Journal of University of Duhok.,Vol. 22, No.1(Agri. and Vet. Sciences),Pp 292-299, 2019
https://doi.org/10.26682/avuod.2019.22.1.27

# HABITAT SUITABILITY ASSESSMENT OF EUROPEAN HARE (*LEPUS EUROPAEUS* PALLAS) IN MAJILMAKHTE IN DUHOK GOVERNORATE

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***(Received: April 6, 2019; Accepted for Publication: July 31, 2019)***

## ABSTRACT

**The main goal of the present study was to determining the habitat suitability assessment and identifying the seasonal influences on European brown hare behavior *Lepus europaeus* Pallas. The study field site located near Majilmakhte village, northeastern of Duhok city, Kurdistan Region of Iraq. Data had collected directly from the field at two times (April and July 2008-2009). Results of this study showed that habitat structure (Agriculture, Silviculture and Horticulture) and seasonal effects (spring, summer) played the main role in European brown hare's fluctuation behavior. In spring, the feeding sites had seen generally in horticultural habitat on which their means were 61, while in agricultural and silvicultural habitats were 43.6 and 19.8 feeding sites respectively. Whereas, the majority of resting and breeding sites found in silvicultural habitat with 15 resting and 13 breeding sites respectively. In summer period, the differences were obvious in silvicultural habitat on where feeding sites increased approximately three times from 19.8 to 53.8. This noticeable change in hare behavior from spring to summer periods could be explained by the abundance of succulent plants in April more than July, especially at the edges of crop fields. Additionally, the resting and breeding sites were mostly found in silvicultural habitat under juniper and oak trees, on where ensure better shelter to protect themselves from predators. In Kurdistan Region, there are real needs for further ecological and biological studies in order to estimate the European brown hare's population density and the influence of landscape changes and farming practices on their biophysiological behavior.**

***KEYWORDS**:* Lepus europaeous, Habitat Suitability Index, Experimental Unit, Behavior, Breeding Sites, Resting Sites.

## 1. INTRODUCTION

European brown hare, Lepus europaeus Pallas, is a medium-sized herbivore belonging to the Lagomorpha order. A range from 2.5 to 7.0 kg had documented for the body weight of this species (Macdonald & Barret, 1995) with an average 3.3 kg (Bonino, 1999). It considered as a native in middle-east and some parts of Asia to southeast Europe and the north much later, probably in association with agriculture (Tapper, 1987; Thulin, 2003). Its geographic range expansion in the past ranged from the Middle East throughout lowland Europe resulting to the clearance of forests and woodlands for agricultural purposes, which occurred after the end of the glacial period in Europe, creating suitable habitats for European brown hare (Tapper, 1987).

The European brown hare has usually found in open fields and rangelands in adjacent to forbs and shrub communities and wood lots close to agricultural areas. They use shallow forms for living, such as grass clumps, weeds, small bushes (Peterson, 1966, Bamsfield, 1974). Furthermore, it is most common in intensive arable land areas and less common in non-arable areas e.g. pasture, uplands and woodland (Klansek et al., 1998; Vaughan et al., 2003, and Smith et al., 2005). The study of the relationship between European brown hare populations and the landscape has become important in recent years in different European countries (Engelhardt et al., 1985; Haller et al., 1997). Where agriculture has become very intense, hare population size are reduced in comparison study with pastures and non-arable lands (Panek & Kamieniarz, 1999). Some authors suggested that small sized fields are, in general, favorable to hares (Meriggi & Alieri, 1989; Lewandowski & Nowakoski, 1993). According to (Pfister et al., 2002) a small area with diversified food is favorable to hares, but large fields can also be beneficial (Vaughan et al., 2003). In addition to

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that, large fields and low habitat diversity are detrimental environmental factors to hares population dynamic (Tapper & Barnes, 1986).

One of the most significant current discussions in ecology of hare is the real relationship between its biophysiological behavior (feeding, resting and breeding) and its habitats suitability (agriculture, silviculture and horticulture). In fact, the hares select well their habitats according to their biophysiological purposes, plant community structure, daytime and the season availableness in the year. For example, the selection of favored feeding sites is influenced by food choice and safety from predators (Hewson, 1989; Savory, 1986). Besides that, human disturbance may play an essential role in the selection of feeding sites (Wolfe, 1995). Foraging habitats can also be reconditioned by the availability of water over time and space (Barnes et al., 1991). Panek & Kamieniarz (1999) revealed that hares prefer sites where a variety of crops exists and their home range depends on food availability during the year. For daytime resting sites in plowed fields, often preferred during winter (Jezierski, 1972) which are destroyed in spring by harrowing; While spring-sown crops provide an abundance of young sprouts, and an attractive food for hares (Chapuis, 1990). Concerning the resting site, Jezierski (1973) noted that globally, with the increase in population density, plowed fields were distinctly preferred by hares as resting places while the interest for winter cereals declined (Pépin & Angibault, 2007). About the breeding sites, this species is associated with native grassland and open woodland. They prefer deciduous and evergreen small shrubs such as prickly juniper (*Juniperus oxycedrus*) as underneath cover (Chapman & Flux, 1990). Always they select inaccessible or difficult access habitat by predators, and give birth in a 'form', or a hollow in the grass or other herbaceous plants. Usually they select darker forms for this purpose (Naugton, 2012). Leverets are precocious and are able to move about soon after birth (Nowak, 1999); (Hayssen & van Tienhoven, 1993). On which gradually disperse from their birthplace (breeding site) to separate hiding locations (Macdonald, 2001), but meet up there each night after sunset to await the doe (Rural Development Service Technical Advice, 2005).

In Kurdistan Region of Iraq, European hare is one of the native small herbivore mammals, always found in valley bush lands, plains and un-forested or open forested mountains. The presence of *Lepus europaeus*had been reported in Iraq in mi-last century as given by Ellerman & Morison-Scott (1951). However, habitat assessment and biology of the European hare in Kurdistan Region need more accurate and deep scientific knowledge. Therefore, the main objectives of this study were to (i) determine the habitat suitability assessment of European hare, specify preferable habitat type in relation to their behavior (feeding, resting, and breeding sites); (ii) identify the seasonal influences on European brown hare behavior;(iii) and finally to address the suitable habitat management plan for this species as it possible.

## 2. MATERIALS AND METHODS

### 2.1. Study Areas

The study site was located near Majilmakhte village (37˚ 01¯ 836″ N, 43˚ 01¯ 083″ E) approximately 10 km in the northeastern of Duhok Governorate (N Iraq). It has been chosen according to the presence of hares and their visible damages to agricultural, vegetable and orchard crops. The study area covers 624.25 ha, which consist of scrublands with forest cover (384.25 ha), arable lands (240 ha), which represents 61.6%, 38.4% alternatively. In addition, the area is characterized with divers agricultural activities: winter cereal cropss (wheat, barley), legumes (lentil, chick-pea), vegetables (cucumber, melon), and fruits (apple, almond, pear and grape) where interfered with forest canopy.

### 2.2. Collection of Data

Data were collected directly in the field at two times (April and July 2008-2009) in order to estimate the hare population density according to the habitat structure in two seasons (spring and summer) (Nancy et al., 2003; Tariku Mekonen, 2007). It is involved the following studies:

#### 2.2.1. Hares density estimation via Presence/Absence Method:

The presence/absence methods was determined on 15 random square plots of (100 X 100 m) for the three habitat structure variables (Agricultural, Horticultural and silvicultural) (Broekhuizen & Masskamp, 1982).

The plots were divided into 10 parallel strips of 10 m wide, where in searching for hare presence evidence had done. The presence of hares recorded when the following categories were fulfilled:

a. Forms: in each experimental unit two kinds of forms were distinguished:

-Permanent forms from where the soils were scraped out.

-Temporary forms from where the soils were not scraped out.

b. Pellet numbers were counted, whether found individually or as groups. Hare density in the studied area was estimated by applying pellet-technique (Arnold & Reynolds, 1943; Andres et al., 1992) by using the equation:

$D = ha\ \bar{X}/TRA$

Where:

D is hare density (individual/ ha),

$\bar{X}$ is Mean number of pellets per experimental unit in the second count,

T is time between first and second count (days),

R is defection rate (number of pellets dropped animal-1 day-1) which was assumed by the mentioned authors to be (410) pellets hare-1 day-1, as estimated by (Flux, 1967),

A is area of each experimental unit ($m^2$).

c. Tracks of foot.

d. Urine.

e. Resting site.

f. Directly seen.

Absences of hares were recorded if none of the mentioned categories was fulfilled (Dingerkus & Montgomery, 2001).

**2.2.2. Habitat Evaluation:**

Three categories of landscape structure had given as follows:

1. Agricultural (consists of cereals).
2. Silvicultural (consists of scrublands and dense forest area).
3. Horticultural (consists of fruit orchard and vegetables).

Habitat evaluation procedure (HEP) employed by the U.S. Fish and Wildlife Service (Schamberger & Krohn, 1982) was used in this study. Habitat unit (HU) and habitat suitability index (HSI) were calculated only for those areas of habitat that were of actual importance to hares at the site (Scheamberger and Krohn, 1982). The HU and HSI depended on the occurrence and quality of:

1. Feeding sites.
2. Breeding sites.
3. Resting sites in the area.

Their occurrences were represented as numbers of their frequencies in each experimental unit. For feeding sites, the frequencies of numbers started with (0-9), and ended with (100-109); and for resting, breeding sites were ($\leq 2 = 0$ poor) ended with ($> 20 = 1$ excellent) as shown in (Table 1).

**Table (1):** Habitat suitability index (HSI) Frequency ranges for feeding resting and breeding sites in Experimental unit's areas for *Lepus Europaeus* in Majilmakhte (2008-2009).

| Feeding site Frequency | Resting & Breeding site Frequency | Indices | Quality categories |
|---|---|---|---|
| 0_9 | ≤ 2 | 0 | Poor |
| 10_19 | 3_4 | 0.1 | Little poor |
| 20_29 | 5_6 | 0.2 | Below weak |
| 30_39 | 7_8 | 0.3 | Weak |
| 40_49 | 9_10 | 0.4 | Below medium |
| 50_59 | 11_12 | 0.5 | Medium (acceptable) |
| 60_69 | 13_14 | 0.6 | Over medium |
| 70_79 | 15_16 | 0.7 | Below good |
| 80_89 | 17_18 | 0.8 | Good |
| 90_99 | 19_20 | 0.9 | Very good |
| 100_109 | >20 | 1 | Excellent |

## 3. RESULTS

European brown hare exhibit different behavior in accordance to seasonal change and habitat type for insuring their life requirements. Therefore, the fluctuation in their behavior showed the influence of different habitat on hare's feeding, resting and breeding sites in agricultural, silvicultural and horticultural habitats during April and July.

**3.1. Habitat suitability of brown hare in spring:**

In spring season, the field investigations showed that there were in total 778 suitable sites for brown hare in studied area with 622 feeding, 87 resting, and 69 breeding sites respectively for all three habitats (Agriculture, Silviculture, and

Horticulture). In fact, in April, the feeding sites had seen mostly in horticultural habitat more than other two habitats, which were 61 feeding sites; while in agricultural and silvicultural habitats were 43.6 and 19.8 feeding sites respectively (Fig. 1).

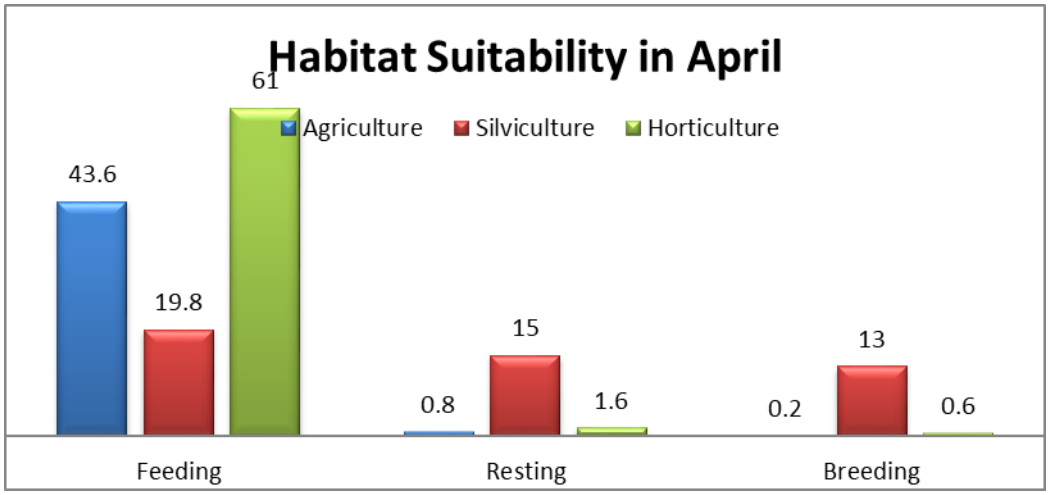


**Fig.(1):** Habitat suitability of brown hare in spring, in three different habitats.

**3.2. Habitat suitability of brown hare in summer:**

As a comprehensive look, the results of this study showed that the average mean of feeding, resting and breeding sites in studying areas were 696, 158, and 69 respectively in July. During the summer period, feeding sites were increased in horticultural and silvicultural habitats as illustrated in (Fig. 2) with the means of 69.8 and 53.8 sites respectively.

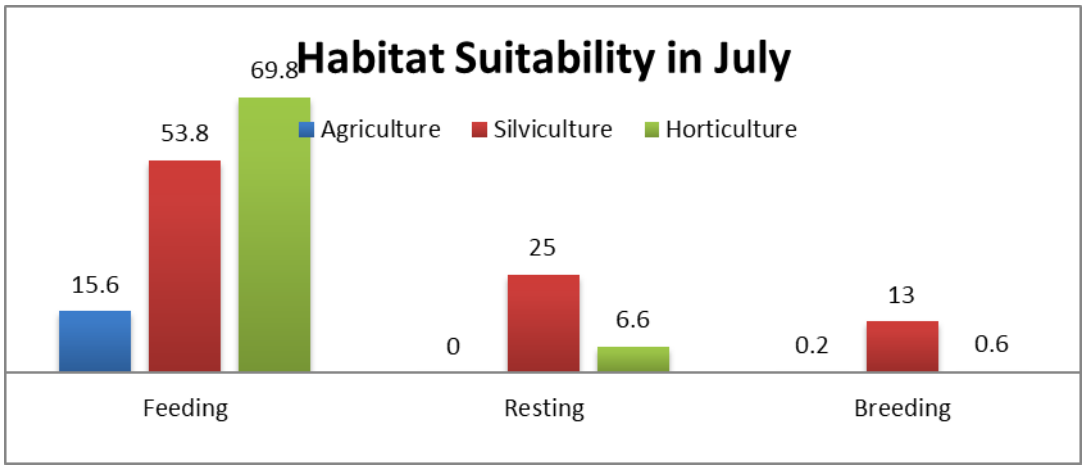


**Fig. (2):** Habitat suitability of brown hare in summer in three different habitats**.**

## 4. DISCUSSION

**4.1. Habitat suitability of European brown hare in spring:**

The richness of feeding sites in horticultural habitats could be due to the plant species richness and the abundance of the forage during the spring season (Fairley, 2001). While in agricultural habitats, feeding sites are less than horticultural habitat; this result could be explained by the clear decrease on diversity of forage plant species. In addition, the agricultural ecosystem is containing only one cereal crop such as wheat or barley which pointing out to monoculture and it is unfavorable by brown hare. Furthermore, the extensive monoculture was negatively associated with hare abundance and density due to the decrease in diversity, cover elimination, cutting of grass for silage and using of herbicide or pesticide

(Bertoti, 1975; Rebecca et al., 2005). Whereas, the plenty of resting and breeding sites found in silvicultural habitat with 15 resting and 13 breeding sites respectively. This fluctuation of behavior could be explained by shelters and permanent cryptic cover availability which used for rearing their offspring and hiding from predators. Furthermore, providing a suitable weather condition especially convenient temperature and humidity that impact on their natality as it's proved by Jennings et al. (2006) and Pépin & Angibault (2007). They revealed that during spring, hares need habitat structures that provide more cover from predators and from unfavorable weather conditions.

**4.2. Habitat suitability of brown hare in summer:**

Compared to spring period, the differences were obvious in silvicultural habitats which were approximately increased three times in silvicultural habitats from 19.8 to 53.8. While it decreased in agriculture habitat from 43.6 to 15.6. This remarkable change in hare behavior from spring to summer periods could be explained by the abundance of succulent plants in April especially at the edge of crop fields than July. In addition, the harvesting season leads the brown hare to change their behavior according to the food quality and quantity in silvicultural habitats simultaneously, and this outcome may be returned back to the presence of favorable perennial herbs in silviculture habitat more than agriculture habitats which were harvested during July. The change in vegetation cover subsequently affected on hare behavior that shifting from agriculture habitat in April to silviculture habitat in July for food compensation. For example, Panek & Kamieniarz (1999) showed that hares prefer sites where diversity are much more exists and their home range relating to the food availability year round. Furthermore, Frylestam (1980) and McLaren (1996) confirmed that in agricultural habitat such as cereal field crops, the abundance of the food decreases during summer due to the harvesting of the yield crops at the same time. In addition, Substitutive food resources are not available because of the loss of hedgerows and plowed land. On the other hand, largest number of resting and breeding sites had seen in silviculture habitats. In spring period, there were no apparent change in these two sites even though there was a slight change in resting site which affected by the food availability and quality, however it is inconsiderable. Whilst, no change had seen in breeding sites neither in April nor in July, since the duration survey was short and the natalities were still not separated from their parent. Nevertheless, there were no conspicuous alteration in resting and breeding site, also may be the reasons returning back to the abundance of shelters and cover which used for breeding and disappearing from predators for survival. For example, Tapper (1987) and Panek & Kamieniarz (1999) reported that shrubs and forested areas are considered of prime importance for hares, because these areas provide shelter to hares against predators. Furthermore, Schneider (2001) demonstrated the effect of predators on prey populations depends largely on habitat structure and subsequently influencing on brown hare behavior. However, there were no significant interactions between habitat and season effect on both resting and breeding sites. This fact could be explained that resting and breeding sites are not depended on season because most of them were found under junipers and oak trees which used as shelters to protect themselves from predators, hunting, and undesirable weather conditions.

The ANOVA table (Table 2) showed that habitat has a significant effect on all feeding, resting, and breeding sites. These results confirmed previously by (Fig.1 and 2) that habitat has a main role in changing hare behavior. Nevertheless, an overlapping founded between habitat and season interaction that affected only on feeding sites. We have to know that this interaction is considered as the most important factor for hare survival which was reduced throughout summer.

**Table (2)**: Showing the effect of habitat and season on feeding, resting and breeding sites.

| | | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|---|
| Feeding | Hab | 2 | 7171 | 3586 | 9.319 | 0.00101 ** |
| | Seas | 1 | 183 | 183 | 0.474 | 0.49758 |
| | Hab:Seas | 2 | 4861 | 2431 | 6.317 | 0.00625 ** |
| | Residuals | 24 | 9235 | 385 | | |
| Resting | Hab | 2 | 2153.4 | 1076.7 | 21.181 | 5.01e-06 *** |
| | Seas | 1 | 172.8 | 172.8 | 3.399 | 0.0776 . |
| | Hab:Seas | 2 | 140.6 | 70.3 | 1.383 | 0.2701 |
| | Residuals | 24 | 1220.0 | 50.8 | | |
| Breeding | Hab | 2 | 1033.8 | 516.9 | 27.666 | 5.88e-07 *** |
| | Seas | 1 | 0.1 | 0.1 | 0.007 | 0.933 |
| | Hab:Seas | 2 | 0.5 | 0.2 | 0.012 | 0.988 |
| | Residuals | 24 | 448.4 | 18.7 | | |
| Significant codes: '***' 0.001; '**' 0.01; '*' 0.05; '.' 0.1 | | | | | | |

## 5. CONCLUSION

The results of this study showed that habitat structure and seasonal change play a main role on *L. europaeus* fluctuation behavior. In fact, this interaction considered as one of the most important factor for hare's survival in order to insure their essential life requirements. For example, the major feeding site in both spring and summer mostly found in horticulture habitat due to the high diversity of plant species and the abundance of forage and succulent plants. While the resting and breeding sites usually found on silvicultural habitat such as under junipers and oak trees which used as a shelter to protect themselves from predators, hunting, and undesirable weather conditions. From biological conservation standpoint, it should be integrating people activities and wildlife management for a sustainable future. In this circumstance, there are real needs for further ecological and biological studies in order to determine the status and distribution of the *L. europaeus* in Kurdistan Region. Notably, studying the influence of landscape changes and farming practices on the ecology and behavior of the *L. europaeus*.

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