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Spatio-temporal characteristics of crop damage caused by wild boar in north-eastern Poland

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ABSTRACT

Increasing wild boar damage to farmlands has resulted in a growing conflict between farmers and hunters in north-eastern Poland. The objective of this study was to evaluate wild boar crop damage and compensation as well as the fiscal balance of wild boar management over an area of 1867.2 km^2, with 27.4% fragmented forests. During 2011–2013, the total area of farmland damaged by wild boar (1365 cases) amounted to 1000.4 ha. In this period, farmers received 432,600 EUR as compensation for destruction of crops caused by wild boar. In the area of damaged crops, cereals predominated (50.2%), followed by grasslands (24.0%) and rapeseed (21.2%). The damage by wild boar was correlated with population density ($r = 0.648$), forest cover ($r = -0.514$) and distance to forest-farmland border ($r = -0.918$). The net income per year from wild boar hunting was EUR 163,100 whereas the compensation paid amounted to EUR 144,200. The issue of reducing the conflict between farmers and hunters through lowering the wild boar population density is discussed.

1. Introduction

Across 18 European countries studied, the culling of wild boar from 1982 to 2013 increased from 864,000 to approx. 2.2 million (Massei et al., 2015). Data obtained from Polish Statistical Office indicate that, in the 2003–2013 period, hunting of wild boar increased 98% from 122,000 to 242,000 individuals. High population densities of wild boars have led to multiple conflicts with humans (Barrios-Garcia and Ballari, 2012). Nevertheless, the single most important conflict between wild boar and humans pertains to the damage caused by this species to crops, which occurs in most European countries (Kristiansson, 1985; Danilkin, 2002; Herrero et al., 2006; Schley et al., 2008; Keuling et al., 2009; Amici et al., 2012; Frackowiak et al., 2013; Hearn et al., 2014), as well as in India (Chauhan et al., 2009), China (Li et al., 2013), Japan (Saito et al., 2011), Kazakhstan, Turkmenistan, and Uzbekistan (Saulich & Sus scrofa, 2008).

There are many published papers describing factors affecting the level of damage caused by wild boar in cultivated fields (Mackin, 1970; Gorynska, 1981; Honda and Sugita, 2007; Cai et al., 2008; Amici et al., 2012; Bleier et al., 2012; Frackowiak et al., 2013; Morelle and Lejeune, 2015), but the impacts of population density of wild boars upon level of crop damage and area of foraging zone in farmlands are poorly documented. There is also a striking lack of publications pertaining to the financial revenues generated from wild boar hunting and the amount of financial compensation paid to farmers for damage to farmlands caused by wild boar. Therefore, the objectives of the presented study were to determine the structure and dimensions of damage to farmlands caused by wild boar, assess factors which determine the level of damage, and the financial balance of wild boar population management in north eastern Poland. The following hypotheses were tested:

1. The number of cases of wild boar damage in fields adjacent to forest decreases as the distance from the farmland-forest border increases.
2. An increase in biodiversity in forest habitat reduces the level of damage caused by wild boar in cultivated fields.

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3. The level of damage caused by wild boar to farmland is positively correlated with the population density of the species concerned.

For the study, an area of forest/farmland mosaic, i.e. the landscape where high population densities of wild boars and considerable damage caused to crops by these animals occur, was selected.

2. Materials and methods

The studies were conducted in 2011–2013 in the lowlands of northeastern Poland in a mosaic of fragmented forests and farmlands (rectangle between points N53°55′ E19°35′ and N54°24′ E20°42'). The principal forest types are mesic and moist deciduous habitats occupying 82.7% of the forest environment. The dominant tree species are oak (*Quercus robur* L.), beech (*Fagus silvatica* L.) and birch (*Betula* sp.) which constitute 49.4% of all forest stands (Bobek, 2016). The game management is carried out by hunting clubs in 52 hunting districts. The forest and game management is administered and supervised by the State Forest Service within five Forest Districts: Dobrocin, Górowo Iławeckie, Młynary, Orneta, and Zaporowo.

Two species of significance to game management are wild boar (*Sus scrofa* L.) and roe deer (*Capreolus capreolus* L.). Over the three years (2011–2013), the average population density of wild boars assessed in February based on analysis of the results of collective hunts was equal to 74.7 individuals/1000 ha of forest (Bobek et al., 2015). The mean population density of roe deer assessed by a driving census amounted to 196.8 individuals/1000 ha of forest (Albinski et al., 2013).

In the study area, the role of agriculture is of major importance. The small forest complexes are surrounded by intensively cultivated farmlands, predominantly grasslands (meadows and pastures) which constitute 23% of the total fields, followed by rapeseed fields (17%), and various cereal species (56%) (Sielicki, 2015).

Information on the damage to farmlands caused by wild boar was collected in 2011, 2012, and 2013 from 26 hunting districts covering an area of 1867.2 km^2 where fragmented forest constitutes a total of 511.6 km^2. Compensation for damage caused by wild boars in farmlands was paid by hunting clubs to farmers on the basis of arbitrary measurements of the area of damaged crops and market prices for crops. The documentation of compensations paid is included in annual reports of hunting clubs. The data included the date when the damage occurred, type and area of damaged crop, and the amount of financial compensation paid to farmers affected by the destruction of crops by wild boars.

Additional data collected pertained to the number of wild boars culled during the given growing season, revenues from sales of carcasses of the culled wild boars, income from collective hunts and the quantities of feed placed in winter baiting stations, divided into cereals and root crops. The price of feeds used in winter supplemental feeding of wild boars, i.e. EUR 143.9 per tonne of concentrated feed and EUR 59.0 per tonne of root crops, reflected the current market pricing. The above data were used to conduct the financial analysis of wild boar game management in 26 game districts studied. The analysis was conducted separately for the hunting districts where the fiscal balance of wild boar management was positive, and for these districts where the fiscal balance was negative.

During the growing season in 2013, 419 GPS measurements were taken in 20 hunting districts, with locations recorded for damage caused by wild boar, allowing calculations of the distance of each damaged site from the farmland-forest border. A logarithmic regression was conducted to relate the number of damage cases to the distance to the forest border.

Linear regression was used to estimate the width of foraging area used by wild boar in the fields adjacent to forests. The equations of linear regression pertaining to the relationship between the number of crop damage cases and distance from forest were calculated for damaged cultivated fields situated within the distance of up to 700 m from the forest border. These covered 90% of all damage cases. It had been assumed that the damage cases located in the distances greater than 700 m from the forest border were inflicted by wild boar which did not constitute resident animals in the studied forests but were either trespassing animals or those living during the vegetation season exclusively in the cultivated fields. Linear regression was conducted separately for the group of 8 game districts with 113 damage cases situated within 0–500 m distance from forest border, and for the group of 12 districts with 265 damage cases from to 0–700 m. The width of wild boar foraging belt in the fields was determined by the intersection between the regression line and the x axis.

The length of the farmland-forest border was calculated on digital maps for each of the hunting districts. This length was then multiplied by the width of wild boar foraging area separately for the group of 8 game districts and for the group of 12 districts. The obtained results were assumed to be the potential foraging area of wild boar on farmlands. The degree of wild boar damage in particular hunting districts was calculated as a percentage of the damaged crop area of the potential foraging area of wild boars in the fields.

The culling figure of wild boar (number of individuals harvested per one thousand ha of forest) in the 2013 growing season was adopted in 20 hunting districts as a relative population density, which was then correlated with the level of damage to crops caused by wild boar. The potential foraging area of wild boar in cultivated fields together with the adjacent forest was treated as the foraging and hiding-cover habitat of wild boar. Within it, the proportion of forest area was calculated. Linear regression was used to calculate relationship between proportion of forest and the percent of area damaged crops (dependent variable).

A linear regression was calculated between the population density vs level of damage to crops and proportion of forest vs the level of damage to crops (see Results). Therefore, using multiple regression and the forward stepwise analysis, the effect of population density and percent of forest in foraging and hiding cover habitat in the level of damage was determined.

The biodiversity indices of forest age structure and their tree species composition were calculated using Simpson's formula (Simpson, 1949). In 20 hunting districts, linear regression was used to calculate relationships between the level of damage within the potential foraging area of the wild boar in cultivated fields and these indices.

The Kruskal-Wallis test was used to examine the differences in the area of particular crops damaged by wild boar and damage compensation in subsequent years. The differences in the number of damage cases in particular crop categories and years were determined by χ^2 tests with Bonferroni adjustments (Sokal and Rohlf, 1995). Statistica 12 was used for all statistical analyses.

3. Results

3.1. Wild boar population size and crop damage trends

In the study area covering 1867.2 km^2, over the three-year period, a total of 3482 wild boars were culled from April to September, with a mean relative population density index of 22.7 individuals/1000 ha of forest. The culling of wild boars increased between 2011 and 2013 from 917 to 1342 animals.