

Wild boar populations up, numbers of hunters down? A review of trends and implications for Europe

Giovanna Massei,^{a*} Jonas Kindberg,^b Alain Licoppe,^c Dragan Gačić,^d Nikica Šprem,^e Jiří Kamler,^f Eric Baubet,^g Ulf Hohmann,^h Andrea Monaco,ⁱ Janis Ozoliņš,^j Sandra Cellina,^k Tomasz Podgórski,^l Carlos Fonseca,^m Nickolay Markov,ⁿ Boštjan Pokorny,^o Carme Rosell^p and András Náhlik^q

Abstract

Across Europe, wild boar numbers increased in the 1960s–1970s but stabilised in the 1980s; recent evidence suggests that the numbers and impact of wild boar has grown steadily since the 1980s. As hunting is the main cause of mortality for this species, we reviewed wild boar hunting bags and hunter population trends in 18 European countries from 1982 to 2012. Hunting statistics and numbers of hunters were used as indicators of animal numbers and hunting pressure. The results confirmed that wild boar increased consistently throughout Europe, while the number of hunters remained relatively stable or declined in most countries. We conclude that recreational hunting is insufficient to limit wild boar population growth and that the relative impact of hunting on wild boar mortality had decreased. Other factors, such as mild winters, reforestation, intensification of crop production, supplementary feeding and compensatory population responses of wild boar to hunting pressure might also explain population growth. As populations continue to grow, more human–wild boar conflicts are expected unless this trend is reversed. New interdisciplinary approaches are urgently required to mitigate human–wild boar conflicts, which are otherwise destined to grow further.

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1 INTRODUCTION

Wild boar (*Sus scrofa*) are among the most widely distributed large mammals in the world. The natural range of the species extends from Western Europe and the Mediterranean basin to Eastern Russia, Japan and South-east Asia.¹ In Europe, wild boar has recently recolonised Sweden, Finland and Estonia.^{2,3} In the United Kingdom and in Denmark the species has become re-established following farm escapes.^{4–6} The presence of wild boar in Sweden meant the species was expected to recolonise Norway,⁷ and in 2013 the first wild boar was shot 40 km from Oslo (<http://sciencenordic.com/wild-boars-generate-worries->). Wild boar occur throughout a wide spectrum of habitat types, ranging from semi-arid environments to marshes, forests and alpine grasslands.¹ In Europe, increasing numbers of wild boar sightings were reported in urban and

c SPW-DEMNA-DNE, Laboratoire de la Faune Sauvage et de Cynégétique, Gembloux, Belgium

d Faculty of Forestry, University of Belgrade, Belgrade, Serbia

e University of Zagreb, Zagreb, Croatia

f Mendel University, Brno, Czech Republic

g Office National de la Chasse et de la Faune Sauvage, Birieux, France

h Research Institute for Forest Ecology and Forestry Rhineland-Palatinate, Trippstadt, Germany

i Regional Parks Agency – Lazio Region, Rome, Italy

j State Forest Research Institute 'Silava', Salaspils, Latvia

k Administration de la Nature et des Forêts, Luxembourg, Luxembourg

l Mammal Research Institute, Polish Academy of Sciences, Białowieża, Poland

m Department of Biology and CESAM, University of Aveiro, Aveiro, Portugal

n Institute of Plant and Animal Ecology, Russian Academy of Sciences, Russia

o ERICo Velenje and Environmental Protection College, Velenje, Slovenia

p MINUARTIA and Facultat Biologia Animal, Universitat de Barcelona, Barcelona, Spain

q University of West Hungary, Sopron, Hungary

* Correspondence to: Giovanna Massei, National Wildlife Management Centre, Animal and Plant Health Agency, Sand Hutton, York YO26 5LE, UK. E-mail: giovanna.massei@apha.gsi.gov.uk

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a National Wildlife Management Centre, Animal and Plant Health Agency, York, UK

b Department of Wildlife, Fish and Environmental Studies, Swedish University of Agricultural Sciences, Umeå, Sweden

suburban areas, for instance in Berlin, Barcelona, Rome, Vilnius and Budapest (e.g. Náhlik A, unpublished; Monaco A, unpublished).^{8,9} In Belgrade, the number of wild boar killed in the suburban area rose from 97 in 2004–2005 to 374 in 2013–2014 (Gačić D, unpublished).

Among ungulates, wild boar are characterised by the highest reproductive rate, with annual population growth rates that may exceed 2.0.^{10–12} The main causes of natural mortality for this species are starvation due to extreme weather conditions,^{13,14} diseases¹⁵ and predation by wolf (*Canis lupus*).^{16,17} However, hunting, and to a lesser extent road traffic accidents, make the greatest contribution to wild boar mortality.^{12,17–22}

The impact of wild boar on conservation and economic interests includes spread of diseases to livestock and people, vehicle collisions, and damage to crops and amenities, as well as reduction in plant and animal abundance and richness.^{23–28} As wild boar numbers appear to increase in many European countries, their impact is also increasing,^{3,12,19,20,29–31} and mitigating human–wild boar conflicts will present a significant challenge.

A review of wild boar population trends carried out in the 1980s³² showed that the simultaneous increases in wild boar numbers in different European countries between the 1960s and the 1980s followed a logistic curve, with a sharp increase in growth rate between 1965 and 1975 and a plateau in the following decade, when numbers appeared to stabilise. These trends in wild boar numbers were attributed to a combination of species-specific biological factors (e.g. very high reproductive output and dispersal potential), as well as to other changes, which included lack of large predators, reforestation, deliberate releases for sport hunting, supplementary feeding, habitat alteration due to human activities and mild winters which improved survival.^{2,29,33–38}

Three decades later, many of these factors are still operating, and current trends of landscape development indicate that human–ungulate conflicts, and in particular human–wild boar conflicts, are increasing.^{39–49} In parallel, the apparent decline in hunter numbers observed in several western countries⁴² suggests that the relative importance of hunting, as the main cause of wild boar mortality, will decrease. Analysing wild boar population trends in recent decades and understanding the factors affecting these trends are crucial to managing the presence of this species and its impact in the near future.

The aims of this paper were: (1) to describe wild boar population trends in European countries over the last three decades; (2) to illustrate hunter population trends in the same timeframe; (3) to discuss the implications of wild boar and hunter population trends for mitigation of human–wild boar conflicts.

2 METHODS

Wild boar population numbers were derived from hunting bags provided by local and national hunters associations or by focal points (academic and research institutions, local authorities, etc.) (see Appendix 1) from 18 selected European countries. Although some countries have maintained hunting statistics since 1930, most started collecting data in the mid-1970s. As trends for some European wild boar populations had been analysed up to the early 1980s,³² this review focused on the last three decades, from 1982 to 2012 or 2013. For ease of presentation, countries were divided into four arbitrary groups, based on the numbers of wild boar harvested in the latest year as follows: <10 000, 10 000–50 000, 50 001–200 000 and >200 000.

For most countries, data were available at the national scale. For some countries, data were collected only for part of the national territory or extrapolated to the whole country as follows:

Italy A complete dataset was available for five out of the 21 regions. Based on hunting bags in other regions in recent years, these five regions represent 73% of the total number of wild boar harvested.⁴³ The data reported in Fig. 1 are extrapolated to the whole country (100%) by adding 27% of the wild boar annually harvested in the five regions to the actual numbers harvested in these five regions. However, the National Ungulate Databank suggests that these statistics might be widely underestimated.⁴³ Thus, we can hypothesise that the total number of wild boar culled in Italy in recent years could be as high as 300 000 animals instead of the ca 200 000 reported here (Monaco A, unpublished).

Belgium Wild boar are present throughout the country, but data are reported only for the southern part of the country (Wallonia), as wild boar colonised Flanders (North Belgium) only a few years ago (data from 2006). Data from Wallonia in 2012 represented 98% of the total hunting bag.

Russia The official statistics reported here are likely to underestimate the true numbers of wild boar harvested, although the bias was impossible to quantify.

Germany Owing to reunification in 1989/90, data on number of hunters and wild boar harvested were likely to be accurate after 1989/90 (Hohmann U, private communication).

Croatia, Serbia and Slovenia The splitting of former Yugoslavia into several countries did not influence the hunting statistics of these countries, as population management and national hunting statistics have been separated for each country since the 1950s. However, data on the number of wild boar harvested in Serbia and Croatia are highly underestimated (by >30%), while data from Slovenia are very accurate (Pokorny B, unpublished).

Although the accuracy of hunting bags was acknowledged to vary significantly between countries, we assumed that potential biases would be relatively constant within each country over time, and that these data would provide the best available indicators of wild boar population trends.

To quantify wild boar population trends during the last three decades, an index of annual population growth rate was estimated for each country by dividing the number of wild boar harvested in one year by the number harvested the previous year. Values were averaged across all the countries and reported for the 1983–2012 period. The quinquennial changes in number of wild boar were also considered because 5 year timeframes are often used when planning population control strategies.⁴² The quinquennial changes in number of wild boar harvested were expressed by dividing the average number of animals harvested in a 5 year period by the average number of wild boar harvested in the previous 5 years. Values were averaged across all the countries and reported for the 1986–2012 period.

Data on the number of hunters or on the number of hunting licences (hereafter referred to as 'number of hunters') were derived from the sources reported in Appendix 1 for 17 countries. While in most instances it was not possible to determine the actual proportion of hunters engaged in wild boar hunting, out of the total population of hunters, the data were used as indicators of trends at the national level. For ease of presentation, data on the number of hunters were divided into four arbitrary groups, based on latest numbers recorded, as follows: <30 000, 30 000–100 000, 100 001–500 000 and >500,000.

For each country, a linear regression was fitted between years and the number of hunters; to account for autocorrelation in the

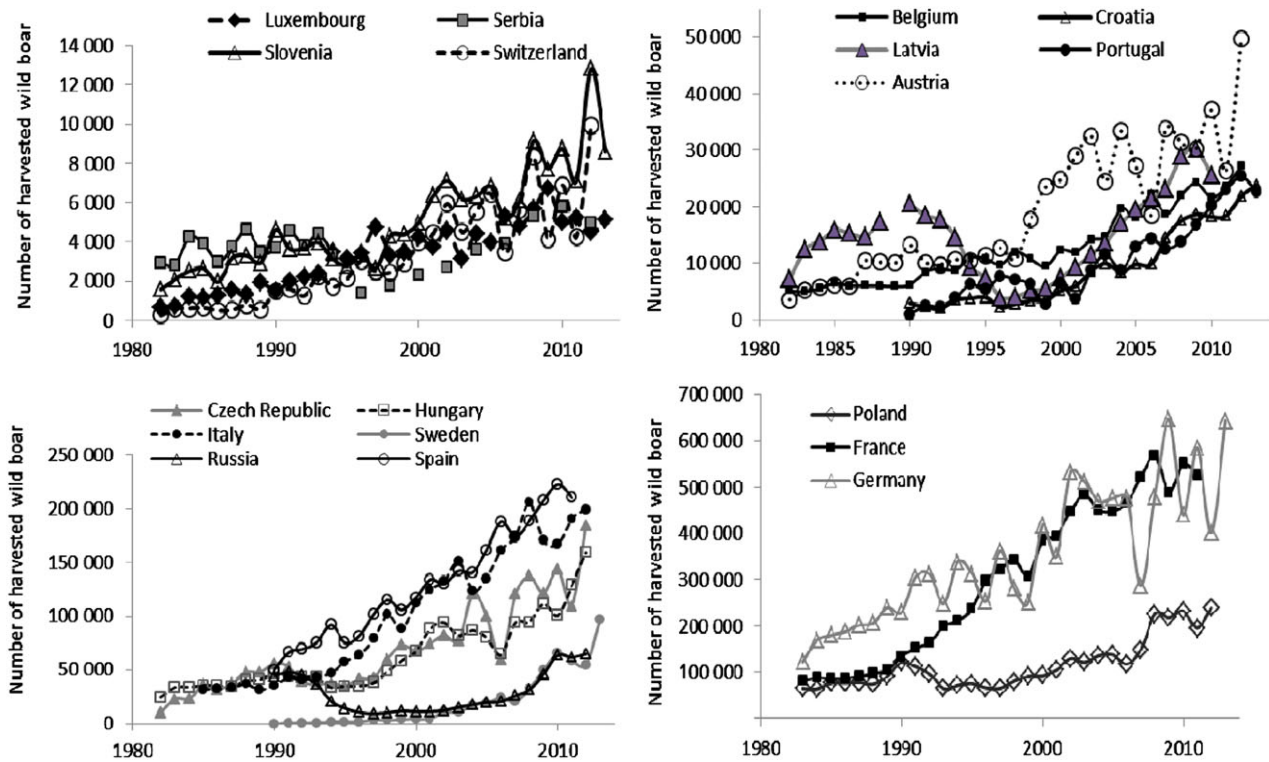


Figure 1. Wild boar hunting bags from selected European countries.

data, an autoregressive model [AR(1)] was fitted to the error term. To analyse overall trends in number of hunters versus number of wild boar harvested in Europe, a linear regression was fitted between these variables for the period between 1991 and 2011, using the 16 countries for which these data were available. To account for autocorrelation in the data, an autoregressive model [AR(1)] was fitted to the error term. All analyses were carried out in GenStat 17.1.

To illustrate overall trends in number of hunters and number of wild boar harvested in Europe, the total number of wild boar harvested and the total number of hunters across all countries were plotted against time for the period between 1991 and 2011 when data were available for all countries.

3 RESULTS

3.1 Wild boar population trends

The most recent wild boar hunting bags, in 2012 and 2013, indicate that some countries such as Spain, Poland, France, Italy and Germany harvest between 200 000 and 640 000 wild boar per year. The trends in hunting bags are consistent with population growth in all countries throughout the last three decades, although growth rates differed among countries (Fig. 1). In many countries the number of wild boar harvested often appeared to stabilise for a few years before further increase was observed. The mean annual population growth rate index (Fig. 2) averaged across all countries showed a fairly regular pattern, with peaks followed by troughs at 3–4 year intervals. In four out of the 30 years considered for the analysis, the mean wild boar population growth index across Europe was lower than 1 (with 1 = stable population), while in all other years the growth rate index varied between 1.00 and 1.46. The quinquennial population growth rate index mirrored the yearly regular pattern and varied between 1.40 and 1.73.

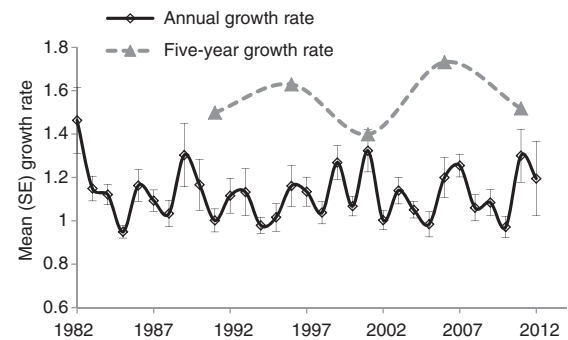


Figure 2. Mean (SE) estimated growth rate of wild boar populations in Europe, derived from hunting bag statistics calculated for each country and averaged across 18 countries. Annual growth rate = number of wild boar harvested per year divided by the number of animals harvested the previous year. Five-year growth rate = mean number of wild boar harvested in 5 years divided by the number of animals harvested the previous 5 years.

3.2 Trends in numbers of hunters

The trends in number of hunters suggest that, in 12 of the 17 countries examined, hunter numbers either declined ($n = 8$ countries) or remained stable ($n = 4$ countries) (Fig. 3). For Luxembourg, Serbia, France, Slovenia, Portugal, Sweden, Italy and Spain, we found a negative correlation between year and number of hunters ($P < 0.05$ for all countries). Hunter numbers remained stable in Montenegro, Croatia, the Czech Republic and Russia, with the regression slope not significantly different from zero ($P > 0.05$ for all countries). In the remaining five countries, Belgium, Poland, Austria, Hungary and Germany, we found a positive correlation between year and number of hunters ($P < 0.05$ for all countries). In Belgium, Poland, Austria, Hungary and Germany the numbers of hunters in 2012 were respectively 1.3, 1.2, 1.1, 1.5 and 1.2 times

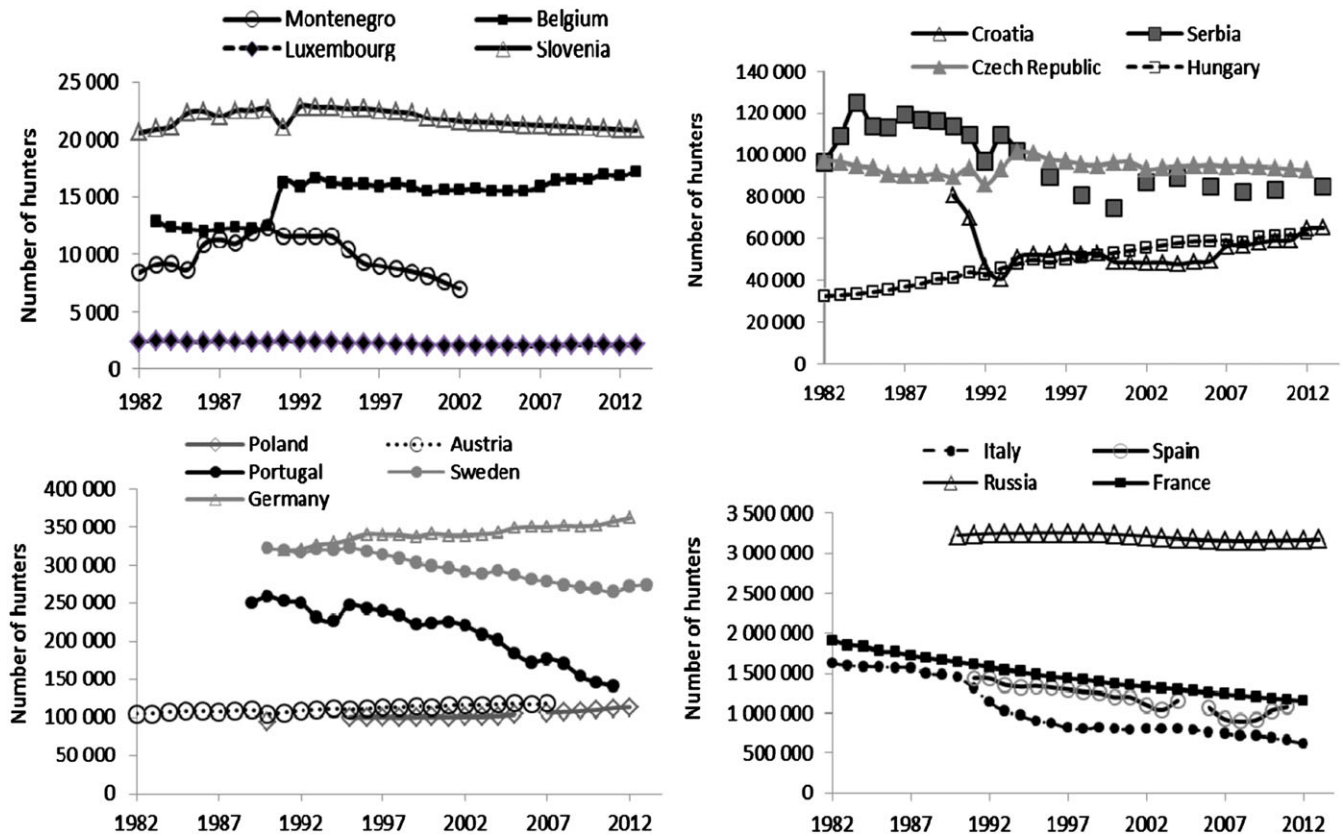


Figure 3. Trends in the number of hunters in selected European countries. Numbers refer either to hunters or to hunting licences.

higher than those recorded in 1990. In the same period, the numbers of wild boar harvested in Belgium, Poland, Austria, Hungary and Germany in 2012 were respectively 4.4, 1.9, 3.8, 3.4 and 1.3 times higher than numbers harvested in 1990.

For most countries, it was impossible to establish whether the actual number of wild boar hunters followed the same pattern as the total number of hunters. For instance, in Sweden, while the total number of hunters decreased owing to a decline in moose population, the relative number of wild boar hunters increased (Kindberg J, unpublished). In other countries, such as Italy, about 37–42% of the hunters in Tuscany (one of the five regions from which the national data were extrapolated, accounting for 36.8% of the total harvest in Italy) are wild boar hunters.^{43,44} In the same region, while the number of hunters declined from 47 000 in 1999 to 41 000 in 2011, the proportion of hunters over 60 years of age increased in the same period from 34% in 1998 to 55% in 2012. This indicates an ageing population of hunters that are not replaced by equivalent numbers of newcomers. Similar trends have occurred in other European countries: in Slovenia the current (2014) age of hunters is 55.6 years old and has been increasing annually by ca 0.3–0.4 years for the last two decades;⁴⁵ in France the average age of hunters was 45 years old in 1983–1984 and 50 years old in 1998–1999 (Baubet E, unpublished).

The overall trends in total number of hunters and in number of wild boar harvested in Europe (Fig. 4) showed that since the early 1990s the number of hunters has decreased by about 18%, while in the same period the number of wild boar harvested has increased by about 150%.

There was a strong negative correlation ($R^2 = 0.873$, $F_{1,19} = 131.3$, $P < 0.0001$) between the total number of hunters and the number

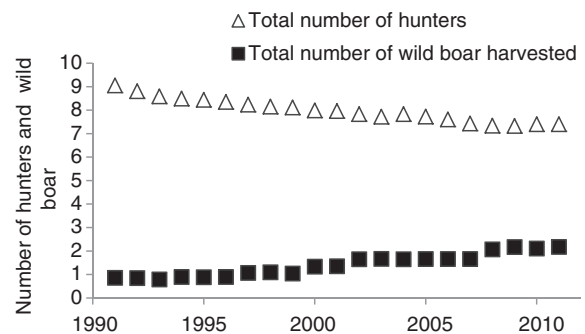


Figure 4. Total number of hunters (in millions) and wild boar harvested (in millions) in selected European countries between 1991 and 2011, when data for both variables were available for the following 16 countries: Luxembourg, Serbia, Slovenia, Belgium, Croatia, Portugal, Austria, Russia, Sweden, the Czech Republic, Hungary, Italy, Poland, France, Spain and Germany.

of wild boar harvested in 16 European countries between 1991 and 2011 (Fig. 5).

4 DISCUSSION AND CONCLUSIONS

The review showed the continued growth of wild boar numbers throughout Europe between 1982 and 2013. In 2012, a minimum of 2.2 million wild boar were harvested across the 18 countries, against ca 864 000 harvested in 1992 (when for the first time data became available for all 18 countries). If the remaining countries that were not included in this analysis were added, the total number of wild boar annually harvested in Europe would be in

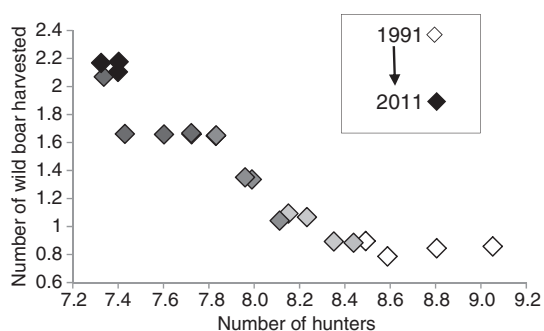


Figure 5. Relationship between the total number of hunters (in millions) and wild boar harvested (in millions) in selected European countries between 1991 and 2011. The shade of the symbol indicates the year, progressing from early years (in white) to recent years (in black).

excess of 3 million. Although numbers are expected eventually to stabilise, the average growth rate index, expressed as annual or quinquennial rate, has consistently exceeded 1 over the past three decades, with the exception of four years. Over the same period, the number of hunters has been comparatively stable or even declined in most European countries.

As it was impossible to differentiate between hunting effort (expressed, for instance, as the number of wild boar hunters, or guns, or hunter-days, or distance covered by hunters⁴⁶) and hunting pressure, defined as the effect of hunting on wild boar population dynamics,^{18,47,48} the number of hunters was used here as a generic indicator of the potential impact of hunting on wild boar numbers.

Assuming that the hunting bag statistics reflect the actual number of animals present, and that the number of hunters is a reasonable indicator for mortality due to hunting, these findings have several implications:

1. There is a mismatch between the consistent growth in number of harvested wild boar across Europe and the numbers of hunters, which in most countries are stable or declining. This suggests that hunters may have increased their effort over time and become more proficient, or that wild boar numbers have grown. This latter hypothesis is supported by the increase in the number of vehicle collisions and crop damage involving wild boar.^{29,39}
2. For European wild boar populations, the relative mortality due to hunting has declined over the past three decades, i.e. the proportion of wild boar removed by hunters in each country has been lower in recent years than in the 1980s or in the 1990s. This means that recreational hunting per se is currently not sufficient to limit wild boar population growth.
3. There is no indication that the growth rate index of wild boar populations has decreased in recent years, as would be expected if populations stabilised. If the main cause of wild boar mortality, namely hunting, is decreasing or remaining stable, and the growth rate index remains >1 (with $1 =$ no growth, $<1 =$ decline, $>1 =$ growth), then wild boar populations will continue to increase and more human–wild boar conflicts will be expected.

The limitations of data based on hunting bags or on number of hunters have been widely acknowledged,^{39,49} and the accuracy of reports of wild boar harvested is difficult to assess. In some countries the number of wild boar harvested is linked to hunting quotas imposed by local authorities; in these instances, hunters

may under- or overreport the number of animals harvested to meet these quotas.³⁹

Biases in actual numbers harvested may also be due to poaching or illegal hunting, which was not accounted for by official statistics, changes in hunting seasons across the years and differences in equipment and hunting practices in different countries (including the use of more efficient guns, spotlight or infrared binoculars or scopes, and off-road vehicles). In addition, some countries have poor records and/or lack centralised data collation, particularly at the national scale.

Although some of these factors may affect the total number of wild boar harvested, as well as the slope of the trend between some years, the generally consistent pattern of growth throughout Europe suggests that wild boar numbers have significantly increased since 1982. The fact that these trends have been paralleled by a simultaneous growth in number of vehicle collisions and wild boar agricultural damage further supports the hypothesis that the number of animals has grown. For instance, in Sweden the number of wild boar–vehicle collisions rose from about 50 per year in the early 2000 to ca 1000 in 2005 and over 4000 in 2012³⁰ (www.viltolycka.se). In the Netherlands this number rose from 142 in 1995 to 320 in 2003,⁵⁰ and in Switzerland, in the same period, the number increased from 212 to 412.⁵¹ In Germany, out of the 227 000 traffic accidents with deer and wild boar in 2005, 13 700 involved wild boar.⁴³ In Catalonia (north-eastern Spain) the number of accidents involving animals increased by 41.6% between 2007 and 2011, with wild boar responsible for 85% of the accidents.⁵² In terms of impact on crops, compensation for crop damage caused by wild boar in France rose from ca €2.5 million in 1973 to €21 million in 2005 and €32.5 million in 2008.^{53,54} In Luxembourg, compensation for crop damage caused by wild boar increased from ca €100 000 in 1971 to €900 000 in 2004,⁵⁵ and in Slovenia from €292 000 in 2005 to €575 000 in 2013.⁵⁶

The number of hunters across Europe appears to have been stable or even declining over the past three decades, and recruitment to hunter populations is low. These data reflect those reported for large game hunters in other countries. Declining trends in number of big game hunters have been recorded in the United States, Canada and Japan for a number of years, in parallel with increased numbers of ungulates.^{42,57} The growing mismatch and increasing gap between the number of hunters and the number of wild boar harvested means that the relative impact of hunting on wild boar population dynamics has probably decreased. If this is correct, trends in numbers of wild boar culled may underestimate the true growth of boar populations. Although wild boar mortality due to road traffic accidents has also increased, this is still small compared with hunting-induced mortality. For instance, between 2004 and 2010, hunting was the cause of death for ca 38% of the 1613 tagged wild boar in Wallonia, while road traffic accidents accounted for less than 1% of the recorded deaths.²² In Sweden, 94% of wild boar mortality is caused by hunting, 4% is due to traffic accidents and 2% is ascribed to natural mortality.⁷ These figures are even more extreme in Slovenia, where hunting represents 97–98% of wild boar mortality, road mortality accounts for 1–1.5% and natural mortality for $<1\%$.⁴⁵

Other factors frequently quoted to explain the increase in wild boar numbers in Europe are the scarcity of large predators, reforestation, supplementary feeding and mild winters, which have improved survival. The wolf is the only large predator that has an impact on wild boar mortality, and in the last 30 years the populations of wolves across Europe have increased or remained stable.^{16,58–63} The mortality of wild boar owing to wolf predation

is relatively small when compared with the mortality imposed by hunters.⁶⁴ For instance, in Poland, wolves annually removed 19–38 wild boar per 100 km² (or 4–8% of spring–summer densities of wild boar), compared with hunters who annually harvested 45–142 wild boar per 100 km².⁶⁰ In Spain, estimated wolf predation caused 12% of the mortality of wild boar, compared with 31% caused by hunting.¹⁶

The mortality due to hunters and predators affects different wild boar age classes: predators such as wolves remove primarily young wild boar, while hunters remove relatively more adult animals.^{12,16,60–65} The implications for population dynamics are significant: as young animals have lower survival rates than adults, some of the mortality due to predation replaces mortality that might otherwise be affected by other natural causes, such as starvation.⁶⁶ Conversely, higher mortality of adult animals owing to hunting removes individuals that might have survived longer and would have contributed more to population growth. Thus, hunters have greater potential than wolves for regulating populations.^{12,67,68}

Hunting can also induce compensatory population response: where hunting pressure is high, wild boar may give birth earlier, which in turn allows juvenile females to grow for longer and to reach the threshold size for giving birth at 1 year of age.¹⁸ In addition, under high hunting pressure, a higher proportion of yearling females give birth compared with populations where hunting pressure is less pronounced.⁴⁷

Reforestation and climate change have often been quoted to explain the increased densities of ungulates in Europe.^{32,47} Over the last 20 years, the forest area has expanded in all European regions.⁶⁹ The increased cover of forests, as well as the shelter provided by some crops such as rapeseed, sunflower and maize, is likely to have favoured the spread of wild boar to previously unoccupied areas, although this is not the case for boreal forests in Northern Europe (Kindberg J, unpublished).^{70,71} Milder winters and reduced winter mortality are also likely to affect recruitment via increased survival of all age classes.^{15,64,72}

Supplementary feeding of wild boar, which is widespread across most European countries, as well as an increased availability of agricultural crops throughout the year, has certainly contributed to increase survival.^{10,29,73} The highest litter size and reproductive output recorded for wild boar are associated with availability of energy-rich crops (maize and sunflower) in summer and autumn, often coupled with supplementary food provided by hunters in winter.^{36,74,75}

Wild boar reproductive rates are significantly affected by food availability;^{35,73,76–78} the fact that sows can maximise reproductive success by adjusting their relative allocation to littermates in relation to the amount of food available could also contribute to population growth.⁷⁹

In conclusion, wild boar have increased significantly across Europe during the past three decades, probably facilitated by a decrease in numbers of hunters but also by a combination of other extrinsic factors. Although the importance of each of these factors is likely to be country specific, a major finding of this review is that, across the continent, recreational hunting has not prevented the growth of wild boar populations and is unlikely to do so in the near future without substantial changes to hunting practices. Although in most European countries wild boar are valued as game, hunters might have little incentive for reducing wild boar populations even when the market value of carcasses outweighs the costs that hunters accrue via compensation payments to farmers for crop damage caused by this species.^{39,80} An ageing

extant hunter population coupled with low hunter recruitment suggests that new strategies may be required if the number of wild boar and their impacts are to be controlled.⁸¹ With regard to hunters, these strategies could include identifying and addressing the reasons for lack of retention of hunters and promotion of hunter recruitment.⁴² Preventing further wild boar population growth will rely on shifting the focus of hunters towards specific age classes,^{12,67,79,82} involving other stakeholders as well as professional hunters, introducing more effective hunting methods and equipment and exploring the use of new tools for hunting. Moreover, educating the public in wild boar control^{83,84} and testing new methods such as fertility control in areas where hunting is unfeasible^{40,85} may assist in controlling wild boar. It is conceivable that recreational hunting of wild boar will be progressively substituted by professional hunting, community service or civic duty carried out by other stakeholder groups.⁴² Cooperation between landowners, hunters and conservation groups, as well as education in wild boar hunting and provision of equipment to increase hunting efficiency, will play an important role in decreasing wild boar populations in the future. Adopting effective strategies to reduce human–wild boar conflicts will be a major challenge in the future.^{39,41} Successfully meeting this challenge could provide a model for mitigating other human–wildlife conflicts.

ACKNOWLEDGEMENT

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APPENDIX

Table A1 Source of data and acknowledgements

Austria	STAT cube – statistical database of statistics, Austria (http://statcube.at/statistik.at/ext/superweb/loadDatabase.do)
Belgium	Service Public de Wallonie – Département de la Nature et des Forêts. Thanks to Michel Villers
Croatia	Ministry of Agriculture, Information System of Central Hunting Records (https://lovistarh.mps.hr/sle/login.aspx?ReturnUrl=%2fsle%2fdefault.aspx), Croatian Hunting Association. Thanks to Ivica Budor and Marko Tomljanović
Czech Republic	Ministry of Agriculture of the Czech Republic
France	Réseau Ongulés Sauvages ONCFS-FNC-FDC (Wild Ungulates Network ONCFS-FNC-FDC) (http://www.oncfs.gouv.fr/Reseau-Ongules-sauvages-ru104). ONCFS = French National Agency for Wildlife (http://www.oncfs.gouv.fr/Reseau-Ongules-sauvages-ru104); FNC = National Hunters Federation; FDC = Departmental Hunters Federation. ONCFS – Validation of hunting license (Budget Division). Thanks to C Saint-Andrieux (ONCFS) and field staff at the Réseau Ongulés Sauvages, and to D Soulie (ONCFS)
Germany	Deutscher Jagdschutzverband (German Hunter Association) (see http://www.jagdnetz.de/datenundfakten/jahresstrecken?meta_id=267 and http://www.jagdnetz.de/datenundfakten?meta_id=116)

Table A1 (continued)

Hungary	National Game Management Database, Gödöllő, Hungary. Thanks to the Foundation of the Hungarian Government (USZT) within project VKSZ_12-1-2013-0034 Agroclimate 2
Italy	National Ungulates Databank, ISPRA (Institute for Environmental Protection and Research) (http://www.isprambiente.gov.it/). Italian National Institute of Statistics (http://www.istat.it/). Thanks to Maria Luisa Zanni, Enrico Merli, Andrea Marsan, Maddalena Mattii, Aurelio Perrone, Sandro Bertolino and Barbara Franzetti
Latvia	The State Forest Service of Latvia (SFS) (www.vmd.gov.lv)
Luxembourg	Administration de la Nature et des Forêts, Luxembourg. Ministère du Développement Durable et des Infrastructures, Département de l'Environnement, Luxembourg. Thanks to P Grivet, P Calmes and JM Berg
Poland	Forestry Statistical Yearbooks (1975–2013), Central Statistical Office of Poland
Portugal	Portuguese Institute for Nature Conservation and Forests (www.icnf.pt). Portuguese Science Foundation (FCT) within project PEst-C/MAR/LA0017/2013
Russia	Russian Committee for Statistics Roskomstat (www.rks.ru)
Serbia	Statistical Office of the Republic of Serbia (www.stat.gov.rs). Hunting Association of Serbia
Slovenia	Statistic Yearbooks of the Republic of Slovenia (1982-2012), annual hunting management plans for all 15 Hunting Management Districts (2009-2013) Slovene hunting information system (2001-2013). Thanks to Marko Jonozovič, Department for Wildlife and Hunting, Slovenia Forest Service
Spain	Spanish Ministry of Agriculture, Food and Environment and Spanish Hunters Federation. Thanks to Antonio Solís from the Spanish Ministry of Agriculture
Sweden	The Swedish Association for Hunting and Wildlife Management, Swedish Environmental Protection Agency
Switzerland	Office Fédéral de l'Environnement OFEV Statistique de la Chasse

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