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GUIDELINES TO PREVENT THE RISK OF POISONING TO MIGRATORY BIRDS

(*Prepared by the CMS Preventing Poisoning Working Group*)

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Introduction and key working group recommendations

Poisoning is a significant global problem affecting a wide range of migratory bird species across almost all habitats. Birds may be exposed to multiple sources of poisoning in their ranges causing lethal and sub-lethal effects, such as a loss of migratory orientation, reduced reproductive output and increased risk of predation, with birds of prey being one of the most vulnerable to poisoning. These impacts include poisoning from:

- feeding on rodents and insects exposed to pesticides (particularly, second-generation anticoagulant rodenticides and the insecticides carbamates and organophosphates);
- poison baits used to control predators and protect game estates, and harvesting;
- feeding on domestic livestock carcasses treated with veterinary pharmaceuticals; and
- ingestion of lead ammunition and/or fishing weights directly from the environment or within prey or carrion.

Further information about the effects on birds is found in the CMS Review of Ecological Effects of Poisoning (2014) (UNEP/CMS/COP11/Inf.34). Globally, most of the drivers resulting in exposure of birds to toxic substances are related to three main activities: (1) agricultural protection of crops and livestock from predators, pests, and diseases; (2) hunting and fishing; and (3) harvesting birds with poison-baits for consumption, e.g., traditional medicine.

In 2011, the Convention on Migratory Species (CMS) recognised this problem and adopted Resolution 10.26 at the 10th Conference of the Parties. This Resolution established a Working Group to advise the CMS Scientific Council on the impacts of poisoning on migratory birds, efforts made to tackle the problem and to produce guidelines on the most effective ways to prevent poisoning.

The work of the Working Group has been coordinated on behalf of CMS by Symone Krimowa, employed by the RSPB with funding from the UK Government (DEFRA) and the CMS African-Eurasian Raptor Memorandum of Understanding. The Working Group met in Tunisia on the 27-31 May 2013 (with funding from the Swiss Government and the European Science Foundation). This technical workshop developed draft global Guidelines for submission to the CMS Scientific Council.

These Guidelines to Prevent Poisoning of Migratory Birds have been developed for adoption by the Conference of the Parties in 2014. Thereafter, it is the responsibility of individual states to transpose the guidelines into their own policy systems. There are a number of non-legislative recommendations that can be utilised by the agricultural sector, hunting/fishing communities and other stakeholders in addition to voluntary compliance with the legislative recommendations in advance of their adoption.

The recommendations cover five priority poisoning areas: insecticides, rodenticides, poison-baits, veterinary pharmaceuticals, lead ammunition and fishing weights.

The key recommendations developed by the CMS Preventing Poisoning Working Group in Tunis, Tunisia on the 27-31 May 2013 from the Guidelines are specifically:

i. Substitute (remove and replace) insecticides with a high risk to birds with safe alternatives, and inclusion of criteria in the Rotterdam Convention to reduce risks of imports toxic to birds, promotion of Integrated Pest Management, and identification of areas of significant risk of poisoning of migratory birds and mitigation of impacts through working with stakeholders;

ii. Restrict/ban the use of second-generation anticoagulant rodenticides in open field agriculture (excluding best practice use for invasive species management); use best practice for the treatment of rodent irruptions minimising use of second-generation anticoagulants; and stop permanent baiting, with preventive rodent measures used instead;

iii. Prohibit the use of poison-baits for predator control for livestock protection and game management (excluding best practice use for invasive species management) and creation or improvement of enforcement legislation, through deterrent mechanisms and infringement penalties, and restriction of access to highly toxic substances, with human-wildlife conflict resolved via multi-stakeholder forums;

iv. Prohibit the use of veterinary diclofenac for the treatment of livestock and substitute with readily available safe alternatives, such as meloxicam, with mandatory safety-testing of all new veterinary pharmaceuticals for risks to scavenging birds before market authorization is granted;

v. Phase-out the use of lead ammunition across all habitats (wetland and terrestrial) with non-toxic alternatives within the next three years with Parties reporting to Conference of the Parties (CoP12) in 2017, working with stakeholders on implementation; promotion of leadership from ammunition-users on safe alternatives, and remediation of lead-polluted sites where appropriate; and

vi. Phase-out the use of lead fishing weights in areas where migratory birds have been shown to be particularly at risk i.e. freshwater habitats, (excluding fishing weights used in coastal areas where there are significant knowledge gaps and further research needed) with non-toxic alternatives, within the next three years with Parties reporting to the Conference of the Parties (CoP12) in 2017, working with all stakeholders on implementation; and promotion of leadership from fishers on safe alternatives.

Recommendations to prevent risk to birds from insecticides used to protect crops

1. Introduction

Bird species that inhabit farmland or use farmland during migration (and in breeding and wintering areas) are at risk of exposure to pesticides used for crop protection, even if used normally per labelled requirements. Effects on birds arising unintentionally from the approved use of pesticides in agriculture are inherently variable (Hart 2008). Studies have estimated between 0.25 and 8.9 birds per hectare of agricultural area in North America are killed each year by pesticides, with certain species more affected than others (Boutin, Freemark and Kirk 1999; Pimentel, et al. 1992), which is unlikely to reflect approved products today, but may still exist in some parts of the world where older substances are used.

Labelled uses of pesticides in North America, Canada and the United Kingdom contributed to 181/736, 92/126, and 7/136, respectively, of documented raptor deaths reported by the specific country monitory schemes between 1985 and 1995 (Mineau, et al. 1999). Bird deaths in other parts of the world are largely unknown and are a key area for further research. This review focuses on improving legal/approved use and reducing misuse (e.g., negligent application inconsistent with label requirements) of pesticides world-wide. Intentional abuse of pesticides, e.g., poison-baits, is discussed in a separate section herein.

Insecticides and rodenticides (rodenticides are discussed in a separate section) are the main pesticides of risk to birds. Waterfowl and some gamebirds which feed on agricultural foliage are at potential risk of exposure. Granivorous passerines may feed on pesticide-treated seeds. Birds in agricultural habitats that prey on insects or scavenge animals that may have been poisoned by insecticides are likewise at risk of exposure to agricultural insecticides.

The likelihood of exposure to insecticides is influenced by a number of factors, including:

- cultivation practices (Osten, Soares and Guilhermino 2005; Mineau et al. 2005);
- crop types (Parsons, et al. 2010);
- pest types (Mineau et al. 1999);
- form of pesticide, e.g., granules, liquids, and persistence in the environment (Prosser, et al. 2006); and
- ecology – diet and habitat preferences of the bird species (Corson, et al. 1998).

If a migratory bird is likely to come into contact with pesticides in either breeding or wintering grounds (exposure risk may be higher in wintering areas because birds often spend the majority of their time in those areas (Faaborg, et al. 2010)), the specific nature of the pesticide, e.g., mode of action and toxicity level to birds, is significant in terms of whether adverse effects may result. The broad spectrum toxicity of many insecticides may lead to birds in the vicinity being at risk of lethal, or sublethal effects, at the time of pesticide application or shortly thereafter, or if they feed on exposed prey or contaminated foliage, and if exposure exceeds safe levels. This is particularly true for organophosphates and carbamates, which are currently the most commonly used substances globally. The use of neonicotinoids is rising, especially as seed treatments, which early evidence indicates may pose a lower risk of poisoning of birds than many organophosphates and carbamates. In some cases, e.g., granular formations, the risk of intoxication can last for months after application of the pesticide (Dietrich, et al. 1995).

Several of the insecticides of high risk to birds, such as carbofuran, have been removed from the agricultural market in developed countries. Others, such as diazinon and chlorpyrifos have seen their use restricted, often because of concerns over human health, but birds have benefitted from these restrictions. Recent analyses from the United States indicate that the use of insecticides that are acutely toxic to birds may have been the most important factor explaining farmland bird declines over the last decades (Mineau and Whiteside 2013).

However, much of the direct effects recorded in the literature are related to the use of substances that are now highly regulated (although they are still used in some regions). This may imply that the insecticides causing the declines in bird species are no longer used in agricultural crop protection in many developed countries.

The risk from insecticides to birds may have decreased in areas where older substances of high risk to birds are no longer used. However, these substances are likely to have been replaced with newer substances whose impacts on birds may not yet have been fully characterised, or have not been in use for a sufficiently long period of time for potential effects in free-living birds to be fully evaluated.

Furthermore, the implications of sublethal and direct reproductive effects of insecticides on birds are little understood and/or are difficult to study in the field. Migratory birds may be particularly susceptible to sub-lethal effects from insecticides if they cause reduced movement (Galindo, et al. 1985), increased vulnerability to predation (Brewer, et al. 1988) and/or affect migratory orientation (Vyas, et al. 1995). Population impacts associated with the depletion of food sources (indirect effects) are not covered in this study.

Noting that neonicotinoid insecticides have become a main replacement for the organophosphates and carbamates reviewed and given their high usage and potential toxicity to vertebrates, bird mortality incidents associated with use should be monitored and reported. Further research to investigate potential unforeseen risks from neonicotinoids and other approved insecticides which may pose a similar hazard, should be considered.

2. Non-legislative recommendations

2.1. Identify local risk hot spots and work with local stakeholders to reduce risk

The risk of pesticide poisoning for migratory birds is greater in those species that have breeding, wintering and stopover sites in agricultural areas where pesticides (particularly carbamates and organophosphates) are used (Strum, et al. 2008). As a result, poisoning hotspots within breeding, wintering and stopover sites need to be identified and addressed by working with local stakeholders.

Risk models exist to identify pesticide uses that present a high risk of acute intoxication and these should be applied more broadly. Better identification of likely risk from insecticides to migratory birds and hotspot risk areas could be achieved by conducting studies in which habitat (initially focusing on the habitat of threatened species and areas of high bird concentration) and areas of pesticide use are overlaid.

Hot spots can be prioritised for encouraging change in pesticide usage by working with local stakeholders, particularly pesticide users in those high-risk regions. Advice to local stakeholders on how to limit risky pesticide usage could include integrated pest management strategies (see below), bird-friendly crops (Nájera and Simonetti 2010), and changes to pesticide application timing and methods.

Monetary incentives to change farmers' behaviour are often short-term, ending with the completion of the subsidies. In contrast, non-monetary incentives, such as social influence, personal satisfaction derived from being environmentally responsible, attachment to a cause (e.g., declining bird populations), and locally-developed policies can be effective and long-lasting motivations to change farming practices (De Young, et al. 1993; Pieters 1991); see Figure 1 for examples.

Figure 1: Examples of non-monetary incentives

Social influence (opinion leaders)
Opinion leaders influence the opinions and behaviour of others in their social system by learning about innovations and then passing information on to their friends and/or co-workers (Vining and Ebreo 2002). In a study of pro-environmental consumer behaviour, Flynn and Goldsmith were able to identify a group of women who performed as opinion leaders; they knew more about environmentally friendly consumer goods and engaged in pro-environmental consumer behaviour more frequently than others (Flynn and Goldsmith 1994).

Locally-developed policies
Locally-developed policies are far more likely to be respected and understood by local people (Berkes 2004; Ostrom 1990), in comparison with externally-imposed rules (Cardenas et al., 2000), and would probably be sustained for a period if monetary payments ceased.

For example, in Cambodia, bird nests are vulnerable to human disturbance, particularly egg and chick collection for wildlife trade. The protection of bird nests are valued by the local community only because a wildlife charity chooses to pay for their protection, not through any particular recognition of the birds' importance, and if payments stopped, even temporarily, collection of bird nests would probably resume (Clements, et al. 2010). Payment programs that are structured to facilitate intrinsic motivations are therefore far more likely to be successful and outlast monetary payments. Additionally, the assignment of nests to individual landowners (on a voluntary basis) reduced nest losses from 54% to 2% in Finland (Santangeli, et al. 2012).

However, often the biggest deterrent to behaviour change is the lack of knowledge of bird-friendly farming practices. Precise information on how, where and what to do is essential for uptake of new techniques (Jacobson, et al. 2003). Therefore, education programmes with local stakeholders (building on influencing strategies produced by the Convention on Biological Diversity/IUCN1), which include non-monetary incentives, should be a key focus for implementation of these Guidelines.

3. Legislative recommendations

3.1. Improve global governance and risk assessment: include migratory bird criteria in Rotterdam Convention to reduce risk of imports of products highly toxic to birds

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (the Convention) entered into force in 2004 and has 153 parties and aims for environmentally sound use of hazardous chemicals. The Convention regulates the international trade of chemicals and currently regulates 43 chemicals, including 32 pesticides. Mandatory consideration of effects of pesticides on migratory birds (eg, migratory bird criteria) could achieve better informed decision-making, particularly when:

(1) national governments are deciding whether to allow import of pesticides:
Risks to migratory birds should be made a mandatory and more prominent component of the guidance so that countries can assess the likelihood of risks to migratory birds in their own region. This information is highly influential because many countries do not carry out their own risk assessments but follow international guidance (Wesseling, et al. 2005).

(2) the Convention is deciding whether to regulate additional pesticides:
The Convention also contains a mechanism for evaluating and regulating additional chemicals (making them subject to the import consent procedure) (Henrik 2010). The review includes eco-toxicological properties of the pesticide formulation, environmental incidents in other States (including bird poisoning), and the existence of environmental restrictions or environmental guidelines in other states.

For both processes, the weight each factor is given when assessing whether to import or regulate the chemical is unknown. There may be an opportunity for CMS, and others, such as the Partners in Flight Group, to work with the Rotterdam Secretariat to develop decision-making criteria that include mandatory consideration of the risk to migratory birds when assessing proposals. This criterion should also be given an effective weight relative to the other decision-making criteria.

3.2. Substitute (remove from the market and replace with environmentally safe with alternatives) substances of high risk to birds and incentivise alternatives, such as integrated pest management; introduce mandatory evaluation mechanisms for existing and new products

Substances of high risk to birds should be immediately substituted. Substances likely to result in lethal or sublethal effects contributing to population declines should be removed and replaced with environmentally safe products.

A pesticide regulatory system should incorporate consideration of effects on migratory birds so as to: (1) ensure substances of high risk to migratory birds are not permitted for use in activities that could result in exposure of migratory bird populations – preventative; and (2) allow for removal of substances if evidence indicates risks to migratory birds from their use – evaluative. These Guidelines focus on the latter, although the risk assessment process for new products also needs further development in both developed and less-developed regions (Forbes and Calow 2013; Murfitt 2012; Kramer, et al. 2011; Sala, et al. 2010).

Regulatory systems should be made more responsive to new information (e.g., regular evidence-based reviews) so that if evidence of risk to migratory birds is discovered post-approval, it can be used to review the approval of the substance and, if necessary, remove certain labelled uses (Hooper, et al. 2010).

[1] Convention on Biological Diversity/IUCN resource on influencing stakeholders: http://bch.cbd.int/protocol/outreach/CBD-Toolkit.pdf.

Figure 2: Example of successful product removal, the case of the Swainson's hawks in Argentina

After provision of evidence of severe effects on Swainson's hawks (*Buteo swainsoni*) in Argentina caused by the insecticide monocrotophos, there was a review that led to the removal of the product from the market in that country (Goldstein, et al. 1999). Despite this being the first such action by Argentina, legislation was rapid and expeditious in protecting migratory birds. Monocrotophos was replaced without negative consequences to the agricultural economy of the country.

National legislative mechanisms should include a mandatory review/evaluation process with criteria to adjust labelled/approved uses, if evidence shows it is necessary to do so. To ensure a re-evaluation process is triggered when risks to migratory birds may occur (Mineau 2003), a monitoring system needs to be put in place. Monitoring of insecticide use and recording of effects on migratory birds should be part of the required mitigation plan at the stage of the original approval of the product's use.

3.3. Adopt integrated pest management at national level and provide incentives for farmers, such as certification schemes and public support

Integrated Pest Management (IPM) is a sustainable approach to crop production and protection that combines different management strategies and practices to grow healthy crops and prevent the use of pesticides, thereby limiting the risk of poisoning of non-target species, including migratory birds (FAO). Studies have shown that IPM systems yield greater biodiversity and reduce pesticide use by at least 20% compared with conventional farming (Freier and Boller 2009). Therefore, many countries have initiated IPM programmes.

Implementation of IPM has been slow compared with approaches associated with individual field-based, market driven (and industry promoted) management (Goodell, et al. 2012). Barriers to adopting IPM are prevalent and include difficulties in stakeholders learning how to use new technologies and decision-making tools, as well as absorbing the transition and possibly higher ongoing costs compared with conventional methods (Brewer, et al. 2009). Additional reasons for the low uptake of IPM are that the benefits of IPM may not be as immediate as conventional agriculture, and they occur over the long-term, benefitting both individual farmers and the community (Goodell, et al. 2012).

Incentives are needed to encourage current users of substances of risk to birds, particularly in agricultural crops (food and non-food crops), to move to an IPM approach, and could include:

- **Certification**

Certification will give food and non-food crop producers access to a national or international third-party certification system for goods produced and protected using IPM. This will provide consumers with information to identify goods in the marketplace that are produced under IPM standards. It has been shown that consumers often prefer products with sustainable labels, thereby, potentially increasing attractiveness of the IPM-farmers' products (Durham, et al 2012). The use of third-party labelling can encourage a move towards environmentally-friendly consumption patterns and also induce governments to increase environmental standards for products through current regulatory systems (Gallastegui 2002).

- **Public support**

All governments provide some public support to their domestic agriculture and rural sector, which provides an opportunity to re-target this support to sustainable practices, such as IPM (Pretty, et al. 2001). Public support, particularly government-funded programmes, to encourage farmer adoption of IPM strategies is an important tool to increase the use of IPM (Brewer, et al. 2004). Conservation-focussed government subsidies are popular in Europe, United States and Canada, and IPM should be integrated or given further emphasis in these programmes (Casey 1999; Baylis, et al. 2008), and some countries even have legal obligations to carry out IPM practices (eg, Sustainable Pesticide Directive in the European Union). Some of the schemes have been designed to address the loss of farmland birds (Dobbs and Pretty 2004), which could provide seamless integration of IPM to prevent risks of pesticides to birds.

A tax on pesticide purchases by farmers (specifically those insecticides with the most risk to non-target species, such as birds) would increase the cost of products causing the most harm to the environment could operate as a monetary incentive to switch to integrated pest management strategies (Falconer 1998). Pesticide taxes have been used in, for example, Denmark, Finland, Sweden and the United States; however, it may take a large price increase to change farmers' behaviour (Pretty, et al. 2001). Research shows that higher prices may not change demand without supportive measures to help farmers change their practices (Praneetvatakul, et al. 2013).

Quotas on pesticide usage may be more effective than taxation or subsidies (Skevas, et al. 2012). By establishing quotas on individual use of pesticides there is also the opportunity to create a tradable market for pesticides to maximise efficiency and reduce pesticide usage. A tradable permit system would mean that farmers who use fewer pesticides could transfer/sell their quotas to farms that have more pesticide intensive crops and systems in place (Jensen, et al. 2002); thereby creating an incentive to reduce pesticide usage in order to profit from the sale of remaining quotas.

As awareness of IPM grows and while taxes/quotas are in place, it may make alternatives, such as IPM, more attractive to farmers. In the interim, the revenues generated from taxation of pesticides could be used for public support of IPM practices and/or for post-registration monitoring of use and research.

To be fully effective, both of these approaches, either to encourage good practices through financial support or penalising environmentally costly behaviour through taxes, require awareness-raising and education for pesticide users. For example, farmer field schools have a positive impact on the use of IPM (Van den Berg and Jiggins 2007). The diffusion of IPM strategies and their uptake by farmers may be stronger through social learning (mimicking your neighbour) than from farmer field schools (Rebaudo and Dangles 2012).

Figure 3: Key knowledge gaps and further research areas

- Documentation of insecticide use by crop and region, especially for organophosphates and carbamates including banned substances.

- Neonicotinoid insecticides have become a main replacement for the organophosphates and carbamates reviewed above. Monitoring in use should be promoted to confirm safe use and research considered to investigate potential unforeseen risks from neonicotinoids and other approved insecticides.

- Sub-lethal effects of insecticide use on populations of migratory birds.

Appendix 1: Rotterdam Convention processes

Where migratory bird criteria can add value to the Rotterdam Convention processes (see legislative recommendation 3.1):

(1) national governments are deciding whether to allow import of pesticides:

Any export of chemicals, including insecticides, that have been banned or severely restricted (for human health or environmental reasons) by two or more countries requires the consent of the importing country. To aid risk assessment and decision-making, the parties are given a guidance document prepared by the Chemical Review Committee, which includes a health and environmental risk evaluation. Risks to migratory birds should be made a mandatory and a more prominent component of the guidance so that countries can assess the likelihood of risks to migratory birds in their own region. This information is highly influential because many developing countries do not carry out their own risk assessments but follow international guidance (Wesseling, et al. 2005).

(2) the Convention is deciding whether to regulate additional pesticides:

The Convention also contains a mechanism for evaluating and regulating additional chemicals (making them subject to the import consent procedure), which can occur through two ways (Henrik 2010). Firstly, after two or more countries ban or severely restrict a chemical, the Chemical Review Committee will decide whether to recommend it for inclusion in the Convention (using risk evaluation information prepared by the countries where it was banned or severely restricted). Secondly, a developing country can propose the inclusion into the Convention of severely hazardous pesticides that are being used in their country; they must also provide evidence of environmental incidents. The Committee evaluates the proposal using the environmental incidents reports plus a review prepared by the Secretariat. To assist countries with recording environmental incidents, a guidance document gives examples of incidents, including examples of bird poisoning. The review includes eco-toxicological properties of the pesticide formulation, environmental incidents in other States (including bird poisoning), and the existence of environmental restrictions or environmental guidelines in other states.

For both processes, the weight each factor is given when assessing whether to regulate the chemical in the Convention and criteria for the decision-making at the Chemical Review Committee level and at the Conference of the Parties is unknown. There may be an opportunity for CMS to work with the Secretariat to develop decision-making criteria that include consideration of the risk to migratory birds for the Chemical Review Committee and the Conference of the Parties to use when assessing proposals, or at least to ensure the Chemical Review Committee's decision guidance document includes this information.

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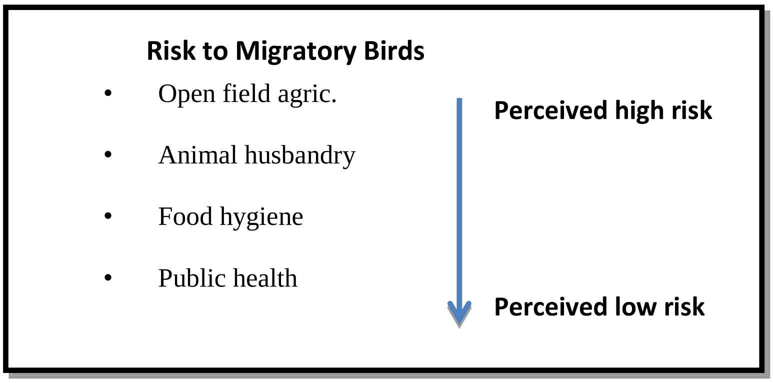
Recommendations to prevent risk from rodenticides used to protect crops

1. Introduction

Rodenticides are used to control rodents for a variety of purposes, such as for the protection of crops and stored grain, in animal husbandry to prevent consumption and spoiling of animal food and transmission of disease to livestock, to enhance food hygiene and to protect human health from diseases for which rodents may be vectors (Figure 1). Anticoagulant rodenticides (ARs) are the most widely used types of rodenticide to control rodent pests worldwide. Environmental risk assessments show that ARs present significant risk to wildlife because they possess very little target specificity (European Commission 2009).

Figure 1: Scale of risk (highest to lowest) of poisoning to migratory birds from generic areas of anticoagulant rodenticide use based on expert judgement from the CMS Preventing Poisoning Workshop in May 2013



Migratory birds are exposed to ARs through the consumption of toxic baits (primary exposure) or by the consumption of contaminated prey which themselves have taken baits (secondary exposure). Widespread exposure in birds to ARs, and in particular second-generation anticoagulant rodenticides (SGARs) has been detected through wildlife monitoring programmes in Europe and North America (Figure 2).

Figure 2: Prevalence of anticoagulant rodenticide exposure in birds of prey

High detection rates of ARs have been reported in birds of prey collected through wildlife monitoring programmes in:

- Canada: 70% of 164 owls (various species) and 60% red-tailed hawks (*Buteo jamaicensis*) exposed, (Albert, et al. 2010; Thomas, et al. 2011)
- USA: 86% of 161 birds tested had liver residues, (Murray 2011)
- United Kingdom: 90% of 96 birds (barn owls *Tyto alba*, red kites *Milvus milvus* and kestrels *Falco tinnunculus*) exposed, (Walker, et al. 2013)
- Norway: 53% of golden eagles (*Aquila chrysaetos*) and eagle owls (*Bubo bubo*) exposed, (Langford, et al. 2013)
- Denmark: 92% of 430 birds exposed from 11 species, (Christensen, et al. 2012)
- France: 44% red kites indicated AR poisoning, (Berny and Gaillet 2008), and
- Spain: 9% indicated AR poisoning (Sánchez-Barbudo, et al. 2012).

It is considered that, among the places where ARs are used, birds that forage in agricultural landscapes may be the most likely to be exposed to them (Figure 2), as this is where primary exposure of rodents and other non-target species is most likely to occur. The ecology of some species will make them more likely to be exposed than others within these areas, e.g., many raptor species are especially likely to be exposed to rodenticides due to their regular consumption of rodents. Scavenging species may be particularly at risk because they feed on carcasses that could be contaminated with rodenticides. For example, studies in the UK and France suggest that the red kite may be particularly susceptible to secondary exposure and poisoning because of the high proportion of carrion in its diet, including the carcasses of rats and other small mammals (Burn, et al. 2002; Coeurdassier, et al. 2012).

If exposure to ARs occurs, the amount ingested will greatly influence the physiological outcome. Ingestion or accumulation of a lethal dose results in fatal haemorrhaging. It has been proposed that ingestion or accumulation of sub-lethal doses may be associated with a number of adverse effects, such as, likely increased severity of haemorrhaging following trauma and behavioural changes that may impair hunting ability. However, the proven occurrence of such effects is lacking (Thomas, et al. 2011).

Despite the known widespread exposure of raptors to rodenticides in some countries, particularly to SGARs, there is no evidence and limited knowledge of impacts on whole populations. There is also scant knowledge of SGAR exposure rates in birds outside Europe, North America and New Zealand.

Recommendations to prevent the risk to migratory birds are discussed below and include both legislative and non-legislative recommendations. There are different types of recommendations for preventative control of rodents versus more extreme scenarios, such as rodent irruptions.

2. Non-legislative recommendations

2.1. Use best practice to prevent and manage rodent irruptions (minimising second generation anticoagulant rodenticide use) as may impact large numbers of raptors in grassland areas

Rodent irruptions, as can occur in regular cycles or irregularly following events such as abundant rainfall, attract raptors (Pavey and Nano 2013). Many different landscapes and habitat types are subject to rodent irruptions (Luque-Larena, et al. 2013). Rodenticides are sometimes used, although rarely in North America and Europe, and when used, they can be deployed over large areas. For example, in 2006, rodenticides were used on 280,000 hectares in Germany to treat a rodent outbreak (Jacob and Tkadlec 2010).

Rodenticides can be a risk for non-target species, such as migratory birds, when used on a large-scale during rodent outbreaks (Olea, et al. 2009). Pest outbreaks may pose a particular risk of exposure to birds whose feeding preferences change with prey availability. For example, the red kite, a species with flexible feeding behaviour, may target water vole (*Arvicola amphibius*) outbreaks when these occur (Coeurdassier, et al. 2012).

Recommendation one: SGARs should not be used for rodent outbreaks, and instead use preventative rodent damage measures. Preventative measures could include e.g., synchronous planting of crops and good field sanitation to limit resource availability/length of planting season (Htwe, et al. 2012; Davis, et al. 2004). If SGARs are used, then they should be deployed in a manner to prevent harm – see Recommendation two below.

*Recommendation two***:** Unavoidable treatment of rodent irruptions with rodenticides should be completed using best practice guidelines to limit risks to migratory birds, particularly birds of prey, from rodenticide use. Best practice guidelines should be developed by users, regulators, and other stakeholders, and encompass:

- treatment options, e.g., timing of rodent management – if done at tilling stage it can have better results than if done later in crop growth (Phung, et al. 2012; Buckle and Smith 1994),
- mitigation techniques to prevent risk when SGARs are used (Singleton, 2010), and
- monitoring and evaluation of outcomes, and
- information shared/education with agricultural community (Palis, et al. 2011).

The best practice guidelines should also be followed when using any substances, not limited to anticoagulant rodenticides, of risk to birds to treat rodent outbreaks.

3. Legislative recommendations

3.1. Restrict/ban SGAR use in open field agriculture

The likelihood of exposure to SGARs used in open-field agriculture is high for migratory birds where these substances are applied. Some open-field agriculture areas experience more problems with rodent pests than others. In temperate areas, rodents are not often a significant pest (Buckle and Smith 1994). In non-temperate areas, rodent pests can cause significant crop damage (Thakur, et al. 2012). However, in many non-temperate areas, rodents are not resistant to the first generation anticoagulant rodenticides, which may be a reflection of a lack of historical use of these products. Therefore, the less toxic and persistent first-generation anticoagulant rodenticides (FGARs) can be effective in these areas, while minimizing the risk to migratory birds.

To identify whether FGARs would be an effective alternative to the more toxic SGARs, new tools are available to test for FGAR resistance making it easier to switch to first-generation ARs in areas lacking resistance (Endepols, et al. 2012; Prescott, et al. 2007). In resistant open-agriculture areas, alternatives to SGARs should be explored and introduced where appropriate, including trapping of pests, integrated pest management strategies, and crop rotation (Laxminarayan 2003; Eason, et al. 2011; Sudarmaji, et al. 2010). Combined research and development with principle research agencies and industry can mitigate the risk of rodent irruptions, particularly through education of researchers (who communicate with growers) and growers with practical, available for immediate use, farm strategies (Hunt, et al. 2012). Alternatives to anticoagulant rodenticides will not only limit risks to non-target wildlife, but will also limit the spread of resistant rat populations (Lambert 2003). However, SGARs may be more effective than alternatives, such as zinc phosphide and warfarin (Pitt, et al. 2011).

Eradications of invasive rodent species, particularly in island ecosystems, also use anticoagulant rodenticides, but these have limited impact on non-targets when using best practice (Ruscoe and Pech 2010). For the continued use of SGARs in conservation programmes, best practice guidelines should be followed.[2]

3.2. Stop permanent baiting: apply rodenticides only when infestations are present followed by bait removal (could also be non-legislative, e.g., change of business model)

Permanent baiting, rather than only using rodenticides when infestations are present, is a likely cause of non-target wildlife exposure to rodenticides, particularly to SGARs, which are widely applied in this way (Laakso, et al. 2010). Many professional pest controllers use permanent baiting with anticoagulant rodenticides as standard procedure (Cefic, 2013). Permanent baiting may also be a factor associated with anticoagulant bait-resistance in rodents (Klemann, et al. 2011).
Best practice guidelines on rodenticide use, including those being developed by Cefic (2013):

- discourage the use of rodenticides as monitoring tools,3 and
- encourage programme baiting, in which rodenticides are applied only when infestations are present, followed by bait removal.

However, there are issues with user awareness and implementation of best practice (Tosh, et al. 2011). This indicates that efforts need to be made to raise user awareness of best practice guidelines, including working with pest control companies and food suppliers (which often dictate pest control policies (Siddiqi and Duggal, 2008)) to change standard business models.

Regulatory changes may also be necessary to prevent permanent baiting being used as a routine practice, such as changes to label requirements and monitoring users' compliance with label requirements.

Figure 3: Key knowledge gaps and further research areas

- Areas of resistance to first generation anticoagulant rodenticides. This can be confirmed using new DNA sequencing detection techniques.
- When does lethal exposure result in population-level effects? What exposure rates are associated with population level impacts in different species? This requires population models.
- Exposure of migratory species. Most information on exposure is from sedentary species. Although this can be used to infer migratory exposure, there may be differences in risk.
- Reliable information on volumes and patterns of SGAR use.
- Sub-lethal effects on fitness and/or reproduction. This is a particular concern in raptors, where a large proportion of some species are exposed.

[2] Best practice guidance is available through many sources, including the Pacific Invasives Initiative: http://www.pacificinvasivesinitiative.org/rk/index.html.

[3] Rodenticides are sometimes used as a monitoring tool to detect the presence of rodents, e.g., if bait is taken then rodents may be present.

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Recommendations to prevent risk from poison-baits used for predator control

1. Introduction

The use of poison-baits is driven by the need for predator control and as a means for harvesting birds for human consumption and traditional medicine. Predator control using poison-baits occurs on a global scale, particularly in areas with livestock farming and game management (Graham, et al. 2005; Sotherton, et al. 2009). Poison-baiting is the most widely used predator eradication method worldwide (Márquez, et al. 2012). However, poison-baits results in blanket poisoning of predators that is not target specific towards individual damage-causing predators, and can affect non-predators (Snow 2008). It is illegal to use poison-baits in many countries (see Figure 1), but migratory birds can be harmed from the misuse (not in compliance with label instructions) or abuse (deliberate or illegal use) of the baits.

Figure 1: Examples of legislation prohibiting use of poison-baits

European Union
The use of poison-baits to control predators is illegal in the European Union and most of the rest of Europe through the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and the Directive on the Conservation of Wild Birds (Birds Directive 2009/147/EC).

United States
Illegal baiters in the United States can be prosecuted under the Federal Insecticide, Fungicide and Rodenticide Act 1947 for using any registered pesticide in a manner inconsistent with its labelling (USC 1972). If bird of prey carcasses are found in the vicinity of the bait site, the suspects may also be charged with violations of the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, the Endangered Species Act, and various state and local laws.

South Africa
Illegal use for any unregistered purpose, sale and repackaging of pesticides can be prosecuted under the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, Act 15 of 1947.

International law
The harvesting of migratory birds is regulated by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). It prohibits the international trade of around 800 species, and controls the trade of a further 23,000 species. Parties to the Convention, presently 178 countries, are prohibited from trading endangered bird species, and can be subject to bilateral sanctions for violations.

The Convention on Migratory Species, especially Resolution 10.26, calls on Parties to prevent the risk of poisoning to migratory birds.

The African Convention on the Conservation of Nature and Natural Resources places signatories under various conservation obligations, including to act against illegal hunting methods. Many migratory species are listed. Article IX 3 b)iii prohibits the use of all indiscriminate means of hunting and the use of all means capable of causing mass destruction. Annex 3 prohibits use of poison and poisoned or anaesthetic bait. Only 40 African countries signed the Convention in 1968, and South Africa, Namibia and Zimbabwe are conspicuously absent.

Predatory and scavenging bird species are at risk of poisoning from poison-baits targeting them directly, and also from baits targeting mammalian species, such as jackals in Africa, mainly towards canids and felids but also to bears and wild boars. The effects on species, other than birds of prey, are not always known and further research is needed to understand this.

The risk of poisoning from harvesting for human consumption and traditional medicine appears to be restricted to particular cultures. Using poisons to harvest migratory birds for consumption and/or traditional medicine occurs in parts of Africa and Asia (Williams, et al. 2013; Thiollay 2006; Odino 2010; Kwon, et al. 2004). In southern and eastern Africa, both aldicarb and carbofuran are widely abused for all forms of illegal poisoning (Endangered Wildlife Trust, Internal Unpublished Database, 1995 – 2012).

Due to the indiscriminate nature of the substances used in poison-baits for predator control, many birds are at risk of poisoning if they come into contact with these poison-baits. For example, the endangered ground hornbill (*Bucorvus leadbeateri*) feeds as a foraging family group on insects, small mammals and reptiles and readily takes carrion and baits. The most common substances abused for predator control are insecticides and, to a lesser extent, rodenticides, usually those that are known as highly toxic by farmers and users. Carbamate insecticides, such as carbofuran and aldicarb, are often used in poison-baits for predator control in numerous areas around the world. In Spain, between 2005 and 2010, 50% of cases of poisoning were caused by aldicarb and 22% of them were by carbofuran (Bodega Zugasti 2012). In South Africa, between 2006 and 2008, 33% of poisonings were caused by aldicarb and 18% by carbofuran (Snow 2013, unpublished data).

Many bird of prey populations are in decline as a result of illegal poison-baits, especially vultures (Ogada, et al. 2012). Illegal poison-baits are the main threat for the conservation of various species of raptors in Europe (Margalida, et al. 2008). For example, poison baiting in southern Spain has been linked with severe raptor declines (such as the cinerous vulture *Aegypius monachus*, Egyptian vulture *Neophron percnopterus*, bearded vulture *Gypaetus barbatus*, and Spanish imperial eagle *Aquila adalberti*) (Márquez, et al. 2013). In three separate recent vulture poisoning events, linked to predator poisoning or poaching, in southern Africa, 183 vultures (Gonarezhou, Zimbabwe), 56 vultures (Swartberg, South Africa), and 600 vultures (Caprivi, Namibia) were killed. In Israel, poison-baits used by farmers caused two events of mass poisoning of Eurasian Griffon in the Mediterranean region resulted in the mortality of 40–50 individuals (including many chicks in their nests) in 1998 and more than 30 in 2007, which constituted between a third and a half of the breeding population in the Mediterranean region of Israel at the time of their poisoning (Yom-Tov, et al. 2012).

Recommendations to address the risk to migratory birds from poison-baits are discussed below and include both non-legislative and legislative options.

2. Non-legislative recommendations

To prevent the use of poison-baits, a number of steps are necessary to accurately identify why poison-baits are being used, resolve the conflict between people and wildlife, educate communities with best practice alternatives, and establish effective enforcement mechanisms (see legislative recommendations). Each step is discussed below in more detail.

Step 1: Identify drivers of the problem and publish regular reports on poisoning incidents

The key issue to resolving the conflict between humans and wildlife is to understand the drivers of using poison-baits. Understanding the nature of the conflict/issue that is leading to the poisoning occurring is essential to successfully address the problem. This is likely to vary significantly by region and industry in terms of what the key predators are (e.g., from jackals to bears) and the livestock at risk of predation (e.g., from chickens to cattle), and/or the economic value of the species being harvested using poison-baits. An initial assessment of the problem can be gained by consulting with communities and those likely to encounter conflicts with predators, such as the agricultural sector.

Compilation of information on poisoning incidents, for both predator control and harvesting (misuse and abuse situations), is needed to understand the extent and trends in occurrence of the problem. Especially to facilitate monitoring, it would be useful for data collection to be undertaken in a standard format (affected wildlife, substances used, consequences of the use of poisons, actions taken to tackle the problem, effectiveness of the actions, alternatives to the use of poisons) jointly by government and non-government parties.

The results should be reported regularly and made publicly available. For example, the Partnership for Action against Wildlife Crime in Scotland, includes the police, land managers, conservationists and the Scottish Government, and reports annually on wildlife crime (PAWS 2013).

Step 2: Resolve human-wildlife conflict using multi-stakeholder forums

Working with the community, industry, and enforcement agencies is necessary to resolve the conflict of poison-bait use. Often the focus of the conflict is related to effective predation management and many resources are available on wildlife conflict resolution, see, for example, Decker et al.'s Practitioner's Guide to Human-

Wildlife Conflict (Decker, et al. 2002).[4] In order to achieve cooperative collaboration, it is critical that farmers be offered alternative, practical, non-poison methods for livestock protection, such as livestock guarding dogs (Marker, et al. 2005), predator-proof enclosures (Jackson and Wangchuk 2004), collars, lights, and other methods (see Figure 2) – estimated costs of various tools available are included in Shivik's study (Shivik 2006).

The successful resolution of human-wildlife conflicts also requires the participation of local communities and other stakeholder groups in formulating management decisions. In the uplands of the United Kingdom, a controversial conservation issue concerns the relationship between the conservation of a legally protected raptor, the hen harrier (*Circus cyaneus*) and the management of a gamebird, the red grouse (*Lagopus lagopus scoticus*). Multicriteria analysis/decision modelling was used to evaluate the perspectives of two groups of stakeholders, grouse managers and raptor conservationists, and the acceptability to them of different management solutions to this conflict. The results showed an area of compromise (diversionary feeding) and moved the positions of individual stakeholders (Redpath, et al. 2004).

Livestock depredation by the endangered snow leopard (*Panthera uncia*) is an increasingly contentious issue in Himalayan villages. Mass attacks in which as many as 100 sheep and goats are killed in a single incident inevitably result in retaliation by local villagers. Human–wildlife conflict is alleviated by predator-proofing villagers' night-time livestock pens and by enhancing household incomes in environmentally sensitive and culturally compatible ways. A study found that a highly participatory strategy (Appreciative Participatory Planning and Action) leads to a sense of project ownership by local stakeholders, communal empowerment, self-reliance, and willingness to co-exist with snow leopards (Jackson and Wangchuk 2004).

Both social and economic factors (even stronger than ecological factors for those who are potentially affected by predation) drive predator control, and therefore these factors need to be incorporated when making decisions to mitigate the human-predator conflict (Delibes-Mateos, et al. 2013). Although most mitigation studies investigate only the technical aspects of conflict reduction, peoples' attitudes towards wildlife are complex, with social factors as diverse as religious affiliation, ethnicity and cultural beliefs all shaping conflict intensity. Moreover, human–wildlife conflicts are often manifestations of underlying human–human conflicts, such as between authorities and local people, or between people of different cultural backgrounds (Dickman 2010).

In Tanzania, spotted hyenas (*Crocuta crocuta*) elicit intense conflict due to beliefs that certain ethnic groups bewitch and 'train' them to kill other peoples' livestock, so tensions over hyaena depredation are heightened by these inter-group suspicions (Dickman 2008). Such perceptions of people bewitching animals or shape-shifting into animal form are found across a broad range of cultures, and involve species as diverse as elephants (*Elephantidae*), chimpanzees (*Pan troglodytes*) and bearded pigs (*Sus barbatus*) (Knight 2000), and in such cases recognizing and easing underlying social tensions is fundamental to effective conflict mitigation.

Economic factors, such as loss of livestock or the trade value of certain species, can lead to the use of poison-baits. In China, the Asiatic black bear (*Ursus thibetanus*) is harvested with poison-baits because of its high value for traditional medicine. Predation on livestock and harm to people also increase community support of illegal bear harvesting (Liu, et al. 2011). To reduce harvesting a multi-prong strategy is necessary, including campaigns to (1) change people's attitudes to bears by increasing bears' intrinsic value (eg, carnivore ecotourism), compensation for damage, assisted removal of nuisance bears, and advice and materials to prevent predation of livestock; and (2) reduce the public demand for bear parts in national and international markets (Roberts and Perry 2000). If demand is decreased, the motivation for killing bears will also be relieved (Liu, et al. 2011).

Step 3: Education – develop and disseminate good practice for predator control and enforcement

Educating individuals, in combination with conflict resolution measures, about the law and the consequences of poison-baits can help to protect natural resources by (a) making potential poison-bait users truly aware of the conservation impacts of their actions as well as of the potential legal penalties for misuse and abuse and can deter them from committing the crime; and (b) informing the general public of the law and the environmental costs of poison-baits can encourage the public to report illegal poison-baits to the police or local conservation authorities (Blevins and Edwards 2009). The ultimate goal is to make the use of poison-baits culturally and socially unacceptable. This needs high-level political support to advocate the unacceptability to society.

An important lesson from the European Union LIFE report is that there is no single best practice that can address all the conservation challenges of poison-baiting (focused on carnivores, but largely transferable to birds);

[4] Other sources with specialist expertise on hand include: Centre for Human-Wildlife Conflict Resolution: http://humanwildlife.cmi.vt.edu/index.html; Wildlife poisoning prevention and conflict resolution: http://wildlifepoisoningprevention.wozaonline.co.za/home.

instead, effective action requires multiple combinations of several practices (European Commission 2013). These include the articulation of damage, conflict prevention actions, loss compensation measures, targeted awareness campaigns and stakeholder involvement – practices that several projects have demonstrated as being the most effective ways of reducing coexistence conflicts between humans and large carnivores and, ultimately, improving species conservation status (see Figure 2).

Figure 2: Key elements of good practice for predator control

Key elements of good practice for predator control, including to raise stakeholder awareness of good practice and the law:

- Work with both the agrochemical industry, farmers and the hunting community;
- Publicise the law and consequences of enforcement (Redpath and Thirgood 2009);
- Promote practical, non-toxic and non-lethal, predation reduction methods;
- Encourage the use of web-based information, such a www.wildlifepoisoningprevention.co.za;
- Encourage farmers to apply systems thinking/ cause and effect analysis of conflicts and resultant actions;
- Increase small game/quality of habitat in areas where the loss of a native game species, e.g., rabbits in Spain, is driving poisoning of migratory birds of prey and other predators of the game species (Sánchez-García, et al. 2012; Villafuerte, et al. 1998). This can be done through agricultural subsidies (Overmars, et al. 2012);
- Livestock protection: preventative predator measures (Treves and Karanth 2003);
- Exclusive authorisation of selective predator control techniques for the targeted game species (i.e., foxes or corvids) when managing hunting estates or livestock exploitations (Muñoz-Igualada, et al. 2010);
- Farmer funded insurance/compensation schemes can be considered where damage occurs from predators, such as wolves and lions (Hazzah, et al. 2009; Zabel and Holm-Muller 2008) and needs to be rapidly paid and adequately cover the loss (European Commission 2013);
- Provide official agriculture insurance aimed at protecting livestock and crops from predators and other species causing damage;
- Raise community awareness and increase monitoring effectiveness by educating the public about signs of wildlife poisoning and how to report suspected incidents;
- Create dog patrols instructed in the search and location of poisoned baits, both as a deterrence mechanism and as a finding method of dangerous areas;
- Establish official ranger teams and environmental bodies specialising in the investigation and prosecution of illegal poisoning;
- Reporting: require veterinarians to report suspected wildlife poisoning incidents to wildlife enforcement agencies;
- Enforcement: prosecute perpetrators of illegal poisoning.

Often the pesticide regulatory system uses prosecution as the only deterrent for poison-bait related crimes. Wildlife law enforcement agents who are investigating illegal poisoning have difficulty convincing some prosecutors to accept these cases and some judges are reluctant to impose penalties for the offences. Reluctance to prosecute and impose penalties may stem from a lack of knowledge about the extent and magnitude of these crimes, insufficient experience with wildlife statues and case law, and lack of interest in pursuing crimes associated with minimal penalties (Vyas, et al. 2002). Many of these issues could be addressed by education programmes targeting judges and prosecutors working in “poison-bait” affected regions, which has been successful in the European context. It is also beneficial to provide capacity building of enforcement officials (e.g., specialized training and equipment, and facilities).

3. Legislative recommendations

Step 4: Ensure legislative/regulatory effectiveness: create enforcement legislation with effective deterrent mechanisms and infringement penalties

A national strategy building on the recommendations herein should be developed in each relevant country and focus on implementation of the recommendations. Central governments should coordinate the development of the national strategy with all relevant stakeholders, and ensure it is reviewed regularly. Preference should be given to supplementing any existing relevant legislation. For example, in Africa, priority should be given to further adoption and implementation of the African Convention on the Conservation of Nature and Natural Resources, which prohibits the use of poison-baits.

The strategy should include best practice recommendations (see above) and be created with community input (including local and regional authority representatives, if applicable, who could be responsible for implementation and enforcement of the strategy's principles and objectives). Transparency and community involvement is essential to raise awareness and to ensure the plans are endorsed by the community (which leads to better entrenchment and support) and to cover the key issues of concern to that particular region (Giorgi and Mengozzi 2011).

Poison-bait issues vary between countries and the needs of the national strategy should be tailored to each particular country. It is however desirable to renounce the use of indiscriminate poison baits internationally. In Africa, 40 signatories to the African Convention on Conservation of Nature and Natural Resources have adopted the prohibition of the use of all indiscriminate means of taking (hunting) and of the use of all means capable of causing mass destruction, including the use of poison and poisoned or anaesthetic bait.

Furthermore, if there is sufficient variation within countries, the development of regional action plans may be appropriate, e.g., particularly for countries where poison-baits are used for both harvesting for human use and predator control (see Figure 3). This should exclude best practice use for invasive species management.

Figure 3: Example of using a national strategy with supporting regional action plans to target illegal use poison-baits

Spain's National Strategy Against the Illegal Use of Poison Baits in the Natural Environment was developed using a multi-stakeholder approach, including public input, and was approved by the Ministry for the Environment in 2004 (and will be updated in 2014).

This national Strategy provides guidelines on how to solve the human-wildlife conflict of control of predators for implementation by Spain's autonomous regions. The three main objectives are to:

- Increase knowledge and information on poisoning, including negative environmental consequences, such as:
  - Knowledge of poisoning mortality through searching and recording all cases of poisoning, risk mapping, information sharing among stakeholders.

- Develop prevention techniques
  - Reduce availability of toxic substances by making access to substances used as poison-baits more difficult, through, for example, changes in legislative controls on plant protection products;
  - Alternative management techniques (rangers in game reserves, hunting code of good practice, rural development measures for the recovery of game species);
  - Measures to prevent damage from feral animals:
    - control pests,
    - develop methods for evaluating the impact of domestic animals on livestock and agriculture,
    - legal accountability for owners of hunting and guard dogs, cats, pigeons and ducks for damage to livestock or crops, and
    - Compensation measures for damage to livestock and agriculture
  - Foster cooperation of opinion leaders in rural communities, recognition of "environmental excellence municipalities", support projects that help to reduce or limit the use of poisons in rural areas by offering non-poison solutions to predator control;
  - Communication, outreach and environmental education.

- Increase efforts for criminal prosecution through:
  - Control and monitoring (specialized training for forest rangers, prevention and inspections on hot-spots, canine units for prevention and detection of poison);
  - Collection and custody of evidence and carcasses (provide the necessary material for the collection of evidence, improve training of enforcement officers in the collection and maintenance of poisoning evidence, create and implement an evidence collection protocol);
  - Toxicological analysis and technical investigation of crimes;
  - Criminal and civil legal accountabilities.

So far, only five regions have developed regional action plans to address illegal poisoning, as recommended by the National Strategy (see above), and are currently operational. However, in the framework of the *Life+ project VENENO*, all of Spain's 17 autonomous regions have committed to develop and/or review action plans.

In the regions where there are approved action plans, there is greater political commitment to the issue and greater effectiveness in the investigation and prevention of the use of poison-baits. Most of the convictions in poison-bait related cases are in the regions where action plans and strategies have been adopted. Furthermore, in some areas, such as Andalusia, wildlife poisoning is decreasing as a result of the measures implemented in its regional strategy.

A template action plan and general protocols are available in English through Life + VENENO at http://www.venenono.org. This could be used as a template to build on for other countries where poison-baits are used to control predators.

3.1. Enhance enforcement and deterrence mechanisms relating to the use of poison-baits

There are many drivers for environmental crime offenders, including those who use poison-baits illegally, making a uniform approach to addressing offending and enforcement ineffective (Canfa 2006; Algotsson 2006). Wildlife crime enforcement thus requires flexibility, allowing for action appropriate to the circumstances of the poison-bait offender and specific nature of the offence (Nurse 2011). The use of poison-baits has many different drivers, some of which are legal in certain countries, including for predator control and human consumption/use, and multiple means of enforcement are needed to successfully address misuse and abuse, in each.

A key obstacle preventing the illegal use of poison-baits is ineffective enforcement of the law, often related to inadequate monitoring and surveillance of poisoning incidents, and minimal investigation of complaints. There is a strong relationship between deterrence and enforcement whereby the lack of enforcement detracts from the deterrent effect of existing policies. Much of the problem stems from wildlife crime's position in the crime agenda – it is generally given a low priority in enforcement agencies and there is a lack of political impetus to push it further up the agenda – much of which could be improved through better enforcement and awareness (Wellsmith 2011), which are discussed below. Obtaining high-level political support should be given a priority in implementing these guidelines.[5] This can also be improved through education (see non-legislative recommendations above), particularly raising the profile of the issue with enforcement agencies, judiciaries and communities.

Recommendations to improve the deterrence and enforcement mechanisms for the wide-range of poison-bait offenders are discussed below and include, strengthened infringement penalties, and stronger enforcement of supply chain, and the introduction of vicarious liability.

3.1.1. Strengthen infringement penalties to effective rates and reduce access to government subsidies for landowners

Enforcement should be equipped with strong infringement penalties. Some European countries have reduced poisoning incidents through more stringent penalties (Ogada, et al. 2012). There is significant variation of infringement penalties even between European countries (see Figure 4), which could be improved by setting penalties at rates shown to be effective.

Figure 4: Level of variation between infringement penalties

In Spain, criminal penalties include between 4-24 months' imprisonment (and disqualification from hunting or the profession, in the case of gamekeepers), and subsequent civil proceeding against those managing the land have resulted in fines as high at €200,000.

In the United Kingdom, the maximum penalty for poison-bait wildlife offences is £5,000 and/or six months incarceration; however, most offenders are only given a small fine, which has been ineffective as a deterrent (RSPB 2011).

Linking enforcement action to other sanctions (in effect, cross-compliance) can be a very powerful way to create a deterrent effect. In Scotland, a reduction in Single Farm Payment subsidies has been made on a number of occasions following pesticide offences. These operate on a reduced civil burden of proof (e.g., "more likely than not" versus "beyond a reasonable doubt" in criminal cases. In Spain, in all criminal prosecutions for wildlife

[5] See, for example, a statement released by the Scottish Minister for the Environment in support of tackling poisoning of wildlife: http://news.scotland.gov.uk/News/Wildlife-Crime-in-Scotland-49f.aspx.

poisoning, compensation for animals killed is considered and, in some cases, it includes expenses generated by the investigation of the crime (e.g., toxicological analyses).This compensation is requested as civil liability within the criminal process, without a specific civil action case.

- *Suspend/withdraw hunting licenses for persons and areas where illegal poison-bait activity occurs*

A potentially effective deterrent to illegal poisoning for predator control on hunting estates is to withdraw permission to hunt on an area of land for a set period of time where there is a conviction for the illegal use of poison baits. For this to work, some form of licensing system needs to be in place for hunting estates. For commercial shoots, this could be a licence to sell hunting rights to the land. For individual shoots, it could be that hunting licences could be withdrawn or suspended.

The suspension of hunting licences could be at the hunter level, i.e., strict liability of anyone hunting in the vicinity of detected poison-baits, and/or a blanket suspension of hunting licences over a specific region where poison-baits have been found (without having to prove that any person in particular placed the bait). The establishment of this policy would likely incentivize hunters to question whether poison-baits are used in the area before hunting (rather than risk losing their licence to hunt, e.g., for the season or longer).

A similar scenario is likely to occur for hunting operators (e.g., tourism hunting). If hunting licences are suspended in the regions they operate, hunting operators would be unlikely to support or participate in the practice of poison-baiting and less likely to willingly operate in areas where poison-baits are used. Both hunters and hunting operators may be more likely to report poison-bait incidents to ensure they can continue to hunt in those areas without risking their hunting licenses.

- *Establish sentencing guidelines to ensure consistent and effective outcomes*

Sentencing guidelines for wildlife crime, particularly for the use of illegal poison-baits and possession of illegal toxic substances, are essential for effective enforcement. For example, the United Kingdom Parliament's Review of its national wildlife crime enforcement stated that enforcement has been undermined by the lack of any sentencing guidelines on wildlife crime for judges, and has led to inconsistent outcomes in the courts (House of Commons, Environmental Audit Committee 2012). Inconsistent legal outcomes undermine the credibility of the judicial system and suggest a lack of seriousness of wildlife crime, thereby defeating the deterrent effect.
In some areas, sentencing guidelines are out-dated and need to reflect current costs, e.g., the South African legislation dates from 1947 and inflationary adjustments have to be made to the fines.

- *Increase capacity and capability for enforcement with focused resourcing*

Without proper funding, effective enforcement measures are unlikely to take place (O'Connell 1995). The lack of funding is one of the key elements affecting successful enforcement (Eliason 2011). This includes insufficient numbers of personnel as well as a lack of basic material resources, such as vehicles and other necessary equipment (e.g., for collecting and transporting evidence). It may further result in a lack of data collection, access to forensic analysis and more advanced assistive technology, such as surveillance equipment. Under-resourcing can also manifest as insufficient training for enforcement agents, prosecutors and the judiciary thus reducing their capacity to effectively enforce legislation and sentence appropriately (Wellsmith 2011).

Increasing capacity for enforcement should be a high priority to ensure the measures put in place are effectively carried out.

- *Introduce vicarious liability*

Vicarious liability was introduced in Scotland in 2011 to prevent the occurrence of poison-baits used to control birds of prey and other predators near areas managed for game hunting. Vicarious liability imposes criminal liability on persons whose employee/agent/contractor commits an offence (unless they can show they were unaware of the offence and had exercised due diligence to ensure the employee obeyed the law).

In practical terms, vicarious liability would encourage landowners to make it clear to their employees and contractors that poison-baits affecting protected wildlife are unacceptable and to check that such practices were not occurring on their land. Since the introduction of vicarious liability, initial evidence indicates a decline in bird-related crime in Scotland's game management areas, but it is still too early to determine whether it has been an effective deterrent in Scotland. Vicarious liability should be introduced, if possible, especially in areas where there is an issue of game managers or livestock managers using illegal poison-baits for predator control. It may also apply in areas where private land is used by poison-baiters in harvesting birds for human consumption/traditional medicine.

3.2. Restrict access to highly toxic substances through stronger enforcement of supply chain: ways poisons are acquired and why the established control mechanisms do not prevent their illegal use

Often illegal substances are stockpiled by poison-bait users and farmers who originally had legal use of these substances, such as carbofuran and other highly toxic carbamates. In Africa, pesticides are sometimes sold in unregulated conditions, or where regulations exist they are illegally sold in small packs in informal trading areas. The stores of highly toxic and illegal substances are often accessible for use in poison-baits (Richards 2011; Sánchez-Barbudo, et al. 2013). To limit accessibility to these substances, there are a number of steps to take, including removal of grace periods, alignment of removal policies, and user/buyer restriction to certified professionals only, each of which are discussed below.

- *Remove grace periods for banned products*

Regulation of substances whose approval is not renewed, should be designed to ensure that existing supplies of the substance are removed and access limited. After a revocation has been issued and the grace period elapsed, the fate of remaining stocks can become ambiguous. In the European Union, plant protection products must now be removed from the market immediately (rather than a six month grace period for the sale and distribution (retailers) and maximum of one year for the disposal, storage, and use of existing stocks for end-users), if they are removed for environmental reasons (European Union Pesticide Regulation 1107/2009). Immediate removal without grace periods is recommended for the substances commonly used in illegal poison-baits.

- *Establish consistent product removal policies between countries*

Limiting discrepancy in how removed products are treated between countries (particularly in neighbouring regions where poison-baits are an issue) can limit the opportunity for poison-baiters to access stockpiles in regions where long grace periods are in place.

In some cases, the cost of hazardous waste disposal of the substance on end-users could be mitigated by offering government or manufacturer supported take-back of the remaining product. Many, but not all, US pharmacies use "reverse distributors" for return of unsold/expired inventory. This existing industry could serve as the foundation for an overarching returns industry—by its expansion into a larger, comprehensive disposal/recycling program that accommodates the consumer sector (Daughton 2003).

Africa has had many pesticides, unwanted elsewhere, "dumped" cheaply and resulting in many obsolete and unwanted stockpiles. Various initiatives have attempted to address this problem, such as the Africa Stockpiles Programme launched in September 2005 with the goal to clear all obsolete pesticide stocks from Africa and establish measures to help prevent their recurrence.

Furthermore, monitoring of pesticide storage (including appropriate labelling) and establishment of sanctions for possession of removed products are effective deterrence mechanisms.

- *Restrict access to certified professionals only*

The adoption of Directive 2009/128/EC and its implementation in the European Union prevents (if implemented correctly) the purchase of pesticides by any individual and its use for purposes other than for which they were manufactured (European Parliament and Council 2009). The Directive allows the use of certain pesticides only by professionals who have been certified (as of December 2013), including those farmers who are authorized to use the pesticide for those particular uses. Without this authorization, it is not possible to buy or use most pesticides. These measures establish traceability of pesticides and restrict their marketing and use allowing law enforcement a better monitoring of substances used in poisoning cases. Similar legislation should be adopted in regions outside the European Union with poison-bait problems.

Figure 5: Key knowledge gaps and further research areas

- Lack of knowledge of the nature of the level/scale of the use of poison-baits in some areas
- Likelihood of exposure to poison-baits in species other than birds of prey
- Occurrence of harvesting using poison-baits outside Africa and China
- Extent of the use of poison-baits compared to other methods of predator control, such as prevention techniques, trapping and shooting in some areas
- Frequency of the use of poison-baits in agricultural areas
- Effects of poison-baits on migratory birds compared to other types of poisoning, such as agricultural pesticides and lead ammunition

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Recommendations to prevent risk from veterinary pharmaceuticals used to treat livestock

1. Introduction

Veterinary pharmaceuticals used to treat domestic ungulates can contaminate food sources of scavenging bird species and lead to poisoned birds. There are a number of different types of veterinary drugs for domestic ungulates and little is known about the effects of these on birds. However, one category of veterinary pharmaceuticals, non-steroidal anti-inflammatories (NSAIDs), has caused declines of scavenging bird species.

Non-steroidal anti-inflammatories (NSAIDs) are used to treat domestic livestock for inflammation and pain relief. Diclofenac, a previously popular NSAID for veterinary care of cattle in India, Pakistan, Bangladesh, and Nepal, is toxic to a number of vulture species. It resulted in the poisoning of scavenging vultures throughout India, Pakistan, Bangladesh, and Nepal by contaminating domestic livestock carcasses available to vultures. Prior to the ban of diclofenac in these countries, the drug was prevalent in livestock carcasses and caused substantial population declines of three *Gyps* vulture species in South Asia (Shultz, et al. 2004). Research is ongoing to determine the effectiveness of the ban, and some studies indicate considerable illegal use of diclofenac. Additionally, the effects of other NSAIDs are subject to further research.

Population declines of *Gyps* vultures were first noticed in India in the early-to-mid 1990s and the cause of the decline was discovered in 2003. Observed rates of population decrease are among the highest recorded for any bird species, leading to total declines in excess of 99.9% for the Oriental white-backed vulture (*Gyps bengalensis*) in India between 1992 and 2007. Long-billed (*Gyps indicus*) and slender-billed (*Gyps tenuirostris*) vultures declined by 96.8% over the same period (Prakash, et al. 2007). Although these birds are not migratory, there are other similar migratory scavenging bird species that may be at risk, such as the Eurasian griffon vulture (*Gyps fulvus*), Himalayan griffon vulture (*Gyps himalayensis*), and potentially other non-*Gyps* vultures and scavenging raptor species (Sharma, et al. 2013, submitted).

While vulture declines in Europe, Africa and South-East Asia are thought to be related to other causes of mortality, such as deliberate poisoning and changes in food availability, there is no evidence that such factors play a key role in South Asia (Green, et al. 2004). The main contributory factor causing declines in South-Asian vulture species has been shown to be the use of diclofenac to treat domestic livestock that are likely to die before the drug is metabolised and thus is available for vultures to feed on (i.e., left in the open after death) (Oaks, et al. 2004; Shultz, et al. 2004; Green, et al. 2004; Green, et al. 2006). After ingestion of livestock carcasses treated with diclofenac near to their death, vultures die as a result of visceral gout that is caused by kidney failure. Death of the vulture usually occurs within a few days of exposure.

The use of diclofenac in regions outside South Asia may pose a risk of poisoning to other vultures. For example, the promotion of diclofenac on the African continent could pose a risk to vultures in this region, including the endangered African white-backed vulture (*Gyps africanus*) and Cape Griffon vulture (*Gyps coprotheres*) due to these species' sensitivity to diclofenac. In comparison with South Asia, exposure levels may be different in Africa, through, for example, the level of NSAID treatment of cattle (particularly, sickly and elderly cattle), removal of cattle carcasses from open areas and variation in vulture diet.

In 2013 diclofenac was licensed in Spain and a few years before in Italy. The licensing of the product for commercial veterinary use in the European Union comes as a worrying development and even if the agro-grazing systems and the level of exposure of carcasses to vultures are very different in Europe and in Asia, it is undeniable that European vulture populations could be seriously affected by the ingestion of diclofenac.

Of the total numbers of vultures in Europe, 95 per cent are in Spain: ca 26,000 pairs of European griffon, 1600 pairs of Egyptian (*Neophron percnopterus*), 2,000 pairs of cinereous (*Aegypius monachus*), and 125 pairs of bearded vultures (*Gypaetus barbatus*). The impact of this product could seriously jeopardize the last remaining large populations of vultures in the EU. In Spain, new regulations (Royal Decree 1632/2011) allow livestock carcasses to be consumed by wild scavengers in the field or at supplementary feeding stations. This means that diclofenac can be directly consumed by vultures from dead cattle. The same strategy of allowing livestock carcasses being offered to consumption by wild vultures would be of key importance also for the remaining and critically endangered Italian populations of European griffon, Egyptian and bearded vultures.

Recommendations, including both non-legislative and legislative, to address the risk of veterinary pharmaceuticals, particularly NSAIDs, to migratory birds are discussed below.

2. Non-legislative recommendations

2.1. Enhance surveillance of ungulate carcasses in high risk areas for diclofenac use and develop vulture safe zones

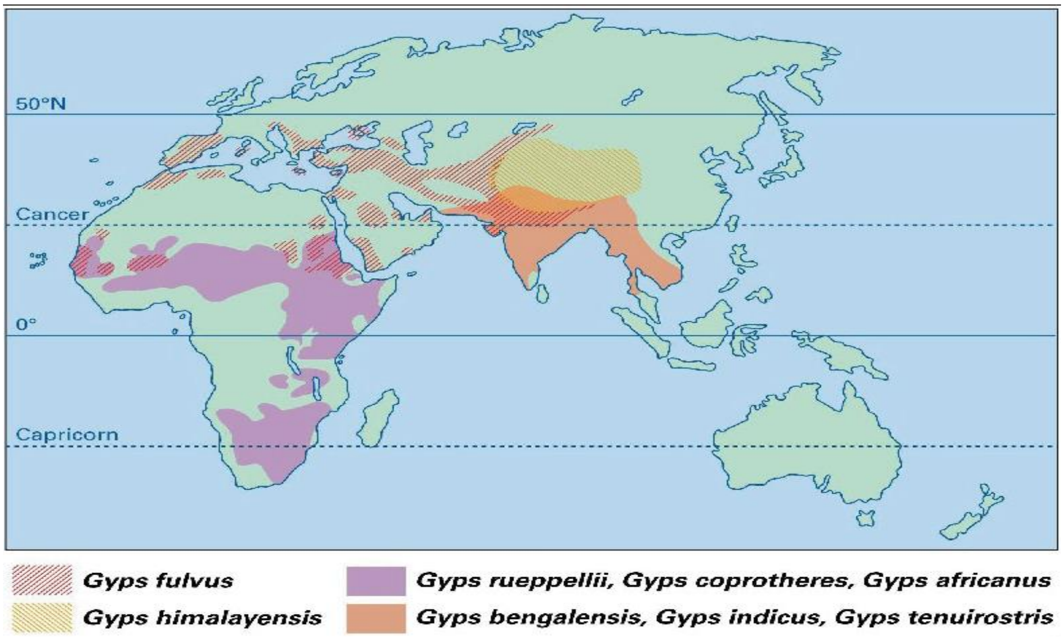
In high risk areas, primarily South Asia, including India, Nepal, Bangladesh and Pakistan, surveillance of ungulate carcasses is done by non-governmental organizations. The surveillance is carried out across South Asia with each region being sampled approximately every year. Non-governmental organizations, such as the Bombay Natural History Society, are struggling to maintain funding for regular carcass monitoring.

To fully enforce the veterinary diclofenac regulation in South Asia, governments should be responsible for monitoring ungulate carcasses to evaluate the effectiveness of the ban. This will also provide information on where to focus enforcement efforts. In India, the Ministry of the Environment, Government of India, Forests and the Wildlife Institute of India, and state forest departments are potential leaders for this work, particularly as many of the vulture colonies are located near national parks managed by the Forest Service.

In high risk areas with ongoing diclofenac use, Vulture Safe Zones should be introduced. Vulture Safe Zones have been developed in some key areas surrounding vulture colonies, with a focus on breeding sites, in South Asia. The aim is to secure a 100 km diameter diclofenac-free (and other harmful NSAIDs) area, which is the average range size of a colony (SAVE 2011). Actions within Vulture Safe Zones include working with local communities and governments to remove stocks of diclofenac, advocacy programmes and monitoring of potential diclofenac users and suppliers (farmers, veterinarians and pharmacies), and providing safe diclofenac-free food for vultures (by herding elderly cattle until they die a natural death). Vulture numbers have shown localized increases within some of the provisional Vulture Safe Zones; for example, breeding numbers at one site increasing from 17 nests in 2006 to 65 nests in 2009 (Chaudhary, et al. 2010).

Presently, there are seven provisional safe zones across Nepal, India and Pakistan and none in the high-risk area of Bangladesh. The seven provisional zones do not yet encompass all three of the endangered vulture species, and therefore, additional safe zones need to be created in these species' breeding areas in South Asia. Further, all zones are provisional – meaning that diclofenac has not been completely removed from any of the safe zones. Independent monitoring of these zones should be introduced to accurately assess how the zones are influencing vulture population levels.

Figure 1: Range map of the eight species of *Gyps* vultures, including the three Critically Endangered resident species in Asia (*Gyps bengalensis*, *Gyps indicus* and *Gyps tenuirostris*), the three resident species within Africa (*Gyps rueppellii*, *Gyps coprotheres* and *Gyps africanus*) and the migratory *Gyps fulvus* and *Gyps himalayensis*



2.2. Raise stakeholder awareness on alternatives to diclofenac; promote product stewardship and voluntary withdrawal of NSAIDs toxic to scavenging birds

Make people care about vultures through community education in high risk areas
Throughout the South Asian region, vultures can benefit from religious beliefs. Concepts of universal compassion in Buddhism, allegiance to Karma in Hinduism and sacred sky burial in Zoroastrianism have all given religious value to vultures as sentient beings. Their specific functions such as disposing of human corpses in sky burial or funeral rites and scavenging holy cattle carcasses are essential community and ecosystem functions (Baral and Gautam 2007). However, vultures can also be viewed as a bad omen by the community, such as in some areas in Nepal, which may prevent the success of vulture initiatives.

An education programme should include the value of vultures to the community, but also highlight the current reasons for decline and how people can address the issue, such as making sure cattle are not treated with diclofenac, hiring licensed veterinarians where possible and by appropriately disposing of fallen cattle that have recently been treated with veterinary drugs.

Educate professionals (livestock veterinarians, pharmacies—veterinary and human) about the use of alternatives to harmful NSAIDs for treating cattle and other domestic ungulates
The country has built up a vast network of over 50,000 veterinary dispensaries and centres which, together, employ over 100,000 veterinarians and para-veterinary staff. However, the primary function of these institutions is to provide clinical veterinary and breeding services, and the service quality continues to be poor.

All relevant parties should work with the Veterinary Council of India, responsible for regulating the veterinary practice, and the equivalent bodies in the other high risk countries in South Asia to cover the risk of diclofenac to scavenging bird species and available alternatives in its education standards (including, continuing education of existing professionals) and also to develop policy for veterinarian illegal use of diclofenac (e.g., loss of veterinary privileges and/or revocation of veterinary license). For example, 15 plus pharmaceutical companies have been approached to raise awareness of the opportunity to produce patent-free formulations of meloxicam (SAVE 2012).

Liaise with manufacturers to promote voluntary withdrawal of NSAIDs toxic to birds in high risk areas and encourage voluntary safety-testing for new/existing NSAIDs on scavenging bird species
Corporate social responsibility (CSR) within the pharmaceutical manufacturing industry should be aligned to consider the effects of their products on the environment, including preventing harm to wildlife (during the development phase) and being responsive to concerns about existing products on the market (Cheah, et al. 2007). CSR policies should be extended to cover the risks to scavenging birds from pharmaceutical products.

An example of what has been carried out already includes liaising with 40 plus pharmaceutical companies, which have been contacted by SAVE regarding the risks associated with multi-dose vials to vultures, which has been met with success in Nepal and also India, to a lesser extent (SAVE 2012). Further efforts are needed to change corporate social responsibility programmes to prevent risks of veterinary products on scavenging bird species, including removal of products toxic to scavenging birds in high-risk areas and using safety-testing for new/existing NSAIDs to assess risks to scavenging bird species.

Work with manufacturers to raise awareness through product stewardship
Product Stewardship is the “act of minimizing health, safety, environmental and social impacts, and maximizing economic benefits of a product and its packaging throughout all lifecycle stages. The producer of the product has the greatest ability to minimize adverse impacts, but other stakeholders, such as suppliers, retailers, and consumers, also play a role. Stewardship can be either voluntary or required by law” (Product Stewardship Institute 2013). Stewardship with veterinary pharmaceutical companies can play an important role in minimizing the environmental impact of NSAIDs.

One of many possible approaches to fostering stewardship programs with veterinary pharmaceutical companies would be to offer patent extensions to companies that develop comprehensive stewardship programs tailored for particular veterinary pharmaceuticals, especially ecologically-safe alternatives to diclofenac and other NSAIDs of risk to migratory birds. Precedent for this resides in what was the US Food and Drug Administration’s Paediatric Rule, which offers 6-month patent extensions for doing research that defines safe dosages for children (Daughton 2003).

Industries can also adopt voluntary codes of practice and these codes can be used to develop a new public identity based on, for example, responsibility and sustainability (Hale and Held 2011). This way forward may be particularly attractive for the pharmaceutical industry in India and other countries, which have been in the public spotlight for their role in environmental pollution (Ramaswamy, et al. 2011; Fatta-Kassinos, Despo and Nikolaou 2011; Huffington Post 2009). Voluntary codes of practice for the veterinary pharmaceutical industry to ensure NSAIDs (and other drugs) are safety-tested for wildlife if wildlife are likely to be exposed to those drugs, could be combined with other incentives such as patent extensions (above).

Trade associations are also a source of encouragement for product stewardship. They can change behaviour through establishing environmental objectives in codes of practice for member firms. Most trade association codes have common objectives, such as continuous improvement in environmental performance, pollution prevention, product stewardship, and community participation, and call on firms to publicly report environmental performance (Nash 2002). Product stewardship guidelines require members to ensure their products are distributed and used without damaging the environment. Public reporting of environmental performance increases transparency and is one of several steps needed to reduce harm to ecosystems from pharmaceuticals (Larsson and Fick 2009). The reporting of safety-test results for NSAIDs (and other veterinary pharmaceuticals) may provide the necessary public involvement for companies to change testing practices to benefit wildlife and ecosystems.

3. Legislative recommendations

3.1. Prohibit the use of veterinary diclofenac for the treatment of livestock and substitute with readily available safe alternatives, such as meloxicam

Diclofenac, a previously popular non-steroidal anti-inflammatory drug (NSAID) in India, Pakistan, Bangladesh, and Nepal, used to treat domestic livestock for inflammation and pain relief, is toxic to a number of scavenging bird species. Prior to the ban of diclofenac in these countries, the drug was prevalent in livestock carcasses and caused catastrophic population declines of three *Gyps* vulture species.

The drug has now also been shown to be toxic to *Aquila* eagles, of which there are 14 species distributed across Asia, Africa, Australia, Europe and North America, well beyond the more restricted distribution of *Gyps* vultures. There is thus an urgent need for a global ban of veterinary diclofenac, including the withdrawal of approvals for veterinary diclofenac in Europe. Non-toxic and readily available alternatives, such as meloxicam, should be used instead.

3.2. Introduce mandatory safety-testing of NSAIDs that pose a risk to scavenging birds, including multi-species testing using in-vitro and read-across methods, with burden of proof on applicant; VICH/OECD to evaluate and provide guidance on wider risks of veterinary pharmaceuticals to scavenging birds

NSAIDs, including diclofenac, are widely used globally as veterinary pharmaceuticals to treat domestic ungulates (Swan, et al. 2006). Determining the toxicity of diclofenac and other NSAIDs to vultures and other scavenging birds (such as raptors and scavenging storks) is an urgent priority to ascertain the wider threat these drugs may pose to birds.

Safety-testing of all veterinary NSAIDs that could be used to treat animals that may become food for scavenger bird species should be introduced as mandatory. This includes safety testing of substances that are currently on the market as well new substances. Mandatory safety-testing of risks to these species will reduce the likelihood of exposure to substances that are highly toxic to birds. Particular focus should be on South Asia where there have been dramatic declines associated with the use of veterinary pharmaceuticals. However, mandatory safety-testing should be introduced in all areas where birds of prey, especially vultures, are concentrated and rely on domestic ungulate food sources (such as South Asia). Many *Gyps* vulture species worldwide rely on domestic ungulates as their traditional wild ungulate food sources have disappeared (Pain, et al. 2008).

The regulatory approval given by the governments in South Asia of diclofenac was a result of an assessment error – arising from the fact that the assessments relied on acute, single species testing (Enick & Moore, 2007). In this case, single species testing is not appropriate given the effects of certain NSAIDs on vultures, and other species. Safety-testing of new and existing NSAIDs for veterinary treatment of cattle should be revised to include multiple species testing by the applicant.

The burden of proof can be changed to rest with the applicant or manufacturer to show that a NSAID is safe for vultures and other scavenger raptors through independent safety testing. Only those NSAIDs, such as meloxicam (Mahmood et al, 2010), that have been shown to be safe should be approved for veterinary purposes in areas of (1) high vultures and other scavenger raptors concentration; and (2) where domestic livestock are the principle food source of vultures and other scavenger raptors. This approach has been used in the European Union for antibiotic growth promoters in livestock, which takes a precautionary approach to veterinary chemical approval (compared to the US, which uses a conservative burden of proof) (Sanderson, et al. 2004).

This approach is likely to be supported at the international-level by VICH (International Cooperation on Harmonisation of Technical Requirements for Registration of Veterinary Medicinal Products). VICH is a trilateral programme between the European Union, Japan and USA; and, countries such as Australia, Canada and New Zealand act as observers (Sarmah et al, 2006). The environmental impact assessment for veterinary medicinal products guidance produced by VICH recommends the following approach to species-level protection:

> Impacts of greatest potential concern are usually those at community and ecosystem function levels, with the aim being to protect most species. However, there may be a need to distinguish between local and landscape effects. There may be some instances where the impact of a veterinary drug at a single location may be of significant concern, for example, for endangered species or a species with key ecosystem functions.
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> These issues should be handled by risk management at that specific location, which may even include restriction or prohibition of use of the product of concern in that specific local area. Additionally, issues associated with cumulative impact of some veterinary drugs may be appropriate at a landscape level. These types of issues cannot be harmonized but need to be considered as part of the EIA and if recommended, addressed by each region/local area (VICH, 2004).

The potential risks of veterinary medicinal product residues in livestock carcasses on scavenging bird species should be evaluated by VICH (Phase II: Ecotoxicity Testing) and/or by the OECD (Organization for Economic Cooperation and Development).

Ecological risk assessments extrapolate the toxic responses of laboratory test species to all species representing that group, e.g., vultures, in the environment (Celander, et al. 2011). Accurate extrapolation is key, and the development of new in-vitro tests[6] and read-across methods7 may play a significant role in ensuring the accuracy of predicting how species will respond to exposure to veterinary pharmaceuticals. This is particularly relevant for *Gyps* vultures, and other endangered species, where testing on birds is unavailable due to their threatened conservation status (Swan, et al. 2006). The use and further development of these methods is critical for successful risk assessment of veterinary pharmaceuticals for scavenging birds.

3.3. Develop methods to reduce likelihood of illegal use of human pharmaceuticals (could also be non-legislative)

Diclofenac has been banned for veterinary use in Nepal, India and Pakistan since 2006, and in Bangladesh from 2010; however, illegal use is occurring, through the use of human prescribed diclofenac on domestic ungulates (Taggart, et al. 2009; Cuthbert, et al. 2011; Harris 2013). A survey between 2007 and 2010 found many 30ml vials of diclofenac intended for human use being sold for veterinary use in India (Mathew & Unnikrishnan, 2012).

Therefore, a number of ways to reduce the likelihood of illegal use of NSAIDs are recommended below and include limitations on marketing of human varieties of illegal veterinary pharmaceuticals, introducing specific label requirements, changing pharmacy dispensing requirements and prescription status, and increasing the supply and availability of safe veterinary pharmaceuticals.

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[6] Read-across is generally defined as a data gap-filling procedure, in which the property of a substance is considered to be equal to (the average toxicity of) sufficiently-similar and relevant analogue substances, for which experimental data are already available (Rorije, Aldenberg and Peijnenburg 2013). Guidance on how to apply the read-across method is provided by numerous sources, such the OECD.

[7] In-vitro toxicology using components of an animal (in comparison to conventional whole animal in-vivo methods), used to determine the hazardous nature of a product, is gaining wider acceptance in the scientific and regulatory community (Murthy 2007); indeed, it is the favoured approach under the new European chemicals legislation (REACH; Lilienblum, et al. 2008; Worth, et al. 2007).

- *Reduce diclofenac vial size to single dose (3ml) in India, Nepal, Bangladesh and Pakistan*

Recommended diclofenac dosage amounts for cattle in India and Pakistan were 1.0mg per kg and 2.5mg per kg, respectively (Green, et al. 2006). The dosage amounts are significantly higher for domestic ungulates than humans. Presently, vials as large as 30ml are produced for human treatment. These guidelines recommend restricting human diclofenac vial size to 3ml in four high risk countries, where veterinary diclofenac is illegal: India, Nepal, Bangladesh, and Pakistan. By reducing vials to 3ml, the administration to cattle becomes less convenient as many vials would be required for a single treatment (which is required daily for some treatments versus meloxicam which is only needed approximately every three days for similar treatments) (SAVE 2012). This will reduce the domestic ungulate owners' costs because the number of veterinary visits and packaging can be reduced.

Will limiting vial size increase the cost for human diclofenac (Lee, et al. 2010)? If yes, legislators may be less willing to adopt such a recommendation as human-health issues in less-developed regions are likely to be given first priority. However, a human-sized dose of diclofenac is 3ml, and so for safety concerns, such as limiting possibility of overdose through misunderstanding dosage instructions (Wolf, et al. 2007; Drain et al, 2003), it may be appropriate to limit the vial size to a single dose for public pharmacy sales, e.g., non-prescription sales. However, even multi-dose vials in hospitals can be subject to wastage of medication and contamination and may not be cost effective (Sheth, et al. 1983; Setia, et al. 2002).

- *Include "not for veterinary use" on labels of human diclofenac*

Changing the labels of human diclofenac to include "not for veterinary use" may be an effective way to prevent the illegal use of human diclofenac for veterinary purposes. This addition could raise awareness of the issue with both human and veterinary pharmacies, as well as veterinarians.

- *Introduce mandatory reporting for pharmacies to third-party regulatory body and require pharmacies to record sale and purchaser details*

A prescription is required to purchase diclofenac in India (Schedule H drug under the Drugs and Cosmetics Act). The consequences of selling diclofenac without a prescription are for the pharmacist to lose their license to practice. However, in practice, it is rare for a pharmacist to lose their license.

One step further is needed to prevent the risk of veterinarians (licensed and unlicensed) purchasing diclofenac: the introduction of mandatory reporting to a third-party regulatory body, e.g., in India, the state's Drug Controlling Authority. In addition to the regular recording of all prescription sales and purchaser details, reporting of frequent purchasers and high volume sales by the pharmacy to the regulatory body may reduce the likelihood of illegal sales. It also removes the burden from the pharmacy of having to refuse sales. However, it relies on both the pharmacy reporting high volume sales (of which they are likely to make higher profits from) and on the regulatory agency contacting the purchaser and investigating the reasons for purchase.

- *Require identification to purchase human diclofenac*

In Canada, the prescription status of a veterinary drug changes for drugs that are known to be diverted to human uses (Mitchell 1988). This could be used for the reverse situation with human drugs that are known to be diverted to illegal veterinary use. In this case, requiring identification, e.g., driver's licence, to purchase large vials (30ml) of human diclofenac may help reduce illegal purchasing for veterinary purposes.

- *Increase supply and availability of "safe" veterinary products and provide subsidies to those unable to afford veterinary care*

Government veterinary centres are given an annual quota of veterinary medicine, which may not be enough to cover demand (Ahuja et al, 2003). There is also a lack of government veterinary facilities in poorer regions (Ibid.). Both of these factors may increase the possibility of the illegal use of diclofenac, e.g., by lack of (1) available alternatives on hand to purchase; and (2) licensed veterinarians (leading to the potential use of unlicensed veterinarians). Annual quotas for veterinary medicines should be tailored to particular regions and based on the number of livestock in the area. Government veterinary centres should be redistributed to poorer **regions and targeted subsidies given to those unable to afford licensed veterinary care.**

Figure 2: Key knowledge gaps and further research needed

- The toxicity of many NSAIDs and other veterinary pharmaceuticals to vultures and other scavenging birds.
- The risk of NSAIDs in other geographical regions, such as Africa and Europe.
- The physiological and cellular modes of action of these drugs within the avian body and how this might be influenced genetically (i.e., for different bird taxa).
- The relevant market dynamics, such as the range of veterinary pharmaceutical products/NSAIDs used, their cost and market share, and the geographic distribution of products.

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Recommendations to prevent risk from lead ammunition and fishing weights

1. Introduction

Lead is a non-specific poison that affects all parts of the body system and all vertebrate taxa including migratory birds (Franson and Pain 2011). It causes both acute and chronic poisoning, resulting in mortality or a range of sub-lethal effects including immunosuppression, loss of coordination and/or partial paralyses which may subsequently contribute to premature death from other causes, such as disease, starvation, predation and flying accidents (Kelly and Kelly 2005; Scheuhammer 1987; Scheuhammer and Norris 1996; Tavecchia *et al.* 2001). Although lead is a naturally occurring element, it has a number of anthropogenic uses, some of which create sources which may expose migratory birds to its toxic effects.

1.1. Lead ammunition (including shot, pellets and bullets)

Of all the anthropogenic sources of lead, ammunition is responsible for the greatest mortality and morbidity of birds due to lead poisoning. The risks to birds from consumption of spent lead shot from the environment have been known since the 19th century (Beintema 2001; Franson and Pain 2011; Pokras and Kneeland 2009). The vast majority of shot fired from shotguns falls irretrievably into the environment. This lead shot is often ingested directly from the environment by birds such as wildfowl and Galliformes, either mistakenly for food items or for grit used in the muscular gizzard to assist digestion. Secondary poisoning occurs in predators and scavengers that consume the tissues of animals shot with either lead shot or bullets (Pain et al, 2009). Scavengers, are mostly exposed when feeding on un-retrieved game carcasses or gut piles abandoned on the field by hunters (Cade 2007; Helander *et al*. 2009). Predators are exposed to the lead ammunition embedded in the tissues of healthy mammals and birds that had been previously wounded by hunters appreciating that infliction rates in some intensively hunted populations can be high (*e.g.* Falk *et al.* 2006; Elmeros *et al*. 2012).

The amount of lead ammunition, of which the majority is lead shot, that enters aquatic and terrestrial environments each year is not accurately known but may be considerable both in terms of tonnage and numbers of shot pellets which are available for ingestion. In European wetlands an annual dispersion of 2,400-3,000 tonnes has been estimated, whilst for some countries the overall amount is considered to be several thousands of tonnes (6,000 in Spain and 4,600-10,000 in Italy) (Guitart and Mateo 2006, Andreotti and Borghesi 2012).

Lead poisoning from this source has been recorded in at least 20 countries with most reports coming from North America and Europe (Friend and Franson 1999; Mateo 2009). However, lead poisoning in migratory birds can be expected to occur wherever lead ammunition is used for shooting (whether hunting, target shooting or for military purposes) and mortality can be high. For example, in Europe, it has been estimated that approximately a million wildfowl (representing 17 different species) or 8.7% of the total population, may die every winter from lead poisoning caused by ingestion of lead gunshot (Mateo 2009). The toxicosis poses a particular risk to threatened populations of birds in areas where there are high levels of hunting activity (*e.g.* in some white-headed duck *Oxyura leucocephala* habitats) or for those species whose life history traits such as naturally low productivity and long lifetime, create vulnerability to the effects of additional adult mortality (*e.g.* large raptors such as California condors *Gymnogyps californianus* and Steller's sea eagles *Haliaeetus pelagicus*).

The motivation for manufacturers to produce lead free ammunition has come from responses to restrictions on use of lead ammunition for wildlife hunting (Kanstrup 2006), and the human health risks and costs of cleaning up shooting ranges used for military purposes (European Commission 2004). Effective non-toxic alternatives to most lead ammunition are now available although the technology for some alternative bullets for certain calibres of gun is still in development (Thomas 2013).

1.2. Lead fishing weights

A number of migratory waterbird species are known to suffer from lead poisoning following the ingestion of recently or historically discarded or lost lead fishing weights. Species with a muscular gizzard which are likely to feed in areas exposed to lead fishing weights are most at risk (AEWA 2012a). The European Commission (2004) notes, in particular, exposure of migratory waterfowl to lead split shot and small sinkers used in inland fishing waters, and comments that the actions of one Member State may naturally influence the other Member States.

Although it is difficult to assess the population-level effects of such poisoning, there is some evidence for effects in species known to be particularly prone to ingesting fishing weights such as the mute swan *Cygnus olor* (Nature Conservancy Council 1981; Birkhead 1982, 1983; Sears 1988) and the common loon *Gavia immer* (Pokras and Chafel 1992). The quantity of lead fishing weights that enters the aquatic environment each year and becomes available for ingestion by birds is not accurately known. New purchases of weights are believed, in the main, to represent replacements for lost weights and there have been estimates of annual purchases of weights equating to approximately 4,000 tonnes in the USA (AEWA 2012a; Scheuhammer *et al.* 2003) and between 2000 and 6000 tonnes in Europe (European Commission 2004).

Predators and scavengers that feed on waterbirds poisoned by fishing weights may also be at risk of secondary poisoning (Goddard *et al.* 2008; Pain, et al.s 2009).

1.3. Industrial pollution from lead mining and smelting processes

Lead mining and smelting processes can release industrial pollution containing high concentrations of lead (Blus *et al.* 1995; Bull *et al.* 1983; Osborn, et al. 1983). When feeding in such contaminated aquatic environments birds ingesting sediments and vegetation are exposed to the highest levels of lead and are at the greatest risk. As a consequence, wildfowl and waders are especially vulnerable. This source has been known to cause both occasional deaths and mass mortality events (Beyer *et al.* 1997; Beyer *et al.* 2004; Beyer *et al.* 2000; Blus *et al.* 1995; Blus *et al.* 1999; Sileo *et al.* 2001; Spears, et al. 2007).

1.4. Leaded paint

Human health concerns have reduced or eliminated the production and use of leaded paint in many parts of the world. However, leaded paint on old buildings and other structures can still provide a source of lead in some circumstances and has been reported as a significant cause of poisoning in young Laysan albatrosses *Phoebastria immutabilis* on Midway Atoll (Sileo and Fefer 1987; Work and Smith 1996; Work, et al. 1998).

2. Recommendations: lead ammunition

The conclusions and recommendations of the IWRB conference in 1991, the 2001 Wetlands International report, and the 2008 Peregrine Fund conference on the solutions to lead poisoning caused by ammunition, *inter alia*, phasing out the use of lead ammunition, remain valid and relevant yet serve to highlight the slow progress made on this issue (Pain 1992; Beintema 2001; Watson *et al.* 2009). This substitution of toxic to non-toxic ammunition is considered the only long term solution for significantly reducing wild bird mortality from ammunition-related lead poisoning (Cromie *et al.* 2012).

2.1. Non-legislative recommendations

Voluntary approaches to restricting use of lead ammunition have been shown to work in some limited circumstances such as on private ranches or shoots (Hill 2009) but have not been shown to work at a national level (*e.g* . Cromie *et al.* 2010). For national transition to non-toxic ammunition, Friend, et al. (2009) highlight the need to address a range of societal issues to help this process. The perceptions of shooters on the issue of lead poisoning and restrictions on use of lead will differ, particularly between countries and cultures, but include philosophical issues regarding gun rights and increased government oversight of shooting (Hill 2009), the belief that lead ammunition is unlikely to actually poison wildlife (Countryside Alliance 2013); lead poisoning being thought to be an insufficient problem to justify restrictions (indeed the disease has been termed “invisible” (Pain 1991)); and a range of perceptions about the efficacy, availability and price of the non-toxic alternatives (Countryside Alliance 2013; Cromie *et al.* 2010; Kanstrup 2006). With respect to cost, the European Commission (2004) estimated that the additional costs to hunters of conversion to lead ammunition, spread over a five year period, would correspond to an annual increment of approximately €13 per hunter (assuming this replacement is a mix of steel, bismuth, tungsten and tin, depending on local conditions). However, following market dynamics, alternative ammunition will likely become cheaper when more commonly used, and, therefore, requested.

As a constituency, hunters are likely to be higher consumers of game meat than the wider public yet several reports indicate the relatively recently recognised risks to human health of consuming game shot with lead has had little effect on the desire of hunters to use the non-toxic alternatives (Countryside Alliance 2013; Hill 2009). Although resistance to using the non-toxic alternatives has come from some parts of the shooting community, there are actually gains for hunters as substitution of lead ammunition would result in more birds becoming available for shooting. After a national ban on lead shot for waterfowl hunting in the USA in 1991, there was a relatively rapid decline in the rate of lead shot ingestion (Anderson, et al. 2000). Consequently, 1.4 million of 90 million ducks in 1997 were estimated to have been spared from fatal lead poisoning (Anderson, et al. 2000).

Awareness raising visual imagery of both the problem of lead poisoning in wild birds and the efficacy of the non-toxic alternatives have been reported as effective educational tools in the USA (Friend, et al. 2009). With respect to public relations and the image of hunting, use of non-toxic ammunition has been reported as reducing the potential of negative public reaction to the issue of lead poisoning of wildlife and environmental contamination from ammunition sources (Kanstrup 2006).

Initiatives such as the African-Eurasian Waterbird Agreement (AEWA) Non-toxic Shot Workshop held in Romania in 2001 (AEWA 2001) show that hunters can be persuaded of the lack of disbenefits of non-toxic shot. It is helpful that international bodies representing hunting concerns and organizations, such as the Federation of Associations for Hunting and Conservation of the European Union (FACE) and the International Council for Game and Wildlife Conservation (CIC), have also promoted the phasing out of lead in ammunition. Leadership from within the hunting community has been shown in at least some countries to prove valuable in the transition to legislative changes to the non-toxic alternatives (Kanstrup 2006) (see Box 1 for the Danish example).

Figure 1: The Danish example of the transition to non-toxic shot

Leadership from within the Danish hunting community helped this constituency appreciate both the problem of lead poisoning and the benefits of non-toxic alternatives prior to introduction of restrictive legislation (Kanstrup 2006).

Denmark began regulation of lead shot in 1985 and in 1996 it became illegal to use lead shot for all shooting. During this period, shooters had fears about the cost and efficacy of non-toxic shot. Some key advocates within their community were crucial in persuading hunters of the benefits of the non-toxic alternatives and the successful introduction of steel shot for clay pigeon shooting allayed shooter concerns by demonstrating that there were suitable, safe, relatively cheap and thus acceptable alternatives to lead. Research by the Danish Hunters Association also demonstrated the efficacy of steel shot for killing birds. When steel shot embedded in trees was deemed unacceptable to foresters, this led to pressure to develop softer alternatives of which mainly bismuth has proven to be popular, despite the comparatively higher cost.

Many Danish hunters were concerned that phasing out of lead shot would lead to the end of hunting, but this has not occurred and the number of hunters and the annual bag has not changed significantly. Furthermore, an initial concern about health and safety of using steel shot in guns was not borne out. Scientific studies conducted by hunters themselves, demonstrated the efficacy of alternative shot and have reassured the hunting community. Moreover, the general image of hunting within the wider Danish community has been maintained.

From the above, it follows that a range of awareness raising initiatives and promotion of the use of non-toxic alternatives for a range of stakeholders would assist in the phase-in period towards complete substitution of lead ammunition.

2.1.1. Raise awareness of lead poisoning, particularly at key sites for migratory waterbirds; promote leadership from ammunition users, including wildlife managers, on non-toxic alternatives and best practice

Raise awareness and create supporting resources (including visual imagery) to encourage immediate substitution of lead ammunition with non-toxic alternatives, including a collaborative multi-MEA, shooter/hunter/fisher, natural resource managers and conservation organizations resource/website with information on:

- best practice for hunting to reduce risks of lead poisoning to wildlife (eg, shooting to prevent crippling and non-retrieval of wildlife);
- the negative impacts of lead poisoning on birds and how public opinion may be affected;
- misperceptions within the shooting community on the non-toxic alternatives;
- the benefits of non-toxic alternatives leading to lower mortality in quarry species populations due to lead poisoning, hence to a higher harvest potential; and

- the potential human health risks of consuming lead ammunition-contaminated game for children, pregnant women and those adults who are likely to consume large quantities of game meat.

Priority should be given to awareness raising initiatives at key sites of migratory waterbirds, such as Ramsar Sites, for the substitution of lead for non-toxic alternatives for all shooting activities being undertaken in these areas. Similar initiatives should also be developed at bottlenecks where raptors funnel and stopover during migration (for instance Gibraltar surroundings, Sicily, *etc*.) and at breeding/wintering grounds where vulnerable species occur in high numbers.

Natural resource managers, and hunting and angling organizations and associations should be encouraged to provide leadership on the issue, including tourism operators, military, sports shooters and hunters to raise awareness of the problem; promote non-toxic alternatives; and to support substitution of lead ammunition within three years.

Conservation organizations and government agencies and other natural resource management professionals which use ammunition for pest and wildlife management, and invasive species control should, with immediate effect, become lead ammunition-free thus leading the way for other bodies and organizations to do likewise.

2.2. Legislative recommendations

The effects of lead on human health have been the main drivers for reduction in environmental contamination by lead and has led to the creation of national policies to remove lead from sources such as petrol and paint (World Health Organization 2013).

With respect to lead ammunition, the most effective way of reducing risks to migratory birds is to create legislative processes to restrict sale, possession and/or use of lead ammunition to ensure lead ammunition is not left un-retrieved within the environment. Thomas (2009), commented, of legal restriction on lead shot in the USA, that “sixteen years of non-toxic shot use in waterfowl hunting is the most cost-effective conservation tool to date in conserving waterfowl populations. Similar savings could be expected from the use of lead-free shot such as for hunting migratory doves and upland birds”.

At least 29 countries have acknowledged the threat of lead ammunition by implementing some form of regulation on its use. There is, however, great variation within those regulations and any given country is likely to have set policy somewhere within a range of voluntary restrictions to partial or complete bans (*e.g.* a complete ban on sale and import of lead ammunition). The most common restriction has been a ban on lead shot use over wetlands (Avery and Watson 2009), many in response to the AEWA Resolution 1.14 and subsequent resolutions (AEWA 1999, 2002, 2008). However, this approach does not protect waterbirds and terrestrial species when feeding on agricultural land and other terrestrial habitats where they may be exposed to legally discharged lead shot (Newth *et al.* 2012).

Partial restrictions, i.e., those relating to use of lead over certain habitat types only, or for certain species, are often reported to be complex to monitor and enforce (AEWA 2012b). A perception of knowing that there is limited enforcement has been cited as one of several reasons for non-compliance with the partial restrictions in England (Cromie *et al.* 2010).

Whilst there is a range of commercially available non-toxic alternatives to lead shot, most bullets are still manufactured from lead despite advances in technology (Thomas 2013). It has been recognized that creating “guaranteed” markets for non-toxic ammunition by introducing statutory bans on lead ammunition encourages the manufacturers to further develop their products and assures the market demand for their products (Kanstrup 2010; Thomas 2009).

Complete legislative phase out of all lead ammunition has been undertaken in countries such as Denmark and in some sub-national regions. Examples include approaches that have been taken in the USA and Japan to reduce risks to Californian condors and Steller’s sea eagles respectively (Cade 2007; Saito 2009).

2.2.1. Phase-out the use of lead ammunition across all habitats (wetland and terrestrial) with non-toxic alternatives within the next three years with Parties reporting to CMS Conference of the Parties (COP12) in 2017, working with stakeholders on implementation

Given the development of non-toxic alternatives to lead ammunition, legislation to phase-out lead ammunition for non-toxic alternatives within three years across all habitats, including terrestrial and wetland habitats, is recommended. All Parties should to report to the CMS COP12 in 2017. To reduce problems with monitoring, compliance and enforcement, such processes should not be partially restrictive. Given the wide product availability, comparable prices, and the effectiveness of high-quality lead-free bullets for most calibres of gun (Thomas 2013), it is also possible to recommend substitution of lead bullets with non-toxic alternatives.

2.2.2. Create legislative processes to facilitate remediation of lead ammunition-contaminated environments

Where appropriate, national regulators should be encouraged to introduce requirements for remediation activities to be undertaken to reduce lead contamination from ammunition, in both wetland and terrestrial environments.

Figure 2: Key knowledge gaps and further research areas

- Collated information on shooting activities, ammunition use and the mapping of this information with at-risk migratory bird habitat (needed to determine likely affected areas and scale of impacts).
- Collated information on current legislative processes plus compliance with, and efficacy of, regulations.
- Quantification of population level impacts (needs better surveillance and updated knowledge of ingestion rates and prevalence of embedded lead ammunition, plus further research on sub-lethal effects).

3. Recommendations: Lead fishing weights

The barriers and solutions to replacement of lead fishing weights with non-toxic alternatives have many parallels with the lead ammunition issue. There is a wide range of non-toxic alternatives to lead fishing weights catering for a broad range of uses (AEWA 2012a). However, lead has remained popular and alternatives may be more expensive due to both costs of raw materials and manufacture (lead weights can be easy to cast and even manufactured at home (European Commission 2004)). As has been reported by hunters purchasing ammunition, cost remains a decisive criterion in the purchase of fishing weights by anglers. However, the additional costs likely represent only a very small proportion of the overall annual expenditure on fishing (an estimate in 2004 for European anglers put this figure at an additional €1.5 - €10.4 per angler per year (European Commission 2004).

3.1. Non-legislative recommendations

Lead poisoned birds usually go unseen (Pain 1991) and as with hunting, there has been resistance to bans on lead fishing weights citing insufficient evidence of a problem. This has no doubt contributed to the ineffectiveness of voluntary bans on lead fishing weights to date.

Small scale initiatives such as tackle-exchange programmes or educational activities have been tried in North America and Europe. In the USA, although some fishing organizations were unconvinced of the scale of the problem there has been acceptance that elimination of lead is a desirable societal goal and have advocated phasing out of smaller fishing weights (AEWA 2012a).

Therefore, awareness raising initiatives plus promotion of the use of non-toxic alternatives for a range of stakeholders would assist in the phase in period towards complete substitution of lead fishing weights.

3.1.1. Raise awareness of the issue of lead poisoning from fishing weights and solutions to the problem

An essential component of the solution to the problem caused by lead fishing weights will involve awareness raising initiatives for anglers of the issue and their role in the problem caused by lead fishing weights; plus promotion of the use of the non-toxic alternatives.

3.1.2. Encourage leadership from angling organizations and manufacturers for non-toxic fishing weights

Angling organizations and associations should be encouraged to provide leadership on the issue, getting this key stakeholder group to: raise awareness of the problem; promote of the non-toxic alternatives; and support substitution of lead fishing weights.

Both the manufacturers and traders of non-toxic fishing weights should be encouraged to actively promote these products.

3.1.3. Promote anglers' codes of practice

Anglers' codes of practice, which would reduce risks to wild birds, should be promoted such as, advice on key areas to avoid fishing with lead fishing weights (whether these be areas of high numbers of at risk species, or areas where loss of weights is more likely to occur).

3.2. Legislative recommendations

At time of writing, Denmark is the only country to have essentially a ban on all lead fishing weights (both the import and sale are banned). Elsewhere, restrictions to date have usually been partial, focusing on discrete sizes of weights or on discrete geographical areas such as reservoirs used by common loons (AEWA 2012a). The phasing out of smaller weights in England in 1987 lead to a significant decline in lead poisoning in mute swans and has been cited as one of the reasons for an increase in their population size in some areas (Newth *et al.* 2012; Rowell and Spray 2004).

As with ammunition, fishing weight manufacturers cite the need for a ban on lead weights to assure them of guaranteed markets for the non-toxic alternatives.

3.2.1. Phase-out the use of lead fishing weights in areas where migratory birds have been shown to be particularly at risk i.e. freshwater habitats, (excluding fishing weights used in coastal areas where there are significant knowledge gaps and further research needed) with non-toxic alternatives, within the next three years with Parties reporting to CMS COP12 in 2017, working with all stakeholders on implementation

Legally binding restrictive regulations should be introduced to substitute lead fishing weights with non-toxic alternatives in habitats where migratory birds have been shown to be particularly at risk, specifically non-coastal habitats. Such regulations need to be enforceable and thus partial restrictions are advised against to help ensure compliance.

Figure 3: Key knowledge gaps and further research areas

- Collated information on fishing practices, plus lead fishing weight usage, globally in relation to at-risk migratory bird species distribution (needed to determine likely affected areas and scale of impacts).
- Collated information on current legislative processes related to fishing weights (needed to help evaluate risk and assess compliance with, and efficacy of, these measures).
- Understanding of the drivers for using lead fishing weights and the opinions of anglers to the non-toxic alternatives.
- Good understanding of possible population level impacts (needs better surveillance of both known at-risk species and other potentially affected species, plus further research on sub-lethal effects).

4. Recommendations: other sources of lead poisoning

4.1 Industrial pollution from lead mining and smelting processes

Where appropriate, national regulators should be encouraged to ensure lead is not released into the wider environment where migratory birds may be exposed directly to lead or lead compounds, or indirectly via bio-accumulated lead in invertebrates and small vertebrates.

4.2 Leaded paint

The extent of leaded paint structures across the world is not known, nor the extent of exposure of migratory birds to ingestion of such paint (usually in the form of flakes or chips), thus recommendations to reduce this exposure have to be focused on situations where a risk has been specifically identified.

In situations of risk, remediation activities should be encouraged to help to minimize risks by removing the toxic source and/or limiting access to lead painted structures.

4.3 Other sources of discarded lead

Although there is a range of other lead sources to which migratory birds may be exposed in some circumstances, the nature of these contacts is, for the most part, not well understood. Thus recommendations made here are appropriately brief.

- Raise awareness of the hazards posed by discarded lead products to migratory birds.
- Encourage enforcement of regulatory processes where migratory birds are exposed to lead risks from legal and illegal waste disposal.

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