CONSULTATION REPORT
"LEAD AND LEAD COMPOUNDS"
EC No. 231-100-4 / CAS No. 7439-92-1
PROPOSED BY THE EUROPEAN CHEMICALS AGENCY (ECHA)
NON-METAL AMMUNITION (GUNSHOT) – ENVIRONMENT

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Federación Sectorial Española
de Armas y Municiones

PROLOGUE

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CONTRIBUTIONS OF THE SPANISH SECTORAL FEDERATION OF FIREARMS AND AMMUNITION (FSA) TO THE CONSULTATION ON THE RESTRICTION PROPOSAL REGARDING "LEAD AND LEAD COMPOUNDS" PUT FORWARD BY THE EUROPEAN CHEMICALS AGENCY (ECHA)

Over the past few years, the Spanish Sectoral Federation of Firearms and Ammunition (hereinafter FSA) has been investigating and conducting studies on the ecological consequences that lead ammunition in the form of gunshot has on terrestrial birds. Evidently concerned about the environment, the FSA set as a goal assessing the consequences which the use of lead shot in traditional hunting has on species through sampling methods using both lead and steel shot. In order to do so, multiple variables have been analysed, such as species (wild, acclimated and farm-bred species), sampling area (several geographic locations), type of hunting (intensive or traditional hunting), sampling season (beginning or end of the hunting season), etc., comparing said variables to multiple analyses conducted on the samples like the gizzard, liver, kidney and muscle tissue concentration, isotope studies, etc.

The conclusions drawn by the FSA after more than four years of studies affirm that bird populations in the terrestrial environment are not affected by the use of lead shot in traditional hunting of small game species.

At the beginning of the year, the European Chemicals Agency (hereinafter ECHA) issued a consultation proposing a restriction on lead ammunition outside wetlands, such as bullets and gunshot within and outside wetlands, as well as on the lead used in fishing tackle. To do so, it drafted a single restriction report with an annex attached thereto.

The first thing that must be said about the report drawn up by the ECHA is that it is a report which jointly addresses the consequences of various lead sources on the environment and human health. In other words, it is a report which analyses and combines four products (lead sources), about which the following must be pointed out:

- The lead used in fishing affects an activity, industry and users that are completely unrelated to hunting and sports shooting, to which the rest of the products mentioned in the ECHA report are related. We therefore do not understand its inclusion and, hence, this sector should be the one to assess the consequences of the ECHA's restriction proposals.
- In so far as the lead used in shooting ranges is concerned, it should be noted that there are currently systems and measures to recover a high percentage of the lead used. The ECHA should therefore assess the possibility of implementing lead recovery systems before proposing restrictions.
- Regarding the lead used in metal ammunition, which is mainly used for large game hunting, in view of the conclusions set out in the ECHA report, about which there is much to discuss, there are at present alternatives to lead which can be assessed.

- Lastly, the restriction proposal on the lead used in non-metal ammunition (lead gunshot) used for small game hunting outside wetlands is not currently feasible and the justification and alternative put forward in the ECHA report are extensively discussed in the report drawn up by the FSA. The harm caused to users, distributors and manufacturers (industry and trade in general) has not been properly assessed, and even less so the effects such a restriction would have on the future of small game hunting.

Combining four products in a single report is therefore a mistake that ultimately results in overstated generic conclusions. Given the transcendence of this error in the specific case of lead shot, the ECHA should have drawn up separate independent documents for each lead source and particular situation.

The FSA has focused its report on the use of lead shot for small game hunting outside wetlands. It claims that there is no alternative to lead gunshot for many reasons, including: that the effects of traditional hunting cannot be compared to the effects on the soil, livestock or water in shooting ranges; that nobody melts lead at home to produce lead shot pellets for small game hunting; that the effects of lead on specific species cannot be extrapolated to general populations; that most of the scientific literature cited has used farm-bred species from intensive hunting areas that have been bagged with lead shot; that the amounts of lead released to the natural environment in traditional hunting using lead shot are about half the amounts authorised for agriculture; that the analyses conducted on lead in the muscle tissues of game birds are within the legal thresholds recognised by the European Union; that studies on lead isotopes in game birds reveal that they are similar to the lead isotopes used in agriculture, etc.

To sum up, the ECHA should reconsider the need to conduct more and better studies that analyse all possible lead sources on an individual basis and, where appropriate, allocate research funds to alternatives that can replace lead shot, which would be well received by the FSA. The alternative proposed by the ECHA is not feasible for the time being, since steel shot for hunting wild small game species cannot currently be considered as an effective, practical and controllable alternative for the safety of users and because of its competitiveness.

1. AIM OF THE REPORT

The main aim of this Report is to submit to the committees of the *European Chemicals Agency* (hereinafter ECHA) observations to the consultation concerning the restriction report on the use of lead in projectiles (non-metal ammunition – lead shot cartridges) used in firearms for small game hunting in the terrestrial environment (EC No. 231-100-4 / CAS No. 7439-92-1).

2. BACKGROUND

In September 2018, the ECHA published the findings of an investigation report on lead in the gunshot used in terrestrial environments, in other types of ammunition and in fishing tackle (ECHA, 2018). The report was based on the findings of the Annex XV dossier for the restriction of lead gunshot in wetlands and was a response to the Commission's request to collect information in order to assess the risk and socioeconomic impact of a possible restriction on other uses of lead ammunition, including hunting in terrain other than wetlands and trapshooting, as well as on the use of lead sinkers in fishing. The ECHA report concluded that there was sufficient evidence of risk in said uses of lead to justify additional regulatory measures.

In July 2019, the European Commission requested the ECHA to prepare a restriction proposal on the placing on the market and use of lead in ammunition and of lead in fishing tackle conforming to the requirements of Annex XV to the Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation (hereinafter REACH). The request is complementary to the restriction on the use of gunshot in wetlands. In said request, the Commission recognised that "the ECHA should also evaluate aspects of animal well-being, such as the suffering of animals minimised in the context of hunting and aspects related to possible accidents affecting hunters and sports shooters caused by lead and its alternatives" (EU Commission 2019).

The scope of the investigation was as follows:

Hunting:

- Hunting with cartridges (outside wetlands)
- Hunting with small-calibre bullets
- Hunting with large-calibre bullets

Sports shooting:

- Sports shooting with gunshot (outside wetlands)
- Sports shooting with bullets outdoors
- Other outdoor shooting with rifles / air rifles / pistols

Shooting with historical firearms:

- Other outdoor shooting activities, including muzzle-loading arms and historical re-enactments

Fishing

- Lead in sinker and bait fishing
- Lead in fishing nets, ropes and lines (where lead is embedded)

The military uses of lead ammunition, along with other non-civilian uses of lead ammunition, such as by the police and customs agencies, are beyond the scope of the investigation. The uses of lead ammunition indoors are also excluded.

The Agency gathered information to back its investigation through a **call for evidence**, which was carried out from October to December 2019, and submitted the proposal on 15 January 2021.

Two documents subject to consultation are among the documents released to the public by the ECHA:

- Restriction report: "Annex XV Restriction Report / Proposal for a Restriction" of 24 March 2021 (ECHA, 2021a).
- Annexes to the Restriction Report: "Annex to Annex XV Restriction Report / Proposal for a Restriction" of 24 March 2021 (ECHA, 2021).

3. METHODOLOGY FOLLOWED

First, the documents submitted by the ECHA in its restriction dossier report and annexes were examined, in particular the contents of any aspects which affect or could affect the environment due to the use of lead shot used for hunting.

Second, all aspects contained in the dossier report under discussion are addressed through an analysis in order to provide new data based on the technical and scientific documentation that was not considered or which was interpreted subjectively by ECHA when preparing its restriction proposal.

Finally, some conclusions are put forward to the consultation concerning the restriction dossier report on the use of lead in the form of gunshot for hunting and its effects on the environment.

4. ANALYSIS (ENVIRONMENT)

The ECHA drew up a dossier report (V.2 of 24 March 2021) "to address the risks to human health and the environment from lead in shot", where it outlines the main evidence that justifies the proposed restriction. In said document, it recognises that hunting regulations generally require that the death of the game hunted is as rapid and as ethical as possible. To achieve this, **the energy transfer that the ammunition used should provide must be sufficient to ensure said result, thereby avoiding unnecessary suffering by the game animal**.

The dossier report sets out the following "general" data:

- First: Around 97,000 tonnes of lead are released annually, of which 79% correspond to sports shooting, 14% to hunting and the rest (7%) to fishing activities.
- Second: At least 135 million birds in the EU are exposed to the risk of primary poisoning due to the firing of lead gunshot and 14 million are exposed to the risk of secondary poisoning.

In this regard, the ECHA affirms that different materials other than lead can provide the same energy by combining sufficient weight with enough velocity to provide sufficient energy transfer at a specific distance.

4.1. Environmental risk:

The environmental risk assessment conducted by the ECHA with regard to the ammunition (gunshot) used in small-game hunting in the terrestrial environment does not, in many cases, differentiate the different uses of the lead analysed (hunting or shooting gunshot / hunting or shooting bullets / fishing tackle) as it attributes causes or risks without differentiating the source.

The approach given to environmental risks by the dossier report can therefore be summed up as follows:

- Risk assessment:
  - Information on hazard to the water or terrestrial environment.
  - Information on severe (in the short-term) and chronic (in the long-term) toxicity after primary or secondary ingestion.
- Exposure assessment:
  - Information on the release of lead to the environment (not including wetlands) and resulting concentrations.
  - Information on prevalence/likelihood of exposure of wildlife (mainly birds) and domesticated animals (livestock).
  - Information on biota concentrations (tissue concentrations).
- Risk characterisation:
  - Incidence on wildlife resulting from ingestion.
  - Incidence on domesticated animals (livestock) which graze on shooting ranges.

4.1.1. Risk assessment (hazard):

The environmental risk assessment conducted by the ECHA is mainly based on the primary and secondary poisoning of wildlife and is defined as follows:

- Primary poisoning: the ingestion of any lead object directly from the environment through normal feeding or foraging activity (e.g., mistaking for grit).

- Secondary poisoning: the indirect ingestion of lead via the consumption of food (e.g., embedded fragments/particles in prey or carrion, contaminated silage or grass, lead-contaminated tissues).

Aside from primary and secondary ingestion, the ECHA warns about other routes of exposure like, for instance, ingestion via soil, plants or invertebrate prey containing lead derived from ammunition, without delving any further on these possible sources of lead contamination throughout the report.

In this regard, recent studies conclude that there are sources of lead contamination having a natural (soil) or artificial (phytosanitary) origin which have not been properly evaluated in the past. The dossier report submitted by the ECHA has not reflected the research work that addresses these deficiencies when generalising on the presence of lead in the form of primary or secondary poisoning, solely associating it to the lead used as ammunition in hunting. Some examples found in the scientific literature that address other causes (sources) of possible primary or secondary poisoning in wildlife include:

- The study conducted by Butt et al. (2018) which relates higher levels of lead in the soil as to agricultural treatments when the mobility of heavy metals is analysed along insect food chains in an agricultural ecosystem.
- The study conducted by Arondo et al. (2020), in which it is recognised by the authors that exposure to the lead contained in the soil's surface layer is more significant than previously thought.
- The study conducted by Sánchez-Virosta et al. (2020) which shows that local contamination in a mining area contributes to an increase in lead concentrations in the blood of chicks.

4.1.2. Risk assessment (toxicity):

The dossier report contains a table setting out indicative thresholds for interpreting lead concentrations in various tissue types:

Table 1. *Summary of thresholds in various tissue types in birds and other wildlife (ECHA)*

Lead intoxication	Blood concentration ppm (wet weight)	Liver concentration ppm (wet weight)	Bone concentration ppm (wet weight)
Background	< 20	< 2	< 10
Subclinical poisoning	20 to < 50	2 to < 6	10 to 20
Clinical poisoning	50 to 100	6 to 15	-
Severe clinical poisoning	> 100	> 15	> 20

4.1.3. Exposure assessment (release):

According to its dossier report, the ECHA "estimated" the following release of lead to the (terrestrial) environment in the form of lead gunshot:

Table 2. *Estimated release of lead due to HUNTING with gunshot*

Use	Release (t/year) to the environment in the EU-27 2020
Hunting with cartridges	14,000 (13,000 - 15,000) [1]

[1] *AMEC (2012) estimated that the release of lead gunshot from hunting in areas other than wetlands amounted to around 20,859 tonnes of lead a year. The sum of other estimates for Spain, Italy and the United Kingdom alone (EU-28) ranged from 15,600 to 29,000 tonnes per year, with Italy accounting for 6,000 tonnes (Guitart and Matthew, 2006); Spain for 1,600 to 10,000 tonnes (Andreotti and Borghesi, 2012); and the UK for 8,000 to 13,000 tonnes (Pain et al., 2014) based on the number of birds killed and the probable number of cartridges used "per bird", including failed shots.*

According to the data provided by the Association of European Manufacturers of Sporting Ammunition (AFEMS), the following amounts of lead cartridges were sold in 2019 by the Member States:

Table 3. *Ammunition sold in EU-27 in 2019 (AFEMS)*

Member State	Hunting cartridges (million)
Austria	12.0
Belgium	8.0
Bulgaria	3.0
Croatia [1]	1.7
Cyprus	6.3
Czech Republic	7.6
Denmark	9.0
Estonia [1]	1.2
Finland	15.6
France	74.3
Germany	39.0
Greece	26.1
Hungary	7.0
Ireland	10.0
Italy	54.6
Latvia [1]	1.2
Lithuania [1]	1.9
Luxembourg	-
Malta [1]	1.3
Netherlands	10.0
Poland	5.0
Portugal	16.8
Romania	3.0

Slovakia [1]	3.4
Slovenia [1]	1
Spain	79.3
Sweden	7.2
TOTAL	405.5

[1] Data obtained from https://trade.ec.europa.eu/access-to-markets/en/. This is a highly conservative figure because all cartridges have been included as if they were for hunting, since no data is available for the percentages used for sports shooting.

This means that 405.5 million lead cartridges for hunting were sold in 2019. Assuming that an amount similar to that used for hunting is sold annually and that the average lead content per cartridge amounts to 32 grams, an approximate total of 12,976 tonnes of lead are released each year (13,000 million tonnes of lead). This figure is situated at the lower end of the figures estimated by the ECHA dossier report. Since it was not possible to differentiate between sports shooting and hunting cartridges in some Member States, a choice was made to include all of them as hunting cartridges. Furthermore, the number of hunters is falling in most Member States according to Massei et al. (2014), a fact which implies a downward trend in the release of lead to the environment via the use of lead gunshot for hunting.

4.1.4. Exposure assessment (availability):

According to its dossier report, the ECHA considers that the likelihood of lead ammunition being ingested depends on several factors:

- Availability of lead objects in the environment.
- The specific feeding behaviour of birds.
- Other environmental and anthropogenic factors:
  - proximity to hunting or other shooting activities;
  - shooting intensity;
  - compliance with bans;
  - time in relation to hunting seasons (exposure towards the end of a hunting season is greater);
  - habitat over which lead is used and its attractiveness to birds;
  - local conditions (affecting sinking/movement of shot over time);
  - land management and land disruption;
  - chemical and physical processes in the environment.

The ECHA assessed a total of 533 wild bird species occurring naturally and regularly in Europe (the presence of some species included by the ECHA is merely testimonial) to analyse the risk of each one in a weight-of-evidence approach of the following evidence:

- Direct evidence of lead object ingestion and/or poisoning in the scientific literature.

- Indirect evidence of the likelihood of exposure based on feeding ecology.
- UNEP/CMS Ad-Hoc Group of Expert's assessment.

The approach to conclude on the likelihood of exposure was as follows:

- Species "**potentially at risk**": those for which multiple lines of evidence indicated that ingestion had either occurred, or could be reasonably expected to occur, based on the three elements above.
- Species "**at low risk**": the rest of species. Despite this, the ECHA conducted a preliminary impact assessment (in terms of the number of birds) on lead ammunition poisoning.

4.1.5. Exposure assessment: (likelihood of primary ingestion - birds):

Exposure has been documented in more than 120 species worldwide. The ECHA analysed the likelihood of exposure for "waterbirds" and "terrestrial birds" separately. Nonetheless, it is pointed out that exposure is often the result of a combined source of exposure and therefore a single species may be exposed to multiple sources of lead during its lifetime.

"Waterbirds":

According to the 2017 assessment by the UNEP/AEWA Secretariat of the 150 migratory waterbird species (AEWA-listed species) which occur regularly within the EU, 100 species are vulnerable to lead poisoning. Of these, 85 species primarily feed in wetlands. The 17 species that could be at greater risk of exposure to lead gunshot in terrestrial environments because they frequently feed in both wet or dry fields (geese, swans and cranes) as well as in flooded fields (the other species) are listed below:

Table 4. *Migratory waterbirds at greater risk of exposure to lead in terrestrial environments (ECHA).*

Taxonomy	Common name	IUCN Red List Category
Anas acuta	Northern pintail	VU
Anas crecca	Common teal	LC
Anas platyrhynchos	Mallard	LC
Anser albifrons	Greater white-fronted goose	LC
Anser anser	Greylag goose	LC
Anser brachyrhynchus	Pink-footed goose	LC
Anser caerulescens	Snow goose	NE
Anser erythropus	Lesser white-fronted goose	CR
Anser fabalis	Bean goose	LC
Branta bernicla	Brent goose	LC
Branta leucopsis	Barnacle goose	LC
Branta ruficollis	Red-breasted goose	NT

Cygnus columbianus	Tundra swan	EN
Cygnus cygnus	Whooper swan	LC
Cygnus olor	Mute swan	LC
Anthropoides virgo	Demoiselle crane	NE
Grus grus	Common crane	LC

The dossier report submitted by the ECHA relates the feeding which it "supposes" certain waterbirds do in the terrestrial environment to the risk of ingesting lead released to the terrestrial environment. This claim about the ingestion of lead shot via their feeding habits in the terrestrial environment (agricultural areas) is neither documented nor supported by any scientific paper or publication. Furthermore, it contradicts other research studies which state that waterbirds have special feeding habits when it comes to ingesting grit. It is evident that birds cannot differentiate grit from gunshot pellets in the aquatic environment. However, there are no references stating that waterbirds ingest lead shot in the terrestrial environment as a result of mistaking it for grit.

- The study conducted by Mateo et al. (2000) recognises that geese regularly fly from the Doñana Marshes to the neighbouring sand dunes and even affirms that hunters take advantage of this behaviour.
- The study conducted by Martínez-Haro et al. (2000) recognises that some waterbird populations or species seem to have developed specific behaviours to search for sand.
- The findings of the study conducted by Read et al. (2004) reveal that the Brent goose (*Branta bernicla nigricans*) chooses places to ingest sand (grit) based mainly on the substrate's calcium carbonate content and, on a secondary basis, depending on the availability of grain size.

In the absence of any scientific evidence relating the 17 waterbird species mentioned above to lead shot ingestion in the terrestrial environment, they should not be considered as species "potentially at risk".

"Terrestrial birds":

The ECHA dossier report sets out a series of data on the presence of lead gunshot in certain terrestrial birds in rather a disorderly way. The following table attempts to set out the information provided in the report in a more orderly way:

Table 5. *Results of different studies on lead in terrestrial birds (ECHA)*

Taxonomy	Type	N	Prevalence	Author	Obs.
Alectoris chukar	Ingestion	123	5.7%	Walter and Reese (2003)	1
Alectoris chukar	Ingestion	?	10.7%	Larsen et al., (2007)	2
Alectoris rufa	Ingestion	637	0.16%	Butler et al. (2005a)	3
Alectoris rufa	Ingestion	144	1.40%	Butler et al. (2005a)	3

Alectoris rufa	Ingestion	7	?	Soler-Rodriguez et al. (2004)	4
Alectoris rufa	Ingestion	76	3.90%	Ferrandis et al. (2008)	5
Columba palumbus	Liver and kidney	?	?	Clausen and Wolstrup (1979)	6
Coturnix coturnix	Ingestion	?	?	Stamberov et al. (2018)	7
Lagopus lagopus scoticus	Bone	111	5.40%	Thomas et al. (2009)	8
Lagopus lagopus scoticus	Bone	85	3.50%	Thomas et al. (2009)	8
Perdix perdix	Ingestion	1318	1.40%	Potts (2005)	9
Perdix perdix	Ingestion	?	?	Clausen and Wolstrup (1979)	6
Perdix perdix	Liver and kidney	?	?	Keymer and Stebbings (1987)	-
Perdix perdix	Ingestion, liver and kidney	?	?	Clausen and Wolstrup (1979)	6
Phasianus colchicus	Ingestion	437	3.00%	Butler et al. (2005b)	10
Phasianus colchicus	Ingestion	947	4.75%	Imre (1994)	11
Phasianus colchicus	Ingestion	?	?	Beer (1988)	-
Phasianus colchicus	Ingestion and liver	?	?	Hunter and Rosen (1965)	12
Phasianus colchicus	Ingestion and bone	?	?	Butler et al. (2005b)	10
Several	Ingestion	530	5.60%	Romero et al. (2020)	13
Zenaida macroura	Ingestion	?	0.3 - 6.4%	Franson et al. (2009)	14

A series of observations is set out below concerning the studies on which the ECHA dossier report is based:

1. Walter y Reese (2003) – *Alectoris chukar*: In this study conducted in Oregon (USA), hunters collected crops and gizzards (sampling with a shotgun and pellets), which were frozen to subsequently analyse them. It not known whether the hunting areas were intensive hunting areas or whether the sampled specimens came from a farm. In any case, the chukar partridge species was introduced into the USA, which makes one suppose that the sampled specimens could have been bred in captivity.
2. Larsen et al., (2007) – *Alectoris chukar*: In this study conducted in Utah (USA), hunters collected crops and gizzards (sampling with a shotgun and pellets), which were frozen to subsequently analyse them. It not known whether the hunting areas were intensive hunting areas or whether the sampled specimens came from a farm. In any case, the chukar partridge

species was introduced into the USA, which makes one suppose that the sampled specimens could have been bred in captivity.

3. Butler et al. (2005a) –*Alectoris rufa*: The records of post-mortem examinations of red-legged partridges carried out by the Game Conservancy Trust were analysed to determine the incidence of lead gunshot ingestion. Between 1955 and 1992, 637 data records were collected, 268 data records on "wild" partridges and 369 data records on "bred" partridges, which revealed that only one female from an intensive hunting game reserve contained a lead pellet in the gizzard (0.157%). Subsequently, the researchers collected 144 samples from intensive hunting game reserves (sampling through hunting) between 2000 and 2001, finding two specimens with pellets in the gizzard (1.389%). The weighted mean would result in a prevalence of 0.384%.

4. Soler-Rodriguez et al. (2004) – *Alectoris rufa*: This is a study conducted with farm-bred partridges and released so they could be hunted intensively. Only seven specimens were reported for their analysis. One specimen from among the farm-bred birds was found to have ingested shot pellets.

5. Ferrandis et al. (2008) – *Alectoris rufa*: This is a study conducted in a game reserve where farm-bred birds (bred in captivity) are probably released.

6. Clausen and Wolstrup (1979) — *Columba palumbus*: The authors compiled several results in this review on lead poisoning in Denmark. It is striking, however, that no reference is made to all the findings and only some of them are highlighted. The results for all the species envisaged are set out below (note that lead shot was used in all areas prior to 1979 and the prevalence found for waterbirds is striking):

Table 6. *Number of birds subjected to an autopsy (Clausen and Wolstrup - 1979)*

Species	Number examined	Poisoned by lead	Prevalence
Phasianus colchicus	199	0	0.0%
Perdix perdix	62	1	1.6%
Geese	55	0	0.0%
Seagulls	351	0	0.0%
Common woodpigeon	142	1	0.7%
Birds of prey	250	0	0.0%
Other species	414	0	0.0%

In the case of the common woodpigeon (*Columba palumbus*), of the 142 necropsies conducted, only one specimen appears to have been supposedly poisoned. The comment the authors make on this fact is the following: "In April 1976, a common woodpigeon (*Columba palumbus*) was found dead in Brande, Jutland. It was an adult female in a below-average nutritional state. Eight pellets were found in the gizzard. The specimen had been suffering from diarrhoea. The lead content in the liver, kidney and muscle tissue respectively amounted to 48, 200 and 1.3."

In the case of the grey partridge (*Perdix perdix*), of the 62 necropsies conducted, only one specimen appears to have been supposedly poisoned. The comment the authors make on this fact is the following: "In June 1976, a grey partridge (*Perdix perdix*) was found dead in

Scorpinge, Zealand. It was an adult male in an extremely thin state without any signs of lead poisoning in the autopsy. Thirty-four new lead pellets were found in the gizzard. The liver and the kidney respectively contained 130 and 440 ppm of lead."

Despite having done some highly interesting work in so far as the number of species is concerned, the ECHA dossier report does not make any reference at all to the common pheasant (*Phasianus colchicus*). In this case, the prevalence for lead poisoning in 199 necropsies amounted to 0.0%.

7. Stamberov et al. (2018) – *Coturnix coturnix*: This is a study in which ten quail specimens (*Coturnix coturnix*) were taken, and a lead pellet was supposedly found in the gizzard of one of them. The diameter and weight of the pellet coincide with the type of ammunition used to capture it (No. 11 pellet).

8. Thomas et al. (2009) – *Lagopus lagopus scoticus*: This study analyses lead in the bones of 234 red grouse specimens. It admits that a lower percentage of grouses in the Scottish highlands had high concentrations of lead as compared to the Yorkshire Moors, where an industrial activity involving lead exists. Moreover, the analysis is unable to differentiate among the different sources of the lead accumulated in the bones, attributing the high values mainly to lead ammunition. It, however, states that: 1) the change in the isotopic signature of the lead in the bones from the two Scottish properties is due to the supposed use of different brands of ammunition in the different areas; 2) over time, the form of molecular lead from hunting pellets begins to comprise a substantial component of the environmental lead found in soil and plants, so that environmental isotopic signatures move away from geologic lead and are closer to lead used in ammunition. Curiously enough, these arguments are not used by the authors to account for other historical sources of lead contamination, such as petrol, acid rain or industry.

9. Portis (2005) –*Perdix perdix*: The records of post-mortem examinations on grey partridges carried out by the Game Conservancy Trust to determine the incidence of lead shot and lead ingestion recorded as a cause of death were examined. Between 1947 and 1992, 1,318 data records (samples) were collected: 872 data records between 1947 and 1958 (three specimens died due to lead – 0.344%); 224 data records between 1963 and 1969 (nine specimens died due to lead – 4.018%); and 222 data records between 1970 and 1992 (six specimens died due to lead – 2.703%). The weighted mean would result in a prevalence of 1.366%.

10. Butler et al. (2005b) – *Phasianus colchicus*: This is a study conducted on specimens bred in captivity and released to the environment for intensive hunting. The samples were obtained by firing at them with lead ammunition and the hunting spaces were intensive hunting areas. The authors analysed gizzards (437) and lead concentrations in bones.

11. Imre (1997b) – *Phasianus colchicus*: This is a study based on specimens bred in captivity and released to the environment for intensive hunting. The samples were obtained by firing at them with lead ammunition and the hunting spaces were intensive hunting areas (the average number of shots per hectare ranged from 110.6 to 1,579.0).

12. Hunter and Rosen (1965) – *Phasianus colchicus*: This is the first report on lead poisoning in a wild pheasant in United States. It deals with a pheasant found dead in a wetland (1963) where waterbirds are hunted intensively. The necropsy revealed that the pheasant contained 29 lead pellets or fragments in the gizzard. The lead concentration in muscle tissue (breast) and the liver respectively amounted to 42 and 168 ppm.

13. Romero et al. (2020a) – Several species: This is a study on different game species of differing origin (wild or bred on hunting farms), which is summarised in the following table:

Table 7. *Number of gizzards analysed (Romero et al. – 2020a)*

Species	Origin	Number examined	Lead in gizzard	Suspected prevalence	Confirmed prevalence
Alectoris barbara	Wild	13	1	7.7%	0.0%
Alectoris rufa	Wild	96	3	3.1%	1.0% [1]
Alectoris rufa	Farm - hunting	97	8	8.2%	4.1%
Alectoris rufa	Farm	26	0	0.0%	0.0%
Columba livia	Wild	99	2	2.0%	0.0%
Columba oenas	Wild	30	1	3.3%	0.0%
Columba palumbus	Wild	107	8	7.5%	0.9% [1]
Coturnix coturnix	Wild	31	0	0.0%	0.0%
Streptopelia turtur	Wild	31	0	0.0%	0.0%

[1] Only one specimen of this species appears in the group, yielding some contradictory ppm lead concentration figures in the liver and the kidney.

According to the values obtained for each batch of species and taking wet weight liver concentration values < 2 ppm, the following table results:

Table 8. *Wet weight hepatic concentration in ppm (Romero et al. – 2020a)*

Species	Origin	Number examined	Background (< 2 ppm)	Subclinical (2-6 ppm)	Clinical (6-15 ppm)	Severe (> 15 ppm)
Alectoris barbara	Wild	13	76.9%	-	23.1%	-
Alectoris rufa	Wild	96	99.0%	-	1.0%	-
Alectoris rufa	Farm - hunting	97	91.7%	5.2%	2.1%	1.0%
Alectoris rufa	Farm	26	100%	-	-	-
Columba livia	Wild	99	100%	-	-	-
Columba oenas	Wild	30	100%	-	-	-
Columba palumbus	Wild	107	95.4%	0.9 %	2.8%	0.9 %
Coturnix coturnix	Wild	31	93.6%	3.2	3.2	0
Streptopelia turtur	Wild	31	100%	-	-	-

14. Franson et al. (2009) – *Zenaida macroura*: In this study conducted in several US states, hunters collected specimens of this kind of turtledove (sampling with shotgun and pellets). It is not known whether the hunting areas were intensive or not. The gizzards and lead concentrations in the liver and bones were analysed. 2.5% of the gizzards contained lead pellets (106 out of 4229). All the turtledoves were young. The average lead concentrations in the turtledoves' liver and bones depending on whether or not they had ingested pellets are summarised in the following table:

Table 9. *Comparison of hepatic concentration in the liver and bones (Franson et al. - 2009)*

	Pellets in gizzard	N	Median concentration (dry weight)
Liver	Yes	107	36.89
Male livers	No	991	0.27
Female livers	No	872	0.34
Bone	Yes	103	89.33
Male bones	No	420	1.56
Female bones	No	267	2.67

The scientific and non-scientific literature on the effects of lead on birds due to primary ingestion is extensive for waterbirds and rather rare for terrestrial birds. An aspect that should be highlighted in most of the studies conducted on terrestrial species is the frequency with which three variables are repeated: **farm-bred species, intensive game reserves and sampling with lead ammunition**. These three anthropic factors increase the results' subjectivity and errors due to the following reasons: **they differ greatly from the real behaviours of wild species**; **they do not reflect the terrain where hunting activity is carried out**; and **they use a sampling method which may contaminate the sample itself** (if lead is to be analysed in a bird, it does not seem logical to obtain the bird by "peppering" it with lead). The following table shows how these factors have affected the studies presented by the ECHA:

Table 10. *Variables contained in the different studies used in the ECHA dossier report*

Obs.	Species	Origin	N	Area	Sampling	Prevalence in gizzard
1	*Alectoris chukar*	Farm?	123	Intensive?	Shot	5.691%
2	*Alectoris chukar*	Farm?	75	Intensive?	Shot	10.667%
3	*Alectoris rufa*	Wild and farm	637	-	-	0.157%
3	*Alectoris rufa*	Farm	144	Intensive	Shot	1.389%
4	*Alectoris rufa*	Farm	7	Intensive	Shot	14.286%
5	*Alectoris rufa*	Farm	76	Intensive	Shot	3.947%
15	*Alectoris rufa*	Farm	97	Intensive	Shot	4.124%
15	*Alectoris rufa*	Wild	96	-	-	1.042%
6	*Columba palumbus*	Wild	142	-	-	0.704%
15	*Columba palumbus*	Wild	107	-	-	0.935%
7	*Coturnix coturnix*	Wild?	10	-	Shot	10.000%
15	*Coturnix coturnix*	Wild	31	-	Shot	0.000%
9	*Perdix perdix*	Wild	1318	-	-	1.366%
6	*Perdix perdix*	-	62	-	-	1.613%
11	*Phasianus colchicus*	Farm	437	Intensive	Shot	2.975%
12	*Phasianus colchicus*	Farm	947	Intensive	Shot	9.752%
14	*Phasianus colchicus*	-	1	-	-	100.000%
16	*Zenaida macroura*	-	4229	-	Shot	2.506%

It can be observed that the game species and type of game reserve variables, where these are respectively farm-bred and intensive, yield lead shot prevalence values found in the gizzard that are much higher than the values found in wild species hunted in traditional (non-intensive) hunting areas.

The proportion of these species and areas across the entire territory is not significant as a source for sampling. Taking, for instance, one of the Member States having the highest "consumption" of lead gunshot for hunting yields the following results:

Table 11. *Percentage of hunting surfaces areas in Spain (INE, 2018)*

	Surface area (ha)	**%**
Surface area of Spain	50,598,300	100.0
Surface area of non-intensive hunting spaces	42,416,921	83.8
Surface area of intensive hunting spaces	518,410	1.0

According to the Forestry Statistics Yearbook for 2018 of the Spanish National Statistics Institute (INE), intensive hunting game reserves account for just 1% of the Spanish state's total surface area. Can a scientific study carried out on specimens bred in captivity and hunted with lead ammunition in an intensive game reserve be deemed acceptable?

Based on a study conducted by Romero et al. (2020a), which places into question the validity of determining the presence of lead in samples taken from sampling in which said samples are obtained from gunfire using lead ammunition, the authors conducted a study which collected 94 samples obtained using lead-free ammunition. The findings obtained on the presence of lead pellets in gizzards were as follows:

Table 12. *Number of gizzards analysed (Romero et al. – 2020b)*

Species	**Origin**	**Number examined**	**Lead in gizzard**	**Suspected prevalence**	**Confirmed prevalence**
Alectoris rufa	Farm - hunting	31	1	3.2%	3.2%
Columba palumbus	Wild	31	0	0.0%	0.0%
Coturnix coturnix	Wild	32	0	0.0%	0.0%

Two recent studies conducted by Romero et al. (2020b) have provided data to the scientific literature as regards lead ingestion (primary poisoning) in birds about which no data were available. One of the examples is the stock dove (*Columba oenas*) and the other the European turtledove (*Streptopelia turtur*) with lead contamination in the liver in all the specimens (n=61) below 1 ppm (wet weight). The ECHA dossier report includes these two species as "potentially at risk", which respectively have populations of almost 750,000 and 3,200,000 in the EU-27. These studies suggest very low or negligible lead contamination levels in these populations, thereby backing the notion that the variables used by most of the studies on primary lead poisoning in terrestrial birds might contain interpretation errors.

The study by Romero et al. (2021) found isotope ratios (Pb^{208}/Pb^{207}) between the lead detected in bird livers and the lead of a type of fertiliser commonly used in agriculture.

Lastly, since many other species have not been specifically studied, the ECHA considers that these species can be assessed by "extrapolation" from other species in the same group of birds, basing itself on their similar feeding ecology. According to this, the ECHA sets out a number of species have a greater likelihood of ingesting lead shot.

Table 13. *Terrestrial birds at greater risk of ingesting lead shot*

Taxonomy	Common name	IUCN Red List Category
Alectoris barbara	Barbary partridge	LC
Alectoris chukar	Chukar partridge	LC
Alectoris graeca	Rock partridge	VU
Alectoris rufa	Red-legged partridge	LC
Bonasa bonasia	Hazel grouse	LC
Coturnix coturnix	Common quail	LC
Lagopus lagopus	Red grouse	VU
Lagopus muta	Rock ptarmigan	VU
Lyrurus tetrix	European black grouse	LC
Perdix perdix	Grey partridge	LC
Phasianus colchicus	Common pheasant	LC
Tetrao urogallus	Western capercaillie	LC
Columba livia	Rock dove	LC
Columba oenas	Stock dove	LC
Columba palumbus	Common woodpigeon	LC
Streptopelia decaocto	Eurasian collared dove	LC
Streptopelia turtur	European turtledove	NT
Columba bollii	Bolle's pigeon	LC
Columba junoniae	Laurel pigeon	NT
Columba trocaz	Torcaz pigeon	LC
Scolopax rusticola	Eurasian woodcock	LC
Pterocles alchata	Pin-tailed sandgrouse	LC
Pterocles orientalis	Black-bellied sandgrouse	LC

Assessing by extrapolation, as the ECHA dossier report does, leads to multiple issues or possible errors, all of which are based on the following:

- Lax data extrapolation yields information that is not very rigorous.
- Results obtained from farm-bred species cannot be extrapolated to wild species.

4.1.6. Exposure assessment: (likelihood of secondary ingestion - birds):

According to the ECHA, bird species can ingest lead-contaminated tissues while feeding in the following cases:

- Scavenger birds when they consume offal or meat discarded by hunters that is left on the ground.
- Birds of prey when they feed on game wounded by non-lethal shots or birds which have been hit by pellets.

Concerning the two cases set out by the ECHA in its dossier report, the following should be pointed out:

- As far as the first case is concerned, hunters do not leave behind bird offal or meat in the countryside and rarely do so in the case of small mammals in the lead shot hunting generally done on small game species (birds and small mammals). In any event, it is a practice that can easily be corrected through education and training on good hunting practices given to hunters. This case is therefore meaningless.
- As far as the second case is concerned, using lead shot and firing at the appropriate distances is very infrequent. In the case of waterbirds, it is a situation that can occur more easily because they are hunted in wetlands, usually from a fixed position and at twilight due to their own ecology. This has been corrected through the use of lead-free ammunition in wetlands.

As in the case of primary ingestion, the ECHA points out that exposure is often the result of a combined source of exposure and therefore a single species may ingest multiple sources of lead during its lifetime while feeding. The dossier report characterises the different bird species prone to suffering secondary poisoning on the basis of:

- Obligate scavengers (vultures): *Accipitridae* and *Catharidae*.
- Facultative scavengers (raptors): *Falconidae* and *Accipitridae*.
- Facultative scavengers (omnivores): *Laridae* and *Corvidae*.
- Opportunistic scavengers (others)

Once more, the ECHA dossier report sets out a series of data (in a rather disorderly way) on secondary lead poisoning in certain birds by including results or data from other areas of the world. The following table attempts to set out the information provided in the report in a more orderly way:

Table 14. *Results of different studies on lead in scavengers*

	Taxonomy	Common name	Author(s)	Obs.
Obligate scavengers	*Neophron percnopterus*	Egyptian vulture	Donázar et al. (2002), Gangoso et al. (2009)	15
	Gypaetus barbatus	Bearded vulture	Ganz et al. (2018), Hernández and Margalida (2009)	16
	Gyps fulvus	Griffon vulture	Berny et al. (2015), Carneiro et al. (2014)	17
	Aegypius monachus	Cinereous vulture	Cardiel et al. (2011)	18
Facultative scavengers (European distribution)	*Pernis apivorus*	European honey buzzard	Lumeij et al. (1985)	19
	Buteo buteo	Common buzzard	Taggart et al. (2020), Macdonald et al. (1983), Komosa and Kitowski (2008), Matthew et al. (2003)	20
	Buteo lagopus	Rough-legged buzzard	Komosa and Kitowski (2008)	20
	Aquila adalberti	Spanish imperial eagle	Pain et al. (2005)	21
	Aquila clanga	Greater spotted eagle	Komosa and Kitowski (2008)	20
	Aquila chrysaetos	Golden eagle	Jenni et al. (2015), Madry et al. (2015), Kenntner et al. (2007)	22
	Aquila fasciata	Bonelli's eagle	Badry et al. (2019), Gil-Sánchez et al. (2018)	23
	Circus aeruginosus	Western marsh harrier	Pain et al. (1993), Mateo et al. (1999), Komosa y Kitowski (2008)	24
	Haliaeetus albicilla	White-tailed eagle	Isomursu et al. (2018), Helander et al. (2009), Krone et al. (2009), Krone et al. (2004), Müller et al (2007), Kenntner et al. (2001), Komosa y Kitowski (2008), Kitowski et al. (2017)	25
	Milvus milvus	Red kite	Molenaar et al. (2017), Pain et al. (2007), Berny et al. (2015)	26
	Falco peregrinus	Peregrine falcon	Adreotti et al. (2018), Mateo et al. (2003), Pain et al. (1995)	27
	Accipiter nisus	Eurasian sparrowhawk	Pain et al. (2005)	21
	Accipiter gentilis	Northern goshawk	Komosa and Kitowski (2008)	20
Facultative scavengers (non-European/overlapping distribution)	*Corvus corax*	Common raven	Legagneux et al. (2014), West et al. (2017)	28
	Corvux frugilegus	Rook	Kitowski et al. (2017)	25
	Corvux cornix	Hooded crow	Kitowski et al. (2017)	25
	Pica pica	Eurasian magpie	Kitowski et al. (2017)	25
	Larus clifornicus	California gull	Quortrup and Shillinger (1941)	29

	Larus glaucescens	Glaucous-winged gull	NWHL (1985)	-
	Larus argentatus	Herring gull	NWHL (1985)	-
	Bubo bubo	Eurasian eagle-owl	Mateo et al. (2003)	27

A series of observations concerning the analysis above on possible accidental lead shot ingestion is set out below concerning the studies on which the ECHA dossier report is based:

15. Donázar et al. (2002) – *Neophron percnopterus*: In this study, 26 blood samples were taken from Egyptian vultures in Fuerteventura between 1998 and 2000, which resulted in five specimens having abnormal values and one having extremely high values indicating lead intoxication. 424 regurgitated pellets were collected in the Canary Islands and gunshot pellets appeared in 13 of them (3%). Curiously enough, the deaths from colliding with power lines during the study amounted to 12 specimens (the main cause of death).

    Gangoso et al. (2009) - *Neophron percnopterus*: In this study, 327 regurgitated pellets were collected in the Iberian Peninsula (Ebro Valley) between 1993 and the 2003 and gunshot pellets did not appear in any of them (0%). 169 blood samples were also collected (Canary Islands n=137; Iberian Peninsula n=32) between 1999 and 2005, yielding a single individual from the Iberian Peninsula with abnormal values (217.3 mg/l) and, in the case of the Canary Islands, ten with values exceeding 200 mg/l, of which three had values above 500 mg/l. The study affirms that the Egyptian vultures which regularly feed in industrial areas or landfills might be exposed to contaminant ingestion.

16. Ganz et al. (2018) – *Gypaetus barbatus*: The study, which was conducted in Switzerland, studied 127 birds (67 golden eagles, 5 bearded vultures, 45 red kites and 10 ravens). Lead concentrations were measured in the liver and bones. Most of the ravens (a game species in Switzerland) were hunted (8) **and only those which had not been collected by shooting were analysed**. Five golden eagles and a bearded vulture contained gunshots caused by poaching. Thirty of the 67 golden eagles died from colliding with overhead power lines or cables. Two of the five bearded vultures died from colliding with overhead power lines. Ten of the 45 red kites died from colliding with overhead power lines. One of the ten crows died from colliding with overhead power lines. The analyses of lead in the bones revealed that fourteen golden eagles, two bearded vultures, one red kite and no crows had a subclinical to clinical concentration. The lowest mean concentrations in both the bones (4.08 µg/g) and the liver (0.45 µg/g) were recorded in the red kites, followed by the concentrations found in the ravens' bones (6.58 µg/g) and liver (0.32 µg/g). The authors state that it is not clear to them why ravens, which are the first scavengers to arrive at a carcass, have such low lead values and put forward several reasons for this. They suggested it might be due to the burial of offal or the use of lead-free ammunition (the references are understood to refer to bullets).

    Hernández and Margalida (2009) – *Gypaetus barbatus*: In this study, 127 blood samples from bearded vultures in the Pyrenees (captured and dead) were analysed. Most of the individuals were found to have very low lead concentrations in the blood, liver and bones. Only two specimens had high (subclinical) values, two in the liver and two in the bones (clinical).

17. Berny et al. (2015) – *Gyps fulvus*: In this study, 120 griffon vultures, 8 bearded vultures and 34 red kites in the French Pyrenees (162 specimens) were analysed. **Most of the cases of intoxication (53% of all cases of intoxication – 39 specimens) were poisoned by pesticides**,

The study attributed lead poisoning to seven specimens (mainly due to ammunition), more specifically, four red kites and three griffon vultures (no bearded vultures).

Carneiro et al. (2014) – *Gyps fulvus*: In this study, 121 griffon vultures captured in Spain and Portugal were analysed (n=30 – 2011 – captured in a landfill in Catalonia; n=24 – 2012 – captured at an artificial feeding point in Portugal; 20 from a recovery centre in Catalonia – 2010 to 2012; 47 from recovery centres in Portugal artificial – 2007 to 2012). Blood samples were taken from the vultures. It is known that the carrion of hunted ungulates is provided at feeding points in both Spain and Portugal. The resulting mean µg/dl values for the vultures from recovery centres were 21.78 in Portugal and 21.87 in Catalonia, while for the captured vultures they amounted to 24.42 in Portugal and 32.51 in Catalonia. **The authors concluded that vultures in Catalonia are more exposed to heavy metals due to the municipal waste dumps (landfills)** located near the feeding stations and the presence of bullet fragments in carrion from hunting.

18. Cardiel et al. (2011) – *Aegypius monachus*: In this study, dry weight lead and aluminium concentrations in the feathers and bones of four large scavenging raptor species were analysed (twenty griffon vultures, three cinereous vultures, nine black kites and ten red kites) were collected either dead or dying at fauna recovery centres in Spain. The specimens having lead levels in the bones exceeding subclinical values included four griffon vultures (20%), a cinereous vulture (33%), a black kite (11%) and two red kites (20%).

19. Lumeij et al. (1985) – *Pernis apivorus*: A European honey buzzard was found in the Netherlands with a gunshot pellet in the gizzard and another in the wing. It yielded a value of 80 µg/dl, which is equivalent to 0.8 ppm. **As the paper suggests, it seems that lead shot was used to fire at the bird**. The bird was recovered and freed.

20. Taggart et al. (2020) – *Buteo buteo*: 220 common buzzards found either dead or dying were collected over 11 years (2007 to 2018) in the United Kingdom. Dry weight lead concentration in the liver (n=187) and femur (n=125) were measured and lead isotopes were analysed. The geometric mean for lead concentration in the liver amounted to 0.795 ppm and concentration in the bones amounted to 2.951 ppm. The estimated proportion of lead mass in the liver attributable to lead shot was 57% (30% -73%).

Komosa and Kitowski (2008) – *Buteo buteo*: The study consisted of collecting the bones of individuals from Poland (57 individuals of 15 species) between 2000 and 2007. Lead concentrations in the liver were analysed. Of the 15 species studied, the Montagu's harrier (*Circus pigargus*), the barn owl (*Tyto alba*), the Ural owl (*Strix uralensis*) and the Eurasian eagle-owl (*Bubo bubo*) had concentrations below the baseline contamination value, which the paper estimated at 6.75 ppm (in the bones). Subclinical intoxication values were found in individuals of the other species, with clinical contamination values in the greater spotted eagle (*Aquila clanga*), the rough-legged buzzard (*Buteo lagopus*) and the western marsh harrier (*Circus aeruginosus*). The paper does not clarify the source of poisoning, **attributing the high lead levels to the widespread use of fertilisers in the agricultural land of the area under study** and to hunting with lead shot.

Mateo et al. (2003) – *Buteo buteo*: Lead concentrations in the bones (dry weight) of 229 raptors of eleven species were analysed in the study from bones obtained between 1998 and 2001 from six wild animal recovery centres in Spain. The specimens' causes of death were electrocution (20.5%), injuries (20.5%), illegal shooting (15.5%), poisoning (6.1%), other causes (6.1%) and unknown causes (31%). Excessive concentrations were found in only three individuals, a Eurasian eagle-owl (*Bubo bubo*), a red kite (*Milvus milvus*) and a griffon vulture (*Gyps fulvus*). Of the 11 species under study among all the specimens, lead concentrations in the bones of five of the species were under the subclinical threshold: the northern goshawk (*Accipiter gentilis* - n=18), the Spanish imperial eagle (*Aquila adalberti* - n=2), the golden eagle (*Aquila chrysaetos* - n=2), Bonelli's eagle (*Hieraaetus fasciatus* - n=6) and the booted eagle (*Hieraaetus pennatus* - n=11). The geometric mean of lead concentration in the bones was lowest among the 107 Buzzards studied, which was 0.58 ppm for all the species (ranging from 0.01 to 10.25). Lead concentrations above 10 ppm were only found in ten birds (4.37%), which included: five red kites (41.6%), a black kite (6.3%), a griffon vulture (25.0%), a common buzzard (0.9%), a peregrine falcon (11.1%) and a Eurasian eagle-owl (2.4%). Of the 42 Eurasian eagle owls studied, only one specimen yielded an excessive value and the rest (n=41) had normal values.

21. Pain et al. (2005) – *Aquila adalberti*: The study consisted of collecting bone (34 specimens) and feather (65 specimens) samples from the Spanish Imperial Eagle Museum, which came from specimens collected between 1980 and 1999 in southern Spain. The paper stated that these eagles feed on common geese from southern Spain in the winter. The results yielded high lead values in the bones of four specimens (n=34) and high lead values in the feathers of three specimens (n=41). Of the 23 birds whose cause of death was known, 41% died from electrocution, 6% from illegal shooting, 15% from illegal poisoning and 6% from hunger. The cause of death of 32% was unknown/not recorded.

22. Jenni et al. (2015) – *Aquila chrysaetos*: The study is based on the lead concentration in the blood, liver, kidney and feathers of 41 golden eagles from the Swiss Alps that were found dead, injured or dying between 2006 and 2013. Most of the deaths were due to intraspecies attacks (22), signs of lead poisoning (6), barbiturate intoxication (1), prematurely leaving the nest (1), electrocution (1) and unknown causes (10). The study assumes that the high lead levels found were caused by the carcasses and offal left behind by hunters.

    Madry et al. (2015) – *Aquila chrysaetos*: The study was based on 36 golden eagles that were found dead, injured or dying in the Swiss Alps between 2006 and 2013 and on 19 Eurasian eagle owls. Lead concentration in the blood, liver, kidney and bones was analysed. No owl specimen was found to have high concentrations in any of the analyses. Three golden eagles were found to have signs of severe lead poisoning. Lead concentration in the golden eagles ranged from 0.2 ppm to 8.41 ppm and had a mean value of 1.14 ppm.

    Kenntner et al. (2007) – *Aquila chrysaetos*: The study was based on seven golden eagles that were found either dead or dying in the Alps between 2000 and 2001 and on one specimen in captivity in an Austrian zoo. Two eagles yielded high lead values. However, the authors did not assess one of them properly since higher lead values were found in the liver (6.674 ppm) than in the kidney (1.492 ppm). The other specimen, which had lead values of 59.490 ppm in the liver and 12.780 ppm in the kidney, is a clear case of lead poisoning. No lead remains were found in the digestive apparatus of any specimen. They suggest that the carrion of large game left in the countryside is at the origin of the secondary contamination.

23. Gil-Sánchez et al. (2018) – *Aquila fasciata*: The study analysed regurgitated pellets of Bonelli's eagles collected between 2004 and 2015 in Granada, Spain from nests and perching places in both the breeding period (12 territories and 1,363 regurgitated pellets) and the non-breeding season (9 territories and 172 regurgitated pellets), along with 57 shed feathers. The frequency with which lead shot appears in the regurgitated pellets amounted to 2.81% in the spring and

1.31% in the autumn. The paper attributes the high number of gunshot pellets in the spring to red-legged partridge hunting with bait and to rabbit hunting in the autumn.

24. Pain et al. (1993) – *Circus aeruginosus*: The study is based on analysing lead in the blood of western marsh harriers (n=94) captured in wetland areas located in France in 1990 and 1992. 30.8% of the specimens had high concentrations (>30 µd/dl). **The authors attributed the high lead concentrations to gunshot ingestion in injured waterbirds hunted in wetland areas**. The study was conducted in 1993. The use of lead ammunition is now banned in wetland areas.

    Mateo et al. (1999) – *Circus aeruginosus*: The study took place in the Ebro Delta with western marsh harriers, which **feed on the carrion of hunted ducks**, as the study affirms. 521 regurgitated pellets (505 valid and 16 discarded) were collected between 1992 and 1995. In addition, 39 harriers were captured in traps (2 died as a result of the trap) between March 1993 and December 1994 and blood samples were taken from them. Lastly, an injured specimen and five specimens that were found dead were included in the study. 11% of the regurgitated pellets contained shot. According to the study, over 52.5% of the birds contained a blood concentration exceeding 0.2 ppm. The bird having the highest concentration had a level of 5.601 ppm and none of the birds which were found dead had lead levels in the blood deemed indicative of severe lead intoxication. The study was conducted in 1999. The use of lead ammunition is now banned in wetland areas.

25. Isomursu et al. (2018) – *Haliaeetus albicilla*: The study was based on 123 white-tailed eagle carcasses collected in Finland between 2000 and 2014. 60% (74) of the deaths were related to human beings, 31% (38) from lead poisoning followed by 24% (30) from colliding with overhead power lines or vehicles. Secondary lead contamination was largely attributed to the offal of large game and **waterbirds** hunted in the terrestrial environment, since the use of lead is banned in wetlands.

    Helander et al. (2009) – *Haliaeetus albicilla*: The study was based on 118 white-tailed eagle carcasses collected in Sweden between 1981 and 2004. Liver and of kidney samples were taken. The causes of death out of a total of 116 specimens on which a necropsy was carried out were: 25 from collisions with vehicles, 22 from collisions with cables or buildings, 16 from lead poisoning, 13 from gunshots or interspecies fights, 9 from other injuries, 5 from illness and 26 from unknown causes.

    Krone et al. (2009) – *Haliaeetus albicilla*: The study has nothing to do with the purpose set out in the ECHA table.

    Krone et al. (2004) – *Haliaeetus albicilla*: The study was based on 12 white-tailed eagle carcasses collected in Greenland between 1997 and 2000. The causes of the death included unspecified injury (6), lead intoxication (2), infectious disease (1), injuries from interspecies fight (1) and death from gunshots (1). One of the dead birds with high lead levels in the liver had a bullet in the gizzard. Four specimens had wounds from firing ammunition.

    Müller et al (2007) – *Haliaeetus albicilla*: The study was based on 87 injured or ill white-tailed eagle specimens collected in Germany between 1998 and 2006. Collision with structures was the most common cause of the injuries, followed by lead toxicosis and anomalies in the plumage of chicks.

    Kenntner et al. (2001) – *Haliaeetus albicilla*: The study was based on 61 dead or dying white-tailed eagle specimens collected in Germany and Austria between 1993 and 2000. The geometric mean of lead concentration in the liver amounted to 0.619 ppm (n=57). 70% (40) of the specimens had hepatic lead levels below 2 ppm, considered within the background level range, while 28% had concentrations exceeding the value of 5 ppm. Two specimens had bullet fragments in their digestive apparatus.

Kitowski et al. (2017) – *Haliaeetus albicilla*: Contrary to what the ECHA report states, it has nothing to do with the white-tailed eagle. The study was based on 34 common buzzard (*Buteo buteo*) specimens collected either dead or dying in Poland between 2010 and 2014. Toxic lead concentrations were found in four individuals (12%). **According to the authors, the possible source of lead may reside in agriculture (fertilisers), the consumption of birds and small mammals related to habitats where fertilisers are used** and lead ammunition.

26. Molenaar et al. (2017) – *Milvus milvus*: The study was based on 162 specimens of red kites released into the wild that were found dead, which were collected in United Kingdom between 1989 and 2007. A toxicological examination on 110 of the 162 specimens diagnosed death from intoxication in 32 specimens (20%), while 19 died from second-generation anticoagulant rodenticides, nine from pesticides and six from lead poisoning (3.7%). Lead-induced death was attributed to the specimens having dry weight concentrations above 15 ppm. Injuries were the cause of death of 46 specimens (28%). The lead source was not analysed.

    Pain et al. (2007) – *Milvus milvus*: The study was based on 87 specimens of red kites released into the wild that were found either dead or ill, which were collected in United Kingdom between 1995 and 2003, whose lead concentration in the liver was analysed. Additionally, it also analysed the blood of 125 young kites that were captured and kept for their subsequent release to the natural environment, 264 regurgitated pellets and lead isotopes. 36.8% of the young kites had high lead concentrations before they were released. 1.5% to 2.3% of the regurgitated pellets contained shot. Of the 44 red kites, seven had dry weight concentrations above 6 mg/kg, six of which had dry weight concentrations of 15 mg/kg, which is compatible with severe intoxication (two of these birds died from banned rodenticides and agricultural pesticides) and the remaining four probably died from lead poisoning (9%). The lead isotopes were found to be compatible with the lead used in ammunition.

27. Adreotti et al. (2018) – *Falco peregrinus*: The study was conducted on a peregrine falcon specimen that was found dead and collected underneath a power pylon in Italy in 2015. It contained six pellets in the crop and one in the cloaca. The concentrations found amounted to 0.10 mg/kg in the blood, 0.086 mg/kg in the liver, 0.198 mg/kg in the kidney, 0.141 mg/kg in abdominal fats and 3.379 mg/kg in the bones.

    Pain et al. (1995) – *Falco peregrinus*: The study was conducted in the United Kingdom by analysing lead in the liver (dry weight) of 424 individuals of 16 species found dead between 1980 and 1990. A peregrine falcon (4%, n=25) and a common buzzard (2% n=50) were found to have high lead concentrations. The remaining 420 individuals did not exceed the threshold of 15 ppm. A large sample of sparrowhawks was available, and all the individuals had low concentrations (except one).

28. Legagneux et al. (2014) – *Corvus corax*: The study was conducted in Quebec with ravens that were hunted and captured alive by taking blood samples from them. The study was based on scavengers which feed on the carrion of large game (moose) on which lead bullets are used.

    West et al. (2017) – *Corvus corax*: The study was conducted on 27 common raven specimens captured in California between 2009 and 2013 in order to extrapolate the risks the California condor is exposed to from the use of lead ammunition. Lead values before and after the hunting season were in both cases below 10 ppm, except in the case of one specimen, which yielded a value of 10.8.

29. Quortrup and Shillinger (1941) – *Larus clifornicus*: The study was conducted in 1941. The use of lead ammunition is now banned in wetland areas.

After reviewing the aforementioned literature, a summary of the main variables is set out below to make a species-by-species analysis, following the order of the papers in which they are a reference species or, where necessary, they are analysed as a secondary species:

Table 15. *Variables contained for the* ***Egyptian vulture*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Neophron percnopterus	Fuerteventura	1998-2000	26	-	-	-	424	19.2	-	-	-	3
Neophron percnopterus	Ebro Valley	1993-2003	-	-	-	-	327	-	-	-	-	0
Neophron percnopterus	Canary Islands	1995-2005	137	-	-	-	-	7.3	-	-	-	-
Neophron percnopterus	Iberian P.	2002-2004	32	-	-	-	-	3.1	-	-	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The source of the lead found in the blood of Egyptian vultures is not clarified in the studies. This is a scavenger bird that also feeds in industrial areas or landfills. In so far as the shot found in the regurgitated pellets is concerned, it is highly striking that no lead pellets were found in the Iberian Peninsula (migratory population), while the presence of lead pellets in the Canary Islands amounted to 3%. The habit of emptying into the countryside the abdominal contents of the rabbits hunted with lead shot in the Canary Islands due to high temperatures is a possible source of lead shot ingestion by Egyptian vultures. Good hunting practices (burying carrion) would eliminate the possible risk of ingestion. The likelihood of this species ingesting lead shot used for small game hunting is very low.

Table 16. *Variables contained for the* ***bearded vulture*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Gypaetus barbatus	Switzerland	-	-	2	-	5	-	-	0	-	40.0	-
Gypaetus barbatus	Pyrenees	2008	127	30	-	54	-	1.6	3.7	-	1.8	-
Gypaetus barbatus	French Pyrenees	-	-	8	8	-	-	-	0.0	0.0	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The source of the lead found in the blood of bearded vultures is not clarified in the studies. This is a necrophagous bird which primarily feeds on the bones of mammal carcasses. Due to its area of distribution, this is a species that is not present in areas where small game hunting is abundant or prevalent, but rather where big game species are present. The likelihood of this species ingesting lead shot used for small game hunting is negligible.

Table 17. *Variables contained for the* ***griffon vulture*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Gyps fulvus	French Pyrenees	-	-	119	119	-	-	-	2.5	2.5	-	-
Gyps fulvus	Spain and Portugal	2007-2012	121	-	-	-	-	-	-	-	-	-
Gyps fulvus	Spain	-	-	-	-	20	-	-	-	-	20.0	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The source of the lead found in the blood of bearded vultures is not clarified in the studies presented. The paper published by Carneiro et al. (2014) highlights the problematic use of landfills by vultures and their feeding on carrion from hunting at artificial feeding points. This is a necrophagous bird which primarily feeds on large ungulates and occasionally in landfills. The likelihood of this species ingesting lead shot used for small game hunting is negligible.

Table 18. *Variables contained for the* ***black vulture*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	F	A	B	C	D	E
Aegypius monachus	Spain	-	-	-	-	-	-	-	-	-	-	-
Aegypius monachus	Spain	-	-	-	-	3	-	-	-	-	33.3	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; F: feathers

This is a necrophagous bird which primarily feeds on large ungulates and occasionally rabbits. The likelihood of this species ingesting lead shot used for small game hunting is very low. Furthermore, this species is undergoing an upward trend in Europe according to BirdLife International (2021).

Table 19. *Variables contained for the* ***European honey buzzard*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Pernis apivorus	Netherlands	< 1985	-	-	-	-	-	-	-	-	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

This is a bird which primarily feeds on insects and invertebrates, mainly wasps and bumblebees. The study is only based on a single specimen, which shows signs of having been shot. The likelihood of this species ingesting lead shot used for small game hunting is negligible.

Table 20. *Variables contained for the* ***common buzzard*** *in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Buteo buteo	Poland	2000-2007	-	34	-	-	-	-	11.8	-	-	-
Buteo buteo	Spain	1998-2001	-	-	-	107	-	-	-	-	0.9	-
Buteo buteo	United Kingdom	1980-1990	50	-	-	-	-	2.0	-	-	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The source of the lead found in the liver of the common buzzard in the study conducted by Komosa and Kitowski (2008) is attributed to the widespread use of fertilisers and to lead used for hunting. In the study conducted in Spain on the bones of 107 buzzards, the geometric mean amounted to 0.58 ppm, the lowest for all the raptors studied (n=229; n species=11). Only one specimen yielded values above the background values.

Table 21. *Variables contained for the **Spanish imperial eagle** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	F	A	B	C	D	F
Aquila adalberti	Spain	1980-1999	-	-	-	34	41	-	-	-	11.8	7.3

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; F: feathers

In the only article of reference on the Spanish imperial eagle, common geese are recognised as the main food source, which were still being hunted in wetlands with lead shot in the specimen collection period from 1980 to 1999. The values found do not therefore correspond with the current situation. It wasn't until 2001 that hunting with lead ammunition was banned in the wetlands of Spain (*Royal Decree 581/2001 of 1 June forbidding the possession and use of lead-containing ammunition for hunting and shooting sports in certain wetland areas*). A fact which corroborates this situation is the species' upward trend in Spain, which underwent a population increase of 135% between 2001 and 2012 according to BirdLife International (2021). The likelihood of this species ingesting lead shot used for small game hunting is very low.

Table 22. *Variables contained for the **golden eagle** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	F	A	B	C	D	F
Aquila chrysaetos	Swiss Alps	2006-2013	7	25	25	17	32	-	-	-	-	-
Aquila chrysaetos	Swiss Alps	2006-2013	-	36	36	-	-	-	8.3	2.7	-	-
Aquila chrysaetos	Alps	2000-2001	-	8	-	-	-	-	12.5	-	-	-
Aquila chrysaetos	Spain	-	-	-	-	2	-	-	-	-	0.0	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; F: feathers

The source of the lead found in the blood of the golden eagle is not clarified in the study by Jenni et al. (2015). They attribute it to the carcasses and offal left behind by hunters. Madry et al. (2015) attributed it through lead isotopes to the lead found in lead ammunition. Kenntner et al. (2007) also attributed the possible source of lead to the carrion left behind in countryside by hunters. Good hunting practices (burial of the carrion of large game or disposing of it in landfills) would eliminate the possible risk of ingestion. Mateo et al. (2003) did not find high levels in two specimens. The likelihood of this species ingesting lead shot used for small game hunting is very low. Furthermore, this species is undergoing an upward trend in Europe according to BirdLife International (2021).

Table 23. *Variables contained for **Bonelli's eagle** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	E	F	A	B	C	E	F
Aquila fasciata	Spain	2004-2014	-	-	-	1535	57	-	-	-	2.6	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; E: regurgitated pellets; F: feathers

In the only article of reference on Bonelli's eagle, the appearance of lead shot in the regurgitated pellets collected in spring (n=1363 – 2.81%) is attributed to red-legged partridge (*Alectoris rufa*) hunting with bait. This kind of hunting ends in February. The appearance of lead shot in autumn (n=172 – 1.31%) is attributed to rabbit hunting. Without any further data for the species, the likelihood of this species ingesting lead shot used for small game hunting is very low.

Table 24. *Variables contained for the **western marsh harrier** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Circus aeruginosus	France	1990-1992	94	-	-	-	-	30.8	-	-	-	-
Circus aeruginosus	Ebro Delta	1992-1995	45	-	-	-	521	0.0	-	-	-	11

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

In the articles of reference by Pain et al. (1993) and Mateo et al. (1999) on the western marsh harrier, the carrion of ducks is recognised as the main food source. This species was still being hunted in wetlands with lead shot in the specimen collection period from 1990 to 1992 and from 1992 to 1995. The values found do not therefore correspond with the current situation. For example, it wasn't until 2001 that hunting with lead ammunition was banned in wetlands in Spain (*Royal Decree 581/2001*). A fact which corroborates this situation is this species' upward trend in Europe according to BirdLife International (2021). The likelihood of this species ingesting lead shot used for small game hunting is very low.

Table 25. *Variables contained for the **white-tailed eagle** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Haliaeetus albicilla	Finland	2000-2014	-	-	-	-	-	-	-	-	-	-

Haliaeetus albicilla	Sweden	1981-2004	-	-	-	-	-	-	-	-	-	-
Haliaeetus albicilla	Greenland	1997-2000	-	-	-	-	-	-	-	-	-	-
Haliaeetus albicilla	Germany	1998-2006	-	-	-	-	-	-	-	-	-	-
Haliaeetus albicilla	Germany and Austria	1993-2000	-	57	57	-	-	-	29.8	29.8	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

In the article of reference by Isomursu et al. (2018) on the white-tailed eagle, the poisoning of 38% of the white-tailed eagles collected was attributed to the consumption of the carrion of large game and waterbirds hunted with lead ammunition (necroscopy). In the article of reference by Helander et al. (2009), lead poisoning is attributed to 13% of the white-tailed eagles collected (necroscopy). In the article of reference by Krone et al. (2004), lead poisoning is attributed to 50% of the white-tailed eagles collected (necroscopy). This species is undergoing an upward trend in Europe according to BirdLife International (2021). The likelihood of this species ingesting lead shot used for small game hunting <u>cannot be assessed</u>.

Table 26. *Variables contained for the **red kite** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Milvus milvus	United Kingdom	1989-2007	-	110	-	-	-	-	3.7	-	-	-
Milvus milvus	United Kingdom	1995-2003	-	44	-	-	264	-	9.1	-	-	-
Milvus milvus	Switzerland	-	-	45	-	45	-	-	0.0	-	2.2	-
Milvus milvus	French Pyrenees	-	-	34	34	-	-	-	-	-	-	-
Milvus milvus	Spain	-	-	-	-	-	-	-	-	-	-	-
Milvus milvus	Spain	-	-	-	-	10	-	-	-	-	20.0	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

In the article of reference by Molenaar et al. (2017), the poisoning of 3.7% of the specimens collected is attributed to lead (necroscopy), without making any reference to the lead source. In the article of reference by Pain et al. (2007), lead poisoning is attributed to 9.1% of the red kites collected (necroscopy). In the article of reference by Ganz et al. (2018) lead poisoning is attributed to 2.2% of the red kites, without making any reference to the lead source, but it does refer to the collection of carrion from hunting. In the article of reference by Berny et al. (2015) lead poisoning is attributed to 11.8% of the red kites, without making any reference to the lead source. In so far as this species in Europe is concerned, the data collected and submitted at the end of 2019 to the European Commission (EC) pursuant to Article 12 of the EU Birds Directive suggest that its population is stable or increasing in most of the countries where it is present, including Germany, France and Spain according to BirdLife International (2021). The likelihood of this markedly scavenging species ingesting lead shot used for small game hunting is <u>very low</u>.

Table 27. *Variables contained for the **peregrine falcon** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Falco peregrinus	Italy	2015	1	1	1	1	-	0.0	0.0	0.0	0.0	0.0
Falco peregrinus	United Kingdom	1980-1990	-	25	-	-	-	-	4.0	-	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The study by Adreotti et al. (2018) is the only one which cites this species and the specimen supposedly died after colliding with an overhead power line. In the study by Pain et al. (1995), two specimens were collected over ten years in the 1980s out of a total of 25 that were found dead. The likelihood of this species ingesting lead shot used for small game hunting cannot be assessed, firstly because of the very lengthy time interval (10 years) and secondly because the food source is unknow, since the use of lead in wetlands was allowed in the case of waterbirds in the 1980s.

Table 28. *Variables contained for the **common raven** in the studies used by the ECHA*

Species	Area	Years [1]	No. of samples					% with Pb (≥ subclinical)				
			A	B	C	D	E	A	B	C	D	E
Corvus corax	Quebec	-	-	-	-	-	-	-	-	-	-	-
Corvus corax	California	2009-2013	27	-	-	-	-	0.0	-	-	-	-
Corvus corax	Switzerland	-	-	-	-	2	-	-	-	-	0.0	-
Milvus milvus	French Pyrenees	-	-	34	34	-	-	-	-	-	-	-
Milvus milvus	Spain	-	-	-	-	-	-	-	-	-	-	-

[1] Years in which samples were collected

A: blood; B: liver; C: kidney; D: bone; E: regurgitated pellets

The article of reference by Legagneux et al. (2014) on the crow is based on the feeding of these birds on the carrion of large game (moose). In the article of reference by West et al. (2017), no animal was found to have high lead values in the blood. The researchers were struck that they had such low lead levels despite these birds being the first scavengers to arrive at carcasses. The likelihood of this markedly scavenging species ingesting lead shot used for small game hunting is negligible.

There are data on other species in the bibliography contained in the ECHA dossier report on this group of species which have not been set out because it is deemed important to provide data only after the different articles have been reviewed.

Table 29. *Variables contained for **other species** in the studies used by the ECHA*

Species	Area	Observations	Author
Circus pigargus	Poland	Low Pb concentrations	Komosa and Kitowski (2008)
Tyto alba	Poland	Low Pb concentrations	Komosa and Kitowski (2008)

Strix uralensis	Poland	Low Pb concentrations	Komosa and Kitowski (2008)
Bubo bubo	Poland	Low Pb concentrations	Komosa and Kitowski (2008)
Accipiter gentilis	Spain	Low Pb concentrations	Mateo et al. (2003)
Aquila adalberti	Spain	Low Pb concentrations	Mateo et al. (2003)
Aquila chrysaetos	Spain	Low Pb concentrations	Mateo et al. (2003)
Hieraaetus fasciatus	Spain	Low Pb concentrations	Mateo et al. (2003)
Hieraaetus pennatus	Spain	Low Pb concentrations	Mateo et al. (2003)
Bubo bubo	Swiss Alps	Low Pb concentrations	Jenni et al. (2015)

In view of the above, the likelihood of secondary ingestion of lead shot used as hunting ammunition in this group of birds is clearly lower than that set out in the ECHA dossier report. The values or percentages provided in the papers refer to individuals belonging to a fraction of the population. In general, these refer to specimens which were either found dead or dying without any kind of statistical processing concerning the species as a whole (population).

4.1.7. Risk characterisation (hazard):

The identified risk in relation to the use of lead shot in the terrestrial environment set out in the ECHA dossier report is as follows:

Table 30. *Environmental risk due to HUNTING with gunshot*

Use	Main risks
Hunting with cartridges	Primary and secondary poisoning of fauna (birds)

The characterisation of the risk related to birds (primary and secondary poisoning) made by the ECHA summarises information on the following:

- Specific case studies on the impact on birds.
- Examples comparing the lead concentration in different kinds of bird tissues with thresholds indicating adverse effects on birds.
- Mortality in the EU.
- Information on lead as a co-factor in other causes of death.

4.1.7.1. Specific case studies on the impact on birds:

- Primary intoxication:
  - ✓ The ECHA dossier report uses the studies by Potts (2005) on grey partridges (*Perdix perdix*) in the United Kingdom based on 1,318 dead birds collected

between 1947 and 1992 that found that lead had been the cause of the death of 18 of the specimens, which amounts to 1.4% (1.366%).

This study is based on the collection of grey partridge (*Perdix perdix*) specimens over 45 years, finding that 1.366% of the partridges found dead had died because of lead. Firstly, it should be noted that the study does not determine the lead contamination source. Secondly and even more importantly, it deals with **cumulative mortality of the entire sample**; recall that it involves partridges that were found dead **over the course of 45 years**. This cannot be compared to the population's overall mortality and even less so to cumulative mortality over 45 years. The annual percentage mortality rate attributed to lead of the total number of dead specimens would amount to 0.03%, but not of the total percentage of the United Kingdom population of 43,000 breeding pairs (BirdLife International, 2015). In order to calculate the possible mortality rate associated to lead properly, one would have to determine the total population of the area where the dead specimens were collected over the course of 45 years and extrapolate the mortality rate to the population's total value, which would yield a much lower figure than 0.03% per year.

- ✓ The ECHA report affirms that, according to the study by Meyer et al. (2016), the continental grey partridge (*Perdix perdix*) population, which was stable at the beginning of the 20th century, had fallen by 10% in 1970s as a result of lead shot ingestion. This study conducted by Meyer et al. (2016) is based on a mathematical probability model which takes a preceding study by Potts (2005) as a source to determine a mortality rate of 7%, which is even higher than the aforementioned mean and without being properly corrected, as set out previously for said study. In the case of the model followed for raptors like the common buzzard (*Buteo buteo*) and the red kite (*Milvus milvus*) set out by Meyer et al. (2016), a mortality rate due to lead is respectively set at 5% and 16% for these birds of prey. **Under no circumstances is the model realistic, since the real populations would not be either stable or growing in the EU-27 with a mortality rate solely due lead** (without taking into account electrocutions, collisions, poisoning, poaching, etc.) **in the common buzzard and the red kite of 5% and 16% respectively, as BirdLife International (2021) states**.

- Secondary intoxication:
  - ✓ Three cases of intoxication in griffon vultures (*Gyps fulvus*) associated to lead ammunition ingestion in the Iberian Peninsula (Carneiro, 2016). This study could not be assessed as it was unavailable at the time of this report's drafting.
  - ✓ 2.7% of common buzzard (*Buteo buteo*) specimens with a concentration in the liver and 4.0% with a concentration in the bones compatible with lead intoxication (Taggart et al., 2020). In this study, 220 buzzards that were found either dead or dying were collected in the United Kingdom over 11 years (2007 to 2018). The average number of breeding pairs in the United Kingdom according to BirdLife International (2015) amount to 68,000 pairs (136,000 individuals). Lead poisoning

is attributed as a possible cause of death to five specimens out of a total of 197, five in the case of liver analyses and five specimens out of a total of 125 in the case of bone analyses. It is not clear whether these five specimens are the same or different. In any event, the fact that five specimens appear over the course of 11 years (0.45 specimens a year) of a total annual population of 136,000 individuals is an extremely low figure.

- ✓ Lead poisoning was attributed to 17% of the specimens in a study of 170 scavenger birds (8 bearded vulture, 120 griffon vultures, 8 Egyptian vultures and 34 red kites) that were found dead (Berny et al., 2015). The study attributed lead poisoning to seven specimens (mainly due to ammunition), more specifically, four red kites and three griffon vultures, which is equivalent to 4.1%.

4.1.7.2. Examples comparing the lead concentration in different kinds of bird tissues with thresholds indicating adverse effects on birds:

- In 2004, two red-legged partridges (*Alectoris rufa*) were found to have ingested lead shot out of a total sample of 10 specimens hunted in Spain. The average lead concentration the in the liver amounted to 21.51 ppm (Ferrandis et al., 2008). The average concentration observed in the liver exceeded the threshold indicating subclinical intoxication. This same study also affirms that only one of 66 partridges hunted in Spain during the 2006 season had a pellet in the gizzard (1.5%). **Biasing the information provided does not enrich the ECHA report. On the contrary, it seems more like a document geared at drawing preconceived conclusions**. It would be convenient if it were clarified whether farm-bred partridges were released or reinforced in the area where the study was conducted (south-eastern central Spain) given the commercial nature of the hunting carried out within it tends to have. Other studies, like the one conducted by Butler et al. (2005) based on a significantly larger sample (n=781), found lead pellets in the gizzards in only 0.38% of the specimens.
- In 1997, a lead shot ingestion rate of 3% was found in 95 female pheasants (*Phasianus colchicus*) in the United Kingdom with a median concentration in the bones of 48.8 ppm (Butler et al., 2005), a median concentration value in the bones exceeding the threshold indicating severe clinical poisoning. The paper deals with farm-bred pheasant (*Phasianus colchicus*) specimens. Hence, the likelihood of this species when it is bred in captivity is much higher than the likelihood that would be found if the sampling had been done among wild specimens of this species.
- The three above-mentioned cases of intoxication in griffon vultures (*Gyps fulvus*) associated to lead ammunition ingestion in the Iberian Peninsula with high concentrations in the blood and liver (Carneiro, 2016). High concentrations with severe clinical poisoning. This study could not be assessed as it was unavailable at the time of this report's drafting.

4.1.7.3. Mortality in the EU:

- Primary intoxication:
  - ✓ **The ECHA dossier report recognises that the available data on terrestrial species does not allow for an estimation of EU-wide mortality from lead ammunition ingestion**, as was indeed done by the ECHA (2017) for waterbird species which ingest lead shot in wetlands.
  - ✓ According to Paint et al. (2019), it is estimated that in the case of the pheasant (*Phasianus colchicus*) and the red-legged partridge (*Alectoris rufa*) the percentage of the United Kingdom population which dies from lead ingestion respectively amounts to 0.56% and 0.32% (an underestimation which does not include juvenile birds and fails to take into account sub-lethal poisoning). **The figures provided in this paper are notably lower than the ones which are generally contained in the ECHA report**. In any event, the latter values have not been found in the paper and their source is therefore unknown. They are, in any case, higher that what they would be in reality.
  - ✓ According to Meyer et al. (2016), the percentage of deaths from lead shot ingestion in grey partridges (*Perdix perdix*) was modelled to amount to 4%. This paper is based on Potts' (2005) mathematical model and on data that are poorly adjusted to reality, as has already been noted in the first section.
  - ✓ According to Potts (2005), the mortality rate in grey partridges (*Perdix perdix*) ranges from 0.3% to 4%. Once again, the error described in the first section is repeated and these values cannot be accepted.
  - ✓ Some waterbirds can also feed in terrestrial environments and are therefore exposed to lead shot used outside wetlands. It is, however, impossible to determine the percentage of birds which die from lead shot ingestion in the terrestrial environment because it is not possible to differentiate between the gunshot pellets ingested in wetlands and those ingested outside them. **The presence of gunshot pellets in the terrestrial environment ingested by waterbirds is a hypothesis that has not been demonstrated in any case**.
  - ✓ **The ECHA assumes that 0.5% to 2.0% is the most likely mortality range for raptor species in the terrestrial environment. The median value of this range (1%) is used.**

    The value set by the ECHA is an unrealistic value, without in any way justifying that it should be calculated under realistic conditions (on wild species, outside intensive hunting game reserves and with sampling done without the use of lead ammunition). As has already been argued in the analysis of Potts' (2005) paper, the ECHA is wrong about lead-induced mortality as a percentage of total mortality. The correct calculation should be performed using the total population. As an example, a calculation based on Potts' (2005) data is carried out below:

According to Potts (2005), 18 specimens that died as a consequence of lead poisoning were collected over 45 years between 1947 and 1992. The annual percentage of deaths due to lead poisoning of total mortality amounted to 0.03%. In other words, 0.4 grey partridges die from lead each year out of an unknown total population. If the partridges have been collected throughout the United Kingdom and said country has 43,000 breeding pairs (86,000 specimens), without counting the specimens born in the year (559,000 partridges in the year), a mortality rate of 0.0005% would result.

The grey partridge (*Perdix perdix*) mortality rate caused by lead (without knowing the lead source) in United Kingdom would therefore be 0.0005% of the total population.

- Secondary intoxication:
  - ✓ **According to the ECHA, making a community estimate based on the available data on mortality from lead ammunition ingestion via secondary poisoning does not currently appear to be possible**. Throughout the analysis of the different papers contained in the ECHA report, mortality caused by lead shot is notably lower than that produced by other causes, principally overhead power lines and infrastructures. Secondary lead shot poisoning is anecdotal in most cases and negligible in avian scavenger and raptor species.

4.1.7.4. Information on lead as a co-factor in other causes of death:

- Slight lead intoxication might not be lethal, but it can impair the immune system, increasing susceptibility to diseases or inattention, which in turn boost the likelihood of accidents or predation (Meyer et al. 2016). The ECHA report constantly makes hypothetical affirmations that make its contents excessively subjective, which is not what is to be expected from a European authority.
- In the absence of any scientific evidence relating the waterbird species mentioned in it to lead shot ingestion in the terrestrial environment, said species should not be considered as species "potentially at risk".

4.1.8. Species potentially at risk of lead intoxication in the EU:

In view of the analysis made by the ECHA, the following species are considered the ones at greater risk of lead poisoning from ammunition:

Table 31. *Bird species at greater risk of exposure to lead in terrestrial environments*

Taxonomy	Common name	Breeding pairs Europe [1]	Breeding pairs EU-27 [1]	Wintering Europe [1]	Wintering EU-27 [1]
Anas acuta	Northern pintail	239,500	12,950	160,000	130,500

Anas crecca	Common teal	736,000	322,500	1,115,000	936,000
Anas platyrhynchos	Mallard	3,730,000	2,305,000	5,140,000	4,315,000
Anser albifrons	Greater white-fronted goose	284,000	0	1,960,000	1,860,000
Anser anser	Greylag goose	343,000	270,000	1,002,500	954,000
Anser brachyrhynchus	Pink-footed goose	65,500	0	422,500	422,500
Anser caerulescens	Snow goose	1,500	0	0	0
Anser erythropus	Lesser white-fronted goose	225	22	4,900	360
Anser fabalis	Bean goose	139,000	2,600	727,500	724,000
Branta bernicla	Brent goose	1,650	0	318,000	318,000
Branta leucopsis	Barnacle goose	221,500	28,350	718,500	718,500
Branta ruficollis	Red-breasted goose	7	0	46,200	42,400
Cygnus columbianus	Tundra swan	5,500	0	22,400	22,000
Cygnus cygnus	Whooper swan	29,050	16,500	117,750	107,650
Cygnus olor	Mute swan	80.250	99,700	194,000	276,000
Anthropoides virgo	Demoiselle crane	11,500	0	0	0
Grus grus	Common crane	149,000	112,300	255,000	245,500
TOTAL "WATERBIRDS" (INDIVIDUALS)		**11,914,025**	**6,339,844**	**12,204,250**	**11,072,410**
Alectoris barbara	Barbary partridge	13,750	13,750		
Alectoris chukar	Chukar partridge	1,084,000	107,250		
Alectoris graeca	Rock partridge	57,600	30,300		
Alectoris rufa	Red-legged partridge	6,070,000	6,070,000		
Bonasa bonasia	Hazel grouse	2,200,000	787,000		
Coturnix coturnix	Common quail	5,020,000	2,125,000		
Lagopus lagopus	Red grouse	1,580,000	532,500		
Lagopus muta	Rock ptarmigan	633,500	85,450		
Lyrurus tetrix	European black grouse	1,630,000	914,000		
Perdix perdix	Grey partridge	2,025,000	1,530,000		
Phasianus colchicus	Common pheasant	4.755.00	4,490,000		
Tetrao urogallus	Western capercaillie	863,000	686,000		
TOTAL "PHASIANIDAE" (individuals)		**42,353,700**	**34,742,500**		
Columba livia	Rock dove	16,800,000	8,260,000		
Columba oenas	Stock dove	800,500	741,500		
Columba palumbus	Common woodpigeon	24,750,000	22,700,000		
Streptopelia decaocto	Eurasian collared	11,155,000	7,865,000		

	dove		
Streptopelia turtur	European turtledove	4,545,000	3,195,000
Columba bollii	Bolle's pigeon	6,250	6,250
Columba junoniae	Laurel pigeon	1,750	1,750
Columba trocaz	Torcaz pigeon	12,000	12,000
TOTAL "COLUMBIDAE" (individuals)		**116,141,000**	**85,563,000**
Scolopax rusticola	Eurasian woodcock	7,800,000	1,099,000
Pterocles alchata	Pin-tailed sandgrouse	5,200	4,900
Pterocles orientalis	Black-bellied sandgrouse	14,750	6,650
TOTAL "OTHERS" (individuals)		**15,639,900**	**2,221,100**
Neophron percnopterus	Egyptian vulture	3,850	1,600
Gypaetus barbatus	Bearded vulture	685	180
Gyps fulvus	Griffon vulture	33,400	32,350
Aegypius monachus	Cinereous vulture	2,400	2,100
Pernis apivorus	European honey buzzard	144,500	57,550
Buteo buteo	Common buzzard	1,102,000	648,000
Buteo lagopus	Rough-legged buzzard	58,200	5,700
Buteo rufinus	Long-legged buzzard	15,500	1,650
Aquila adalberti	Spanish imperial eagle	375	375
Clanga clanga	Greater spotted eagle	885	25
Aquila chrysaetos	Golden eagle	10,800	5,300
Aquila heliaca	Eastern imperial eagle	1,600	220
Aquila fasciata	Bonelli's eagle	1,150	1,150
Aquila nipalensis	Steppe eagle	1,000	0
Hieraaetus pennatus	Booted eagle	26,100	22,650
Circus aeruginosus [2]	Western marsh harrier	70,825	31,375
Circus cyaenus [2]	Hen harrier	21,100	5,625
Circus pygargus [2]	Montagu's harrier	36,675	9,250
Haliaeetus albicilla	White-tailed eagle	10,650	3,850
Milvus milvus	Red kite	29,300	27,950
Milvus migrans	Black kite	95,100	50,200

Falco peregrinus	Peregrine falcon	21,850	10,800
Falco biarmicus	Lanner falcon	635	220
Falco cherrug	Saker falcon	425	310
Falco rusticolus	Gyrfalcon	1,500	150
Accipiter gentilis	Northern goshawk	193,000	68,500
Corvus corax	Common raven	885,500	378,000
Corvux corone	Carrion crow	12,695,000	7,745,000
TOTAL "SCAVENGERS" (INDIVIDUALS)		**30,928,010**	**18,220,160**

[1] BirdLife International, 2015

[2] They appear as females in the records of BirdLife International, 2015

The list above sets out the populations potentially at risk of lead poisoning in the EU, against which the following should be argued:

- First: Including species defined as waterbirds without any scientific argumentation whatsoever is a merely subjective act in the ECHA report, in as much as these birds' feeding habits in non-aquatic areas does not necessarily mean that their feeding habits outside wetlands involve the ingestion of grit by these birds in the terrestrial environment. Some waterbirds have even been included as being potentially at risk of intoxication without lead shot contamination ever having been proven in them.

- Second: Most of the studies have been conducted on specimens from game reserves in the case of the Phasianidae group of birds. They have therefore yielded values of possible primary lead shot poisoning that are higher than the real values which can be found among wild populations due to their phenology and feeding habits, as well as because of the area in which this type of farm-bred specimen is usually hunted (intensive hunting game reserves). In the study by Romero et al. (2020), the wild partridges hunted in Zamora (n=30) yielded a median wet weight lead concentration value in the liver of 0.026 ppm, which is lower than the value of the partridges acquired directly from a game farm (n=26) in Navarre, whose wet weight median value was 0.074 ppm. Despite having found some specimens with ingested lead pellets, mortality among wild specimens is extremely low (minimal) throughout the scientific literature. A general mortality rate from lead shot ingestion for all species cannot be attributed to a species in a specific area or situation, as is the case in the ECHA report, which even includes species like *Tetrao urogallus*, *Bonasa bonasia*, *Lagopus muta* or *Lyrurus tetrix* without there being any solid scientific argumentation that would justify it. Lastly, the ECHA dossier report does not generally define the lead source in the case of contamination among birds despite there being numerous authors that admit agricultural treatments are a lead source. It fails to take into account other possible sources such as natural lead in the soil or lead associated to former anthropic uses (petrol, industry or mining).

- Third: In so far as Columbidae birds (species with a large number of individuals in the EU) are concerned, the ECHA dossier report includes a large number of species, including some for which there is no evidence whatsoever of primary lead poisoning in any scientific paper, as is the case for the following species: *Columba oenas*, *Streptopelia decaocto*, *Streptopelia turtur*, *Columba bollii*, *Columba junoniae* o *Columba trocaz*. Once more, the ECHA does not generally define the lead source for this group.

- Fourth: In the case of other species, particularly the species *Scolopax rusticola*, *Pterocles alchata* or *Pterocles orientalis*, the ECHA increases the degree of its dossier report's subjectivity by including them in as much as nothing whatsoever backs this decision.
- Fifth: Lastly, the group of scavenger birds and raptors is perhaps the group which benefits most from a "collage-type" report which mixes different lead sources, hypotheses and ambiguities in order to include almost all species of this type "in a bucket" within the ECHA report. The ECHA should have divided up the dossier report by separating the different sources of lead it includes, including those which it has preferred not to deal with — such as pesticides, industry, landfills or mining — in order to give it greater clarity and objectivity. In any event, as has already been seen for this group in previous sections, the likelihood of these species ingesting lead shot in a secondary way is negligible in most cases (if the likelihood is negligible, so is the risk). Hence, poisoning cannot be attributed to lead shot and these species cannot therefore be including as species potentially at risk. Some simple good hunting practices would ensure that these species would no longer be included in the group of species potentially at risk of secondary lead shot ingestion.

In short, the list of species potentially at risk in the EU-27 should at most contain the following:

Table 32. *Bird species at greater risk of exposure to lead in terrestrial environments*

Taxonomy	Common name	Breeding pairs EU-27 [1]
Alectoris barbara	Barbary partridge	13,750
Alectoris chukar	Chukar partridge	107,250
Alectoris graeca	Rock partridge	30,300
Alectoris rufa	Red-legged partridge	6,070,000
Coturnix coturnix	Common quail	2,125,000
Lagopus lagopus	Red grouse	532,500
Perdix perdix	Grey partridge	1,530,000
Phasianus colchicus	Common pheasant	4,490,000
TOTAL "PHASIANIDAE" (individuals)		**14,898,800**
Columba livia	Rock dove	8,260,000
Columba palumbus	Common woodpigeon	22,700,000
TOTAL "COLUMBIDAE" (individuals)		**30,960,000**

Neophron percnopterus	Egyptian vulture	1,600
Aegypius monachus	Cinereous vulture	2,100
Buteo buteo	Common buzzard	648,000
Buteo lagopus	Rough-legged buzzard	5,700
Buteo rufinus	Long-legged buzzard	1,650
Aquila adalberti	Spanish imperial eagle	375
Clanga clanga	Greater spotted eagle	25
Aquila chrysaetos	Golden eagle	5,300
Aquila heliaca	Eastern imperial eagle	220
Aquila fasciata	Bonelli's eagle	1,150
Aquila nipalensis	Steppe eagle	0
Circus aeruginosus [2]	Western marsh harrier	31,375
Haliaeetus albicilla	White-tailed eagle	3,850
Milvus milvus	Red kite	27,950
Milvus migrans	Black kite	50,200
TOTAL "SCAVENGERS" (INDIVIDUALS)		**779,495**

[1] BirdLife International, 2015

2 They appear as females in the records of BirdLife International, 2015

4.1.9. Soil contamination:

According to the ECHA, groundwater contamination can be supposed in the uses associated to hunting since lead ammunition is deposited on the ground and as a result of its subsequent corrosion and dissolving. It is assumed that the risk increases as more of it is released. The ECHA dossier report states that hunting with cartridges (lead shot) involves a risk level that varies between low and moderate. **This risk is low in traditional hunting areas (non-intensive). As has been stated before, the intensive area in the case of the Member State Spain solely accounts for 1% of the Spanish state's total surface area (INE, 2018)**.

4.1.10. Groundwater contamination:

According to the ECHA, groundwater contamination can be supposed in the uses associated to hunting since lead ammunition is deposited on the ground and as a result of its subsequent corrosion and dissolving. It is assumed that the risk increases as more of it is released. The ECHA dossier report states that hunting with cartridges (lead shot) involves a **risk level that is low**.

4.1.11. Surface water contamination:

According to the ECHA, surface water contamination can be supposed in the uses associated to hunting since lead ammunition is deposited on the ground and as a result of its subsequent corrosion and dissolving. It is assumed that the risk increases as more of it is released. The ECHA dossier report states that hunting with cartridges (lead shot) involves a risk level that varies between low and moderate. **This risk is low if we take into consideration the recent *Commission Regulation (EU) 2021/57 of 25 of January of 2021 amending Annex XVII to Regulation (EC) No. 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in gunshot in or around wetlands***.

4.1.12. Livestock grazing and agricultural use:

According to the ECHA, corroded lead is a source for increasing lead concentrations in the biomass of grass or crops used for agricultural purposes. The risk level depends on the amount of shooting in terrestrial habitats. The ECHA dossier report states that hunting with cartridges (lead shot) involves a risk level that varies between low and moderate. **This risk is low traditional hunting areas (non-intensive). As has been stated before, the intensive area in the case of the Member State Spain solely accounts for 1% of the Spanish state's total surface area (INE, 2018)**.

4.2. Justification for an EU-wide restriction measure:

The four main pillars (which are set out in the ECHA dossier report) to establish an EU-wide restriction measure are as follows:

- To ensure a harmonised high level of protection of the environment to address the identified risks.

As has already been explained, the risk affecting the species is very low or negligible. One cannot extrapolate to a species level the specific harm done to specimens (individuals). Some good practices may reduce the low risk to negligible for some of the species (principally scavenger birds).

- To address the lack of EU-wide commitment to fulfil the EU Birds Directive, the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), the Convention (CMS) and the CMS Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia (Raptors MOU) commitments towards the protection of birds and their habitats.

The reality in Europe and the EU's commitment to the conservation of both sedentary and migratory wild birds is well known. The degree of fulfilment of conservation agreements on migratory bird by other continents like Africa and Asia should be one of the EU-27's top priorities.

- To ensure the free movement of goods within the Union.

This pillar defined in the ECHA dossier report should not be set out as an argument for an EU-wide restriction.

- To ensure equal conditions for all those who do shooting sports in the EU.

This pillar defined in the ECHA dossier report does not affect the case which concerns us in this report.

4.3. Grounds for the justification:

In so far as the lead used in hunting is concerned, the baseline according to the ECHA was estimated from the amount of lead used in a preceding assessment (wetlands dossier) and from hunting statistics. The reference scenario below describes how the use of lead would evolve in the absence of any regulatory action:

4.3.1. Shot:

The ECHA estimates that the total amount of lead in the form of gunshot released by hunters in the EU-27 after the restriction's implementation in wetlands would be in the order of 14,000 tonnes a year (13,000 to 15,000 t/year). It estimates around 280,000 tonnes (260,000 to 300,000 t/20 years) over 20 years.

As mentioned above, the actual figure for the lead released is lower than the average figure indicated above, it being 13,000 tonnes per year. If the hunting surface area in each Member State is determined approximately, the figure for the lead released per hectare based on the cartridges sold contained in Table 3 would result in the following average figures in grams per hectare in the Member States for which it has been possible to obtain information on their hunting surface areas:

Table 33. *Hypothetical relationship of lead in g/hunting ha per year released annually in EU-27*

Member State	Lead shot (t)	Hunting surface area (ha)	g/ha year
Austria	384.0	8,216,400 [1]	46.74
Germany	1,248.0	32,090,000 [1]	38.89
Hungary	224.0	8,900,000 [1]	25.17
Ireland	320.0	6,600,000 [1]	48.48
Poland	160.0	28,639,500 [1]	5.59
Portugal	537.6	7,000,000 [2]	76.80
Spain	2,537.6	42,935,331 [3]	59.10

[1] European Federation for Hunting and Conservation
[2] de Sousa (2020)
[3] INE (2018)

The weighted average figure in grams per hectare for the release of lead shot resulting from the renewable resource of hunting in the Member States listed in Table 33 yields a figure of **40.27 g/hunting hectares per year**.

If we compare this value with the average legal figure in grams for agricultural use in the EU pursuant to *Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 of June of 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003*, it turns out that the EU authorises lead concentrations in organic fertilisers, organic mineral fertilisers, macronutrient-based inorganic fertilisers, micronutrient-based inorganic fertilisers, limestone compost, organic compost, inorganic compost and plant biostimulants up to a figure of 120 mg/kg of dry matter, except for micronutrient-based inorganic fertilisers, for which it authorises a figure of up to 600 mg/kg. Fertilising agricultural land in Europe is carried out with average figures that range from 500 kg/ha to 1,100 kg/ha, the overall average figure being 800 kg/ha of fertiliser. If we assume a humidity of 14%, the annual dose per hectare would amount to 688 kg/agricultural ha per year. If the legal figures set forth in Regulation 2019/1009 are abided by, **82.56 g/agricultural ha** of lead are released annually through agricultural use – more than twice the amount released by hunting – only through fertilisers and **without taking into account the use of herbicides and pesticides**.

Other sources of lead released to the environment like the gases reported by the European Environment Agency (posted on its website), mining activities, landfills, etc. must be added to the release of lead from agricultural use in EU land.

4.3.2. Birds:

The ECHA estimates in its dossier report that the number of individuals across the EU-27 at risk of poisoning from lead ammunition is as follows:

Table 34. *Number of birds at high risk of lead ammunition poisoning in the EU-27*

	Type of population	Number of individuals	Mortality due to direct ingestion (not sublethal)
Primary poisoning	Breeding	127,559,526	0.5 - 2.0% (median value 1%)
	Wintering	7,869,678	0.5 - 2.0% (median value 1%)
	Total	135,429,204 (of 135 million)	135,429,204
Secondary poisoning	Breeding	14,391,990	Not defined (the dataset is insufficient, and it is not possible to differentiate mortality due to different causes. In the case of vulnerable species, even the death of just one individual is concerning in terms of conservation)
	Wintering	227	Not defined (the dataset is insufficient, and it is not possible to differentiate mortality due to different causes)

	Total	14,392,217 (of 14 million)	Not defined

According to the species listed in Table 32 along with the mortality rate calculated in this report, the number of birds at high risk of lead shot ammunition poisoning in the EU-27 would be as follows:

Table 35. *Number of birds at high risk of lead shot ammunition poisoning*

	Type of population	Number of individuals	Mortality due to direct ingestion (not sublethal)
Primary poisoning	Breeding	22,929	0.0005%
	Wintering	0	0.0005%
	Total	22,929 (**of 23,000**)	-
Secondary poisoning	Breeding	390	0.0005%
	Wintering	0	0.0005%
	Total	390 (**of 400**)	-

In the case of the raptors, the risk of secondary poisoning would be reduced considerably and could become negligible through the use of some good practices in lead shot hunting (burial of carrion principally in the case of lagomorphs — rabbits and hares — when they are skinned in the countryside).

The following table of the ECHA dossier report shows the number of species at risk due to lead ammunition by IUCN categories:

Table 36. *Number of birds at high risk of lead ammunition poisoning in the EU-27*

Type of population	**Number of species**	**IUCN categories (CR/EN/VU/NT/LC/NE)**
Primary poisoning	41	1/2/4/3/28/3
Secondary poisoning	29	1/2/6/3/16/1

The following table shows the number of species at risk due to lead ammunition by IUCN categories according to this report:

Table 37. *Number of birds at high risk of lead shot poisoning in the EU-27*

Type of population	**Number of species**	**IUCN categories (CR/EN/VU/NT/LC/NE)**
Primary poisoning	10	0/0/2/0/8/0
Secondary poisoning	15	0/1/4/1/9/0

In addition to the species at greater risk of lead poisoning, the ECHA dossier report states that other species may be at certain risk (low) according to the assessment made by the UNEP/CMS Ad Hoc Group of Experts (2020). More specifically and based on this, the ECHA calculated that around 650 million birds (at least) would be exposed to a low risk of lead poisoning via primary lead ammunition ingestion and around 50 million birds (at least) would be exposed to a risk of secondary lead ammunition poisoning. It is expected that more information will become available in the 2021 consultation to back this estimate. If this affirmation set out in the ECHA dossier report is correct, it is manifestly clear that the EU-27's wildlife recovery centres would be flooded with bird species that are either dead or dying as a result of lead poisoning. Moreover, the majority of birds handed over to recovery centres are suffering from injuries resulting from collisions with cables, being run over or electrocution.

4.4. Impact assessment:

4.4.1. Analysis of restriction options to the use of lead shot in hunting:

The ECHA identified and analysed the following restriction options (RO):

- RO1: Ban on the placing on the market and use of lead gunshot for hunting.
- RO2: Require a specific design/construction of lead gunshot.
- RO3: Ban on placing on the market of game meat (collected with lead gunshot or maximum levels of lead in game meat).
- RO4: Advice to cut away more meat when handling game and meat bagged with lead gunshot.
- RO5: Compulsory information on the hazards of lead and the risks of using lead ammunition to be incorporated in national hunting exams and labelling of risks of lead on the package at points of sale.

The ECHA only identified one plausible restriction proposal, RO1 (Ban on the placing on the market and use of lead gunshot for hunting) to meet all the REACH restriction criteria; namely effectiveness, practicability, enforceability and monitorability. It argues the following in the analysis:

- Costs per year: relatively low (steel shot costs almost the same as lead shot).
- Practicability: yes (alternative available).

Based on everything set out in the analysis to date, which demonstrates that the risk to the environment from the use of lead shot for hunting is very low or negligible for most of the aspects addressed, the proposed restriction (RO1) should be analysed in terms of the effectiveness, practicability, enforceability and monitorability criteria on which it is based.

4.4.2. Alternatives to and technical solutions for shot in hunting:

According to the conclusions of the ECHA dossier report, the availability of alternatives to lead shot is good.

As will be seen below, once the feasibility of the alternatives and technical solutions put forward by the ECHA have been analysed, **the availability of alternatives to lead shot is poor, otherwise the sector and industry involved in lead shot for hunting would not oppose it.**

4.4.3. Technical feasibility of shot in hunting:

The ECHA dossier report affirms that the number of old guns that would need to be replaced is not precisely known, since many Member States do not keep a shotgun register or do not require any kind of registration of the number of shotguns owned by each hunter.

According to the ECHA, the only possible concern about the use of steel and other kinds of hard shot in standard guns refers to the choke region of the barrel, where large shot (larger than 3.5 mm in diameter) passing through a thin-walled and tightly choked barrel may cause a small ring bulge around the choke cones. However, this is widely considered not to be a safety issue, but rather a cosmetic issue (Coburn, 1992).

According to the conclusions of the ECHA dossier report, the technical feasibility of the alternative to lead shot is good.

The feasibility analysed in the ECHA dossier report does not delve any further into the matter. Though comparisons may be made through the technical tests conducted, it must be highlighted that we are dealing here with an activity (hunting) that is performed in the countryside, where there are other factors which could alter the results and technical evaluation of the proposed alternative, which is steel shot two sizes larger. It therefore turns out that:

- It would be necessary due to the material's (steel) characteristics to change old guns or run prior tests and checks on any guns that are not specifically prepared to use this type of ammunition. Likewise, chokes need to be prepared to handle it, since in both cases the guns may either break or blow-up over the course of time, thereby endangering the gun's user. Similarly, it is not stated that chokes are reduced to 0.5 mm, greatly limiting long-distance shots exceeding 30 metres.
- The risk of pellets ricocheting on any surface (the ground, rocks, logs, etc.) in the case of hunting game mammals or low-flying birds like quails, partridges or woodcocks endangers the accompanying hunter or hunters and dogs. As far as waterbirds are concerned, shots are usually aimed towards the sky at the flying area, considerably reducing the risk of ricochets.
- Steel shot loses energy and increases dispersion when shots are fired at hunting species despite being two sizes larger, thus diminishing the ability to bag game properly.
- Game species are more easily wounded by short-range shots due to steel shot's greater hardness and non-deformability, losing or decreasing the ability to hunt them down and increasing the game's suffering, therefore losing its "ecological" aspects.

In light of the above, **the technical feasibility of the only alternative to lead shot, steel shot, is poor, primarily due to the safety of users and those accompanying them (other hunters and their hunting dogs)**.

4.4.4. Economic viability of shot in hunting:

The ECHA has gathered price information from a great number of retail outlets located in the EU. The most striking and interesting result is perhaps that the average price of the steel shot alternative for the 12/70 mm and 20/70 mm calibres is cheaper than that of lead shot.

In so far as 12/70 mm calibre copper shot is concerned, its cost on average 176% more than lead shot, while the price differences between bismuth and tungsten shot on the one hand and lead shot on the other are even more pronounced. The average prices of bismuth and wolfram cartridges respectively exceed lead cartridge prices by 306% and 647%.

According to the conclusions of the dossier report, the economic viability of the alternative to lead shot is good.

The copper, bismuth and wolfram alternatives are economically unviable at the time of this report's drafting. The steel alternative may currently turn out to be economically viable, but in the event of a total ban on lead shot, increased product demand and supply shortages could have an impact on manufacturers' ability to provide an ample supply of steel shot. This would exert an influence on steel ammunition prices in the short and medium-term and therefore on the cost of cartridges.

Due to the evident fall in the number of game animals bagged, there is a much greater risk of hunters giving up hunting because they would lack the incentive of having minimally successful hunting days.

We highlight once more that steel shot:

- Loses its energy rapidly

- Disperses shots, leaving clear gaps in its pellet distribution

- Does not deform on impact, thus wounding numerous game animals with no chance of bagging them and causing them suffering.

-There is no chance of constricting shot pellets due to the impossibility of fitting tight chokes

4.4.5. Effectiveness and risk reduction (environmental):

The ECHA dossier report identified the following main risks for the environment as regards this restriction and what its implementation would suppose:

- Release of 14,000 tonnes lead shot a year, 280,000 tonnes over 20 years. A total ban with a 5-year transition period (70,000 tonnes) would suppose preventing the release of 210,000 over 20 years.

Despite the macro figures set out by the ECHA, the EU-27 legally permits an amount of lead to be released per unit area through fertilisers that is twice the amount of lead released in the form of lead shot. **According to the data gathered in this report, said release is lower than the figure indicated by the ECHA, and affirms that it will be further reduced in the future due to a significant fall in the number of hunters (recruitment) who annually apply for hunting licences. In addition, there is an even more pronounced diminishing trend in the number of hunters engaged in small game hunting and, hence, they will use less lead shot in their activity**.

- At least 135 million birds would be exposed the risk of primary poisoning, from the which 1.2 million game birds die annually from direct lead shot ingestion. Other birds (not quantified) would die as a consequence of sublethal effects. If the placing on the market or use of lead ammunition for hunting is not banned, 14 million birds would be at risk of secondary poisoning (including raptor and scavenger species). The number of birds which die from secondary poisoning, as well as from both lethal and sublethal effects, could not be properly quantified due to a lack of specific data. Only a general restriction on lead shot would ensure complete protection. It must be taken into account that the main predator in modern ecosystems are hunters, and that hunting remains (that is to say, discarded offal from major game hunting after "field dressing") are a much more significant food source for wildlife than at any other time in history for many species, particularly obligate scavengers. Burying hunting remains if they contain lead particles would greatly reduce the availability of food for many species, including rare species, and cannot be considered an option to reduce risks. Moreover, around 650 million birds (at least) would be exposed to some risk of primary ingestion and around 50 million birds (at least) would be exposed to a risk of secondary ingestion.

As has been analysed in this report, the order of magnitude set out in the ECHA dossier report is simply unrealistic. Concepts such as lead-induced mortality of total mortality are mixed up, cumulative mortality over lengthy time periods is used instead of annual mortality, and specific individual cases are extrapolated to the entire (species) population. The annual figures of 135,000,000 birds being affected by primary poisoning and 14,000,000 birds by secondary poisoning are unrealistic. The figures calculated in this report vary greatly from those set out by the ECHA, finding that 23,000 birds might be affected by primary poisoning and 400 birds by secondary poisoning.

5. CONCLUSIONS:

A. With the information available, there is no statistically significant scientific evidence which shows that the use of lead shot for small game hunting in the terrestrial environment poses a risk to the environment.

B. The use of lead shot for small game hunting in the terrestrial environment does not pose a risk to animal populations. Only 0.0005% of some bird species could be exposed to lead shot used in small game hunting, which translates into a figure of 23,400 birds as against the 149,000 million birds set out in the ECHA dossier report. In so far as the risk of lead intoxication is concerned, most of the species with EU-27 populations are undergoing an upward trend, a fact which contrasts with the figure of birds potentially at risk set out in the ECHA dossier report.

C. The use of lead shot for small game hunting in the terrestrial environment does not pose a risk to the soil, groundwater, surface water, livestock grazing or agricultural use.

D. The ECHA dossier report was drafted for a particular set of lead uses (hunting, shooting and fishing) on a joint basis. In a document of such transcendence, each specific use of lead should be dealt with as an independent document, since the ECHA is unable to differentiate among lead sources on numerous occasions, as the dossier report itself admits.

E. The ECHA dossier report does not analyse other possible lead sources, such as landfills or waste dumps, mines, petrol-derived contamination and principally the products used in agriculture. This report clearly shows that the amount of lead that may be legally (legislated) released to the natural environment through agriculture is twice the amount of lead in the form of gunshot used for small game hunting.

F. This report demonstrates that there are no suitable or economically viable alternatives to replace lead shot used for small game hunting in the terrestrial environment.

G. Lastly, the research on lead sources should continue, using new techniques like isotope ratio analysis. Future studies conducted on animal species in the terrestrial environment should be carried out outside intensive hunting areas with wild species that do not come from farms, always using sampling methods that do not include lead shot to capture said species.

6. BIBLIOGRAPHY

Arrondo, E., Navarro, J., Pérez-García, J. M., Mateo, R., Camarero, P. R., Rodríguez Martín-Doimeadios, R. C., Jiménez-Moreno, M., Cortés-Avizanda, A., Navas, I., García-Fernández, A. J., Sánchez-Zapata, J. A., Donázar, J. A. 2020. Dust and bullets: Stable isotopes and GPS tracking disentangle lead sources for a large avian scavenger. *Environmental Pollution* 266 (Part 3), 115022.

Berny, P., Vilagines, L., Cugnasse, J. M., Mastain, O., Chollet, J. Y., Joncour, G. & Razin, M. 2015. VIGILANCE POISON: Illegal poisoning and lead intoxication are the main factors affecting avian scavenger survival in the Pyrenees (France). Ecotoxicology and Environmental Safety, 118, 71-82.

BirdLife International (2015) European Red List of Birds. Luxembourg: Office for Official Publications of the European Communities.

BirdLife International (2021) IUCN Red List of Birds. Downloaded from http://www.birdlife.org on 27/05/2021

Butt, A., Qurat-ul-Ain, Rehman, K. *et al.* Bioaccumulation of cadmium, lead, and zinc in agriculture-based insect food chains. *Environ Monit Assess* 190, 698 (2018)

Butler, D. A. 2005a. Incidence of lead shot ingestion in red-legged partridges (Alectoris rufa) in Great Britain. Veterinary Record 157: 661-662.

Butler, D. A., R. B. Sage, R. A. H. Draycott, J. P. Carroll, and D. Potts. 2005b. Lead exposure in ring-necked pheasants on shooting estates in Great Britain. Wildlife Society Bulletin 33: 583–589.

Carneiro, M., Nieto, R., Colaco, B., Brandao, R., Da Costa, R. G., Colaco, A., Pires, M., Oliveira, P. & Lavin, S. 2014. Acute Lead Poisoning in a Griffon Vulture Secondary to Bullet Ingestion. Journal of Comparative Pathology, 1, 124.

Cardiel, I. E., Taggart, M. A. & Mateo, R. 2011. Using Pb–Al ratios to discriminate between internal and external deposition of Pb in feathers. Ecotoxicology and Environmental Safety, 74, 911-917.

Clausen, B., and C. Wolstrup. 1979. Lead poisoning in game from Denmark. Dan. Rev. Game Bioi. 11: 1-22. ECHA 2018. 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 NUMBER: 1 .4. DATE: 27 November 2018.

De Sousa, S. 2020. Linking population trends of wild herbivores harvested in Portugal and Hunting Zone characteristics: Effects of location, management, interspecific competition and land use dynamics. Universidade de Évora.

Donázar, J. A., Palacios, C. J., Gangoso, L., Ceballos, O., González, M. A. J. & Hiraldo, F. 2002. Conservation status and limiting factors in the endangered population of Egyptian vulture (Neophron percnopterus) in the Canary Islands. Biological Conservation, 107, 89-97.

ECHA 2019a. ANNEX XV RESTRICTION REPORT, Proposal for a restriction, VERSION NUMBER: 2.0. DATE: 24 March 2021.

ECHA 2019b. ANNEX to the ANNEX XV RESTRICTION REPORT, Proposal for a restriction, VERSION NUMBER: 2.0. DATE: 24 March 2021.

EU COMMISSION 2019. Request to the European Chemicals Agency to prepare a restriction proposal on the placing on the market and use of lead in ammunition (gunshots and bullets) and of lead in fishing tackle conforming to the requirements of Annex XV to REACH, 16 July 2019.

Ferrandis P., Mateo R., López-Serrano F. R, Martínez-Haroand M., Martínez-Duro E. (2008). Lead shot exposure in Red-legged Partridge (Alectoris rufa) on a driven shooting estate. Environmental Science and Technology 42:6271–6277.

Franson, J. C., S. P. Hansen, and J. H. Schulz. 2009. Ingested shot and tissue lead concentrations in Mourning Doves. In R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt (Eds.). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA

Gangoso, L., Alvarez-Lloret, P., Rodríguez-Navarro, A. A., Mateo, R., Hiraldo, F. & Donazar, J. A. 2009. Long-term effects of lead poisoning on bone mineralization in vultures exposed to ammunition sources. Environmental Pollution, 157, 569-574.

Ganz, K., Jenni, L., Madry, M. M., Kraemer, T., Jenny, H. & Jenny, D. 2018. Acute and chronic lead exposure in four avian scavenger species in Switzerland. Archives of environmental contamination and toxicology, 75, 566-575.

Gil-Sanchez, J. M., Molleda, S., Sanchez-Zapata, J. A., Bautista, J., Navas, I., Godinho, R., Garcia-Fernandez, A. J. & Moleon, M. 2018. From sport hunting to breeding success: Patterns of lead ammunition ingestion and its effects on an endangered raptor. Science of the Total Environment, 613, 483-491.

Green, Rhys E.; Pain, Deborah J..(2020). Additional mortality rate of wildfowl caused by ingestion of lead shotgun pellets: a re-analysis of data from a 70-year-old field experiment on wild Mallards Anas platyrhynchos. Wildfowl, [S.l.], p. 242-256, Nov. 2020. ISSN 2052-6458.

Helander, B., Axelsson, J., Borg, H., Holm, K. & 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.

Hernández, M. & Margalida, A. 2009. Assessing the risk of lead exposure for the conservation of the endangered Pyrenean bearded vulture (Gypaetus barbatus) population. Environmental Research, 109, 837-842.

Hunter, B F, and Rosen, M N. 1965. Occurrence of lead poisoning in a wild pheasant (Phasianus colchicus). United States: N. p., 1965. Web.

Instituto Nacional de Estadística. 2018. *Estadística Anual de Caza*. Ministerio de Agricultura, Pesca y Alimentación, Madrid.

Imre, Á. (1994). Vadkacsák sörét eredetú ólommérgezése. Magyar Állatorvosok Lapja, 49, 345-348.

Isomursu, M., Koivusaari, J., Stjernberg, T., Hirvelä-Koski, V. & Venäläinen, E.-R. 2018. Lead poisoning and other human-related factors cause significant mortality in white-tailed eagles. Ambio, 47, 858-868.

Jenni, L., Madry, M. M., Kraemer, T., Kupper, J., Naegeli, H., Jenny, H. & Jenny, D. 2015. The frequency distribution of lead concentration in feathers, blood, bone, kidney and liver of golden eagles Aquila chrysaetos: insights into the modes of uptake. Journal of Ornithology, 156, 1095-1103.

Kenntner, N., Crettenand, Y., Fünfstück, H.-J., Janovsky, M. & Tataruch, F. 2007. Lead poisoning and heavy metal exposure of golden eagles (Aquila chrysaetos) from the European Alps. Journal of Ornithology, 148, 173-177.

Kenntner, N., Tataruch, F. & 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: An International Journal, 20, 1831-1837.

Kitowski, I., Jakubas, D., Wiącek, D., Sujak, A. & Pitucha, G. 2017. Trace element concentrations in livers of Common Buzzards Buteo buteo from eastern Poland. Environmental Monitoring and Assessment, 189, 421.

Komosa, A. & Kitowski, I. 2008. Elevated lead concentration in skeletons of diurnal birds of prey Falconiformes and owls Strigiformes from eastern Poland-ecological approach and review. Ecol Chem Eng S, 15, 349-358.

Krone, O., Kenntner, N., Trinogga, A., Nadjafzadeh, M., Scholz, F., Sulawa, J., Totschek, K., Schuck-Wersig, P. & Zieschank, R. 2009b. Lead poisoning in white-tailed sea eagles: causes and approaches to solutions in Germany. Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI, 10.

Krone, O., Wille, F., Kenntner, N., Boertmann, D. & Tataruch, F. 2004. Mortality factors, environmental contaminants, and parasites of white-tailed sea eagles from Greenland. Avian Diseases, 48, 417-424.

Larsen, R. T., J. T. Flinders, D. L. Mitchell, and E. R. Perkins. 2007. Grit size preferences and confirmation of ingested lead pellets in Chukars (Alectoris chukar). Western North American Naturalist 67:152-155

Lee DE, Hamman MG, Black JM (2004) Grit-site selection of black brant: particle size or calcium content? Wilson Bull 116:304–313

Legagneux, P., Suffice, P., Messier, J.-S., Lelievre, F., Tremblay, J. A., Maisonneuve, C., Saint-Louis, R. & Bêty, J. 2014. High risk of lead contamination for scavengers in an area with high moose hunting success. PLoS One, 9, e111546.

Lumeij, J., Wolvekamp, W. T. C., Bron-Dietz, G. & Schotman, A. 1985. An unusual case of lead poisoning in a honey buzzard (Pernis apivorus). Veterinary Quarterly, 7, 165-168.

MacDonald, J., Randall, C., Ross, H., Moon, G. & Ruthven, A. 1983. Lead poisoning in captive birds of prey. British Medical Journal Publishing Group.

Madry, M. M., Kraemer, T., Kupper, J., Naegeli, H., Jenny, H., Jenni, L. & Jenny, D. 2015. Excessive lead burden among golden eagles in the Swiss Alps. Environmental Research Letters, 10.

Massei G, Kindberg J, Licoppe A, Gačić D, Šprem N, Kamler J, Baubet E, Hohmann U, Monaco A, Ozoliņš J, Cellina S, Podgórski T, Fonseca C, Markov N, Pokorny B, Rosell C, Náhlik A. Wild boar populations up, numbers of hunters down? A review of trends and implications for Europe. Pest Manag Sci. 2015 Apr; 71(4):492-500.

Mateo, R., Taggart, M. & Meharg, A. A. 2003. Lead and arsenic in bones of birds of prey from Spain. Environmental Pollution, 126, 107-114.

Mateo, R., Estrada, J., Paquet, J.-Y., Riera, X., Domínguez, L., Guitart, R. & Martínez-Vilalta, A. 1999. Lead shot ingestion by marsh harriers Circus aeruginosus from the Ebro delta, Spain. Environmental Pollution, 104, 435-440.

Mateo R, Bonet A, Dolz JC, Guitart R (2000b) Lead shot densities in a site of grit ingestion for greylag geese Anser anser in Doñana (Spain). Ecotoxicol Environ Restor 3:76–80

Meyer, C. B., Meyer, J. S., Francisco, A. B., Holder, J. & Verdonck, F. 2016. Can Ingestion of Lead Shot and Poisons Change Population Trends of Three European Birds: Grey Partridge, Common Buzzard, and Red Kite? Plos One, 11.

Molenaar, F. M., Jaffe, J. E., Carter, I., Barnett, E. A., Shore, R. F., Rowcliffe, J. M. & Sainsbury, A. W. 2017. Poisoning of reintroduced red kites (Milvus Milvus) in England. European Journal of Wildlife Research, 63, 94.

Monica Martinez-Haro, Andy J. Green, Pelayo Acevedo, Rafael Mateo. Use of grit supplements by waterbirds: an experimental assessment of strategies to reduce lead poisoning. European Journal of Wildlife Research, Springer Verlag, 2010, pp.475-484.

Müller, K., Altenkamp, R. & Brunnberg, L. 2007. Morbidity of free-ranging white-tailed sea eagles (Haliaeetus albicilla) in Germany. Journal of avian medicine and surgery, 21, 265-274.

NWHL 1985. Lead poisoning in non-waterfowl avian species. In: LABORATORY, U. F. W. S. N. W. H. (ed.). Unpublished report.

Pain Deborah J., Mateo Rafael, Green Rhys E. (2019). Effects of lead from ammunition on birds and other wildlife:A review and update. Article in AMBIO A Journal of the Human Environment. March 2019.

Pain, D., Amiard-Triquet, C., Bavoux, C., Burneleau, G., Eon, L. & Nicolau-Guillaumet, P. 1993. Lead poisoning in wild populations of Marsh Harriers Circus aeruginosus in the Camargue and Charente-Maritime, France. Ibis, 135, 379-386.

Pain, D. & Amiardtriquet, C. 1993. Lead poisoning of raptors in France and elsewhere. Ecotoxicology and Environmental Safety, 25, 183-192.

Pain, D., Sears, J. & Newton, I. 1995. Lead concentrations in birds of prey in Britain. Environmental Pollution, 87, 173-180.

Pain, D. J., Meharg, A., Ferrer, M., Taggart, M. & Penteriani, V. 2005. Lead concentrations in bones and feathers of the globally threatened Spanish imperial eagle. Biological Conservation, 121, 603-610.

Pain, D., Carter, I., Sainsbury, A., Shore, R., Eden, P., Taggart, M. A., Konstantinos, S., Walker, L., Meharg, A. & Raab, A. 2007. Lead contamination and associated disease in captive and reintroduced red kites Milvus milvus in England. Science of the Total Environment, 376, 116-127.

Potts, G.R. (2005). Incidence of ingested lead gunshot in wild grey partridges (Perdix perdix) from the UK. European Journal of Wildlife Research, 51, 31-34.

Quortrup, E. & Shillinger, J. 1941. 3,000 wild bird autopsies on western lake areas. Journal of the American Veterinary Medical Association, 99, 382-387.

Romero, Diego & José, Antonio & Theureau, Juan & Ferrer, Andrés & Soler, Juan Bautista. (2021). Estudio isotópico sobre plomo en aves cinegéticas.

Romero, Diego & José, Antonio & Theureau, Juan & Ferrer, Andrés & Raigón, María & Soler, Juan Bautista. (2020a). Lead in terrestrial game birds from Spain. Environmental science and pollution research international.

Romero, Diego & José, Antonio & Theureau, Juan & Ferrer, Andrés & Soler, Juan Bautista. (2020b). Presencia de perdigones y niveles hepáticos de plomo en aves cinegéticas cazadas con munición sin plomo.

Sánchez-Virosta, P., León-Ortega, M., Calvo, J. F., Camarero, P. R., Mateo, R., Zumbado, M., Luzardo, O. P., Eeva, T., García-Fernández, A. J., Espín, S. 2020. Blood concentrations of 50 elements in Eagle owl (Bubo bubo) at different contamination scenarios and related effects on plasma vitamin levels. *Environmental Pollution* 265 (Part A), 115012.

Soler-Rodríguez F, Oropesa-Jiménez AL, García-Cambero JP, Pérez-López M (2004) Lead exposition by gunshot ingestion in Red-legged Partridge (Alectoris rufa). Vet Hum Toxicol 46:133-134.

Stamberov, Petar & Zhelev, Chavdar & Todorov, Toni & Ivanova, Sofiya & Mehmedov, Tanju & Manev, Iliyan & Taneva, Ella. (2018). Epidemiological Data on Lead Tissue Concentration in Game Birds Induced by Lead Pellets. 1. 479-484. 10.2478/alife-2018-0075.

Taggart, M. A., Shore, R. F., Pain, D. J., Peniche, G., Martinez-Haro, M., Mateo, R., Homann, J., Raab, A., Feldmann, J. & Lawlor, A. J. 2020. Concentration and origin of lead (Pb) in liver and bone of Eurasian buzzards (Buteo buteo) in the United Kingdom. Environmental Pollution, 267, 115629.

Thomas VG, Scheuhammer AM, Bond DE (2009). Bone lead levels and lead isotope ratios in red grouse from Scottish and Yorkshire moors. Science of the Total Environment 407(11), 3494-3502.

West, C. J., Wolfe, J. D., Wiegardt, A. & Williams-Claussen, T. 2017. Feasibility of California Condor recovery in northern California, USA: contaminants in surrogate Turkey vultures and Common Ravens. The Condor: Ornithological Applications, 119, 720-731.