Game & Wildlife
CONSERVATION TRUST

Lead – Your Questions Answered

Effects of lead on wildlife

Can lead be dangerous to wildlife?
Yes. When any bird or mammal ingests spent lead ammunition by mistaking it for grit or foodstuffs, or by scavenging unretrieved shot quarry, it can result in lead poisoning[1]. In addition, animals that are shot but not killed may carry lead shot in their bodies and this adversely affects their wellbeing[2].

How long does lead remain available in the environment for ingestion by wildlife?
Lead ammunition degrades very slowly and so may take several decades or longer to become unavailable to foraging wildlife.

How big is the problem?
Recent published estimates (2015) suggest 50-100,000 wildfowl die each year from lead poisoning in the UK[3], with between 200-400,000 thought to suffer welfare effects from ingestion or through embedded lead[4].

Is this likely to result in population-level effects in any species?
Computer modelling of bird populations and correlative studies suggest that lead poisoning may be affecting population growth rates and sizes in a number of bird species including grey partridges[5], red kites[5] and both dabbling and diving ducks[6] in the UK, and common buzzards in Germany[5].

What species are susceptible to lead poisoning?
Effects of lead poisoning have been documented extensively in waterbirds[7–12], and also in terrestrial birds including game and predatory species[13–16]. In some species present in the UK, namely Mallards, Whooper Swans and Golden Eagles, recent studies elsewhere have shown effects at lower blood concentrations than previously reported[17–19]. This development reflects conclusions that there is no clear threshold below which human health is not affected by lead exposure[20].

Are there also sub-lethal effects?
Yes. Although these are difficult to measure there is increasing evidence of welfare impacts and behavioural change, including in reproduction, predator avoidance, foraging ability and in avian flight[21–25].

Is this why lead ammunition was banned over wetlands across Europe?
The wetland ban came about because, historically in Britain and elsewhere in Europe, the process of lead shot ingestion and its harmful effects were documented first for waterfowl[26–30]. To alleviate these effects, legislation restricting the use of lead was introduced in England in 1999, Wales in 2002 and Scotland in 2004.

Why are wildfowl susceptible to the harmful effects of lead?
Wildfowl can ingest lead shot in place of either grit, which they use in their gizzard to aid with digestion, or food. The diving or dabbling feeding habits of wildfowl make it more likely that they will take in shot than species that use other feeding strategies[31]. This shot can then pass either to the stomach, where lead begins to degrade because of the acidic conditions, or to the gizzard, where it is gradually ground down over time, and some of the released lead will be absorbed into the bloodstream.

Is this legislation the same across the UK?
No. The regulations in England and Wales are based on species as well as habitat, but Scotland and Northern Ireland differ by restricting lead use in certain habitats only.

What are these restrictions?
In England and Wales the use of lead shot is prohibited:

- On or over any area below the high-water mark
- On or over certain Sites of Special Scientific Interest (SSSI's)
- For the shooting of ducks, geese or swans of any species, coots of moorhens, even on terrestrial habitats and farmed land.

In Scotland and Northern Ireland, the use of lead shot is prohibited for shooting anything on or over all wetland areas.

How are the estimates for the number of wildfowl that die from lead poisoning generated?
The estimates are based upon published lead shot ingestion incidence in different species, corrected for hunting bias, turnover of lead shot in the alimentary canal, and increases in mortality as a result of ingesting different numbers of lead pellets[3]. Wildfowl that die outside the shooting season will be additional, as will birds dying from the indirect results of lead poisoning.

As mortality estimates are relatively high, why are so few dead birds found?
Wildfowl that have died of lead poisoning remains largely invisible because sick birds die a few at a time, may hide themselves away and are more vulnerable to predation (so their dead body may look like a predator kill). The body may also be scavenged or lie in an inaccessible wetland location[32].

Is there any evidence that lead shot exposure is having an impact on game birds?
A GWCT study published in 2005 found that 4.5% of discovered dead birds contained lead shot in their gizzards and estimated that 1.2% of living wild grey partridges contained ingested lead shot at any one time[14]. Other UK studies report similar findings in pheasants[13] and red-legged partridge[33] but do not record impacts on bird health and welfare. A Canadian study found elevated levels of lead in American woodcocks that were traced back to lead shot ingestion[34].

Is there any evidence that lead ammunition exposure is having an impact on other terrestrial wildlife?
Yes. Although little evidence is available from the UK, an increasing number of studies worldwide have shown that predatory birds suffer from lead poisoning through ingestion of spent lead ammunition while scavenging carcasses of unretrieved quarry or discarded offal ("grallochs")[35–38]. The most famous example is that of the California Condor, which was driven to the brink of extinction by such lead poisoning. It was saved by captive breeding and reintroduction to the wild combined with a ban on the use of lead ammunition, initially across the reintroduction zone and since 2019 throughout California[39].

Is lead shot the only remaining source of lead exposure for wildlife?
No. Some areas of the UK have high levels of naturally occurring lead minerals on the ground, but these are localised[15], whereas throughout Europe exposure to lead ammunition ground sources is much more widespread. Water run-off from lead roof sheeting and the agricultural use of sewage sludge and manure are additional minor sources of wildlife lead exposure, as is the presence of lost lead fishing weights in water bodies (noting that weights under 1 oz are illegal in UK since 1987)[40].

Is there evidence of non-compliance with existing lead ammunition legislation?
Yes. Informal purchases of duck from game dealers in England suggest that up to 70% are still being shot illegally with lead[41]. The GWCT condemns this illegal activity and has periodically emphasized the need for compliance in its publications.

Has anyone been prosecuted for illegally using lead ammunition?
Not yet. Compliance with and enforcement of the current legislation, designed to protect wildlife in our wetland areas, is essential. Alternatively, it is suggested that a complete ban is the only way to ensure compliance, as has happened in Denmark since 1996[42].

Would changing to non-lead ammunition reduce lead in the environment?
Yes. Data from Denmark suggest that it does reduce environmental lead[42,43]. In Denmark, compliance with the ban on lead is close to 100% and wildlife exposure has reduced, benefiting the environment, the species and also the hunters[42].

Effects of lead on human health

Note: the GWCT, along with most other wildlife organisations, does not have human health experts on its staff. The following advice has been guided by human health experts at the Food Standards Agency (FSA).

What is the FSA's advice on eating lead-shot game?
"Consuming lead is harmful; health experts advise to minimise lead consumption as much as possible. Anyone who eats lead-shot game should be aware of the risks posed by consuming large amounts of lead, especially children and pregnant women".

and

"To minimise your risk of lead intake, if you frequently eat lead-shot game meat, particularly small game, you should cut down your consumption. Exposure to lead can harm the developing brain and nervous system. So, cutting down the amount of lead-shot game eaten is especially important for toddlers, children, pregnant women and women trying for a baby".

Has the FSA given advice on the number of portions of game that should be eaten?
No, but they do say *"There is no agreed safe level for lead intake. Independent scientific expert groups across the European Union advise that exposure to lead should be reduced as far as possible".*

So how do I know if I am a frequent consumer of lead-shot game?
We contacted the FSA to clarify this. They stated that *"The levels of lead in game are very variable so that the people who consume the largest quantity of game shot with lead ammunition may not have the highest lead exposure. Because of this, the FSA has not given advice in terms of only consuming a certain number of game portions as it could be misleading. However, broadly, lead exposure and the risk of adverse effects associated with lead is likely to increase as game consumption increases. Therefore, individuals who consume a lot of game (more than a few times a month as a rough guide) should reduce consumption, particularly of small game or game birds killed with lead shot. This is*

particularly important for children and pregnant women because of the risk to the developing nervous system even at very low levels of lead exposure."

The term "high consumer" of game meat and offal used by EFSA (2010) described adults with a mean frequency of consumption of game meat of one 200g game meat meal per week, averaged over a year.

Is the FSA advice the same for everyone?
No. Toddlers, children, pregnant women and women trying for a baby should avoid eating lead-shot game because exposure to lead can harm the developing brain and nervous system[44].

Is lead toxic?
Lead is toxic and has a threshold tolerance of zero which means it is not possible to set a level of intake below which no health impacts would be expected for either wildlife or humans[20,45].

How does the toxicity of lead compare to other metals?
Other metals we are exposed to such as cadmium, mercury, tin, aluminium and copper are less toxic than lead; some of them require at least ten times the dose to reach the same level of toxicity. Unlike lead, they all have tolerance thresholds for either wildlife or humans, so exposure below that level would be considered safe[46–49].

I thought the human body needed some of these metals?
Yes. Copper is an essential element required at low levels for proper functioning of the body, but it is toxic in high doses. However, lead is not required by the human body and remains toxic in even the smallest quantity.

How does lead enter the human body?
By breathing particles suspended in the air, drinking water, eating food, and (particularly children) ingesting soil and dust. Water and food are the main sources of lead in adults, while lead in air is now at very low concentrations[20,45].

What happens to the lead that is ingested?
The amount of ingested lead that the body absorbs depends on age and various other dietary factors, for example calcium and protein intake. In a well-nourished adult, around 15-20% of dietary lead is absorbed and the rest excreted[20].

Where in the body is lead found?
Lead in the body is distributed to the brain, liver, kidney and bones. It is stored in the teeth and bones, where it accumulates over time. Human exposure is usually assessed through the measurement of lead in blood. Around 95% or more of lead in the body is in bones and teeth, and less than 5% is in blood and soft tissues[20,50].

How long does lead stay in the body?
Lead levels in the blood and soft tissues vary quite rapidly, rising and falling in line with exposure over the course of a month or so. Longer-term lead accumulation occurs in the bones and teeth, which can store lead for decades and can therefore be an indicator of lifetime exposure[20,50].

Does lead stored in the bones stay there for life?
Lead in the bones and teeth usually exchanges very slowly with the blood but can be released gradually over a long period of time. This exchange may happen more rapidly during certain illnesses such as kidney disease, or events such as pregnancy, breastfeeding, or broken bones[20,51].

How does lead affect human health?
Increased levels of lead in the blood are associated with effects such as reduced IQ and hearing, increased blood pressure, and reduced kidney function. Children are particularly vulnerable to IQ reductions even at very low levels of lead[20,50,51].

Was lead removed from pipes, paint and petrol on human health grounds?
Yes. Increased knowledge about lead toxicity and its impact on human health prompted the removal of lead from pipes, paint and petrol.

Has this reduced human lead exposure?
Yes. Human blood lead levels in the UK are ten times lower than they were 30 years ago[51]. The main source of lead exposure now is from food and drink[45]. The food includes lead-shot game; the FSA advises people who eat such game regularly to reduce their consumption.

Which foods do humans get the most lead from?
Intake of lead from background sources is unavoidable. In the average diet, humans ingest lead through a variety of foodstuffs such as bread, tap water, beer, tea and potatoes, as well as those we are encouraged to eat more of for health reasons (fresh vegetables, cereal products)[45]. Although these foods and drinks contain very low levels of lead from background sources, they are consumed in relatively large quantities and consequently make up a significant proportion of lead exposure in the average diet. Although the consumption of lead-shot game is avoidable, people consuming this meat, even at low to moderate levels, will substantially increase their exposure to lead[52].

How do levels of lead in game meat differ from those in non-game meat?
A report published by the EFSA in 2012 gives the average measured level of lead in non-game meat as 16 parts per billion (ppb), with 5% of samples having levels above 60 ppb[45]. Putting these numbers in context, the EU maximum regulatory level of lead in non-game meat (excluding offal) is 100 ppb. The same report gives an average measured lead level of 48 ppb for venison, 155 ppb for hare and 344 ppb for pheasant meat, with 5% of samples having levels above 124, 475 and 982 ppb respectively. The report states *"Particularly high results were recorded for … pheasant meat, presumably associated with the use of lead ammunition."*

What contribution does lead-shot game make to overall dietary exposure?
Meat shot with lead ammunition forms a very small part of the average UK diet. However, there are people who consume shot game regularly, often throughout the year, and this is likely to increase exposure. FSA advice is that those who eat lead-shot game should minimise the amount they eat, especially if eating small game animals such as pheasant and partridge.

Can I reduce my exposure by removing lead from the meat?
Removing lead shot and some tissue from around the impact area and wound channel (see video https://www.youtube.com/watch?v=vH_roSYGNC8) can help reduce the total lead content of the meat. However, lead ammunition fragments on impact, particularly if it comes into contact with bone structures within the carcass, and these micro or nano-particles are impossible to detect during meat preparation[53,54].

If these particles are so small, surely they won't contribute significantly to exposure?
Smaller particles have a relatively larger surface, which leads to proportionately greater exposure than may come from intact pellets. A single shot carcass has been shown to contain many of these undetectable fragments[54]. Exposure can be increased if the meat is cooked in an acidic liquid such as wine or vinegar, because the acid aids the release of lead from the pellet or fragment into the meat, from where the body can absorb it[55,56].

Who advises the UK government on the safety aspects of lead in human food?
The UK's Food Standards Agency (FSA) which works closely with the European Food Safety Authority (EFSA) and the UK Committee on Toxicity (COT). Current advice on lead-shot game is based on a study of consumers of wild game, conducted by the FSA in Scotland and published in 2012[57].

Does the EFSA set a lead risk level?
There is no agreed safe level for lead intake. The European Food Safety Authority's expert Panel on contaminants (CONTAM Panel) concluded in 2010, following a review of the available data, that the Provisional Tolerable Weekly Intake (PTWI) was no longer appropriate and that a new guidance level could not be established, as there was no clear threshold below which the Panel was confident that adverse effects would not occur. The opinion concludes that current levels of exposure to lead pose a low to negligible health risk for most adults but there is potential concern over possible neurodevelopmental effects in young children[20]. This conclusion was confirmed by the Joint FAO/WHO Expert Committee on Food Additives in 2010.

How many people consume game in the UK?
It has been estimated that at least one million people in the UK consume wild game at least once per year[52]. Surveys indicate that at least tens of thousands of people from the shooting community are high-level consumers of game, much of which will have been shot with lead ammunition[57].

Background

Why is lead ammunition under scrutiny?
Lead ammunition is now the main source of human lead emissions to soil[40] and has been linked to risks to wildlife and human health[52,58]. Each of these aspects is considered in more detail below.

What are current environmental regulations on the use of lead ammunition?
Restrictions on the use of lead ammunition were introduced in England in 1999, Wales in 2002 and Scotland in 2004. Legislation is different across the UK. In England and Wales, the use of lead shot is prohibited:

a) On or over any area below the high-water mark,
b) On or over certain Sites of Special Scientific Interest or
c) For the shooting of ducks, geese or swans of any species, coot or moorhens.

The shooting of species restricted in c) applies to both wetlands and terrestrial habitats.

In Scotland and Northern Ireland, the use of lead shot is prohibited for shooting anything on or over all wetland areas.

Why have the health risks now come to the fore for people consuming game shot with lead ammunition?
Medical opinion has altered in recent years and experts have set a zero threshold for exposure to lead. This means that even the smallest quantity will have a deleterious effect[20].

Current Food Standards Agency advice can be found here or in the Human health section above.

Why is lead used for ammunition?
Ever since the invention of firearms, lead has been the metal of choice for bullets and shotgun pellets because its high density and softness gives the projectiles good range, penetration and killing power, and its low melting point makes it easy to cast into ammunition.

Are there alternatives to lead ammunition?
Alternatives to lead ammunition are being continually developed using other metals including steel, copper, tungsten or bismuth.

How much of the lead produced is used as ammunition, compared to other uses?
Between 10 and 12 million tonnes (2014-2018 statistics) is produced each year worldwide. Lead in ammunition is a relatively minor use (3%), but nevertheless is now the main source of human-induced lead emissions to soil, accounting for 67% of emissions compared with 7% for the next highest source, lead sheet[40]. Eighty percent of lead produced is used to make batteries – mainly for cars, and backup batteries for computer and telecommunications networks[40,59]. In the past considerable amounts were used in pipes, paint and petrol; but lead has now been removed from those products.

What is the Lead Ammunition Group (LAG)?
The Lead Ammunition Group was set up in 2010 at the invitation of the Department for Environment, Food and Rural Affairs (Defra) and the Food Standards Agency (FSA). The group was chaired by John Swift (BASC Chief Executive until 2013) and included a range of stakeholders such as the RSPB, Wildfowl & Wetlands Trust, Countryside Alliance, Gun Trade Association, Game Dealers Association and GWCT, as well as other professionals and academics. On the government side, the Food Standards Agency and Defra, were present; the latter initially provided the secretariat. The group submitted reports to Government in 2015[60].

What was the aim of the LAG?
Defra requested that the LAG evaluate the published scientific evidence of the impact of lead ammunition on human health (for people eating shot game), on wildlife and the environment generally, and on livestock grazing on shot-over land. The Group were asked to focus on the likely impact in England, pay attention to population-level effects, to examine mitigation strategies, and to bring forward consensus recommendations.

Did the Group deliver a consensus on the future use of lead in ammunition?
No. Instead, the 2015 report recognised that viewpoints diverged. Some stakeholders believed that the risks from lead ammunition were not sufficiently proven to justify further restrictions. Others believed that, as the body of scientific evidence globally is compelling, and since replacements for lead ammunition are available and have been successfully used in other countries, it would be prudent to phase out lead ammunition.

Furthermore, as some members resigned from the group and were not replaced, a consensus outcome was not reached. This meant that the report did not fulfil the group's terms of reference.

Why did some members of the group resign?
They were unhappy with the structure and workings of the Group. As a result, there was a dispute over the evidence used and the process followed to produce it. Documents published after a Freedom of Information request supported the view that some members of the group were working to eliminate all risk rather than establish strategies to mitigate risk.

What was the conclusion of the final report submitted to Defra?
The report concluded that *"it is a matter of political judgment whether the actual and potential risks to wildlife and human health described in the report and associated risk assessments merit further mitigation effort in addition to the regulations for wetlands already in place. If it is decided that the risks to wildlife and human health need to be better addressed, there is no convincing evidence, yet available, that anything other than an eventual phase-out of lead ammunition and phase-in of the non-toxic ammunition alternatives will do it."*

What was the response of the Secretary of State to the Report?
The Defra Secretary of State Liz Truss MP wrote a letter to John Swift in July 2016 which said *"…it was disappointing that a number of Group members resigned and that a whole group consensus could not therefore be reached on this important issue. However, I fully appreciate the challenges the divergence of opinions within the Group presented you with.*

Following receipt of your report, the Food Standards Agency (FSA) sought independent scientific advice from the Committee on Toxicity about the human health risk assessment within it. This has led the FSA to conclude that the evidence provided in your report does not affect their current advice. This advice, which has been in place since 2012 […]

With regard to the impact of lead ammunition on wildlife, we note that the report does not provide evidence of causation linking possible impacts of lead ammunition with sizes of bird populations in England.

In both instances – human health and wildlife – the report did not show that the impacts of lead ammunition were significant enough to justify changing current policy; we therefore do not accept your recommendation to ban the use of lead ammunition.

The use of lead ammunition is already banned on all foreshores, certain SSSIs and for the shooting of all ducks, geese, coot and moorhen. I do, however, recognise that there appears to be an issue with poor compliance with the Lead Shot Regulations and I can confirm that Defra will look at how the existing Regulations on wildfowling can be better implemented. We also understand that the FSA will be considering if action is required to raise awareness of their advice amongst the at-risk population.

As you know the European Chemicals Agency (ECHA) has been asked by the European Commission to gather information on the potential risks presented by metallic lead, to establish if there is a case for regulating its use within the European Union; we will keep the evidence presented by the ECHA under review.[….]"

Did the Secretary of State seek further clarification of any aspects of the recommendations from the remaining members of the LAG?
No. The letter stated that *"… this marks the end of the Group which the Government established in 2010, I have no doubt that the evidence you have gathered together will form a useful input to the exercise the ECHA is taking forward. I would like to thank you again for your efforts."*

What is the current status of the LAG?
LAG was stood down as an official body after the 2015 report but continues to operate independently. However, Government is considering whether any changes to current regulations are required following an Update Report produced by LAG in April 2018 and the findings of the ECHA review.

What additional evidence does the LAG update report present?
The 2018 update provides further evidence of the effects of lead ammunition on wildlife, expanding previous evidence to include non-wetland bird species, an additional pathway of exposure resulting in higher estimates of the number of birds suffering welfare effects and population-level effects (an area of weakness in the 2015 report identified by the Secretary of State – see letter above), and human health. It also reviews recent developments in international policy and practice. It *concludes "that the numerous peer-reviewed papers and other information published since production of the LAG report both support and strengthen its conclusions."*

Does the new evidence demonstrate population scale effects occurring in species in the UK?
No, none of the new evidence, except a paper based on computer models, relates to studies in the UK, although a number of species that occur in the UK are shown to be affected.

What did the ECHA report to the European Commission conclude?
In September 2018 the ECHA reported that its investigation into non-wetland uses of lead in ammunition (gunshot and bullets) and in fishing weights had found sufficient evidence of risk to justify regulating the use of lead ammunition in terrestrial environments as well as those proposed for wetlands. The report was issued in November 2018[61]. The Commission is expected to take a decision

mandating ECHA to take forward the restriction in terrestrial environments, most likely when a new Commission is appointed following the recent (June 2019) European elections.

The proposed restriction on the use of lead shot over wetlands is currently being taken forward by the Commission according to REACH process.

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