Effectiveness of actions intended to achieve a voluntary transition from the use of lead to non-lead shotgun ammunition for hunting in Britain

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DOI: https://doi.org/10.52201/CEJ19/SAFD8835

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SUMMARY

In 2020, nine major UK shooting and rural organisations proposed a voluntary transition from the use for hunting of lead shotgun ammunition to non-lead alternatives. The major food retailer Waitrose & Partners has announced its intention to move to not supplying game meat products from animals killed using any kind of lead ammunition and the National Game Dealers Association announced a plan for a similar policy to be implemented in 2022. The SHOT-SWITCH research project, which is intended to monitor the progress of these voluntary initiatives, began in the 2020/2021 shooting season. The project monitors changes in the proportions of wild-shot common pheasants *Phasianus colchicus* available to consumers in Great Britain that had been killed using lead and non-lead shotgun ammunition, as assessed by using inductively coupled plasma atomic emission spectrometry to identify the composition of shotgun pellets recovered from carcasses. In 2020/2021, 99.4% of the pheasants sampled had been killed using lead ammunition. We report here further results from this study for the 2021/2022 season. We found that 99.5% of the 215 pheasants from which shotgun pellets were recovered had been killed using lead ammunition. We conclude that the shooting and rural organisations' joint statement and two years of their considerable efforts in education, awareness-raising and promotion, have not yet had a detectable effect on the ammunition types used by hunters who supply pheasants to the British game meat market.

BACKGROUND

There is no existing UK-wide legal regulation to require the use of non-lead shotgun ammunition for all game hunting (Mateo and Kanstrup 2019), despite the documentation of significant negative effects of poisoning by spent lead ammunition from hunting for both wildlife (Pain *et al*. 2019) and public health (Green & Pain 2019). UK shooting and rural organisations and the UK government have opposed the introduction of regulations to achieve a change from lead to non-lead ammunition for hunting, except in the case of wetlands (e.g. BASC 2020a).

In 2019, the UK supermarket chain Waitrose & Partners, the largest UK retailer of game meat, indicated that it intended to sell only game meat from animals killed with non-lead ammunition (Barkham 2019). In March 2021, members of the National Game Dealers Association, the UK's trade organisation for dealers and wholesalers of game meat, committed to ensuring all its bird and mammal meat will be obtained from lead-free sources from 1st July 2022 (National Game Dealers Association 2021).

Recently, there has been a significant shift in the positions adopted by UK shooting and rural organisations and the government. In February 2020, nine major shooting and rural organisations issued a joint statement expressing their collective wish to see an end, within five years, to both lead shotgun pellets and single-use plastic wads in shotgun ammunition used by those taking all live quarry (BASC 2020b). They intend that this transition should proceed on a voluntary basis. In March 2021, the Parliamentary Under-Secretary of State for the Environment, Food and Rural Affairs (Rebecca Pow) announced that the UK Government would now consider a ban on lead ammunition to protect wildlife and nature (Defra 2021).

ISSN 1758-2067

Possible future changes to regulations are uncertain and likely to be years away, so we wished to assess the effectiveness of the current and planned voluntary efforts. We therefore began a research project (SHOT-SWITCH) in the game shooting season of 2020/2021 to monitor changes in the proportion of wild-shot common pheasants *Phasianus colchicus* available to consumers that were killed using lead ammunition. In the UK, pheasant is the most numerous quarry species killed using shotgun ammunition and the meat is widely purchased as food and also consumed by many of those directly involved in hunting (PACEC 2014). In 2020/2021 (the first shooting season after the introduction of the voluntary initiative), 99.4% (179/180) of pheasants purchased as food from sources widely distributed in England, Wales and Scotland, and from which shot were recovered and identified, were killed using lead ammunition (Green *et al.* 2021). Here, we make a second assessment of the effectiveness of voluntary efforts to phase out the use of lead shotgun ammunition by reporting results from the second year of monitoring (shooting season 2021/2022).

ACTIONS

Statement of intent to encourage voluntary phasing out of lead shotgun ammunition

On 24th February 2020, a joint statement on the future of shotgun ammunition for live quarry shooting in the UK (BASC 2020b) was issued by nine UK shooting and rural organisations: the Game & Wildlife Conservation Trust (GWCT); British Game Alliance; British Association for Shooting and Conservation (BASC); Countryside Alliance; Country Landowners' Association; The Moorland Association; The National Gamekeepers' Organisation; Scottish Land & Estates; and the Scottish Association for Country Sports. It called for a complete voluntary transition from the use of lead to non-lead shotgun ammunition for hunting within five years. In 2020, the text of the joint statement was placed on the websites of all the signatory organisations and it has remained there since.

Efforts in 2021 by shooting and rural organisations to promote voluntary phasing out of lead shotgun ammunition

In February 2021, an update statement on the five-year transition towards sustainable ammunition was produced by the nine organisations (GWCT 2021a). It welcomed the recognition of the need for change by large parts of the shooting community and stated that "the organisations believe the developments in ammunition, evidence collected in trials and the willingness of our community to learn about effective alternatives continues to keep us on a steady path to transition" (GWCT 2021a). We have limited information on actions carried out by seven of the organisations, although information may be on websites only accessible by members. We report on the actions of the remaining two (BASC and GWCT).

In 2021, BASC provided a practical guide to using non-lead shotgun ammunition on its website (BASC 2021). Its membership magazine, *Shooting and Conservation*, has carried articles about the transition to non-lead shotgun ammunition in every edition since the start of 2020 and articles have also been regularly published on social media. BASC increased the number of its sustainable ammunition training days, which involved practice shooting at clay targets, from 25 events in 2020 (350 participants) to 72 events in 2021 (967 participants). BASC circulated 10,000 guides to alternatives to lead shot at events and courses and a copy was sent to all 150,000 BASC members in January 2022. BASC's regional and country teams have been briefing many thousands of members and non-members at COVID-19-safe visits conducted across the UK. In all, they have conducted 352 such visits.

In 2021, GWCT increased the amount and detail of information and advice about the transition to non-lead shotgun ammunition available on its website, in particular through the GWCT Lead Ammunition Hub (GWCT 2021b). The website's question and answer material offers practical advice and corrects several common misconceptions about making the transition and also reinforced the message about negative effects on human health of exposure to lead. GWCT's newsletter carried several items about the transition, including a report on the results of a survey of members' intentions regarding their future use of non-lead ammunition on driven shoots (Brewin 2021).

Transition by food retailers and distributors to selling only meat from game killed with non-lead ammunition

In 2019, the supermarket chain Waitrose & Partners indicated that it would sell no game meat from animals killed with lead ammunition from the 2020/2021 shooting season onwards; but this was subsequently delayed until the 2021/2022 season due to difficulties created by the COVID-19 pandemic (Waitrose 2020). During 120 visits and checks at 28 different stores, we found that the whole pheasants required for our study were unavailable in the Waitrose supermarkets visited throughout the 2021/2022 season. A spokesperson for Waitrose & Partners informed us that: "The availability of game has again been a challenge this season, exacerbated by our business's continued transition from game shot with lead to game shot using non-lead alternatives... consequently there was very limited availability of Waitrose 'No. 1 Pheasant'…".

The National Game Dealers Association, which has 19 members, has committed to obtaining all meat of birds and mammals from lead-free sources from 1st July 2022 (after the 2021/2022 shooting season). We sampled pheasant carcasses supplied by National Game Dealers Association members, where the source or labelling allowed us to identify them, to enable a future before-and-after comparison with samples taken during the 2022/2023 season. We present these results separately.

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CONSEQUENCES

Sampling of pheasants

We obtained 336 whole birds or oven-ready prepared carcasses from 70 businesses of various types (Table 1). Pheasant carcasses were purchased from retailers or obtained directly from shoots by co-workers, who were the principal investigators (REG, DJP and MAT) and individuals or couples known to them. Co-workers were selected to achieve wide geographical coverage of Great Britain and were asked to obtain pheasants from sources dispersed as widely as possible in the area where they lived. Where possible, they asked the supplier where the birds had been shot.

Table 1. Numbers of common pheasant carcasses from which at least one shotgun pellet was recovered for each of seven source types. The number of businesses that supplied the carcasses is also given.

Source type	Number of carcasses	Number of businesses
Butcher's shop	140	46
Farm shop	12	7
Fishmonger	1	1
Game dealer	14	3
Online retailer	33	9
Supermarket	6	2
Shoot	9	2
All	215	70

We assigned each sampled pheasant to one of the 11 Nomenclature of Territorial Units for Statistics (NUTS) regions of Great Britain, (Office for National Statistics 2020) based upon information from the supplier or label on where it had been shot (180 birds). Where this information was lacking, we assumed that the pheasant had been shot in the same region as the location of the supplier (35 birds; 16%). To present the results, we grouped the nine English NUTS regions into three larger categories: Northern England (comprising Northeast, Northwest and Yorkshire & the Humber); Central England (East Midlands, West Midlands and East of England); and Southern England (London, Southeast and Southwest). Results for pheasants obtained from National Game Dealers Association members are also reported separately.

Extracting shotgun pellets from pheasant carcasses

Co-workers dissected each pheasant carcass to locate and collect at least one shotgun pellet or large fragment using methods described previously (Green *et al.* 2021). At least one shot and/or shot fragment was recovered from 215 of the 336 pheasants. A single pellet or fragment was recovered from 116/215 carcasses (54%), and between two and ten pellets or fragments were collected from 99/215 carcasses. Co-workers collected a total of 437 pellets and 12 large fragments, which were washed and dried. All the collected pellets and fragments from each carcass were placed in a screw-topped polyethylene tube marked with a unique code.

Identification of the principal chemical element in shotgun pellets

Laboratory examination and chemical analysis of shotgun pellets were conducted in two phases at the Environmental Research Institute, University of the Highlands and Islands, Thurso, UK, by two authors (MAT and SP). The first phase was a set of qualitative tests to determine whether shotgun pellets recovered from each of these pheasants were all of the same type or of different types. We used the methods described by Green *et al.* (2021) on each pellet to determine surface colour, deformability/brittleness and attraction to a magnet. We also used two additional methods: (1) weighing each pellet to the nearest 0.001 g with an electronic balance and measuring its diameter with 0.01 mm precision with calipers, from which its approximate specific gravity was calculated by assuming that the pellet was a sphere and (2) touching the pellet with the tip of an Antex SZ004W0 6W battery-powered soldering iron to determine whether it melted. The soldering iron test was added because our experiments on pellets composed of tungsten powder mixed with a polymer (Kent Gamebore Impact Tungsten Matrix) showed that they did not dissolve in nitric acid, which is the first preparatory step in the second phase of the analysis (ICP-AES: see below). Hence, ICP-AES analysis does not provide usable results for tungsten polymer pellets, though it does so for tungsten alloy pellets, which do not contain polymer. The soldering iron melted tungsten polymer pellets readily and did not melt any other types, so we used this as our test for this pellet type. We emphasise that, apart from the soldering iron test, these qualitative tests were used only to determine whether all pellets collected from the same carcass had similar characteristics and not to identify the principal metal type. In the second phase, pellets were analysed individually using an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES; Varian 720ES with SPS3 autosampler) to identify the principal metallic elements of which they were composed (elements in use are lead, tungsten, bismuth, iron, and copper (Kanstrup & Thomas 2019)). The methods are described in detail by Green *et al*. (2021).

Principal chemical element in shotgun pellets collected from pheasants in the 2021/2022 shooting season

For pheasant carcasses from which more than one shotgun pellet was recovered, our qualitative tests indicated that all pellets from the same carcass were of the same type. We therefore prepared one pellet from each carcass for the second phase of the analysis. None of the recovered pellets melted when subjected to the soldering iron test and all dissolved in nitric acid. This indicates that tungsten polymer pellets were not present in our sample. Of the 215 pellets analysed by ICP-AES, lead was the principal element in 214 pellets (mean percentage lead; 93.3%; minimum percentage

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86.5%). A small amount of copper (3.1%) was detected in one of the pellets composed principally of lead (89.2%), but no copper, bismuth, tungsten or iron was detected in any of the other pellets composed principally of lead. The only non-lead pellet tested was composed principally of iron (99.8%). All three pellets from the carcass from which this pellet was recovered were attracted to a magnet and so we concluded that this bird had been killed using steel gunshot. No other pellets were attracted to a magnet. Only pheasants shot using pellets composed principally of lead were found in all the countries and regions sampled, except for Central England, where steel pellets were recovered from one bird (Table 1). We recovered shot from 39 pheasants identified as having been supplied by six companies which are members of the National Game Dealers Association. All of these were composed principally of lead.

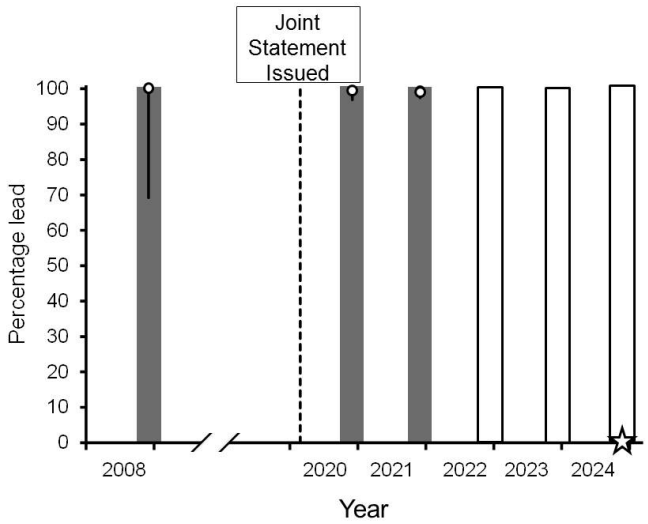

Figure 1. Comparison of the estimated percentages of wild-shot common pheasants killed in Great Britain using lead shotgun ammunition between a study conducted in the 2008/2009 shooting season (Pain *et al.* 2010), a study by Green *et al.* (2021) conducted in the 2020/2021 shooting season, and the present study conducted in the 2021/2022 shooting season (white circles). The vertical lines associated with the white circles are 95% Clopper-Pearson confidence intervals. The white star represents the expected endpoint of the voluntary complete transition to the use non-lead shotgun ammunition advocated by nine shooting and rural organisations in their joint statement of February 2020. Grey bars represent the timing of the October – January shooting seasons with existing data on shotgun ammunition types and white outlined bars denote future seasons remaining within the proposed transition period.

Comparison between results obtained in the 2008/2009, 2020/2021 and 2021/2022 shooting seasons

We found that lead shotgun pellets had been used to kill 99.5% (214/215) of the sampled pheasants from the 2021/2022 shooting season from which pellets were recovered (Clopper-Pearson binomial 95% confidence interval, 97.4 to 99.99%; Clopper & Pearson 1934). This proportion is consistent with results from the study carried out in the 2020/2021 shooting season (99.4%; Green *et al.* 2021) and also for pheasants shot in the 2008/2009 season (100%; Pain *et al.* 2010), 12 years before the shooting and rural organisations issued their joint statement in 2020. Our results from the large samples of pheasants obtained in the two shooting seasons immediately following the joint statement (2020/2021 and 2021/2022), indicate that almost all pheasants shot in Britain and available to the public (> 99%) were killed using lead ammunition (Figure 1: Table 2).

DISCUSSION

These results indicate that efforts made by the shooting and rural organisations to promote the transition to non-lead ammunition have not yet had any detectable effect on the types of ammunition used by hunters of pheasants who supply the retail trade. This is despite these organisations and shooting magazines having communicated consistently positive messages for two years about the efficacy and practicality of non-lead shotgun ammunition. We are not aware of any large-scale evidence-based dissent among hunters about the accuracy of this information. Most reported comments by hunters who have tried non-lead ammunition recently indicate that they found it to be correct (see below).

Our findings contrast with those of recent surveys of attitudes and intentions of various groups of hunters, which indicate that a large proportion had already implemented, or intended to implement, the transition. Feedback from participants in BASC's sustainable ammunition training days indicated that 93% of attendees thought that the non-lead ammunition types used in these sessions for clay target shooting were effective for this purpose and 97% of attendees thought they would be confident to use them for both clay and game shooting. The majority of participants (92%) said that they would make the transition from lead to non-lead shot immediately (Peter Marshall, personal communication). However, it should be borne in mind that the attitudes of the approximately 1,300 self-selected participants in the training days might have been atypically favourable to non-lead ammunition. In an online survey conducted by GWCT at the end of the 2020/2021 shooting season, 2,500 participants in driven shooting, which is principally of pheasants, red-legged partridges *Alectoris rufa* and red grouse *Lagopus lagopus*, reported their current and intended future practice regarding the use of non-lead ammunition

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(Brewin 2021). Some respondents (4%) reported that they had used non-lead shotgun ammunition in the 2020/2021 season and a further 20% had tested non-lead cartridges in that season. This contrasts with our previous finding that only 0.6% of pheasants sampled in 2020/2021 had been killed using non-lead cartridges (Green *et al.* 2021).

The GWCT survey also asked about future intentions and found that, in addition to the 24% who had already used non-lead cartridges in the 2020/2021 season, a further 28% of respondents planned to test the use of non-lead cartridges in the 2021/2022 season. Combining these results with the favourable reaction of participants in the BASC training days to training with non-lead cartridges, these surveys of hunters led us to expect that a larger proportion of pheasants would have been killed using non-lead ammunition in the 2021/2022 season, given that 52% of respondents indicated that they would be using or at least testing non-lead ammunition by then. However, our survey results showed that the proportion of sampled birds killed using non-lead pellets was only 0.5%. This mismatch suggests that survey respondents were not representative of hunters who supply pheasant carcasses for sale for human consumption. Although some delay in switching to non-lead ammunition is to be expected, given that hunters wish to use up their existing stocks of lead ammunition, we suggest that such constraints would have influenced the responses given about current practice and short-term intentions, rather than only affecting actual practice

An alternative approach is to ask shooting estates about their current practice and future intentions regarding the use of lead and non-lead shotgun ammunition on their land. A survey in 2021 of 91 shoots, which together accounted for about 5% of all the gamebirds shot in the UK in the 2019/2020 season, indicated that 3% of shoots were already not allowing the use of lead shotgun ammunition in the 2020/2021 season. A further 65% planned to phase out lead shot by 2023 and a further 20% intended to do so by 2025 (Savills 2021). Only 12% of shoots had no plan for phasing out the use of lead shot. As with the GWCT survey of individual hunters, these results indicate a much higher level of current and planned use of non-lead shot than that found by our surveys of shotgun pellets recovered from pheasant carcasses in both 2020/2021 and 2021/2022. Although shooting estates were asked about their current practice and intentions, a possible explanation for this discrepancy is that they were actually reporting on their plans for what they would do if the UK government were to ban lead ammunition or if a substantial proportion of game dealers and food retailers were to insist upon lead-free sources of gamebird meat. However, until these possible changes happen, we conclude that the actual practice of hunters of pheasants is not yet showing any sign of change.

We were unable to assess progress towards the intended goal of Waitrose & Partners of not selling any game killed using lead ammunition through our survey of pheasant carcasses, except to say that we were unable to purchase any whole pheasant carcasses from Waitrose stores and therefore did not find any birds on sale that had been killed using lead ammunition. To our knowledge, Waitrose & Partners was the first major retailer in the world to adopt such a policy and this pioneering initiative and the reasons behind it have attracted considerable attention from hunters and shooting and rural organisations (e.g. GWCT 2020). We intend to monitor the implementation of these new voluntary policies of retailers and distributors of game meat products by sampling pheasant carcasses purchased from Waitrose stores and from sources supplied by members of the National Game Dealers Association in each of the next three shooting seasons.

Table 2. Numbers of common pheasant carcasses obtained in Great Britain in the 2021/2022 shooting season for which the principal component in a shotgun pellet was identified as one of five elements. Results are shown according to the source of the bird (country or region in which the bird was most likely to have been shot). One pellet was analysed from each bird.

	Number of birds with a pellet composed principally of this element					
Source	**Lead**	**Tungsten**	**Bismuth**	**Iron**	**Copper**	**Total birds**
Southern England	77	0	0	0	0	77
Central England	74	0	0	1	0	75
Northern England	13	0	0	0	0	13
Scotland	35	0	0	0	0	35
Wales	15	0	0	0	0	15
Total	214	0	0	1	0	215

ISSN 1758-2067

ACKNOWLEDGEMENTS

We thank Leo Batten, Margot Brownsword, Jacquie Clark, Sophie Green, Shireen Green, Pat Harcup, Roderick Leslie, Jonathan More O'Ferrall, Rob Robinson, Alastair Stobart, Matthew Webster and Alastair M. Wilson for assistance with obtaining and processing the pheasant carcasses. We are grateful to Niels Kanstrup, Dan Reynolds and John Swift, who supplied us with shotgun pellets of known types to test our chemical analysis methods. Rob Sheldon thanks Wild Justice for funding support. Peter Marshall kindly provided detailed information on the efforts made by BASC to promote the transition to non-lead shotgun ammunition. We are grateful to Andrew Teanby for permission to cite the Savills Game and Conservation Benchmarking Survey. We thank Ann Thornton, Bill Sutherland and anonymous reviewers for useful comments. The Royal Society for the Protection of Birds, Waitrose & Partners and Lincolnshire Game contributed to the costs of materials and reagents for the study.

This paper is the second publication of results from the SHOT-SWITCH project. More information on the objectives and methods of the project is available from the Environmental Research Institute, University of the Highlands and Islands, Thurso, UK https://eri.ac.uk/research/major-projects/shot-switch/

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