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ORIGINAL PAPER

The German wildlife information system (WILD): population densities and den use of red foxes (*Vulpes vulpes*) and badgers (*Meles meles*) during 2003–2007 in Germany

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Abstract Monitoring the populations of badgers and red foxes may help us to manage these predator species as a matter of wildlife conservation and regulation. To fit the needs of a monitoring programme, the most practicable method has to be selected. Hunting bag statistics deliver large but inaccurate data amounts with low effort. Indirect and also often direct counts might deliver only presence–absence data with high effort. Direct counts with high accuracy are very costly. Den mapping by volunteer local hunters can deliver reliable data on density and additional biological variables while being feasible and cost effective. Within reference areas all over Germany, fox and badger dens and litters were recorded, and spring and summer densities estimated as well as potential annual population increases were calculated for 2003–2007. Habitat preferences for breeding dens were also analysed. Additionally, in 2006, the distribution of badgers was surveyed by a nationwide questionnaire. Fox and badger are distributed all over Germany with some small gaps and regionally differing densities. During the monitoring period, fox and badger densities and reproduction stayed stable, at a high level corresponding to hunting bags. However, densities varied between geographical regions, with lower densities in the sparsely wooded lowland regions. A preference for forest and habitats offering shelter was clear for breeding setts and dens. Badgers especially preferred setts of natural origin.

Keywords Monitoring · Reference areas · Population density · Small game predators · Management · Sett usage

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Introduction

The German wildlife information system "WILD" (Wildtier-Informationssystem der Länder Deutschlands) was founded in 2001 and is the first monitoring programme recording population sizes of huntable game species throughout Germany. The project was initiated on behalf of the German hunting association (Deutscher Jagdschutz-Verband e.V. (DJV)) as a permanent integral part of environmental assessment with the aim of developing strategies for conservation and sustainable use of game populations (see Strauß et al. 2008) by monitoring live animals instead of estimating population sizes from hunting bags. Especially for cryptic or rare species, many detection errors persist within any survey method (Elphick 2008). Therefore, within every monitoring programme, the most practicable method has to

be established, as different methods have different levels of cost–benefit ratios, i.e. accuracy and precision versus cost efficiency (Gaidet-Drapier et al. 2006; Lyra-Jorge et al. 2008; Vine et al. 2009). Hunting bag statistics are most practical for large area monitoring, as they deliver area-wide data casually. Hunting bags give a good view on long-term population tendencies; however, they depend very much on the willingness and ability of hunters as well as on weather conditions (Gaillard et al. 2003; Grauer and König 2009). Therefore, WILD established a live survey network of so-called reference areas, in which the densities of the European hare (*Lepus europaeus*, first results presented in Strauß et al. 2008), the red fox (*Vulpes vulpes*), the badger (*Meles meles*), the carrion crow (*Corvus corone*) and the hooded crow (*Corvus cornix*) are recorded using standardised methods (DJV 2003). As the accuracy of such live surveys depends a lot on accessibility to area and interaction with local people (Gaidet-Drapier et al. 2006), the reference areas are monitored by the local hunters. At periodical intervals, other small game species are estimated by querying hunters area-wide all over Germany.

Red fox populations, as indicated by annual hunting bags, decreased in Germany owing to rabies and the gassing of dens in the 1960s. Since gassing stopped in the mid (FRG) and later (GDR) 1970s, the population increased a little but remained stable until the start of vaccination against rabies in 1986 (DJV 1990; Bellebaum 2003; Pegel 2004). Since the late 1980s, the population has increased very rapidly and has varied since 1995 at a high level. The annual hunting bag in Germany increased from about 180,000 in the late 1960s to around 630,000 recently, with a tendency for a slight decrease (DJV 1990, 2009; Bellebaum 2003). Monitoring fox populations is important for the conservation of endangered prey species, management of small game (Reynolds and Tapper 1995; Baker et al. 2006) and for disease control (e.g. rabies or echinococcosis, Bellebaum 2003; König et al. 2008; Vos et al. 2008).

Badger populations, as indicated by annual hunting bags, were reduced much more by rabies and gassing (Schwierz and Wachendörfer 1981) than was fox density. Since the end of gassing of setts, the annual hunting bag has increased from less than 5,000 in the 1960s and 1970s and now remains stable at a high level of about 50,000 since 2003 (DJV 1990, 2009; Pegel 2001). However, reliable large-scale population data are sparse today in most parts of Europe (Griffiths and Thomas 1997; Kowalczyk et al. 2000; Sleeman et al. 2009). Monitoring badgers is important for wildlife management (Eichstädt and Roth 1997; Revilla et al. 2001; Sleeman et al. 2009), agricultural damage (Roper et al. 1995; Moore et al. 1999; Schley 2000; Delahay et al. 2009) and disease control (e.g. bovine tuberculosis in Britain and Ireland, Griffin et al. 2005; Woodroffe et al. 2008).

Our aims were to assess densities and density changes of foxes and badgers in Germany between the years 2003 and 2007 as well as to monitor differences of densities between geographical regions. We discuss the reliability of the methods and data. Additionally, we queried the distribution of badgers from every German hunting ground. Besides population data, also habitat parameters for breeding dens were evaluated from the mapping data. The data from WILD may serve as a basis for further research.

Material and methods

Since 2002, the project has established more than 800 reference areas, randomly distributed over all German agricultural regions. The mean size of these reference areas is 738 ha (minimum 95, maximum 4,500 ha). For several reasons (e.g. organisational matters and weather), the number of reference areas providing data differs between years. In total, 360 reference areas delivered density data for fox and badger populations.

Hunters monitoring the reference areas were instructed and trained according to the WILD manual, which includes detailed descriptions of the methods used (DJV 2003). The local hunters familiar with their hunting grounds map all fox dens and badger setts every winter. Therefore, the hunters visit every known den and sett. Additionally, they search for dens and setts systematically. Unknown dens might be found by following fox and badger tracks in winter (Briedermann and Dittrich 1982; Stubbe 1989), especially during fox mating and in snow (January and February). In spring, during rearing of puppies (April–June), the hunters control the mapped dens and setts and noted several parameters: type, location and habitat of den, number of entrances, inhabited or not, species inhabiting, breeding den or not, litter size and additional notes.

The sex ratio of red foxes is male biassed (Goretzki and Paustian 1982; Tryjanowski et al. 2009). Thus, for calculating the minimum spring fox density, we multiplied the number of litters by the factor 2.5, adding non-reproductive females and surplus males to the litters' parents (Wandeler and Lüps 1993; Stubbe and Stubbe 1995). Potential minimum summer densities were calculated by adding the spring adult density and cub density. The cub density was the observed mean number of cubs per litter at the breeding den multiplied by the number of observed litters.

For calculating badger densities, every sett was observed carefully during spring and early summer, to record the litter density and size. The sex ratio of badgers was assumed to be 1:1 (Macdonald and Newman 2002), although populations are often slightly female biassed (Do Linh San 2002). As badgers live in their setts all the year,

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