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Avian species richness, human population and protected areas across Italy's regions

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SUMMARY

Fundamental to environmental conservation, the spatial location of biodiversity, people and protected areas has been studied for the species richness of various taxa, including plants, invertebrates and birds. However, few avian studies have analysed these three-way interactions for total versus breeding, and for threatened, human-avoiding and human-adapted species. Correlations between bird species richness, human population size and protected areas were studied across Italy's regions, controlling for variations in area, latitude, main land cover and spatial autocorrelation. Whilst total bird species richness increases with increasing human population size, breeding species richness does not vary with human population size. The number of globally threatened bird species is positively correlated with human population size, but this correlation is not significant when controlling for overall region bird species richness. There is no evidence that the increase in total bird species richness with human population size is owing to species typically found in urban habitats, and the proportion of human-avoiding species increases with human population size. For all groups of species, there is a negative correlation of the number of species with the proportion of protected area, indicating that the conservation of Italy's avifauna should be addressed over the entire landscape, and not just in protected areas.

Keywords: biogeography, latitudinal gradient, macroecology, reserve selection, sampling, scale, species-area relationship, species-people coexistence, waste production, Western Palaearctic

INTRODUCTION

Several recent studies have documented a spatial coincidence of people and biodiversity over large regions (for example sub-Saharan Africa, Balmford *et al.* 2001; East Asia, Ding *et al.* 2006; Australia, Luck 2007; the Andes, Fjeldså & Rahbek 1998; the Brazilian Cerrado, Diniz-Filho *et al.* 2006; Mexico, Vazquez & Gaston 2006; and Europe, Araújo 2003). These studies have focused on fungi (Pautasso & Zotti 2009), vascular plants (for example Marini *et al.* 2008), butterflies (for example Luck *et al.* 2004), grasshoppers (Steck & Pautasso 2008), ants (Schlick-Steiner *et al.* 2008), stream macro-invertebrates (Pautasso & Fontaneto 2008), amphibians and reptiles (for example Moreno-Rueda & Pizarro 2007), mammals (for example Real *et al.* 2003; Moreno-Rueda & Pizarro 2009) and birds (for example Hunter & Yonzon 1993; Pidgeon *et al.* 2007).

Human activities often cause species endangerment and biotic homogenization, through processes such as habitat degradation, land-use change, species introductions, environmental pollution and urbanization (Ford *et al.* 2001; Costa *et al.* 2005; You *et al.* 2005; Clergeau *et al.* 2006; Venter *et al.* 2006; Araújo & Rahbek 2007). At a local level, human settlements are often associated with an increased presence of human-adapted species (Blair 1996; McKinney 2006), although patches of semi-natural habitats in urbanized areas may still contain high numbers of other species. Roughly speaking, the more numerous people are in a certain region, the higher their potential impact on that region's biodiversity (McKinney 2001; Brown & Laband 2006; Rondinini *et al.* 2006; Luck 2007). This presupposes that other things are kept equal, most notably environmental awareness (de Groot & Steg 2007), per person consumption of local resources (Collins *et al.* 2000), spatial distribution of human settlements (Pandit & Laband 2007) and level of technological development.

Given that these factors can differ substantially amongst countries (Weidner & Jänicke 2002; Seip *et al.* 2005), it is necessary to analyse the spatial correlation between human population size and biodiversity within countries. Single countries are relatively homogeneous in terms of environmental awareness and consumption patterns of their population, as shown for example by the proportional increase of waste production (Fig. 1*a*) and number of new buildings (Fig. 1*b*) with increasing regional human population size in Italy. This implies that at this scale of analysis human population size can be a good surrogate variable for other environmental impacts caused by people.

For animals, analyses of the large-scale spatial species-people correlation at the national level have been performed for vertebrates other than fish in Australia (Luck *et al.* 2004), birds in South Africa, Great Britain and the USA (Chown

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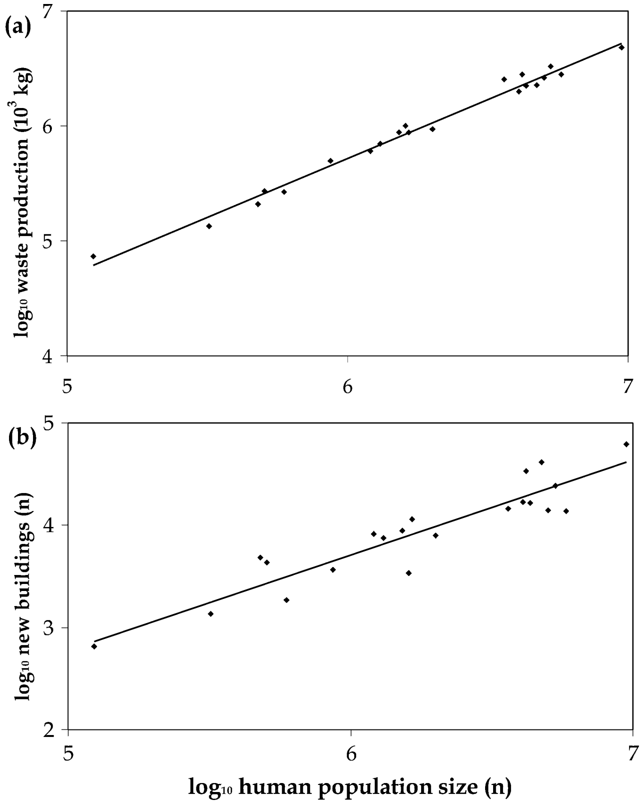

Figure 1 Correlation between (*a*) waste production in 2005 (10^3 kg) and human population size in 2006 ($n = 21$, $r^2 = 0.99$, $y = -0.35 + 1.01x$, slope standard error [sse] $= 0.02$, $p < 0.001$), and (*b*) number of new buildings in 2004 and human population size in 2006 ($n = 21$, $r^2 = 0.86$, $y = -2.17 + 0.98x$, sse $= 0.06$, $p < 0.001$) for Italy's regions.

et al. 2003; Evans & Gaston 2005; Pidgeon *et al.* 2007), and mammals in Mexico (Vazquez & Gaston 2006). Only for Australia, Mexico and South Africa has the species-people correlation been related to the current network of protected areas. For South Africa, quarter-degree grid cells next to current protected areas have a higher human density than expected by chance (Chown *et al.* 2003). For Mexico and Australia, the size of protected areas is inversely related to human population density in those areas, as large protected areas were chosen in areas of lower human population size, which also tend to be areas of lower species richness (Vazquez & Gaston 2006; Luck 2007). In Finland, the network of protected areas is unevenly distributed and tends to be biased towards the less populated northern regions (Virkkala & Rajasarkka 2007). However, there is a need for further study of how species-people correlations fit with variations in the presence of protected areas, not just for total species richness of a taxon, but also for subsets of species such as, for birds, breeding, human-avoiding and threatened species.

We investigated the presence of a species-people correlation for birds (total, human-avoiding, human-adapted, breeding and threatened species) across Italy's regions, controlling for variations in area, latitude, percentage of protected area and spatial autocorrelation. In addition, we ran models including land-cover variables such as proportions of agricultural, forest and mountainous areas. Italy is a species-rich and densely populated, yet relatively understudied, country.

METHODS

Bird species richness of Italy's regions was obtained from an updated compilation of existing regional bird checklists (Boano *et al.* 1985; Brichetti & Cambi 1987; Pellegrini 1992; Scebba *et al.* 1993; Laurenti *et al.* 1995; Grussu 1996*a*, *b*; Bocca & Maffei 1997; Brunelli & Fraticelli 1997; Battista *et al.* 1998; Niederfriniger *et al.* 1998; Fraissinet *et al.* 2002; Bagni *et al.* 2003; Giacchini 2003; Pedrini *et al.* 2005) (Table 1).

Analyses were subdivided for (1) all species reported (no matter their frequency and season of occurrence: breeding, sedentary, wintering, migrant, vagrant), (2) breeding species and (3) threatened species. It was also investigated how the proportion of (total and breeding) bird species which are normally (4) only and (5) not present in human-modified habitats (based on Sukopp & Werner 1982; Dinetti 1994; Dinetti & Fraissinet 2001) varied with human population size. Threatened species were identified following Stattersfield and Capper (2000). For Basilicata, only the number of breeding species was available. For the Trentino-Alto Adige region, data on the total and the breeding species richness were available for the two provinces (Trentino and Alto Adige).

Human population size in 2006 and the proportions of protected (2003), mountainous, forest and agricultural use (2005) areas were obtained from the Italian National Institute of Statistics (ISTAT) (Table 2). Mountainous areas are defined as regions generally above 600–700 m altitude, forest areas are obtained by the sum of all forest stands of area > 0.5 ha, and agricultural areas comprise effectively cultivated areas (crops, horticulture, grassland and pastures) (Schipani 2008). The proportion of protected areas considered national parks, national reserves, regional parks, regional reserves and other protected areas together, as overall these five types of protected areas provide the same level of protection, the only difference being that national parks and national reserves are regulated and managed at the national level, while the other types depend on local administrations (Maiorano *et al.* 2008). A visualization of the spatial data is provided in the Appendix (see Supplementary material at http://www.ncl.ac.uk/icef/EC.Supplement.htm).

The correlation of total, breeding and threatened bird species richness with human population size was analysed on its own and controlling for region area, latitude and percentage of protected area. Additional models were run controlling for three main land-cover variables (proportion of mountainous, forest and agricultural area). Total and breeding bird species richness, region area and human population size were log-transformed prior to analyses to better approach a normal distribution. Analyses were run in SAS 9.1. Spatial autocorrelation was controlled for using mixed models with

Table 1 Total (Spp), breeding (Br) and threatened (Thr) bird species, area (km^2), human population size (Pop; thousand individuals) and density (Dens; number of people per km^2) in 2006, and percentage in 2003 of protected areas (Prot), and in 2005 of mountainous (Mont), forest (For) and agricultural (Agr) areas in each of Italy's regions (see Methods for data sources).

Region	*Spp (n)*	*Br (n)*	*Thr (n)*	*Area (km^2)*	*Pop (10^3)*	*Dens (n km^{-2})*	*Prot (%)*	*Mont (%)*	*For (%)*	*Agr (%)*
Abruzzo	276	162	3	10 793	1305	121	28	65	21	39
Alto Adige	344	142	–	7392	480	65	25	100	42	35
Basilicata	–	133	–	9992	594	59	13	47	19	55
Calabria	320	151	7	15 083	2004	133	17	42	32	34
Campania	332	145	8	13 592	5791	426	24	35	21	41
Emilia Romagna	394	209	12	22 122	4188	189	4	25	18	47
Friuli Venezia Giulia	388	192	11	7712	1208	157	7	43	24	29
Lazio	374	168	10	17 210	5305	308	12	26	22	40
Liguria	396	142	9	5421	1610	297	5	65	53	9
Lombardy	379	205	11	23 861	9475	397	5	41	21	41
Marche	337	150	6	9695	1529	158	9	31	17	51
Molise	335	164	9	4438	321	72	1.5	55	16	48
Piemonte	361	196	11	25 398	4342	171	7	43	26	41
Puglia	346	178	13	19 364	4072	210	7	1	6	63
Sardinia	355	170	9	24 090	1656	69	4	14	22	44
Sicily	408	172	11	25 701	5017	195	11	24	9	49
Trentino	262	145	–	6207	505	81	16	100	52	23
Tuscany	422	167	11	22 990	3620	157	7	25	39	35
Umbria	295	157	4	8454	868	103	7	29	31	40
Valle d'Aosta	252	127	2	3266	124	38	13	100	24	21
Veneto	402	211	13	18 390	4738	258	5	29	15	43
Italy (all regions)	>450	250	16	301 171	58 752	195	10	35	23	42

Table 2 Maximum, minimum, mean, median and standard deviation of total (Spp), breeding (Br) and threatened (Thr) bird species, area (km^2), human population size (Pop; thousand individuals) and density (Dens; number of people per km^2) in 2006, and percentage in 2003 of protected areas (Prot), and in 2005 of mountainous (Mont), forest (For) and agricultural (Agr) areas in each of Italy's regions.

	Spp	*Br*	*Thr*	*Area*	*Pop*	*Dens*	*Prot*	*Mont*	*For*	*Agr*
Max	422	211	13	25 701	9475	426	28	100	53	63
Min	252	127	2	3266	124	38	1.5	1	6	9
Mean	350	165	9	14 300	2800	109	11	45	25	39
Med	350	165	10	15 600	1700	157	7	41	22	41
SD	49	35	3	7700	2400	175	7	28	12	12

exponential co-variance structure (Pautasso 2007). Results from non-spatial and spatial models were qualitatively consistent, but, for simplicity, we only present results which took into account a potential spatial non-independence of data. Spatial non-independence of data occurs if data close to each other tend to resemble each other (see Legendre 1993). It is important to control for spatial autocorrelation, as this factor can lead to misleading parameter estimates (for example Vazquez & Gaston 2006).

RESULTS

The total number of bird species in a region (*spp*) was positively correlated with human population size (*pop*) (Fig. 2*a*). This correlation persisted when controlling for variations in area (*area*), latitude (*lat*) and proportion of protected areas (*prot*) ($n = 20$, $r^2 = 0.63$, log spp = 2.00 + 0.09 log pop – 0.01 log area + 0.002 lat – 0.003 prot, slope standard error [sse] = 0.04, 0.08, 0.004, 0.001, $p = 0.05, 0.87, 0.70, 0.02$). There was no significant association of area and latitude with total avian species richness, but the proportion of protected areas correlated negatively with total avian species richness (Fig. 2*b*).

There was no evidence that the presence of species that are normally only or typically present in urbanized environments might be responsible for the increase of total bird species richness with human population size, as these species (*Apus apus, A. pallidus, Athene noctua, Columba livia, Corvus monedula, Delichon urbica, Hirundo rustica, Passer italiae* [replaced by *P. hispaniolensis* in Sardinia and Sicily], *P. montanus, Streptopelia decaocto, Sturnus vulgaris* and *Tyto alba*) were present in all regions. Some of these species are also frequently found outside towns (for example *A. noctua* and *T. alba*). Conversely, the proportion of species normally absent

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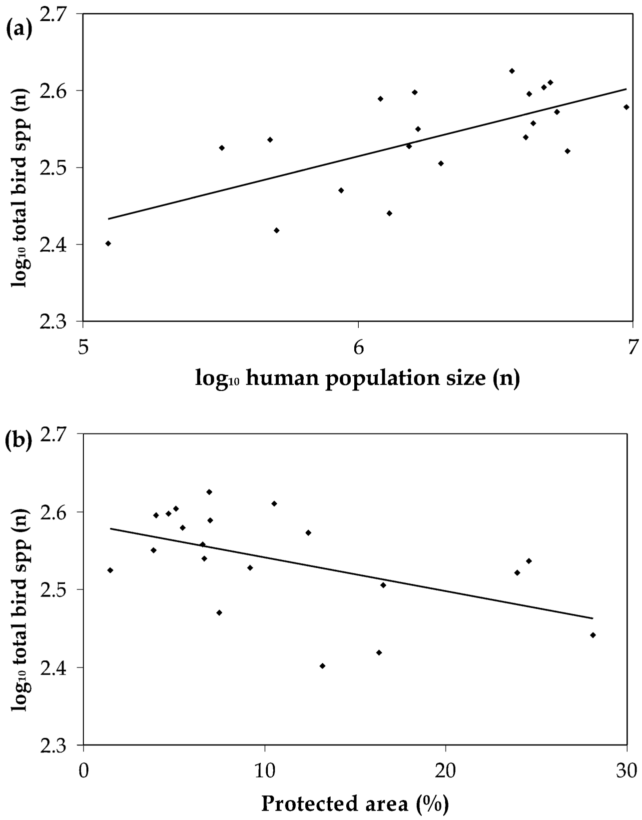

Figure 2 Correlation between total bird species richness and (*a*) human population size ($n = 20$, $r^2 = 0.47$, $y = 1.98 + 0.09x$, sse $= 0.02$, $p = 0.001$), (*b*) proportion of protected areas ($n = 20$, $r^2 = 0.26$, $y = 2.58 - 0.004x$, sse $= 0.001$, $p = 0.02$) for Italy's regions.

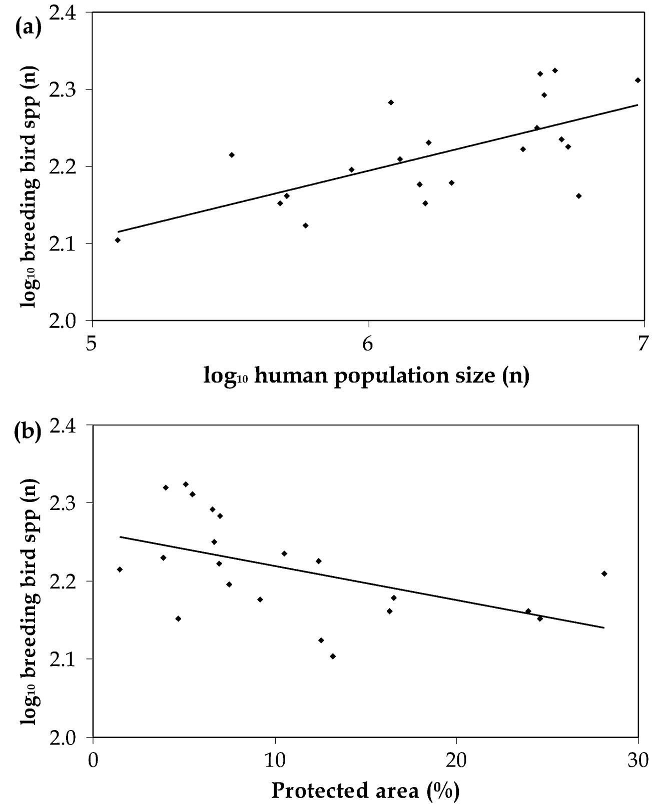

Figure 3 Correlation between breeding bird species richness and (*a*) human population size ($n = 21$, $r^2 = 0.45$, $y = 1.65 + 0.09x$, sse $= 0.02$, $p < 0.001$), (*b*) proportion of protected areas ($n = 21$, $r^2 = 0.25$, $y = 2.26 - 0.004x$, sse $= 0.002$, $p = 0.02$) for Italy's regions. The first correlation is not significant when controlling for variations in region area and latitude.

from human-modified habitats (which varied between 46 and 62% amongst regions) increased with increasing human population size ($n = 19$, $r^2 = 0.47$, proportion anthropophobic spp $= 11.6 + 7.1$ log pop, sse $= 1.8$, $p = 0.001$). This result was confirmed when controlling for region area, latitude and proportion of protected area, and in this model the proportion of human-avoiding species declined significantly with increasing proportion of protected areas, thus mirroring the pattern of total bird species richness.

Breeding bird species richness (*brspp*) increased with human population size (Fig. 3*a*), but this result was not confirmed when controlling for variations in area, latitude and proportion of protected areas ($n = 21$, $r^2 = 0.72$, log brspp $= 1.20 + 0.03$ log pop $+ 0.12$ log area $+ 0.008$ lat $- 0.003$ prot, sse $=$ 0.03, 0.07, 0.003, 0.001, $p = 0.37$, 0.10, 0.03, 0.02). In this case, there was no significant association with human population size. However, breeding bird species richness increased with latitude and decreased with proportion of protected areas (Fig. 3*b*). There were no significant variations in the proportion of breeding species typically absent from human-modified habitats with human population size and protected area, in a model controlling for variations in area and latitude.

The number of threatened bird species present in a region increased with human population size (Fig. 4*a*). This result was confirmed when controlling for variations in area, latitude and proportion of protected areas ($n = 18$, $r^2 = 0.78$, threatened spp $= -13.5 + 5.4$ log pop -1.4 log area -0.1 lat $- 0.27$ prot, sse $= 1.9$, 3.3, 0.2, 0.06, $p = 0.01$, 0.68, 0.66, 0.001). However, this was not the case when also controlling for total bird species richness ($n = 18$, $r^2 = 0.83$, threatened spp $= -99.8 + 0.5$ log pop $+ 3.2$ log area $+ 0.3$ lat -0.12 prot $+ 32.2$ log spp, sse $= 1.7$, 2.3, 0.3, 0.05, 9.1, $p = 0.77$, 0.20, 0.37, 0.04 and $p < 0.0001$, respectively). The last model showed that variations in the threatened bird species richness amongst Italy's regions can be largely explained by variations in overall bird species alone ($n = 18$, $r^2 = 0.77$, threatened spp $= -116.5 + 49.4$ log spp, sse $= 6.2$, $p < 0.0001$), although there is also a negative association with proportion of protected areas (Fig. 4*b*).

For total, breeding and threatened bird species, these results were confirmed when including in models the proportion of agricultural, forest and mountainous area, which were not factors significantly affecting the three response variables in the models above. These three land-use variables were

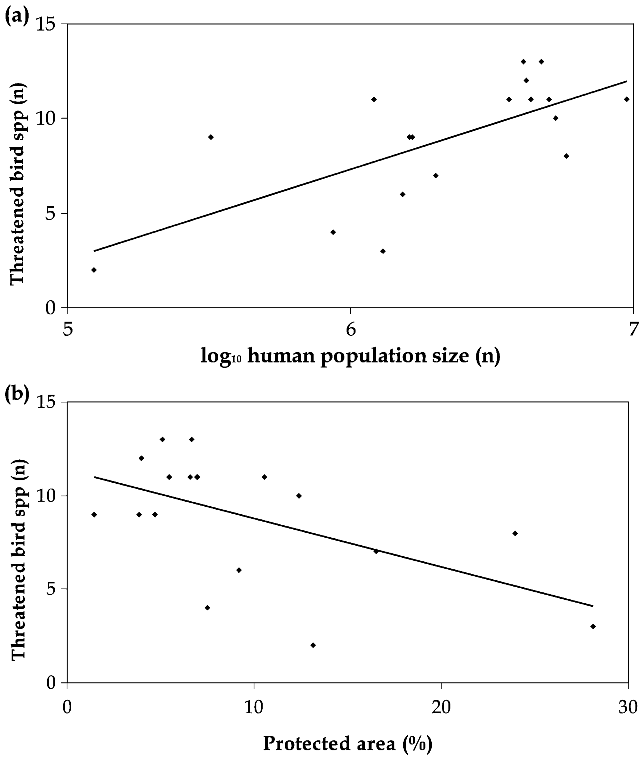

Figure 4 Correlation between number of threatened bird species and (*a*) human population size ($n = 18$, $r^2 = 0.47$, $y = -21.3 + 4.8x$, sse = 1.3, $p = 0.002$), (*b*) proportion of protected areas ($n = 18$, $r^2 = 0.31$, $y = 11.4 - 0.26x$, sse = 0.10, $p = 0.02$) for Italy's regions.

interrelated: the proportion of forest area (*for*) increased with proportion of mountainous area (*mont*) ($n = 21$, $r^2 = 0.36$, for = 13.3 + 0.26 mont, sse = 0.09, $p = 0.007$), the proportion of agricultural area (*agr*) declined with proportion of mountainous area ($n = 21$, $r^2 = 0.42$, agr = 51.2 − 0.26 mont, sse = 0.08, $p = 0.003$), and the proportion of agricultural area declined with proportion of forest area ($n = 21$, $r^2 = 0.64$, agr = 58.7 − 0.78 for, sse = 0.13, $p < 0.0001$). There was no significant variation of the proportions of mountain, forest and agriculture area with variations in latitude amongst regions.

As for the other correlations between the other independent variables, human population size (*pop*) increased with region area (*area*) and did not vary significantly with variations in latitude or proportion of protected areas ($n = 21$, $r^2 = 0.76$, log pop = −0.29 + 1.31 log area + 0.05 lat + 0.01 prot −0.017 agr −0.012 mont −0.004 for, sse = 0.33, 0.04, 0.01, 0.008, 0.004, 0.006, $p = 0.003$, 0.19, 0.18, 0.03, 0.01, 0.49, respectively). Human population size also significantly decreased with increasing proportion of agricultural area and of mountainous area, and did not vary significantly with variations in forest area. The proportion of protected area did not vary significantly with variations in human population size, latitude, proportion of agricultural and forest area, but increased with increasing region area and proportion of mountainous area ($n = 21$, $r^2 = 0.29$, prot = −85.5 + 19.4 log area + 0.34 mont, sse = 6.8, 0.08, $p = 0.01$, 0.003).

DISCUSSION

The species-people correlation can be considered in various ways, from the perspective of human impacts on biodiversity to how biodiversity copes with human presence. We make no claim of causality, thus we are not arguing that the presence of more human beings is causing more species to be present (although this might not to be excluded a priori if more people meant an increased habitat heterogeneity, which might then enable the coexistence of more species). In order to adopt an impacts-framed approach, baseline data on bird species richness prior to human modification of the landscape would be needed. Such data are unavailable, and in Italy widespread human impacts on flora and fauna go back to at least Ancient Roman times.

Italy is indeed an ancient seat of civilization (Astour 1985; Celecia 1997; Malone 2003; Pellecchia *et al.* 2007) and a country with relatively high human population density (more than five times greater than the USA, although roughly half that of England; Pautasso and Weisberg 2008). At the same time, Italy is situated in the Mediterranean hotspot of plant biodiversity, has a wide range of habitats, from alpine ecosystems to coastal marshes, and hosted many relict patches of woodland during the last glaciations (Caldecott *et al.* 1996; Cowling *et al.* 1996; Malcolm *et al.* 2006). From an ornithological point of view, with more than 450 reported species, Italy is one of the most species-rich European countries (Fauna Europaea 2004).

This analysis shows a substantial spatial co-occurrence of people and avian biodiversity in Italy's regions. Moreover, Italian regions with higher proportion of protected areas tend to have fewer avian species than those with a lower proportion of protected territory. The finding of an increase in total bird species richness in Italy's regions with increasing human population size is consistent with previous reports from other regions of a positive spatial correlation of people and biodiversity over large spatial scales (for example Araújo 2003; Gaston 2005; Pautasso 2007). For total bird species richness (comprising not only breeding species but also migrants and vagrants), this positive correlation is robust to variations in area, latitude and proportion of protected areas amongst Italian regions. Mechanisms that have been proposed to explain such a coincidence of high numbers of species and people are essentially of two kinds.

People have probably tended to settle and flourish in areas of more favourable climate, and these regions with longer growing season and energy availability are frequently those where species richness is also higher (Gardezi & Gonzalez 2008; Harrison *et al.* 2008; Field *et al.* 2009). This follows from the often reported positive relationship between species richness and environmental productivity (for birds, Hawkins *et al.* 2003; Ding *et al.* 2006; Koh *et al.* 2006; Mönkkönen *et al.* 2006; Lepczyk *et al.* 2008). Additionally, people have often increased the number of species present in regions of high human presence with species introductions and habitat modifications (Benton *et al.* 2003; Tait *et al.* 2005; La Sorte *et al.* 2007). However, variation in the main habitat types (mountain, forest and agricultural area) does not seem to play a role in the observed patterns, as none of these proportions was a significant factor in the models of bird species richness as a function of human population size, area, latitude and proportion of protected area.

There is also no evidence that the presence of human-adapted bird species could explain the positive relationship between total bird species richness and human population size, as all Italian regions report the presence of these relatively few species. Similarly, there is no evidence that the presence of human-avoiding bird species might decline with increasing human population size in spite of an overall positive trend, as this category of bird species appears to contribute to that positive trend. The contribution of exotic species to the reported patterns is likely to be negligible, as in this country there are very few introduced bird species, even in urbanized areas (Clergeau *et al.* 2006). Currently, 26 exotic bird taxa are reported in Italy, but none of these is abundant or widespread, and only eight species are considered in the national bird checklist (Andreotti *et al.* 2001; Gariboldi *et al.* 2004). Only a few of these species are believed to be able to pose a future threat to native bird biodiversity (*Leiothrix lutea*, *Oxyura jamaicensis*, *Psittacula krameri* and *Threskiornis aethiopicus*).

There is evidence that the increase in overall bird species richness with human population size is not caused by a correlation of breeding species richness with human presence, but by migrant and occasional bird species. Breeding bird species are more affected by detrimental human activities than migrant and vagrant species as they require a more reliable source of resources (Levey & Stiles 1992). At first sight, there is a correlation between breeding bird species richness and human population size (Fig. 3*a*), but this is not significant when controlling for region area, latitude and proportion of protected areas; this shows that positive species-people correlations may disappear when controlling for confounding factors. It is possible that a sampling effect may apply to species occasionally sighted; regions with higher numbers of people might have a higher presence of ornithologists and thus a higher chance of rare species being spotted. However, there is independent evidence for birds in Britain and vascular plants in the USA that variations in sampling effort might not explain the observed positive species-people correlations (Evans *et al.* 2007; Pautasso & McKinney 2007).

There is also a mismatch between overall and breeding bird species richness in relation to latitude. Whereas overall bird species richness does not vary significantly with latitude, possibly as a consequence of the narrow range of variation in latitude amongst Italian regions (Fattorini 2006), breeding bird species richness increases significantly with latitude, in contrast to the commonly observed pattern in natural ecosystems (but see Rabenold 1979). This reversed latitudinal gradient of Italian breeding bird species richness is possibly a consequence of the peninsular shape of Italy (Massa 1982; Battisti & Contoli 1995). Interestingly, a reversed latitudinal gradient also occurs for the species richness of veteran trees in Italy (Pautasso & Chiarucci 2008). For both birds and trees, more northern Italian regions, in spite of the presence of the Alps, are connected to the pool of species which is present in Central Europe, whereas southern regions are isolated from other areas with similar climate by the presence of the Mediterranean Sea. There is no evidence that broad variations in habitat type could play a role in this reversed latitudinal gradient, as the proportions of mountain, forest and agricultural area did not significantly vary with variations in latitude amongst Italian regions. We also did not observe any significant association of breeding bird species richness with the altitudinal range of Italian regions, in spite of an overall trend for this range to increase with increasing latitude.

Both for total and for breeding bird species richness there is a significant decrease with increasing proportion of protected areas. It is unlikely that protected areas are causing a decrease in bird species richness: protected areas have been shown to be successfully preserving the presence of natural habitats in Lombardy, one of the most urbanized Italian regions (Canova 2006). Within that region, protected areas have significantly more bird species than control zones in the surroundings, although surrounding land use can have a negative influence on biodiversity inside protected areas (Canova 2006). However, our interregional analysis shows that regions with higher proportion of protected areas tend to have fewer bird species. This is likely to be a consequence of the historical choice of areas of relatively low human density for many natural reserves, despite the role of human activities in the preservation of Italian biodiversity (Hall 2000; Maiorano *et al.* 2007; see also Battisti & Gippoliti 2004). Less populated areas are of conservation importance because of their wilderness status and the low impact of human activities, but do not tend to harbour more species than regions with higher presence of human settlements. This issue is of relevance to many regions of the world, such as Nepal (Hunter & Yonzon 1993), the USA (Parks & Harcourt 2002; McKinney 2005; Hopton & Mayer 2006), Australia (Luck 2007) and Finland (Virkkala & Rajasarkka 2007). A negative correlation of bird species richness with the presence of protected areas makes it important that the whole landscape be considered for conservation activities, a policy also endorsed in the European Landscape Convention (Dejeant-Pons 2006). The positive correlation of total bird species with human population size poses a challenge for such activities, but makes increasing people's awareness of bird biodiversity in Italy easier. A large-scale spatial co-occurrence of people and biodiversity is in this respect an important finding, because conservation efforts are ultimately only supported if the majority of the population has a sufficient environmental education (Turner *et al.* 2004; Miller 2005; Dinetti 2006).

Italian regions with a larger human population size also have a higher number of threatened bird species, but this positive association can be explained by the positive correlation between the number of threatened species and overall bird species richness. Regions with more people have a higher number of threatened bird species because they also have a higher total number of bird species; there is no evidence for a further effect of human population size in addition to that association. Together with the positive association of total bird richness and human population size, this result implies that, over a regional scale, human settlements can coexist with bird biodiversity in this country. In Italy, humans and birds have coexisted for millennia in a mainly agricultural landscape (Bertollo 2001; Laiolo 2005; Giupponi *et al*. 2006). Although some Italian regions have remarkably high overall human densities (Lombardy, Campania and Lazio have > 300 inhabitants per km^2; Table 1), which might translate into a strong human impact on ecosystems, human settlements are concentrated in some areas and scattered in others, thus still providing some room for semi-natural ecosystems even in strongly urbanized regions (Lorenzetti & Battisti 2007).

This analysis shows a spatial coincidence of bird biodiversity and human presence using Italy as the study extent, and its different regions as the study grain. Previous studies have documented the co-occurrence of people and habitat patches of conservation value in single Italian regions (such as Lombardy; Bani *et al*. 2002, 2006; Canova 2006). Other local to intraregional scale studies in Italy, mainly involving lichens, have shown the widespread presence of anthropogenic impacts (Loppi *et al*. 2002; Nali *et al*. 2004; Frati *et al*. 2006; Giordani 2007). Land-use change potentially has a profound impact on Italy's biodiversity (Gomarasca *et al*. 1993; Andreone & Luiselli 2000; Maiorano *et al*. 2006; Falcucci *et al*. 2007) given the overlap, but also the peculiarities of the fauna and flora in different regions, and the differing levels of human impact.

Rapid urbanization and sprawl following World War II (Rolando *et al*. 1997; Zapparoli 1997; Sorace 2001; Lorenzetti & Battisti 2006; Sorace & Gustin 2008), as well as the abandonment of marginal land (Farina 1997; Laiolo *et al*. 2004; Rossi *et al*. 2007; Tasser *et al*. 2007), are likely to have affected ecosystems throughout the country. There is concern about agricultural intensification in fertile areas and neglect of traditionally cultivated sub-fertile areas. Together with the negative interregional correlation of bird biodiversity and proportion of protected area, the positive correlation of human population size and bird biodiversity suggests that, in order to achieve the European objective of halting biodiversity loss by 2010 (Mace & Baillie 2007), the current network of Italian protected areas needs to be integrated with more sustainable land-use at the whole landscape level.

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References

Andreone, F. & Luiselli, L. (2000) The Italian batrachofauna and its conservation status: a statistical assessment. *Biological Conservation* **96**: 197–208.

Andreotti, A., Baccetti, N., Perfetti, A., Besa, M., Genovesi, P. & Guberti, V. (2001) *Mammiferi ed Uccelli Esotici in Italia: Analisi del Fenomeno, Impatto sulla Biodiversità e Linee Guida Gestionali*. Savignano, Modena, Italy: Istituto Nazionale per la Fauna Selvatica.

Araújo, M.B. (2003) The coincidence of people and biodiversity in Europe. *Global Ecology and Biogeography* **12**: 5–12.

Araújo, M.B. & Rahbek, C. (2007) Conserving biodiversity in a world of conflicts. *Journal of Biogeography* **34**: 199–200.

Astour, M.C. (1985) Ancient Greek civilization in Southern Italy. *Journal of Aesthetic Education* **19**: 23–37.

Bagni, L., Sighele, M., Passerella, M., Premuda, G., Tinarelli, R., Cocchi, L. & Leoni, G. (2003) Check-list degli uccelli dell'Emilia-Romagna dal 1900 al Giugno 2003. *Picus* **29**: 85–107.

Balmford, A., Moore, J.L., Brooks, T., Burgess, N., Hansen, L.A., Williams, P. & Rahbek, C. (2001) Conservation conflicts across Africa. *Science* **291**: 2616–2619.

Bani, L., Baietto, M., Bottoni, L. & Massa, R. (2002) The use of focal species in designing a habitat network for a lowland area of Lombardy, Italy. *Conservation Biology* **16**: 826–831.

Bani, L., Massimino, D., Bottoni, L. & Massa, R. (2006) A multiscale method for selecting indicator species and priority conservation areas: a case study for broadleaved forests in Lombardy, Italy. *Conservation Biology* **20**: 512–526.

Battista, G., Carafa, M., Colonna, N. & De Lisio, L. (1998) Checklist degli uccelli del Molise con note sullo status e sulla distribuzione. *Rivista Italiana di Ornitologia* **68**: 11–26.

Battisti, C. & Contoli, L. (1995) La componente di ricchezza della diversità avifaunistica in Italia: una sintesi cartografica. *Ricerche di Biologia della Selvaggina* **96**: 1–13.

Battisti, C. & Gippoliti, S. (2004) Conservation in the urban-countryside interface: a cautionary note from Italy. *Conservation Biology* **18**: 581–583.

Benton, T.G., Vickery, J.A. & Wilson, J.D. (2003) Farmland biodiversity: is habitat heterogeneity the key? *Trends in Ecology and Evolution* **18**: 182–188.

Bertollo, P. (2001) Assessing landscape health: a case study from Northeastern Italy. *Environmental Management* **27**: 349–365.

Blair, R.B. (1996) Land use and avian species diversity along an urban gradient. *Ecological Applications* **6**: 506–519.

Boano, G., Brichetti, P., Cambi, D., Meschini, E., Mingozzi, T. & Pazzucconi, A. (1985) Contributo alla conoscenza dell'avifauna della Basilicata. *Ricerche di Biologia della Selvaggina* Nr. 75, 37 pp.

Bocca, M. & Maffei, G. (1997) Check-list degli uccelli della Valle d'Aosta. In: *Gli Uccelli della Valle d'Aosta. Indagine Bibliografica e Dati Inediti*, Ristampa con aggiornamento al 1997, pp. 277–284. Aosta, Italy: Regione Autonoma Valle d'Aosta.

Brichetti, P. & Cambi, D. (1987) Check-list degli uccelli della Lombardia. *Sitta* **1**: 57–71.

Brown, R.M. & Laband, D.N. (2006) Species imperilment and spatial patterns of development in the United States. *Conservation Biology* **20**: 239–244.

Brunelli, M. & Fraticelli, F. (1997) Checklist degli uccelli del Lazio aggiornata al Dicembre 1996. *Alula* **4**: 60–78.

Caldecott, J.O., Jenkins, M.D., Johnson, T.H. & Groombridge, B. (1996) Priorities for conserving global species richness. *Biodiversity and Conservation* **5**: 699–727.

Canova, L. (2006) Protected areas and landscape conservation in the Lombardy plain (northern Italy): an appraisal. *Landscape and Urban Planning* **74**: 102–109.

Celecia, J. (1997) Urban ecology: biodiversity and contemporary stakes of inventories. *Journal d'Agriculture Traditionelle et Botanique Appliquée* **39**: 241–263.

Chown, S.L., van Rensburg, B.J., Gaston, K.J., Rodrigues, A.S.L. & van Jaarsveld, A.S. (2003) Energy, species richness, and human population size: conservation implications at a national scale. *Ecological Applications* **13**: 1233–1241.

Clergeau, P., Croci, S., Jokimäki, J., Kaisanlahti-Jokimäki, M.-L. & Dinetti, M. (2006) Avifauna homogenisation by urbanisation: analysis at different European latitudes. *Biological Conservation* **127**: 336–344.

Collins, J.P., Kinzig, A., Grimm, N.B., Fagan, W.F., Hope, D., Wu, J. & Borer, E.T. (2000) A new urban ecology. *American Scientist* **88**: 416–425.

Costa, L.P., Leite, Y.L.R., Mendes, S.L. & Ditchfield, A.D. (2005) Mammal conservation in Brazil. *Conservation Biology* **19**: 672–679.

Cowling, R.M., Rundel, P.W., Lamont, B.B., Arroyo, M.K. & Arianoutsou, M. (1996) Plant diversity in Mediterranean-climate regions. *Trends in Ecology and Evolution* **11**: 362–366.

de Groot, J.I.M. & Steg, L. (2007) Value orientations and environmental beliefs in five countries: validity of an instrument to measure egoistic, altruistic and biospheric value orientations. *Journal of Crosscultural Psychology* **38**: 318–332.

Dejeant-Pons, M. (2006) The European Landscape Convention. *Landscape Research* **31**: 363–384.

Dinetti, M. (1994) *Atlante degli Uccelli Nidificanti a Livorno*. Quaderni dell'Ambiente 5. Livorno, Italy: Comune di Livorno.

Dinetti, M. (2006) Urban avifauna: is it possible to live together? *Veterinary Research Communications* **30**: 3–7.

Dinetti, M. & Fraissinet, M. (2001) *Ornitologia Urbana*. Bologna, Italy: Calderini-Edagricole.

Ding, T.S., Yuan, H.W., Geng, S., Koh, C.N. & Lee, P.F. (2006) Macro-scale bird species richness patterns of the East Asian mainland and islands: energy, area and isolation. *Journal of Biogeography* **33**: 683–693.

Diniz-Filho, J.A.F., Bini, L.M., Pinto, M.P., Rangel, T.F.L.V.B., Carvalho, P. & Bastos, R.P. (2006) Anuran species richness, complementarity and conservation conflicts in Brazilian Cerrado. *Acta Oecologica* **29**: 9–15.

Evans, K.L. & Gaston, K.J. (2005) People, energy and avian species richness. *Global Ecology and Biogeography* **14**: 187–196.

Evans, K.L., Greenwood, J.J.D. & Gaston, K.J. (2007) The positive correlation between avian species richness and human population density in Britain is not attributable to sampling bias. *Global Ecology and Biogeography* **16**: 300–304.

Falcucci, A., Maiorano, L. & Boitani, L. (2007) Changes in land-use/land-cover patterns in Italy and their implications for biodiversity conservation. *Landscape Ecology* **22**: 617–631.

Farina, A. (1997) Landscape structure and breeding bird distribution in a sub-Mediterranean agro-ecosystem. *Landscape Ecology* **12**: 365–378.

Fattorini, S. (2006) Testing the latitudinal gradient: a narrow-scale analysis of tenebrionid richness (Coleoptera, Tenebrionidae) in the Aegean archipelago (Greece). *Italian Journal of Zoology* **73**: 203–211.

Fauna Europaea (2004) Fauna Europaea database [www document]. URL http://www.faunaeur.org/

Field, R., Hawkins, B.A., Cornell, H.V., Currie, D.J., Diniz-Filho, J.A.F., Guegan, J.F., Kaufman, D.M., Kerr, J.T., Mittelbach, G.G., Oberdorff, T., O'Brien, E.M. & Turner, J.R.G. (2009) Spatial species-richness gradients across scales: a meta-analysis. *Journal of Biogeography* **36**: 132–147.

Fjeldså, J. & Rahbek, C. (1998) Continent-wide conservation priorities and diversification process. In: *Conservation in a Changing World*, ed. G.M. Mace, A. Balmford & J. Ginsberg, pp. 139–160. Cambridge, UK: Cambridge University Press.

Ford, H.A., Barrett, G.W., Saunders, D.A. & Recher, H.F. (2001) Why have birds in the woodlands of Southern Australia declined? *Biological Conservation* **97**: 71–88.

Fraissinet, M., Cavaliere, V., Conti, P., Milone, M., Moschetti, G., Piciocchi, S. & Scebba, S. (2002) Checklist degli uccelli della Campania. *Rivista Italiana di Ornitologia* **71**: 9–25.

Frati, L., Caprasecca, E., Santoni, S., Gaggi, C., Guttova, A., Gaudino, S., Pati, A., Rosamilia, S., Pirintsos, S.A. & Loppi, S. (2006) Effects of NO_2 and NH_3 from road traffic on epiphytic lichens. *Environmental Pollution* **142**: 58–64.

Gardezi, T. & Gonzalez, A. (2008) Scale dependence of species-energy relationships: evidence from fishes in thousands of lakes. *The American Naturalist* **171**: 800–815.

Gariboldi, A., Andreotti, A. & Bogliani, G. (2004) *La Conservazione degli Uccelli in Italia. Strategie e Azioni*. Bologna, Italy: Alberto Perdisa.

Gaston, K.J. (2005) Biodiversity and extinction: species and people. *Progress in Physical Geography* **29**: 239–247.

Giacchini, P. (2003) Check-list degli uccelli delle Marche. *Rivista Italiana di Ornitologia* **73**: 25–45.

Giordani, P. (2007) Is the diversity of epiphytic lichens a reliable indicator of air pollution? A case study from Italy. *Environmental Pollution* **146**: 317–323.

Giupponi, C., Ramanzin, M., Sturaro, E. & Fuser, S. (2006) Climate and land use changes, biodiversity and agri-environmental measures in the Belluno province, Italy. *Environmental Science and Pollution* **9**: 163–173.

Gomarasca, M.A., Brivio, P.A., Pagnoni, F. & Galli, A. (1993) One century of land-use changes in the metropolitan area of Milan, Italy. *International Journal of Remote Sensing* **14**: 211–223.

Grussu, M. (1996*a*) Check-list degli uccelli della Sardegna (first part). *Rivista Italiana di Ornitologia* **65**: 113–122.

Grussu, M. (1996*b*) Check-list of the birds of Sardinia (second and last part). *Rivista Italiana di Ornitologia* **66**: 9–16.

Hall, M. (2000) Comparing damages: American and Italian concepts of degradation. In: *Methods and Approaches in Forest History*, ed. M. Agnoletti &. S. Anderson, pp. 145–152. Wallingford, UK: CAB International.

Harrison, S., Viers, J.H., Thorne, J.H. & Grace, J.B. (2008) Favorable environments and the persistence of naturally rare species. *Conservation Letters* **1**: 65–74.

Hawkins, B.A., Porter, E.E. & Diniz-Filho, J.A.F. (2003) Productivity and history as predictors of the latitudinal diversity gradient of terrestrial birds. *Ecology* **84**: 1608–1623.

Hopton, M.E. & Mayer, A.L. (2006) Using self-organizing maps to explore patterns in species richness and protection. *Biodiversity and Conservation* **15**: 4477–4494.

Hunter, M.L. & Yonzon, P. (1993) Altitudinal distributions of birds, mammals, people, forests, and parks in Nepal. *Conservation Biology* **7**: 420–423.

Koh, C.N., Lee, P.F. & Lin, R.S. (2006) Bird species richness patterns of northern Taiwan: primary productivity, human population density, and habitat heterogeneity. *Diversity and Distributions* **12**: 546–554.

Laiolo, P. (2005) Spatial and seasonal patterns of bird communities in Italian agroecosystems. *Conservation Biology* **19**: 1547–1556.

Laiolo, P., Dondero, F., Ciliento, E. & Rolando, A. (2004) Consequences of pastoral abandonment for the structure and diversity of the alpine avifauna. *Journal of Applied Ecology* **41**: 294–304.

La Sorte, F.A., McKinney, M.L. & Pysek, P. (2007) Compositional similarity among urban floras within and across continents: biogeographical consequences of human-mediated biotic interchange. *Global Change Biology* **13**: 913–921.

Laurenti, S., Paci, A.M. & Stagnini, L. (1995) Check-list degli uccelli dell'Umbria. *Gli Uccelli d'Italia* **20**: 3–20.

Legendre, P. (1993) Spatial autocorrelation: trouble or new paradigm. *Ecology* **74**: 1659–1673.

Lepczyk, C.A., Flather, C.H., Radeloff, V.C., Pidgeon, A.M., Hammer, R.B. & Liu, J. (2008) Human impacts on regional avian diversity and abundance. *Conservation Biology* **22**: 405–416.

Levey, D.J. & Stiles, F.G. (1992) Evolutionary precursors of long-distance migration: resource availability and movement patterns in Neotropical landbirds. *The American Naturalist* **140**: 447–476.

Loppi, S., Ivanov, D. & Boccardi, R. (2002) Biodiversity of epiphytic lichens and air pollution in the town of Siena (Central Italy). *Environmental Pollution* **116**: 123–128.

Lorenzetti, E. & Battisti, C. (2006) Area as component of habitat fragmentation: corroborating its role in breeding bird communities and guilds of oak wood fragments in Central Italy. *Revue d'Ecologie – la Terre et la Vie* **61**: 53–68.

Lorenzetti, E. & Battisti, C. (2007) Nature reserve selection on forest fragments in a suburban landscape (Rome, Central Italy): indications from a set of avian species. *Landscape Research* **32**: 57–58.

Luck, G.W., Ricketts, T.H., Daily, G.C. & Imhoff, M. (2004) Alleviating spatial conflict between people and biodiversity. *Proceedings of the National Academy of Sciences USA* **101**: 182–186.

Luck, G.W. (2007) The relationships between net primary productivity, human population density and species conservation. *Journal of Biogeography* **34**: 201–212.

Mace, G.M. & Baillie, J.E.M. (2007) The 2010 biodiversity indicators: challenges for science and policy. *Conservation Biology* **21**: 1406–1413.

Maiorano, L., Falcucci, A. & Boitani, L. (2006) Gap analysis of terrestrial vertebrates in Italy: priorities for conservation planning in a human dominated landscape. *Biological Conservation* **133**: 455–473.

Maiorano, L., Falcucci, A., Garton, E.O. & Boitani, L. (2007) Contribution of the Natura 2000 network to biodiversity conservation in Italy. *Conservation Biology* **21**: 1433–1444.

Maiorano, L., Falcucci, A. & Boitani, L. (2008) Size-dependent resistance of protected areas to land-use change. *Proceedings of the Royal Society London B* **275**: 1297–1304.

Malcolm, J.R., Liu, C.R., Neilson, R.P., Hansen, L. & Hannah, L. (2006) Global warming and extinctions of endemic species from biodiversity hotspots. *Conservation Biology* **20**: 538–548.

Malone, C. (2003) The Italian Neolithic: a synthesis of research. *Journal of World Prehistory* **17**: 235–312.

Marini, L., Prosser, F., Klimek, S., Marrs, R.H. (2008) Water-energy, land-cover and heterogeneity drivers of the distribution of plant species richness in a mountain region of the European Alps. *Journal of Biogeography* **35**: 1826–1839.

Massa, B. (1982) Il gradiente faunistico nella penisola italiana e nelle isole. *Atti della Società Italiana di Scienze Naturali* **123**: 353–374.

McKinney, M.L. (2001) Role of human population size in raising bird and mammal threat among nations. *Animal Conservation* **4**: 45–57.

McKinney, M.L. (2005) Scaling of park trail length and visitation with park area: conservation implications. *Animal Conservation* **8**: 135–141.

McKinney, M.L. (2006) Urbanization as a major cause of biotic homogenization. *Biological Conservation* **127**: 247–260.

Miller, J.R. (2005) Biodiversity conservation and the extinction of experience. *Trends in Ecology and Evolution* **20**: 430–434.

Mönkkönen, M., Forsman, J.T. & Bokma, F. (2006) Energy availability, abundance, energy-use and species richness in forest bird communities: a test of the species-energy theory. *Global Ecology and Biogeography* **15**: 290–302.

Moreno-Rueda, G. & Pizarro, M. (2007) The relative influence of climate, environmental heterogeneity, and human population on the distribution of vertebrate species richness in south-eastern Spain. *Acta Oecologica* **32**: 50–58.

Moreno-Rueda, G. & Pizarro, M. (2009) Relative influence of habitat heterogeneity, climate, human disturbance, and spatial structure on vertebrate species richness in Spain. *Ecological Research* **24**: 335–344.

Nali, C., Crocicchi, L. & Lorenzini, G. (2004) Plants as indicators of urban air pollution (ozone and trace elements) in Pisa, Italy. *Journal of Environmental Monitoring* **6**: 636–645.

Niederfriniger, O., Schreiner, P. & Unterholzner, L. (1998) *Atlante dell'Avifauna dell'Alto Adige*. Bolzano, Italy: Tappeiner.

Pandit, R. & Laband, D.N. (2007) Threatened species and the spatial concentration of humans. *Biodiversity and Conservation* **16**: 235–244.

Parks, S.A. & Harcourt, A.H. (2002) Reserve size, local human density, and mammalian extinctions in US protected areas. *Conservation Biology* **16**: 800–808.

Pautasso, M. (2007) Scale dependence of the correlation between human population presence and vertebrate and plant species richness. *Ecology Letters* **10**: 16–24.

Pautasso, M. & Chiarucci, A. (2008) A test of the scale-dependence of the species-abundance people correlation for veteran trees in Italy. *Annals of Botany* **101**: 709–715.

Pautasso, M. & Fontaneto, D. (2008) A test of the species-people correlation for stream macro-invertebrates in European countries. *Ecological Applications* **18**: 1842–1849.

Pautasso, M. & McKinney, M.L. (2007) The botanist effect revisited: plant species richness, county area, and human population size in the United States. *Conservation Biology* **21**: 1333–1340.

Pautasso, M. & Weisberg, P.J. (2008) Negative density-area relationships: the importance of the zeros. *Global Ecology and Biogeography* **17**: 203–210.

Pautasso, M. & Zotti, M. (2009) Macrofungal taxa and human population in Italy's regions. *Biodiversity and Conservation* **18**: 473–485.

Pedrini, P., Caldonazzi, M. & Zanghellini, S., eds. (2005) *Atlante degli Uccelli Nidificanti e Svernanti in Provincia di Trento*. Trento, Italy: Museo Tridentino di Scienze Naturali.

Pellecchia, M., Negrini, R., Colli, L., Patrini, M., Milanesi, E., Achilli, A., Bertorelle, G., Cavalli-Sforza, L.L., Piazza, A., Torroni, A. & Ajmone-Marsan, P. (2007) The mystery of Etruscan origins: novel clues from *Bos taurus* mitochondrial DNA. *Proceedings of the Royal Society London B* **274**: 1175–1179.

Pellegrini, M. (1992) Check-list degli uccelli d'Abruzzo. *Rivista Italiana di Ornitologia* **62**: 88–104.

Pidgeon, A.M., Radeloff, V.C., Flather, C.H., Lepczyk, C.A., Clayton, M.K., Hawbaker, T.J. & Hammer, R.B. (2007) Associations of forest bird species richness with housing and landscape patterns across the USA. *Ecological Applications* **17**: 1989–2010.

Rabenold, K.N. (1979) Reversed latitudinal diversity gradient in avian communities of Eastern deciduous forests. *The American Naturalist* **114**: 275–286.

Real, R., Barbosa, A.M., Porras, D., Kin, M.S., Marquez, A.L., Guerrero, J.C., Palomo, L.J., Justo, E.R. & Vargas, J.M. (2003) Relative importance of environment, human activity and spatial situation in determining the distribution of terrestrial mammal diversity in Argentina. *Journal of Biogeography* **30**: 939–947.

Rolando, A., Maffei, G., Pulcher, C. & Giuso, A. (1997) Avian community structure along an urbanization gradient. *Italian Journal of Zoology* **64**: 341–349.

Rondinini, C., Chiozza, F. & Boitani, L. (2006) High human density in the irreplaceable sites for African vertebrates conservation. *Biological Conservation* **133**: 358–363.

Rossi, P., Pecci, A., Amadio, V., Rossi, O. & Soliani, L. (2007) Coupling indicators of ecological value and ecological sensitivity with indicators of demographic pressure in the demarcation of new areas to be protected: the case of the Oltrepò Pavese and the Ligurian-Emilian Apennine area (Italy). *Landscape and Urban Planning* **85**: 12–26.

Scebba, S., Moschetti, G., Cortone, P. & Di Giorgio, A. (1993) Check-list degli uccelli della Calabria aggiornata a Gennaio 1993. *Sitta* **6**: 3–45.

Schipani, S. (2008) *Statistiche Ambientali*. Roma, Italy: Istituto Nazionale di Statistica: **648** pp.

Schlick-Steiner, B.C., Steiner, F.M. & Pautasso, M. (2008) Ants and people: a test of two mechanisms potentially responsible for the large-scale human population–biodiversity correlation for Formicidae in Europe. *Journal of Biogeography* **35**: 2195–2206.

Seip, K.L., Cobelas, M.A., Doledec, S., Fang, J.H., Smith, V.H. & Vorontsova, O.S. (2005) Preferences for environmental issues among environmentally-concerned citizens in six countries. *Environmental Conservation* **32**: 88–293.

Sorace, A. (2001) Value to wildlife of urban-agricultural parks: a case study from Rome urban area. *Environmental Management* **28**: 47–560.

Sorace, A. & Gustin, M. (2008) Homogenisation processes and local effects on avifaunal composition in Italian towns. *Acta Oecologica* **33**: 15–26.

Stattersfield, A. & Capper, D., eds. (2000) *Threatened Birds of the World*. Barcelona, Spain: Birdlife International.

Steck, C.E. & Pautasso, M. (2008) Human population, grasshopper and plant species richness in European countries. *Acta Oecologica* **34**: 303–310.

Sukopp, H. & Werner, P. (1982) *Nature in Cities*. Nature and Environment Series nr 28. Strasbourg, France: Council of Europe.

Tait, C.J., Daniels, C.B. & Hill, R.S. (2005) Changes in species assemblages within the Adelaide Metropolitan Area, Australia, 1836–2002. *Ecological Applications* **15**: 346–359.

Tasser, E., Walde, J., Tappeiner, U., Teutsch, A. & Noggler, W. (2007) Land-use changes and natural reforestation in the Eastern Central Alps. *Agriculture, Ecosystems and Environment* **118**: 115–129.

Turner, W.R., Nakamura, T. & Dinetti, M. (2004) Global urbanization and the separation of humans from nature. *Bioscience* **54**: 585–590.

Vazquez, L.B. & Gaston, K.J. (2006) People and mammals in Mexico: conservation conflicts at a national scale. *Biodiversity and Conservation* **15**: 2397–2414.

Venter, O., Brodeur, N.N., Nemiroff, L., Belland, B., Dolinsek, I.J. & Grant, J.W.A. (2006) Threats to endangered species in Canada. *Bioscience* **56**: 903–910.

Virkkala, R. & Rajasarkka, A. (2007) Uneven regional distribution of protected areas in Finland: consequences for boreal forest bird populations. *Biological Conservation* **134**: 361–371.

Weidner, H. & Jänicke, M., eds. (2002) *Capacity Building in National Environmental Policy. A Comparative Study of 17 Countries*. Berlin, Germany: Springer.

You, M.S., Xu, D.M., Cai, H.J. & Vasseur, L. (2005) Practical importance for conservation of insect diversity in China. *Biodiversity and Conservation* **14**: 723–737.

Zapparoli, M. (1997) Urban development and insect biodiversity of the Rome area, Italy. *Landscape and Urban Planning* **38**: 77–86.