



Evaluating the tuberculosis hazard posed to cattle from wildlife across Europe



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ABSTRACT

Tuberculosis (TB) caused by infection with *Mycobacterium bovis* (*M. bovis*) and other closely related members of the *M. tuberculosis* complex (MTC) infects many domestic and wildlife species across Europe. Transmission from wildlife species to cattle complicates the control of disease in cattle. By determining the level of TB hazard for which a given wildlife species is responsible, the potential for transmission to the cattle population can be evaluated. We undertook a quantitative review of TB hazard across Europe on a country-by-country basis for cattle and five widely-distributed wildlife species. Cattle posed the greatest current and potential TB hazard other cattle for the majority of countries in Europe. Wild boar posed the greatest hazard of all the wildlife species, indicating that wild boar have the greatest ability to transmit the disease to cattle. The most common host systems for TB hazards in Europe are the cattle-deer-wild boar ones. The cattle-roe deer-wild boar system is found in 10 countries, and the cattle-red deer-wild boar system is found in five countries. The dominance of cattle with respect to the hazards in many regions confirms that intensive surveillance of cattle for TB should play an important role in any TB control programme. The significant contribution that wildlife can make to the TB hazard to cattle is also of concern, given current population and distribution increases of some susceptible wildlife species, especially wild boar and deer, and the paucity of wildlife TB surveillance programmes.

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1. Introduction

In Europe, many different domestic and wild species have been identified with tuberculosis (TB) caused by infection with *Mycobacterium bovis* (*M. bovis*) and closely related members of the *M. tuberculosis* complex (MTC) (Table 1). The presence of sympatric infected wild species in areas with TB-infected cattle herds (Delahay et al., 2002; Witmer et al., 2010) is thought to be one reason for the failure of several European countries (Ireland, Italy, Portugal, Spain and the UK) to obtain an official tuberculosis free (OTF) status set out by the World Organisation for Animal Health (OIE) (www.oie.int/fileadmin/Home/eng/Health_standards/tahc/2010/en_chapitre_1.1.1.6, 03/02/2012). Infected wild species may be able to infect cattle, helping the disease to persist within the cattle population (Nugent, 2011). Sympatric infected wild species may also infect one another, as is the case for feral pigs acquiring TB from possums in New Zealand (*Trichosurus vulpecula*) (Nugent et al., 2012). The role of different potential host species may vary geographical-

ly with habitat, ecology, land use and consequently, behaviour (Gortázar et al., 2011). Some species are dead-end hosts, e.g. Iberian lynx (*Lynx pardinus*) in Spain (Martin-Atance et al., 2006), and others may serve as reservoirs of the disease, e.g. badgers (*Meles meles*) in Britain (Cheeseman et al., 1989). Wild boar (*Sus scrofa*) are considered to be reservoir hosts in Spain (Naranjo et al., 2008), but spill-over hosts in North-West Italy (Dondo et al., 2007). These differences between countries mean that the optimal surveillance and possible control strategies are likely to be different for different countries and for different species within those countries.

Calculating the TB hazard posed by different species in a given situation (e.g. Kilpatrick et al., 2009) is potentially of considerable value to policy-makers, since it can help to focus disease prevention and surveillance strategies, e.g. Kilpatrick et al. (2010). TB prevalence data for wild species may contain inherent biases as a consequence of different numbers of individuals being tested. However, the impact of this bias on estimations of TB hazard can be reduced by focusing on those species most commonly tested and found to be infected across several countries.

To review TB hazards posed by wildlife across Europe, we therefore concentrated our study on badgers, wild boar, red (*Cervus elaphus*), roe (*Capreolus capreolus*) and fallow deer (*Dama dama*). Of

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Table 1

Animal species recorded with TB infection within the European Union from the mid-1980s to the present day (including Switzerland and Norway).

Countries	Official TB free status ^l	Domesticated (farmed) animal species	Wild animal species
Austria	y	Cattle [#]	
Belgium	y	Cattle [#]	
Bulgaria	n	Wild boar [#]	
Cyprus	y		
Czech Republic	y	Deer ^{g,h,i}	Red deer ^{g,h,i}
Denmark	y		
Estonia	y		
Finland	y		
France	y	Pigs [#] , Cattle [#] , Goats [#] , Cats [#] , Horses ^l	Red deer [#] , Wild boar [#] , Roe deer [#] , Red Fox ^q , Badger ^q
Germany	y	Sheep [#] , Pigs [#] , Cats [#] , Cattle ^{#f}	
Greece	n	Cattle ^{#,p}	
Hungary	n	Deer [#] , Cattle ^{g,h,i} , Pigs [#]	Fox [#] , Roe deer [#] , Fallow Deer [#] , Wild boar [#] , Red deer ^{g,h,i}
Ireland [*]	n	Cattle [#] , Cats [#] , Donkey [#] , Goat [#] , Sheep ^r , Alpaca [#] , Red ^s , Fallow ^s and Sika deer ^m	Badger [#] , Red deer ^s
Italy [*]	Some provinces y	Cattle [#] , Buffalo [#] , Goats [#] , Pigs ^{sw} , Dogs [#] , Sheep [#]	Birds [#] , Wild boar [#] , Roe deer ^v
Latvia	y		
Lithuania	n		
Luxembourg	y		
Malta	y		
Netherlands	y		
Norway	y		
Poland	y	Cattle [#] , Pigs [#] , Sheep [#] , Dog ^{g,h,i}	Bison, Roe deer ^{g,h,i} , Badger ^x
Portugal [*]	n	Cattle [#] , Pigs [#] , Sheep [#] , Goats ^e	Red deer ^e , Wild boar ^e , Rabbit [#]
Romania	n	Cattle [#]	
Slovakia	y	Cattle ^{g,h,i}	Wild boar ^{g,h,i}
Slovenia	y	Cattle ^{g,h,i}	
Spain [*]	n	Cattle [#] , Goats [#] , Free-ranging Iberian Pigs ^o	Red deer [#] , Wild boar [#] , Fallow deer [#] , Lynx ^d , Hare ^d , Badger ^d , Red fox ^d , Mouflon [#] , Roe deer ^v
Sweden	y	Deer ^b	
Switzerland	y		
U.K. [*]	n, Scotland y	Cattle [#] , Cats [#] , Dogs ^k , Llama ^l , Deer [#] , Pigs [#] , Sheep [#] , Alpaca [#]	Wild Boar ^u , Badger [#] , Fallow [#] , Roe [#] , Sika deer [#] , Fox [#] , Mink ^{c,d} , Mole ^{c,d} , Brown Rat ^{c,d} , Ferret ^{c,d} , Bank vole ^{c,d} , Stoat ⁿ , Common shrew ⁿ , Field vole ⁿ , Grey squirrel ⁿ , Yellow-necked ⁿ and Wood mice ⁿ , Grey seal ^v .

* Receiving financial support to help eliminate the disease from the EU.

2004–11 EFSA reports.

^a Zanella et al. (2008a).^b Wahlstrom et al. (1998).^c Delahay et al. (2001).^d Martin-Atance et al. (2006).^e Duarte et al. (2008).^f Schmidbauer et al. (2007).^g Pavlik et al. (2002).^h Pavlik et al. (2005).ⁱ Pavlik (2006).^j Reviriego Gordejo and Vermeersch (2006).^k Ellis et al. (2006).^l Twomey et al. (2007).^m Partridge et al. (2008).ⁿ Delahay et al. (2007).^o Parra et al. (2003).^p Hellenic Republic Ministry of Agriculture (2002).^q Zanella et al. (2008b).^r Malone et al. (2003).^s Quigley et al. (1997).^t Keck et al. (2010).^u Foyle et al. (2010).^v Balseiro et al. (2009).^w di Marco et al. (2012).^x Jerzy et al. (2012).^y Barnett et al. (2013).

the domestic species, cattle, pigs, goat and sheep may all be susceptible to TB. However, TB testing in most European countries focuses on cattle, and very few countries test a significant proportion of other pigs, goats and sheep to yield comparable data (EFSA, 2008). These species do undergo active surveillance at the abattoir (EC regulation: 854/2004) but very few (up to the end of 2010) have been found to be positive, although non-visible lesions will not be detected. Furthermore, since the head of sheep and goats may not be checked for lesions if it is not going to be consumed by humans (EC regulation: 854/2004), some infected animals may be

missed. An increasing number of pig carcasses are being rejected by abattoirs in Spain due to *M. bovis* infection (C. Gortazar, pers. comm.), but pigs in Southern Spain are mainly kept outdoors where they are in contact with other species (as occurs with out-door pigs in the Great Britain; Bailey et al., 2013) whereas the majority of pigs in Europe are housed indoors. Because of these inconsistencies in testing and surveillance across these four domestic species, together with the low numbers of pigs, goats and sheep tested, we therefore restricted our analysis to an evaluation of the TB hazard posed to cattle alone.

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