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HABITAT USE BY BROWN HARES (LEPUS EUROPAEUS) IN AN AGRICULTURAL ECOSYSTEM IN TUSCANY (ITALY) USING GPS COLLARS: IMPLICATION FOR AGRI-ENVIRONMENTAL MANAGEMENT

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In the last fifty years hare (Lepus europaeus) populations have been decreasing in Italy and in Europe. This species mostly frequents agricultural habitat and in some cases also depends on it. Cultivated territories have been subject to important changes especially after World War II. These changes may be summarized in two major effects on land use: the intensification (especially on lowlands) and land abandonment and encroachment (especially on uplands).

The hilly regions of Central Italy are characterised by an heterogeneous agricultural landscape favourable to hare populations, however both agricultural intensification and land abandonment are present and may represent a problem for hares in specific areas.

The aim of the present study was to investigate the habitat use of Brown hares in an agricultural ecosystem of the Tuscany region (Central Italy) where a mix of agricultural intensification and land abandonment is present. We wish to improve our knowledge of special behaviour and habitat use of hares in this typical agricultural landscape to improve habitat management practices for hares.

The application of the agro-environmental policies and in particular the CAP reform (EC Reg. 1783/03 on Cross Compliance and EC Reg. 1698/05 on Rural Development), together with national and local policies on wildlife habitat improvement (L. 157/1992, regional and provincial wildlife plans, regional agricultural plans, etc.), may help the conservation and management of High Nature Value agricultural habitat for hares and biodiversity.

ИЗУЧЕНИЕ ИСПОЛЬЗОВАНИЯ СРЕДЫ ОБИТАНИЯ ЗАЙЦЕМ-РУСАКОМ (LEPUS EUROPAEUS) В СЕЛЬСКОХОЗЯЙСТВЕННОЙ ЭКОСИСТЕМЕ ПРОВИНЦИИ ТОСКАНА (ИТАЛИЯ) С ПОМОЩЬЮ ПРИМЕНЕНИЯ ОШЕЙНИКОВ С ПРИКРЕПЛЕННЫМИ СИСТЕМАМИ GPS: ЗНАЧЕНИЕ ДЛЯ АГРО-ЭКОЛОГИЧЕСКОГО МЕНЕДЖМЕНТА

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В последние пятьдесят лет популяция зайцев-русаков (Lepus europaeus) сократилась как в Италии, так и в Европе. Это животное часто наведывается на сельскохозяйственные угодья, и во многих случаях его благополучие зависит от них. На посевных площадях произошли значительные изменения, особенно после Второй мировой войны. Эти изменения можно свести к двум основным последствиям для землепользования: интенсивное использование земель (особенно в долинах), их забрасывание и «наползание» угодий (особенно на нагорье).

Холмистые регионы Центральной Италии характеризуются гетерогенным сельскохозяйственным ландшафтом, благоприятным для популяции зайцев, однако, здесь наблюдается как интенсивное землепользование, так и заброшенность земель, что может представлять угрозу для популяции зайцев в этих областях.

Цель настоящего исследования состояла в том, чтобы изучить использование среды обитания зайца-русака в сельскохозяйственной экосистеме провинции Тоскана (Центральная Италия), где присутствует сочетание интенсивного землепользования и заброшенности земель. Для совершенствования методов управления местами обитания зайцев нам необходимо повысить уровень наших знаний относительно особенностей их поведения и среды обитания в этом конкретном сельскохозяйственном ландшафте.

Применение агро-экологической политики и в особенности реформы Единой сельскохозяйственной политики (ЕС Рег.№ 1783/03 (Соблюдение системы норм, необходимых для получения помощи от ЕС) и ЕС Рег.№ 1698/05 (Развитие сельских районов), наряду с национальными и местными политиками по усовершенствованию среды обитания диких животных (L. 157/1992, региональные и местные планы по охране диких животных, региональные сельскохозяйственные планы, т.д.), может помочь сохранению и управлению сельскохозяйственными местами обитания, имеющими высокую природную ценность для зайцев и биологического разнообразия в целом.

HABITAT USE BY BROWN HARES (*LEPUS EUROPAEUS*) IN AN AGRICULTURAL ECOSYSTEM IN TUSCANY (ITALY) USING GPS COLLARS: IMPLICATION FOR AGRI-ENVIRONMENTAL MANAGEMENT

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Introduction

In the last fifty years hare (*Lepus europaeus*) populations have been decreasing in Italy [1] and in Europe [2], [3]. This species mostly frequents agricultural habitat and in some cases also depends on it [4], [5], [6]. Cultivated territories have been subject to important changes especially after World War II. These changes may be summarized in two major effects on land use: the intensification (especially on lowlands) and land abandonment and encroachment (especially on uplands). Several Authors have pointed out the negative effects of agricultural intensification on hares. Main impacts are due to: the reduction on environmental diversity, the increase of field size and monocultures, the reduction of ecotones and field margins, the intensification of agricultural practices, etc. [7].Land abandonment on uplands increases the presence of uncultivated and forest areas that are not favorable to hare populations [8], [9]. Brown hares prefer heterogeneous habitats, with arable crops and pastures where food and shelter can be found throughout the year [10].
The hilly regions of Central Italy are characterised by an heterogeneous agricultural landscape favourable to hare populations, however both agricultural intensification and land abandonment are present and may represent a problem for hares in specific areas.
The aim of the present study was to investigate the habitat use of Brown hares in an agricultural ecosystems of the Tuscany region (Central Italy) where a mix of agricultural intensification and land abandonment is present. We wish to improve our knowledge of spatial behaviour and habitat use of hares in this typical agricultural landscape to improve habitat management practices for hares.
The application of the agro-environmental policies and in particular the CAP reform (EC Reg. 1783/03 on Cross Compliance and EC Reg. 1698/05 on Rural Development), together with national and local policies on wildlife habitat improvement (L. 157/1992, regional and provincial wildlife plans, regional agricultural plans, etc.), may help the conservation and management of High Nature Value agricultural habitat for hares and biodiversity.

Materials and Methods

The study was carried out in a protected area of Tuscany (Italy), "Spicciano" (43°33'N, 11°11'E).
In January 2008 we captured 15 hares (8 females and 7 males) by means of nets. Hares were marked with gps collars (Tellus mini – Televilt, weighting 74 g) scheduled to acquire animal location every 2 hours for 98 days. Hares were immediately released after capture in the same place. We evaluated the location error of gps collars in 15 m, thus a circle of 15 m of radius centered on the position recorded should cover most true location.
Land use data were recorded by means of field surveys. For the analysis the vegetation was classified into 7 categories: A) woodland B) scrub land, hedges C) winter cereals D) vineyards and orchards with cover-crops inter-row ("extensive fruit crops") E) vineyards and orchards without inter-row cover-crops ("intensive fruit crops") F) meadows G) fallow fields. Classification and

analysis of GIS data were obtained using AcrView 3.2 (ESRI, Redlands, California). We analyzed habitat selection using compositional analysis [11]. Total habitat availability was defined by a minimum convex polygon (MCP) obtained pooling the localizations of all hares with a buffer zone outlining the MCP of 256 m. The radius of the buffer zone was based on the mean home range size of hares. Assuming a circle of 20.5 ha the radius is 256 m. Home range size was calculated using 95% fixed kernel ranges [12]. At each location collected we attributed the larger habitat category present in the circle of 15m of radius around the GPS position recorded.
We compared used to available habitat at two levels: home range vs. available area, and proportional habitat use based on individual GPS location vs. home range. For the second comparison we separated locations collected during day and night. Male and female home range size was compared by Mann Withney U test.

Results

During the study 2 hares were preyed upon by foxes, 1 hare died due to a car accident, 1 hare died for unknown reasons and 1 hare died 7 days after the release and has been excluded from the analysis. From the beginning of January to the end of March GPS collars collected a mean of 785 (± sd 219) position fix per hare. Home range size was dependent by sex, in particular male home range ((min 17.62 - max 29.21) size was significantly larger than that of females (min 11.07 max 45.32) (U test = 9; $p<0.05$). Land use of the study area was characterized by woodland (30%), extensive fruit crops (25%), winter cereal (17%), fallow fields (11%), scrub land (7%), meadows (5%) and intensive fruit crops (5%). We didn't find significant sex differences in habitat selection, consequently data were pooled for the analysis.
At first level, we observed that habitat use in the home range compared with the habitat availability in the study area was not selected at random ($\lambda=0.046$; $P<0.001$) (tab. 1). At the second level, by comparing GPS location distribution vs. home range we observed a non random distribution of the position during the day ($\lambda=0.168$; $P<0.01$) (tab2), and the night ($\lambda=0.055$; $p<0.001$) (tab 3).

Discussion

GPS collars applied on brown hares gave us accurate information about home range size and habitat use during winter. As reported in previous studies male home range size is larger than that of females [14], but no differences were found between sexes in habitat selection. this fact could be due to similar ecological needs (refuge, food etc.) at the beginning of the breeding season. During winter Brown hares avoided woodland and selected in the home range winter cereals and scrub land, the first was used more during the night (rank 1) but used also during the day (rank 3), while the second is more used during the day (rank 1) and avoided during the night (rank 7). To improve management and identify the limiting factors of hare populations it should be useful to take into account the different habitat use between day and night, and, indeed, manage farmland habitats for hare, providing both feeding opportunities and cover to reduce predation risk.

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Table 1 Matrix of habitat ranking of brown hares, comparing home range vs. study area. Each mean element in the matrix was replaced by its sign; +++ and --- represent significant deviation from random at $P < 0.05$. Lower ranks indicate higher level of selection.

	Habitat							
Habitat	woodland	scrub land	winter cereals	extensive fruit crops	intensive fruit crops	meadows	fallow fields	Rank
woodland	.	---	---	---	-	---	---	7
scrub land	+++	.	---	+++	+	+++	+++	2
winter cereals	+++	+++	.	+++	+++	+++	+++	1
extensive fruit crops	+++	---	---	.	+	+	+	3
intensive fruit crops	+	-	---	-	.	-	-	6
meadows	+++	---	---	-	+	.	+	4
fallow fields	+++	---	---	-	+	-	.	5

Table 2. Matrix of habitat ranking of brown hares, comparing GPS position during the day vs. home range. Each mean element in the matrix was replaced by its sign; +++ and --- represent significant deviation from random at $P < 0.05$. Lower ranks indicate higher level of selection.

	Habitat							
Habitat	woodland	scrub land	winter cereals	extensive fruit crops	intensive fruit crops	meadows	fallow fields	Rank
woodland	.	-	-	+	+++	+	-	4
scrub land	+	.	+++	+++	+++	+++	+++	1
winter cereals	+	---	.	+	+++	+	-	3
extensive fruit crops	-	---	-	.	+	+	-	5
intensive fruit crops	---	---	---	-	.	-	---	7
meadows	-	---	-	-	+	.	---	6
fallow fields	+	---	+	+	+++	+++	.	2

Table 3. Matrix of habitat ranking of brown hares, comparing GPS position during the night vs. home range. Each mean element in the matrix was replaced by its sign; +++ and --- represent significant deviation from random at $P < 0.05$. Lower ranks indicate higher level of selection.

	Habitat							
Habitat	woodland	scrub land	winter cereals	extensive fruit crops	intensive fruit crops	meadows	fallow fields	Rank
woodland	.	+	---	-	-	-	-	6
scrub land	-	.	---	---	---	-	---	7
winter cereals	+++	+++	.	+++	+	+++	+++	1
extensive fruit crops	+	+++	---	.	-	+	-	4
intensive fruit crops	+	+++	-	+	.	+	+	2
meadows	+	+	---	-	-	.	-	5
fallow fields	+	+++	---	+	-	+	.	3