Springer.

Dinarvand, M. & Sharifi, M. (2009). An Outlook on Vegetation of Habitats in South - West of Iran (Khuzestan Province). *Pajouhesh Va Sazandegi*, 81: 77-86.

Dolatkhahi, M., Yousofi, M., Baghernejad, J., & Dolatkhahi, A. (2010). Introductory Study of the Medicinal Plants Species of Kazeroon in Fars Province. *Journal of Herbal Drugs*, 3: 47-56.

Durham, C. A., & King, R. P. (2010). Principles of Principal Component Analysis. *Journal of Food Distribution Research*, 41(1): 35-39.

Elith, J., & Leathwick, J. R. (2009). Species Distribution Models: Ecological Explanation and Prediction across Space and Time. *Annual Review of Ecology, Evolution and Systematics*, 40(1): 677-697.

Elith, J., Graham, C. H., Anderson, R. P., Dudik, M., Ferrier, S., Guisan, A., … & Zimmermann, N. E. (2006). Novel Methods Improve Prediction of Species Distributions from Occurrence Data. *Ecography*, 29: 129-151.

Elith, J., Phillips, S. J., Hastie, T., Dudi M. K., En Chee, Y., & Yates, C. J. (2011). A Statistical Explanation of MaxEnt for Ecologists. *Diversity and Distributions*, 17: 43-57.

Elton, C. S. (1927). *Animal Ecology*. London: Sidgwick and Jackson.

Elton, C. S. (2001). *Animal Ecology*. Chicago: University of Chicago Press.

Elton, C. S., & Miller, R. S. (1954). The Ecological Survey of Animal Communities: With A Practical System of Classifying Habitats by Structural Characters. *Journal of Ecology*, 42(2): 460-496.

Eltringham, S. K. (1979). *The Ecology and Conservation of Large African Mammals* (p. 166). London and Basingstoke: The Macmillan press.

Erfanian, B., Mirkarimi, S. H., Mahini, A. S., & Rezaei H. R. (2013). A Presence-Only Habitat Suitability Model for Persian Leopard *Panthera pardus saxicolor* in Golestan National Park, Iran. *Wildlife Biology*, 19(2): 170-178.

Esfahan Center for Research of Agricultural Science and Natural Resources (2012), Map of dry condition in Iran. Dry land agriculture management center, Esfahan, Iran.

Eskandari Dameneh, H., Borjib, M., Hhosravi, H. & Salajegheh, A. (2016). Desertification in Forest, Range and Desert Landuses of Tehran Province, Under the Impact of Climate Change. *Solid Earth Discuss*ions, 28: 1-12.

Estelaji, A. & Shariat Panahi, M.V. (2013). *Iran Human Geography* (p. 200). Tehran, Iran: National Geographical Organization Publication.

Etemad, I. (1985). *Mammals of Iran*. Tehran: Department of Environment of Iran.

Etienne, R. S., & Heesterbeek, J. A. P. (2000). On optimal size and number of reserves for metapopulation persistence. *Journal of Theoretical Biology*, 203(1): 33-50.

Fadakar, D., Rezaei H. R., Hosseini, Sheykhi Ilanloo S., & Zamani, W. (2013). Detecting Domestic Dog (*Canis lupus familiaris*) in Diet of Persian Leopard (*Panthera pardus saxicolor*) Using DNA Tools. *The International Journal of Environmental Resources Research,* 1(3): 247-252.

Fahrig, L. (2002). Effect of Habitat Fragmentation on the Extinction Threshold: A Synthesis. *Ecological Applications*, 12(2): 346-353.

Fahrig, L., & Paloheimo, J. (1988). Effect of Spatial Arrangement of Habitat Patches on Local Population Size. *Ecology*, 69: 468-475.

Fan, C. (2016). *A Spatial Statistical Framework for Evaluating Landscape Pattern and Its Impacts on the Urban Thermal Environment* (Doctoral dissertation). Arizona State University, USA.

Fanni, Z., Hosayni, Z., Afsharmanesh, H., Nezammahalleh, M.A., & Rastegar, A. (2013). The Effects of Urban Environment on Climate Changes, Case study: Tehran, Iran. *Journal of Tethys*, 1(2): 138-147.

Faraj Zadeh, M. (2005). *Drought from Concepts to Solution* (p. 128). Tehran, Iran: National Geographical Organization.

Farajzadeh, H. (2003). *Climatic Classification Northwest of Iran on the Basis Multivariate Statistical Analysis* (Master's thesis). Faculty of Geography, University of Tehran.

Farajzadeh, H., & Matzarakis, A. (2009). Quantification of Climate for Tourism in the Northwest of Iran. *Meteorological Applications*, 16: 545-555.

Farhadinia M. S., Mahdavi, A., & Hosseini-Zavarei, F. (2009). Reproductive Ecology of Persian Leopard, *Panthera pardus saxicolor* in Sarigol National Park, North-Eastern Iran. *Zoology in the Middle East*, 48: 13-16.

Farhadinia, M. S., Farahmand, H., Gavashelishvili, A., Kaboli, M., Karami, M., Khalili, B., & Montazamy, S. (2015). Molecular and Craniological Analysis of Leopard, *Panthera pardus* (Carnivora: Felidae) in Iran: Support for a Monophyletic Clade in Western Asia. *Biological Journal of the Linnean Society*, 114(4): 721-736.

Faucon, M. P., Parmentier, I., Colinet, G., Mahy, G., Luhembwe, M. N. & Meerts, P. (2011). May Rare Metallophytes Benefit from Disturbed Soils Following Mining Activity? The Case of the *Crepidorhopalon tenuis* in Katanga (D. R. Congo). *Restoration Ecology*, 19: 333-343.

Ferdowsi, A. (2006). *Shahnameh: The Persian Book of Kings*, (Davis, D, Trans.). New York: Viking.

Field, A. P. (2005). *Discovering statistics using SPSS* (2nd ed.). London: Sage.

Fielding, A. H. (2002). What Are the Appropriate Characteristics of An Accuracy Measure? In J. M. Scott, P. J. Heglund, J. B. Haufler, M. Morrison, M. G. Raphael, W. B. Wall, & F. Samson (Eds.), *Predicting Species Occurrences: Issues of Accuracy and Scale* (pp. 271-280). Covelo, CA: Island Press.

Fielding, A.H., & Bell, J.F. (1997). A Review of Methods for the Assessment of Prediction Errors in Conservation Presence/Absence Models. *Environmental Conservation*, 24(1): 38-49.

Firouz, E. (2000). *A Guide to the Fauna of Iran* (p. 50). Tehran, Iran: Iran University Press.

Flather, C. H., Hayward, G. D., Beissinger, S. R., & Stephens, P. A. (2011). Minimum Viable Populations: Is There A 'Magic Number' For Conservation Practitioners? *Trends in Ecology and Evolution*, 26: 307-316.

Forrest, J. L., Wikramanayake, E., Shrestha, R., Areendran, G., Gyeltshen, K., Maheshwari, A., Mazumdar, S., … & Thapa, K. (2012). Conservation and Climate Change: Assessing the Vulnerability of Snow Leopard Habitat to Treeline Shift in the Himalaya. *Biological Conservation*, 150: 129-135.

Forsythe, G. E., Malcolm, M. A., & Moler, C.B. (1977). *Computer Methods for Mathematical Computations*, Englewood Cliffs, NJ: Prentice-Hall, Inc.

Forte, B., & Hughes, W. (1989). A Representation Theorem for Entropies with the Branching Property, *Aequationes mathematicae*, 37: 219-232.

Franklin, I. R. (1980). Evolutionary changes in small populations. In M. E. Soulé & B. M. Wilcox (Eds.), *Conservation Biology an Evolutionary-Ecological Perspective* (pp. 135-149). Sunderland, MA: Sinauer.

Franklin, J. (2010). *Mapping Species Distribution: Spatial Inference and Prediction*. UK: Cambridge University Press.

Freeman, E. A. & Moisen, G. G. (2008). A Comparison of the Performance of Threshold Criteria for Binary Classification in Terms of Predicted Prevalence and Kappa. *Ecological Modelling*, 217: 48-58.

Gandomkar, A., & Azhdary Mamooreh, K. (2015). Detection of Precipitation, Temperature Rather to Mean, and Its Effect on Ponds in Khuzestan Province. *International Journal of Current Research and Academic Review*, 3(1): 10-19.

Gardner, R.H. & O'Neill, R.V. (1991). Pattern, Process, and Predictability: the Use of Neutral Models for Landscape Analysis. In M. G. Turner & R. H. Gardner (Eds.), *Quantitative Methods in Landscape Ecology* (289–307). New York: Springer.

Gavashelishvili, A., & Lukarevskiy, V. (2008). Modelling The Habitat Requirements of Leopard *Panthera pardus* in West and Central Asia. *Journal of Applied Ecology*, 45: 579-588.

Gerber, B. D., Karpanty, S. M., & Randrianantenaina, J. (2012). The Impact of Forest Logging and Fragmentation on Carnivore Species Composition, Density and Occupancy in Madagascar's Rainforests. *Oryx*, 46: 414-422.

Getis, A. (1999). Spatial statistics. In P. A. Longley, M. F. Goodchild, D. J. Maguire, & D. W. Rhind (Eds.), *Geographic Information Systems* (2nd ed, pp. 239-251). New York: John Wiley & Sons, Inc.

Ghaemi, P., Sadr-Shirazi, N., & Ghaemi, P. (2011). Study on Helminithic Parasites of Persian Leopard in Golestan National Park and Biosphere Reserve of Iran. *World Applied Sciences Journal*, 13(6): 1471-1473.

Ghazanfari, H., Namiranian, M., Sobhani, H., & Mohajer, M.R. (2004). Traditional Forest Management and Its Application to Encourage Public Participation for Sustainable Forest Management in the Northern Zagros Mountain of Kurdistan Province, Iran. *Scandinavian Journal of Forest Research*, 19(4): 65-71.

Ghoddousi A., Hamidi Kh. A. H., Ghadirian, T., Ashayeri, D., Moshiri, H., & Khorozyan, I. (2008). The Status of the Persian Leopard in Bamu National Park, Iran. *Cat News*, 49: 10-13.

Ghoddousi, A., Hamidi Kh. A. H., Ghadirian, T., Ashayeri, D., & Khorozyan, I. (2010). The Status of the Endangered Persian Leopard, *Panthera pardus saxicolor* in Bamu National Park, Iran. *Oryx*, 4(4): 551-557.

Gholizadeh, B. *Assessment of the Climate Change in Mazandaran Province Using Geostatistical Methods*. Paper presented at 29th Conference on Agricultural and Forest Meteorology. Colorado, U.S.A. August 2010. Retrieved from http://www.ces.iisc.ernet.in/energy/lake2010/theme4/T4_Oral_05.pdf.

Ghorbani, F., Mohammadi, Z., Darvish, J., Kami, H. G., & Siahsarvie, R. (2015). Morphological and Morphometric Characterization of the New Records of the East European Vole (Microtus Levis Miller, 1908) from Northeast Iran. *Journal of Asia-Pacific Biodiversity*, 8(3): 233-237.

Glor, R.E., & Warren, D. (2010). Testing Ecological Explanations for Biogeographic Boundaries. *Evolution*, 65(3): 673-683.

Goff, F. G., & Mitchell R. (1975). A Comparison of Species Ordination Results from Plot and Stand Data. *Vegetatio*, 31(1): 15-22. Doi: 10.1007/BF00127871.

Golub, G. H., Zhang, Z., & Zha, H. (2000). Large Sparse Symmetric Eigenvalue Problems with Homogeneous Linear Constraints: the Lanczos Process with Inner–Outer Iterations. *Linear Algebra and Its Applications*, 309(1-3): 289-306.

Gorsuch, R. L. (1983). *Factor Analysis* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Gotelli, N. J., & Ellison, A. M. (2004). *A Primer of Ecological Statistics*. Sunderland, MA: Sinauer Associates Publishers.

Greaves, G. J., Mathieu, R., & Seddon, P. J. (2006) Predictive Modelling and Ground Validation of the Spatial Distribution of the New Zealand Long-tailed Bat (*Chalinolobus tuberculatus*). *Biological Conservation*, 132: 211-221.

Grinnell, J. (1904). The Origin and Distribution of the Chestnut-backed Chickadee. *The Auk*, 21(3): 364-378.

Grinnell, J. (1917). The Niche-relationships of the California Thrasher. *The Auk*, 34(4): 427-433.

Grinnell, J. (1924). Geography and Evolution. *Ecology*, 5(3): 225-229.

Guiasu S., & Shenitzer, A. (1985). The Principle of Maximum Entropy. *The Mathematical Intelligencer*, 7(1): 42-48.

Guisan, A., & Zimmermann, E. N. (2000). Predictive Habitat Distribution Models in Ecology. *Ecological Modelling*, 135(2): 147-186.

Guisan, A., & Thuiller, W. (2005). Predicting Species Distribution: Offering More than Simple Habitat Models. *Ecology Letters*, 8(9): 993-1009.

Haidari, M. & Rezaei, D. (2013). Study of plant diversity in the Northern Zagros forest (Case study: Marivan region). *International Journal of Advanced Biological and Biomedical Research*, 1(1): 1-10.

Hanski I., & Gilpin, M. (1991). Metapopulation Dynamics: Brief History and Conceptual Domain. *Biological Journal of the Linnean Society*, 42: 3-16.

Hanski, I., & Gaggiotti, O. E. (Eds.). (2004). *Ecology, Genetics, and Evolution of Metapopulation*. Amsterdam: Elsevier.

Harmon, L.J., & Braude, S. (2010). Conservation of Small Populations: Effective Population Size, Inbreeding, and the 50/500 Rule. In S. Braude & S. B. Low (Eds.), *an Introduction to Methods and Models in Ecology and Conservation Biology* (pp. 125-138). Princeton, NJ: Princeton University Press.

Harrington, F. A., & Darreshuri, B. F. (1977). *A Guide to the Mammals of Iran* (p. 89). Tehran, Iran: Tehran Department of the Environment.

Harris, L. D. (1984). *The Fragmented Forest: Island Biogeography Theory and Preservations of Biotic Diversity*. Chicago: University Chicago Press.

Harte, J. J. (2011). *Maximum Entropy and Ecology: A Theory of Abundance, Distribution, and Energetics*. NYC, New York: Oxford University Press.

Hatcher, L. (1994). *A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equation Modelling*. Cary: SAS Institute.

Hatt, R. T. (1959). The Mammals of Iraq. *Miscellaneous Publications*, *Museum of Zoology*, *University of Michigan*, 106: 1-113.

Hayward, M. W., Henschel, P., O'Brien, J., Hofmeyr, M., Balme, G., & Kerley, G. I. H. (2006). Prey Preferences of the Leopard (*Panthera pardus*). *Journal of Zoology*, 270: 298-313.

Heptner, V. G., & Sludsky, A. A. (1972). *Mammals of the Soviet Union*: *Carnivores (Hyaenas and Cats)*. Moscow: Vysschaya shkola.

Hermidas, Sh. (2011). Leopard in the Art and History of Iran and World. *Conservation of Preys and Nature*, 7(24): 96.

Hernandez, P. A., Graham, C. H., Master, L. L., & Albert, D. L. (2006). The Effect of Sample Size and Species Characteristics on Performance of Different Species Distribution Modeling Methods. *Ecography*, 29: 773-785.

Hetzel, R. D. (1996). A Primer on Factor Analysis with Comments on Patterns of Practice and Reporting. In B. Thompson (Ed.), *Advances in Social Science Methodology* (Vol 4, pp. 175-206). Greenwich, CT: JAI Press.

Hirzel, A., & Le Lay, G. (2008). Habitat Suitability Modelling and Niche Theory. *Journal of Applied Ecology*, 45: 372-1381.

Holden, M. (2008). *The Effect of Habitat Fragmentation on Population Persistence in Spatially Heterogeneous Landscapes*. Department of Mathematics, University of California, Davis, CA. Retrieved from https://www.math.ucdavis.edu/files/6413/5795/0380/HoldenThesis.pdf.

Holt, R. D. (2009). Bringing the Hutchinsonian Niche into the 21st Century: Ecological and Evolutionary Perspectives. *Proceedings of the National Academy of Sciences*, 106: 19659-19665.

Holyoak, M. (2000). Habitat Patch Arrangement and Metapopulation Persistence of Predator and Prey. *The American Naturalist*, 156: 4.

Houet, T., & Hubert-Moy, L. (2006). Modeling and Projecting Land-Use and Land-Cover Changes with Cellular Automaton in Considering Landscape Trajectories. *EARSeL eProceedings*, 5(1): 63-76.

Hua, L., Tang, L., Cui, S., & Yin, K. (2014). Simulating Urban Growth Using the Sleuth Model in a Coastal Peri-Urban District in China. *Sustainability*, 6: 3899-3914.

Hutcheson, G., & Sofroniou, N. (1999). *The Multivariate Social Scientist: Introductory Statistics Using Generalized Linear Models*. London: Sage Publication.

Hutchinson, G. E. (1957). Concluding Remarks. *Cold Spring Harbor Symposia on Quantitative Biology*, 22(2): 415-427.

Hutchinson, G. E. (1965). *Ecological Theatre and the Evolutionary Play*. New Haven, CT: Yale University Press.

Hutchinson, G. E. (1978). An Introduction to Population Biology. New Haven, CT: Yale University Press.

Hyde, R. (2008). *Bioclimatic Housing: Innovation Designs for Warm Climates*. London: Earthscan.

Ingram, V. J. (2012). Forest to Farm to Market Interfaces for Non-Timber Forest Products in Central Africa. *Nature and Faune*, 26(2): 43-48.

Irwin, E.G., & Geoghegan, J. (2001). Theory, Data, and Methods: Developing Spatially Explicit Economic Models of Land-Use Change. *Agriculture, Ecosystems and Environment*, 85(1): 7-23.

Iran Elevation Map (2008). National Geographical Organization of Iran, Iran. Unpublished Documents.

Iran Land Use Map (2008). National Geographical Organization of Iran, Iran. Unpublished Documents.

Iran Land Cover Map (2008). Geographical Organization of Iran, Tehran, Iran. Unpublished Documents.

Iran Meteorological Organization (2017). Climate data. Retrieved from http://www.irimo.ir/fa.

Iran Topography Map (2008). National Geographical Organization of Iran, Iran. Unpublished Documents.

IUCN, (1994). *Categories and Criteria* (Version 2.3). Retrieved from http://www.iucnredlist.org.

IUCN, (2007). *Connectivity Conservation*: *International Experience in Planning*, *Establishment and Management of Biodiversity Corridors*. IUCN Regional Protected Areas Programme, Asia, Bangkok.

IUCN, (2008). 2008 *IUCN Red List of Threatened Species: Panthera pardus saxicolor*. Retrieved from http://www.iucnredlist.org.

IUCN, (2016). *2016 IUCN Red List of Threatened Species*. Retrieved from http://www.iucnredlist.org.

Janžekovič, F., & Novak, T. (2012). *PCA: A Powerful Method for Analyse Ecological Niches* (Doctoral dissertation). Fakulteta Za Naravoslovje in Matematiko, Univerza v Mariboru, Slovenia.

Jaynes, E. T. (1990). Probability Theory as Logic. In P. F. Fougère (Ed.), *Maximum Entropy and Bayesian Methods.* Dordrecht, Holland: Kluwer Academic Publishers.

Jenks, K. E., Songsasen, N., & Leimgruber, P. (2012). Camera Traps Records of Dholes in Khao Ang Rue Nai Wildlife Sanctuary, Thailand. *Canid News*.
Retrieved from http://www.canids.org/canidnews/15/Camera_trap_records_of_dholes_in_Thailand.pdf.

Jiménez -Valverde, A., & Lobo, J. M. (2007). Threshold Criteria for Conversion of Probability of Species Presence to Either-Or Presence-Absence. *Acta Oecologica- International Journal of Ecology*, 31: 361-369.

Johnson, C. J., Boyce, M. S., Case, R. L., Cluff, H. D., Gau, R., Gunn, A. & Mulders, R. (2005). Cumulative Effects of Human Developments on Arctic Wildlife. *Wildlife Monograph*, 160: 1-36.

Johnson, K. N., Agee, J., Beschta, R., Dale, V., Hardesty, L., Long, J., ... & Trosper, R. (1999). Sustaining the People's Lands: Recommendations for Stewardship of the National Forests and Grasslands into the Next Century. *Journal of Forestry*, 97(5): 6-12.

Johnstone, Ch., Reina, R. & Lill, A. (2010). Impact of Anthropogenic Habitat Fragmentation on Population Health in a Small, Carnivorous Marsupial. *Journal of Mammalogy*, 91: 1332-1341.

Jokar Arsanjani, J. (2011). Dynamic Land Use/Cover Change Modelling: *Geosimulation and Multiagent-Based Modelling*. The Netherlands: Springer Science & Business Media. Doi: 10.1007/978-3-642-23705-8_2.

Joslin, P. (1990). Leopards in Iran. In A. Shoemaker (Ed.), *International Leopard Studbook* (pp. 13-15). Columbia, South Carolina: Riverbanks Zoological Park.

Jueterbock, A. (2015). *R package MaxentVariableSelection: selecting the Best Set of Relevant Environmental Variables along with the Optimal Regularization Multiplier for Maxent Niche Modeling*. Retrieved.from.https://cran.r-project.org/web/packages/MaxentVariableSelection/index.html.

Kaiser, H. F. (1960). The Application of Electronic Computers to Factor Analysis. *Educational and Psychological Measurement*, 20(1): 141-151.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1): 31-36.

Karam, A., Ranjbar, M., Eftekhari, M., & Yaghoob, N. A. N. (2014). Classification of Morph Climatic Zones of Kermanshah Province Using Cluster Analysis Method. *Geography*, 39(11): 235-256.

Karanth, K. U. (2003). Tiger Ecology and Conservation in the Indian Subcontinent. *Journal of Bombay Natural History Society*, 100(2-3): 169-189.

Kareiva, P. (1990). Population Dynamics in Spatially Complex Environments: Theory and Data. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *330* (1257): 175-190.

Karimi-Googhari, Sh. (2011). Analysis of Precipitation Climate and Evapotranspiration in Kerman of Iran. *International Journal of Agricultural Science, Research and Technology in Extension and Education Systems*, 1(3): 105-108.

Kasmaei, M. (1994). Climatic Zoning of Iran for Educational Buildings. Organization for Development, Renovation and Equipping Schools of Iran, Tehran, Iran.

Kellow, J. T. (2006). Using Principal Components Analysis in Program Evaluation: Some Practical Considerations. *Journal of MultiDisciplinary Evaluation*, 3(5): 89-107.

Kennedy, C., Wilkison, J.B. & Balch, J. (2003). *Conservation Thresholds for Land Use Planners*. Washington, DC: Environmental Law Institute.

Khatibi, M. & Sheikholeslami, R. (2016). Ecological Niche Theory: A Brief Review of Khorasan Provinces, Iran. *International Journal of Agriculture and Crop Sciences*, 7(6): 297-303.

Kazemi Rad, L. K., Mohammadi, H., & Teyfoori, V. (2015). Impacts of Climate Change on Droughts in Gilan Province, Iran. *Ecologia Balkanica*, 7(1): 29-38.

Khorozyan, I. (2003). Habitat Preferences by the Endangered Persian Leopard (*Panthera pardus saxicolor* Pocock, 1927) in Armenia. *Zoology in the Middle East*, 30: 25-36.

Khorozyan, I. G., & Abramov, A. V. (2007). The Leopard, *Panthera pardus* (Carnivora, Felidae) and its resilience to human pressure in the Caucasus. *Zoology in the Middle East*, 41(1): 11-24.

Khorozyan, I. G., Baryshnikov, G. F., & Abramov, A. V. (2006). Taxonomic Status of the Leopard, *Panthera pardus* (Carnivora, Felidae) in the Caucasus and Adjacent Areas. *Russian Journal of Theriology,* 5(1): 41-52.

Khorozyan, I. G., Malkhasyan, A. G., & Asmaryan, S. G. (2005). The Persian Leopard Prowls Its Way to Survival. *Endangered Species Update*, 22(2): 51-60.

Khorozyan, I. G., Malkhasyan, A. G., Asmaryan, S. G. & Abramov, A. V. (2010). *Using Geographical Mapping and Occupancy Modeling to Study the Distribution of the Critically Endangered Leopard (Panthera pardus) Population in Armenia.* In S. A. Cushman & F. Huettmann (Eds.), *Spatial Complexity, Informatics, and Wildlife Conservation* (pp. 331-347). Japan, Tokyo: Springer.

Khosravi, S., Namiranian, M., Ghazanfari, H., & Shirvani, A. (2012). Crown Biomass Relationships of Lebanon Oak in Northern Zagros Forests of Iran. *Croatian Journal of Forest Engineering*, 33(2): 239-247.

Kiabi, B. H., Dareshouri, B. F., Ghaemi, R. A., & Jahanshahi, M. (2002). Population Status of the Persian Leopard (*Panthera pardus saxicolor* Pocock, 1927) in Iran. *Zoology in the Middle East,* 26(1): 41-47.

Kieffer, K. M. *Orthogonal versus Oblique Factor Rotation: A Review of the Literature Regarding the Pros and Cons*. Paper presented at the 27th Annual Meeting of the Mid-South Educational Research Association, New Orleans, LA. November.1998..Retrieved.from.https://files.eric.ed.gov/fulltext/ED427031.pdf.

Knaepkens, G., Bervoets, L., Verheyen, E., & Eens, M. (2004). Relationship between Population Size and Genetic Diversity in Endangered Populations of the European Bullhead (*Cottus gobio*): Implications for Conservation. *Biological Conservation*, 115(3): 403-410.

Krebs, C. J. (1989). *Ecological Methodology*. New York: Harper-Collins Publishers.

Krzyzanowski, J., & Almuedo, P. L. (2010). Cumulative Impacts of Natural Resource Development on Ecosystems and Wildlife: An Annotated Bibliography for British Columbia. *FORREX Series*, 26.

Kumar, S. & Stohlgren, Th. J. (2009). Maxent Modeling for Predicting Suitable Habitat for Threatened and Endangered Tree *Canacomyrica monticola* in New Caledonia. *Journal of Ecology and Natural Environment*, 1(4): 094-098.

Kutner, M. H., Nachtsheim, C., & Neter, J. (2008). *Applied Linear Regression Models* (4th ed., pp. 25) Singapore: McGraw-Hill/Irwin Education.

Lambin, E. F. (1997). Modelling and Monitoring Land-Cover Change Processes in Tropical Regions. *Progress in Physical Geography*, 21(3): 375-393.

Lay D. M. (1967). A Study of the Mammals of Iran Resulting From the Street Expedition of 1962-63. *Fieldiana: Zoology*, 54: 219-220.

LeBuhn, G., & Miller, Th. E. (2014). *Population Viability*. Retrieved from http://accessscience.com/content/757600.

Levins, R. (1969). Some Demographic and Genetic Consequences of Environmental Heterogeneity for Biological Control. *Bulletin of the Entomological Society of America*, 15: 237-240.

Levins, R. (1970). Extinctions. Some Mathematical Questions in Biology: Lectures on Mathematics in the Life Sciences. *American Mathematical Society*, 2: 77-107.

Lindenmayer, D. B., & Fischer, J. (2006). *Habitat Fragmentation and Landscape Change: An Ecological and Conservation Synthesis*. Washington, DC: Island Press.

Lindenmayer, D. B., Lacy, R. C., Thomas, V. C., & Clark, T. W. (1993). Predictions of the Impacts of Changes in Population Size and Environmental Variability on Leadbeater's Possum, *Gymnobelideus leadbeateri* McCoy (Marsupialia: Petauridae) Using Population Viability Analysis: An Application of the Computer Program VORTEX. *Wildlife Research*, 20(1): 67-85.

Liu, C., Berry, P. M., Dawson, T. P., & Pearson, R. G. (2005). Selecting Thresholds of Occurrence in the Prediction of Species Distributions. *Ecography*, 28: 385-393.

Liu, C., White, M. & Newell, G. (2013). Selecting thresholds for the prediction of species occurrence with presence-only data. *Journal of Biogeography*, 40: 778–789.

Lockwood, M., Worboys, G. L. & Kothari, A. (2006). *Managing Protected Areas: A Global Guide*. London, UK: Earthscan.

Loiselle, B. A., Howell, C. A., Graham, C. H., Goerck, J. M., Brooks, T., Smith, K. G., & Williams, P. H. (2003). Avoiding Pitfalls of Using Species Distribution Models in Conservation Planning. *Conservation Biology*, 17(6): 1591-1600.

Lorena, A. C., Jacintho, L. F., Siqueira, M. F., De Giovanni, R., Lohmann, L. G., De Carvalho, A. C., & Yamamoto, M. (2011). Comparing Machine Learning Classifiers in Potential Distribution Modelling. *Expert Systems with Applications*, 38(5): 5268-5275.

Lu, D., Mausel, P., Brondizio, E., & Moran, E. (2004). Change Detection Techniques. *International Journal of Remote Sensing*, 25(12): 2365-2401.

Lukarevsky, V. (2001). *The Leopard, Striped Hyena and Wolf in Turkmenistan [Leopard, Polosataya Giena I Volk V Turkmenistane]*. Moscow, Russia: Signar Publishers.

Lukarevsky, V., Akkiev, M., Askerov, E., Agili, A., Can, E., Gurielidze, Z., ... & Yarovenko, Y. (2007). Status of the Leopard in the Caucasus. *Cat News Special*, 2: 15-21.

Luoto, M., Heikkinen, R. K., Pöyry, J., & Saarinen, K. (2006). Determinants of the Biogeographical Distribution of Butterflies in Boreal Regions. *Journal of Biogeography*, 33(10): 1764-1778.

MacCallum, R. C., Widaman, K. F., Preacher, K. J. & Hong S. (2001). Sample Size in Factor Analysis: The Role of Model Error. *Multivariate Behavioural Research*, 36, 611-637. Doi: 10.1207/S15327906MBR3604_06.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong S. (1999). Sample Size in Factor Analysis. *Psychological Methods*, 4: 84–99. Doi: 10.1037/1082-989X.4.1.84.

MacKenzie, D. I., Nichols, J. D., Lachman, G. B., Droege, S., Royle, A., & Langtimm, C. A. (2002). Estimating Site Occupancy Rates When Detection Probabilities Are Less Than One. *Ecology*, 83(8): 2248-2255.

Malkhasyan, A., Khorozyan, I., & Boyajyan, M. (2008). *National Action Plan for Leopard (Panthera pardus) Conservation in Armenia*. Retrieved from http://www.catsg.org/fileadmin/filesharing/3.Conservation_Center/3.4._S trategies_Action_Plans/leopard_Asia/Anonymous_2008_National_Action _Plan_Leopard_in_Armenia.pdf.

Manel, S., Dias, J. M., Buckton, S. T., & Ormerod, S. J. (1999). Alternative Methods for Predicting Species Distributions: An Illustration with Himalayan River Birds. *Journal of Applied Ecology*, 36: 734-747.

Manel, S., Williams, H. C., & Ormerod, S. J. (2001). Evaluating Presence–Absence Models in Ecology: The Need to Account for Prevalence. *Journal of Applied Ecology*, 38(5): 921-931.

Manville, A. M. (2005). Bird Strikes and Electrocutions at Power Lines, Communication Towers, and Wind Turbines: State Of The Art and State of the Science–Next Steps toward Mitigation. *USDA Forest Service General Technical Report PSW-GTR-191*: 1051-1064.

McCalla, J., & Edwards, C. C. (2013). *Ti-84 plus Graphing Calculator for Dummies*. Hoboken, NJ: J. Wiley & Sons.

McDonald, J. H. (2014). *Handbook of Biological Statistics* (3rd ed., pp. 213-219). Baltimore, Maryland: Sparky House Publishing.

McDonald, R. P. (1985). *Factor Analysis and Related Methods*. Hillsdale, NJ: Lawrence Erlbaum Associates.

McEuen, A. (1993). The Wildlife Corridor Controversy: A Review. *Endangered Species Update*, 10: 11-12.

McGarigal, K., Romme, W. H., Crist, M., & Roworth, E. (2001). Cumulative Effects of Roads and Logging on Landscape Structure in the San Juan Mountains, Colorado (USA). *Landscape Ecology*, 16(4): 327-349.

Meffe, G. K. & Carroll, C. R. (1997). *Principles of Conservation Biology* (2nd ed., p. 729) Sunderland, MA: Sinauer and Associates Inc.

Megahed, Y., Cabral, P., Silva, J., & Caetano, M. (2015). Land Cover Mapping Analysis and Urban Growth Modelling Using Remote Sensing Techniques in Greater Cairo Region-Egypt. *ISPRS International Journal of Geo-Information*, 4(3): 1750-1769.

Meijaard, E. (2004). Biogeographic History of the Javan Leopard *Panthera pardus* Based on A Craniometric Analysis. *Journal of Mammalogy,* 85: 302-310.

Memariani, F., Akhani, H., & Joharchi, M. R. (2016). Endemic Plants of Khorassan-Kopet Dagh Floristic Province in Irano-Turanian Region: Diversity, Distribution Patterns and Conservation Status. *Phytotaxa*, 249(1): 31-117.

Mesdaghi, M. (2012). *Statistical and Regression Methods* (1st ed.). Mashhad, Iran: Imam Reza International University Press.

Michalski, F., & Peres, C. A. (2005). Anthropogenic Determinants of Primate and Carnivore Local Extinctions in a Fragmented Forest Landscape of Southern Amazonia. *Biological Conservation*, 124: 383-396.

Miller, J. (2010) Species Distribution Modeling. *Geography Compass*, 4(6): 490-509.

Mirmousavi, S. H., Gharoosi, H. A. & Khaefi, N. (2014). Study of Climatic Characteristics of Kermanshah and Kordestan Based on Factor and Cluster Analyses. *Journal of Geography and Planning*, 47: 235.

Mirzaei, F. & Yazdani M. M. (1992). *Darreh Bagh Protected Area in Fars Province*. Fars: Fars DoE provincial office.

Mirzaei, J., Mohamadi, A., Heidarizadi, Z., Noorolahi, H., & Omidipour, R. (2015). Assessment of Land Cover Changes Using RS and GIS (Case Study: Zagros Forests, Iran). *Journal of Materials and Environmental Science*, 6(9), 2565-2572.

Misonne, X. (1959). Analyse Zoogeographique Des Mammiferes De l'Iran. *Institut Royal des Sciences Naturelles de Belgique, Deuxieme Serie*, 59: 1-157.

Mitchell, T. M. (1997). *Machine Learning*. New York: McGraw Hill.

Miththapala, S., Seidensticker, J., & O'Brien S. J. (1996). Phylogeographic Subspecies Recognition in Leopards (*Panthera pardus*): Molecular Genetic Variation. *Conservation Biology*, 10(4): 1115-1132.

Mobargha, M. (2006). *Habitat evaluation of Persian leopard (Panthera pardus saxicolor) in Turan National Park, Iran*. (Master's thesis). Azad University, Tehran, Iran

Moilanen, A., Franco, A. M., Early, R. I., Fox, R., Wintle, B., & Thomas, C. D. (2005). Prioritizing Multiple-Use Landscapes for Conservation: Methods for Large Multi-Species Planning Problems. *Proceedings of the Royal Society of London B: Biological Sciences*, 272(1575): 1885-1891.

Molavi-Arabshahi, M., Arpe, K., & Leroy, S. A. G. (2015). Precipitation and Temperature of the Southwest Caspian Sea Region during the Last 55 Years: Their Trends and Teleconnections with Large-Scale Atmospheric Phenomena. *International Journal of Climatology*, 36(5): 2156-2172.

Mondal, K., Sankar, K., & Qureshi, Q. (2013). Factors Influencing the Distribution of Leopard in a Semiarid Landscape of Western India. *Acta Theriologica*, 58(2): 179-187.

Mooi, E., & Sarstedt, A. (2011). A Concise Guide to Market Research: *The Process, Data, and Methods Using IBM SPSS Statistics*. NY: Springer-Verlag Berlin Heidelberg.

Mowlavi, G., Marucci, G., Mobedi, I., Zahabiioon, F., Mirjalali, H., & Pozio, E. (2009). *Trichinella britovi* in a Leopard (*Panthera pardus saxicolor*) in Iran. *Veterinary Parasitology*, 164(2): 350-352.

Mousaei Sanjerehei, M. (2014). Determination of the Probability of the Occurrence of Iran Life Zones (An Integration of Binary Logistic Regression and Geostatistics). *Journal of Biodiversity and Environmental Sciences*: 408-417.

Mundfrom, D. J., Shaw, D. G., & Ke, T. L. (2005). Minimum Sample Size Recommendations for Conducting Factor Analyses. *International Journal of Testing*, 5: 159-168. Doi: 10.1207/s15327574ijt0502_4.

Namroodi, S., Gholami, A., & Shariat-Bahadori, E. (2016). Toxoplasmosis May Lead to Road Kills of Persian Leopards (*Panthera pardus saxicolor*) in Golestan National Park, Iran. *Journal of Wildlife Diseases*, 52(2): 436-438.

Naqinezhad, A., Hamzeh'ee, B., & Attar, F. (2008). Vegetation–Environment Relationships in the Alderwood Communities of Caspian Lowlands, N. Iran (Toward an Ecological Classification). *Flora-Morphology, Distribution, Functional Ecology of Plants*, 203(7): 567-577.

Naseri, H. R. (2008). *Investigation of Soil and Water Effective Parameters on Playa Marginal Vegetation (Case Study: Playa of Hoze- Soltan, Meyghan and Maranjab)* (Doctoral dissertation). University of Tehran, Karaj, Iran.

Nasri, M. & Modarres, R. (2009). Dry spell trend analysis of Isfahan Province, Iran, *International Journal of Climatology*, 29(10):1430-1438.

National Competition Council, (2011). *Human poverty index in the cities.* Retrieved from https://www.nicc.gov.ir.

National Geographical Organization of Iran (2000). *The gazetteer of townships in the I.R. of Iran, Orumieh Township*. Iran, Tehran.

National Geographical Organization of Iran (2001). *The gazetteer of townships in the I.R. of Iran: Tabriz Township*. Tehran, Iran.

National Geographical Organization of Iran (2011). *Guide Atlas of Iranian Provinces* (3rd ed., p. 67). Tehran, Iran.

Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. (1996). *Applied Linear Statistical Models* (Vol. 4, p. 318). Chicago: Irwin.

Newmark, W. D. (1987). A Land-Bridge Island Perspective on Mammalian Extinctions in Western North American Parks. *Nature*, 325(6103): 430-432.

Niebuhr, B. B., Wosniack, M. E., Santos, M. C., Raposo, E. P., Viswanathan, G. M., Da Luz, M. G., & Pie, M. R. (2015). Survival in patchy landscapes:

the interplay between dispersal, habitat loss and fragmentation. *Scientific reports*, 5: 11898.

Norris, D. (2014). Model Thresholds Are More Important Than Presence Location Type: Understanding the Distribution of Lowland Tapir (*Tapirus terrestris*) in a Continuous Atlantic Forest of Southeast Brazil. *Tropical Conservation Science*, 7(3): 529-547.

Noss, R. F. & Cooperrider, A. Y. (1994). *Saving Nature's Legacy: Protecting and Restoring Biodiversity*. Washington, DC: Defenders of Wildlife and Island Press.

Nouhuys, S. V. (2009). *Metapopulation Ecology*. *Encyclopedia of life sciences.* Chichester, England: John Wiley & Sons, Ltd. Retrieved from www.els.net.

Nouhuys, S. V. (2016). *Metapopulation Ecology*. Chichester, England: John Wiley & Sons, Ltd.

Nowell, K., & Jackson, P. (1996). *Wild Cats: Status Survey and Conservation Action Plan*. Switzerland: IUCN.

Nowell, K., Schipper, J., & Hoffmann, M. (2007). Re-evaluation of the Felidae of the 2008 IUCN Red List. *Cat News*, 47(5).

Nunnally, J. C. (1978). *Psychometric Theory* (2nd Ed.). New York: McGraw Hill.

Nyamasyo, S. K., & Odiara Kihima, B. (2014). Changing Land Use Patterns and Their Impacts on Wild Ungulates in Kimana Wetland Ecosystem, Kenya. *International Journal of Biodiversity*, 2014 (2014): 1-10.

O'Rourke, N., & Hatcher, L. (2013). *A Step-by-Step Approach to Using SAS for Factor Analysis and Structural Equation Modeling* (2nd ed.). Cary, NC: SAS Institute Inc.

Okland, R. H., Eilersten, O., & Okland, T. (1990). On The Relationship between Sample Size and Beta Diversity in Boreal Coniferous Forests. *Vegetatio*, 87: 187-190. Doi: 10.1007/BF00042954.

Omidi, M., Kaboli, M., Karami, M., Mahini, A. S., & Kiabi, B. H. (2010). Modeling of the Persian Leopard (*Panthera pardus saxicolor*) Habitat Suitability in Kolah-Ghazi National Park Using ENFA. *Science and Environmental Technology*, 12: 137-148.

Operation Report of the Natural Environment Office of the Zahedan DoE (2000). General DoE Office of Sistan and Baluchistan Province, Iran.

Ostertagová, E. (2012). Modelling Using Polynomial Regression. *Procedia Engineering*, 48: 500-506.

Otypková, Z., & Chytrý, M. (2006). Effects of Plot Size on the Ordination of Vegetation Samples. *Journal of Vegetation Science*, 17(4): 465-472.

Parker, D. C., Manson, S. M., Janssen, M. A., Hoffmann, M. J., & Deadman, P. (2003). Multi-Agent System Models for the Simulation of Land-Use and Land-Cover Change: A Review. *Annals of the Association of American Geographers*, 93(2): 314-337.

Pearce, J., & Ferrier, S. (2000). Evaluating the Predictive Performance of Habitat Models Developed Using Logistic Regression. *Ecological Modelling*, 133(3): 225-245.

Pearman, P. B. (2002). The Scale of Community Structure: Habitat Variation and Avian Guilds in Tropical Forest Understory. *Ecological Monographs*, 72: 19-39.

Pearson, R. G. (2007). Species' Distribution Modeling for Conservation Educators and Practitioners. *Synthesis: American Museum of Natural History*, 50: 56-89.

Pearson, R. G., & Dawson, T. P. (2003). Predicting the Impacts of Climate Change on The Distribution of Species: Are Bioclimate Envelope Models Useful? *Global Ecology and Biogeography*, 12(5): 361-371.

Pearson, R. G., Dawson, T. P., & Liu, C. (2004). Modelling Species Distributions in Britain: A Hierarchical Integration of Climate and Land-Cover Data. *Ecography*, 27: 285-298.

Pearson, R. G., Raxworthy, C. J., Nakamura, M., & Peterson, A. T. (2007). Predicting Species Distributions from Small Numbers of Occurrence Records: A Test Case Using Cryptic Geckos in Madagascar. *Journal of Biogeography*, 34(1): 102-117.

Pearson, R. G., Thuiller, W., Araújo, M. B., Martinez-Meyer, E., Brotons, L., McClean, C., ... & Lees, D. C. (2006). Model-based Uncertainty in Species Range Prediction. *Journal of Biogeography*, 33(10), 1704-1711.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, Design, and Analysis: An Integrated Approach*. Hillsdale, NJ: Erlbaum.

Penha, R.M.L., & Hines, J. W, (2001). *Using Principal Component Analysis Modeling to Monitor Temperature Sensors in a Nuclear Research Reactor*. Proceedings from the Maintenance and Reliability conference, Knoxville, TN.

Persian Leopard Online Portal (2012*). Unpublished Records of Archived Persian Leopard Data*. Retrieved from www.Persian-leopard.com.

Peterson, A. T. (2006). Uses and Requirements of Ecological Niche Models and Related Distributional Models. *Biodiversity Informatics*, 3: 59-72.

Peterson, A. T., & Soberón, J. (2012). Species Distribution Modeling and Ecological Niche Modeling: Getting the Concepts Right. *Natureza & Conservação*, 10(2): 102-107.

Peterson, A. T., Papeş, M., & Soberón, J. (2008). Rethinking Receiver Operating Characteristic Analysis Applications in Ecological Niche Modeling. *Ecological Modelling*, 213(1): 63-72.

Peterson, T. C., Willett, K. M., & Thorne, P. W. (2011). Observed Changes in Surface Atmospheric Energy Over Land. *Geophysical Research Letters*, 38(16): L16707.

Phillips, S. J. (2006). *A Brief Tutorial on Maxent*. Retrieved from http://www.cs.princeton.edu/~schapire/maxent/tutorial/tutorial.doc.

Phillips, S. J. (2017). *A Brief Tutorial on Maxent*. Retrieved from http://biodiversityinformatics.amnh.org/open_source/maxent/.

Phillips, S. J., Anderson, R. P., & Schapire, R. E. (2006). Maximum Entropy Modeling of Species Geographic Distributions. *Ecological Modelling*, 190: 231-259.

Phillips, S. J., Anderson, R. P., Dudík, M., Schapire, R. E., & Blair, M. E. (2017). Opening the Black Box: An Open-Source Release of Maxent. *Ecography*, 40: 887-893. Doi: 10.1111/ecog.03049.

Phillips, S. J., & Dudík, M. (2008). Modeling Of Species Distributions with Maxent: New Extensions and A Comprehensive Evaluation. *Ecography*, 31(2): 161-175.

Phillips, S.J., Dudik, M., & Schapire, R.E. (2004). *A Maximum Entropy Approach to Species Distribution Modeling*. Proceedings from the 21st International Conference on Machine Learning (pp. 655-662). ACM Press, New York.

Pocock, R. I. (1930). The Panthers and Ounces of Asia. *Journal of Bombay Natural History Society*, 1: 63-82 and 307-336.

Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). *Numerical Recipes: The Art of Scientific Computing* (p. 1235). London, UK: Cambridge University Press.

Rah Chamani N. S., Ezazi, F., & Nejhad, G. F. A. *Comparison among Salook and Sarigl National Parks, North Khorasan Province*. Paper presented at the 1st National Seminar on Conservation Ecology (pp. 35-36). Shahid Beheshti University, Tehran, Iran. 2010. Retrieved from www.SID.ir.

Rahimi, A., & Atri, M. (2013). Study of Flora of Miandasht Wildlife Refuge in Northern Khorassan Province, Iran (a). *Journal of Ecology and the Natural Environment*, 5(9): 241-253.

Ramiadantsoa, T., Ovaskainen, O., Rybicki, J., & Hanski, I. (2015). Large-Scale Habitat Corridors for Biodiversity Conservation: A Forest Corridor in Madagascar. *PloS One*, 10(7): e0132126.

Raza, H., Ahmad, S. A., Hassan, N. A., Ararat, K., Qadir, M., & Ali, L. (2012). First Photographic Record of the Persian Leopard in Kurdistan, Northern Iraq. *Cat News*, 56: 34-35.

Raziei, T., & Pereira, L. S. (2013). Spatial Variability Analysis of Reference Evapotranspiration in Iran Utilizing Fine Resolution Gridded Datasets. *Agricultural Water Management*, 126: 104-118.

Rebelo, H., & Jones, G. (2010). Ground Validation of Presence-Only Modelling with Rare Species: A Case Study on Barbastelles *Barbastella barbastellus* (Chiroptera: Vespertilionidae). *Journal of Applied Ecology*, 47(2): 410-420.

Reed, D. H., O'Grady, J. J., Brook, B. W., Ballou, J. D., & Frankham, R. (2003). Estimates of Minimum Viable Population Sizes for Vertebrates And Factors Influencing Those Estimates. *Biological Conservation*, 113(1): 23-34.

Reese, G. C., Wilson, K. R., Hoeting, J. A., & Flather, C. H. (2005). Factors Affecting Species Distribution Predictions: A Simulation Modelling Experiment. *Ecological Applications*, 15: 554-564.

Rencher, A. C., & Schaalje, G. B. (2008). *Linear Models in Statistics* (2nd ed., p. 672). Hoboken: John Wiley & Sons.

Rezaei, M., Sameni, A., Shamsi, S. R. F., & Bartholomeus, H. (2016). Remote Sensing of Land Use/Cover Changes and Its Effect on Wind Erosion Potential in Southern Iran. *PeerJ*, 4: e1948.

Richman, M. B. (1988). A Cautionary Note Concerning a Commonly Applied Eigen Analysis Procedure. *Tellus B: Chemical and Physical Meteorology*, 40(1): 50-58.

Rietveld, T., & Van Hout, R. (1993). *Statistical Techniques for the Study of Language and Language Behaviour*. Berlin/New York: Walter de Gruyter.

Ringnér, M. (2008). What Is Principal Component Analysis? *Nature Biotechnology*, 26(3): 303-304.

Rissler, L. J., & Apodaca, J. J. (2007). Adding More Ecology Into Species Delimitation: Ecological Niche Models and Phylogeography Help Define Cryptic Species in the Black Salamander (*Aneides flavipunctatus*). *Systematic Biology*, 56: 924-942.

Robertson, M. P., Caithness, N., & Villet, M. H. (2001). A PCA-based Modelling Technique for Predicting Environmental Suitability for Organisms from Presence Records. *Diversity and Distributions*, 7(1-2): 15-27.

Rondinini, C., Wilson, K. A., Boitani, L., Grantham, H., & Possingham, H. P. (2006). Tradeoffs of Different Types of Species Occurrence Data for Use in Systematic Conservation Planning. *Ecology Letters*, 9(10): 1136-1145.

Roques, L., & Hamel, F. (2007). Mathematical Analysis of the Optimal Habitat Configurations for Species Persistence. *Mathematical Biosciences*, 210(1): 34-59.

Roques, L., & Stoica, R. S. (2007). Species Persistence Decreases with Habitat Fragmentation: An Analysis in Periodic Stochastic Environments. *Journal of Mathematical Biology*, 55(2): 189-205.

Rouse, J. W. J., Haas, R. H., Deering, D. W., Schell, J. A., & Harlan, J. C. (1974). *Monitoring the Vernal Advancement and Retro Gradation (Green Wave Effect) of Natural Vegetation*. NASA/GSFC Final Report, Greenbelt, USA.

Roy, H. G., Fox, D. M., & Emsellem, K. *Predicting Land Cover Change in a Mediterranean Catchment at Different Time Scales.* Paper presented at International Conference on Computational Science and Its Applications (pp. 315-330). Basel: Switzerland. June 2014.

Rozhnov V. V., Lukarevsky V. S., & Sorokin, P. A. (2011). Using Molecular Genetic Characteristics under Reintroduction of the Leopard (*Panthera pardus* L., 1758) in the Caucasus. *Doklady Akademii Nauk*, 437(2): 280-285.

Salehvnd, I., Gandomkar, A., Fatahi, A., & Azizi, G. (2016). Returning Annual Periods of Drought and Wet in Lorestan Iran Using Markov Chain. *Weather and Climate Extremes* (Withdrawn). Retrieved from http://dx.doi.org/10.1016/j.wace.2016.05.002.

Samadi, S., Ehteramian, K. & Sari Sarraf, B. (2011). SDSM Ability in Simulate Predictors for Climate Detecting Over Khorasan Province. *Procedia Social and Behavioral Sciences*, 19: 741–749.

Samin, N. & Kesdek, M. (2014). A Faunistic Study on the Carabidae (Coleoptera) from Golestan Province, Northern Iran. *Persian Gulf Crop Protection*, 3(1): 41-45.

Sanchez, I. B., & Alonso, C.L. (2008). *Deforestation Research Progress*. New York, USA: Nova Science.

Sanei A., Zakaria, M., & Hermidas Sh. (2011). Prey Composition in the Persian Leopard Distribution Range in Iran. *Asia Life Sciences Supplement*, 7: 19-30.

Sanei, A. (2004). *Analysis of Leopard Status in Iran* (BSc. thesis). Azad University, Tehran, Iran.

Sanei, A. (2007). *Analysis of Leopard (Panthera pardus) Status in Iran* (No.1, p. 298). Tehran: Sepehr Publication Center.

Sanei, A. (2016). *Persian Leopard National Conservation and Management Action Plan in Iran*. Tehran: Department of Environment of Iran.

Sanei, A. (2012). *Mapping Transboudary Habitats of the Persian Leopard in East Azarbaijan Province.* Submitted to Provincial DoE Office of East Azarbaijan Province. Asian Leopard Specialist Society, Tehran.

Sanei, A., Mousavi, M., Kiabi, B. H., Masoud, M. R., Gord Mardi, E., Mohamadi, H., Shakiba, M., … & Raeesi, T. (2016). Status Assessment of the Persian Leopard in Iran. *Cat News Special Issue*, 10: 43-50.

Sanei A., Gordmardi E., Jafari B., Absalan H., & Zakaria, M. (2013). *Persian Leopard Distribution in Relation to Human Pressures and Prey Resources in North Khorasan Province, Iran*. Proceedings from International Forestry Graduate Students' Conference (pp. 58-61), Faculty of Forestry, Universiti Putra Malaysia, Selangor, Malaysia.

Sanei A., Mousavi, M., Mousivand, M., & Zakaria, M. (2012). *Assessment of the Persian Leopard Mortality Rate in Iran*. Proceedings from UMT 11th International Annual Symposium on Sustainability Science and Management (pp.1458 - 1462), Universiti Malaysia Terengganu, Terengganu, Malaysia.

Sanei, A., Rabie, K., Teimouri, M., Shamsayee, M., Fahraji, N., Raeesi, T., … & Hermidas, Sh., *A Report to the Least Mortality Rate of the Persian Leopard in Iran - Second Report (2015).* Asian Leopard Specialist Society, Tehran, Iran. 2015.

Sanei, A., & Zakaria, M. (2008). *Distribution of Panthera pardus In Iran in Relation to Its Habitat and Climate Type*. Proceedings from 3rd Regional Symposium on Environment and Natural Resources (p. 54), Universiti Kebangsan Malaysia, Selangor, Malaysia.

Sanei, A., & Zakaria, M. (2011a). Impacts of Human Disturbances on the Habitat Use by the Malayan Panther in a Fragmented Secondary Forest, Malaysia. *Asia Life Sciences*, 7: 57-72.

Sanei, A., & Zakaria, M. (2011b). Occupancy Status of Malayan Leopard Prey Species in a Fragmented Forest in Selangor, Malaysia. A*sia Life Sciences Supplement*, 7: 41-55.

Sanei, A., & Zakaria, M. (2011c). Distribution pattern of the Persian leopard in Iran. A*sia Life Sciences Supplement*, 7: 7-18.

Sanei, A., & Zakaria, M. (2011d). Survival of the Persian leopard (*Panthera pardus saxicolor*) in Iran: primary threats and human-leopard conflicts. A*sia Life Sciences Supplement*, 7: 31-39.

Sanei, A., Zakaria, M., Yusof, E., & Roslan, M. (2011). Estimation of Panther Population Size in a Secondary Forest within Malaysia's Capital Agglomeration Using Unsupervised Classification of Pugmarks. *Tropical Ecology*, 52(2): 209-217.

Sargeant, G. A., Johnson, D. H. & Berg, W. E. (2003). Sampling Designs for Carnivore Scent-Station Surveys. *Journal of Wildlife Management*, 67: 289-298.

Saunders, D. A., Hobbs, R. J., & Margules, C. R. (1991). Biological Consequences of Ecosystem Fragmentation: A Review. *Conservation Biology*, 5(1): 18-32.

Scharnweber, T., Rietschel, M. & Manthey, M. (2007) Degradation Stages Of the Hyrcanian Forests in Southern Azerbaijan. *Archiv für Naturschutz und Landschafts Forschung*, 46:133-156.

Schoener, T. W. (1986). *The Ecological Niche. In J. M. Cherret (Ed.), Ecological Concepts: The Contribution of Ecology to an Understanding of the Natural World. Cambridge: Blackwell Scientific Publications.*

Searcy, C. A., & Shaffer, H. B. (2014). Field Validation Supports Novel Niche Modeling Strategies in a Cryptic Endangered Amphibian. *Ecography*, 37(10): 983-992.

Semenov, U. (2002). Tracking the Anatolian Leopard in the Western Caucasus. *Russian Conservation News*, 30: 30-31.

Shabanian, N., Soheili, S., & Haidari, M. (2013). Tree Spatial Patterns in the Zagros Forests (Case Study: Kurdistan Forests; Western Part of Iran*). The European Journal of Experimental Biology*, 3:121-125.

Shaffer, M. L. (1981). Minimum Population Sizes for Species Conservation. *BioScience*, 31: 131-134.

Shahriar, F., Montazeri, M., Momeni, M., & Freidooni, A. (2015). Regionalization of the Climatic Areas of Qazvin Province Using Multivariate Statistical Methods. *Modern Applied Science*, 9(2): 123.

Shannon, C.E. (1948). A Mathematical Theory of Communication. *Bell System Technical Journal*, 27: 379-423 and 623-656.

Shaukat, S. S., Rao, T. A., & Khan, M. A. (2016). Impact of Sample Size on Principal Component Analysis Ordination of an Environmental Data Set: Effects on Eigenstructure. *Ekologia*, 35(2): 173-190.

Sherbafi, E. (2010). *Analysis of Leopard Diet in the Habitats of Golestan NP* (Master's thesis). Tehran: Azad University.

Shirvani, A. (2017). Change in Annual Precipitation in the Northwest of Iran. *Meteorological Applications*, 24(2): 211-218.

Silakhori, E., & Arami, S.A. (2014). Climate role in desertification of Khorasan provinces, Iran. *International Journal of Agriculture and Crop Sciences*, 7 (6): 297-303.

Sillero, N. (2011). What Does Ecological Modelling Model? A Proposed Classification of Ecological Niche Models Based on Their Underlying Methods. *Ecological Modelling*, 222(8): 1343-1346.

Singh, A. K. (2003). *Modelling Land Use Land Cover Changes Using Cellular Automata in a Geo-Spatial Environment* (Master's thesis). International Institute for Geo-Information Science and Earth. Observation Enschede, the Netherlands.

Smith, L. I. (2002). A Tutorial on Principal Components Analysis. *Cornell University, USA*, 51(52): 65.

Soberón, J. (2007). Grinnelian and Eltonian Niches and Geographic Distributions of Species. *Ecology Letters*, 10: 1115-1123.

Soberón, J., & Peterson A.T. (2011). Ecological Niche Shifts and Environmental Space Anisotropy: A Cautionary Note. *Revista Mexicana de Biodiversidad*, 82: 1348-1355.

Soltani, M., Laux, P., Kunstmann, H., Stan, K., Sohrabi, M. M., Molanejad, M., ... & Zawar-Reza, P. (2016). Assessment of Climate Variations in Temperature and Precipitation Extreme Events over Iran. *Theoretical and Applied Climatology*, 126(3-4): 775-795.

Soltanzadeh Z., Saghaei N., & Ostovan, H. (2015). A Contribution to the Fauna of Fruit Flies (Diptera, Tephritidae) in Fars Province, Southern Iran. *Linzer Biologische Beiträge*, 47(1): 925-937.

Soufi, M. (2004, July). *Morpho-Climatic Classification of Gullies in Fars Province, Southwest of IR Iran*. Paper presented at 13th International Soil Conservation Organisation Conference, Brisbane, Australia. July 2004.

Statistical Centre of Iran (2012). Iran statistical yearbook. *Presidency* of the I.R.I., *vice presidency* for *strategic planning* and *supervision*, Tehran, Iran.

Steel, R.G.D., & Torrie, J. H. (1960). *Principles and Procedures of Statistics with Special Reference to the Biological Science*. New York: McGraw-Hill Company, Inc.

Stein, A.B., Athreya, V., Gerngross, P., Balme, G., Henschel, P., Karanth, U., Miquelle, D., Rostro-Garcia, S., Kamler, J.F., Laguardia, A., Khorozyan, I. & Ghoddousi, A. (2016). *Panthera pardus*, *The IUCN Red List of Threatened Species 2016:.e..T15954A50659089..*Retrieved.from.http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T15954A50659089.en.

Stevens, J. (1992). *Applied Multivariate Statistics for the Social Sciences* (2nd ed.). Hillsdale, N.J: Lawrence Erlbaum Associates.

Stevens, J. (2002). *Applied Multivariate Statistics for the Social Sciences* (4th ed.). Mahwah, N.J: Lawrence Erlbaum Associates.

Stith, B. M., & Kumar, N. S. (2002). Spatial Distributions of Tigers and Prey: Mapping and the Use of GIS. In K. U. Karanth & J. D. Nichols (Eds.), *Monitoring Tigers and Their Prey* (pp. 51-59). Bangalore, India: Centre of Wildlife Studies.

Stockwell, D. R. B. (2006). Improving Ecological Niche Models by Data Mining Large Environmental Datasets for Surrogate Models. *Ecological Modelling*, 192:188-196.

Stratmann, T. S., Barrett, K., & Floyd, T. M. (2016). Locating Suitable Habitat for a Rare Species: Evaluation of a Species Distribution Model for Bog Turtles (*Glyptemys muhlenbergii*) in the Southeastern United States. *Herpetological Conservation and Biology*, 11(1): 199-213.

Sunquist, M. E., & Sunquist, F. (2001). Changing Landscapes: Consequences for Carnivores. In J. L. Gittleman, S.M. Funk, D. W. Macdonald & R. K. Wayne (Eds.), *Carnivore Conservation*. *Conservation Biology Series 5* (Vol. 5, pp. 39-418). Cambridge, UK: The Zoological Society of London.

Sunquist, M., & Sunquist, F. (2002). *Wild Cats of the World* (p. 452). Chicago: University of Chicago Press.

Sykes, A. O. (1993). An Introduction to Regression Analysis. *Coase-Sandor Working Paper Series in Law and Economics*, 20: 34.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using Multivariate Statistics* (5th ed.). Upper Saddle River, NJ: Pearson Allyn & Bacon.

Taghdisi, M., Mohammadi, A., Nourani, E., Shokri, S., Rezaei, A. & Kaboli, M. (2013). Diet and Habitat Use of the Endangered Persian Leopard (*Panthera pardus saxicolor*) In Northeastern Iran. *Turkish Journal of Zoology*, 37: 554-561.

Taghizadeh-Mehjardi, R., Mahmoodi, S. & Heidari, A. (2009). Micromorphological evidences of climatic change in Yazd region, Iran. *Journal of Mountain Science*, 6(2):162-172.

Tayyebi, A., & Pijanowski, B. C. (2014). Modeling Multiple Land Use Changes Using ANN, CART and MARS: Comparing Tradeoffs in Goodness of Fit and Explanatory Power of Data Mining Tools. *International Journal of Applied Earth Observation and Geoinformation*, 28: 102-116.

Temple, S.A. (1986). The Problem of Avian Extinctions. *Current Ornithology*, 3: 453.

Ter Braak, C. J. (1995). Non-Linear Methods for Multivariate Statistical Calibration and Their Use in Palaeoecology: A Comparison of Inverse (K-Nearest Neighbours, Partial Least Squares and Weighted Averaging Partial Least Squares) and Classical Approaches. *Chemometrics and Intelligent Laboratory Systems*, 28(1): 165-180.

Theobald, D. M., Miller, J. R., & Hobbs, N. T. (1997). Estimating the Cumulative Effects of Development on Wildlife Habitat. *Landscape and Urban Planning*, 39(1): 25-36.

The Gazetteer of Mountains in the I. R. of Iran (2006). National Geographical Organization of Iran, Tehran, Iran.

Thompson, B. (1984). *Canonical Correlation Analysis: Uses and 2R Factor Rotation 26 Interpretation*. Thousand Oaks, CA: Sage.

Thurstone, L. L. (1947). *Multiple Factor Analysis: A Development and Expansion of Vectors of the Mind*. Chicago: University of Chicago Press.

Tilson, R., & Nyhus, P. (2010). Tigers of the World: The Science, Politics, and Conservation of *Panthera tigris* (2nd ed.). London: Elsevier.

Torabi, S. M. M., Halabian, A. H. (2015). Effects of Changes in Temperature and Rainfall on Potato Cultivation in South Khorasan Province using the Model LARS. *Biological Forum – An International* Journal, 7(1): 512-517.

Tsoar, A., Allouche, O., Steinitz, O., Rotem, D., & Kadmon, R. (2007). A Comparative Evaluation of Presence-Only Methods for Modelling Species Distribution. *Diversity and Distributions*, 13(4): 397-405.

Turner, B. L., Geoghegan, J., & Foster, D. R. (Eds.). (2004). *Integrated Land-Change Science and Tropical Deforestation in the Southern Yucatán: Final Frontiers*. Oxford, UK: Oxford University Press.

Turner, I. M., & Corlett, R.T. (1996). The Conservation Value of Small, Isolated Fragments of Lowland Tropical Rain Forest. *Trends in Ecology and Evolution*, 11: 330-333.

Turner, M. G., Gardner, R. H., & O'neill, R. V. (2001). *Landscape Ecology in Theory and Practice* (Vol. 401). New York: Springer-Verlag.

Ullrich, B., & Riffel, M. (1993). New Evidence for the Occurrence of the Anatolian Leopard, *Panthera pardus tulliana* (Valenciennes, 1856), in Western Turkey. *Mammalia*, 57: 5.

Uphyrkina, O., Johnson, W. E., Quigley, H., Miquelle, D., Marker, L., Bush, M., & O'Brien, S. J. (2001). Phylogenetics, Genome Diversity and Origin of Modern Leopard, *Panthera pardus*. *Molecular Ecology*, 10(11): 2617-2633.

Vahdati, F. B., Mehrvarz, S. S., Naqinezhad, A. R., & Shavvon, R. S. (2014). Floristic Characteristics of the Hyrcanian Sub-mountain Forests (Case Study: Ata-Kuh Forest). *Caspian Journal of Environmental Sciences*, 12(2): 169-183.

Valipour, A., Namiraninan, M., Etemad, V., & Ghazanfari, H. (2009). Relationships between Diameter, Height and Geographical Aspects with Bark Thickness of Lebanon Oak Tree (*Quercus libani* Oliv.) in Armardeh, Baneh (Northern Zagros of Iran). *Research Journal of Forestry*, *3*(1), 1-7.

Van der Hoek, Y., Zuckerberg, B. & Manne, L. L. (2015). Application of Habitat Thresholds in Conservation: Considerations, Limitations, and Future Directions. *Global Ecology & Conservation*, 3: 736 – 743.

Vega, P. A., Mas, J. F., & Zielinska, A. L. (2012). Comparing Two Approaches to Land Use/Cover Change Modelling and Their Implications for the Assessment of Biodiversity Loss in a Deciduous Tropical Forest. *Environmental Modelling & Software*, 29: 11-23.

Velicer, W. F., & Fava J. L. (1998). The Effects of Variable and Subject Sampling on Factor Pattern Recovery. *Psychological Methods*, 3: 231-251. Doi: 10.1037/1082-989X.3.2.231.

Verdade, L. M., Lyra-Jorge, M. C., & Piña, C. I. (Eds.). (2014). *Applied Ecology and Human Dimensions in Biological Conservation* (pp. 3-17). Heidelberg, NY: Springer.

Vereschangin, N. K. (1959). Ovtsebyk Na Wevere Sibiri. *Priroda*, 48: 105-106.

Virzi, T., Lockwood, J. L., Lathrop Jr., R.G., & Drake, D. (2017). Predicting American Oystercatcher Breeding Distribution in an Urbanized Coastal Ecosystem Using Maximum Entropy Modeling. *Waterbirds*, 40(1): 104-122.

Vogt, W. P. (1993). *Dictionary of Statistics and Methodology: A Nontechnical Guide for the Social Sciences*. Newbury Park, CA: Sage.

Vold, T. & Buffett, D. A. (Eds.). (2008). *Ecological Concepts, Principles and Applications to Conservation* (p. 36). Biodiversity BC. Retrieved from www.biodiversitybc.

Walker, D. A., Forbes, B. C., Leibman, M. O., Epstein, H. E., Bhatt, U. S., Comiso, J. C., ... & Kaplan, J. O. (2011). Cumulative Effects of Rapid Land-Cover and Land-Use Changes on the Yamal Peninsula, Russia. In *Eurasian Arctic Land Cover and Land Use in a Changing Climate* (pp. 207-236). The Netherlands: Springer.

Wang S., Haegeman, B., & Loreau, M. (2015). Dispersal and Metapopulation Stability. *PeerJ*, 3:e1295.

Warren, D. L., Glor, R. E., & Turelli, M. (2008). Environmental Niche Equivalency versus Conservatism: Quantitative Approaches to Niche Evolution. *Evolution*, 62(11): 2868-2883.

Watson, M. L. (2005). *The Effects of Roads on Wildlife and Habitats*. New Mexico: Department of Game and Fish, Conservation Services Division.

White, R., Engelen, G., & Uljee, I. (1997). The Use of Constrained Cellular Automata for High-Resolution Modelling of Urban Land-Use Dynamics. *Environment and Planning B: Planning and Design*, 24(3): 323-343.

Whittow, John (1984). *The Dictionary of Physical Geography* (p. 352). London: Penguin.

Wiens, J. A. (1996). Wildlife in Patchy Environments: Metapopulations, Mosaics, and Management. In D. R. McCullough (Ed.), *Metapopulations and Wildlife Conservation* (pp. 53-84). Washington, DC: Island Press.

Wiens, J. A. (1997). The Emerging Role of Patchiness in Conservation Biology. In S. T. A. Pickett, R. S. Ostfeld, M. Shachak & G.E. Likens (Eds.), *Enhancing the Ecological Basis of Conservation: Heterogeneity, Ecosystem Function, and Biodiversity* (pp. 93-107). Chapman and Hall, New York.

Wilcox, B. A., & Murphy, D. D. (1985). Conservation Strategy: The Effects of Fragmentation on Extinction. *The American Naturalist*, 125(6): 879-887.

With, K. A. (1997). The Application of Neutral Landscape Models in Conservation Biology. *Conservation biology*, 11(5): 1069-1080.

With, K. A., & King, A. W. (1999). Extinction Thresholds for Species in Fractal Landscapes. *Conservation Biology*, 13(2): 314-326.

WWF, (2016). *Leopards with Amputated Legs Are Found in The Caucasus*. Retrieved from http://wwf.panda.org/who_we_are/wwf_offices/azerbaijan/news.

Yang, Y., Zhang, S., Yang, J., Xing, X., & Wang, D. (2015). Using a Cellular Automata-Markov Model to Reconstruct Spatial Land-Use Patterns in Zhenlai Country, northeast China. *Energies*, 8(5): 3882-3902.

Youlatos, D. (2004). Multivariate Analysis of Organismal and Habitat Parameters in Two Neotropical Primate Communities. *American Journal of Physical Anthropology*, 123(2): 181-194.

Young, N., Carter, L., & Evangelista, P. (2011). *A MaxEnt Model v3. 3.3 E-tutorial* (ArcGIS v10). Fort Collins, Colorado.

Youssefi, M., Sh, H., Hoseini, S., Zaheri, B., & Tabari, M. A. (2010). First Report of *Ancylostoma tubaeforme* in Persian Leopard (*Panthera pardus saxicolor*). *Iranian Journal of Parasitology*, 5(1): 61-63.

Zakaria, M., & Sanei, A. (2011). Conservation and Management Prospects of the Persian and Malayan Leopards. *Asia Life Sciences Supplement*, 7: 1-5.

Ziaie, H. (2008). *A Field Guide to the Mammals of Iran* (2nd ed). Tehran, Iran: Wildlife Center.

Zulfiqar, A. (2001). Leopard in Pakistan's North West Frontier province. *Cat News*, 35: 9-10.