Avocetta 37: 43-60 (2013)

Hunting effects on Bird communities: the case of the province of Perugia

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Abstract – This study aims to verify if there can be differences between protected and free hunting areas as regards bird populations, taking into account the whole provincial territory of Perugia. Starting from a sample of 1266 points visited from year 2000 to year 2005 both in winter and in spring, 137 couples of points were individuated, each of them representing a point belonging to the protected territory and another belonging to the non-protected territory. The two groups of points (protected and non-protected) were compared according to the following parameters, calculated on a seasonal scale: species richness, total abundance, abundance of each species, abundance of some superspecific *taxa*, rarity index (Blana 1980). In winter, both species richness and total abundance were significantly greater within protected areas, the same showing a markedly higher value of the rarity index; significantly higher abundance values within protected stations were observed for 4 superspecific groups (Phasianidae, Falconiformes, *Turdus*, Corvidae) and for 10 species; only one superspecific group (Alaudidae) and 3 species were significantly more abundant within non-protected areas. In spring, no significant differences emerged between protected and non-protected areas in terms of richness, abundance and rarity index; only one superspecific group (Phasianidae) and 9 species came out to be significantly more abundant within the protected territory, 6 species within the free hunting area. The analysis undertaken reveals how during shooting season the hunting activity limits the settlement of the potential bird communities.

Key-words: hunting effects, Bird communities, Central Italy, point-counts.

INTRODUCTION

Directive 79/409/CEE (currently Directive 2009/147/CE) on the conservation of wild birds allows hunting activity at the expense of bird populations, by establishing (article 7, paragraph 1) the huntable species within each Member State of the EU and by setting the condition that "the hunting of these species does not jeopardise conservation efforts in their distribution". The considerable amount of contentions about hunting pushed the European Commission to enact in 2008 an interpretative document , "Guide to sustainable hunting under the Bird Directive, Council Directive 79/409/CEE on the conservation of wild birds". In paragraph 2.4.2 this document pinpoints that "Member States must ensure that hunting is compatible with the maintenance of the population of the species concerned at a satisfactory level" and that "the practice of hunting must not represent a significant threat to efforts for the conservation of both huntable as well as non-huntable species". In paragraph 2.6.15 it is recognized the possible role of disturbance of hunting that, if too intensely played, can force birds to make continuous movements and flights, causing negative repercussions on the individual energy balance and on the population survival rate, giving rise to an additive mortality that adds up to shooting. Among the mitigation proposed, there is the creation of undisturbed refuge areas (paragraph 2.6.22), that allow birds to feed and rest.
Hunting in Italy is a widely popular activity, with more than 700000 practitioners (Schipani 2009). Hunting is regulated by the national law 11 February 1992, n. 157 and by regional laws within the sector. The practice is possible from the beginning of September to the end of January, following species-specific hunting calendars different for each region. The Italian law subdivides the rural territory (territorio agro-silvo-pastorale - TASP) into different kinds of areas:

- protected areas, where hunting is prohibited: parks, national and regional reserves, refuge areas, restocking areas, mountain passes, state forests. On the whole, protected areas must cover from 20% to 30% of the TASP of each region;
- game preserves (aziende venatorie - AV), where the exploitation of the game is assigned through an exclusive concession to a private citizen. Species that can

be taken are individuated by the regional authority and are by custom in limited number with respect to the complete list of the huntable species. All other species are non-huntable. AV don't have to exceed 15% of the regional TASP;

- programmed hunting territory, subdivided into sub-regional hunting districts (Ambiti Territoriali di Caccia - ATC). Every hunter has access to one ATC that belongs to the region where he lives, and eventually he can access to other ATC (extra-regional as-well) upon agreement of their management bodies. The quantitative planning of the taking is often rough: plans based on the knowledge of the size and of the trend of population are frequently adopted for Ungulates, rarely for Bird Fauna.

The yet mentioned Directive 2009/147/CE imposes on Member States to encourage the necessary researches for protection, management and exploitation of bird species (art. 10), with particular attention to the subjects listed in Annex V of the Directive, among which is included "assessing the influence of methods of taking wild birds on population levels". Despite the Directive and the importance of hunting at a national level, in Italy the effect of hunting on Bird communities has been valued till now quite exclusively with reference to wetlands (for example: Faralli 1991, Faralli & Lambertini 1991,Tinarelli *et al*. in press, Velatta 1996), while the terrestrial environments have been rarely considered. The only paper on this subject is that of Lambertini (1991), who analyzed the evolution of a Bird community in a forest area (Parco Regionale di San Rossore-Migliarino-Massaciuccoli - Tuscany, Central Italy) after the closing of hunting, comparing it with a similar reference area where hunting was still acting. The aim of my work is to concur to plug this gap by verifying if there are differences in Bird populations between protected and free hunting areas. In doing so, an entire provincial territory (that of Perugia) is taken into consideration. As far as I know, this is in Italy the first analysis not concerning wetlands conducted on a so wide spatial scale.

METHODS

The province of Perugia (Umbria region, Central Italy) covers an area of 6342 km² and it is characterized by an eastern highland and a western hilly sector with small plains corresponding to the main river valleys. According to the geobotanical map of Umbria (Orsomando *et al*. 2004), the mainly represented land use categories are woods (39,4%), sowable lands (36,6%) and grasslands (10,1%); urban and productive settlements cover 5,4% of the surface only.

During the survey the surface area of the protected zones was 914 km², equivalent to 14,4% of the provincial territory. Protected areas as a whole included all the environmental typologies present in the province of Perugia, even if in a non-proportional manner compared to their to-

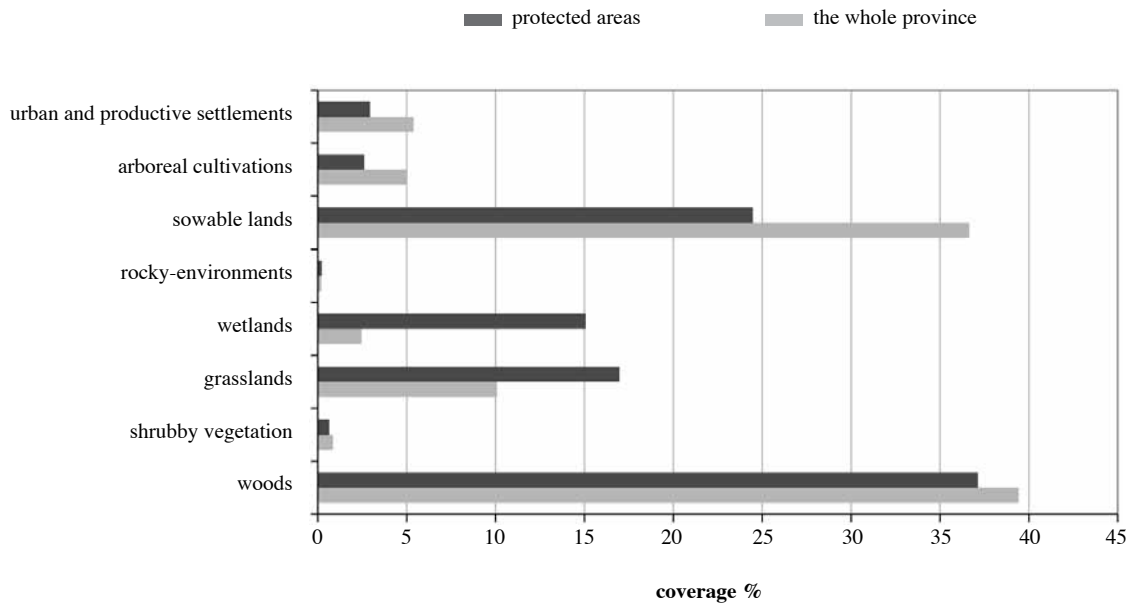

Figure 1. Land use in the whole province of Perugia and in the protected areas.

tal extension (Fig. 1); in particular, regarding the totality of the territory, a great diffusion of wetlands and grasslands and a small diffusion of cultivated areas.

The provincial territory is subdivided into two Territorial Hunting Areas (ATC PG1 and ATC PG2), and during the study period their extensions were respectively 2458 and 2377 km² (without protected areas, game preserves and built-up areas). During the same years, the corresponding average density of hunters was equal to 7,6 individuals/km² inside ATC PG1 and to 7,4 individuals/km² inside ATC PG2 (Tab. 1).

For the purposes of the analysis, the data collected from year 2000 to 2005 by the "Osservatorio Faunistico Regionale" were employed. OFR carried on both in spring (May-June) and in winter (December- January) six seasonal surveys based on the repeated visits of about 1700 points distributed within the entire umbrian territory (Velatta *et al*. 2010).

The localization of the stations was obtained by the application of a sampling scheme inspired to the north-american Breeding Bird Survey (Robbins *et al*.1986): inside each UTM square 10x10 km, a route was traced along secondary roads, chosen in order to cross the most represented environments within the square; the stations were set along such routes at fixed intervals of 1 km, assuring for each square a density of a sampling point every 5 km².
The method used in the field was a version of point-counts. In spring was followed the methodology adopted by the MITO2000 national project (Fornasari *et al*. 2002), whose aim is to monitor the populations of common breeding birds: in each station was undertaken a ten minutes survey in the morning, during which all the individuals seen or heard were recorded, making a distinction between contacts occurred within or beyond 100 metres from the observer. Winter surveys were undertaken in the same way, except for their shorter duration (8 minutes for each station) due to the reduced amount of daylight.

To the extent of this analysis the 1266 stations placed within the province of Perugia were considered. Among them, the following two groups of points were selected:

- "protected stations" (from now on indicated as P; N=168): stations within protected areas;
- "non-protected stations" (from now on indicated as NP; N=871): stations more than 500 metres away from protected areas and from game preserves (AV).

This analysis does not include the AV because they represent a kind of "hybrid" between protected areas and programmed hunting territory.

To each selected station were assigned the altitude and the % coverage (within a 100 metres radius) of the following 8 land use categories (obtained from the geobotanical map of Umbria - Orsomando *et al*. 2004): woods, shrubby vegetation, grasslands, wetlands, rocky-environments, sowable lands, arboreal cultivations, urban and productive settlements.

The above mentioned environmental variables were standardized by means of the following algorithm:

$x_{stand} = (x_{obs} - \text{mean})/STD$ where mean and STD are those of the general sample "P + NP".

The stations of the two groups were then grouped into 6 height classes:

altitude limits (m a.s.l.)	**NP stations**	**P stations**
0-250	120	15
251-375	228	26
376-500	154	17
501-750	190	41
751-1000	131	36
>1000	48	33

Within each height class the Euclidean distance among each station P and each station NP was calculated starting from the standardized environmental variables. Then, cou-

Table 1. Number and density of hunters registered in the two ATC of the province of Perugia.

hunting season	**hunters registered**		**hunters/km²**	
	ATC PG1	**ATC PG2**	**ATC PG1**	**ATC PG2**
2001-2002	14655	17285	6,0	7,3
2002-2003	19164	17837	7,8	7,5
2003-2004	19598	17685	8,0	7,4
2004-2005	20122	17613	8,2	7,4
2005-2006	19624	17054	8,0	7,2
mean	18633	17495	7,6	7,4

Table 2. Mean values of environmental variables inside the groups of protected (P) and non-protected (NP) stations. Each group is made up of 137 stations.

environmental variable		group of stations	
		P	**NP**
height (m a.s.l.)		656	654
woods %	within 100 m	45.2	45.1
	within 300 m	48.1	50.2
	within 500 m	48.5	51.2
shrubby vegetation %	within 100 m	0.2	0.2
	within 300 m	0.5	0.4
	within 500 m	0.7	0.7
grasslands %	within 100 m	14.5	14.6
	within 300 m	13.6	12.5
	within 500 m	13.7	12.5
wetlands %	within 100 m	0.0	0.0
	within 300 m	0.6	0.1
	within 500 m	0.7	0.1
rocky- environments %	within 100 m	0.0	0.0
	within 300 m	0.1	0.1
	within 500 m	0.2	0.1
sowable lands %	within 100 m	29.8	29.9
	within 300 m	29.7	29.6
	within 500 m	29.1	28.7
arboreal cultivations %	within 100 m	3.5	3.4
	within 300 m	3.1	3.0
	within 500 m	3.1	3.1
urban and productive settlements %	within 100 m	6.8	6.8
	within 300 m	4.3	4.0
	within 500 m	4.0	3.5

ples of similar stations "P-NP" were created, obtained associating to each station of the group P the stations of the group NP set at the shorter Euclidean distance and eliminating the couples of stations whose Euclidean distance was above 1. In this way, 137 couples of stations "P-NP" were individuated (Tab. 2); it is worth noting that the environmental homogeneity of the two samples is high even increasing to 500 metres the distance radius within which are calculated the covering values of the different land use categories.

Inside the two groups of stations the predominant environments are woods, sowable lands and grasslands, and together cover approximately the 90% of the stations; the less represented typologies are rocky- environments and wetlands, with paltry covering values (less than 1%).

The above mentioned procedure, which is preliminary to the true analysis, was undertaken with the precise goal of evaluating the effects of protection under the same environmental conditions. In other terms, the fact that the two groups of stations are homogeneous under the altimetric and land use profile, brings us the well-founded certainty that possible differences within bird populations are almost exclusively due to the diverse management system (hunting - not hunting).

The two groups of 137 stations were then compared (mean calculation and Wilcoxon's non-parametric test for matched pairs) with regards to the following parameters, calculated by considering both the contacts within 100 metres only and the total number of contacts without distance limits:

1. species richness per station during winter;
2. species richness per station during spring;
3. species richness per station during spring, considering the resident species only (species present all year

round, even if with a partial turnover of the population);
4. abundance (= number of individuals belonging to all species) per station during winter;
5. abundance per station during spring;
6. abundance per station during spring, considering the resident species only;
7. abundance per station during winter, separately calculated for the following superspecific *taxa*: Phasianidae, Falconiformes (including Accipitridae, Pandionidae, Falconidae), Picidae, Alaudidae, *Turdus*, Corvidae, Fringillidae;
8. abundance per station during spring, separately calculated for the same above mentioned superspecific *taxa*;
9. abundance of each species per station during winter;
10. abundance of each species per station during spring.

For each station, the average of the values gathered each year (generally 6) was considered . In case of lack of one or more years in a couple of stations "P - NP", only the years with both the stations covered were entered in the analysis. By way of summary, for both P and NP were considered 754 winter point-counts and 812 spring ones.

Finally, for each group of stations (P and NP) was calculated the rarity index value (IR - Blana 1980) whose formula is: IR = $\sum$ (Fi % / Qi %), where:
- Fi % = percentage of point counts undertaken in the group of stations examined where the species was found;
- Qi % = percentage of point counts undertaken within the whole regional territory (Velatta *et al*. 2010) where the species was found.

The rarity index ascribes as much more high scores to a sample of stations as more rare the species are at the regional level and as more frequent the species are inside the same sample. Therefore, it is an index of the "conservation value" of a specific bird community. As the previous parameters, also the rarity index was calculated in two different ways, that is to say considering the contacts within 100 metres only and their total number.

RESULTS

Considering the contacts within 100 metres only, species richness and abundance do not show significant differences between group P and group NP. If we consider all the contacts without limits of distance, both richness and winter abundance are significantly higher in P stations (Tab. 3), with mean values exceeding the values of group NP to an extent of 10% and 16% respectively. Analyzing the abundance values of the 7 superspecific groups considered (Tab. 4), during winter there are statistically significant differences between P and NP in the following cases:
- Phasianidae, Corvidae, Falconiformes, *Turdus* more abundant in P. With regards to the last two *taxa* the difference is not significant if we only consider the contacts within 100 metres;
- Alaudidae, more abundant in NP.

During spring, the only group that shows significant differences of abundance between the two samples of stations is that of Phasianidae, more abundant in P (but with a definitely lower gap than in winter).

As regards the single species, the abundance in the protected territory and in the free hunting one are shown in Tab. 5 (winter) and in Tab. 6 (spring). 10 species (11.0%) out of 91 recorded during winter are significantly more abundant in P, only 3 (3.3%) in NP. The gap seems smaller during spring: 9 species (7.4%) out of 121 are significantly more abundant in P, 6 species (5.0%) more abundant in NP. Five species significantly more abundant in winter within the protected areas, were also reported in the work of Lambertini (1991) as increasing after the establishment of the hunting ban; these species are: *Columba palumbus, Garrulus glandarius, Phylloscopus collybita, Turdus merula, Sylvia melanocephala*.

Within the NP sample the rarity index takes on clearly lower values compared to those observed in P (Fig. 2);on the contrary, in spring the two groups of stations do not show relevant differences.

DISCUSSION

The study shows that in the province of Perugia hunting is a factor that limits the settlement of potential bird communities in the territories where shooting is practiced. In fact, during the hunting season (winter surveys), the main "macro-indicators" (species richness, abundance, rarity index) are higher within the protected areas. Higher richness and abundance values in the protected area than those recorded in the free hunting one, were observed by Lambertini (1991) too.

The lack of significant differences about winter richness and abundance, that can be underlined considering the contacts within 100 metres only, arguably depends on an insufficient sampling, that is to say that probably the number of contacts is too low so that differences between the two types of territories could emerge.

The "inhibitory" effect of hunting seems to be at least

Table 3. Species richness and abundance: comparison between protected and non-protected stations (in bold type the significant differences).

parameter	contacts considered	mean			Wilcoxon's test	
		P	NP	P/NP	Z	P (2-tailed)
species richness (winter)	within 100 metres	5.3	4.9	1.07	-1.659	0.097
	all the contacts	7.3	6.7	1.10	-2.965	**0.003**
species richness (spring)	within 100 metres	7.8	7.4	1.06	-1.370	0.171
	all the contacts	12.4	12.0	1.03	-0.860	0.390
species richness (spring - resident species only)	within 100 metres	6.4	6.0	1.06	-1.525	0.127
	all the contacts	9.6	9.2	1.04	-1.422	0.155
species richness (spring - migratory species only)	within 100 metres	1.5	1.4	1.03	-0.441	0.659
	all the contacts	2.8	2.8	1.00	-0.098	0.922
abundance (winter)	within 100 metres	11.9	11.4	1.04	-0.844	0.398
	all the contacts	27.0	23.3	1.16	-2.588	**0.010**
abundance (spring)	within 100 metres	14.1	14.5	0.97	-0.467	0.640
	all the contacts	27.4	28.3	0.97	-0.784	0.433
abundance (spring - resident species only)	within 100 metres	11.1	11.6	0.95	-0.523	0.601
	all the contacts	19.9	21.5	0.92	-1.459	0.145
abundance (spring - migratory species only)	within 100 metres	3.0	2.9	1.03	-0.391	0.696
	all the contacts	7.6	6.8	1.12	-0.563	0.573

partly reversible: during spring (when hunting season is closed), the differences between the two samples do not reach the statistical significance level. A similar trend was observed during a previous survey undertaken on Trasimeno Lake (the main wetland of the Province) before its closing to hunting (Velatta 1996).

The event is partly explained by the fact that in spring several summer visitors species arrive, and they are not affected by hunting pressure. However, even considering the resident species only, we can notice the lack of significant differences about spring richness and abundance between protected and non-protected areas. This phenomenon could depend on the fact that in Central Italy different population of many apparently residential species alternate during the year: some locally breeding individuals can migrate (thus avoiding hunting) and can be replaced by birds from the northern latitudes.

Autumn-winter influxes of foreign individuals are for instances known for *Columba palumbus, Turdus merula, Fringilla coelebs, Sturnus vulgaris* (Andreotti *et al*. 2010, Spina & Volponi 2008).

However, it is also confirmed that a seasonal re-distribution of some resident species occurs on a strictly local basis, as demonstrated by data regarding *Phasianus colchicus* and *Corvus cornix,* two species that show insignificant or scarce migratory movements. This re-distribution could take place according to two different modalities:

- decrease in abundance within hunting areas after the taking of a part of the individuals, followed by the irradiation of the populations belonging to protected areas, that compensates for the loss;
- active displacement, at the beginning of the hunting season, of individuals from hunting areas to the protected ones, the latter used as refuges, followed by a reverse movement when hunting season ends.

However things turn out, these mechanisms could not be sufficient to prevent the establishment of negative population trends within all species. If we take two huntable species as an example, *Phasianus colchicus* and *Columba palumbus*, both characterized by a strong lack of balance in winter abundance between protected and non-protected areas, the first shows a negative trend of the breeding population at a regional level, while the second shows a positive trend (Velatta *et al*. 2010). As regards *Phasianus colchicus,* a management strategy based on the creation of protected areas only (at least considering their current extension) seems to be inadequate to keep a satisfactory level of the provincial population and should be supported by a reliable planning of the taking.

It is important to underline that the effect of hunting disturbance does not affect the huntable species only: strong lack of balance in winter between protected and non-protected areas has been recorded for the group of diurnal raptors and for some protected small passerines (*Periparus ater, Phylloscopus collybita* and *Sylvia melano-*

Table 4. Abundance of the superspecific groups considered: comparison between protected and non-protected stations (in bold type the significant differences).

group of species	season	mean abundance			Wilcoxon's test	
		P	NP	P/NP	Z	P (2-tailed)
contacts within 100 metres						
Phasianidae	winter	0.046	0.001	37.60	-4.559	**0.000**
	spring	0.177	0.071	2.51	-3.430	**0.001**
Falconiformes	winter	0.082	0.073	1.12	-0.612	0.541
	spring	0.034	0.056	0.60	-1.624	0.104
Picidae	winter	0.118	0.105	1.12	-0.400	0.689
	spring	0.107	0.095	1.13	-0.729	0.466
Alaudidae	winter	0.106	0.361	0.29	-3.403	**0.001**
	spring	0.463	0.333	1.39	-1.245	0.213
Turdus	winter	0.941	0.788	1.19	-0.956	0.339
	spring	0.890	0.779	1.14	-1.536	0.124
Corvidae	winter	1.318	1.075	1.23	-2.106	**0.035**
	spring	0.885	0.737	1.20	-1.631	0.103
Fringillidae	winter	3.995	3.733	1.07	-1.406	0.160
	spring	2.261	2.280	0.99	-0.743	0.458
group of species	**season**	**mean abundance**			**Wilcoxon's test**	
		P	**NP**	**P/NP**	**Z**	**P** (2-tailed)
all the contacts						
Phasianidae	winter	0.158	0.011	14.44	-4.726	**0.000**
	spring	0.840	0.282	2.99	-4.709	**0.000**
Falconiformes	winter	0.227	0.154	1.47	-2.371	**0.018**
	spring	0.150	0.160	0.94	-0.085	0.933
Picidae	winter	0.335	0.278	1.20	-1.424	0.154
	spring	0.360	0.363	0.99	-0.023	0.982
Alaudidae	winter	0.341	0.589	0.58	-1.976	**0.048**
	spring	0.880	0.793	1.11	-1.054	0.292
Turdus	winter	1.269	0.955	1.33	-2.000	**0.045**
	spring	1.875	1.982	0.95	-0.693	0.489
Corvidae	winter	5.546	3.799	1.46	-3.400	**0.001**
	spring	2.682	2.235	1.20	-1.782	0.075
Fringillidae	winter	8.063	6.675	1.21	-1.858	0.063
	spring	3.355	3.760	0.89	-1.399	0.162

cephala). As regards *Periparus ater*, it is possible that the difference observed does not depend on protection, but on the fact that within the sample of protected areas the average coverage of conifer reforestations is higher (10.8% compared to 2.4%), and in Umbria they represent the typical habitat of the species.

Only 3 out of 10 species significantly more abundant within protected areas during winter resulted to be more abundant in spring: *Phasianus colchicus*, *Columba palumbus*, *Periparus ater*. However, in comparison to winter the above species show a considerable attenuation of the gap. The existence of (few) species (all belonging to small passerines) significantly more abundant in non-protected areas has a difficult interpretation: the phenomenon could maybe depend on subtle environmental differences that were not pointed out at the scale of the survey; another suggesting theory is that the major density of predators that characterizes the protected territory (as demonstrated in this study for Corvidae and Falconiformes in winter) could determine the decrease of some prey species.

Table 5. Species recorded in winter and comparison of their abundance between protected and non-protected stations (in bold type the significant differences). In the "status" column the asterisk (*) shows the species hunted in Umbria in derogation of the dispositions of Directive 2009/147/CE.

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
Cygnus olor	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
Anas crecca	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.002	0.000	-1.000	0.317
Anas platyrhynchos	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.055	0.012	-1.604	0.109
Aythya ferina	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.049	0.000	-1.000	0.317
Alectoris rufa	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.012	0.000	-1.000	0.317
Perdix perdix	huntable	within 100 metres	0.011	0.000	-1.000	0.317
		all the contacts	0.011	0.000	-1.000	0.317
Phasianus colchicus	huntable	within 100 metres	0.035	0.001	-4.505	**0.000**
		all the contacts	0.136	0.011	-4.703	**0.000**
Phalacrocorax carbo	huntable *	within 100 metres	0.004	0.002	-0.447	0.655
		all the contacts	0.751	0.011	-3.035	**0.002**
Egretta garzetta	protected	within 100 metres	0.000	0.000		
		all the contacts	0.006	0.000	-1.633	0.102
Casmerodius albus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.002	-0.577	0.564
Ardea cinerea	protected	within 100 metres	0.005	0.004	-0.378	0.705
		all the contacts	0.011	0.009	-0.367	0.714
Circus aeruginosus	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.019	0.001	-1.342	0.180
Circus cyaneus	protected	within 100 metres	0.001	0.002	-0.577	0.564
		all the contacts	0.002	0.004	-0.447	0.655
Accipiter nisus	protected	within 100 metres	0.010	0.007	-0.636	0.525
		all the contacts	0.014	0.010	-0.785	0.432
Buteo buteo	protected	within 100 metres	0.048	0.045	-0.192	0.848
		all the contacts	0.143	0.101	-1.715	0.086
Aquila chrysaetos	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.006	-1.633	0.102
Pandion haliaetus	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.002	0.000	-1.414	0.157
Falco tinnunculus	protected	within 100 metres	0.013	0.017	-0.756	0.450
		all the contacts	0.036	0.032	-0.346	0.729
Falco columbarius	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.002	0.000	-1.414	0.157
Falco peregrinus	protected	within 100 metres	0.005	0.000	-1.633	0.102
		all the contacts	0.008	0.000	-2.060	**0.039**
Gallinula chloropus	huntable	within 100 metres	0.004	0.001	-0.816	0.414
		all the contacts	0.006	0.001	-1.300	0.194
Vanellus vanellus	huntable	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.054	0.027	-0.271	0.786

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Scolopax rusticola	huntable	within 100 metres	0.001	0.002	-0.447	0.655
		all the contacts	0.001	0.002	-0.447	0.655
Chroicocephalus ridibundus	protected	within 100 metres	0.005	0.024	-0.707	0.480
		all the contacts	0.198	0.055	-0.943	0.345
Larus michahellis	protected	within 100 metres	0.004	0.106	-1.121	0.262
		all the contacts	0.117	1.914	-1.493	0.135
Columba palumbus	huntable	within 100 metres	0.072	0.008	-2.256	**0.024**
		all the contacts	0.988	0.025	-3.398	**0.001**
Streptopelia decaocto	protected	within 100 metres	0.006	0.038	-1.913	0.056
		all the contacts	0.031	0.091	-1.888	0.059
Athene noctua	protected	within 100 metres	0.000	0.004	-1.732	0.083
		all the contacts	0.001	0.005	-1.342	0.180
Strix aluco	protected	within 100 metres	0.010	0.001	-1.289	0.197
		all the contacts	0.010	0.002	-0.962	0.336
Picus viridis	protected	within 100 metres	0.057	0.065	-0.203	0.839
		all the contacts	0.255	0.220	-1.071	0.284
Dendrocopos major	protected	within 100 metres	0.060	0.041	-1.337	0.181
		all the contacts	0.078	0.058	-0.931	0.352
Dendrocopos minor	protected	within 100 metres	0,001	0.000	-1,000	0,317
		all the contacts	0,001	0.000	-1,000	0,317
Galerida cristata	protected	within 100 metres	0,027	0.055	-1,313	0,189
		all the contacts	0,061	0.089	-1,243	0,214
Lullula arborea	protected	within 100 metres	0,058	0.085	-0,982	0,326
		all the contacts	0,191	0.165	-0,179	0,858
Alauda arvensis	huntable	within 100 metres	0,020	0.221	-2,701	**0,007**
		all the contacts	0,089	0.335	-2,152	**0,031**
Anthus pratensis	protected	within 100 metres	0,179	0.078	-1,364	0,173
		all the contacts	0,230	0.127	-1,273	0,203
Motacilla cinerea	protected	within 100 metres	0,001	0.005	-1,089	0,276
		all the contacts	0.001	0.005	-1.089	0.276
Motacilla alba	protected	within 100 metres	0.043	0.090	-2.320	**0.020**
		all the contacts	0.063	0.113	-1.768	0.077
Troglodytes troglodytes	protected	within 100 metres	0.157	0.136	-1.043	0.297
		all the contacts	0.178	0.167	-0.532	0.595
Prunella modularis	protected	within 100 metres	0.066	0.061	-0.020	0.984
		all the contacts	0.101	0.103	-0.078	0.938
Prunella collaris	protected	within 100 metres	0.006	0.002	-0.756	0.450
		all the contacts	0.006	0.002	-0.756	0.450
Erithacus rubecula	protected	within 100 metres	0.593	0.571	-0.411	0.681
		all the contacts	0.778	0.741	-0.148	0.882
Phoenicurus ochruros	protected	within 100 metres	0.021	0.025	-0.480	0.632
		all the contacts	0,024	0.031	-0,556	0,578
Saxicola torquatus	protected	within 100 metres	0,036	0.039	-0,425	0,671
		all the contacts	0,058	0.058	-0,219	0,827
Monticola solitarius	protected	within 100 metres	0,000	0.000		
		all the contacts	0,001	0.000	-1,000	0,317
Turdus torquatus	protected	within 100 metres	0,000	0.001	-1,000	0,317
		all the contacts	0,000	0.001	-1,000	0,317

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
Turdus merula	huntable	within 100 metres	0,560	0.466	-1,549	0,121
		all the contacts	0,898	0.687	-2,522	**0,012**
Turdus pilaris	huntable	within 100 metres	0,187	0.157	-0,814	0,416
		all the contacts	0,219	0.233	-0,917	0,359
Turdus philomelos	huntable	within 100 metres	0.054	0.023	-1.597	0.110
		all the contacts	0.129	0.048	-1.752	0.080
Turdus iliacus	huntable	within 100 metres	0.050	0.039	-0.444	0.657
		all the contacts	0.080	0.064	-0.635	0.526
Turdus viscivorus	protected	within 100 metres	0.089	0.103	-0.699	0.485
		all the contacts	0.162	0.154	-0.483	0.629
Cettia cetti	protected	within 100 metres	0.011	0.004	-1.897	0.058
		all the contacts	0.017	0.009	-1.178	0.239
Cisticola juncidis	protected	within 100 metres	0.006	0.005	-0.333	0.739
		all the contacts	0.006	0.007	-0.322	0.748
Sylvia atricapilla	protected	within 100 metres	0.137	0.164	-0.666	0.505
		all the contacts	0.206	0.259	-1.264	0.206
Sylvia undata	protected	within 100 metres	0,006	0.000	-1,342	0,180
		all the contacts	0.007	0.000	-1.342	0.180
Sylvia melanocephala	protected	within 100 metres	0.112	0.082	-1.481	0.139
		all the contacts	0.201	0.120	-2.366	**0.018**
Phylloscopus collybita	protected	within 100 metres	0.017	0.010	-1.225	0.221
		all the contacts	0.027	0.011	-2.148	**0.032**
Regulus regulus	protected	within 100 metres	0.078	0.050	-1.892	0.059
		all the contacts	0.107	0.082	-1.573	0.116
Regulus ignicapilla	protected	within 100 metres	0.024	0.010	-1.839	0.066
		all the contacts	0.024	0.010	-1.839	0.066
Aegithalos caudatus	protected	within 100 metres	0.540	0.517	-0.269	0.788
		all the contacts	0..586	0.663	-1.068	0.285
Cyanistes caeruleus	protected	within 100 metres	0.443	0.473	-0.283	0.777
		all the contacts	0.591	0.647	-0.909	0.363
Parus major	protected	within 100 metres	0.367	0.285	-1.834	0.067
		all the contacts	0.518	0.453	-1.202	0.229
Periparus ater	protected	within 100 metres	0.258	0.057	-4.301	**0.000**
		all the contacts	0.311	0.071	-4.414	**0.000**
Poecile palustris	protected	within 100 metres	0.101	0.116	-0.221	0.825
		all the contacts	0.116	0.150	-0.454	0.650
Sitta europea	protected	within 100 metres	0.129	0.108	-0.242	0.809
		all the contacts	0.198	0.190	-0.176	0.860
Certhia brachydactyla	protected	within 100 metres	0.048	0.029	-1.422	0.155
		all the contacts	0.057	0.039	-1.631	0.103
Lanius excubitor	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
Garrulus glandarius	huntable	within 100 metres	0.539	0.407	-2.563	**0.010**
		all the contacts	0.975	0.786	-2.382	**0.017**
Pica pica	huntable	within 100 metres	0.126	0.108	-0.393	0.695
		all the contacts	0.355	0.303	-0.907	0.365
Pyrrhocorax pyrrhocorax	protected	within 100 metres	0.019	0.000	-1.633	0.102
		all the contacts	0.368	0.000	-1.826	0.068

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Corvus monedula	protected	within 100 metres	0.107	0.099	-0.246	0.805
		all the contacts	0.637	0.532	-1.130	0.259
Corvus cornix	huntable	within 100 metres	0.526	0.462	-0.237	0.813
		all the contacts	3.211	2.177	-2.683	**0.007**
Sturnus vulgaris	huntable *	within 100 metres	0.815	0.355	-0.182	0.856
		all the contacts	1.928	1.353	-0.647	0.518
Passer domesticus	huntable *	within 100 metres	0.569	1.169	-1.825	0.068
		all the contacts	1.202	2.232	-2.076	**0.038**
Passer montanus	protected	within 100 metres	0.275	0.421	-1.106	0.269
		all the contacts	0.468	0.477	-0.262	0.793
Petronia petronia	protected	within 100 metres	0.000	0.000		
		all the contacts	0.012	0.000	-1.000	0.317
Montifringilla nivalis	protected	within 100 metres	0.000	0.000		
		all the contacts	0.073	0.000	-1.000	0.317
Fringilla coelebs	huntable *	within 100 metres	2.233	2.206	-0.957	0.338
		all the contacts	4.823	3.903	-1.213	0.225
Serinus serinus	protected	within 100 metres	0.121	0.087	-0.351	0.726
		all the contacts	0.179	0.381	-0.097	0.922
Carduelis chloris	protected	within 100 metres	0.157	0.103	-0.336	0.737
		all the contacts	0.194	0.133	-0.164	0.870
Carduelis carduelis	protected	within 100 metres	1.192	1.117	-1.580	0.114
		all the contacts	2.136	1.920	-1.791	0.073
Carduelis spinus	protected	within 100 metres	0.096	0.057	-0.257	0.797
		all the contacts	0.112	0.069	-0.277	0.782
Carduelis cannabina	protected	within 100 metres	0.147	0.064	-1.055	0.291
		all the contacts	0.557	0.151	-0.766	0.444
Loxia curvirostra	protected	within 100 metres	0.004	0.007	-0.378	0.705
		all the contacts	0.004	0.007	-0.378	0.705
Pyrrhula pyrrhula	protected	within 100 metres	0.022	0.026	-0.412	0.680
		all the contacts	0.027	0.041	-0.373	0.709
Coccothraustes coccothraustes	protected	within 100 metres	0.023	0.067	-0.168	0.867
		all the contacts	0.031	0.069	-0.076	0.940
Emberiza citrinella	protected	within 100 metres	0.004	0.000	-1.342	0.180
		all the contacts	0.102	0.000	-1.604	0.109
Emberiza cirlus	protected	within 100 metres	0.093	0.146	-0.058	0.954
		all the contacts	0.295	0.214	-0.574	0.566
Emberiza cia	protected	within 100 metres	0,006	0.002	-0,962	0,336
		all the contacts	0,006	0.002	-0,962	0,336
Emberiza schoeniclus	protected	within 100 metres	0,005	0.006	-0,816	0,414
		all the contacts	0,010	0.020	-0,368	0,713
Emberiza calandra	protected	within 100 metres	0,017	0.089	-0,676	0,499
		all the contacts	0,034	0.096	-0,159	0,873

Table 6. Species recorded in spring and comparison of their abundance values between protected and non-protected stations (in bold type the significant differences). Not all species breed in the study area. In the "status" column the asterisk shows the species hunted in Umbria in derogation of the dispositions of Directive 2009/147/CE.

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
Anas platyrhynchos	huntable	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.023	0.015	-0.681	0.496
Alectoris graeca	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.003	-1.000	0.317
Alectoris rufa	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.006	0.000	-1.342	0.180
Perdix perdix	huntable	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.002	0.001	-0.577	0.564
Coturnix coturnix	huntable	within 100 metres	0.051	0.040	-0.393	0.694
		all the contacts	0.083	0.092	-0.060	0.952
Phasianus colchicus	huntable	within 100 metres	0.124	0.030	-3.865	**0.000**
		all the contacts	0.748	0.185	-5.212	**0.000**
Phalacrocorax carbo	huntable *	within 100 metres	0.000	0.000		
		all the contacts	0.004	0.000	-1.000	0.317
Nycticorax nycticorax	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.002	-1.000	0.317
Bubulcus ibis	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.004	0.000	-1.000	0.317
Egretta garzetta	protected	within 100 metres	0.000	0.000		
		all the contacts	0.002	0.002	0.000	1.000
Ardea cinerea	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.002	-1.414	0.157
Ardea purpurea	protected	within 100 metres	0.000	0.000		
		all the contacts	0.011	0.000	-1.604	0.109
Tachybaptus ruficollis	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
Podiceps cristatus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.023	0.000	-1.000	0.317
Pernis apivorus	protected	within 100 metres	0.002	0.006	-0.707	0.480
		all the contacts	0.010	0.010	-0.243	0.808
Milvus migrans	protected	within 100 metres	0.000	0.000		
		all the contacts	0.004	0.000	-1.000	0.317
Milvus milvus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.002	0.000	-1.000	0.317
Circaetus gallicus	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.002	0.001	-0.447	0.655
Circus aeruginosus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.001	-1.000	0.317
Circus pygargus	protected	within 100 metres	0.003	0.000	-1.342	0.180
		all the contacts	0.004	0.002	-0.707	0.480
Accipiter gentilis	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.002	0.000	-1.414	0.157
Accipiter nisus	protected	within 100 metres	0.002	0.004	-0.447	0.655
		all the contacts	0.004	0.006	-0.905	0.366

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Buteo buteo	protected	within 100 metres	0.014	0.027	-1.229	0.219
		all the contacts	0.074	0.081	-0.265	0.791
Aquila pomarina	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.000		
Pandion haliaetus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
Falco naumanni	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.004	-1.000	0.317
Falco tinnunculus	protected	within 100 metres	0.009	0.016	-1.153	0.249
		all the contacts	0.047	0.054	-0.090	0.928
Falco subbuteo	protected	within 100 metres	0.001	0.001	0.000	1.000
		all the contacts	0.001	0.006	-1.414	0.157
Gallinula chloropus	huntable	within 100 metres	0.001	0.001	0.000	1.000
		all the contacts	0.005	0.001	-1.134	0.257
Fulica atra	huntable	within 100 metres	0.000	0.000		
		all the contacts	0.200	0.000	-1.000	0.317
Himantopus himantopus	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.005	-1.000	0.317
Larus michahellis	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.069	0.168	-0.105	0.916
Columba palumbus	huntable	within 100 metres	0.128	0.084	-1.983	**0.047**
		all the contacts	0.433	0.335	-2.389	**0.017**
Streptopelia decaocto	protected	within 100 metres	0.014	0.033	-1.880	0.060
		all the contacts	0.075	0.121	-1.143	0.253
Streptopelia turtur	huntable	within 100 metres	0.338	0.316	-0.448	0.655
		all the contacts	0.755	0.682	-0.578	0.563
Cuculus canorus	protected	within 100 metres	0.085	0.065	-1.497	0.134
		all the contacts	0.709	0.830	-1.117	0.264
Otus scops	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.002	0.000	-1.414	0.157
Athene noctua	protected	within 100 metres	0.006	0.007	-0.175	0.861
		all the contacts	0.010	0.012	-0.368	0.713
Strix aluco	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.005	0.002	-0.816	0.414
Asio otus	protected	within 100 metres	0.003	0.000	-1.000	0.317
		all the contacts	0.003	0.000	-1.000	0.317
Caprimulgus europaeus	protected	within 100 metres	0.004	0.001	-1.134	0.257
		all the contacts	0.006	0.002	-1.265	0.206
Apus apus	protected	within 100 metres	0.816	0.405	-2.389	**0.017**
		all the contacts	2.929	1.318	-2.706	**0.007**
Alcedo atthis	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
Merops apiaster	protected	within 100 metres	0.000	0.004	-1.000	0.317
		all the contacts	0.004	0.005	0.000	1.000
Upupa epops	protected	within 100 metres	0.044	0.038	-0.578	0.563
		all the contacts	0.178	0.202	-0.150	0.881
Jynx torquilla	protected	within 100 metres	0.007	0.011	-0.905	0.366
		all the contacts	0.026	0.032	-0.681	0.496

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Picus viridis	protected	within 100 metres	0.056	0.052	-0.660	0.509
		all the contacts	0.273	0.282	-0.032	0.974
Dendrocopos major	protected	within 100 metres	0.044	0.032	-0.797	0.426
		all the contacts	0.061	0.049	-0.598	0.550
Calandrella brachydactyla	protected	within 100 metres	0.000	0.002	-1.000	0.317
		all the contacts	0.000	0.006	-1.342	0.180
Galerida cristata	protected	within 100 metres	0.040	0.017	-1.026	0.305
		all the contacts	0.092	0.051	-1.864	0.062
Lullula arborea	protected	within 100 metres	0.083	0.110	-0.971	0.331
		all the contacts	0.275	0.344	-0.738	0.461
Alauda arvensis	huntable	within 100 metres	0.340	0.203	-1.972	**0.049**
		all the contacts	0.512	0.393	-1.469	0.142
Riparia riparia	protected	within 100 metres	0.000	0.002	-1.000	0.317
		all the contacts	0.000	0.002	-1.000	0.317
Hirundo rustica	protected	within 100 metres	0.523	0.667	-2.335	**0.020**
		all the contacts	0.790	1.012	-1.926	0.054
Delichon urbicum	protected	within 100 metres	0.264	0.450	-0.741	0.458
		all the contacts	0.576	0.882	-0.209	0.834
Anthus campestris	protected	within 100 metres	0.036	0.030	-0.158	0.874
		all the contacts	0.039	0.041	-0.434	0.665
Anthus trivialis	protected	within 100 metres	0.011	0.019	-0.676	0.499
		all the contacts	0.014	0.028	-0.888	0.375
Anthus spinoletta	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
Motacilla flava	protected	within 100 metres	0.004	0.030	-2.057	**0.040**
		all the contacts	0.004	0.037	-2.157	**0.031**
Motacilla cinerea	protected	within 100 metres	0.013	0.000	-1.841	0.066
		all the contacts	0.015	0.000	-1.826	0.068
Motacilla alba	protected	within 100 metres	0.065	0.062	-0.171	0.864
		all the contacts	0.074	0.083	-0.303	0.762
Troglodytes troglodytes	protected	within 100 metres	0.312	0.292	-0.544	0.586
		all the contacts	0.462	0.533	-0.249	0.804
Erithacus rubecula	protected	within 100 metres	0.695	0.833	-2.054	**0.040**
		all the contacts	0.855	1.362	-2.533	**0.011**
Luscinia megarhynchos	protected	within 100 metres	0.132	0.153	-0.384	0.701
		all the contacts	0.416	0.454	-0.595	0.552
Phoenicurus ochruros	protected	within 100 metres	0.024	0.006	-1.676	0.094
		all the contacts	0.026	0.010	-1.276	0.202
Phoenicurus phoenicurus	protected	within 100 metres	0.011	0.012	-0.136	0.891
		all the contacts	0.017	0.012	-0.464	0.643
Saxicola rubetra	protected	within 100 metres	0.001	0.003	-0.816	0.414
		all the contacts	0.001	0.004	-1.134	0.257
Saxicola torquatus	protected	within 100 metres	0.117	0.085	-1.194	0.233
		all the contacts	0.175	0.138	-1.150	0.250
Oenanthe oenanthe	protected	within 100 metres	0.052	0.043	-1.073	0.283
		all the contacts	0.073	0.075	-0.236	0.814
Monticola saxatilis	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.002	0.000	-1.414	0.157

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Monticola solitarius	protected	within 100 metres	0.001	0.004	-0.447	0.655
		all the contacts	0.001	0.005	-0.447	0.655
Turdus merula	huntable	within 100 metres	0.830	0.740	-1.268	0.205
		all the contacts	1.760	1.913	-1.143	0.253
Turdus philomelos	huntable	within 100 metres	0.027	0.010	-1.891	0.059
		all the contacts	0.038	0.017	-1.517	0.129
Turdus viscivorus	protected	within 100 metres	0.034	0.029	-0.969	0.333
		all the contacts	0.078	0.053	-0.783	0.433
Cettia cetti	protected	within 100 metres	0.024	0.021	-0.316	0.752
		all the contacts	0.054	0.063	-0.534	0.593
Cisticola juncidis	protected	within 100 metres	0.094	0.057	-1.634	0.102
		all the contacts	0.151	0.092	-2.186	**0.029**
Acrocephalus scirpaceus	protected	within 100 metres	0.011	0.000	-1.342	0.180
		all the contacts	0.011	0.000	-1.342	0.180
Acrocephalus arundinaceus	protected	within 100 metres	0.004	0.000	-1.000	0.317
		all the contacts	0.010	0.000	-1.604	0.109
Hippolais polyglotta	protected	within 100 metres	0.044	0.022	-1.911	0.056
		all the contacts	0.053	0.029	-1.784	0.074
Sylvia atricapilla	protected	within 100 metres	1.023	1.032	-0.146	0.884
		all the contacts	1.641	2.082	-2.752	**0.006**
Sylvia communis	protected	within 100 metres	0.022	0.051	-1.130	0.258
		all the contacts	0.030	0.060	-1.071	0.284
Sylvia undata	protected	within 100 metres	0.001	0.006	-0.447	0.655
		all the contacts	0.001	0.006	-0.447	0.655
Sylvia cantillans	protected	within 100 metres	0.119	0.130	-0.164	0.870
		all the contacts	0.144	0.155	-0.130	0.896
Sylvia melanocephala	protected	within 100 metres	0.059	0.062	-0.365	0.715
		all the contacts	0.106	0.086	-0.636	0.525
Phylloscopus bonelli	protected	within 100 metres	0.268	0.245	-0.193	0.847
		all the contacts	0.288	0.356	-0.724	0.469
Phylloscopus sibilatrix	protected	within 100 metres	0.000	0.002	-1.414	0.157
		all the contacts	0.000	0.004	-1.342	0.180
Phylloscopus collybita	protected	within 100 metres	0.302	0.327	-0.578	0.563
		all the contacts	0.487	0.696	-2.062	**0.039**
Regulus ignicapilla	protected	within 100 metres	0.074	0.052	-0.897	0.370
		all the contacts	0.077	0.052	-0.969	0.333
Muscicapa striata	protected	within 100 metres	0.004	0.009	-0.811	0.417
		all the contacts	0.004	0.010	-1.026	0.305
Ficedula hypoleuca	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
Aegithalos caudatus	protected	within 100 metres	0.220	0.269	-0.437	0.662
		all the contacts	0.251	0.314	-0.532	0.595
Cyanistes caeruleus	protected	within 100 metres	0.309	0.392	-1.821	0.069
		all the contacts	0.389	0.495	-1.622	0.105
Parus major	protected	within 100 metres	0.315	0.271	-1.104	0.270
		all the contacts	0.547	0.506	-0.841	0.400
Periparus ater	protected	within 100 metres	0.155	0.046	-3.284	**0.001**
		all the contacts	0.184	0.071	-2.894	**0.004**

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Poecile palustris	protected	within 100 metres	0.040	0.094	-2.322	**0.020**
		all the contacts	0.040	0.111	-2.589	**0.010**
Sitta europea	protected	within 100 metres	0.056	0.074	-0.959	0.338
		all the contacts	0.076	0.120	-1.379	0.168
Certhia brachydactyla	protected	within 100 metres	0.052	0.039	-0.948	0.343
		all the contacts	0.065	0.052	-0.449	0.654
Remiz pendulinus	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.002	-1.414	0.157
Oriolus oriolus	protected	within 100 metres	0.066	0.058	-0.112	0.911
		all the contacts	0.248	0.272	-0.479	0.632
Lanius collurio	protected	within 100 metres	0.058	0.071	-0.783	0.434
		all the contacts	0.091	0.127	-1.196	0.232
Lanius senator	protected	within 100 metres	0.001	0.001	-0.447	0.655
		all the contacts	0.001	0.001	-0.447	0.655
Garrulus glandarius	huntable	within 100 metres	0.242	0.224	-1.011	0.312
		all the contacts	0.363	0.417	-0.760	0.447
Pica pica	huntable	within 100 metres	0.085	0.076	-0.903	0.366
		all the contacts	0.202	0.168	-0.814	0.416
Pyrrhocorax pyrrhocorax	protected	within 100 metres	0.000	0.000		
		all the contacts	0.012	0.000	-1.000	0.317
Corvus monedula	protected	within 100 metres	0.093	0.015	-2.404	**0.016**
		all the contacts	0.259	0.129	-2.787	**0.005**
Corvus cornix	huntable	within 100 metres	0.466	0.422	-0.559	0.576
		all the contacts	1.847	1.519	-0.795	0.426
Corvus corax	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.001	-1.000	0.317
Sturnus vulgaris	huntable *	within 100 metres	0.509	0.840	-1.483	0.138
		all the contacts	0.973	1.390	-1.204	0.229
Passer domesticus	huntable *	within 100 metres	0.925	1.414	-1.642	0.101
		all the contacts	1.189	1.832	-1.427	0.153
Passer montanus	protected	within 100 metres	0.186	0.452	-1.404	0.160
		all the contacts	0.209	0.516	-1.402	0.161
Fringilla coelebs	huntable *	within 100 metres	0.787	0.557	-3.390	**0.001**
		all the contacts	1.365	1.314	-0.649	0.516
Serinus serinus	protected	within 100 metres	0.469	0.444	-0.404	0.686
		all the contacts	0.618	0.619	-0.023	0.981
Carduelis chloris	protected	within 100 metres	0.145	0.156	-0.244	0.807
		all the contacts	0.345	0.408	-1.418	0.156
Carduelis carduelis	protected	within 100 metres	0.651	0.855	-1.222	0.222
		all the contacts	0.803	1.099	-1.838	0.066
Carduelis cannabina	protected	within 100 metres	0.203	0.257	-0.281	0.779
		all the contacts	0.215	0.302	-0.948	0.343
Pyrrhula pyrrhula	protected	within 100 metres	0.006	0.011	-0.884	0.377
		all the contacts	0.009	0.018	-1.253	0.210
Emberiza citrinella	protected	within 100 metres	0.009	0.015	0.000	1.000
		all the contacts	0.012	0.034	-0.960	0.337
Emberiza cirlus	protected	within 100 metres	0.292	0.269	-0.541	0.588
		all the contacts	0.622	0.516	-1.259	0.208

continued

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	**NP**	**Z**	**P** (2-tailed)
Emberiza cia	protected	within 100 metres	0.034	0.017	-1.617	0.106
		all the contacts	0.038	0.024	-1.183	0.237
Emberiza hortulana	protected	within 100 metres	0.017	0.011	-0.632	0.527
		all the contacts	0.021	0.012	-1.065	0.287
Emberiza calandra	protected	within 100 metres	0.247	0.148	-2.610	**0.009**
		all the contacts	0.300	0.254	-1.330	0.184

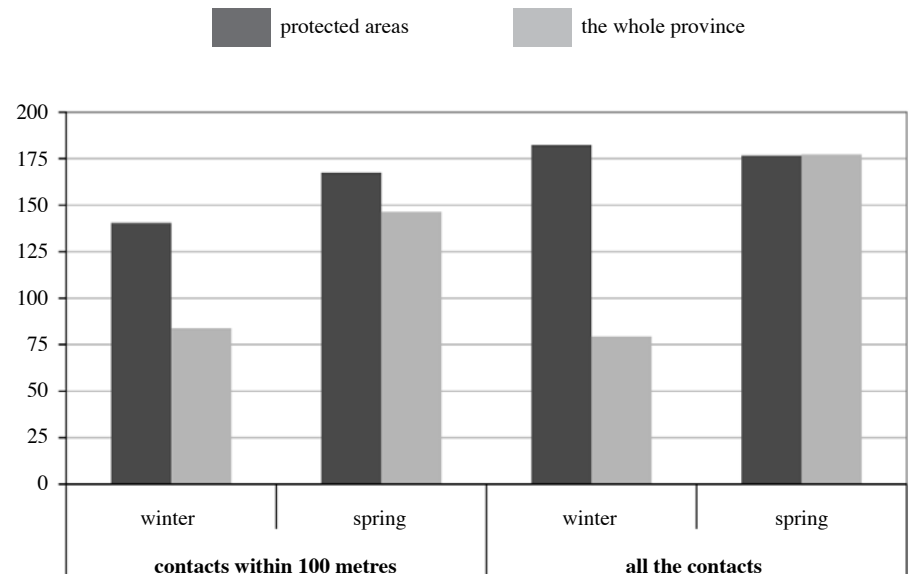

Figure 2. Seasonal values of the rarity index within protected and non-protected stations.

Acknowledgements – The present analysis has been undertaken in the context of the activities aimed at the drafting of the Wildlife Management Plan (Piano Faunistico Venatorio) of the Province of Perugia. Besides the author, took part in the field surveys: Enrico Cordiner, Laura Cucchia, Angela Gaggi, Daniele Iavicoli, Sara Marini, Alberto Masci, Monica Montefameglio, Andrea Maria Paci, Roberto Papi, Francesco Renzini. Giuseppina Lombardi and Umberto Sergiacomi (Osservatorio Faunistico della Regione Umbria) contributed to the database set up and to the GIS analysis.

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Associate editor: ***Bruno Massa***