



Short communication

Past experiences drive citizen perception of wild boar in urban areas

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ABSTRACT

Wild boar (*Sus scrofa*) populations in urban environments have increased during the last decades. This has led to a new scenario where humans share the space with this recent colonising species inside urban areas. Citizen perception on wild boar presence must be taken into account to assure the most suitable design, application and acceptance of management measures. In order to advance in the knowledge and comprehension of urban wild boar perception by citizens, we conducted 181 surveys to women and men representing all age classes. Our questions were focused on assessing citizen features, experiences and attitudes regarding wild boar presence in the urban area of La Floresta (Sant Cugat del Vallès, Barcelona, Spain). We used a recursive partitioning approach through regression trees to explore the relationship between a Wild Boar Perception Score (WBPS) and citizen profile, past and current experiences involving wild boars, contact with wild boars and acceptance of management measures.

Our results show that the WBPS is mainly driven by previous incidents suffered by the respondent, independently of citizen profile, current experiences, level of contact and acceptance of management measures.

The respondents answered that measures should be taken to minimize wild boar incidents (37%) and to help wild boars to return to their habitat (27%), whereas 16% chose to coexist with wild boars in the current conditions. Culling all the wild boars was not supported at all, even among the citizens with the most negative perception of wild boar.

Citizens with positive perception of wild boar presence in urban areas contribute to reinforce the phenomenon by feeding wild boars. Our results verify that socio-demographic variables such as gender, education and public health concern are less important than past experiences to drive citizen perception and explain resident attitudes. Information campaigns on the causes, consequences and effective management options for urban wildlife could help to improve understanding and acceptance of the circumstances and currently non-socially accepted possible solutions. Evaluation of citizen perception and information campaigns should precede wildlife management measures, in order to gain acceptance by residents before being implemented.

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Wild boar (*Sus scrofa*) has the widest geographical range of all northern wild ungulates and this range has been greatly expanded by planetary-scale changes such as depopulation of rural areas, mild winters, lack of predators and forest encroachment in some areas (Vetter et al., 2015; Massei et al., 2015). Wild boar is considered a potential invasive species and the annual intensification of

hunting pressure in an attempt to control and reduce its populations has proven to be ineffective (Massei et al., 2015).

The number of wild boar records in several European cities (for instance Berlin, Barcelona, Rome, Vilnius and Budapest, among others) has also increased in the last decades (Sáez-Royuela and Tellería, 1986; Castillo-Contreras et al., 2018). This wild boar increase in urban areas could be a consequence of exploiting anthropogenic food resources, such as refuses and waste material, food and water at public green areas and food provided by wild boar feeders (Kotulski and Koenig, 2008; Castillo-Contreras et al., 2018).

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Inside urban areas, wild boars cause traffic accidents, damage to courtyards, green areas and street furniture. Minor attacks have been recorded on humans as well as domestic pets, and they have been reported to follow an increasing trend in some urban areas (Mayer, 2013; Fernández-Aguilar et al., 2018). Wild boar also pose a risk of pathogen transmission, such as *Mycobacterium tuberculosis* complex, *Salmonella enterica*, *Campylobacter* spp., *Streptococcus suis*, *Rickettsia slovaca*, *Leptospira* spp. or *Chlamydia* spp.; and they produce negative effects on plant and animal species richness and abundance (Jansen et al., 2007; Ortuño et al., 2007; Di Francesco et al., 2013; Navarro-González et al., 2013; Mentaberre et al., 2014; Fernández-Aguilar et al., 2018).

Lethal measures such as culling have been proposed as successful wildlife management measures in order to deal with local overabundant populations, including the introduced American mink (*Neovison vison*) in southern England (Harrington et al., 2009); stabilization of chronic wasting disease in white-tailed deer (*Odocoileus virginianus*) in Illinois (Manjerovic et al., 2014); mitigation of wild boar (*Sus scrofa*) overpopulation in Europe, Australia and the United States (Massei et al., 2011); control of bovine tuberculosis infection in European badger (*Meles meles*) in Ireland (Abdou et al., 2016) or introduced coypu (*Myocastor coypus*) populations in Italy (Panzacchi et al., 2007). In the particular case of growing Mediterranean wild boar populations, selective elimination (culling) of juvenile and young wild boars has been recently proposed as a more efficient measure than simply intensification of traditional non-selective hunting pressure to control population increase (González-Crespo et al., 2018).

However, local attitudes towards wildlife are key for humans and wildlife coexistence (Bencin et al., 2016), and management measures acceptance varies according to different areas, human perception of the problem and different characteristics of the affected species (Liordos et al., 2017). Therefore, to implement management measures it is essential to assess public perception of the conflict and acceptance of the measures.

Wildlife presence in urban areas can modify resident perception on a cost-benefit trade-off, depending on positive or negative past experiences with the particular species (Belaire et al., 2016; Sekhar, 2003; Bencin et al., 2016; Brook and van Beest, 2014). People are a part of all human-wildlife conflicts, so social research methods are essential for finding solutions. Conflicts arise when the costs that wildlife causes to residents are more significant than benefits, suggesting that negative perceptions more strongly determine human attitudes (Kansky and Knight, 2014).

The objective of this study is to obtain information about the factors driving citizen perception of wild boar presence in urban environments, providing information and tools for managers to deal with wild boar-related conflicts according to citizen perception and acceptance of management measures.

We interviewed 181 citizens, 85 women and 96 men classified into five age groups: “under 18 years old” (n=22), “18 to 30 years old” (n=46), “31 to 45 years old” (n=67), “46 to 60 years old” (n=39) and “over 60 years old (n=7)”, in La Floresta (Sant Cugat del Vallès, Barcelona, Spain) during June and July 2015. La Floresta (UTM31 N/ETRS89 X: 422564, Y: 4589101) is a neighbourhood of 4430 inhabitants in Sant Cugat del Vallès, a municipality of the metropolitan area of Barcelona. The entire neighbourhood lies on the northwestern slope of Collserola Natural Park (CNP) within the Collserola massif. The urban area of La Floresta is hilly, poorly planned and structured, mostly made up of family dwellings interspersed with scrubland and forest patches. Due to sociological, environmental and urban planning reasons, a stable and habituated wild boar population openly thrives throughout the urban area (Cahill et al., 2012). This provides an exceptional scenario of increased interaction between human and wild boars to study citizen perception of urban wild boar.

The questionnaire (Electronic supplementary material -ESM- Table 1 and Figures 1 and 2) had 20 questions divided into two sections, the first one aimed at characterizing the individual traits of the surveyed inhabitant and the second one focused on issues related to wild boar presence inside the neighbourhood. Five questions from the second section (PS1, PS2, PS3, PS4, and PS5) were used to calculate the Wild Boar Perception Score (WBPS) using the formula $WBPS = PS1 + PS2 + PS3 + PS4 + PS5$, positively correlated with a positive perception of wild boar (the higher the WBPS, the better the perception of wild boar). On the other hand, questions number 12, 14 and 16 served as a proxy for urban wild boar feeders (WBfeed), people who consume wild boar (WBconsumer) and people who had previously suffered incidents with wild boar (WBinc), respectively. In order to assess the relationship between citizen profile and wild boar perception in urban areas, WBPS values were used as a continuous response variable and citizen profile variables as either continuous or categorical explanatory variables to construct a regression tree (ESM Table 2 and 3) using a cross-validation method considering calibration and validation errors. Models were run in the R software version 3.5.0 (R Development Core Team, 2018), using “rpart” (Therneau et al., 2015), “gplots” (Warnes et al., 2016), and “rpart.plot” (Milborrow, 2016) packages.

Most of the respondents (93%) liked seeing wild boar in urban areas (question number -Q- 11, PS1), and perceived wild boar presence as a positive distinction for the neighbourhood (51%; Q17, PS4), feeling respect (61%) and friendship (31%) for wild boars (Q13, PS2). A small proportion of citizens also found wild boar presence in urban areas positive as a local and organic protein source (6%), contributing to less presence of stray dogs (5%) and beneficial for children as they can play together (3%, see Q17, PS4).

Overall, wild boar presence in urban areas was not perceived as negative at all by 37% of the citizens (Q18, PS5) whereas 31% affirmed that wild boars cause some minor problems and 25% not problems at all (Q15, PS3).

Conversely, 15% of the participants agreed that wild boar presence in urban areas was not beneficial at all (Q17, PS4) and 27% of the participants thought that wild boars should live in the forest (Q20). The major negative concern about wild boar presence was vehicle collision risk (17%), followed by damage to urban zones (16%) and risk towards pets (7%). Finally, 7% of the participants were worried about the risk for people related to health issues (Q18, PS5).

On Q20, regarding the potential need for management measures to be undertaken, 37% of the answers pointed that measures should be taken to minimise wild boar incidents in urban areas for a better coexistence. The most popular option was helping the wild boars to return to their habitat (27%), followed by coexisting with wild boars in the current conditions (16%). No culling of wild boars at all was supported by 13% of the participants, while 7% agreed on the use of contraception and 1% proposed that people should feed wild boars. Nobody supported culling all wild boars as an option.

Our regression tree analysis explained 12.2% of the observed WBPS variability and 10% after our cross validation procedure (Fig. 1). The citizens with the highest WBPS (3.6) were those scoring less than 0.5 points in incidents suffered (Q16, WBinc) and usual or occasional feeders of wild boars. Therefore, citizens with positive perception of wild boar presence in urban areas contributed to reinforce the phenomenon by habituating the wild boar to consume anthropogenic food. In this case, awareness campaigns focused on the reduction of wild boar direct feeding can contribute to minimise their presence in urban areas. Conversely, citizens with a WBinc value of 0.5 or more, who “always” or “never” feed wild boars and have the highest education level, showed the lowest WBPS value (−0.18). This suggests that negative incidents determine negative perception both for habitual feeders, who have an increased chance of having negative interactions, as well as for citizens not particularly prone to interact with wild boar.

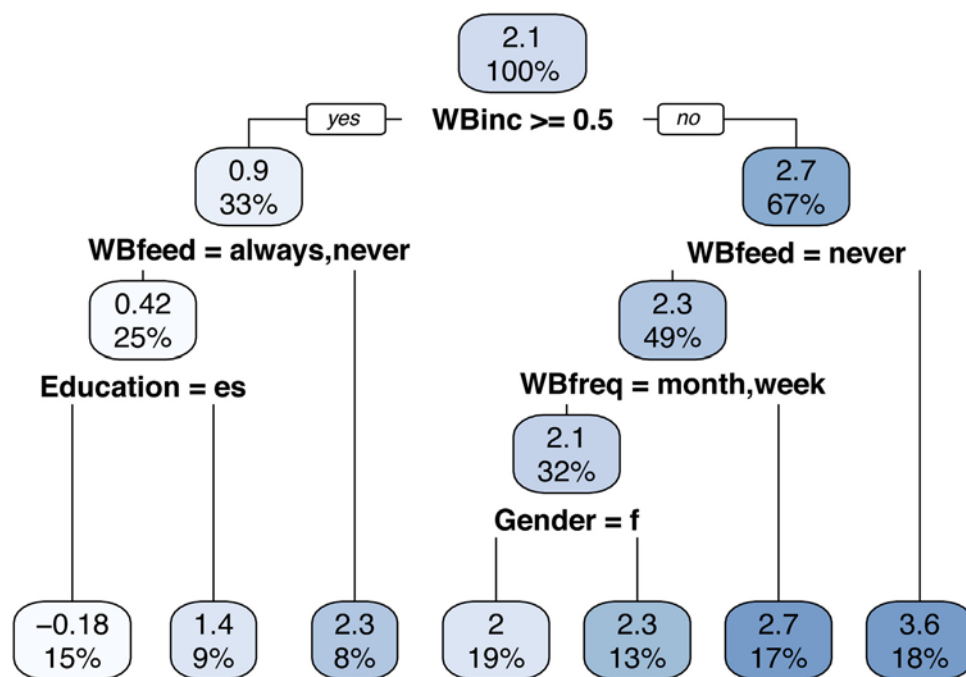


Fig. 1. Regression tree model predicting the Wild Boar Perception Score (WBPS) according to five explanatory variables detailed below. The text in each split shows the variable used to divide the dataset according to a value or category from that variable (Electronic supplementary material, Tables 2 and 3). The value at the top of each node indicates the predicted WBPS value for the citizens accomplishing the conditions leading to that node. The percentage indicates the proportion of observations included in the node. In each node the sample is split into two subgroups; the observations agreeing with the node condition are included in the left branch, whereas the ones failing to comply with the condition are included in the right branch. The first explanatory variable selected by the tree model is wild boar incidents (WBinc, Question 16). Descending left from the first node (overall WBPS = 2.1), citizens with a WBinc score of 0.5 or higher are more likely to show a lower value in WBPS (0.9) than citizens who have not suffered incidents with wild boar (WBinc < 0.5, WBPS = 2.7). Citizens with WBinc ≥ 0.5 who “always” or “never” feed the wild boar are more likely to show a lower value in WBPS (0.42) than the citizens into the same category who “occasionally” feed the wild boar (2.3). Among the citizens with WBinc ≥ 0.5 and who “always” or “never” feed wild boar, WBPS is lower (−0.18) in citizens with superior studies than without them (1.4). Citizens with WBinc < 0.5 who never feed wild boar are more likely to show a lower WBPS (2.3) than the citizens who “always” or “sometimes” feed wild boar “always” or “sometimes” (3.6). Then, citizens with WBinc < 0.5 who do not feed wild boar and see them “monthly” or “weekly” show a lower WBPS (2.1) than citizens who see wild boars “daily” or “never” (2.7). Within this node (WBfreq = “month” and “week”), female citizens show a lower WBPS value (2) than male citizens (2.3).

Hence, our model shows that wild boar perception in urban areas is influenced by the past negative experiences suffered by the citizens. Previous studies already pointed out that negative attitudes towards wildlife are associated with negative experiences (Bencin et al., 2016). Furthermore, people who have suffered direct experiences are more likely to have stable, difficult-to-change attitudes (Browne-Nuñez et al., 2014), and direct contact leading to negative experiences involving wild boar could provoke anxiety or fear in people (Baltasar et al., 2008). Thus, the negative perception of wild boar presence in urban areas is expected to rise with increasing negative incidents related to wild boar (Baltasar et al., 2008; Liordos et al., 2017). The close contact between wild boars and humans in our study area (Cahill et al., 2012) could therefore lead to an increasing negative perception of urban wild boar.

However, our results reveal a substantial level of tolerance towards wild boar in our study area (ESM Table 1, section 2, Q11, Q15 and Q18), a key determinant for sustainable coexistence between humans and wildlife (Bruskotter et al., 2009; Treves and Bruskotter, 2014; Bencin et al., 2016). This tolerance for wildlife is a common topic of research and a management objective in wildlife conservation in order to decrease conflict, and there is ongoing debate on how to conceptualise this concept when conducting human dimension research (Browne-Nuñez et al., 2014). As in other published studies, our results verify again that socio-demographic variables such as gender, education and public health concern are less important than past experiences to explain resident attitudes (Kansky and Knight, 2014). Living in a more pleasant residential environment in contact with nature is one of the reasons for peri-urban human migration (Ford, 1999). Altogether with

the biased features of the sample population, with predominance of higher educated (66%) and pet owners (74%), could explain this positive perception of wild boar in La Floresta in spite of the close contact.

The concern about threats and risks caused by wildlife, particularly those related to human safety, cause negative perception among residents (ESM Table 1, section 2, Q18, Browne-Nuñez et al., 2014; Sakurai et al., 2013) and may more strongly determine attitudes than positive perceptions (Kansky and Knight, 2014). The relative importance of costs versus benefits in determining attitudes to different wildlife species would usefully inform about the benefits needed in order to counter the costs of living with wildlife (Kansky and Knight, 2014).

In this specific scenario, increased tolerance may be related to human attitudes that worsen the problem. Tolerant citizens in front of wild boar presence are commonly those directly feeding wild boar, which contributes to wild boar habituation to human presence. This human behaviour fosters the persistence of wild boar in urban areas and increases the human-wildlife conflict. The respondents of this survey reported traffic accidents (5%) and aggressiveness towards humans (5%) and pets (12%) as negative experiences involving wild boars. The danger posed by wild boar presence in urban areas is higher than the danger posed by other species ranging in the same conditions due to its size, weight, strength and tusks. The reported incidents suggest that the sustainable coexistence with wild boar may differ from that suitable for other urban species with less harmful potential.

Because of the aforementioned problems, a variety of management approaches are being considered to regulate wildlife

populations, ranging from attempts of complete local eradication to reduction of urban population once number or damage thresholds are exceeded (González-Crespo et al., 2018; Toger et al., 2018). However, resident values and attitudes must be considered if wildlife management programs are to be successful and sustainable (Sakurai et al., 2013). As in other studies, public preferences for urban wildlife management were controversial in La Floresta, and the most effective methods for reducing conflict are not always accepted (Liordos et al., 2017). Attempts to decrease wild boar abundance by culling individuals could lead to public opposition (Toger et al., 2018), since lethal wildlife managing methods were not widely accepted in La Floresta (ESM Table 1, Q15 to Q20). However, only 13% of the population supported no killing at all, which means that the remaining 87% could accept some forms of culling. The questionnaire aimed at detecting extreme attitudes towards culling (i.e., no culling acceptance at all or culling all the wild boars), but fine-tuning questions about culling acceptance in certain cases and under specific conditions could help managers to design socially accepted management protocols including partial culling as a measure.

Information campaigns on the causes, consequences and effective management options for urban wildlife could help to improve understanding and acceptance of the circumstances and possible solutions, but communication programs conducted by wildlife management organisms can be ineffective if people have distrust in public managers (Sakurai et al., 2013). Our findings suggest that sustainable coexistence in La Floresta can be maintained if incidents are prevented by culling aggressive individuals and restricting wild boar access to anthropogenic resources.

Evaluation of citizen perception and information campaigns should precede the application of any wildlife management measure in humanized areas (either human or rural, for wild boar or for any other potentially conflictive species), in order to gain acceptance by residents before being implemented. Then, measures are more understood, feasible and with higher chance of succeeding. By analysing citizen perception, it is possible to determine the human social groups perpetuating the conflict. Authorities can gain feasibility concentrating efforts on those specific groups. Awareness and information campaigns focused on preventive measures to counter the risk posed by wild boar presence can contribute to allow the currently non-socially accepted measures to be more acceptable. Such campaigns should be carried out to promote this change in attitude through knowledge and not by fear, in order to keep a sustainable coexistence between humans and wildlife.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.mambio.2019.04.002>.

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