

## *Regional Environmental Law Developments*

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# Promoting the Transition to Non-Lead Hunting Ammunition in the European Union Through Regulation and Policy Options

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**Abstract.** Regulation (EU) 2021/57, banning the use of lead gunshot in wetland hunting, and adoption of the proposed European Union (EU) restriction on lead ammunition use by civilians in other types of hunting and target shooting, would complete the transition to non-lead ammunition use in the EU and ensure major compliance among hunters and shooters. The transition is possible since non-lead substitutes for all types of shotgun and rifle ammunition are produced already by leading European manufacturers. To ensure ammunition non-toxicity, EU standards are needed for lead substitutes to accompany both existing and potential future lead ammunition restrictions. Meat from wild game birds and mammals is a large and important commodity in the EU. Setting a maximum lead level in all marketed game meats under Regulation (EC) 1881/2006, aided by mandatory food labelling, would add extra health protection to human consumers. This regulatory step would help ensure that all wild game destined for retail markets were taken with non-lead ammunition, would complement existing and proposed European Commission restrictions on lead hunting ammunition and aid monitoring and enforcement. Increased public awareness of the risks posed by lead from ammunition to the health of humans, wildlife, and the environment, and especially their associated externalized costs to society, would promote and facilitate the passage of regulation to protect human and environmental health from toxic lead ammunition.

**Keywords:** Hunting, transition, compliance, human, wildlife, health, externalized costs

## 1. Introduction

Lead poisoning in waterfowl resulting from the ingestion of spent lead gunshot, mistakenly for grit or food, has been recognised for more than a century<sup>1</sup>. At an international workshop on lead poisoning in waterfowl in Brussels in 1991<sup>2</sup> it was concluded that solving this problem required the

replacement of lead gunshot with non-toxic alternatives, and that suitable alternatives were already available and in use. This stimulated new policy initiatives, and the Contracting Parties to the intergovernmental treaty, the African-Eurasian Migratory Waterbirds Agreement (AEWA) agreed to endeavour to phase out the use of lead shot in wetlands by 2000. The European Union (EU) *en bloc* is an AEWa Party, as are most EU countries individually except Austria, Greece, Malta, and Poland<sup>3</sup>. However, some EU Member States

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(Ireland, Greece, Poland, Slovenia, and Romania) still have not taken action, and some others have not met their AEWA obligations by not fully enacting restrictions over wetlands (i.e. member states that restrict only within designated sites)<sup>4</sup>. Limited progress by 2008 resulted in AEWA further calling on Contracting Parties to phase out the use of lead gunshot over wetlands as soon as possible, whilst obligations made in 2014 by the EU and its member states under the Convention on Migratory Species recommended a full phase out of all lead ammunition<sup>5,6</sup>.

Given limited and inconsistent progress under AEWA, in 2015, the European Commission (EC) initiated a process to evaluate and, if necessary, restrict the use of lead gunshot in wetlands under the REACH Regulation (Regulation for the Registration, Evaluation, Authorisation and Restriction of Chemicals). The process is outlined in Table 1. The EC requested the European Chemicals Agency (ECHA) to propose a restriction on the use of lead gunshot over wetlands. Following calls for and scrutiny of evidence, in April 2017, ECHA completed an Annex XV dossier proposing a restriction on the use of lead gunshot in and over wetlands<sup>7</sup>. Following a wide public consultation, the dossier was passed to the two ECHA technical committees, the Committee for Risk Assessment (RAC) and the Committee for Socio-economic Analysis (SEAC), for assessment. The RAC commented particularly on the relevance of the proposed restriction for reducing risks to human health and the environment. After further consultation, in June, 2018, both technical committees adopted ECHA's proposal that lead gunshot requires restriction in wetlands.

The usual EU procedure is for there to be a period of about three months after receipt of the compiled RAC and SEAC opinions during which the EC can consider and, if necessary, amend the proposal before it is voted upon by the EU REACH Committee (representing EU member states). The EC amended several aspects of the wetland restriction to ensure its enforceability and maximise the health protection of the proposal. The restriction was subject to considerable national lobbying from hunting and ammunition interests and many delays. Consequently, the REACH Committee vote did not take place until September 3, 2020, when it approved the restriction, with 18 of the 27 member states voting for the restriction, 5 against, and 4 abstentions<sup>8</sup>. The 18 States that voted in favour hold

c.90% of the EU population, surpassing the required 65% population threshold (i.e. qualified majority) by a considerable margin (Table 1). On November 29, 2020, the European Parliament voted to accept the restriction, and on January 25, 2021, the Members of the European Council ratified European Commission Regulation (EU) 2021/57<sup>9</sup> which is due to take effect on February 15, 2023. This Regulation will satisfy the EU's obligation to the AEWA, but requires individual member states and Schengen states to enforce the ban at their national level.

With this restriction, the EU has adopted a regulatory, as opposed to a non-regulatory, approach to the lead ammunition issue<sup>10</sup> which is similar to the regulative approaches taken by other jurisdictions, both within and outside the EU. The EU Regulation also parallels the regulative approaches taken by the EU to restrict the use of lead in other anthropogenic uses (e.g. gasolines, paints, and solders). In all these cases, regulation is possible because effective and available lead substitutes exist. The same applies to lead gunshot substitutes which are already made by leading European companies<sup>11</sup>.

In September, 2018, ECHA published, at the Commission's request, a report on the use of lead shot in terrestrial environments beyond wetlands, other types of ammunition (bullets), and fishing tackle<sup>12</sup>. This report built on evidence gathered under the earlier restriction proposal for wetlands and concluded that there was sufficient evidence of risk from those other uses to justify additional regulatory measures. Consequently, in July, 2019 the Commission asked ECHA<sup>13</sup> to prepare a restriction proposal on the placing on the market and use of lead in ammunition (gunshot and bullets) and of lead in fishing tackle conforming to the requirements of Annex XV to REACH. This restriction request covered both wetland and terrestrial habitats. Having assessed various risk management options, ECHA identified a preferred option to address the risks to the environment and human health in a proposal brought forward in February 2021. This option was summarised as<sup>14</sup>.

"1. Lead sold and used in hunting, sports shooting and other outdoor shooting:

ban on the sale and use of lead gunshot (with a five-year transition period). As current Olympic rules specify the use of lead ammunition for certain disciplines, ECHA also considered an

Table 1

## Chronology of stages and outcomes for restrictions and proposed restrictions on the use of lead ammunition under EU REACH Regulations (as of May 2021)

Sequence of stages in the restriction process	Restriction on the use of lead gunshot in wetlands (EU) 2021/57	Proposed restriction on the placing on the market and use of lead in ammunition (gunshot and bullets) and of lead in fishing tackle <sup>e</sup> .
Investigation Report		September 2018 <sup>b</sup> (v1)
Request from the Commission	03 December 2015 <sup>c</sup>	03 December 2015 <sup>c</sup> ; 16 July 2019 <sup>d</sup>
Intention to prepare restriction dossier	12 April 2016	03 October 2019
Call for evidence	April 2016-21 July 2016	3 October 2019 –16 December 2019
Annex XV Restriction Report submitted	7 April 2017 <sup>e</sup>	15 January 2021 <sup>f</sup>
Consultation of the Annex XV dossier (if conformity is passed)	Comments and contributions by 21 December 2017.	24 March 2021 – 24 September 2021
RAC opinion	Adopted 9 March 2018 <sup>g</sup>	Q4 2021
Draft SEAC opinion	Adopted 14 June 2018 <sup>g</sup>	Q4 2021
Consultation on draft SEAC opinion		Q1 2022
Combined final opinion submitted to the Commission	17 August 2018	Q2 2022
Draft amendment to the Annex XVII (draft restriction) by Commission	Planned for within 3 months of receipt of opinions but subject to numerous delays	Within 3 months of receipt of opinions
Discussions with member state authorities and vote	3 September 2020. 18 member states representing 89.99% of the EU population voted in favour of the restriction, with 5 against and 4 abstentions <sup>h</sup>	Q3/Q4 2022
Scrutiny by Council and European Parliament		Before adoption (3 months)
Vote in ENVI	Two objections tabled were rejected 29th October 2020 <sup>i</sup>	
Vote in the European Parliament	24th and 25th November 2020. European Parliament voted to reject two objections to the proposal <sup>j</sup> leaving the Commission free to adopt the proposal.	
Adoption by the European Commission	Adopted on 25 January 2021 <sup>k</sup> . It will become operational 24 months after the date of entry into force of the Regulation or 36 months after entry into force in those Member States where at least 20 % in total of the territory, excluding the territorial waters, are wetlands.	If Agreed - Q1/Q2 2023

<sup>a</sup>Timings subsequent to 15 May 2021 are tentative and subject to change. From references given and adapted on 15 May 2021 from: <https://echa.europa.eu/hot-topics/lead-in-shot-bullets-and-fishing-weights> Accessed 15 May 2021. <sup>b</sup>ANNEX XV INVESTIGATION REPORT. A review of the available information on lead in shot used in terrestrial environments, in ammunition and in fishing tackle. Version 1.4 27 November 2018. [https://echa.europa.eu/documents/10162/13641/lead\\_ammunition\\_investigation\\_report\\_en.pdf/efdc0ae4-c7be-ee71-48a3-bb8abe20374a](https://echa.europa.eu/documents/10162/13641/lead_ammunition_investigation_report_en.pdf/efdc0ae4-c7be-ee71-48a3-bb8abe20374a) Accessed 15 May 2021. <sup>c</sup>Request to the European Chemicals Agency to prepare restriction proposals conforming to the requirements of Annex XV to Reach. Brussels 2015, 12-03. [https://echa.europa.eu/documents/10162/13641/echa\\_annex\\_xv\\_restriction\\_proposals\\_en.pdf/ed07424a-328d-88e0-b7c6-412251426582](https://echa.europa.eu/documents/10162/13641/echa_annex_xv_restriction_proposals_en.pdf/ed07424a-328d-88e0-b7c6-412251426582) Accessed 15 May 2021. <sup>d</sup>Request to the European Chemicals Agency to prepare a restriction proposal on the placing on the market and use of lead in ammunition (gunshot and bullets) and of lead in fishing tackle conforming to the requirements of Annex XV to REACH 16 July 2019. [https://echa.europa.eu/documents/10162/13641/rest\\_lead\\_ammunition\\_COM\\_request\\_en.pdf/f607c957-807a-3b7c-07ae-01151001d939](https://echa.europa.eu/documents/10162/13641/rest_lead_ammunition_COM_request_en.pdf/f607c957-807a-3b7c-07ae-01151001d939). <sup>e</sup>ANNEX XV RESTRICTION REPORT PROPOSAL FOR A RESTRICTION. Lead in shot. Version 1. [https://echa.europa.eu/documents/10162/13641/restrictions\\_lead\\_shot\\_axv\\_report\\_en.pdf/6ef877d5-94b7-a8f8-1c49-8c07c894ff7](https://echa.europa.eu/documents/10162/13641/restrictions_lead_shot_axv_report_en.pdf/6ef877d5-94b7-a8f8-1c49-8c07c894ff7) Accessed 15 May 2021. <sup>f</sup>Annex XV Restriction Report. Lead in outdoor shooting and fishing. Version 2. 24 March 2021. <https://echa.europa.eu/documents/10162/1a42c9e1-e36a-65b0-da45-bc1ca093b632> Accessed 15 May 2021. <sup>g</sup>Committee for Risk Assessment (RAC) Committee for Socio-economic Analysis (SEAC) Opinion on an Annex XV dossier proposing restrictions on LEAD IN GUNSHOT. Compiled version prepared by the ECHA Secretariat of RAC's opinion (adopted 9 March 2018) and SEAC's opinion (adopted 14 June 2018) <https://echa.europa.eu/documents/10162/b092e670-3266-fb5d-6296-544eacbb5d4a> Accessed 15 May 2021. <sup>h</sup>Comitology Register. External voting sheet - Draft Commission Regulation (EU) amending Annex XVII to the REACH Regulation (EC) No 1907/2006 as regards lead in gunshot in or around wetlands <https://ec.europa.eu/transparency/comitology-register/screen/documents/068887/1/consult> Accessed 15 May 2021. <sup>i</sup>European Parliament. Committee on Environment, Food Safety and Public Health Result of roll-call votes of 29.10.2020 [https://www.europarl.europa.eu/cmsdata/214593/2020-10-29\\_roll-call-votes.pdf](https://www.europarl.europa.eu/cmsdata/214593/2020-10-29_roll-call-votes.pdf) Accessed 15.05.21. <sup>j</sup>European Parliament Results of Votes P9\_PV(2020)11.23-26(VOT)\_EN.docx [https://www.europarl.europa.eu/doceo/document/PV-9-2020-11-25-VOT\\_EN.pdf](https://www.europarl.europa.eu/doceo/document/PV-9-2020-11-25-VOT_EN.pdf) Accessed 15.05.21. <sup>k</sup>COMMISSION REGULATION (EU) 2021/57 of 25 January 2021 <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0057&from=EN> .

optional derogation for use of lead gunshot for sports shooting only under strict conditions, i.e. when releases to the environment are minimised.

ban on the use of lead in bullets and other projectiles (small calibre: five-year; large calibre: 18-month transition periods). Derogations for continued use if releases to the environment are minimised, i.e. when sports shooting ranges are equipped with bullet traps.”

Lead fishing tackle is also included within this restriction but not dealt with further in our analysis. The restriction process is ongoing (at the time of writing) with a provisional timetable as outlined in Table 1.

Lead from ammunition presents well-established risks, not only to waterfowl, but also to terrestrial birds, including scavengers and predators, that ingest lead fragments from ammunition when eating shot and injured or unretrieved game, or gralloch (discarded viscera of large game animals<sup>15</sup>). Because of the large body of peer-reviewed literature on the subject<sup>16</sup>, there is a consensus on the risks that lead ammunition poses to human and wildlife health which is supported by the scientific community in Europe and globally<sup>17</sup>. As well as publishing evidence-based consensus statements, scientists with expertise in this area have also recently produced open letters commending the European Commission for initiating the development of restriction proposals and encouraging a rapid transition away from all lead ammunition to non-toxic alternatives<sup>18</sup>.

There was considerable opposition to Regulation (EU) 2021/57 on the use of lead gunshot in and over wetlands, largely from the ammunition industry and the game hunting and shooting communities<sup>19</sup>, and this is also true of broader transitions to the use of all non-lead ammunition. The resistance to change occurs despite available European-made non-lead substitutes for both shotgun and rifle ammunition<sup>20</sup> and widespread acknowledgement that these perform well, and especially for rifle calibers over 0.243. Even bullet calibres of 0.243 and smaller, for which options were previously more restricted, are now produced more widely, partly due to stimulation of the market by enactment of a ban on all lead ammunition use for hunting in California State (USA) from July, 2019<sup>21</sup>. Nonetheless, restrictions on the use of lead gunshot were implemented decades ago in some countries, both within and beyond the EU. These include the USA

(1991), and Canada (1999), where it is illegal to shoot migratory wildfowl while in possession of lead gunshot<sup>22</sup>, and also the Netherlands and Denmark where use of lead gunshot was banned for all types of shooting and in all habitats in 1993 and 1996, respectively<sup>23</sup>. However, seven EU nations, Greece, Ireland, Lithuania, Malta, Poland, and Slovenia, had no restrictions on lead ammunition<sup>24</sup>.

A comparison of the efficacy of the complete ban on lead gunshot in Denmark with that of the numerous partial bans (i.e. over some or all wetlands, and/or for shooting wildfowl) in other countries is informative. In some countries, measured compliance by hunters with partial bans is low. In England, measured compliance has remained at about only 30% since a ban on shooting wildfowl using lead gunshot was introduced in 1999, despite a campaign by shooting organisations to improve compliance and informing hunters that continued failure to comply increased chances of a complete ban<sup>25</sup>. However, there has been little enforcement of this legislation in England. In Sweden, a third of people hunting in wetlands used lead gunshot despite its being banned 15 years ago<sup>26</sup>. Where partial, site or species-based bans have been introduced, good compliance appears to have required a high level of monitoring and control of ammunition types used, as illustrated in the protected wetlands of Ebro Delta region of Spain<sup>27</sup>. However, there has been high compliance with the complete ban on all lead gunshot use introduced in 1996 in Denmark, where possession and sale of lead shot cartridges is illegal<sup>28</sup>. Much wetland hunting in Europe is conducted on private lands, and there is no government agency devoted to ensuring hunter compliance with shooting regulations in any EU member state. This contrasts with countries such as Canada and the USA where itinerant federal and provincial/state government conservation officers are required to meet hunters in the field and enforce prevailing laws<sup>29</sup>. The financial resources required to enable the comprehensive monitoring and enforcement necessary were seldom made available even before the current pandemic-related economic impacts and are unlikely to be of increased priority to EU decision makers today.

In Regulation (EU) 2021/57<sup>30</sup> the carrying of lead gunshot within 100m of a wetland is prohibited “where this occurs while out wetland shooting or as part of going wetland shooting” and this provides an enforcement mechanism. However, the examples above suggest that, in the absence of widespread

and active enforcement, this ban on lead gunshot use in EU wetlands is unlikely to be as effective as needed to protect the environment and human health. In this paper we address further policy and regulative options that could be undertaken to complement and make more effective Regulation (EU) 2021/57 on lead gunshot in wetlands, and to facilitate a rapid transition to the use of non-lead ammunition across the EU. The paper also emphasizes the importance of further restrictions on lead ammunition use presently under consideration by the EU as both a critical adjunct to the 2021 EU Regulation and as further protection of wildlife, human, and environmental health. The inclusion of the UK (no longer an EU member state) in this paper derives from this country's foremost involvement with this issue, its membership in AWEA, its large international ammunition industry, and its game meat sales to the EU.

## 2. Discrete Components of European Hunting and Shooting

Waterbird hunting mainly involves migratory species whose flyways extend within and beyond the EU. The conservation interests of these species and their wetland habitats, which frequently span national boundaries, are covered by the Ramsar Convention (The Convention on Wetlands of International Importance Especially as Waterfowl Habitat)<sup>31</sup>, and AWEA, developed under the framework of the UN Convention on the Conservation of Migratory Species of Wild Animals (CMS)<sup>32</sup>. The CMS and the AWEA have provided strong focus for the use of non-lead ammunition to protect these and other migratory bird species from avoidable lead poisoning<sup>33</sup>. The EU is a full Party to both AWEA and the CMS. Furthermore, legal acts of the EU address the subject indirectly including the Birds' Directive<sup>34</sup> requiring that hunting does not jeopardise conservation efforts in the distribution areas of huntable species (Articles 7). At the 25th anniversary conference of the Birds Directive in 2004, a stated intention was to “*Aim to phase of the use of lead shot in wetlands as soon as possible and ultimately by 2009*”<sup>35</sup> and this has been included in subsequent debates in the Directive's ‘Ornis Committee’ that helps the Commission implement the Birds Directive<sup>36</sup>.

The hunting of birds and smaller-sized mammals (e.g. rabbits (*Oryctolagus cuniculus*) and hares

(*Lepus europaeus*)) in terrestrial habitats, including uplands, forest and grasslands is widespread across the EU, and mostly involves shotguns and lead-based ammunition. The many millions of animals shot annually are either consumed directly by hunters, sold into retail markets and the restaurant trade, or are killed as ‘pests’. Most ‘pest’ animals are not eaten by people but disposed of in the environment where they are likely to be scavenged. Hunting of larger mammals is also common practice in most EU nations. Lead rifle ammunition is used traditionally to hunt mainly four species of deer, wild boar (*Sus scrofa*), and several other mammal species. Germany is the leading nation in the transition to use of non-lead rifle ammunition, requiring its use in several regions<sup>37</sup>. In addition, in several UK countries the agencies responsible for managing populations of deer and wild boar in the nation's forests have required their staff to use non-lead bullets for hunting since 2016 (England) or are currently transitioning to non-lead bullets (Scotland)<sup>38</sup>. In November, 2020, the Danish government announced a nation-wide ban on lead rifle hunting ammunition, effective from 2023<sup>39</sup>.

Clay target shooting is common and widespread within the EU and occurs at both designated shooting grounds and itinerant sporting events. There are different target shooting disciplines (e.g. skeet and trap events) and lead shotgun ammunition is generally required, especially for international competitive events<sup>40</sup>. Target shooting with rifles and handguns is common and popular in most European countries. Target shooting with rifles is often associated with hunting practice. Lead-core ammunition is most frequently used although comparable non-lead bullets are available for most applications. Bullets are normally fired into earth berms, from which spent bullet fragments can be recovered and recycled regardless of bullet material, hence the environmental impact can potentially be minimised. However, some rifle target shooting disciplines are located in natural environments with limited possibilities of retrieval of ammunition (“field shooting”).

Only 1.8% of the European population hunts, ranging from 0.2% in Belgium and The Netherlands, to 8% in Ireland<sup>41</sup>. However, a recent report found that each year, hunters from just 12 of the 27 EU countries for which data are available, and the UK, shoot over 6 million large game mammals, 12 million rabbits and hares and over 80 million birds. Collectively they support an

international game meat market worth over 1.1 thousand million Euros<sup>42</sup>. Many game animals are consumed by individual hunters and their families and friends. In countries such as the UK and Denmark, where much hunting is done on estates with employees engaged to control predators and release captive-bred gamebirds, game may also be consumed by full-time and occasional employees<sup>43</sup>. About 5 million people across the EU (largely associated with hunting) are estimated to be high level consumers of game, i.e. eating one meal or more of game meat per week, with many more consuming game meat less frequently. In a representative survey of 1000 people in Germany, >38% of respondents indicated consuming large game at some time throughout the year<sup>44</sup>.

### 3. Potential Non-Compliance with the EU Ban On Lead Gunshot Use in Wetlands

Regulation (EU) 2021/57 that restricts the use of lead gunshot in and over wetlands is made possible because an array of non-lead gunshot is already made by the leading European manufacturers and distributed throughout Europe<sup>45</sup>. However, lead gunshot continues to be manufactured, and is used for game hunting in forests, farmland and uplands in all EU nations except Denmark and The Netherlands<sup>46</sup>. Thus, hunters can still easily obtain lead gunshot suitable for shooting wetland bird species. For example, lead shot in sizes and cartridge loads suited for hunting hares could be used to hunt different species of geese and large-bodied ducks. Lead shot cartridges used for shooting pheasants could be used effectively to hunt ducks, and the lead-based shot cartridges marketed for clay target shooting could be effectively deployed to hunt small migratory wetland species such as teal (*Anas crecca*) and common snipe (*Gallinago gallinago*).

Potential non-compliance of hunters unwilling to forgo the use of lead ammunition, reinforced by widespread weak regulatory enforcement, would reduce the effectiveness of the EU lead gunshot ban over wetlands and the potential future ban on all lead-based ammunition (depending upon the conditions of such a ban). For migratory species, their protection across the entire flyway is essential<sup>47</sup>. Conservation goals are not realised when birds migrate from a region where toxic risks from spent lead shot are reduced by high hunter

compliance to regions where risks remain high due to non-compliance with regulations or lack of regulation. Individual nations within the EU have the right to enact further legislation to complement and enhance the effectiveness of a particular EU regulation (e.g. Birds Directive Article 14<sup>48</sup>). An example would be the passing of a national regulation prohibiting the use of lead gunshot for all categories of hunting and clay target shooting as has been done in Denmark, where possession and trade of lead gunshot cartridges is illegal. Such legislation effectively prohibits the importation, sale, and use of lead gunshot and potentiates the national demand for non-toxic alternatives<sup>49</sup>.

### 4. Public Engagement and Awareness of the Societal and Environmental Impacts of Lead from Ammunition

European society has accepted the regulations removing or limiting the presence of lead in gasoline, paints, glass, and other anthropogenic uses because of its well-established risks to human and environmental health. As well as enabling lead's removal from many products, modern technology has facilitated enhanced recovery and recycling in others. An estimated 39–40,000 tonnes of unreclaimed lead from spent hunting and shooting ammunition are released annually into EU wetland, forested, and upland environments<sup>50</sup>. According to industry figures, annually approximately 21,000 tonnes of lead from shotgun cartridges used in hunting is dispersed into the environment in the EU (28), although some estimates indicate the tonnage is probably significantly higher<sup>51</sup>. While ammunition from target shooting is sometimes recovered, that dispersed in the environment from hunting is not and accumulates over time<sup>52</sup>. If these sports were classified as industries, it is likely that prevailing EU regulations would require an immediate halt to such lead release, especially in the absence of extensive lead reclamation.

As part of the EU REACH restriction process several opportunities exist for interested parties to give their views (Table 1). However, the vast majority of responses have involved hunting and shooting organisations, the arms and ammunition industries, conservation organisations, and scientists specialised in the risks lead-based ammunition poses to human and wildlife health. The non-hunting public is poorly represented in these

consultations, probably largely due to lack of awareness of their existence. Pollution from lead ammunition has been regarded as a problem created by the hunting and shooting communities that the political process needs to address, with few attempts by public authorities to inform the public or engage people in debates around the issue, including its wider international and socio-economic implications<sup>53</sup>. The social and economic costs of impaired human, wildlife and environmental health are externalized and paid for by the whole of European society<sup>54</sup>, and the ‘polluter pays’ principle has been largely ignored, despite this being a tenet of the Treaty on the Functioning of the EU (Article 191, ex Article 174 TEC)<sup>55</sup>.

Risks posed by lead gunshot to waterfowl have been documented for well over a century. Risks to predatory and scavenging birds from lead poisoning following ingestion of lead from gunshot or bullets in their prey have been acknowledged for at least forty years, particularly for Bald Eagles (*Haliaeetus leucocephalus*)<sup>56</sup>, California Condors (*Gymnogyps californianus*) in the USA<sup>57</sup> and White-tailed Sea-Eagles (*Haliaeetus albicilla*) in Europe<sup>58</sup>. However, the extent of this problem in these and other terrestrial birds and the wide range of species affected across the world has only become apparent in recent decades<sup>59</sup>. What was formerly regarded as primarily a disease of waterfowl has become recognised as a disease of all animals that ingest fragments of spent lead-based ammunition, and this appears to include wild mammals<sup>60</sup> as well as birds. The substantial body of scientific literature that has appeared in the past 20 years<sup>61</sup> also documents the risks to human health from frequent ingestion of game shot with lead ammunition<sup>62</sup>.

Chronic low level exposure to lead is associated with a range of critical effects in humans, including elevation of systolic blood pressure and kidney disease in adults, and reduced IQ in children<sup>63</sup>. Children are particularly vulnerable to the effects of lead as they absorb a higher proportion of ingested lead than adults. Also, their developing nervous systems are particularly sensitive to its effects and there is currently no evidence for a threshold for critical lead induced effects<sup>64</sup>. Even low blood lead concentrations have been associated with reduced Intelligence Quotient (IQ) in children and associated behavioural impacts<sup>65</sup> that may be irreversible<sup>66</sup>. Green and Pain<sup>67</sup> estimated that least 83,000 children a year in the EU and Britain aged eight years or younger were at risk of suffering a 1

point reduction in IQ from the consumption of game killed with lead-based ammunition. This was linked to an ongoing potential yearly loss of at least 40 million to 104 million Euros to the EU economy for each year that game consumption continues<sup>68</sup>. For those cohorts of children experiencing more than a 1 point IQ loss because of a greater than average consumption of game meats, the costs would be greater. At least 5 million adults across the EU are estimated to be frequent consumers of game<sup>69</sup> increasing their risks to negative effects on the cardiovascular and renal systems<sup>70</sup>.

The direct loss of wildlife due to lead exposure also has a cost to society, for example through the loss of European species of predatory and scavenging birds that die following the ingestion of lead in contaminated game carcasses<sup>71</sup>. It is estimated that about 1 million European waterfowl die from lead poisoning, and three times that number suffer chronic sub-lethal effects<sup>72</sup>. The ingestion of lead shot may also be affecting the population trends of some European wildfowl, including the globally threatened (Vulnerable) Common Pochard (*Aythya ferina*)<sup>73</sup>. This avoidable loss of avian biodiversity is of concern to society. Using a “willingness to pay” approach the societal value of wildfowl losses alone was estimated, broadly, to be 2.2 thousand million Euros<sup>74</sup>. Where local governments are required to reclaim accumulated lead from long-abandoned shooting grounds, local authorities must pay for the recovery, which normally far exceeds the value of the lead removed from the ground<sup>75</sup>.

The general public across the EU remain largely unaware of the risks associated with the use of lead ammunition and the related health, environmental and economic costs<sup>76</sup> incurred by society. On the contrary, there has been promotion by some hunting organisations of game meat as a healthy alternative to meat from domesticated species. This contrasts strongly with relatively high levels of public awareness of the risks associated with lead in petrol, paint, and water, which are all strictly regulated across the EU, as well as other highly recognized historical environmental toxicants, e.g. DDT and mercury. This may initially appear understandable, as societal exposure to lead from these and some other industrial sources was generally of greater magnitude and/or more widespread across the population, especially for lead in petrol. However, lead is unusual in that the dose-effect relationship between blood lead levels and IQ does not appear to

be linear, but rather to reflect a greater relative impact at lower lead concentrations<sup>77</sup>. Consequently, for health protection, exposure should be reduced to the minimum possible. Society needs to be aware of and understand the need for this, and that lead from ammunition is one dietary source of exposure that is technically straightforward to remove. High profile global campaigns and publications aimed at increasing lead awareness omit discussion of this remaining, largely unregulated, source of dietary lead exposure<sup>78</sup>. Since 2011, food safety and standards organisations in a range of EU countries have published guidance on the risks to human health associated with the consumption of wild game shot with lead ammunition<sup>79</sup>. These agencies advise pregnant women and children to limit their consumption or avoid eating game shot with lead ammunition. In the UK, the National Health Service (NHS) also advises pregnant women to avoid game meats such as goose, pheasant and partridge that may contain lead shot<sup>80</sup>. However, finding advice from these agencies usually involves proactive searching on websites and it is unlikely that many people are aware of such advice. For example, in the UK, public awareness is more likely to have resulted from the actions of supermarket chain Waitrose than advice provided by the Food Standards Agency and NHS. The company Waitrose is the largest retailer of game meat in the UK and proactively initiated food labelling in 2018, highlighting the risks from lead ammunition to consumers. In 2019, Waitrose pledged that all of the game they sell would be harvested without the use of lead ammunition from the 2020-21 season<sup>81</sup>. This received public attention in several major daily newspapers<sup>82</sup>, reaching millions and possibly tens of millions of people.

There is a clear need for greater social awareness of and involvement in decisions relating to the use of lead-based ammunition in Europe, especially given the political influence of the European hunting and ammunition organisations<sup>83</sup>. The evidence, collectively, warrants a wider adoption of lead substitutes in European hunting and shooting, and the decision by the European Commission to ban the use of lead shot over wetlands marks an important first step in this direction. It is notable though that this recent decision trails behind by three decades of comparable regulatory action taken in the USA (in 1991/92), a country with a broadly similar population size (c.75% of the EU) and double the land area of the EU.

## 5. Complementary Actions to Enhance Compliance with EU Restrictions on the Use of Lead Ammunition and Better Manage Risks

### 5.1. EU Regulatory Measures

The need for further measures to protect wildlife and human health, beyond restricting lead gunshot in wetlands, was identified in an ECHA Annex XV Investigation Report<sup>84</sup>. A restriction proposal on the placing on the market and use of lead in ammunition (gunshot and bullets) in all habitats and of lead in fishing tackle is currently being prepared (Table 1). Both hunting and target shooting activities are being considered and while target shooting does not impact human health via dietary exposure, its retention in the restriction is important as it nonetheless results in significant local environmental contamination and can present associated risks to environmental health<sup>85</sup>. It also presents risks to target shooters directly through the inhalation and/or ingestion of lead particles. A review of relevant literature<sup>86</sup> concluded that at firing ranges, shooting with lead ammunition results in the discharge of lead dust, raised blood lead concentrations, and exposure levels associated with a range of negative health outcomes. With respect to target shooting, detailed scientific and policy rationales for using non-lead ammunition for all Olympic and related sporting events have already been defined<sup>87</sup>. Kanstrup and Thomas<sup>88</sup> indicated that it is feasible to make this transition for target shooting with shotguns within five years of an EU ban on lead gunshot use in wetlands.

The non-lead ammunition types required to effect transition to non-lead ammunition for all civilian uses are already produced in Europe and marketed and distributed in the EU<sup>89</sup>. Any restriction on lead ammunition would increase the demand for, and availability of, a wider selection of non-lead substitutes<sup>90</sup>. A total regulatory ban on lead ammunition would practically eliminate the demand for lead-based ammunition (except for limited specific uses, e.g. by the military and police, excluded from the EU restriction under development). It would build upon voluntary and statutory restrictions on rifle ammunition already in place in parts of the EU including Germany and the UK as described above, and the recently announced intention of the Danish Government to replace lead-based bullets with alternatives in Denmark



from 2023<sup>91</sup>. A successful precedent for this regulatory proposal is provided by the state of California, which has required since July 2019 use of non-lead shotgun and rifle ammunition for all types of hunting on both private and state-owned lands<sup>92</sup>. Kanstrup and Thomas<sup>93</sup> indicated that such a transition across the EU could be implemented within 3-4 years of passage of an EU regulation applied to wetland hunting. The introduction of a comprehensive regulation restricting the importation, sale, carrying and use of lead ammunition for all hunting would substantially facilitate monitoring, enforcement and compliance and seen, for example, in Denmark after the total ban of use, sale and possession of lead gunshot<sup>94</sup>. The burden of responsibility would include importers and retailers and this is far easier and more cost effective to monitor and enforce than partial bans where activities need to be monitored at the level of the individual hunter.

For both the existing EU regulation on lead gunshot use in wetlands, and the potential more comprehensive ban including all ammunition and habitats, certain additional regulatory activities would further facilitate monitoring of compliance, aid enforcement and thus reduce risks to human and wildlife health. Among these is a regulation aimed at protecting human health. The established health risks to people that frequently consume game meats containing lead particles from ammunition and especially to pregnant women and young children are described above. These apply to not only hunters and their families, but also to employees on shooting estates who receive game meat as an employment benefit and other people who purchase wild game meat which is widely traded in Europe. Based on data provided by the Food and Agricultural Organization of the United Nations<sup>95</sup> Thomas *et al.*<sup>96</sup> estimated the export trade value of wild game meat to be approximately 1,123 million (1.1 billion) Euros a year across the EU. Commission Regulation (EC) 1881/2006<sup>97</sup> sets maximum allowable levels (MLs) of various contaminants, including lead, for a wide range of food products put on the market including the meat of domestic and some wild animals. However, despite being widely consumed, and in relatively large quantities by some communities, MLs are not listed for wild game. Thomas *et al.*<sup>98</sup> proposed that Regulation (EC) 1881/2006 be amended to include all types of game meats marketed within, and imported into, the EU. Such harmonisation would

ultimately result in reduced incidence of lead particles from ammunition in all wild game animals sold in retail markets and restaurants. Meeting MLs for game would almost certainly require that wild game entering the food chain be obtained from game shoots or other sources that only use non-lead ammunition. While such a regulatory change would not protect the substantial numbers of people who hunt and consume their own game or meat they obtain informally, it would protect the retail market and the general public that purchase game meat from retailers for domestic consumption and/or eat game meals in restaurants.

While the setting of MLs for lead in game would not preclude the use of lead-based ammunition by hunters who do not sell their quarry, it would nonetheless increase and extend awareness of the associated risks to all hunting communities (i.e. hunters of waterfowl, upland game birds and mammals, and large game), and would promote the transition to non-lead ammunition. The reduced demand for lead-based ammunition would be offset by increased demands and production of non-lead ammunition<sup>99</sup>. An immediate and positive effect would be to enhance compliance with the ban on lead gunshot use in wetlands, as wild waterfowl containing lead shot, or traces thereof, could not be sold in the marketplace.

Setting a maximum level of lead in game meat would harmonise the regulations across domestically reared and wild game animals in EU and would also apply to non-EU countries where wild game meat and meat products are traded commercially; this would be a logical and health-protective move independent of broader concerns. However, while practical, enforceable and capable of being monitored, we appreciate that setting MLs for lead in game meat alone would neither fully nor adequately address the risks that lead ammunition use presents to either human or environmental health.

## 5.2. Other Policy and Practice Measures

While numerous safe alternatives exist to replace lead-based ammunition, it is essential that any existing or new products do not themselves present unacceptable risks, and there is no mandatory safety testing system for alternative gunshot types in the EU. However, both the USA and Canada conduct a mandatory process to approve non-toxic shot types.

This is a rigorous process that ensures that materials do not pose a significant risk of toxicity to migratory birds and other wildlife or their habitats<sup>100</sup>. A range of non-toxic shot types has been approved for use including iron (steel) and shot types largely based on iron, tungsten and bismuth<sup>101</sup>. The same shot types can, therefore, be used in other countries in the knowledge that they have met strict environmental safety standards. Some shot types have not been approved, e.g. shot made from zinc failed the testing and cannot be used legally in North America and as such should not be used elsewhere<sup>102</sup>. Lead shot coated with plastic and other various materials should not be used as the coating can be ground down rapidly in a waterbird's gizzard exposing the lead<sup>103</sup>. The coating can also be damaged when pellets strike the ground, collide with each other or hit the target, exposing the lead core to the environment. Consequently, as a matter of policy and practice, the EU could recommend that only shot types approved for use in the USA or Canada be used in the EU.

The Codex Alimentarius<sup>104</sup> international food standards, guidelines and codes of practice help ensure the safety, quality and fairness of international food trade. Codex standards are based on science provided by independent risk assessment bodies or consultations organized by the Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO). Surprisingly, ingestion of meat from game shot with lead ammunition is not identified as a route of exposure to dietary lead in the Codex Alimentarius Code of Practice on reducing exposure to lead in food<sup>105</sup>. This may be because it was supposed until a couple of decades ago that little of the lead from gunshot and bullets shot into game animals was eaten by human consumers and was not bioavailable. However, if this were the case, these assumptions were not made explicit. This may also be why no maximum level (ML) for lead in human foodstuffs derived from wild shot game animals has been set in the Codex Alimentarius General Standard for Contaminants and Toxins<sup>106</sup> and in EU Maximum Levels (MLs) under Regulation (EC) 1881/2006. It is however possible that lead from ammunition will be included in an upcoming revision of Codex Alimentarius following comments made by the EU on the proposed draft revision of the code of practice for the prevention and reduction of lead contamination in foods<sup>107</sup>. If translated into MLs in Codex

Alimentarius and Regulation (EC) 1881/2006 as described above, and international food standards advice, this will begin the removal of a significant health risk to European citizens.

Changes in policy and/or practice have been implemented by many agencies, organisations, businesses and landowners to reduce the risks from lead ammunition use. These include state-wide restrictions on the use of lead bullets in some parts of Germany and similar actions by national agencies in other countries, like the bodies managing state forests in the UK, as described above, and also conservation organisations, individual landowners, and hunters. Such actions are important and can be very effective at the scale at which they are implemented, i.e. on land over which these decision makers have direct control. The decision announced in July 2019 by UK by supermarket chain Waitrose to market only game brought to bag without the use of lead ammunition was particularly significant as it had implications not only for consumers but also for game shoots and game dealers distributing to Waitrose. Subsequently, in February 2020, nine major UK organisations associated with hunting publicly called for an end to lead in ammunition used by people shooting all live quarry with shotguns within five years '*in consideration of wildlife, the environment and to ensure a market for the healthiest game products ...*'<sup>108</sup>. More recently Highland Game, the largest processor of venison in the UK, report that the majority of their venison is currently shot with lead-free ammunition and they are aiming to ensure that their retail supply chain is lead-free by the end of 2021 (E. Ross, *pers. comm*). The decision by Waitrose is the first example we are aware of where the market place has had a direct effect upon the use of hunting ammunition in any country. Unfortunately the evidence indicates that voluntary bans (such as that proposed by the UK shooting organisations mentioned above) are generally ineffective with poor compliance and the risks from lead ammunition are unlikely to be adequately controlled in the absence of comprehensive regulation<sup>109</sup>. Nonetheless, such positive interim steps are valuable in the broader transition to non-lead ammunition use.

### 5.3. Public Awareness

Improved public awareness can be achieved in a variety of ways. From a human health perspective,

public awareness campaigns associated with food safety advice provided by national agencies have been inadequate or absent and would be beneficial. Such advice is sometimes brought to the attention of the public when NGOs highlight this to the media. However, the risks posed to human health by dietary exposure to lead from ammunition have been largely overlooked by major agencies such as the WHO and UNICEF<sup>110</sup>, whose campaigns often receive public attention. It is essential that such agencies take account of the risks posed by lead from ammunition which affects sectors of society in both the developed and developing world<sup>111</sup>, and may disproportionately affect some of the poorer sectors of society, such as subsistence shooting communities. Inclusion of lead ammunition as a route of dietary exposure in the next revision of the code of practice for the prevention and reduction of lead contamination in foods of Codex Alimentarius<sup>112</sup>, as proposed by the EU, would raise awareness.

Food labelling can be an effective way of highlighting risks to the public. Game meat products from animals shot with lead gunshot in the UK have traditionally carried labels indicating that the product 'may contain lead shot' but with no indication of the associated implications. This type of labelling may also be interpreted as implying that, if the consumer does not find any shot, then the product does not contain lead. This is erroneous, because many meals prepared from gamebirds found by X-radiography to contain no gunshot still had markedly elevated lead levels because of fragmentation of lead pellets<sup>113</sup>. However, during the transition period to non-lead ammunition, Waitrose's labels gave clear advice: *"Based on public health advice vulnerable groups, in particular children, pregnant women, & women trying for a baby, should not consume this product due to the possible presence of lead shot residue"*. There are several advantages to making similar clear and informative food labelling a mandatory requirement for all game retailers. The health risks from exposure to elevated dietary lead are already widely acknowledged and this approach would be entirely consistent with governments' traditional role of mandating food labelling where safety issues are concerned<sup>114</sup>. It would both ensure that a much wider proportion of consumers are informed of the risks and would set a level playing field for game retailers in advance of lead ammunition being replaced by non-toxic materials.

## 6. Conclusion

Lead exerts its toxic effects on humans, wildlife and the environment independent of source, whether from use in paints, gasolines, solders, or hunting ammunition<sup>115</sup>. In the interests of public and environmental health, EU regulations now restrict most uses, except for ammunition. This omission has been partly dealt with under Regulation (EU) 2021/57 banning the use of lead gunshot cartridges in wetlands. If adopted, the further, broader, restriction proposal covering all lead ammunition and fishing tackle (Table 1), currently under preparation, would correct this omission leading to a virtually complete transition to non-lead hunting ammunition in the EU.

It is important for any EU regulation to be effectively enforced across all member states. Given the highly traditional and locally organised nature of European hunting, weak enforcement of the wetland gunshot ban will be of concern. This is especially the case given low compliance levels with existing long-established regulations in countries such as the UK and Sweden, where a reasonably high level of awareness across the hunting community about the risks associated with lead-based ammunition exists, and alternative ammunition types are available for all applications. However, the ability to monitor and enforce the wetland restriction will be facilitated by the inclusion of the restriction on carrying lead gunshot within 100 m of a wetland where this occurs while out wetland shooting.

More comprehensive restriction of the use of lead-based ammunition, and its replacement with non-toxic alternatives, as is currently being considered under the next phase of the REACH process, is essential to protect human health, the health of predatory, scavenging and other terrestrial birds and the environment. The introduction of such restrictions would greatly enhance compliance, especially if such restrictions include importation and carrying of lead ammunition in addition to placing on the market and use. This is because a large part of the burden of responsibility would shift from individual hunters to importers and retailers, making monitoring and enforcement straightforward and cost-effective. Comprehensive regulation is also required because ammunition manufacturers need a guaranteed market to innovate and scale up production. While lead ammunition can still be legally purchased and used for some

types of shooting, it can also be obtained and used for illegal purposes.

Before such regulation exists, a range of interim measures would reduce risks from lead ammunition, help protect human and environmental health, and help pave the way for a lead-free future. Including wild game as a food for which MLs are set within Regulation (EC) 1881/2006 is an important step to promote healthy food and protect human health. Inclusion of lead from ammunition as a source of dietary exposure within revisions under consideration for the Codex code of practice for the prevention and reduction of lead contamination in foods<sup>116</sup> may facilitate this. Establishing MLs of lead in game would also, incidentally, provide one monitoring mechanism for ammunition types used to shoot both wetland and other game species, and be a complementary adjunct to lead ammunition restrictions.

Beneficial policies and practices include adoption of non-lead gunshot types that have passed the stringent USA approval system. This would ensure that one toxic substance is not replaced with another. The rapid introduction of further national or sub-national restrictions with broader reach than the wetland restrictions, as has happened in Denmark and the Netherlands, would be highly beneficial and reduce environmental and human health risks. Measures taken by national agencies, organisations and individual landowners also help to reduce the cumulative and persistent effects of lead contamination, while enhancing awareness and shifting public opinion. Retail organisations can also be influential and effective, as markets are needed for the large amounts of game animals killed annually. Beyond the hunting and shooting communities, public awareness of this issue appears to be low, especially when compared to knowledge of the risks associated with other sources of lead contamination. Food labelling can help with this<sup>117</sup>, and national food standards and safety agencies should be encouraged to ensure that their advice is proactively publicised to ensure that it reaches those in society most vulnerable to the effects of lead.

The impacts of dietary exposure to lead from ammunition on wildlife have been communicated for far longer than risks to human health, but there remains limited public understanding of the issue, particularly beyond impacts on waterbirds. Public agencies have a responsibility to communicate these risks effectively to European citizens. Hunting organisations have been largely ambivalent about

the use of non-lead ammunition but could play a key role in education and awareness, both at national level and across the EU via The European Federation for Hunting and Conservation (FACE). Non-toxic substitutes for lead ammunition are already available and used in the EU. They have been shown to be very effective in hunting all types of game<sup>118</sup>. The adoption of non-lead ammunition by the European hunting community would increase the sustainability of hunting<sup>119</sup> and demonstrate a responsible approach regarding the safety of an important European food source. Economic benefits would also accrue from the adoption of non-lead ammunition for all hunting and shooting. These include benefits to human and environmental health and a reduction in sites where remediation for lead contamination is needed. The use of lead-based ammunition imposes substantial externalized costs to society. Minimum annual costs of a limited selection of the impacts on humans, wildlife, and the environment were estimated at 383–960 million Euros for the EU, and 444 million – 1.3 thousand million Euros for Europe<sup>120</sup>. All society, European and beyond, would benefit from the reduced toxic threats to avian biodiversity much of which is already under EU-wide legal protection<sup>121</sup>.

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## Conflicts of interest

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<sup>27</sup> *Supra*, note 24.

<sup>28</sup> Kanstrup, N. and Balsby, T.J.S. 2019. "Danish pheasant and mallard hunters comply with the lead shot ban". *AMBIO Special Issue* 48(9): 1009-1014. doi.org/10.1007/s13280-019-01152-7

<sup>29</sup> Officials can test a hunter's ammunition directly using a portable electronic device and magnets to ensure that it complies with non-lead criteria.

<sup>30</sup> *Supra*, note 9.

<sup>31</sup> The Ramsar Convention. <https://www.ramsar.org/>

<sup>32</sup> The Convention on Migratory Species. <https://www.cms.int/>

<sup>33</sup> Stroud, D.A. 2015. "Regulation of some sources of lead poisoning: a brief review". In: Delahay, R.J. and Spray, C.J. (Eds) *Proceedings of the Oxford Lead Symposium: Lead ammunition: understanding and minimizing the risks to human and environmental health*. pp 8-26, Oxford: University of Oxford, Edward Grey Institute; and Kanstrup, N., Swift, J. D.A. Stroud, D.A. and Lewis, M. 2018. "Hunting with lead ammunition is not sustainable: European perspectives". *AMBIO* 47:846–857. doi.org/10.1007/s13280-018-1042-y.

<sup>34</sup> The Birds Directive. [https://ec.europa.eu/environment/nature/legislation/birdsdirective/index\\_en.htm](https://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm)

<sup>35</sup> Ministry of Agriculture, Nature and Food Quality of the Netherlands and the Directorate General for the Environment of the European Commission, April 2005. Report of the EU Conference "25 Years of the Birds Directive: Challenges for 25 Countries" 7-9 November 2004, Bergen op Zoom, The Netherlands. <https://edepot.wur.nl/118449>

<sup>36</sup> See Stroud, *supra*, note 33.

<sup>37</sup> *Supra*, note 24; and Gerofke, A., Ulbig, E., Martin, A.C., Müller-Graf, C., et al. 2018. "Lead content in wild game shot with lead or non-lead ammunition: Does state of the art consumer health protection require non-lead ammunition"? *PLoS ONE* 13: e0200792. doi.org/10.1371/journal.pone.0200792; and Gerofke, A., Martin A., Schlichting, D., Gremse, C. and Müller-Graf, C. 2019. "Heavy metals in game meat". In *Chemical hazards in foods of animal origin. Food safety assurance and veterinary public health, No. 7*, Eds. Smulders, F.J.M., Rietjens, I.M.C.M. and Rose, M.D. pp 585–609. Wageningen: Wageningen Academic Publishers. doi.org/10.3920/978-90-8686-877-3\_24

<sup>38</sup> Pain, D.J., Swift, J., Green, R.E. and Cromie, R. 2020. "The tide is turning for lead ammunition". *British Birds* 113: 110-118.

<sup>39</sup> Kanstrup, N., Hansen, H.P., Balsby, T.J.S., and Mellerup, K.A. 2021. "Non-lead rifle ammunition: Danish hunters' attitudes". *Environmental Sciences Europe*. doi:10.1186/s12302-021-00485-z

<sup>40</sup> Thomas, V.G. and Guitart, R. 2013. "Transition to non-toxic gunshot for Olympic shooting: policy implications for IOC and UNEP in resolving an environmental problem". *AMBIO* 42(6): 746-754. doi: 10.1007/s13280-013-0393-7; and Thomas, V.G., and

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<sup>41</sup> FACE. 2020. Hunters in Europe. Annual Report 2009-2010, page16.

<sup>42</sup> Thomas, V.G., Pain, D.J., Kanstrup, N. and Green, R.E. 2020. "Setting maximum levels for lead in game meat in EC regulations: an adjunct to replacement of lead ammunition". *AMBIO*: doi:10.1007/s13280-020-01336-6.

<sup>43</sup> PACEC 2014. The Value of Shooting. The economic, environmental, and social benefits of shooting sports in the UK. May 2014, Cambridge.

<sup>44</sup> See Gerofke et al., *Supra*, note 37.

<sup>45</sup> *Supra*, note 20.

<sup>46</sup> *Supra*, note 24.

<sup>47</sup> See Thomas and Owen, *supra*, note 10.

<sup>48</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0147&from=EN>

<sup>49</sup> Kanstrup, N. 2019. "Lessons learned from 33 years of lead shot regulation in Denmark". *AMBIO Special Issue* 48(9): 999–1008. doi.org/10.1007/s13280-018-1125-9; and Kanstrup and Thomas, *supra*, Note 13.

<sup>50</sup> Thomas, V.G., and Guitart, R. 2010. "Limitations of European Union policy and law for regulating use of lead shot and sinkers: comparisons with North American regulation". *Environmental Policy and Governance* 20:57–72. doi: 10.1002/eet.527. Table 1 in this paper indicates the amounts of lead shot released by each member nation of the EU using estimates from several distinct sources.

<sup>51</sup> AMEC. 2012. Abatement Costs of Certain Hazardous Chemicals. Lead in shot—Final Report December 2012. Report for European Chemicals Agency (ECHA). Contract No: ECHA 2011/140, Annankatu 18, 00121 Helsinki, Finland. doi: [https://echa.europa.eu/documents/10162/13580/abatement+costs\\_report\\_2013\\_en.pdf/6e85760e-ec6d-4c8a-8fcf-e86a7ffd037d](https://echa.europa.eu/documents/10162/13580/abatement+costs_report_2013_en.pdf/6e85760e-ec6d-4c8a-8fcf-e86a7ffd037d); and EC HA. 2018. A review of the available information on lead in shot used in terrestrial environments, in ammunition and in fishing tackle. Annex XV. Investigation Report Version Number 1.4. Helsinki: European Chemicals Agency; and Tukker, A., Buist, H., van Oers, L. and van der Voet, E. 2006. "Risks to health and environment of the use of lead in products in the EU". *Resources, Conservation and Recycling* 49:89-109. doi.org/10.1016/j.resconrec.2006.03.005

<sup>52</sup> Kanstrup, N., Fox, A.D. and Balsby, T.J.S. 2020 "Toxic lead gunshot persists accessible to waterbirds after a 33-year ban on their use". *Science of The Total Environment*:136876. doi.org/10.1016/j.scitotenv.2020.136876

<sup>53</sup> Thomas, V.G. 2010. "Achieving uniform regulation of environmental lead exposure and poisoning in wildlife and humans". *The Environmentalist* 30(2): 206-210. doi:10.1007/s10669-010-9263-z

<sup>54</sup> Pain, D.J., Dickie, I., Green, R.E., Kanstrup, N. and Cromie, R. 2019. "Wildlife, human and environmental costs of using lead ammunition: An economic review and analysis". *AMBIO Special Issue* 48(9): 969–988. <https://doi.org/10.1007/s13280-019-01157-2>.

<sup>55</sup> Consolidated version of the treaty on the functioning of the European Union: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?Uri=CELEX:12012E/TXT&from=EN#page86>

<sup>56</sup> Kaiser, T. E., Reichel, W.L., Locke, L.N., Cromartie, E. et al. 1980. "Organochlorine pesticide, PCB, and PBB residues and necropsy data for bald eagles from 29 states 1975-77". *Journal of Pesticide Monitoring* 14:145-149.

<sup>57</sup> Wiemeyer, S., Scott, J., Anderson, M., Bloom, P. and Stafford, C. 1988. "Environmental contaminants in California Condors". *Journal of Wildlife Management* 52(2): 238-247. doi:10.2307/3801228

<sup>58</sup> Helander, B., Axelsson, J., Borg, H., Holm, K., and Bignert, A. 2009. "Ingestion of lead from ammunition and lead concentrations in white-tailed sea eagles (*Haliaeetus albicilla*) in Sweden". *Science of The Total Environment* 407:5555-5563. doi.org/10.1016/j.scitotenv.2009.07.027; and Kennntner, N., Tataruch, F., and Krone, O. 2001. "Heavy metals in soft tissue of white-tailed eagles found dead or moribund in Germany and Austria from 1993 to 2000". *Environmental Toxicology and Chemistry* 20:1831-1837 doi:10.1897/1551-5028(2001)020<1831:hmisto>2.0.co;2; and Menzel, A.-C., and Krone, O. 2021. "Using regurgitated pellets from white-tailed sea-eagles as noninvasive samples to assess lead exposure caused by hunting in Germany". *Journal of Raptor Research*. doi:10.3356/jrr-20-52

<sup>59</sup> Pain, D. J., Mateo, R. and Green, R.E. 2019. "Effects of lead from ammunition on birds and other wildlife: a review and update". *AMBIO Special Issue* 48(9):935-953. doi:10.1007/s13280-019-01159-0; and Monclús, L., Shore, R.F. and Krone, O. 2020. "Lead contamination in raptors in Europe: A systematic review and meta-analysis". *Science of the Total Environment* 748:141437. doi.org/10.1016/j.scitotenv.2020.141437

<sup>60</sup> See Pain et al. *Supra*, note 59.

<sup>61</sup> See Arnemo et al., *Supra*, note 19.

<sup>62</sup> Green, R.E. and Pain, D.J. 2019. "Risks to human health from ammunition-derived lead in Europe". *AMBIO Special Issue* 48(9): 954-968. doi.org/10.1007/s13280-019-01194-x.

<sup>63</sup> EFSA. 2010. "Scientific Opinion on Lead in Food". *EFSA Journal* 8:1570 doi:10.2903/j.efsa.2010.1570.

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<sup>65</sup> Lanphear, B.P., Hornung, R., Khoury, J., Yolton, K., et al. 2005. "Low-level environmental lead exposure and children's intellectual function: An international pooled analysis". *Environmental Health Perspectives* 113:894-899. https://doi.org/10.1289/ehp.7688.

<sup>66</sup> *Supra*, note 65; and WHO 2019. World Health Organization. Fact Sheet: Lead poisoning and health. 23 August 2019. https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-andhealth#: :text=The%20neurological%20and%20behavioral%20effects,behavioral%20difficulties%20and%20learning%20problems.

<sup>67</sup> *Supra*, note 62.

<sup>68</sup> *Supra*, note 54.

<sup>69</sup> *Supra*, note 55.

<sup>70</sup> *Supra*, note 63.

<sup>71</sup> Krone, O. 2018. "Lead Poisoning in Birds of Prey". In: *Birds of Prey: Biology and Conservation in the XXI century*. Eds. Saratola, J.H., Grande, J.M. and Negro, J.J. pp 251-272. Springer, Cham. doi.org/10.1007/978-3-319-73745-4\_11; and Plaza P.I. and Lambertucci, S.A. 2019. "What do we know about lead contamination in wild vultures and condors? A review of decades of research". *Science of the Total Environment* 654: 409-417. doi.org/10.1016/j.scitotenv.2018.11.099.

<sup>72</sup> *Supra*, note 15.

<sup>73</sup> Green, R.E. and Pain, D.J. 2016. "Possible effects of ingested lead gunshot on populations of ducks wintering in the UK". *Ibis* 158 (4): 699-710. doi.org/10.1111/ibi.12400

<sup>74</sup> *Supra*, note 54.

<sup>75</sup> See Kanstrup and Thomas, *supra*, note 19.

<sup>76</sup> *Supra*, note 54; See Kanstrup and Thomas, *Supra*, note 19.

<sup>77</sup> *Supra*, note 63.

<sup>78</sup> UNICEF and Pure Earth. 2020. "The Toxic Truth: Children's Exposure to Lead Pollution Undermines a Generation of Future Potential". UNICEF and Pure Earth, New York. pp 96. https://www.unicef.org/media/73246/file/The-toxic-truth-children%E2%80%99s-exposure-to-lead-pollution-2020.pdf; and Pain, D., Green, R. and Taylor, C. 2020. Children are at risk from game shot with lead. *Guardian Letters* 10 August 2020. https://www.theguardian.com/society/2020/aug/10/children-are-at-risk-from-game-shot-with-lead.

<sup>79</sup> Knutsen, H.K., Brantsaeter, A.-E., Alexander, J. and Meltzer, H.M. 2015. "Associations between consumption of large game animals and blood lead levels in humans in Europe: the Norwegian experience". pp 44-50, In: Delahay and Spray (Eds), *supra*, note 16.

<sup>80</sup> https://www.nhs.uk/conditions/pregnancy-and-baby/foods-to-avoid-pregnant/

<sup>81</sup> This has subsequently been changed to the 2021-22 season as the Covid 19 situation resulted in many game shoots closing and difficulty in accessing game shot with lead free ammunition.

<sup>82</sup> https://www.theguardian.com/business/2019/jul/29/experts-call-for-ban-on-lead-shot-as-waitrose-overhauls-sale-of-game; https://www.telegraph.co.uk/news/2019/07/29/waitrose-stop-selling-game-killed-lead-shot-following-warning/; and https://www.dailymail.co.uk/news/article-7299583/Waitrose-ends-sale-game-birds-shot-toxic-lead-experts-call-Government-ban-use.html

<sup>83</sup> *Supra*, note 19.

<sup>84</sup> *Supra*, note 12.

<sup>85</sup> Payne, J.H., Holmes, J.P, Hogg, R.A., Van Der Burgt, G.M., et al. 2013. "Lead intoxication incidents associated with shot from clay pigeon shooting". *Veterinary Record* 173(22): 552. doi: 10.1136/vr.102120.

<sup>86</sup> Laidlaw, M. A. S., Filippelli, G., Mielke, H., Gulson, B. and Ball, A. S. 2017. "Lead exposure at firing ranges – a review". *Environmental Health* 16:34. doi: 10.1186/s12940-017-0246-0

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<sup>89</sup> *Supra*, note 20.

<sup>90</sup> See Kanstrup and Thomas, *supra* note 19.

<sup>91</sup> Kanstrup, N., Hansen, H.P., Balsby, T.J.S., and Mellerup, K.A. 2021. "Non-lead rifle ammunition: Danish hunters' attitudes". *Environmental Sciences Europe*. doi:10.1186/s12302-021-00485-z

<sup>92</sup> AB 711. 2013. Assembly Bill 711, Rendon. "Hunting: Nonlead ammunition. Chapter 742. An act to amend Section 3004.5 of the Fish and Game Code, relating to hunting". http://leginfo.ca.gov/faces/billNavClient.xhtml?bill\_id=201320140AB711.

<sup>93</sup> See Kanstrup and Thomas, *supra*, note 19.

<sup>94</sup> *Supra*, notes 28 and 49.

<sup>95</sup> FAO. 2018. "Game meat. Production and trade in the ENECE region". Rome: Food and Agricultural Organization of the United Nations.

<sup>96</sup> *Supra*, note 42.

<sup>97</sup> EC. 2006. “European Commission Regulation EC 1881/2006. Setting maximum levels for certain contaminants in foodstuffs”. Official Journal of the European Union EC 1881/2006 (20.12.2006), L364/365-L364/324. <http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1442063437890&uri=CELEX:32006R1881>.

<sup>98</sup> *Supra*, note 42.

<sup>99</sup> See Kanstrup and Thomas, *supra*, note 19.

<sup>100</sup> <https://www.law.cornell.edu/cfr/text/50/20.134>

<sup>101</sup> FWS. 2018. U.S. Fish and Wildlife Service. “Nontoxic shot regulations for hunting waterfowl and coots in the U.S”. <https://www.fws.gov/birds/bird-enthusiasts/hunting/nontoxic.php>; and Thomas, V.G. 2019. “Chemical composition standards for non-lead hunting ammunition and fishing weights”. *AMBIO Special Issue* 48(9): 1072-1078. doi.org/10.1007/s13280-018-1124-x

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<sup>117</sup> *Supra*, note 114.

<sup>118</sup> *Supra*, note 20.

<sup>119</sup> See Kanstrup et al., *supra* note 33.

<sup>120</sup> *Supra*, note 54.

<sup>121</sup> Arnemo, J.M., Cromie, R., Fox, A.D., Kanstrup, N. et al. 2019. “Transition to lead-free benefits all”. *AMBIO Special Issue* 48(9): 1097-1098. doi.org/10.1007/s13280-019-01221-x