Causes of human impact to protected vertebrate wildlife parallel long-term socio-economical changes in Spain

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Abstract
Obtaining information on the way human activities impact protected wildlife is not an easy task. Here, we analyze the news published by knowledgeable naturalists in Spain’s most prestigious and oldest magazine devoted to the study and conservation of nature, during a 28-year period (1982–2009). We studied the logarithm of the ratio of news published annually on direct (poaching, trapping and poisoning) versus indirect impacts (road casualties, electrocutions and collisions with infrastructure), and it turned out to be negative, strong (5% annual decrease) and statistically significant, suggesting an exponential decrease of the ratio. The decreasing trend was stronger (λ = 9%) when considering only direct impacts excluding cases of poisoning that showed an increasing trend over time, showing a more realistic idea of the decreasing impact by hunters. Our modelling clearly showed that the decreasing trend in the ratio was explained by the decreasing number of hunting licences active on a yearly basis, controlled by the increase in indirect impacts. In order to validate our results, we compared our analysis with the trend shown by vertebrate admissions to a major rescue centre in eastern Spain from 1994 to 2011. The results of this second analysis showed a trend with a similar inversion of causes of impact but of a stronger magnitude (λ = 15%). We discuss our findings within the context of a rapidly changing economy, evolving from a rural structure to an industrialized one, and provide some applied conservation recommendations. Indirect impacts caused by infrastructure should be approached, correcting technical problems, particularly black spots where mortality cases concentrate. Direct impacts, notably the rise in the rate of poisoning cases, need to be handled, managing the causes of increase of generalist predators, such as habitat structure, promoting the return of top predators and removing sources of subsidy, better than only fighting poaching by force.

Introduction
Subsistence economies typically impact wildlife in direct ways, such as trapping, hunting and poaching, poisoning or collecting, because human survival in these societies is directly dependent on the consumption of natural resources (Jorgenson, 1998; Carpaneto & Fusari, 2000; Milner-Gulland, Bennett & the SCB, 2003 Annual Meeting Wild Meat Group, 2003; Brashares et al., 2004). On the contrary, industrialized economies have more potential to impact wildlife indirectly by means of habitat alteration and loss, one of the major agents in the process of global anthropic change (MA, 2003). The main ways in which habitat is altered or destroyed are by means of pollution and infrastructure development, including roads and railways, power lines or wind farms (Ferrer & Hiraldo, 1992; Bevanger, 1998; Martínez-Abraín et al., 2006, 2012; Guíet et al., 2011; Carrete et al., 2012). Spain is a European country especially interesting to analyze how different socio-economical scenarios influence the way we impact wildlife because (1) it is one of the richest countries in biodiversity within the European context due to the nature of southern European peninsulas as refuges during the glacial periods of the Pleistocene (Nieto, 2011) and (2) it has experienced a rapid economical increase during the last few decades, having moved from a rural economy to an economy based on industry and tourism in a short time period. Human population grew from c. 38 million inhabitants in 1980 to more than 46 million in 2011, and moved away from rural areas to create large industrial cities, exploiting the surrounding countryside with advanced...
technological means. The number of licences for motor vehicles increased by 23% from 1995 to 2009, increasing the chances of animal road casualties; and the rate of power consumption increased by 45% during the period 1995–2011, leading to an increase in power-related infrastructures, which, in turn, increases chances of animal collision and electrocution. Specifically, the accumulated wind power in Spain has grown up to 19.149 MW installed in January 2010, which makes Spain the third largest wind-power producer in the world, just after the US and Germany (Carrete et al., 2009), increasing the chances of collision of birds and bats with wind turbines. Major economic subsidies to build infrastructures arrived since the incorporation of Spain to the European Union in 1986.

However, obtaining information on direct and indirect impacts to wildlife, at a country scale and for a long longitudinal series, is not an easy task. We did a first attempt of assessing this problem by using data on bird admissions to a wildlife rehabilitation centre in a particular Spanish region (i.e. Comunidad Valenciana) for a 14-year period (Martínez-Abraín et al., 2009). Other authors have worked with long-term data on the causes of raptor admission to rehabilitation centres in other Spanish geographical regions (see, e.g. Fajardo, 2001; Molina-López, Casal & Darwich, 2011).

Here, we have used a different data source on impacts by exploring all the issues published from 1982 to 2009 of the Spanish magazine Quercus. This is the oldest (i.e. 30 years old in December 2011) and most prestigious popular science publication in Spain dealing with nature study and conservation, which compiles news on impacts to wildlife recorded by knowledgeable naturalists, wardens, wildlife managers and ecologists all over the country. We cross-validated our results with a different dataset consisting of admissions of vertebrate wildlife to a major rehabilitation centre in eastern Spain for an 18-year period (1994–2011) in order to check whether or not pieces of evidence coming from different sources coincide in finding the same pattern.

We predict a negative trend in the relative frequency of the number of news published reporting direct impacts (poaching either by illegal poisoning, trapping or shooting) versus indirect impacts (damages by infrastructures) over the last 30 years, paralleling the large and rapid economical growth of the country that has distanced humans from the countryside, and is increasingly covering the territory with a complex network of energy- and communication-related infrastructures.

**Methods**

In order to test our hypothesis, we sampled the 215 issues of the magazine Quercus published between 1982 and 2009 (28 years). We looked for news reporting both direct and indirect impacts to protected wildlife. We considered as news all articles and short notes reporting injuries to individuals of any protected vertebrate species (excluding fish species) at any location of the Spanish geography. For each news, we recorded the type of damage (direct or indirect), the specific cause of direct (shooting, poisoning and trapping) or indirect damage (road kills, collision in wind farms, collision or electrocution in power lines, among other minor ones) and the taxon affected. Because an uneven number of issues was published annually, we standardized the number of news recorded per year in relation to the number of issues published annually, when comparing news recorded among years.

Firstly, to study the change over time in the relative influence of direct versus indirect impacts on wildlife, we run a simple linear regression of the ratio between direct (S) and indirect (I) impacts with time using the natural logarithm as a link function to obtain the slope of the model, and its 95% confidence interval (CI), so that the back-transformed exponentials of the slope and its 95% CI corresponded to the population growth rate (λ) and its 95% CI (see Martínez-Abraín et al., 2009). CIs were used to test the null hypothesis of stability (λ = 1) in the trend of the S/I ratio so that a CI containing the value 1 implies a statistically non-significant result. Values of λ higher and lower than 1 indicate increasing and decreasing trends of the ratio, respectively, that is, either a relative dominance of news reporting direct impacts in relation to news reporting indirect impacts or vice versa. We analyzed the trends for all vertebrate groups together and also for each individual vertebrate group considered: birds, mammals and herpetofauna (reptiles and amphibians). The relative variability of the trends of the S/I ratios was compared by means of the coefficient of variation of λ.

Secondly, in order to judge whether the observed negative trend of the S/I ratio for the overall dataset was due to a decrease in direct human persecution (S) or to an increase in indirect impacts (I), we explored simultaneously, by means of Poisson regressions (i.e. generalized linear models with Poisson error), multiple hypotheses explaining the number of records on direct impacts as a function of year and number of hunting licences active annually in Spain (source: National Institute of Statistics and Ministry of Agriculture), controlled by the number of news recording indirect impacts, using the software and environment R (R Development Core Team, 2010). The reason why we controlled by news on indirect impacts is that the space in the magazine to publish news is limited, and hence, a decrease in news on direct impacts could be just due to an increase in news on indirect impacts. Models were compared and selected by means of theoretical information criteria, duly corrected both for small sample size and overdispersion. Models with a difference in Akaike’s Information Criterion < 2 were considered as statistically equivalent (Burnham & Anderson, 2002). Modelling was only performed for the overall dataset with all vertebrate groups pooled together because sample sizes for zoological groups other than birds were small to have enough power for modelling.

A parallel analysis of the ratio between admissions due to direct impacts and admissions due to indirect impacts was performed with data on admissions of non-game vertebrate wildlife to a major rehabilitation centre in eastern Spain (i.e. La Granja de El Saler rehabilitation centre), during the period 1994–2011. Data were extracted only for the prov
ince of Valencia and for the months comprising the hunting season (October–February) so that comparison with indirect causes of impact can be performed. We used the results of this second analysis, using data from a completely different source, to cross-validate the results of our initial analysis of the news reported on impacts.

**Results**

**News data**

A total of 846 news was obtained over the 28 years of study, 65% of them dealing with direct impacts and 35% dealing with indirect impacts. Out of the indirect impacts, 50% dealt with accidents in power lines (electrocution and collision), 31% with communication infrastructure (roads, highways and railways) and 8% with collisions at wind farms. Out of the direct impacts, 51% of the news dealt with illegal shooting, 37% with illegal poisoning and 12% with illegal trapping. The trend of direct impacts reported (S) through time did not follow a clear decreasing trend, as it was weak and statistically non-significant [slope = −0.26 (slope 95% CI: 0.24, −0.76); \( r^2 = 0.04 \)]. However, when we removed the cases of poisoning from the cases of direct impact, to better show the direct impact of shooting, a stronger decreasing and statistically significant trend over time showed up [slope = −0.94 (slope 95% CI: −0.49, −1.39); \( r^2 = 0.4 \)]. The trend of the number of news reporting poisoning was strong, positive and statistically significant [slope = 0.68 (slope 95% CI: 0.45, 0.90); \( r^2 = 0.57 \)]. On the contrary, the trend of indirect impacts (I) recorded followed a much clearer increasing (and statistically significant) trend with time [slope = 0.56 (slope 95% CI: 0.24, 0.89); \( r^2 = 0.35 \)].

The natural logarithm of the number of news reporting indirect impacts was approximately half that reporting direct impacts in the 1980s, but it became roughly equal to the number of news on direct impacts towards the end of the time series (Fig. 1).

The relative comparison of news on direct versus indirect impacts showed a marked declining trend of the natural logarithm of the S/I ratio [slope = −0.049 (slope 95% CI: −0.074, −0.025); \( r^2 = 0.4 \)], suggesting an exponential decrease of the ratio (Fig. 2). This trend was stronger when considering only direct impacts without news related to poisoning [slope = −0.09 (slope 95% CI: −0.11, −0.07); \( r^2 = 0.7 \)] (Fig. 2). The magnitude of the decreasing trend was 5% annually for the dataset containing information on all vertebrate groups, although it rose to 9% when considering only direct impacts without poisoning. The values of \( \lambda \) for birds, mammals and herpetofauna were very similar, ranging from 3 to 5% annually, except for the case of birds when poisoning was not considered among direct impacts.
which rose to 10% (Table 1), suggesting that the overall λ,
when not considering poisoning, was mostly influenced by
birds. The higher coefficients of variations, indicating more
variable time series of the S/I ratio, were obtained for birds
when not considering poisoning (21%) or considering poi-
soning (15%), versus 3–9% for herpetofauna and mammals,
respectively (Table 1).

The results of our subsequent modelling, to disentangle
whether the decrease in the S/I ratio was due to a decrease in
news on direct impacts or to an increase in news on indirect
impacts, showed that the most parsimonious model explain-
ing the number of news reporting direct impacts (S) was the
null model. However, when using as dependent variable S
but excluding news on poisoning, the best model was the
one containing only the variable hunting licences as an
explanatory variable (Table 2). This was also the case when
modelling the number of news reporting poisoning (see
degree of fit of the most parsimonious models to data in
Fig. 3). Models containing licences together with the
number of news on indirect impact were statistically equiva-
lent to models containing only licences, but had much lower
Akaike’s weights (Table 2). Indeed, the trend of the number
of news reporting direct impacts, without including poison-
ing cases, decreases as the number of licences active annu-
ally in Spain decreases and also over time (Fig. 4).

Admissions data

The pattern reflected by the data on admissions to the
wildlife rehabilitation centre (n = 1604; 840 by direct causes and
764 by indirect causes) was similar (and even more pro-
nounced) to that obtained exploring the news on impacts
published in Quercus magazine. The natural logarithm of
the S/I ratio followed a strong decreasing trend over time
[slope = −0.16; 95% CI of slope: −0.2, −0.13]; \( r^2 = 0.84; \)
\( \lambda = 0.85 \) (95% CI: 0.82, 0.88), meaning a 15% annual
decrease and an exponential decrease of the S/I ratio

Table 1 Growth rates of the curves representing the ratio between
news recorded on direct (S) and indirect (I) causes of human impact
to wildlife and its 95% confidence intervals (CI). CV stands for the
coefficient of variation of the slope of a linear regression of the S/I
ratio with time. The subscript wp stands for ‘without accounting for
news on poisoning’

<table>
<thead>
<tr>
<th></th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
<th>CV</th>
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<tbody>
<tr>
<td>Total</td>
<td>0.95</td>
<td>0.92</td>
<td>0.97</td>
</tr>
<tr>
<td>Totalwp</td>
<td>0.91</td>
<td>0.88</td>
<td>0.93</td>
</tr>
<tr>
<td>Birds</td>
<td>0.95</td>
<td>0.92</td>
<td>0.99</td>
</tr>
<tr>
<td>Birdswp</td>
<td>0.90</td>
<td>0.87</td>
<td>0.93</td>
</tr>
<tr>
<td>Mammals</td>
<td>0.97</td>
<td>0.95</td>
<td>1.0</td>
</tr>
<tr>
<td>Herpetofauna</td>
<td>0.96</td>
<td>0.93</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Table 2 Multiple hypotheses testing by means of theoretical
information criteria of the effects of hunting licences active annually
(licences) on the number of news on direct impacts to wildlife (S)
reported annually, controlled by news reported on indirect causes (I).
(a) Considering all direct impacts. (b) Removing news dealing with
poisoning. (c) Considering only news on poisoning. The most
parsimonious models are shown in bold

<table>
<thead>
<tr>
<th></th>
<th>Res Dev</th>
<th>K</th>
<th>log-lik</th>
<th>QAICc</th>
<th>wi</th>
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</thead>
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<tr>
<td>(a) Models (S with all data)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S ~ 1</td>
<td>89.99</td>
<td>1</td>
<td>−113.4</td>
<td>65.89</td>
<td>0.54</td>
</tr>
<tr>
<td>S ~ Licences</td>
<td>86.92</td>
<td>2</td>
<td>−111.9</td>
<td>67.63</td>
<td>0.23</td>
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<tr>
<td>S ~ I</td>
<td>89.36</td>
<td>2</td>
<td>−113.1</td>
<td>68.29</td>
<td>0.16</td>
</tr>
<tr>
<td>S ~ Licences + I</td>
<td>85.03</td>
<td>3</td>
<td>−110.9</td>
<td>69.93</td>
<td>0.07</td>
</tr>
<tr>
<td>(b) Models (S without poisoning)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>S ~ 1</td>
<td>167.9</td>
<td>1</td>
<td>−146.5</td>
<td>65.13</td>
<td>0.01</td>
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<tr>
<td>S ~ Licences</td>
<td>114.4</td>
<td>2</td>
<td>−118.3</td>
<td>56.01</td>
<td>0.79</td>
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<tr>
<td>S ~ I</td>
<td>165.2</td>
<td>2</td>
<td>−145.2</td>
<td>67.14</td>
<td>0.00</td>
</tr>
<tr>
<td>S ~ Licences + I</td>
<td>111.2</td>
<td>3</td>
<td>−118.2</td>
<td>58.79</td>
<td>0.20</td>
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<tr>
<td>(c) Models (S with poisoning only)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S ~ 1</td>
<td>128.6</td>
<td>1</td>
<td>−113.5</td>
<td>76.99</td>
<td>0.00</td>
</tr>
<tr>
<td>S ~ Licences</td>
<td>73.30</td>
<td>2</td>
<td>−85.88</td>
<td>61.22</td>
<td>0.75</td>
</tr>
<tr>
<td>S ~ I</td>
<td>115.1</td>
<td>2</td>
<td>−106.7</td>
<td>74.64</td>
<td>0.00</td>
</tr>
<tr>
<td>S ~ Licences + I</td>
<td>71.50</td>
<td>3</td>
<td>−84.98</td>
<td>62.65</td>
<td>0.25</td>
</tr>
</tbody>
</table>

log-lik, log-likelihood; QAICc, Akaike’s Information Criterion; Res Dev,
residual deviance; wi, Akaike’s weights.
This decrease happened in parallel with a decrease of 55% in the number of hunting licences active in the region from 1994 to 2011 (from more than 100 000 to less than 50 000 licences active annually).

**Discussion**

We have used two types of proxies of the way protected wildlife is impacted in Spain: news reporting on damages to wildlife and admissions to a rehabilitation centre. Both types of data have their particular biases. Accidental impacts by indirect causes tend to be overestimated because monitoring of man-made infrastructures can be performed in a systematic way and relate deaths or injuries to causes easily, whereas impacts by direct causes (poaching, poisoning) tend to be underestimated because these activities are forbidden by law and victims are hidden by hunters or game managers (González *et al.*, 2007; Rodríguez *et al.*, 2010). However, as we have worked with the relative weight of both types of impacts, we can safely assume that biases are similar for direct and indirect impacts among years. As far as we know, the editorial policy of the magazine Quercus has not changed over the years (e.g. changes in the decision of highlighting more indirect vs. direct impacts in recent years), despite one change in editor-in-chief during the study period (Sastre *et al.*, 2004). Some positive bias on news dealing with negative effects caused by infrastructures could be due to the fact that news in popular science magazines tend to increase after research was published in scientific journals. Research on bird electrocutions in Spain started to be published at the beginning of the 1990s (Ferrer, de la Riva & Castroviejo, 1991; Ferrer & Negro, 1992; Ferrer & Janss, 1999) and research on the effects of wind farms by the mid-2000s (Barrios & Rodríguez, 2004; De Lucas, Janss & Ferrer, 2004, 2005, 2007), with a time lag of about one decade after the negative impact on wildlife became evident (Guyonne *et al.*, 2010). Hence, a likely ‘publication effect’ could be an underestimation of the effects of infrastructures during the study period, meaning that most likely we have been conservative in our results.

Data on admissions due to direct or indirect impacts are subject to different types of biases compared with published news (e.g. poisoned individuals found thanks to radio-marking birds and reported as news, do not necessarily are admitted in rehabilitation centres, although they should), but again the important fact is that main biases affect direct and indirect admissions equally over the years, and hence, the relative comparison between both datasets is informative. Only during the last 3 years of study (2009–2011), we suspect that there may be some positive bias towards admissions by indirect impacts in the rescue centre studied because special attention has been invested to exploring the impact of power lines on bird species. However, this is not very relevant because the trend of the S/I ratio crosses the line of a 1:1 S/I ratio in 2004 and remains beyond the line from that year on. The fact of having found similar patterns (i.e. decreasing S/I ratio over time) from both sources of data is quite reassuring, suggesting that our results are prob-
ably representative of the real pattern. Importantly, our modelling allowed us to state without doubts that the decreasing trend in direct persecution S, without accounting for poisoning, was not an apparent decrease due to an increase in indirect causes, but a real decrease in direct shooting and trapping, a point that has been identified as an unsolved conundrum in other studies (see, e.g. Martinez et al., 2006).

The pattern found also coincides with the more partial analysis carried out by Martinez-Abrain et al. (2009) for birds and also with the long-term analysis (1994–2009) of the dataset on carnivore admissions to three rehabilitation centres run by the regional government at Comunidad Valenciana (Conselleria de Infraestructuras, unpublished data). A similar pattern emerged in the pioneer study by Fajardo (2001) on the causes of mortality of the barn owl Tyto alba in Spain, with reduced levels of shooting and nest robbing, but increased number of road casualties for the period 1990–1999 compared with 1983–1989. Similarly, Margalida et al. (2008) found that whereas the number (n = 106) of bearded vultures Gypaetus barbatus dead in Europe because of collision/electrocution had remained stable or increased slightly between 1986 and 2006, the number of cases of shooting declined during the last 6 years of their study and the cases of poisoning increased.

The analysis of admissions of raptors (n = 2611) to a rehabilitation centre in the Canary Islands during the period 1998–2007 also reports on increasing weight of indirect impacts versus direct persecution of birds of prey (Rodríguez et al., 2010). Additionally, the results by Molina-López et al. (2011) are also quite coincident with ours because they found increasing trends for electrocutions and unknown traumas, decreasing trends for vehicle trauma and a constant impact of gunshot injuries for Catalanian raptors admitted to a rehabilitation centre (n = 7021 birds) during 13 years (from 1995 to 2007).

The relative increase in indirect causes of impact (i.e. infrastructures) during the study period clearly reflects the rapid and deep change in Spanish socio-economic indicators, with most people gathered in a few large industrial cities (c. 30% of the population in 25 major cities), far from the rural world. This fact is well-reflected by the decrease in hunting licences active annually in Spain, as this activity traditionally aiming at small prey such as partridges, quails, rabbits, hares, pigeons, doves or thrushes by rural inhabitants is lately moving towards the more selective hunting of big game such as deer and wild boars, as a luxurious activity practiced by a lower number of upper class citizens. This trend most likely will become more pronounced in the future as rural areas continue to be abandoned, Spanish hunters become increasingly aware of environmental problems (González et al., 2007; Martinez-Abrain et al., 2008), and the growth of infrastructure goes on, although at a slower pace.

In order to see how direct persecution by hunting has decreased in relation to indirect causes, it was necessary to analyze the time series of poisoning cases (without distinguishing between planned and secondary poisoning with products used for pest control; see, e.g. Schultz et al., 2004) independently because poisoning has increased at a dangerous pace during the study period all over Europe (see Margalida et al., 2008), despite substantial efforts to prevent its use by environmental authorities and non-governmental organizations (e.g. SEO/BirdLife Antidoto program and Life+ VENENO project in Spain). Its increase is probably related to the demographic recovery of generalist mesopredators (i.e. meso-predator release; Gomper & Vanak, 2008) due to its legal protection and hence reduced human persecution, together with the scarcity of top predators that could regulate its numbers, and the abundance of human-related sources of food subsidy (see, e.g. Gosselin et al., 2007; Ritchie & Johnson, 2009). It is therefore a conservation paradox that the recovery of opportunistic mesopredators may have led to an indiscriminate use of poisons in the countryside, with undesirable side effects on threatened wildlife (e.g. González et al., 2007; Recio & Virgós, 2010; Tavecchia et al., 2011). In occasions, meso-predator persecution has also been triggered by population crashes in small prey-game species caused by emerging infectious diseases (such as viral haemorrhagic pneumonia) and hence unrelated to predator density (see, e.g. Villafuerte, Viñuela & Blanco, 1998).

Both types of impacts (indirect and direct) are now reported at an equal rate; however, we cannot tell whether the number of individuals affected by both types of causes is larger or smaller because we did not record the number of individuals affected in each news, simply because many of them did not provide that information. For example, an electrocution event affecting 400 individuals in a given time period, and generating a single news, cannot be compared with 10 news on shooting affecting one individual each during the same time period. Or, alternatively, one single poisoning news affecting many individuals cannot be compared with 10 news on collision against wind farms affecting one individual each. Hence, we can only be conclusive regarding the frequency of both types of causes, but translating this into numbers of individuals affected is not possible.

Applied conservation implications

Ideally, knowing the way we are impacting wildlife should shed some light to prevent future impacts. Clearly, in the case of Spain, and probably of other European countries such as Portugal, Italy, Greece or France, management should focus on reducing the growing impact of infrastructures and on investing massive effort in eradicating poison from the countryside. The first point requires focusing on technical solutions such as removing particular black spots of mortality (see, e.g. Real et al., 2001; González et al., 2007; Ferrer et al., 2011; López-López et al., 2011), with special attention to non-breeding areas in the case of large raptors, as mortality in wind farms and power lines does not happen evenly in space but tends to concentrate in some individual power pylons and wind turbines (see, e.g. Mañosa, 2001; Barrios & Rodriguez, 2004; Gui et al., 2011; De Lucas...
et al., 2012; Martínez-Abrain et al., 2012), and improving inadequate safety correction measures (Negro & Ferrer, 1995; Janss & Ferrer, 1999; González et al., 2007; Tintó, Real & Mañosa, 2010; López-López et al., 2011). The second point requires reducing subsidies to meso-predators, promoting the recovery of top predators (see, e.g. Palomares et al., 1995; Gosselink et al., 2007; Bino et al., 2010; Fernández-Olalla et al., 2012; but see Mateo-Tomás et al., 2012), and managing the structure and keystone ecological factors of the landscape against the proliferation of smaller predators (Brown & Litvaitis, 1995; Litvaitis & Villafuerte, 1996; Fernández-Olalla et al., 2012). This way, small-game managers will not feel tempted to use poison illegally to try to artificially regulate populations of generalist predators by means of non-selective culling methods, with undesirable side effects for non-target threatened species (see, e.g. González et al., 2007). This indirect strategy, in combination with law reinforcement, most likely would have higher efficacy and efficiency rates than only fighting poisoning by force.

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