Developing a Sampling Protocol for the Surveillance of Diseases in Wildlife Populations.

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SUMMARY

In order to develop a national sampling protocol we aimed at subdividing Switzerland into geographically distinct areas for sampling wild boars (sampling unit). We are elaborating a way of estimating the degree of variation in population density across Switzerland based on hunting statistics and landscape composition. This estimate of the variation in wild boar population densities will provide the basis for the specification (i.e. mapping) of several distinct sampling units. As we expected, we found that the percentage of the spatial unit covered by forest is positively associated with the number of wild boars killed by hunters. Surprisingly however, the degree of spatial aggregation of open land was positively associated with the number of wild boars killed by hunters.

INTRODUCTION

In a national surveillance system for contagious diseases a reliable sampling scheme is of crucial importance. A representative sample regarding both sample size and geographic distribution must be selected in order to reliably document the country's disease status. The length of the time interval between sampling rounds is important if the surveillance system is used as an early warning system or to assess the impact of actions targeted at preventing the further spread of newly introduced diseases.

In order to develop a national sampling protocol we aimed at subdividing Switzerland into geographically distinct areas for sampling wild boars (sampling unit). Each sampling area had to fulfil the assumption that, following a disease outbreak in one specific wild boar pack, (1) each other pack in the same sampling area is equally likely to contract the disease under consideration and (2) that the spread of the disease remains confined within the primarily infected sampling area for the time between two consecutive survey rounds with a probability 95%.

Host density is an important determinant of the magnitude of R0, the average number of secondary cases of infections generated by one primary case in a susceptible host population (basic reproduction rate). After introduction, the parasite population will initially increase in size provided its R0 is larger than one. Below a critical density of hosts, Nt, R0 is less than one. So, if the density of susceptible hosts is less than Nt, the initial inoculum of parasites will decay to extinction (Anderson and May 2002). Consequently, the size of the wild boar population within each specific sampling unit and its spatial configuration is are assumed to influence both the size and the duration of an outbreak within each specific sampling unit. Unfortunately, in contrast to the

monitoring of contagious diseases in domestic animals, the investigation of such diseases in wildlife needs to consider that data on population sizes and the variation in spatial and temporal abundance is usually not available on a national basis. Therefore, we are elaborating a way of estimating the degree of variation in population density across Switzerland based on hunting statistics and landscape composition. This estimate of the variation in wild boar population densities will provide the basis for the specification (i.e. mapping) of several distinct sampling units.

Packs of wild boars defend their core areas against neighbouring packs. However, home ranges may overlap geographically. Wild boar population density is influenced by environmental patterns such as the distribution of forest areas, crop fields and traffic ways or high mountains. Because wild boars avoid areas above 2000m above sea level, the Alps separate the wild boars in Switzerland into two populations: north and south of the Alps. Our aim was to further subdivide the area north of the Alps into smaller sampling units fulfilling the above-mentioned criteria.

MATERIAL AND METHODS:

The number of wild boars hunted per hunting district or community, respectively, was obtained from 7 out of 15 cantons (administrative regions) where wild boars were occurred between 1997 and 2000. For each community/hunting area in Switzerland, the following parameters were calculated: average altitude above sea level, road density (total of high ways and main roads/hunting district/community), the percentage of area comprised of (1) forest, (2) open land below 2000m above sea level and (3) human settlement was calculated using ArcView3.2 (Environmental Systems Research Institute, Inc 1999). In addition, the spatial configuration of forest, open land and settlements in each community was calculated using FRAGSTATS3.3 (www.umass.org/fragstats). Electronic maps of landscape type and streets (Vector200; 1:200'000) and altitude (DHM25) from Swisstopo (www.swisstopo.ch; 1999/2000) were used. Each of these landscape parameters was related to the number of wild boars shot during two hunting seasons (2001/2002 and 2002/2003, respectively) using univariate negative binomial regression. (STATA 6.0, Statistics/Data Analysis, Stata Corporation 1999). Parameters which were associated ($p<0.05$) with the number of wild boars hunted per community/hunting district is being further analysed using multiple regression as a basis for drawing a map of the potential suitability of the landscape for wild boars in Switzerland at the community level. The potential suitability of the landscape will provide an estimate of the expected variation in wild boar population density across the country.

RESULTS

In total, there are 2866 communities/hunting districts in Switzerland. Communities which consist of several parts (e.g. enclaves) were treated as distinct spatial units in the analysis. Therefore the analysis included 3040 spatial units. Spatial units with an average altitude >2000 m above sea level or less than 20% of the area covered by forest and open land combined were considered unsuitable for wild boars (and therefore excluded, n=88. Hunting statistics were available for 715 spatial units (25%). At least one wild boar was killed by hunters during the two hunting periods

(2000/2001 and 2001/2002) in 537 (75%) of these spatial units. The number of wild boars killed by hunters ranged from 1 to 116 (median=5) per spatial unit. The spatial area of the units ranged from 40 to 5913 hectares (median=703).

The number of wild boars killed by hunters per spatial unit was positively correlated with (1) the proportion of land comprised of forest (0.016; 95%CI=0.009-0.022), (2) forest being aggregated (0.340; 95%CI=0.048-0.632), (3) open land being aggregated (0.924; 95%CI=0.642-1.206, and (4) the area of the spatial units (hectares; 0.0004, 95%CI=0.0002-0.0006). The number of wild boars killed by hunters per spatial unit was negatively associated with (1) the number of open land patches per spatial unit (-0.0149; 95%CI=-0.022 -- -0.008), (2) the number of settlement patches per spatial unit (-0.032; 95%CI=-0.047-- -0.0166); and (3) street density (-0.123; 95%CI=-0.019-- -0.006).

DISCUSSION

As we expected, we found that the percentage of the spatial unit covered by forest is positively associated with the number of wild boars killed by hunters. Surprisingly however, the degree of spatial aggregation of open land was positively associated with the number of wild boars killed by hunters. This was also reflected by the finding that the number of wild boars killed was lower in spatial units where the area covered by open land was subdivided into an increasing number of individual patches. Biologically, wild boars might be expected to favour small patches of open land adjacent to forested areas, rather than large areas of open land. However, wild boars may be more likely to be hunted in large areas of open land, which mostly consists of crop fields. This bias may be due to an increased pressure on hunters in crop areas in order to prevent wild boars from feeding on crop and thus more hunters being active in such areas. Hunting statistics can therefore only provide a rough estimate of the actual population density.

We restricted the present analysis to spatial units in which at least one wild boar was killed by hunters within the two hunting periods considered as the absence of killings could not be unambiguously interpreted. The absence of shot wild boars in a spatial unit may be due to the hunters' failure or due to the fact that they have not yet colonized that area. This is particularly relevant for areas in the centre of Switzerland between the major east-west highway and the Alps. Wild boars were absent from this area until a few years ago but they are steadily moving into it. A more complex model involving a combination of landscape parameters and also the spatial structure of the data obtained by the hunting statistics is currently being developed.

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LITERATURE

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