

# The Lead Fix: a brief global overview

The Conservation Symposium, Lions River, KwaZulu-Natal, South Africa 4-8 Nov 2019<sup>1</sup>

Invited Plenary Keynote Address by John Swift on 7 Nov 2019 and Lead (Pb) Strategy Workshop on 8 Nov 2019<sup>2</sup>

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<sup>1</sup> <https://conservationsym2019.dryfta.com>

<sup>2</sup> “Developing a strategy for ensuring wildlife is not harmed by exposure to lead (PbB). Question & Answer session with John Swift, UK Lead Ammunition Working Group, hosted by the Lead Task Team.”

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## Introduction

Thank you for inviting me to give this “global overview” of

- Sources of lead and how things stand around the world,
- Issues for wildlife, people and the environment
- Efforts made to reduce exposures, lessons learned, what works and doesn't.

I have no doubt that you will teach me a lot about your issues here in South Africa, and I hope what I say today and tomorrow will be helpful.

So you know who I am, I have been involved in hunting and wildlife conservation programmes most of my working life, and – among them lead-related issues for over 45 years. I was Chief Executive of the British Association for Shooting and Conservation for 25 years and a senior Vice President of the Federation of European Associations for Hunting and Conservation (FACE) for many of them. Although retired now, I continue as Chair of the UK Lead Ammunition Working Group<sup>3</sup>, founded in 2010 and continuing as an expert group dealing with science and evidence connected to lead-based and alternative ammunitions.

There are two ways to look at today's brief:

1. Complicated. Lead poisoning of wildlife and people is multifaceted and multidisciplinary - described by a huge volume of sophisticated scientific literature from many countries, which to the uninitiated can be confusing;
2. Simple. Lead is a nasty poison and has been recognised as such for hundreds of years – hence the issue now is how best to reduce or prevent exposures to it wherever possible.

## The science

Scientific opinion on the poisonous nature of lead is settled<sup>1</sup>, though the evidence-base where poisoning occurs (or risks occurring) is expanding all the time – expanding not just in terms of wildlife and human health risks, but unexpected exposures - and not just in the

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<sup>3</sup> <http://www.leadammunitiongroup.org.uk>

workplace where it should already be well-controlled and monitored; but surprisingly it seems, from simply going shooting or fishing; perhaps as the result of home-loading, making shot weights, handling carcasses and feeding the off cuts to hunting dogs (see LAG Resources<sup>4</sup>).

Looking at lead generally, many reviews have been completed: for example, and since this is a wildlife conservation symposium, the Convention on Migratory Species Ecological Review, which identifies a variety of industrial sources which are now mostly controlled by law, regulation and commercial good practice.<sup>ii</sup>

I refer also to the most recent, namely the scientific journal *Ambio*, a journal for the human environment, published this September in cooperation with The Royal Swedish Academy of Sciences <sup>iii</sup>.

This covers much ground but underlines that lead poisoning is now being reported from more wildlife species and places not least connected with lead-based ammunition – and it explains that non-lead ammunition and fishing weights are demonstrably effective substitutes <sup>iv, v</sup>.

Nothing in any peer reviewed scientific literature contradicts this picture of the impacts of lead.

So, what is being done? Where do things stand with institutional orchestras?

## The Institutions

World Health Organisation (WHO)

From the human health perspective, the World Health Organisation is emphatic <sup>vi</sup>. WHO emphasises that:

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<sup>4</sup> <http://www.leadammunitiongroup.org.uk/information/>

1. Lead is a cumulative toxicant that affects multiple body systems and is particularly harmful to young children (due to impacts on neurodevelopment).
2. Lead in the body is distributed in the blood to the brain, liver, kidney and bones.
3. Lead in bone is released back into blood during pregnancy and becomes a source of exposure to the developing foetus.
4. There is no known level of lead exposure that is considered safe.
5. Lead exposure is preventable.

How big is the problem? The Institute for Health Metrics and Evaluation, quoted by WHO, in 2016 estimated that lead exposure accounted for 540,000 deaths worldwide due to its long-term effects on health. The highest burden was in low- and middle-income countries. Lead exposure accounted for 63.8% of the global burden of developmental intellectual disability, 3% of the global burden of ischaemic heart disease and 3.1% of the global burden of stroke.

#### UN Environment Programme (UNEP)

From the environmental perspective, the United Nations agencies' actions derive from high-level aspirations for a "pollution free planet", linking reduced lead exposures to the UN's pollution and human health Sustainable Development Goals <sup>5</sup>.

In 2017 the UN Environment Assembly in Nairobi took this up and recognised the need to address lead ammunition, adopting a resolution specifically acknowledging problems caused by lead ammunition and the need for action.

Ammunition lead stands out compared to the much larger-scale uses of lead in industry and commerce, because its discharge into the environment as ammunition projectiles and fragments is almost totally unregulated and mostly irrecoverable where it builds toxic legacy.

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<sup>5</sup>

[https://www.genevaenvironmentnetwork.org/docs/Presentation%20to%20the%20Permanent%20Missions%20Geneva\\_%2005-11.pdf](https://www.genevaenvironmentnetwork.org/docs/Presentation%20to%20the%20Permanent%20Missions%20Geneva_%2005-11.pdf)

## African-Eurasian Migratory Waterbird Agreement (AEWA)

It all started with lead shot and waterfowl, and although that remains important, things have moved on - first addressed legislatively in North America in 1991, it was central to the negotiation of African-Eurasian Migratory Waterbird Agreement in the early 1990s, and in 1995 this treaty called on Parties to “... endeavour to phase out the use of lead shot for hunting in wetlands by the year 2000.”

That date has turned out to be optimistic, and a recent update is that the AEWA Strategic Plan for the period 2019-2027 says: "By 2021, Parties that have not already done so phase out the use of lead shot in wetlands in accordance with the AEWA Action Plan."<sup>viii</sup>

To this end more detailed actions are identified in the revised Plan of Action for Africa.<sup>viii</sup>

## Convention on Migratory Species (CMS)

The lead agenda widened to include wildlife threats generally and human health risks following the Peregrine Fund conference in Idaho in 2008<sup>ix</sup>. The Convention on Migratory Species reflected this and expanded the AEWA ambition by calling on Parties in 2014 to “Phase-out the use of lead ammunition across all habitats (wetland and terrestrial) ...”<sup>6</sup>

This reflected CMS’s wider taxonomic scope - the need to eliminate poisoning of large raptors arising from use of lead bullets - and acknowledging that lead ammunition poses a risk to birds in both wetland and terrestrial habitats.

To this end CMS has established a number of groups and initiatives with interests in lead and ammunition.

1. There is a Multi-species Vulture Action Plan<sup>x</sup>.
2. And there is a Preventing Poisoning Working Group<sup>xi</sup>.
3. Within that group a Task Group has been established though progress to date has been limited due to funding constraints<sup>xii</sup>.

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<sup>6</sup> Resolution 11.15

## Convention on Biological Diversity (CBD)

Fundamental to all this, in 1992 the Convention on Biological Diversity (CBD), agreed on a high-level framework for *“no use of the components of biodiversity that will lead to the decline of biodiversity”* and *the need to minimise adverse environmental impacts.* <sup>xiii</sup>

## International Olympic Committee (IOC)

And it is also appropriate to mention the International Olympic Committee which appears to be dragging its feet with continued use of lead shot for Olympic skeet and trap competitions, despite its Olympic charter on Environmental Concern, recognition of CBD, and partnerships with UNEP <sup>xiv</sup>.

So where have we got to so far?

WHO, UN agencies and numerous treaty bodies, all emphasise the scale of the health and environmental problems caused by lead and the need to control them. These agencies and national ones too, are emphasising the importance of reducing all exposures, including the last great unregulated ones arising from lead ammunition and fishing weights.

Let's turn to the main biogeographic regions and what is happening.

## What's happening

### Southern Africa

I start in Southern Africa. You understand better than me, how big a country South Africa is and the special issues that arise. I know by reputation that this also is where greatest attention has been paid to lead outside North America and Europe, with lively strands of engagement from energetic wildlife NGOs, academics and also the hunting communities. The highlights – though risks will inevitably run much wider – appear to be focused on vultures and we will hear more about these later <sup>xv, xvi, xvii</sup>.

We have recently heard about the setting up of vulture-safe zones and I understand that real progress is being made in cooperation with hunters of large game in some areas.

I am also aware that following declines in Nile crocodile, their exposure to lead after intake of lead fishing weights during gastrolith ingestion, is associated with harmful consequences for their egg development and hatchling health. <sup>xviii</sup>

## North America and Canada

In the USA, non-toxic shot has been required by law for hunting all species of waterfowl, nation-wide since 1991. In January 2017, the US Fish and Wildlife Service issued an order to extend this, on the basis of good science, and phase out lead-based ammunition in all 568 million acres of agency-managed lands and waters. But Donald Trump issued a counter-order overturning it – so as “to expand access for outdoor enthusiasts and also make sure the community’s voice is heard” <sup>xix</sup>.

Although there is extensive literature on avian scavenger exposure and vulnerability to hunter-killed waterfowl and big game carcasses throughout USA and Canada<sup>xx</sup>, only California has implemented complete non-toxic laws for lead and bullets, starting in 2019, for hunting all state-regulated game species, whether on public or private lands.

In Canada, non-toxic shot is required for the hunting of migratory birds that fall under Federal authority. Upland species and all big game mammals fall under provincial jurisdiction, so the use of lead shot and rifle bullets continues to be allowed. <sup>xxi</sup>

But lead is listed in the Canadian Environmental Protection Act, which provides for the federal government to undertake measures to reduce exposures. The Canadian governmental ministry, Environment Canada, is currently conducting “a conversation” to encourage more use of lead-free shotgun and rifle ammunition, and they will publish conclusions this winter 2019.

Evidence of lead exposure in Arctic subsistence hunters needs to be mentioned <sup>xxii, xxiii</sup> suggesting that the lead shot ban for waterfowl has benefited both eagles which were being poisoned after eating waterfowl, and hunters and their families alike.

## South America

South America has special issues too, and a paper published in July this year <sup>xxiv</sup> describes the lead levels and isotopic fingerprints in free-ranging animals belonging to 18 wild game species in four remote areas of the Peruvian Amazon. This provides a comprehensive picture of lead pollution in tropical rainforests, and concludes that hunting ammunition is probably the main source of lead in wildlife, but oil-related pollution is also a source of contaminant-lead in areas where oil is extracted.

Argentina is a major hunting destination where changes in hunting practice are being advocated<sup>xxv</sup>, and there are numerous papers from there <sup>xxvi</sup>.

A literature search by Pablo Plaza from Argentina and his co-authors <sup>xxvii</sup> found 39 scientific papers on this topic involving 68 bird species. Most come from Argentina and Brazil (71.7%), but also from Chile (7.7%), Venezuela (7.7%), Colombia (5.1%), Bolivia (2.6%), Ecuador (2.6%) and Peru (2.6%). Seventy percent of the studies show individuals with lead concentrations that exceed established safety thresholds levels.

## Europe

### European Union

In the European Union, it wasn't until 2004 that its European Commission, with the agreement of all Member States and hunters, announced its aim to phase out the use of lead shot in wetlands by 2009<sup>xxviii</sup>.

### European Chemicals Agency (ECHA)

In 2016 however, after the failure of most Member States to introduce demonstrably effective regulations for protecting wetlands and waterfowl, the European Commission asked the European Chemicals Agency (ECHA) to produce a formal Restriction Proposal requiring all Member States to act consistently and ban the use of lead shot over wetlands.

In the light of the evidence collected and the ensuing discussions surrounding the proposed restriction on lead shot use over wetlands, not least the growing evidence of avian

scavenger and raptor poisoning across Europe<sup>xxxix</sup>, the evidence was deemed sufficient in 2018<sup>xxx</sup> to extend this Restriction Process, mandating the Chemicals Agency (ECHA) to prepare a wider Restriction Proposal to protect the health of humans, and wildlife in all habitats - eliminating many of the inherent problems and costs of the wetlands only approach – and this is now underway.

#### Registration Evaluation Authorisation and Restriction of Chemicals (REACH)

On another tack, under a formal process for Registration, Evaluation, Authorisation of Hazardous Chemicals, it was established last year that metallic lead be identified as what is termed a Substance of Very High Concern (SVHC) not least on grounds of its cumulative toxicity<sup>xxxi</sup>.

That having been done, such substances are regularly assessed to determine which should then be included in an “Authorisation list”. If lead metal is included on this list, it will almost certainly result in a regulatory move towards non-lead ammunition – because authorisation is not granted if alternatives exist.

#### European Food Safety Authority (EFSA)

The issue of food safety and reducing dietary lead exposures was addressed by the European Food Safety Authority (EFSA) in 2010<sup>xxxii</sup>, identifying the close-to-health-threshold lead levels for the general public resulting from normal diet, and the additional potential for risks to consumers of game especially women of pregnancy age, children and high-level game consumers.

#### Member State actions

After further detailed research and health risk assessment in the light of EFSA, a number of European countries have now issued public health warning advice for lead-shot game including Norway<sup>xxxiii</sup>, Sweden, Germany, Spain, France<sup>xxxiv</sup>, Italy and UK<sup>7</sup>.

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<sup>7</sup> NHS 2017. NHS 23 January 2017 – Foods to avoid in pregnancy <https://www.nhs.uk/conditions/pregnancy-and-baby/foods-to-avoid-pregnant/>

And in the UK, I am aware that high street supermarkets are now labelling game meat products with lead warnings, or committing themselves, for consumer safety reasons, to requiring all wild-shot game and venison to have not been shot with lead ammunition <sup>xxxv</sup>.

Two European countries, Denmark and The Netherlands, have a total ban of lead gunshot use in all types of habitats. These are hugely valuable laboratories for technical R&D and demonstrating that lead is replaceable without prejudice to hunting.

At other locations across Europe, in Germany, Italy, UK, Austria and France projects are underway where hunters have been successfully trialling non-lead ammunition for large game culling - this due to growing concerns about threats to avian scavengers feeding on carcasses and gralloch from hunted animals, as well as need to sustain public game meat markets.

## Asia

There is a significant lesson from Japan, which introduced a partial ban on lead ammunition for sika deer in 2000 following problems with scavenging eagles. Subsequent studies of white-tailed and Stella's sea eagles in Hokkaido revealed that dead birds collected some time after the ban on the use of lead bullets still had elevated liver lead concentrations clearly associated with poisoning and hence continued illegal use of lead bullets. Isotope analysis was consistent with lead ammunition <sup>xxxvi</sup>.

## Australia and New Zealand

Australia operates at state level where some have banned duck or quail shooting completely, and others have banned lead shot at specified sites.

But Australians shoot and eat a vast number of wild and feral animals in their considerable hinterlands.

A recent article titled *Heads in the sand: public health and ecological risks of lead-based bullets for wildlife shooting in Australia* <sup>xxxvii</sup> argued for urgent research into this field in Australia.

New Zealand banned most lead shot use in 2006, but some sources of dietary lead exposure are not immediately apparent, such as that from their considerable volume of exported wild game.<sup>xxxviii</sup>

## Solutions

There is no doubt that both science and regional experiences tell us that wildlife and health will be substantially better served if we hunters and fishermen do not use lead ammunition and lead weights. The evidence also tells us how we should best go about achieving this.

Wildlife and health of course face innumerable challenges, and ammunition lead, of course, is just one. But it is one that the evidence shows we can fix.

I know that many hunters and anglers don't yet recognise the harms being done – but I assure you they are real and substantial - and some continue to suspect a plot or threat to ban hunting – which I assure you it is not. Rolling back traditions is indeed difficult and faces many challenges. But if we care about wildlife and health the evidence is compelling that it needs to be done.

Let's unpack a this a bit more. The evidence tells us that change will happen effectively when hunters and anglers are obliged to change and their leaders own the problems and give leadership – which boils down to effective regulation. Necessity is a hard task master. Voluntary and unpoliced measures have their place, but the evidence shows they will not ultimately serve the big picture. Regulations restricted to specific aspects of the problem or restricted regions leave too many other risks uncapped and loopholes for non-compliance. And we are finding ever more unexpected areas of exposure and risk all the time. The lessons from Denmark and the Netherlands are clear: the only way to do the job properly and nail it, is at source; by prohibiting the sale and use of these lead products. And the other big lesson learned is that this will not harm or reduce hunting – absolutely the opposite.

A separate but crucial problem is the commercial dimension. Ammunition manufacturers and local ammunition retail outlets can and will only supply the necessary variety of alternatives, to your local store, when it is profitable for them to do so.

There are two big drivers – and both point once again to the need for regulatory support:

1. Manufacturers must be confident of sufficient demand to invest in production, upscaling and distribution, and
2. Retailers must have sufficient customers to carry stocks on their shelves they know they can shift.

Countries with known problems and political will, can of course now confidently regulate against sale and use of lead products in their jurisdiction, as the Danes and Dutch have successfully done and the Californians are doing - and experience tells us that manufacturers will supply user-needs pretty damn quickly because the markets for product will not disappear, they've got the products ready to go, and there is money to be made.

But a big key lies with a multi-national jurisdiction such as the EU, where important manufacturers and substantial user-markets are based, and the Restriction and REACH Authorisation processes mentioned earlier are going forward. That has the potential to change the weather big time.

## Direction of travel

In the meantime, the direction of travel is clear. The problem is not going to go away and it will grow. Expect:

1. More evidence on poisoning and risks from medical, veterinary and environmental communities
2. More acceptance of the problem and need for solutions
3. More R&D of alternatives will improve and diversify non-lead ammunition
4. More shared experience will normalise their acceptance and use

## Big wins

Competing priorities and politics understandably weigh on regulators but there's much to be won:

1. More secure and sustainable hunting <sup>8</sup>
2. Jobs and economy securely based on ethically practised hunting and tourism (especially in areas where economic opportunities are difficult).
3. Game meat products and markets strengthened by being lead-free, as well as healthy and nourishing.
4. Raptor and vulture conservation improved – as a tourist spectacular, and for ecosystem services as well as their intrinsic value.
5. More ecologically resilient landscapes and wildlife - and South Africa continuing its imaginative leadership with so much opportunity there to be grasped?

I wish you every success today.

## Acknowledgements

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<sup>8</sup> Kanstrup, N., J. Swift, D.A. Stroud, and M. Lewis. 2018. Hunting with lead ammunition is not sustainable: European perspectives. *Ambio* 47: 846–857. [CrossRefGoogle Scholar](#)

## End notes

- <sup>i</sup> Group of Scientists, 2014. Wildlife and Human Health Risks from Lead-Based Ammunition in Europe: A Consensus Statement by Scientists. <https://www.zoo.cam.ac.uk/system/files/documents/European-Statement.pdf>
- <sup>ii</sup> [https://www.cms.int/sites/default/files/document/COP11\\_Inf\\_34\\_Review\\_effects\\_of\\_Poisoning\\_on\\_Migratory\\_Birds\\_Eonly.pdf](https://www.cms.int/sites/default/files/document/COP11_Inf_34_Review_effects_of_Poisoning_on_Migratory_Birds_Eonly.pdf)
- <sup>iii</sup> Kanstrup K, Thomas V.G. and Fox A.D. *Lead in Hunting Ammunition: Persistent Problems and Solutions*. Ambio Volume 48, Issue 9, September 2019.
- <sup>iv</sup> Thomas, V.G., Kanstrup, N. & Fox, A.D. Ambio (2019) 48: 925. <https://doi.org/10.1007/s13280-018-1132-x>
- <sup>v</sup> Stokke, S., Arnemo, J.M. & Brainerd, S. Ambio (2019) 48: 1044. <https://doi.org/10.1007/s13280-019-01171-4>
- <sup>vi</sup> <https://www.who.int/en/news-room/fact-sheets/detail/lead-poisoning-and-health>
- <sup>vii</sup> <https://www.unep-aewa.org/en/document/aewa-strategic-plan-2019-2027>
- <sup>viii</sup> <https://www.unep-aewa.org/en/node/1984>
- <sup>ix</sup> Watson RT, Fuller M, Pokras M and Hunt G Eds (2008). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. May 2008 Conference Proceedings. Boise State University.
- <sup>x</sup> <https://www.cms.int/raptors/en/workinggroup/multi-species-action-plan-protect-african-eurasian-vultures>
- <sup>xi</sup> <https://www.cms.int/en/workinggroup/preventing-poisoning-migratory-birds>
- <sup>xii</sup> As adopted through Res. 11.15 (Rev.COP12), the Terms of Reference of the PPWG have now included a new Task Group as a subgroup focusing on poisoning from lead ammunition, fishing weights and other sources of lead. The Secretariat has convened relevant stakeholders and experts for the **Task Group on Lead**. The establishment of this Task Group by COP12 is an example of international cooperation in the efforts to minimize the impact of some of the worst contaminants.
- <sup>xiii</sup> <https://www.cbd.int/sustainable/addis.shtml>
- <sup>xiv</sup> Schmidt R. 2018 *The European Journal of International Law* Vol. 28 no. 4
- <sup>xv</sup> V. Naidoo, K. Wolter and C.J. Botha (2017) *Environmental Research* 152 (2017) 150–156
- <sup>xvi</sup> *Science of the Total Environment* 631–632 (2018) 1654–1665
- <sup>xvii</sup> Kreuger S C and Amar A (2018) *J Raptor Res.* 52(4):491-499
- <sup>xviii</sup> Warner J K, Combrink X, Myburgh J and Downs C (2016) *Blood lead concentrations in Nile crocodile*. *Ecotoxicology* DOI 10.1007/s10646-016-1652-8
- <sup>xix</sup> <https://www.reuters.com/article/us-usa-interior-zinke/new-interior-head-lifts-lead-ammunition-ban-in-nod-to-hunters-idUSKBN16930Z>
- <sup>xx</sup> <https://www.ontario.ca/page/bald-eagle-management-plan#section-9>. (See Wayland and Bollinger 1999, Scheuhammer and Norris 1996, Hunt et al. 2006, Craighead and Bedrosian 2008, Stauber et al.2010, Bedrosian et al. 2012, Redig et al. 2009)
- <sup>xxi</sup> Vernon G.Thomas 2019. *Rationale for the regulated transition to non-lead products in Canada: A policy discussion paper*. *Science of the Total Environment* 649 (2019) 839-845
- <sup>xxii</sup> DEWAILLY, E., P. AYOTT, S. BRUNEAU, G. LEBEL, P. LEVALLOIS, AND J. P. WEBER. 2001. Exposure of the Inuit population of Nunavik (Arctic Quebec) to lead and mercury. *Archives Environmental Health* 56:350–357.
- <sup>xxiii</sup> JOHANSEN, P., G. ASMUND, AND F. RIGET. 2004. High human exposure to lead through consumption of birds hunted with lead shot. *Environmental Pollution* 127:125–129.
- <sup>xxiv</sup> Cartró-Sabaté, M., Mayor, P., Orta-Martínez, M., Rosell-Melé, A. 2019. Anthropogenic lead in Amazonian wildlife. *Nature Sustainability*. 2: 702-709. DOI: 10.1038/s41893-019-0338-7
- <sup>xxv</sup> Uhart, M., Ferreyra, H., Romano, M. et al. Ambio (2019) 48: 1015. <https://doi.org/10.1007/s13280-019-01178-x>
- <sup>xxvi</sup> <https://phys.org/news/2019-04-ammunition-polluting-argentina.html>
- <sup>xxvii</sup> Plaza, Pablo & Uhart, Marcela & Caselli, Andrea & Wiemeyer, Guillermo & Lambertucci, Sergio. (2018). A review of lead contamination in South American birds: The need for more research and policy changes. *Perspectives in Ecology and Conservation*. 10.1016/j.pecon.2018.08.001.
- <sup>xxviii</sup> <https://edepot.wur.nl/118449>
- <sup>xxix</sup> Jenni et al. (2015)
- <sup>xxix</sup> Madry et al. (2015)
- <sup>xxix</sup> Ecke et al. 2017
- <sup>xxix</sup> Gil-Sánchez et al. (2018)
- <sup>xxix</sup> Kitowski et al. (2017a)
- <sup>xxix</sup> Isomursu et al. (2018)
- <sup>xxix</sup> O'Donoghue (2017)

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- xxix Ganz et al. (2018)
- xxix Horowitz. et al. (2014)
- xxix Berny et al. (2015)
- xxix Mateo-Tomás et al. (2016)
- xxix Carneiro et al. (2016)
- xxix Molenaar et al. (2017)
- xxix Berny et al. (2015)
- xxix Carneiro et al. (2014)
- xxix Kitowski et al. (2016)
- xxix Andreotti et al. (2018b)
- xxx [https://echa.europa.eu/-/call-for-evidence-on-a-possible-restriction-on-the-placing-on-the-market-and-use-of-lead-in-ammunition-shot-and-bullets-and-fishing-tackle?\\_cldee=bWFyaWFubmUudHZlcm15ckBtaWxqb2Rpci5ubw%3d%3d&recipientid=lead-fcd3fcd4c0e0e71180fa005056952b31-e8613eba32c34b11b1a62536422f13ba&esid=51826de2-65df-e911-8113-005056b9310e](https://echa.europa.eu/-/call-for-evidence-on-a-possible-restriction-on-the-placing-on-the-market-and-use-of-lead-in-ammunition-shot-and-bullets-and-fishing-tackle?_cldee=bWFyaWFubmUudHZlcm15ckBtaWxqb2Rpci5ubw%3d%3d&recipientid=lead-fcd3fcd4c0e0e71180fa005056952b31-e8613eba32c34b11b1a62536422f13ba&esid=51826de2-65df-e911-8113-005056b9310e)
- xxxi The authorization now contains 201 substances. The new substances to the Candidate List are carcinogenic, toxic to reproduction, persistent, bioaccumulative, and toxic (PBT) and very persistent and bioaccumulative (vPvB) properties.
- xxxii EFSA PANEL ON CONTAMINANTS IN THE FOOD CHAIN (CONTAM) 2010. Scientific opinion on lead in food. EFSA journal 8(4), 1570. DOI: 10.2903/j. efsa.2010.1570. Available at: [http://www.efsa.europa.eu/sites/default/files/scientific\\_output/files/main\\_documents/1570.pdf](http://www.efsa.europa.eu/sites/default/files/scientific_output/files/main_documents/1570.pdf)
- xxxiii Knutsen, H.K., Brantsæter, A-L, Alexander, J., & MeltzerIn, H.M. 2015. Associations between consumption of large game animals and blood lead levels in humans in Europe: The Norwegian experience. Pages 44-50 In: Delahay, R.J. & Spray, C.J. (Eds.). Proceedings of the Oxford Lead Symposium. Lead Ammunition: understanding and minimising the risks to human and environmental health. Edward Grey Institute, University of Oxford, UK. 152pp. [http://www.oxfordleadsymposium.info/wp-content/uploads/OLS\\_proceedings/papers/OLS\\_proceedings\\_kuntsen\\_brantsaeter\\_alexander\\_meltzer.pdf](http://www.oxfordleadsymposium.info/wp-content/uploads/OLS_proceedings/papers/OLS_proceedings_kuntsen_brantsaeter_alexander_meltzer.pdf)
- xxxiv ANSES 2018. AVIS de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif au "risque sanitaire lié à la consommation de gibier au regard des contaminants chimiques environnementaux (dioxines, polychlorobiphényles (PCB), cadmium et plomb)". Avis de l'ANSES Saisine n° 2015-SA-0109. ANSES 14 Rue Pierre et Marie Curie, 94701 Maisons-Alfort Cedex. Accessed January, 2019, from: <https://www.anses.fr/fr/content/consommation-de-gibier-sauvage-agir-pour-r%C3%A9duire-les-expositions-aux-contaminants-chimiques>
- xxxv Waitrose 2019. (July 31<sup>st</sup>) Animal Welfare: Lead shot pledge. [https://www.waitrose.com/home/inspiration/about\\_waitrose/the\\_waitrose\\_way/waitrose\\_animal\\_welfarecommitments.html](https://www.waitrose.com/home/inspiration/about_waitrose/the_waitrose_way/waitrose_animal_welfarecommitments.html).
- xxxvi Ishii, C., S.M.M. Nakayama, Y. Ikenaka, H. Nakata, K. Saito, Y. Watanabe, H. Mizukawa, S. Tanabe, et al. 2017. Lead exposure in raptors from Japan and source identification using Pb stable isotope ratios. *Chemosphere* 186: 367–373. <https://doi.org/10.1016/j.chemosphere.2017.07.143>.
- xxxvii Hampton J., Laidlaw M., Buenz E and Arnemo J. 2018. Heads in the sand: public health and ecological risks of lead-based bullets for wildlife shooting in Australia. *Wildlife Research*, 2018, 45, 287–306 <https://doi.org/10.1071/WR17180>
- xxxviii Buenz, E.J. 2016b. Eliminating potential lead exposure in imported New Zealand wild game. *Public Health*. 139: 236-237. DOI: 10.1016/j.puhe.2016.06.025.
- Buenz, E.J. 2016a. Non-lead ammunition may reduce lead levels in wild game. *Environmental Science and Pollution Research*. 23(15): 15773-15773. DOI: 10.1007/s11356-016-7020-7.
- Buenz, E.J and Parry, G.J. 2017. Chronic Lead Intoxication from Eating Wild-Harvested Game. *American Journal of Medicine*. <https://doi.org/10.1016/j.amjmed.2017.11.031>.