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Economic assessment of wild bird mortality induced by the use of lead gunshot in European wetlands

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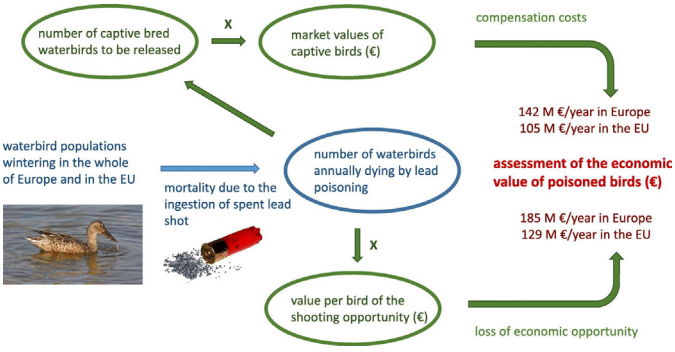
HIGHLIGHTS

- Waterbirds mortality due to lead shot ingestion is a relevant political issue.
- New methods to assess economic cost of lead poisoning on waterbirds are proposed.
- Cost estimates convert biological data into relevant information for policy.
- Restocking with captive birds in Europe would cost 105–142 million euros per year.
- Lost shooting opportunities imply an annual GVA reduction of 129–185 million euros.

GRAPHICAL ABSTRACT



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ABSTRACT

In European wetlands, at least 40 bird species are exposed to the risk of lead poisoning caused by ingestion of spent lead gunshot. Adopting a methodology developed in North America, we estimated that about 700,000 individuals of 16 waterbird species die annually in the European Union (EU) (6.1% of the wintering population) and one million in whole Europe (7.0%) due to acute effects of lead poisoning. Furthermore, threefold more birds suffer sub-lethal effects. We assessed the economic loss due to this lead-induced mortality of these 16 species by calculating the costs of replacing lethally poisoned wild birds by releasing captive-bred ones. We assessed the cost of buying captive-bred waterbirds for release from market surveys and calculated how many captive-bred birds would have to be released to compensate for the loss, taking into account the high mortality rate of captive birds (72.7%) in the months following release into the wild. Following this approach, the annual cost of waterbird mortality induced by lead shot ingestion is estimated at 105 million euros per year in the EU countries and 142 million euros in the whole of Europe. An alternative method, based upon lost opportunities for hunting caused by deaths due to lead poisoning, gave similar results of 129 million euros per year in the EU countries and 185 million euros per year in the whole of Europe. For several reasons these figures should be regarded as conservative. Inclusion of deaths of species for which there were insufficient data and delayed deaths caused indirectly by lead poisoning and effects on reproduction would probably increase the estimated losses substantially. Nevertheless, our results suggest that the benefits of a restriction on the use of lead gunshot over wetlands could exceed the cost of adapting to non-lead ammunition.

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1. Introduction

It has been known since the end of the 18th century that ingestion of lead pellets causes deaths of birds both in terrestrial and aquatic habitats (Calvert, 1876; Grinnell, 1894). In wetlands, ducks, geese, swans, waders, rails, flamingos and other waterbirds ingest spent gunshot from the soil surface and from mud. Differences among waterbird species in the proportion of sampled birds with ingested lead pellets in the alimentary tract tends to be consistent, despite large differences for a given species among regions and countries (Green and Pain, 2016; Mateo, 2009). Species which take in large-diameter grit to grind up their food in the muscular gizzard and which feed on large seeds tend to ingest lead pellets frequently, whereas species which ingest small-diameter grit and feed on leaves rarely ingest gunshot (Bellrose, 1959; Mateo, 2009; Mateo et al., 2000; Thomas et al., 1977). These observations support the idea that waterbirds ingest gunshot pellets because they mistake them for grit or food items. Both grit and lead pellets are usually retained until they are totally milled (Del Bono and Braca, 1973). Infrequently, some pellets pass through the alimentary tract and are eliminated in the faeces, but their mass is greatly reduced by then, owing to the combined effects of mechanical abrasion and gastric acid (Plouzeau et al., 2011). Substantial amounts of lead derived from ingested gunshot are absorbed by the digestive system of the bird and enters their bloodstream (Rodríguez et al., 2010). Given the high toxicity of this metal (De Francisco et al., 2003), the ingestion of just one pellet can be enough to cause the death of a small or medium-sized duck by primary poisoning (Guillemain et al., 2007; Mautino and Bell, 1986; Olney, 1960).

In wetlands open to hunting, the density of lead pellets lying in superficial sediments may reach very high densities, up to hundreds per m^2 (Bianchi et al., 2011; Mateo, 2009). In Europe, the highest pellet densities have been recorded in north-western countries and in the Mediterranean region, where most of western Palearctic Anatidae (ducks, geese and swans) congregate to overwinter (Scott and Rose, 1996). Therefore, waterbird populations are exposed to a substantial risk of lead pellet ingestion. The proportion of wildfowl found in Europe with ingested gunshot is normally high, both in hunter-shot birds and in birds dead from other causes (Green and Pain, 2016; Mateo, 2009; Pain et al., 2015). According to a conservative estimate, based upon the prevalence of pellet ingestion in 17 waterfowl species wintering in Europe, around one million Anatidae die every year as a consequence of lead poisoning, which corresponds to 8.7% of the wintering population (Mateo, 2009).

Raptors living in wetlands are also exposed to the risk of secondary poisoning with lead when they depredate or scavenge lead-contaminated animals. The intoxication may occur when a raptor eats a waterbird with lead pellets in the digestive tract, with elevated lead levels in its tissues or with embedded shot-in pellets, including un-retrieved quarry that has been wounded or killed by hunters (Helander et al., 2009; Mateo, 2009; Mateo et al., 1999; Pain, 1991; Pain et al., 1993, 1997; Wayland and Bollinger, 1999). Such events are likely to occur frequently, given the high prevalence of waterbirds with ingested and/or embedded shot pellets revealed by several studies (Falk et al., 2006; Guillemain et al., 2007; Tavecchia et al., 2001).

Because of the high prevalence of lead poisoning in waterbirds, the issue is addressed in several Multilateral Environmental Agreements (Stroud, 2015). These include the UNEP-CMS Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), which was approved in 1995 (Beintema, 2001). Furthermore, in recent decades many countries have been adopting partial or total bans on the use of lead ammunition to avoid or reduce the accumulation of spent lead gunshot in wetlands (AEWA Secretariat, 2008). In this framework, the European Union (EU), as a signatory party of the AEWA Agreement, in 2015, started a process to assess whether a generalized ban could be introduced under the Regulation for the Registration, Evaluation, Authorization and Restriction of Chemical Substances (REACH), adopted to improve the protection of human health and environment from the risks posed by chemicals. For this purpose, the European Commission, in accordance with Article 69 (1) of the REACH Regulation, has requested the European Chemicals Agency (ECHA) to assess the possible risks posed by lead gunshot to human health and the environment, particularly to aquatic bird species, and the need for EU-wide action. ECHA has prepared an Annex XV dossier (ECHA, 2017). Restriction proposals need to contain a description of the risks as well as information on the health and environmental benefits, the associated costs and other socio-economic impacts.

In this paper we aim to provide an estimate of the economic value of the waterbirds which are lost annually because of poisoning by spent lead gunshot. We do this by i) proposing two new approaches to quantify monetary damages caused by injuries to waterbirds and ii) applying these approaches to evaluate the economic value of waterbirds poisoned by lead pellets in the 28 EU Member States and in the whole of Europe. In the last few decades, several methods have been developed to quantify monetary damages for injuries caused to wildlife, habitat, and the services they provide (Ando and Khanna, 2004; Hampton and Zafonte, 2003). A practical way to assess Natural Resource Damage (NRD) is to evaluate the cost of remediation and/or restoration interventions (Burger, 2008; Cole, 2010). When NRD has a relevant impact on birds, three different procedures can be followed to recover the affected populations: 1) implementation of habitat restoration projects with potential ecological benefits for birds (Norton and Thomas, 1994; Zafonte and Hampton, 2005); 2) reduction of mortality deriving from other causes that can be prevented more easily (Cole and Dahl, 2013); 3) restocking/reintroduction programmes to replace birds that die because of human-related causes. The first two procedures have been applied especially at local levels where compensatory actions can be effective, while the last method is widely adopted by hunters in many European countries to counteract the effects of overhunting and enhance their hunting opportunities (Champagnon, 2011; Söderquist, 2015), or as part of conservation projects (Pacheco and McGregor, 2004; Tavecchia et al., 2009). We used the third of these methods and estimated the costs involved in replacing the loss of waterbirds poisoned by lead shot used in aquatic habitats, through the release of captive-bred birds. In the case of waterbirds, restocking costs can be estimated because most species are reared in captivity and sold either as ornamental birds or hunting decoys. Furthermore, in Europe three million hand-reared mallards (*Anas platyrhynchos*) are estimated to be released annually to enhance hunting opportunities (Champagnon, 2011; Champagnon et al., 2016; Söderquist, 2015). These circumstances offer the opportunity to assess the value of each bird and also to evaluate the effectiveness of restocking programmes. A further consideration is that studies carried out on mortality rates revealed that released captive-bred waterbirds have a life expectancy considerably lower than wild individuals (Schladweiler and Tester, 1972; Söderquist et al., 2013; Tavecchia et al., 2009). The main reasons for their low survival are: 1) inadequate development of the digestive system in juveniles fed with artificial food and their consequent inability to adapt to natural food; 2) inexperience of captive birds not used to search for food in natural habitats; 3) inadequate behavioural responses to predators (Champagnon, 2011; Champagnon et al., 2012). To counterbalance this additional post-release mortality, restocking programmes should foresee the release of a number of birds largely exceeding the losses that they are intended to compensate. This implies extra costs to be evaluated in NRD assessments because a high proportion of released waterbirds are expected to die before their use value is realised during the hunting season.

An alternative method for NRD evaluation is to estimate the opportunity cost of waterbird hunting foregone by hunters because of the deaths of lead-poisoned birds. We evaluate the per capita Gross Value Added GVA) of hunted ducks and geese in the UK and use this, together with estimates of annual waterbird deaths caused by lead poisoning, to evaluate economic loss at the European and EU levels.

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