

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 sub-

ject 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-

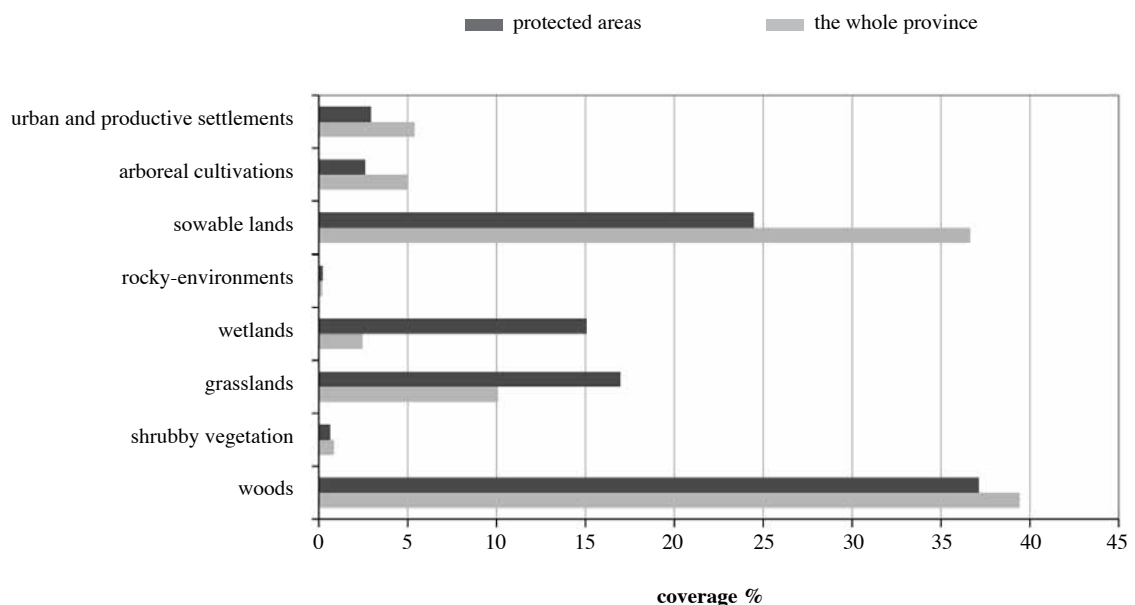


Figure 1. Land use in the whole province of Perugia and in the protected areas.

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, so-wable lands, arboreal cultivations, urban and productive settlements.

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

$$x_{\text{stand}} = (x_{\text{obs}} - \text{mean})/\text{STD}$$

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

continued

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

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
<i>Scolopax rusticola</i>	hunnable	within 100 metres	0.001	0.002	-0.447	0.655
		all the contacts	0.001	0.002	-0.447	0.655
<i>Chroicocephalus ridibundus</i>	protected	within 100 metres	0.005	0.024	-0.707	0.480
		all the contacts	0.198	0.055	-0.943	0.345
<i>Larus michahellis</i>	protected	within 100 metres	0.004	0.106	-1.121	0.262
		all the contacts	0.117	1.914	-1.493	0.135
<i>Columba palumbus</i>	hunnable	within 100 metres	0.072	0.008	-2.256	0.024
		all the contacts	0.988	0.025	-3.398	0.001
<i>Streptopelia decaocto</i>	protected	within 100 metres	0.006	0.038	-1.913	0.056
		all the contacts	0.031	0.091	-1.888	0.059
<i>Athene noctua</i>	protected	within 100 metres	0.000	0.004	-1.732	0.083
		all the contacts	0.001	0.005	-1.342	0.180
<i>Strix aluco</i>	protected	within 100 metres	0.010	0.001	-1.289	0.197
		all the contacts	0.010	0.002	-0.962	0.336
<i>Picus viridis</i>	protected	within 100 metres	0.057	0.065	-0.203	0.839
		all the contacts	0.255	0.220	-1.071	0.284
<i>Dendrocopos major</i>	protected	within 100 metres	0.060	0.041	-1.337	0.181
		all the contacts	0.078	0.058	-0.931	0.352
<i>Dendrocopos minor</i>	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.001	0.000	-1.000	0.317
<i>Galerida cristata</i>	protected	within 100 metres	0.027	0.055	-1.313	0.189
		all the contacts	0.061	0.089	-1.243	0.214
<i>Lullula arborea</i>	protected	within 100 metres	0.058	0.085	-0.982	0.326
		all the contacts	0.191	0.165	-0.179	0.858
<i>Alauda arvensis</i>	hunnable	within 100 metres	0.020	0.221	-2.701	0.007
		all the contacts	0.089	0.335	-2.152	0.031
<i>Anthus pratensis</i>	protected	within 100 metres	0.179	0.078	-1.364	0.173
		all the contacts	0.230	0.127	-1.273	0.203
<i>Motacilla cinerea</i>	protected	within 100 metres	0.001	0.005	-1.089	0.276
		all the contacts	0.001	0.005	-1.089	0.276
<i>Motacilla alba</i>	protected	within 100 metres	0.043	0.090	-2.320	0.020
		all the contacts	0.063	0.113	-1.768	0.077
<i>Troglodytes troglodytes</i>	protected	within 100 metres	0.157	0.136	-1.043	0.297
		all the contacts	0.178	0.167	-0.532	0.595
<i>Prunella modularis</i>	protected	within 100 metres	0.066	0.061	-0.020	0.984
		all the contacts	0.101	0.103	-0.078	0.938
<i>Prunella collaris</i>	protected	within 100 metres	0.006	0.002	-0.756	0.450
		all the contacts	0.006	0.002	-0.756	0.450
<i>Erithacus rubecula</i>	protected	within 100 metres	0.593	0.571	-0.411	0.681
		all the contacts	0.778	0.741	-0.148	0.882
<i>Phoenicurus ochruros</i>	protected	within 100 metres	0.021	0.025	-0.480	0.632
		all the contacts	0.024	0.031	-0.556	0.578
<i>Saxicola torquatus</i>	protected	within 100 metres	0.036	0.039	-0.425	0.671
		all the contacts	0.058	0.058	-0.219	0.827
<i>Monticola solitarius</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
<i>Turdus torquatus</i>	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)
<i>Turdus merula</i>	hunnable	within 100 metres	0,560	0.466	-1,549	0,121
		all the contacts	0,898	0.687	-2,522	0,012
<i>Turdus pilaris</i>	hunnable	within 100 metres	0,187	0.157	-0,814	0,416
		all the contacts	0,219	0.233	-0,917	0,359
<i>Turdus philomelos</i>	hunnable	within 100 metres	0.054	0.023	-1,597	0.110
		all the contacts	0.129	0.048	-1,752	0.080
<i>Turdus iliacus</i>	hunnable	within 100 metres	0.050	0.039	-0,444	0.657
		all the contacts	0.080	0.064	-0,635	0.526
<i>Turdus viscivorus</i>	protected	within 100 metres	0.089	0.103	-0,699	0.485
		all the contacts	0.162	0.154	-0,483	0.629
<i>Cettia cetti</i>	protected	within 100 metres	0.011	0.004	-1,897	0.058
		all the contacts	0.017	0.009	-1,178	0.239
<i>Cisticola juncidis</i>	protected	within 100 metres	0.006	0.005	-0,333	0.739
		all the contacts	0.006	0.007	-0,322	0.748
<i>Sylvia atricapilla</i>	protected	within 100 metres	0.137	0.164	-0,666	0.505
		all the contacts	0.206	0.259	-1,264	0.206
<i>Sylvia undata</i>	protected	within 100 metres	0,006	0.000	-1,342	0,180
		all the contacts	0,007	0.000	-1,342	0,180
<i>Sylvia melanocephala</i>	protected	within 100 metres	0.112	0.082	-1,481	0.139
		all the contacts	0.201	0.120	-2,366	0,018
<i>Phylloscopus collybita</i>	protected	within 100 metres	0.017	0.010	-1,225	0.221
		all the contacts	0.027	0.011	-2,148	0,032
<i>Regulus regulus</i>	protected	within 100 metres	0.078	0.050	-1,892	0.059
		all the contacts	0.107	0.082	-1,573	0.116
<i>Regulus ignicapilla</i>	protected	within 100 metres	0.024	0.010	-1,839	0.066
		all the contacts	0.024	0.010	-1,839	0.066
<i>Aegithalos caudatus</i>	protected	within 100 metres	0.540	0.517	-0,269	0.788
		all the contacts	0,586	0.663	-1,068	0.285
<i>Cyanistes caeruleus</i>	protected	within 100 metres	0.443	0.473	-0,283	0.777
		all the contacts	0.591	0.647	-0,909	0.363
<i>Parus major</i>	protected	within 100 metres	0.367	0.285	-1,834	0.067
		all the contacts	0.518	0.453	-1,202	0.229
<i>Periparus ater</i>	protected	within 100 metres	0.258	0.057	-4,301	0,000
		all the contacts	0.311	0.071	-4,414	0,000
<i>Poecile palustris</i>	protected	within 100 metres	0.101	0.116	-0,221	0.825
		all the contacts	0.116	0.150	-0,454	0.650
<i>Sitta europea</i>	protected	within 100 metres	0.129	0.108	-0,242	0.809
		all the contacts	0.198	0.190	-0,176	0.860
<i>Certhia brachydactyla</i>	protected	within 100 metres	0.048	0.029	-1,422	0.155
		all the contacts	0.057	0.039	-1,631	0.103
<i>Lanius excubitor</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1,000	0.317
<i>Garrulus glandarius</i>	hunnable	within 100 metres	0.539	0.407	-2,563	0,010
		all the contacts	0.975	0.786	-2,382	0,017
<i>Pica pica</i>	hunnable	within 100 metres	0.126	0.108	-0,393	0.695
		all the contacts	0.355	0.303	-0,907	0.365
<i>Pyrhocorax pyrhocorax</i>	protected	within 100 metres	0.019	0.000	-1,633	0.102
		all the contacts	0.368	0.000	-1,826	0.068

continued

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

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
<i>Corvus monedula</i>	protected	within 100 metres	0.107	0.099	-0.246	0.805
		all the contacts	0.637	0.532	-1.130	0.259
<i>Corvus cornix</i>	hunnable	within 100 metres	0.526	0.462	-0.237	0.813
		all the contacts	3.211	2.177	-2.683	0.007
<i>Sturnus vulgaris</i>	hunnable *	within 100 metres	0.815	0.355	-0.182	0.856
		all the contacts	1.928	1.353	-0.647	0.518
<i>Passer domesticus</i>	hunnable *	within 100 metres	0.569	1.169	-1.825	0.068
		all the contacts	1.202	2.232	-2.076	0.038
<i>Passer montanus</i>	protected	within 100 metres	0.275	0.421	-1.106	0.269
		all the contacts	0.468	0.477	-0.262	0.793
<i>Petronia petronia</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.012	0.000	-1.000	0.317
<i>Montifringilla nivalis</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.073	0.000	-1.000	0.317
<i>Fringilla coelebs</i>	hunnable *	within 100 metres	2.233	2.206	-0.957	0.338
		all the contacts	4.823	3.903	-1.213	0.225
<i>Serinus serinus</i>	protected	within 100 metres	0.121	0.087	-0.351	0.726
		all the contacts	0.179	0.381	-0.097	0.922
<i>Carduelis chloris</i>	protected	within 100 metres	0.157	0.103	-0.336	0.737
		all the contacts	0.194	0.133	-0.164	0.870
<i>Carduelis carduelis</i>	protected	within 100 metres	1.192	1.117	-1.580	0.114
		all the contacts	2.136	1.920	-1.791	0.073
<i>Carduelis spinus</i>	protected	within 100 metres	0.096	0.057	-0.257	0.797
		all the contacts	0.112	0.069	-0.277	0.782
<i>Carduelis cannabina</i>	protected	within 100 metres	0.147	0.064	-1.055	0.291
		all the contacts	0.557	0.151	-0.766	0.444
<i>Loxia curvirostra</i>	protected	within 100 metres	0.004	0.007	-0.378	0.705
		all the contacts	0.004	0.007	-0.378	0.705
<i>Pyrrhula pyrrhula</i>	protected	within 100 metres	0.022	0.026	-0.412	0.680
		all the contacts	0.027	0.041	-0.373	0.709
<i>Coccothraustes coccothraustes</i>	protected	within 100 metres	0.023	0.067	-0.168	0.867
		all the contacts	0.031	0.069	-0.076	0.940
<i>Emberiza citrinella</i>	protected	within 100 metres	0.004	0.000	-1.342	0.180
		all the contacts	0.102	0.000	-1.604	0.109
<i>Emberiza cirulus</i>	protected	within 100 metres	0.093	0.146	-0.058	0.954
		all the contacts	0.295	0.214	-0.574	0.566
<i>Emberiza cia</i>	protected	within 100 metres	0,006	0.002	-0.962	0,336
		all the contacts	0,006	0.002	-0.962	0,336
<i>Emberiza schoeniclus</i>	protected	within 100 metres	0,005	0.006	-0.816	0,414
		all the contacts	0,010	0.020	-0.368	0,713
<i>Emberiza calandra</i>	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.

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

continued

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

species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
<i>Buteo buteo</i>	protected	within 100 metres	0.014	0.027	-1.229	0.219
		all the contacts	0.074	0.081	-0.265	0.791
<i>Aquila pomarina</i>	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.000		
<i>Pandion haliaetus</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.001	0.000	-1.000	0.317
<i>Falco naumanni</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.004	-1.000	0.317
<i>Falco tinnunculus</i>	protected	within 100 metres	0.009	0.016	-1.153	0.249
		all the contacts	0.047	0.054	-0.090	0.928
<i>Falco subbuteo</i>	protected	within 100 metres	0.001	0.001	0.000	1.000
		all the contacts	0.001	0.006	-1.414	0.157
<i>Gallinula chloropus</i>	hunnable	within 100 metres	0.001	0.001	0.000	1.000
		all the contacts	0.005	0.001	-1.134	0.257
<i>Fulica atra</i>	hunnable	within 100 metres	0.000	0.000		
		all the contacts	0.200	0.000	-1.000	0.317
<i>Himantopus himantopus</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.005	-1.000	0.317
<i>Larus michahellis</i>	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.069	0.168	-0.105	0.916
<i>Columba palumbus</i>	hunnable	within 100 metres	0.128	0.084	-1.983	0.047
		all the contacts	0.433	0.335	-2.389	0.017
<i>Streptopelia decaocto</i>	protected	within 100 metres	0.014	0.033	-1.880	0.060
		all the contacts	0.075	0.121	-1.143	0.253
<i>Streptopelia turtur</i>	hunnable	within 100 metres	0.338	0.316	-0.448	0.655
		all the contacts	0.755	0.682	-0.578	0.563
<i>Cuculus canorus</i>	protected	within 100 metres	0.085	0.065	-1.497	0.134
		all the contacts	0.709	0.830	-1.117	0.264
<i>Otus scops</i>	protected	within 100 metres	0.001	0.000	-1.000	0.317
		all the contacts	0.002	0.000	-1.414	0.157
<i>Athene noctua</i>	protected	within 100 metres	0.006	0.007	-0.175	0.861
		all the contacts	0.010	0.012	-0.368	0.713
<i>Strix aluco</i>	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.005	0.002	-0.816	0.414
<i>Asio otus</i>	protected	within 100 metres	0.003	0.000	-1.000	0.317
		all the contacts	0.003	0.000	-1.000	0.317
<i>Caprimulgus europaeus</i>	protected	within 100 metres	0.004	0.001	-1.134	0.257
		all the contacts	0.006	0.002	-1.265	0.206
<i>Apus apus</i>	protected	within 100 metres	0.816	0.405	-2.389	0.017
		all the contacts	2.929	1.318	-2.706	0.007
<i>Alcedo atthis</i>	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
<i>Merops apiaster</i>	protected	within 100 metres	0.000	0.004	-1.000	0.317
		all the contacts	0.004	0.005	0.000	1.000
<i>Upupa epops</i>	protected	within 100 metres	0.044	0.038	-0.578	0.563
		all the contacts	0.178	0.202	-0.150	0.881
<i>Jynx torquilla</i>	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)
<i>Picus viridis</i>	protected	within 100 metres	0.056	0.052	-0.660	0.509
		all the contacts	0.273	0.282	-0.032	0.974
<i>Dendrocopos major</i>	protected	within 100 metres	0.044	0.032	-0.797	0.426
		all the contacts	0.061	0.049	-0.598	0.550
<i>Calandrella brachydactyla</i>	protected	within 100 metres	0.000	0.002	-1.000	0.317
		all the contacts	0.000	0.006	-1.342	0.180
<i>Galerida cristata</i>	protected	within 100 metres	0.040	0.017	-1.026	0.305
		all the contacts	0.092	0.051	-1.864	0.062
<i>Lullula arborea</i>	protected	within 100 metres	0.083	0.110	-0.971	0.331
		all the contacts	0.275	0.344	-0.738	0.461
<i>Alauda arvensis</i>	hunnable	within 100 metres	0.340	0.203	-1.972	0.049
		all the contacts	0.512	0.393	-1.469	0.142
<i>Riparia riparia</i>	protected	within 100 metres	0.000	0.002	-1.000	0.317
		all the contacts	0.000	0.002	-1.000	0.317
<i>Hirundo rustica</i>	protected	within 100 metres	0.523	0.667	-2.335	0.020
		all the contacts	0.790	1.012	-1.926	0.054
<i>Delichon urbicum</i>	protected	within 100 metres	0.264	0.450	-0.741	0.458
		all the contacts	0.576	0.882	-0.209	0.834
<i>Anthus campestris</i>	protected	within 100 metres	0.036	0.030	-0.158	0.874
		all the contacts	0.039	0.041	-0.434	0.665
<i>Anthus trivialis</i>	protected	within 100 metres	0.011	0.019	-0.676	0.499
		all the contacts	0.014	0.028	-0.888	0.375
<i>Anthus spinoletta</i>	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
<i>Motacilla flava</i>	protected	within 100 metres	0.004	0.030	-2.057	0.040
		all the contacts	0.004	0.037	-2.157	0.031
<i>Motacilla cinerea</i>	protected	within 100 metres	0.013	0.000	-1.841	0.066
		all the contacts	0.015	0.000	-1.826	0.068
<i>Motacilla alba</i>	protected	within 100 metres	0.065	0.062	-0.171	0.864
		all the contacts	0.074	0.083	-0.303	0.762
<i>Troglodytes troglodytes</i>	protected	within 100 metres	0.312	0.292	-0.544	0.586
		all the contacts	0.462	0.533	-0.249	0.804
<i>Erithacus rubecula</i>	protected	within 100 metres	0.695	0.833	-2.054	0.040
		all the contacts	0.855	1.362	-2.533	0.011
<i>Luscinia megarhynchos</i>	protected	within 100 metres	0.132	0.153	-0.384	0.701
		all the contacts	0.416	0.454	-0.595	0.552
<i>Phoenicurus ochruros</i>	protected	within 100 metres	0.024	0.006	-1.676	0.094
		all the contacts	0.026	0.010	-1.276	0.202
<i>Phoenicurus phoenicurus</i>	protected	within 100 metres	0.011	0.012	-0.136	0.891
		all the contacts	0.017	0.012	-0.464	0.643
<i>Saxicola rubetra</i>	protected	within 100 metres	0.001	0.003	-0.816	0.414
		all the contacts	0.001	0.004	-1.134	0.257
<i>Saxicola torquatus</i>	protected	within 100 metres	0.117	0.085	-1.194	0.233
		all the contacts	0.175	0.138	-1.150	0.250
<i>Oenanthe oenanthe</i>	protected	within 100 metres	0.052	0.043	-1.073	0.283
		all the contacts	0.073	0.075	-0.236	0.814
<i>Monticola saxatilis</i>	protected	within 100 metres	0.002	0.000	-1.414	0.157
		all the contacts	0.002	0.000	-1.414	0.157

continued

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species	status	contacts considered	mean abundance		Wilcoxon's test	
			P	NP	Z	P (2-tailed)
<i>Monticola solitarius</i>	protected	within 100 metres	0.001	0.004	-0.447	0.655
		all the contacts	0.001	0.005	-0.447	0.655
<i>Turdus merula</i>	hunnable	within 100 metres	0.830	0.740	-1.268	0.205
		all the contacts	1.760	1.913	-1.143	0.253
<i>Turdus philomelos</i>	hunnable	within 100 metres	0.027	0.010	-1.891	0.059
		all the contacts	0.038	0.017	-1.517	0.129
<i>Turdus viscivorus</i>	protected	within 100 metres	0.034	0.029	-0.969	0.333
		all the contacts	0.078	0.053	-0.783	0.433
<i>Cettia cetti</i>	protected	within 100 metres	0.024	0.021	-0.316	0.752
		all the contacts	0.054	0.063	-0.534	0.593
<i>Cisticola juncidis</i>	protected	within 100 metres	0.094	0.057	-1.634	0.102
		all the contacts	0.151	0.092	-2.186	0.029
<i>Acrocephalus scirpaceus</i>	protected	within 100 metres	0.011	0.000	-1.342	0.180
		all the contacts	0.011	0.000	-1.342	0.180
<i>Acrocephalus arundinaceus</i>	protected	within 100 metres	0.004	0.000	-1.000	0.317
		all the contacts	0.010	0.000	-1.604	0.109
<i>Hippolais polyglotta</i>	protected	within 100 metres	0.044	0.022	-1.911	0.056
		all the contacts	0.053	0.029	-1.784	0.074
<i>Sylvia atricapilla</i>	protected	within 100 metres	1.023	1.032	-0.146	0.884
		all the contacts	1.641	2.082	-2.752	0.006
<i>Sylvia communis</i>	protected	within 100 metres	0.022	0.051	-1.130	0.258
		all the contacts	0.030	0.060	-1.071	0.284
<i>Sylvia undata</i>	protected	within 100 metres	0.001	0.006	-0.447	0.655
		all the contacts	0.001	0.006	-0.447	0.655
<i>Sylvia cantillans</i>	protected	within 100 metres	0.119	0.130	-0.164	0.870
		all the contacts	0.144	0.155	-0.130	0.896
<i>Sylvia melanocephala</i>	protected	within 100 metres	0.059	0.062	-0.365	0.715
		all the contacts	0.106	0.086	-0.636	0.525
<i>Phylloscopus bonelli</i>	protected	within 100 metres	0.268	0.245	-0.193	0.847
		all the contacts	0.288	0.356	-0.724	0.469
<i>Phylloscopus sibilatrix</i>	protected	within 100 metres	0.000	0.002	-1.414	0.157
		all the contacts	0.000	0.004	-1.342	0.180
<i>Phylloscopus collybita</i>	protected	within 100 metres	0.302	0.327	-0.578	0.563
		all the contacts	0.487	0.696	-2.062	0.039
<i>Regulus ignicapilla</i>	protected	within 100 metres	0.074	0.052	-0.897	0.370
		all the contacts	0.077	0.052	-0.969	0.333
<i>Muscicapa striata</i>	protected	within 100 metres	0.004	0.009	-0.811	0.417
		all the contacts	0.004	0.010	-1.026	0.305
<i>Ficedula hypoleuca</i>	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.001	-1.000	0.317
<i>Aegithalos caudatus</i>	protected	within 100 metres	0.220	0.269	-0.437	0.662
		all the contacts	0.251	0.314	-0.532	0.595
<i>Cyanistes caeruleus</i>	protected	within 100 metres	0.309	0.392	-1.821	0.069
		all the contacts	0.389	0.495	-1.622	0.105
<i>Parus major</i>	protected	within 100 metres	0.315	0.271	-1.104	0.270
		all the contacts	0.547	0.506	-0.841	0.400
<i>Periparus ater</i>	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)
<i>Poecile palustris</i>	protected	within 100 metres	0.040	0.094	-2.322	0.020
		all the contacts	0.040	0.111	-2.589	0.010
<i>Sitta europea</i>	protected	within 100 metres	0.056	0.074	-0.959	0.338
		all the contacts	0.076	0.120	-1.379	0.168
<i>Certhia brachydactyla</i>	protected	within 100 metres	0.052	0.039	-0.948	0.343
		all the contacts	0.065	0.052	-0.449	0.654
<i>Remiz pendulinus</i>	protected	within 100 metres	0.000	0.001	-1.000	0.317
		all the contacts	0.000	0.002	-1.414	0.157
<i>Oriolus oriolus</i>	protected	within 100 metres	0.066	0.058	-0.112	0.911
		all the contacts	0.248	0.272	-0.479	0.632
<i>Lanius collurio</i>	protected	within 100 metres	0.058	0.071	-0.783	0.434
		all the contacts	0.091	0.127	-1.196	0.232
<i>Lanius senator</i>	protected	within 100 metres	0.001	0.001	-0.447	0.655
		all the contacts	0.001	0.001	-0.447	0.655
<i>Garrulus glandarius</i>	hunnable	within 100 metres	0.242	0.224	-1.011	0.312
		all the contacts	0.363	0.417	-0.760	0.447
<i>Pica pica</i>	hunnable	within 100 metres	0.085	0.076	-0.903	0.366
		all the contacts	0.202	0.168	-0.814	0.416
<i>Pyrhocorax pyrrhocorax</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.012	0.000	-1.000	0.317
<i>Corvus monedula</i>	protected	within 100 metres	0.093	0.015	-2.404	0.016
		all the contacts	0.259	0.129	-2.787	0.005
<i>Corvus cornix</i>	hunnable	within 100 metres	0.466	0.422	-0.559	0.576
		all the contacts	1.847	1.519	-0.795	0.426
<i>Corvus corax</i>	protected	within 100 metres	0.000	0.000		
		all the contacts	0.000	0.001	-1.000	0.317
<i>Sturnus vulgaris</i>	hunnable *	within 100 metres	0.509	0.840	-1.483	0.138
		all the contacts	0.973	1.390	-1.204	0.229
<i>Passer domesticus</i>	hunnable *	within 100 metres	0.925	1.414	-1.642	0.101
		all the contacts	1.189	1.832	-1.427	0.153
<i>Passer montanus</i>	protected	within 100 metres	0.186	0.452	-1.404	0.160
		all the contacts	0.209	0.516	-1.402	0.161
<i>Fringilla coelebs</i>	hunnable *	within 100 metres	0.787	0.557	-3.390	0.001
		all the contacts	1.365	1.314	-0.649	0.516
<i>Serinus serinus</i>	protected	within 100 metres	0.469	0.444	-0.404	0.686
		all the contacts	0.618	0.619	-0.023	0.981
<i>Carduelis chloris</i>	protected	within 100 metres	0.145	0.156	-0.244	0.807
		all the contacts	0.345	0.408	-1.418	0.156
<i>Carduelis carduelis</i>	protected	within 100 metres	0.651	0.855	-1.222	0.222
		all the contacts	0.803	1.099	-1.838	0.066
<i>Carduelis cannabina</i>	protected	within 100 metres	0.203	0.257	-0.281	0.779
		all the contacts	0.215	0.302	-0.948	0.343
<i>Pyrhula pyrrhula</i>	protected	within 100 metres	0.006	0.011	-0.884	0.377
		all the contacts	0.009	0.018	-1.253	0.210
<i>Emberiza citrinella</i>	protected	within 100 metres	0.009	0.015	0.000	1.000
		all the contacts	0.012	0.034	-0.960	0.337
<i>Emberiza cirrus</i>	protected	within 100 metres	0.292	0.269	-0.541	0.588
		all the contacts	0.622	0.516	-1.259	0.208

continued

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

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

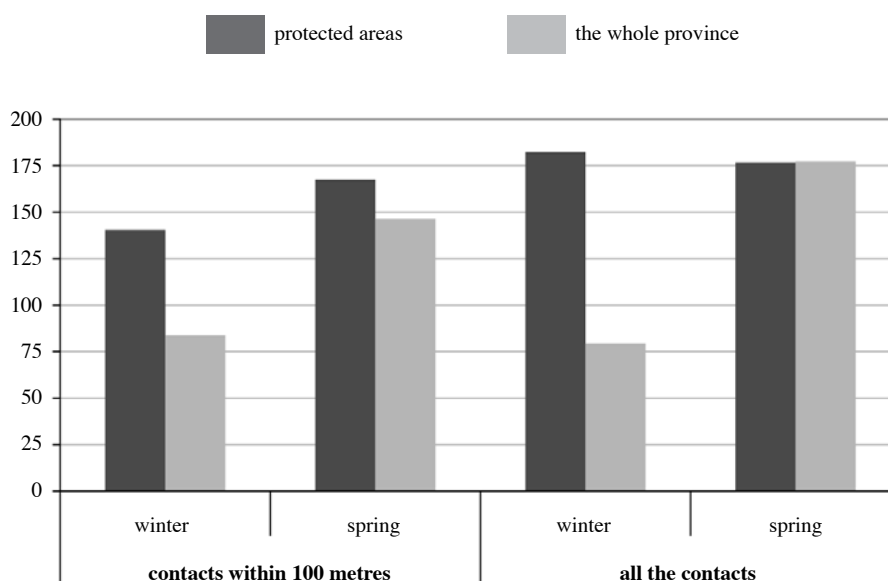


Figure 2. Seasonal values of the rarity index within protected and non-protected stations.

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