Appendix 6.
Register of risks and mitigation

This is an appendix to the report, "Lead Ammunition, Wildlife and Human Health" by the Lead Ammunition Group, 2 June 2015.

Worksheet	Topic	Relevant pages in main report
Human health (Sheet 2)	Human health risks and mitigation	22-34; 44-52 refer
Wildlife (Sheet 3)	Wildlife risks and mitgation	35-38; 52-59 refer
Risk reduction efficacy (Sheet 4)	Risk and migation efficacy	73-82 refer

Notes

1. *Columns and rows may be frozen to enable scrolling - electronic version*
2. References to the grading scales for likelihood, impact and risk rating are provided at the head of each column as appropriate.
3. References to key texts are provided in the relevant cells as appropriate.
4. Only the principal risks are covered in Sheets 2 and 3.
5. Only risks considered to merit a residual risk rating "high" or "medium"are covered in the risk and migation efficacy worksheet (Sheet 4).

Appendix 6. Register of risks and mitigation **Human health risks and mitigation**

Risk no.	Title	Description	Cause/ source of risk	Consequences	Current likelihood (Grading scale on page 40)	Current impact (Grading scale on page 40)	Current risk rating (Grading scale on page 42)	Possible countermeasures		Owners	RAG Rating (Grading scale on page 39-40)	Residual likelihood	Residual impact	Residual risk rating	Notes
HH1	**Harm to children**	Neurodevelopmental harm to children particularly in families where game is eaten regularly i.e. high level consumers	Unavoidable lead residues in cooked game meat including sausages, pies, burgers etc.	See pages 44-45. Principally neurodevelopmental harm and reduction of IQ. Could apply to at least 10,000 young children from the community of live-quarry shooters. In addition, children from the general population are exposed to elevated exposure to lead from consuming game less frequently. This may apply to “tens of thousands to hundreds of thousands” of young children (see Appendix 1 and 8).	“High” as very likely to occur this year and at frequent intervals in the future. (Significantly greater than 50:50 chance.)	"Medium" See p 40.	"High"	Awareness raising (pages 76-77). Raise awareness of risk amongst parents of children who eat game meat and encourage reduction in consumption of lead-shot game meat for children under 8	Media communications. Revise game consumption advice given by FSA and shooting organisations in light of size of 'at risk' population and other factors highlighted in risk assessments and reissue advice	Food Standards Agency/ Shooting and trade organisations	Although a "targeted campaign has been proposed no coherent plan has been seen. The underlying messaging remains conflicting and confused. No coherent action plan has been prepared or the actions that have been taken so far seem to have had insufficient impact on the risk or a critical point is looming and decisive action is necessary to avoid serious problems/external	"High"	"Medium"	"High"	
									Codes of conduct	Shooting and trade organisations	No progress seen				Industry codes such as the Code of Good Shooting Practice have been suggested.
									Best practice and education resources	Shooting and trade organisations	No progress seen				Various routes have been suggested such as the DMQ Best Practive Guides, FSA/LANTRA Trained Hunter requirements and other industry and food supply training and CPD models.
								Special measures	Take measures to ensure that wildfowl shot with lead are not sold in England and Wales	Shooting and game handling, dealing and processing organisations					BASC's Shoot Lead Legally initiative has been in place for some time but unfortunetely has not had measurable effects.
									Compulsory food labelling that highlights health risks of lead	Shooting and game handling, dealing and processing organisations	No progress seen				
									Quality assurance. Set and enforce maximum lead level in game meat sold for consumption in the UK	FSA with game handling, dealing and processing organisations	No progress seen				Public spending limitations make this an unlikely option?
								Lead ammunition replacement (pages 73-75)	Gunshot/living quarry	Defra	Wildfowl and wetlands issues addressed by 1999 regulations, but implementation appears to be poor. 1999 regulations do not address health hazards from other gamebird species that form the principal supplies to local and				High level policy direction required. Experience of replacement in wetlands noted, as well as some European countries and in North America. Key consideration is the efficacy and "hamenness" of steel shot ammunition. Research studies indicate steel shot ammunition is comparably effective relative to lead shot ammunition at recommended live quarry shooting distances. Opinion among shooters disagrees strongly with this conclusion but practical evidence is lacking.
									Gunshot/all shooting	Defra	No action taken				
									Lead bullets/living quarry	Defra	No action taken				
									Lead bullets/all shooting	Defra	No action taken				
									All lead ammunition/ living quarry	Defra	No action taken				
									All lead ammunition/all	Defra	No action taken				
HH2	**Harm to pregnant women** **(See pages 45-46, 48)**	Consumption of lead residues by a pregant woman exposes her foetus.The foetus is considered to be as sensitive to the detrimental effects of lead as a young child.	Unavoidable lead residues in cooked game meat including sausages, pies, burgers etc.	The number of women within the shooting community eating one game meal a week is estimated from Ellis (2014) to be some 13,500 of which some 2.5% may be pregnant, suggesting that a risk for unborn children would apply in some hundreds of instances.	“High” as there is high likelihood of occurrence in the current year and foreseeable future.	"Medium"	"High"	Possible countermeasures are the same as for Risk 1 above but with clear messaging for pregnant women and mothers-to-be.		As above	No action taken	"High"	"Medium"	"High"	

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Risk no.				At least 23,000 pregnant women, including those in the shooting community, may be exposed to additional lead from game consumption annually as the result of eating one or more game meat meal. The proportion of these who consume enough gamebird meat to produce an effect on their unborn child of significance to society cannot be estimated. (See Appendix 8).	"High" as there is high likelihood of occurrence in the current year and foreseeable future.	Unknown	Unknown			As above	As above	As above	As above		
		Early pregnancy miscarriage		It is estimated that 745 to 1700 women per year are potentially at increased risk as the result of consuming this amount of gamebird meat. Given known rates of miscarriage in early pregnancy this represents a possible additional 7 to 17 cases. (See page 48)	High	Very low	Medium			As above	No action taken				
HH3	**Renal damage and chronic kidney disease**	Consumption of 200g of wild gamebird meat per week could increase the dietary exposure to lead of adults in the UK by approximately 7 to 8 times over exposure from all other dietary components combined - i.e. 'background exposure'.	Unavoidable lead residues in cooked game meat including sausages, pies, burgers etc	Within the shooting community "tens of thousands" of adult game consumers may be at risk from the 10% increase in the prevalence of chronic kidney disease (the EFSA BMR) effects at this BMR).	High	Medium	High	Possible countermeasures are the same as for Risk 1 above but with clear messaging		As above	No action taken				
		EFSA (2010) Benchmark Response for chronic kidney disease (CKD) - a 10% increased prevalence of CKD - occurring in adults that consume 1.2 to 1.9 (240-380 g total weight) or 4.0 to 6.5 (800-1300 g total weight) gamebird meals per week (See pages 46-47).		In the general population "thousands to hundreds of thousands" of people may be at risk to lesser degree. It has to be stressed that these ranges especially for the general population are extremely broad due to uncertainties in the data, however the conclusion to be drawn is that the risks involve non-trivial numbers of people.	High	Unknown	Unknown	Possible countermeasures are the same as for Risk 1 above but with clear messaging		As above	As above	As above	As above		
HH4	**Cardio vascular disease**	EFSA 2010 anticipated that some frequent consumers of game (i.e. one 200g meal per week) might potentially be at risk from negative effects on the cardio vascular system as a result of exposure to dietary lead. This report extends that estimation. On the basis of feasible levels of gamebird meat consumption in UK evidence confirms that there is potential risk of a 1% increase in systolic blood pressure (the EFSA BMR) in adults who consume 3.2 to 5.2 (640-1040 g total weight) gamebird meals per week. (See pages 47-48)	Unavoidable lead residues in cooked game meat including sausages, pies, burgers etc	Within the shooting community "hundreds to thousands" of adults may be at risk of the 1% increase in their systolic blood pressure. In the general population "thousands to tens of thousands" of adults may be exposed to elevated lead to a lesser degree in proportion to their consumption.	"High"	"low"	"Medium"	Possible countermeasures are the same as for Risk 1 above but with clear messaging		As above	As above	As above	As above	As above	
HH5	**Effects in shooting ranges**		Principally concerning adequacy of ventilation at indoor shooting ranges with inhalation of lead fume. (See page 48)	Elevated exposure to lead with harm as above.	Unknown	Unknown	Unknown	Local Area Ventilation (LEV) in place meeting British Standard for lead fume.There has been no information made available to the Group to indicate the level of clay ground and target range management across the spectrum of facilities currently in operation, from the large and full-time establishments, to the small and occasionally used.		Target shooting governing bodies and Home Office approved clubs	Unknown	Unknown	Unknown	Unknown	
HH6	**Home loading**		Principally inhalation of lead fume and ingestion of lead residues from hands	Elevated exposure to lead with harm as above.	Unknown	Unknown	Unknown	Codes of practice and communications. There is little or no information available on ammunition home loading in UK and the risks cannot be quantified, but it is likely that the attendant health risk exists and certain that it would not be mitigated by existing regulations.		Shooting and trade organisations	Unknown	Unknown	Unknown	Unknown	

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W1	**General wildlife exposure to lead from ammunition (See page 52 et seq).**	(See page 36) At least 6,000 tonnes of lead are dispersed annually from ammunition in the UK. This comes from gunshot and/or bullets from game shooting, clay shooting, pest control and deer stalking. Potentially this is available to wildlife. Exposure potentially occurs wherever shooting takes place and spent ammunition remains on/in soil or water or in the bodies of shot animals.	1. Direct ingestion of spent lead ammunition from the environment. 2. Indirect ingestion of spent lead ammunition by predators/scavengers in the bodies of their prey. 3. Movement of spent ammunition lead via plants into their consumers. 4. Movement of spent ammunition lead via soil ingestion or soil organisms/invertebrates into their consumers. 5. Movement of spent ammunition lead from embedded shot/bullets into body tissues/organs.	Debilitation and possible mortality. This report has estimated the possible numbers of terrestrial gamebirds, wildfowl and predatory and scavenging birds affected by and dying from such exposure. The estimates indicate that non-trivial numbers in all these types of bird die annually, and others suffer non-lethal and hence welfare effects. (See Appendix 7). Evidence of pathway 1 is available for many species of wildfowl, some other waterbirds and gamebirds, in the UK and overseas. Evidence of pathway 2 exists for some raptor species in the UK and overseas. Evidence exists for pathway 3 and 4, but there are few studies from the UK. A possible pathway 4 is identified for woodcock. There are few studies of pathway 5. A range of other species of wildlife may be exposed, although few relevant studies have been done in the UK. These include corvids and other scavengers (pathway 2). Ground-foraging passerines and pigeons, as well as other forms of wildlife, including small mammals/ frogs may be exposed through pathway 3 and 4 in areas of high shot-fall (such as clay target grounds).	"High"	Low < medium	Medium <high	Replacement of lead ammunition with alternatives See Human health worksheet)	Defra	A decision in principle has not been taken. It would require a policy direction from Defra to initiate development of an action plan based either on self-regulation by shooting and landowning stakeholders or regulation by Government.	"Low"	"Low"	"Low"	
W2	**Exposure of wildfowl and waterbirds (See page 53)**	Many species of wildfowl and some other species of waterbirds are affected through ingesting lead shot, and this causes mortality and debilitation. The level of the exposure is high. Many studies in UK and overseas have shown the percentages of individuals that carry lead shot in their gizzards; such shot being either voided or ground down and absorbed into the body within two or three weeks at most. This level of exposure means that during the course of a year many wildfowl are regularly exposed to repeat exposure with sub-lethal effects or death.	1. Direct ingestion of spent lead ammunition from the environment.	It is estimated that 30,000-50,000 wildfowl, which is a few percent of the wintering population, may die each winter as a direct result of lead poisoning in Britain. There may be further mortality outside the winter. Other water birds may also be affected. Welfare impacts will affect all of these birds before they die and additional unknown numbers of birds that survive. (See slight revisions to figures in Appendix 7)	"High"	"Medium"	"High"	Environment Protection (Use of Lead Shot)(England) Regulations 1999 et seq.	Defra and shooting stakeholders	The 1999 regulations have been in force since 1999. While there has been some uptake, research indicates that implementation is far from complete.	"High"	"Medium"	"High"	
W3	**Exposure of terrestrial gamebirds (See page 55)**	Considerable numbers of terrestrial gamebirds die annually from ingesting lead; in the order of hundreds of thousands. The numbers suffering sub -lethal effects are to be added to them.	1. Direct ingestion of spent lead ammunition from the environment.	The proportions of pheasants and partridges with pellets in their viscera at any time have been found to be 1.4% and 3% in shot red-legged partridges and pheasants respectively and 4.5% in found dead grey partridges (Butler 2005, Butler et al 2005, Potts 2005). If the length of time pellets remain in the birds' alimentary canal is as long as 30 days (although it could be much shorter) much larger percentages of pheasants and partridges must ingest pellets and be exposed to lead shot annually. Whatever the precision of the estimates, some considerable numbers of terrestrial gamebirds die annually from ingesting lead; in the order of hundreds of thousands.	"High"	"Medium < high"	"High"	Replacement of lead ammunition with alternatives See Human health worksheet)	Defra	A decision in principle has not been taken. It would require a policy direction from Defra to initiate development of an action plan based either on self-regulation by shooting and landowning stakeholders or regulation by Government.	"Very Low"	"Very low or negligible"	"Very low"	
W4	**Exposure of raptors and scavenging species (See page 56)**	Limited studies of raptor and scavenging species in UK suggest that some 2-9% of those that have died may have died from exposure to lead ammunition. Appendix 7 describes what is known for a variety of raptors and scavengers in UK and from other countries.	2. Indirect ingestion of spent lead ammunition by predators/scavengers in the bodies of their prey.	The limited studies that have been conducted in the UK show results consistent with those from elsewhere in terms of risk, pathway and effects: namely that there is credible possibility of changes in populations, with impacts on some individuals in some populations, and the possibility of some qualitative, non-quantifiable impacts.To date they are recorded in UK for red kite, and possibly other raptors (buzzard/ peregrine falcon).	"High"	"Medium"	"High"				"Very Low"	"Very low or negligible"	"Very low"	

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W5	**Exposure of ground foraging passerines and other animals (See page 57)**	Exposure of ground foraging passerines, and ground dwelling animals such as amphibians, soil arthropods and microfauna to the potential impacts of lead ammunition has not been widely studied in the UK although the few UK studies available show the potential for increased exposure and uptake by ground dwelling animals Studies from the UK and elsewhere provide evidence of elevated soil lead concentrations where shooting occurs regularly and at high intensity, and that some of the lead from deposited ammunition is available for plant uptake. Where levels of soil, water and/or biota are elevated as a result of the degradation of lead from ammunition, there is likely to be uptake of lead by certain animals.	Mainly pathways 1,3 and 4.	There will be a spectrum of impacts between the extremes on areas where intensive shooting takes place on the one hand, and where little or no shooting takes place on the other. But the gradient of impacts cannot be further charactarised or quantified on the basis of current research.	"High"	"Low"	"Medium"	Replacement of lead ammunition with alternatives See Human health worksheet)			"Very Low"	"Very low or negligible"	"Very low"	
W6	**Wildlife welfare impacts. (See pages 57-58)**	Effects on the welfare of the animals exposed to lead from ammunition are supported by veterinary evidence on bodily functions, laboratory experiments and observed behavioural changes in affected animals. The effects may be sub-clinical i.e. with no outward display, or clinical i.e. with manifest signs and symptoms. The effects may interfere with behavioural, developmental and reproductive capabilities.	As above all 5 pathways	Ingestion of lead ammunition or lead fragments from ammunition by whatever pathway can be expected to affect welfare broadly in proportion to dose, whether affected animals recover or die. This report estimates the numbers of animals of certain kinds that may be exposed to welfare effects (see Appendix 7). Whatever weight is placed on the exact numbers it is clear that non-trivial numbers are involved: in the order of millions of animals.	"High"	"High"	"High"	Replacement of lead ammunition with alternatives See Human health worksheet)			"Very Low"	"Very low or negligible"	"Very low"	
W7	**Risks to individuals and population processes. (See pages 58 -59)**	Deaths and impaired reproduction of individual animals, caused by direct and indirect ammunition lead poisoning, will affect death rates and birth rates and therefore population processes. Adverse effects from ingested ammunition lead, including death, occur or are likely to occur in individual birds (and some other animals) where source-pathway-receptor linkages occur or are likely to occur.	As above pathways	To date effects are recorded in the UK for wildfowl and some other waterbirds, some gamebirds, red kite, and possibly other raptors (buzzard/peregrine falcon). The biological and ecological consequences of effects on population processes are not whether they reduce a population's counted numbers and hence conservation status, but whether exposure is likely to affect the longer term resilience of populations to external threats, and their ability to maintain themselves in the longer term.	"High"	"Medium"	"High"	Replacement of lead ammunition with alternatives See Human health worksheet)			"Very Low"	"Very low or negligible"	"Very low"	
W8	**Effects on population numbers and status. (See page 59)**	The extent of lead exposure in some species suggests the potential for effects on population size, although the detailed studies necessary to establish this have not been undertaken in species found in the UK. The extent to which lead poisoning mortality may be compensated for by other factors affecting survival is unknown, and therefore population size may or may not necessarily be impacted.	As above pathways	If population numbers and hence status are affected it will manifest itself in lower numbers than would otherwise occur, as a contributory factor to population decline,or a reduced rate of growth in population numbers. Research has not been done in UK to investigate this. It is however agreed that the potential exists in some species. Increases in Mute Swan have been associated with removal of fishing weights in southern England.	"Very low"	Research not done	Unknown	Replacement of lead ammunition with alternatives See Human health worksheet)			"Very low"	Research not done	Unknown	

Risk and mitigation efficacy

Mitigation Measures		Human health risks					Wildlife and animal welfare risks						
		Neurodevelopmental harm to children .	Effects on foetus resulting from exposure of mother (consumption of lead residues by a pregant woman exposes her foetus)	Exposure of mother-to-be/pregnant woman results in early pregnancy miscarriage	Renal damage and CKD	Cardio vascular disease	General wildlife exposure to lead from ammunition	Exposure of wildfowl and waterbirds	Exposure of raptors and scavengers	Exposure of ground foraging passerines and other animals	Animal welfare impacts	Risks to individuals and population processes	Effects on population numbers and status
Awareness raising and best practice	Revising game consumption advice given by FSA and shooting organisations	Plans needed (Next revision of FSA Game Guide 2017)					Countermeasures can reasonably be expected to have negligible or no possible significant effect for the risk in question						
	Developing media campaigns	Plans needed					Plans needed						
	Developing codes of conduct	COGSP revisions awaited					COGSP revisions awaited						
	Developing best practice and educational resources	Plans needed					Plans needed						
Special measures	Take further steps to ensure that wildfowl shot with lead are not sold in England and Wales	Practicality issue?					Unlikely significantly to help as welfare risks scale to volume of shotgun shooting in upland habitats	Observance critical	Shotgun pellet risks only	Unlikely significantly to help as risks mainly in upland habitats	Unlikely significantly to help as welfare risks scale to volume of shotgun shooting in upland habitats	Would help wildfowl risks only	Would help wildfowl risks only
	Compulsory food labelling that highlights health risks of lead	Indirect benefit but thought unlikely to affect high level consumers because they don't buy much game from highstreet retailers					Countermeasures can reasonably be expected to have negligible or no possible significant effect for the risk in question						
	Quality assurance. Set and enforce maximum lead level in game meat sold for consumption in the UK	Indirect benefit but thought unlikely to affect high level consumers because they don't buy much game from highstreet retailers											
Lead Ammunition replacement	Gunshot/living quarry	Partial because health risks from wild-shot venison not mitigated					Gunshot risks only	Countermeasure likely to remove or prevent the risk entirely or to a very considerable extent	Gunshot risks only	Countermeasure likely to remove or prevent the risk entirely or to a very considerable extent	Gunshot risks only		
	Gunshot/all shooting												
	Lead bullets/living quarry	Parital because heath risks from lead-shot gamebirds not mitigated					Bullet risks only		Bullet risks only		Bullet risks only		
	Lead bullets/all shooting												
	All lead ammunition/living quarry	Countermeasure is likely to remove or prevent the risk entirely or to a very considerable extent											
	All lead ammunition/all shooting												