Public Attitudes to Badger Culling to Control Bovine Tuberculosis in Rural Wales

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Introduction

The management of wildlife to prevent the transmission of disease to farmed animals has become a matter of controversy amongst farmers, the public, scientists and politicians. Bovine Tuberculosis (bTB) provides probably the best worldwide example of this. As a zoonotic disease, bTB can be passed from animals to humans by consuming infected meat or milk. Human health risks are now considered negligible thanks to meat hygiene regulations and mandatory milk pasteurisation. However, international trade regulations mean that countries exporting beef and/or dairy products must operate a bTB surveillance and eradication programme.

To minimise the spread of bTB from wildlife to cattle and to protect agricultural exports, some countries have instigated wildlife culling policies without significant public opposition. Examples include: the culling of feral water buffalo (*Bubalus bubalis*) in Australia (Lehane, 1996); the brushtail possum (*Trichosurus vulpecula)* in New Zealand (Ryan et al., 2006); white-tailed deer (*Odocoileus virginianus)* in Michigan, USA (Carstensen et al., 2011; O'Brien et al., 2011); badgers (*Meles meles*) in Ireland (Sheridan, 2011); and wild boar (*Sus scrofa*) in Spain (García-Jiménez et al., 2013; Gortazar et al., 2011) However, in Great Britain, policies to cull wild badgers that can transmit bTB to cattle have been mired in controversy and public protest. Since the 1970's, various Governments have pursued – to varying degrees of enthusiasm – policies of badger culling as a way of reducing the spread of disease to cattle. The iconic status badgers play within British culture (Cassidy, 2012) has meant that politicians have been wary of badger culling policies, preferring to leave the decision to scientists (Grant, 2009). Nevertheless, scientific trials to evaluate the effectiveness of badger culling and subsequent policies have been disrupted by protestors.

Despite the significant levels of public opposition to a badger cull in Great Britain, the only attempts to account for these public attitudes have been limited to public opinion polling (Black, 2011; League Against Cruel Sports, 2011; Humane Society International, 2012; Bow Group, 2012; National Farmers Union, 2011). Whilst all but one of these polls suggest that a majority of the public are against a

badger cull, they fail to explain why these attitudes are held and how attitudes vary between socio-spatial contexts. By contrast, academic studies of other wildlife management and animal disease controversies suggest that public attitudes and policy preferences are linked to a range of factors. Firstly, studies have suggested that specific beliefs about nature shape the acceptability of wildlife control methods. Research by Dandy et al (2011; 2012) explores public attitudes to different methods of wild deer management revealing that when it comes to prioritising wildlife management options, lethal control – i.e. culling deer – is ranked low by the public. It is only once other methods have been tried and failed that the public begin to accept deer culling. Dandy et al. (2012) suggest that attitudes towards control methods are related to underlying beliefs about nature in general. One such belief is in over-abundance: the idea is that there is a "natural" population level for wildlife. When these perceived ecological limits are exceeded, beliefs in over-abundance provide legitimate grounds for culling deer (see also Bruskotter et al., 2009). Likewise, Buller's (2008) work on the re-introduction of wolves to the Mercantour region in the Southern French Alps, reveals how their acceptance is connected to different philosophies of nature. Whilst the reintroduction of wolves chimed with the visceral reality of naturalism, free-ranging wolves challenged beliefs in a pastoral nature where nature is carefully crafted and balanced.

Secondly, wildlife control preferences are likely to vary according to demographic and social variables such as age (Teel et al., 2002), gender (Dougherty et al., 2003; Loyd and Miller, 2010) and socio-economic position. Kendall (2006) argues that place and social structure also impact upon people's beliefs about nature and wildlife from an early age. The effects of socialisation lead those connected to farming to accept lethal control, whilst people from lower socio-economic groups to identify with animals' marginal position as similar to their own social position and expect higher levels of wellbeing for them. Beliefs about nature are also likely to vary according to spatial contexts. Debates about wildlife management are often framed around the differences between urban and rural ways of life (Bell, 1994). People living in rural areas may have different attitudes to wildlife control because of their experience and familiarity with wildlife and their impacts (Loker et al., 1999;

Green et al., 1997; Heberlein and Ericsson, 2005). Where wildlife pose an immediate disease threat to human populations, Fulton et al. (2004) show that the public are more likely to accept lethal control to avoid severe human consequences. Moreover, both Fulton et al. (2004) and Loker et al. (1999) suggest that those living closer to animal disease are more likely to accept wildlife culling policies.

However, broader socio-spatial changes, such as urban-rural migration and the decline of traditional rural industries such as agriculture may diversify and accentuate different views held about wildlife management preferences by rural populations. Geographers suggest that social change has led to the countryside becoming increasingly differentiated (Marsden et al., 1993) as affluent migrants seek to consume a particular version of rural living (Halfacree, 1995). Marsden et al (1993) identify four different kinds of countryside to emerge from these social changes ranging from the "paternalistic countryside" in which agriculture continues to play a dominant social and economic function, through to the "preserved countryside" where agriculture has declined in significance and the population comprised of people commuting to jobs in nearby urban settlements. As a result, geographical proximity to nature and disease may provide no guideline to public attitudes towards wildlife control. For example, in the management of deer, Dandy et al. (2011) found no significance difference between survey respondents who had frequent contact with deer and those with infrequent contact. Similarly, Konig's (2008) study of urban foxes in Munich Germany, suggests that the public are relaxed over their presence despite the potential for the transmission of hydatid disease to humans and pet dogs. In this case, proposals for culling foxes were rejected on practical grounds or seen as a last resort.

Thirdly, attitudes to wildlife control are also likely to relate to the public's trust in the institutions and organisations proposing wildlife control measures. Trust in government and science has been shown to be a crucial factor in the acceptance of a range of scientific and government advice on environmental risks (Poortinga and Pidgeon, 2003). In studies of animal disease management,

research has highlighted how disputes between scientists over the most appropriate forms of expertise to use to manage animal disease outbreaks are settled by politicians preferences (Bickerstaff and Simmons, 2004). For cases such as the Foot and Mouth Disease (FMD) outbreak in the United Kingdom 2001, the involvement of politicians in scientific debates threatens public trust in both science and Government. For example, Poortinga et al. (2004) found low levels of trust amongst members of the public in the Government's handling of the FMD outbreak. Similarly, disputes over the scientific advice to manage bTB have become highly politicised (Grant, 2009; Enticott, 2001). Enticott (2008) argues that amongst farmers, the politicisation of science and the marginalisation of farmers from the scientific process has led to a loss of trust in Government and scientists. Farmers have low levels of trust in Government, and have low levels of confidence in alternative methods of controlling bTB in badgers such as vaccination (Enticott et al., 2012).

Drawing on these understandings of public attitudes to wildlife control, and in the absence of in-depth quantitative studies of the public's attitudes to badger culling to control bTB, the aim of this paper is to quantify levels of support for a badger cull and explore the reasons why a badger cull is supported or rejected by the public living in rural areas of the United Kingdom. In doing so, the paper examines the extent to which public attitudes vary between different kinds of rural location, levels of disease and the extent to which attitudes towards a badger cull are related to levels of trust in Government, science and other organisations associated the management of bTB.

Materials and Methods

Policy Background

In Great Britain, bTB policy is devolved to the Governments of Wales, Scotland and Northern Ireland. Policy in England is led by the Department for Environment, Food and Rural Affairs (Defra). Levels of bTB vary in each of these countries, except for Scotland which is officially bTB-free. In England,

Wales and Northern Ireland there have been on-going debates over the need to cull badgers to prevent the spread of bTB in cattle. Scientific advice suggests that ineffective badger culls disrupts badgers' social territories, leading to surviving badgers spreading bTB to cattle. This so-called 'perturbation effect' thereby offsets reductions in bTB as a result of badger culling (Independent Scientific Group (ISG). 2007). Nevertheless, despite scientific advice and in the absence of a usable cattle vaccine against bTB, Governments in the United Kingdom have attempted to pursue badger culling policies. Moreover, devolution of animal disease policy has meant that different administrations have pursued different policies based on the same evidence (Spencer, 2011). In England, between 2010-15 a policy of state-sponsored badger vaccination was replaced by a policy of farmer-led badger culling (Maye et al., 2014). In two areas, licences were issued by Natural England (a government agency) to farmer owned companies to conduct badger culling.

In Wales, the Welsh Government announced plans for a badger cull in west Wales in 2009. The policy was challenged successfully in the Court of Appeal by the Badger Trust. However, new badger culling policies were announced in 2010. Following an election in May 2011, these plans were put on hold until March 2012 when the Welsh Government announced that badgers would instead by vaccinated against bTB rather than culled. For this study, research took place in February 2012 at a time when the badger cull plans were in the public domain but prior to the announcement that they would not proceed. Choosing Wales to conduct the research therefore had the advantage of badger culling being a 'live' policy topic to which members of the public were likely to have been exposed. Despite the change in policy, results still remain valid given that the history of bTB policy shows frequent political vascillation in approaches to badger culling. It is therefore likely that badger culling may return to the policy agenda in future. Moreover, the findings are also likely to be illustrative of public opinion in areas of England where badger culling has proceeded.

Study Sites

Research was undertaken in four different areas of Wales. Study sites were chosen that were characteristic of different degrees of rurality and incidence of bTB. Study locations were identified using the Office for National Statistics' urban-rural classification scheme and the Welsh Government's classification of deep rural areas (Wales Rural Observatory, 2009) – so called due to their absence of services and distance from large settlements. Two deep rural areas and two rural fringe areas were chosen. The deep rural areas can be considered to be part of the "paternalistic countryside" (Marsden et al, 1993) in which agriculture continues to play a dominant social and economic function. The two rural fringe areas can be seen to be characteristic of the so-called "preserved countryside": areas where agriculture has declined in significance and the population comprised of people commuting to jobs in nearby urban settlements. Study areas were also identified using data of bTB incidence (Animal Health and Veterinary Laboratories Agency., 2011) to identify areas with high and low levels of bTB. High and low levels of bTB were defined using county level bTB incidence data. Using these data, four areas were identified which reflected different combinations of rurality and disease incidence: one was deep rural with high bTB (Crymych, in Pembrokeshire); one was rural fringe with high bTb (Usk, in Monmouthshire); one was rural fringe with low bTB (Cowbridge, in the Vale of Glamorgan); and one was deep rural with low bTB (Llangammarch Wells, in South Powys). County level data suggests that the number of cattle farms is lowest in the Cowbridge area, with land-use comprising cropping and utility/recreation. Beef farms are most common in the area surrounding Llangammarch Wells, accounting for 95% of cattle herds. Dairy herds accounted for 37% and 23% of herds in the Crymych and Usk areas (Animal Health and Veterinary Laboratories Agency., 2011)

Questionnaire

In each of the four areas, a questionnaire survey was conducted. The questionnaire was developed containing questions relating to the main themes of the research. In total it contained 35 questions

which could be answered in approximately 10 minutes. Surveying was completed by five researchers who had attended a training course to ensure surveying was conducted consistently and familiarity with the subject area. As the aim of the research was to collect data from respondents characteristic of the two types of rural classification, a target of 250 respondents for each rural classification was set. In fact, as shown in table 1, more responses were obtained from deep rural areas (n=311) than rural fringe areas (222). Responses were collected in face-to-face interviews, at different locations in each of the survey locations. Prior to surveying, researchers were allocated separate areas of each location (e.g. different housing areas and shopping areas). Surveys were conducted on weekdays and at weekends, and questionnaires with a freepost return envelope were left at houses where there was no response. Postal responses accounted for 20% of the sample.

The questionnaire was split into four sections with most questions requiring a response along a five point scale (e.g. from disagree to agree). The first section asked about knowledge and attitudes towards bovine TB and a badger cull; a second asked about who respondents would trust to tell them the truth about a badger cull; a third section asked who respondents thought was responsible for bovine TB; and a fourth section asked respondents to assess what would be considered an acceptable benefit from a badger cull. The survey also collected demographic and economic characteristics from each respondent.

The issue of what counts as an acceptable benefit from a badger cull has been central to debates over a badger cull in Wales. Respondents were presented with a scientific estimate of the effectiveness of badger culling in reducing bTB in cattle and asked if it they thought it was acceptable. Respondents replying 'no' were then asked what level of badger culling effectiveness they viewed as acceptable. To guard against any anchoring effects (Tversky and Kahneman, 1974), two versions of the questionnaire were produced. In one, respondents were told that the benefit derived from badger culling was a 16% reduction in instances of bovine TB over 10 years in a 300km^2 area. In the other, the benefit was a 28% reduction. The 16% figure is based on scientific data

measuring the effectiveness of badger culling (Department for Environment Food and Rural Affairs., 2011a), whilst the 28% figure is based on advice from epidemiologists and veterinarians to the Welsh Government (National Assembly for Wales., 2011). Respondents were also shown a map of their local area marked with a 300km^2 area so they could gauge the geographical scale of any badger cull and its benefit. Both versions of the survey were visually identical and were randomly distributed amongst the surveys given to the researchers before each day's surveying.

Data Analysis

The data from each questionnaire was coded and inputted manually into IBM SPSS Statistics v.20 by the author. Questions that were answered incorrectly were coded as missing data. Analysis of response differences between different questionnaires and types of rural classification were conducted using an independent samples T-test and Chi-square. To explore the relationship between attitudinal and contextual variables upon public attitudes to badger culling, survey variables were included in an OLS regression. Respondents' answers to the question "In general, I feel that a badger cull is an acceptable way of dealing with bovine TB in Wales" acted as the dependent variable. Independent variables included degree of rurality, gender, and level of disease. Groups of variables were combined using Principal Components Analysis (PCA) with varimax rotation. Questions on which organisations and activities were to blame for bTB were combined using a Principal Components Analysis (PCA) with varimax rotation. Two clear components were identified explaining 73.29% of variance. The first grouped together modern farming methods, illegal activities and consumer demands for cheap food (accounting for 37.73% of variance); the second grouped the Welsh and UK Governments (accounting for 35.56% of variance). Additionally, questions on legislation that protects badgers and natural transmission were forced into the multi-variate analysis as single items. Variables on trust were also combined using PCA. The PCA found 3 distinct components, accounting for a total of 62.29% of variance. The first related to trust in

agricultural institutions, and included vets and farming unions (25.17%); the second related to the media (21.65%); and the third independent scientists (15.46%). Finally, to tap respondents' level of concern for the impact of bTB, variables relating to respondents concern for cattle and farmers were combined using PCA. Suitability for combining variables was assessed using the Kaiser-Meyer-Olkin measure of sampling adequacy and in each case was above the 0.5 acceptability level.

Results

Respondent Characteristics

The survey was answered by a total of 533 respondents. Most respondents were interviewed face-to-face, with 104 surveys being returned by post (a response rate of 10%). Male respondents accounted for 56% of the surveys. Of the survey locations, most respondents were drawn from deep rural locations (58%). Respondents tended to be from older age groups: 18% of respondents were under 44, 44% were aged between 45-64, and 40% over 65. Most (67%) respondents earned less than £31000. In general, incomes were lower in deep rural areas, whilst respondents were older in areas of low bTB (see Table 2). Although the sample was meant to be illustrative of the two different kinds of rural classification, comparisons of respondent characteristics for each survey location with census data suggest similar demographic profiles in the Usk, Crymych and Llanyrtyd Wells areas. The Cowbridge area has a greater proportion of respondents in the 16-44 age groups which may reflect the time of day surveys were completed.

Awareness of Bovine Tuberculosis and Causes

Overall, respondents demonstrated a high level of awareness of bTB and proposals for a badger cull. A total of 97% of all respondents were aware of bTB whilst 87% had heard of proposals to cull

badgers to manage the disease. There was no significant difference in awareness between respondents from deep rural areas and rural fringe areas, or areas with high and low levels of bTB Respondents demonstrated a concern for the impacts of the disease. Most believed that the Government should eradicate bTB, and expressed concern for the welfare of cattle and farmers because of the disease (see Table 3).

When asked to consider who they blamed for the level of bTB, the most frequently cited reason was that disease was simply a 'natural' phenomena (see Table 4). Despite public concerns over the government's handling of previous food safety and agricultural crises such as Bovine Spongiform Encephalopathy and Foot and Mouth Disease, support for the Government's role in managing bTB was mixed: approximately 27% of respondents agreed the UK Government were to blame for the spread of bTB, whilst 26% blamed the Welsh Government. Respondents from deep rural areas were more likely to blame either Government than those from the rural fringe. Respondents in areas with high bTB incidence were also more likely to blame the Government than respondents in areas of low bTB. There was also less agreement amongst other causes of bTB. Whilst many respondents blamed farmers, consumers wanting cheap food or modern farming practices, similar numbers of respondents dismissed these as valid reasons. However, respondents from low bTB areas were more likely to blame farmers. When it came to assessing the role of the badger, respondents were evenly balanced on the role that badger protection legislation plays in disease transmission. However, there was a clear difference between the location of respondents: respondents were more likely to blame badger protection legislation if they were from deep rural areas or from areas with high levels of bTB (see Table 4).

Attitudes towards a Badger Cull

Respondents were asked a series of questions about the acceptability of a badger cull, alternative management solutions and who they trusted to provide accurate information about a badger cull. In assessing the general acceptability of a badger cull, more respondents were in favour than against: approximately 43% agreed it was acceptable but 36% disagreed. Support was higher in deep rural areas (46%) compared to the rural fringe survey locations (38%). Support for a badger cull and was highest in those rural areas with high levels of bTB (50%) and lowest in those areas where the disease was low (33%).

There were also variations in respondents' attitudes to paying for a badger cull. Most respondents said that either the Welsh Government or a combination of the Government and farmers should pay for the cull. Only 3% suggested that farmers should pay the entire cost of a badger cull. Respondents in deep rural areas (44%) were more likely to suggest that the Government should pay for a badger cull compared to respondents (30%) in the rural fringe survey locations.

Support for interventions other than badger culling was highest in the rural fringe. Respondents were asked about their attitudes to vaccinating badgers against bTB and vaccinating cattle. A vaccine for badgers is currently available, but a cattle vaccine remains under development. Overall, 62% respondents agreed that it would be better to vaccinate badgers than cull them with support highest in the rural fringe. Similarly, 67% of respondents preferred cattle vaccination to badger culling, with support highest in the rural fringe (72%) and lowest in deep rural areas (63%). There was also a significant difference of opinion between respondents in high bTB areas over the role of vaccination. These respondents rated both badger and cattle vaccination significantly lower than respondents in low bTB areas.

Independent scientists and vets were trusted most by respondents to provide truthful information about bTB. Conservation groups were trusted more than farming unions. A quarter of respondents trusted the Welsh Government, but the level of trust was lower in areas of low bTB incidence. Farming unions were trusted more in deep rural areas, whilst support for conservation groups was higher in rural fringe areas. Respondents in areas with high levels of disease were more trusting of practising vets, farming unions and friends. In all cases, the least trusted sources of information were the national media and social media (see Table 5).

When respondents were presented with the scientific estimates of badger culling effectiveness, the majority suggested it was too low to be acceptable. For those presented with the evidence of a 28% reduction, 24% of respondents found it acceptable, whilst just 20% of respondents found the evidence for a 16% reduction acceptable. For both sets of evidence, similar proportions judged a badger cull never to be acceptable (23 – 28%), whilst the remainder suggested that it depended on the effectiveness of a cull. Levels of acceptability did not vary according to rurality or gender, but in areas with high levels of bTB, 30% of respondents said that a 28% reduction was acceptable, compared to only 18% acceptability for areas with low bTB.

When respondents were asked to assess what would be an acceptable outcome from a badger cull, the average figures far exceeded those suggested by the current scientific evidence. Amongst respondents who indicated that a badger cull might be acceptable, the average level of effectiveness suggested was between a 57% reduction in bTB incidents (for the 16% reduction estimate) and 68% (for a 28% reduction. See Table 6). Overall, differences between male and female respondents, those from areas of high and low bTB incidence, and deep rural and rural fringe areas were small and statistically insignificant.

Multi-variate Analysis

To explore the relationship between attitudinal and contextual variables upon public attitudes to badger culling, survey variables were included in an OLS regression with answers to the question "In general, I feel that a badger cull is an acceptable way of dealing with bovine TB in Wales" acting as the dependent variable. Results from the OLS regression show that the variables explain 59% of the variance (Adjusted R^2=0.593, F=50.362, p=0.000) in the dependent variable. Five independent variables were significantly correlated. The variable with most explanatory power was that which tapped respondents' views of nature management, that is whether the protection of badgers was to blame for the spread of bTB (t =8.021, p=0.000). Respondents who trusted agricultural institutions were also more likely to agree with a cull (t = 7.070, p=0.000), but those that trusted independent scientists did not (t= -4.632, p=0.000). Respondents who expressed concern for cattle and farmers also supported a badger cull (t = 6.232, p=0.000), but not those who blamed farming practices for spreading bTB (t = -2.309, p=0.021). Variables that were not statistically significantly related to the acceptability of badger culling included gender, type of rural location and level of disease.

Discussion and Conclusions

The survey reported here represents the first in-depth quantitative investigation of public attitudes towards bTB badger culling. This section discusses a number of the study's findings in relation to the existing literature on wildlife control, and the implications for policy makers attempting to communicate the benefits of wildlife control for bTB to the public.

Firstly, the survey results provided a mixed picture on the public acceptability of badger culling. For example, whilst 43% of respondents agreed in principle to a badger cull, just 21% rated the scientific evidence of a badger cull as acceptable. Moreover, whilst respondents generally agreed that badger culling was an acceptable method of dealing with bTB, they also set a much higher level of effectiveness for badger culling than current scientific studies would suggest is feasible. These different results alert us to the way that questions about a badger cull framed in different ways can

elicit very different responses. The analysis also revealed evidence of an anchoring effect when presenting scientific data on wildlife control to members of the public. On average, respondents presented with data suggesting badger culling leads to a 28% reduction in bTB cases suggested a minimum level of acceptability 11% greater than those respondents presented with the 16% reduction. This pattern was repeated whether respondents were in deep rural or rural fringe areas, low or high risk bTB areas, or were male or female. The reasons for these differences are not clear, other than the scientific data presented to respondents acting as an anchor for their subsequent estimates of minimum acceptable effectiveness. The differences therefore raise methodological challenges in researching the public acceptability of wildlife controls, particularly where there is scientific uncertainty over their effectiveness.

Secondly, a key question for this research was whether respondent's attitudes to a badger cull were related to their socio-spatial environments. The survey provided evidence both to confirm and challenge the relationship between rurality and proximity to disease, and attitudes to badger culling. There were no significant differences between respondents' attitudes towards badger culling in deep rural or rural fringe locations. However, respondents in deep rural areas were less likely to agree that badger vaccination or cattle vaccination were appropriate solutions to bTB. For policy makers, the results suggest that alternative bTB control strategies such as vaccination would receive more public support. Support for vaccination is more pronounced in rural fringe areas and areas of low disease incidence. Policy makers may find that by targeting these areas or those with lower levels of disease, they may be able to encourage greater enthusiasm for badger vaccination policies either through Government-led or voluntary schemes.

In terms of trust, deep rural respondents expressed low levels of confidence in independent scientists to tell the truth about the badger cull. Respondents from rural fringe locations, meanwhile, were less likely to be concerned about bTB and place less trust in farming unions than conservation groups. These results reflect key differences in the debate over the badger cull: culling versus

vaccination, and trust in rural organisations (such as Farming Unions) compared to extra-rural organisations (such as conservation groups and scientists). Whilst the kinds of social changes in deep rural and rural fringe areas documented by Marsden et al (1993) are not reflected in the overall acceptability of badger culling, these differences are reflected in the way respondents form opinions about a badger cull. Indeed, rural location was not a significant factor in the regression analysis, but the differences in trust were. These results reflect broader research findings on the way certain kinds of animal disease expertise are trusted more by some social groups than others. Veterinary practitioners and epidemiologists responsible for conducting trials on badger culling have appeared divided over the role of badger culling. In research, farmers have revealed their distrust for scientists but not practicing vets whose cultural and physical proximity means they are perceived are seen to be on their side (Enticott, 2008; Bickerstaff and Simmons, 2004). The survey results provide some evidence to support these concerns further. Respondents from the rural fringe trusted independent scientists significantly more than deep rural respondents. In deep rural areas, practicing vets were also more trusted than independent scientists. It may be therefore that different cultures of evidence, such as preferences for field based versus scientific expertise, are not limited to those professions (in this case farmers) directly affected by such disputes, but are connected to broader spatial and social-environmental contexts.

As other studies have found, attitudes towards badger culling did, however, vary according to the level of disease. Of all survey respondents, those living in areas with high levels of disease were the most likely to support badger culling policies, reflecting findings by Fulton et al. (2004) and Loker et al. (1999). The survey shows that respondents in areas of high bTB incidence were more likely to blame badgers protection legislation for bTB, suggesting that they connect the protection of badgers with a growth in their population and spread of disease. However, it is also likely that these results reflect knowledge of the social impacts of bTB. Recent research has highlighted the social and emotional impacts of animal disease felt by farmers and their families (Farm Crisis Network, 2009; Convery et al., 2008) whilst farming unions have connected support for a badger cull with the

emotional and economic impacts facing farmers whose herds have bTB. The survey results support this hypothesis: respondents living in areas with high levels of disease were the most concerned about the social and economic impacts of bTB than any other. However, no difference in the acceptable effectiveness of a badger cull was recorded between areas with different levels of disease.

More broadly, the survey found similarities with research on attitudes towards the management of other animal diseases, such as FMD. When it came to assessing the causes of bTB, 66% of respondents attributed its spread to the natural processes of disease transmission. In relation to FMD, Poortinga et al (2004) found higher levels of agreement during the FMD crisis (88% cited this reason as a cause of FMD). In both cases, this may be explained by the cultural significance that beliefs about chance and luck play in explaining the spread of disease. Such beliefs are also found in public health research (Davison et al., 1991), and feature strongly in farmers' understandings of why they do and do not get bTB (Enticott, 2008). The belief in luck and chance may also be because a lack of trust in science and government. Indeed, in the areas with high bTB incidence, vets and friends and family were one of the most trusted sources of advice about bTB, rather than scientists or the Government. Respondents trust in the Government was on a par with those attitudes displayed in relation to FMD (Poortinga et al, 2004). Nevertheless, low levels of support in the Government did not mean that survey respondents believed the Government should have no role in managing bTB.

Respondents who did not unconditionally rule out a badger cull believed that bTB controls should be funded by Government rather than farmers. This is interesting for two reasons. Firstly, despite low levels of trust in Government, the public continue to look to them to resolve problems affecting agriculture and wildlife. This tension is also evident amongst farmers who despite low levels of trust in Government believe that Government should resolve animal disease problems (Heffernan et al., 2008). For farmers, this tension may be explained by the fact that they do not trust other farmers to contribute to collective efforts to eradicate diseases. For the public in rural areas, these conflicting

attitudes may relate more to sympathy for poor socio-economic conditions that farmers face in marginal agricultural areas. Secondly, the preference for Government funding for bTB controls is at odds with the way Governments see the solution to animal disease problems. By passing costs and responsibilities to farmers, Governments believe that farmers will behave more responsibly and manage the disease more effectively (Department for Environment Food and Rural Affairs., 2013). These survey results however, suggest that the public believe that Governments should remain responsible for animal disease control and if farmers are to contribute financially they should do so only in conjunction with the Government.

These results raise a dilemma for policy makers and stakeholders. On the one hand, the results suggest that public acceptability of a badger cull is a long way away from current scientific estimates of its effectiveness. On the other hand, in the absence of new evidence, the most common tactic for Government officials has been to refer to scientific evidence and claim that 'no other country has successfully controlled the disease in cattle without tackling its presence in the native wildlife' (Department for Environment Food and Rural Affairs., 2011b: 4). Similarly, pro-badger cull organisations, such as the National Farmers' Union (NFU), have sought to disseminate scientific evidence on badger culling in the belief that this will engender public support. In this respect the distrust of social media is interesting as many farming groups have suggested it represents a way to reconnect farming with the public and persuade them of the need to support farming causes, like the badger cull. Indeed, the NFU in England established a web site called www.TBfreeEngland.co.uk complete with videos on YouTube and social media Facebook and Twitter accounts (e.g. @TBFreeEngland). The aim of the social media campaign was to communicate to the public the problems faced by farmers as a result of bTB and to encourage support for the NFU's campaign for a badger cull. The results from the survey, however, suggest that such campaigns may face a lack of credibility in the eyes of the public.

This strategy is also likely to be problematic for other reasons. Although about half of the respondents thought a badger cull was unacceptable because of low levels of effectiveness, as in other studies (Fulton et al., 2004), improved effectiveness mediated views on acceptability. However, for a substantial proportion of respondents, culling effectiveness makes no difference to their views on a badger cull. Whilst some respondents set a threshold under which a badger cull was not acceptable, a significant proportion were morally opposed to any kind of badger cull, whether it was effective or not. As suggested by Buller (2008), it is likely these contrasting opinions are based on different philosophies of nature – distinct sets of moral and ethical reasonings, or beliefs about fairness and nature. Frequently, these philosophical beliefs of nature invoke ideas of 'natural balance' or 'equilibrium' to justify particular forms of nature management (Bruskotter et al., 2009). This may take the form of calls for human intervention to restore a self-regulating natural balance, or criticisms of human intervention for allowing nature to fall out of balance by protecting certain species (Eden and Bear, 2011). This may explain why respondents form deep rural areas and areas of high bTB incidence were against badger vaccination and blamed the legal protection afforded to badgers for bTB. For them, the problem is one of over-population which vaccination cannot address.

Given that such beliefs about nature are often deep-seated, mass 'deficit style' forms of communication about badger cull science are likely to have a limited effect. Indeed, these concerns are reflected in existing qualitative research about bTB. Interactive workshops involving the public and scientific experts (Department for Environment Food and Rural Affairs., 2006) revealed that when the public have the opportunity to examine the scientific evidence, the uncertainties of the science on offer meant that participants found it difficult to make a decision about the cull. When forced to decide, there was marginal support for a cull, but this was reluctant and heavily caveated with little movement between pro- and anti-badger cull positions (Department for Environment Food and Rural Affairs., 2006: 28). Thus, when it comes to conducting wildlife controls, attempts to address knowledge gaps amongst the public will not necessarily affect public acceptance, as has been recognised in other environmental controversies such as climate change (Kahan et al., 2010;

Kahan et al., 2012). Similarly, beliefs about badger culling are likely to be tied up in moral beliefs about nature that are likely to be hard to change through the communication of scientific evidence on the effectiveness of culling or references to the experiences of other countries alone.

How might policy makers resolve this dilemma? One response may be to consider whether generating public support is worthwhile at all: does resolving an animal disease like bTB need public support, and are the consequences of not receiving it likely to result in policy failure? History tells us that politicians have thought a badger cull to be a political liability since the 1970s (Grant, 2009), whilst scientific trials and badger cull policies have consistently come up against public protest that have arguably affected their effectiveness. If public support is seen as desirable, then rather than rely on deficit models of scientific communication, seeking to reframe the ways in which animal disease policy is made and for what purposes might provide a way round this impasse. In New Zealand, possum control is framed within attempts to protect the agricultural economy, native wildlife and the purity of nature, which in turn is linked to attempts to define a biosecurity identity for New Zealanders (see: Parliamentary Commissioner for the Environment, 2011). However, reframing the debate is complicated by the fact that it is already organised around social, economic and cultural values (Cassidy, 2012). The extent to which it is possible to reframe badger culling around these different narratives of national identity and biodiversity in England and Wales may reveal the limits to which badger culling represents a realistic policy option. Alternatively, it may be that by refocusing the objects of veterinary regulation from old diseases like bTB to newer animal disease challenges may provide a different solution. Challenging the economic rationale for controlling bovine tuberculosis, and removing barriers to alternative solutions, such as cattle vaccination, may provide an opportunity to question whether diseases like bovine tuberculosis require eradication. Such a debate may also contribute to broader thinking about the role of democratic rights and distributive rather than procedural justice in the management of animal disease.

In conclusion, this paper has explored public attitudes to animal disease and methods of controlling its spread between wild and farmed animals. In focussing on bovine tuberculosis and a badger cull, a key aim has been to examine how these attitudes vary between different types of rural space, and the extent to which the public's expectations of a badger cull correspond to the scientific evidence. The paper has shown that respondents in "deep rural" areas and those from areas with high levels of bTB are most in favour of a badger cull, whilst respondents from rural fringe and/or areas with low levels of bTB favour other control methods such as badger vaccination. A significant majority of respondents do not believe the current scientific evidence on the effectiveness of a cull is acceptable, and suggest for it to be acceptable it would have to be over three times its current level. The results raise interesting questions for policy makers and stakeholders who have sought to persuade the public to accept the cull by referring to the current scientific evidence. This strategy is likely to fail not just because there is a vast disparity between public and scientific expectations, but – as other research has shown – these attitudes are drawn from deep-seated beliefs about nature that are unlikely to be easily changed. If public support is central to badger cull policies, then policy makers may wish to explore alternative ways of governing animal disease.

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Tables

Table 1: Respondent Characteristics (number of respondents)								
	Survey Version		Level of Disease		Gender		Type of survey location	
	16%	28%	High	Low	Male	Female	Rural Fringe	Deep Rural
Crymych Area	87	93	180		89	88		180
Cowbridge Area	57	53		110	51	57	110	
Llanyrtyd/Llangammarch Wells Area	55	76		131	44	85		131
Usk/Raglan Area	57	55	112		47	64	112	
Total (N)	256	277	292	241	231	294	222	311
Total (%)	48%	52%	54.8%	45.2%	44%	56%	41.7%	58.3%

Table 2: Respondent Characteristics					
		Level of Disease		Rurality	
		High	Low	Rural Fringe	Deep Rural
		%	%	%	%
Household Income (£)	less than £5000	8.2	4.5	6.0	7.0
	5000-9999	6.1	8.4	7.1	7.0
	10000-15499	16.5	16.8	11.3	20.2
	15500-20999	13.0	14.5	9.5	16.5
	21000-30999	28.6	16.2	19.6	25.6
	31000-51999	16.5	22.9	22.6	16.9
	52000-78000	6.1	10.6	13.7	4.1
	more than 78000	5.2	6.1	10.1	2.5
Gender	Male	47.2	40.1	44.7	43.5
	Female	52.8	59.9	55.3	56.5
Age	16-24	5.9	2.6	2.3	5.9
	25-44	21.5	12.8	16.5	18.4
	45-54	20.1	17.0	21.1	17.0
	55-64	18.1	25.1	21.6	21.0
	65-74	19.1	26.0	22.5	22.0
	75+	15.3	16.2	16.1	15.4
	9	0.0	0.4	0.0	0.3

Table 3: Attitudes to Bovine Tuberculosis and a Badger Management Options (Mean response to 5 point scale)							
	All Respondents	Deep Rural	Rural Fringe	Male	Female	High Disease	Low Disease
1. The Welsh Government should eradicate animal diseases like bovine TB	4.24	4.36**	4.08	4.31	4.18	4.35**	4.11
2. I am concerned about the impact bovine TB has on the health and welfare of cattle.	4.32	4.42**	4.18	4.35	4.29	4.42**	4.19
3. I am concerned about the social & economic impact to farmers when their cows are killed because of bovine TB	4.30	4.35	4.23	4.36	4.25	4.46***	4.10
4. In general, I feel that a badger cull is an acceptable way of dealing with bovine TB in Wales	3.09	3.18	2.95	3.26*	2.93	3.38***	2.73
5. Badgers should be culled if there is a substantial risk of humans catching bovine TB	3.77	3.77	3.78	3.92*	3.66	3.95**	3.56
6. I would support a badger cull if it saved the Welsh Government money it spends on managing bovine TB	3.07	3.17	2.93	3.27*	2.91	3.43***	2.63
7. In general, I feel that it would be better to vaccinate badgers against TB rather than kill them.	3.67	3.52**	3.89	3.52*	3.80	3.41***	3.99
8. In general, I feel that it would be better to vaccinate cattle against bovine TB rather than kill badgers	3.85	3.71**	4.05	3.70*	3.97	3.58***	4.18
Notes Levels of statistical significance: *** <0.001, ** <0.01 * <0.05							

Table 4: Who respondents blame for the spread of bTB (Mean response to 5 point scale)							
	All Respondents	Deep Rural	Rural Fringe	Male	Female	High Disease	Low Disease
1. Natural processes of disease transmission	3.85	3.76**	3.99	3.83	3.87	3.80	3.92
2. Modern farming practices	2.94	2.88	3.02	2.87	3.00	2.90	2.99
3. Consumers wanting cheap food	2.93	3.00	2.82	2.78*	3.05	2.94	2.91
4. Some farmers acting illegally	3.04	3.05	3.03	2.99	3.07	2.87**	3.25
5. The Welsh Government	2.83	2.95**	2.66	2.82	2.83	2.97**	2.65
6. The UK Government	2.86	2.97**	2.69	2.85	2.87	3.03**	2.66
7. Legislation that protects badgers	3.05	3.15	2.92	3.18	2.94	3.29***	2.76

Notes
Levels of statistical significance: *** <0.001, ** <0.01 * <0.05

Table 5: Who respondents trust to tell truth about a badger cull (Mean response to 5 point scale)							
	All Respondents	Deep Rural	Rural Fringe	Male	Female	High Disease	Low Disease
1. The Welsh Government	2.68	2.72	2.62	2.75	2.63	2.86***	2.47
2. Farming Unions	3.18	3.35**	2.94	3.14	3.20	3.37***	2.95
3. Friends/relatives	3.30	3.41*	3.15	3.33	3.27	3.48**	3.09
4. Conservation groups (e.g. RSPCA, National Trust)	3.31	3.20 *	3.48	3.17*	3.43	3.20*	3.45
5. Independent scientists	3.72	3.57 ***	3.94	3.71	3.73	3.75	3.69
6. Vets (working in private practice)	3.82	3.83	3.80	3.80	3.82	3.93*	3.68
7. National media (newspapers, TV)	1.93	1.86	2.02	1.88	1.96	1.98	1.86
8. Social media – such as Facebook and twitter	1.75	1.77	1.71	1.77	1.74	1.75	1.74
Notes Levels of statistical significance: *** <0.001, ** <0.01 * <0.05							

Table 6: Public Acceptability of a Badger Cull									
	Overall acceptability						Mean Minimum Acceptable Reduction		
	16% Reduction			28% Reduction			16%	28%	All Respondents
	Acceptable (%)	Not yet Acceptable (%)	Never Acceptable (%)	Acceptable (%)	Not yet Acceptable (%)	Never Acceptable (%)	(%)	(%)	(%)
All Respondents	19.9	57.4	22.7	24.2	48.0	27.8	56.6	67.7	62.0
Deep Rural	22.3	57.6	20.1	24.4	47.6	28.0	55.5	69.3	61.4
Rural fringe	17.0	57.1	25.9	23.8	48.6	27.6	59.7	67.8	62.8
High Disease	21.8	61.3	16.9	29.9	49.0	21.1	57.3	68.4	61.2
Low Disease	17.4	52.3	30.3	17.5	46.8	35.7	57.5	69.3	63.0
Male	21.7	56.5	21.7	24.6	51.8	23.7	56.0	65.1	60.4
Female	18.0	58.6	23.3	23.7	45.5	30.8	57.3	70.0	63.3