

## Priority contribution

# Role of international conventions in promoting avian conservation through reduced lead toxicosis: progression towards a non-toxic agenda

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### Summary

The transition to the use of non-toxic shot and fishing weights has been slow at the international level despite the Bern Convention and the African Eurasian Migratory Waterbird Agreement (AEWA) having called for a ban on lead shot use by the year 2000. Adopting lead substitutes is also consistent with the habitat goals of the Ramsar Convention and the Biodiversity Convention. In countries where non-toxic shot and sinkers are required by law, published studies show a marked reduction in lead toxicosis and large savings of birds. A renewed commitment from the AEWA, the Bern Convention, and especially the Ramsar Convention is needed to encourage their parties to regulate the use of non-toxic materials. Eleven different non-toxic substitutes for shot now exist, and some of these can also serve as substitutes for lead sinkers. While previous regulatory emphasis has been placed on wetland habitats, any new initiatives could also propose a phasing out of lead shot in upland habitats to reduce the prevalence of secondary lead poisoning of migratory raptors.

### Resumen

La transición hacia el empleo de perdigones y de pesos de pesca no tóxicos ha sido lenta a escala internacional, y eso a pesar de que la Convención de Berna y el Acuerdo sobre la Conservación de las Aves Acuáticas Migratorias de África y Eurasia (AEWA) promovían una prohibición del uso de plomo para el año 2000. La adopción de alternativas al plomo está, además, en concordancia con los objetivos para los hábitats de la Convención de Ramsar y de la Convención de la Biodiversidad. En los países en los que se requiere por ley el uso de alternativas no tóxicas en perdigones y en pesos de pesca, los estudios publicados muestran en aves una marcada reducción de las intoxicaciones por plomo y una disminución de la mortalidad. Un renovado compromiso del AEWA y las Convenciones de Berna y, especialmente, de Ramsar, es necesario para que animen a las partes firmantes a fomentar el uso de materiales no tóxicos. En la actualidad están disponibles once alternativas al plomo para la fabricación de perdigones, algunas de las cuales también son útiles para los pesos de pesca. Mientras que las iniciativas anteriores han puesto énfasis en la actuación sobre las zonas húmedas, las futuras deberían también incluir los ecosistemas terrestres, con el objetivo de reducir el número de intoxicaciones secundarias que se producen entre aves de presa migradoras.

## Introduction

Centuries of use of lead shot and fishing weights by hunters and anglers have left heavy lead burdens wherever these sports have been practised throughout the world (Pain 1992). Spent shot and lost fishing weights become toxic to wild species when the metal is ingested, whether in upland regions, wetlands, lakes or rivers. Primary lead toxicosis occurs when birds ingest shot or fishing weights directly from their habitats (U.S. Fish and Wildlife Service 1986). Secondary lead poisoning occurs when game animals are wounded by gunfire, or killed but not retrieved, and then consumed by predatory or scavenging birds which ingest the embedded shot with the tissues of the prey.

Lead toxicosis arising from the ingestion of lead shot is known to occur in at least 21 countries worldwide (Beintema 2001). Substantial losses of swans from lead fishing weight and shot ingestion have occurred in England (Sears and Hunt 1991), Ireland (O'Halloran *et al.* 1991), Japan (Honda *et al.* 1990) and North America (Blus 1994). In North America losses of Common Loon *Gavia immer* and other avian piscivorous species from lead weight ingestion account for about one-third of those cases where the cause of death could be ascertained reliably (Twiss and Thomas 1998, Sidor *et al.* 2003). Losses of waterfowl species in the United States from primary lead poisoning were estimated to be 1.6–3.8 million birds a year (Feierabend 1983) before the 1991 ban took effect. The United States implemented the national ban on use of lead shot for waterfowl hunting not only to conserve wild populations of waterfowl, but also to protect Bald Eagle *Haliaeetus leucocephalus* and Golden Eagle *Aquila chrysaetos* from secondary lead poisoning (Anderson 1992).

The United Kingdom was the first country to ban lead fishing weights in 1987, and Norway and the United States were the first nations to ban the use of lead shot for waterfowl hunting in 1991. Since that time, an array of legally approved, non-toxic lead substitutes has been produced and marketed (Department of the Interior 2004). Because of the multi-national scale of lead toxicosis in birds and the need to address the problem of lead toxicosis in migratory birds at the continental level, explicit recommendations to cease using lead shot and fishing weights have been made under the African Eurasian Migratory Waterbird Agreement (AEWA) of the Bonn Convention (CMS), and the Bern Convention. A similar recommendation has also been made by the Organization of Economic Cooperation and Development (OECD 1996, Nordic Council of Ministers 1994). Stopping the addition of toxic materials to wetlands is implicit in the goal statements of the 1975 Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) and the Convention on Biological Diversity (CBD), both of which identify the conservation of critical habitats for migratory birds. To date, only seven nations have imposed a statutory ban on the use of lead for hunting in wetlands, and a further 11 nations have imposed a partial ban for certain waterfowl species or areas (Section 8 in Beintema 2001).

While the distribution of waterbirds is cosmopolitan, the scientific evidence for mortality from lead ingestion comes mainly from countries with a capacity for avian pathological examination. Nonetheless, lead toxicosis is likely to occur wherever hunting and angling have long traditions. Despite abundant empirical evidence for lead toxicosis in wild birds, the availability of lead substitutes, international agreements recommending lead bans, and the progressive actions of some nations to phase out lead sinkers and shot (Beintema 2001), adoption of non-toxic regulations has been

slow at the international level and, at best, piece-meal (Thomas and Guitart 2003a). This paper recalls the roles of several international conventions that have expressed the need for remediation of avian lead toxicosis in the conservation of many species and their habitats. We also suggest that a renewed commitment from these international conventions is needed to achieve a broad-scale transition to the use of non-toxic hunting and angling materials in wetland and upland environments.

### **Provisions of the Bonn, Bern and Ramsar Conventions, and the CBD**

Under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds of the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention), Section 4.1.4 of the Action Plan states that "Parties shall endeavour to phase out the use of lead shot for hunting in wetlands by the year 2000". This Agreement was adopted in 1995. The AEWA has promoted the use of non-toxic shot for wetland hunting (available at: <http://www.unep-aewa.org/eng/info/Leadshot/leadpage1.htm>), but concedes that the issue of lead toxicosis caused by lead shot is poorly acknowledged. A similar recommendation was adopted in 1991, under Recommendation No. 28 of the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention), as administered by the Council of Europe. The date for implementing the ban on lead shot use by the Parties has passed, but without any further commitment to follow-up action by either convention. The Bern Convention also recommends that European nations develop educational and training programmes to facilitate the transition to non-toxic shot use, but this has not materialized, especially in those countries that have resisted the transition.

The Bern Convention applies to a large geographic area since it has been ratified by 35 member states, and contains various provisions that are consistent with the wide-scale protection of migratory species from lead toxicosis. Thus, the Preamble to the Bern Convention identifies the need for international cooperation "to protect migratory species in particular". Article 1(1) of Chapter 1 stipulates "species and habitats whose conservation requires the cooperation of several States, and to promote such co-operation". Article 3(2) requires each Party to "undertake ... measures against pollution", but here, does not equate "pollution" with spent lead shot and sinkers. Chapter 2 of the Convention deals with the protection of habitats, and, again, Article 4(3) exhorts Parties to pay special attention to conserving the habitats of migratory birds (such as flyways, wintering, feeding, staging, breeding and moulting areas), especially for species listed in Appendixes II and III of the Convention. These are the areas that are most commonly polluted by spent shot.

The CBD does not deal explicitly with the issue of avian lead toxicosis or its remediation. However, certain articles could be interpreted as being consistent with the phasing out of lead shot and sinkers. Thus Article 6 of the Convention obliges any Party that has ratified it to "develop national strategies, plans and programmes for the conservation and sustainable use of biological diversity". In this regard, the implementation of non-toxic shot and fishing sinker regulations is consistent with a programme of conservation of birds and their habitats. Moreover, the use of non-toxic weights and shot makes the recreational sports of angling and hunting more sustainable because a toxic legacy would then not be left in game birds' habitats to cause further lead toxicosis.

Article 7 of the Convention also directs Parties to “identify components of biological diversity important for its conservation and sustainable use”, and refers specifically to the ecosystems and habitats of migratory birds. In this regard, lead toxicosis of migratory waterfowl and piscivorous birds begins with spent lead shot and sinkers that contaminate their habitats, whether in their breeding range, the annual migratory ranges or the wintering ranges. For many migratory species these ranges may extend across several distinct biomes and ecosystems. Thus, phasing out the use of lead in the sporting environment is consistent with enhancing the biological quality of these species’ habitats, and the promotion of their future sustainability.

The Ramsar Convention has placed explicit emphasis on the protection of key areas of waterbird and waterfowl habitats across the world. Contracting Parties to the Convention must develop wetland policies at the national level, including conservation and wise use provisions in land use plans. This Convention regards the concepts of wise and sustainable use as being synonymous (Frazier 1996). It is paradoxical that this Convention contains no explicit provisions for managing and remediating lead toxicosis. It could be argued that the formation of this Convention in 1975 preceded the period (1991 to the present) when the American, Norwegian and other governments began dealing with avian lead toxicosis. However, this Convention is revisited frequently to keep it modern and to promote cooperative activities (Frazier 1996). At the Sixth Meeting of the Conference of the Contracting Parties (to the Ramsar Convention) in 1996, Recommendation 6:14: Toxic Chemicals exhorted nations to recognize the deleterious impacts of toxic chemicals on components of wetlands, and to view these actions as contraventions of wise use. In this Recommendation, “toxic chemicals” have been identified as pesticides, persistent organic pollutants, and synthesized chemicals that may act as endocrine disrupters. Nowhere in this recommendation is lead from shot and fishing weights identified, explicitly, as a toxic chemical, although it could be argued that it is identified implicitly. Given the demonstrated damage that lead has caused, and will cause, to global wetland biota (e.g. Pain 1992, Beintema 2001) and the relative ease of phasing out use of this recreational point-source poison (compared with industrial, municipal and agricultural pollutants of diffuse origins), one may question why lead shot and sinkers have not been included in more Recommendations to the Convention.

It is surprising that the Convention has not yet called upon its Parties to implement non-toxic requirements consistent with both the AEWa and the Bern Convention. Allowing a toxic material to be added to those wetlands that are central to the persistence of intercontinental waterbird species is the antithesis of both wise and sustainable use (Lecocq 1992). The recently created (April 2004) Joint Work Programme among the CMS, the AEWa and the Ramsar Bureau could be an opportunity to adopt such an initiative to better conserve the habitats of migratory species.

### **Why emphasize international conventions?**

Beintema (2001) indicated that the implementation of non-toxic shot regulations throughout the world is both sporadic and patchy. The list of countries that have implemented non-toxic sinker regulations is even shorter. The only initiatives that have been successful to date are those of individual countries. The fact that the AEWa and the Bern Convention have been unsuccessful in bringing their Parties to implement non-toxic shot regulations attests to the general unwillingness of most nations to participate in this conservation initiative, rather than the provisions of these

instruments to achieve an end to use of lead products. However, this fact does not negate these conventions as the best way to introduce lead-free programmes for hunting and angling.

The protection of waterfowl from lead toxicosis requires consistent policy and legislation throughout entire flyways (Thomas and Owen 1996). The conservation of waterfowl through non-toxic regulations in parts of their northern breeding and migratory range (e.g. Canada, Denmark, Finland, Norway, Sweden, The Netherlands, and northern United States), while reducing the overall risk of toxicosis, is thwarted by the persistent use of lead shot in other parts of these species' range, especially the wintering range (as in Greece, Mediterranean France, Italy, Malta, Turkey, and central America). It is also possible to see inconsistency in policy on lead shot and sinker reduction within a country. Thus, in the United Kingdom, only England and Wales have passed legislation to prohibit the use of lead shot over wetlands and the use of common lead sinkers in angling. Scotland and Northern Ireland, with devolved political power, have still to achieve the same position on lead shot use as England, despite the fact that many species of migratory birds traverse their political boundaries.

It is the power of conventions to act on behalf of all their members, and in a consistent manner, that makes them so important. Lead toxicosis is national to inter-continental in scale, and so the remediation should reflect this, both in time and space. If all the Parties to the AEWa and Bern Convention, alone, had exercised their commitment to phase out lead shot use in 2000, then remediation would be far more advanced than at present, and the routes of migratory birds would be more secure.

However, not even the presence of a strong international treaty can always ensure passage of appropriate legislation in a timely manner among all parties. The United States, Canada and Mexico are signatories to the Migratory Bird Treaty (Lyster 1985). Under this Treaty, the United States enacted national non-toxic shot regulations in the Migratory Bird Treaty Act for the hunting of migratory birds in 1991. Canada, privy to the same information, with its own problem of lead toxicosis, and a co-manger of the continental waterfowl with the United States, was unable to launch its national non-toxic regulations under the Migratory Birds Convention Act until 1999. Mexico has still to complement this initiative, despite evidence of regional lead shot toxicosis (Schmitz *et al.* 1990), and its role in managing waterfowl habitats used by birds breeding north of its border.

Thomas and Owen (1996) investigated the capacity of voluntary measures, economic incentives and environmental education to induce sportsmen to change to the use of non-toxic materials. They concluded that none of these measures, whether alone or in combination, was successful, and that legislation was the most effective way to induce change in behaviour and compliance. Reference to the list of nations (Beintema 2001) that have initiated non-toxic shot and sinker requirements indicates that legislation has been the instrument of choice. Without laws, there is little incentive for individuals to comply, and certainly no incentive for the private manufacturing sector to invest in the invention, production and marketing of accepted substitutes for lead shot and fishing weights.

### **The disconnection among hunting, angling and avian conservation constituencies**

The nature of lead toxicosis varies little among the different taxonomic groups of animals that are poisoned by this heavy metal. However, the management of the

syndrome has fallen into different camps, each with their own characteristic approach (Thomas and Guitart 2003a). Understandably, human lead poisoning has been the purview of the medical profession and those entrusted with managing the human environment. Lead poisoning of waterfowl has been dealt with as an issue of the waterfowl hunting community, and dealt with separately from the lead poisoning of birds from ingested fishing weights: that is viewed commonly as the responsibility of the angling community (Thomas 1995, 1997, Twiss and Thomas 1998). This disconnection can be attributed to several factors. The understanding of lead toxicity in humans has pre-dated that in wildlife by a long time, and this understanding has not been generally extended to other forms of life and the scientific literature that addresses them (Thomas and Guitart 2003a). The fact that human health issues have often taken precedence over the health of animal species is another compounding factor.

The issue of lead poisoning of wild birds has also been regarded as an acceptable externality of angling and hunting until it reaches some arbitrary level. In the United States and Canada, the arbitrarily set level of shot ingestion above which non-toxic shot was required for an area was 5% and 10% of birds sampled, respectively, before nationwide bans on lead shot occurred. Thus the criteria for intervening on lead exposure are far more restrictive in the human environment than in the natural environment. In the human case, governments are concerned about exposure levels that may produce chronic, subclinical, effects in the individual (Lanphear 1998, Nevin 2000, Canfield *et al.* 2003). In the case of wildlife toxicosis, the agencies responsible are still dealing with lead exposures that produce acute signs and levels of mortality in avian populations (U.S. Fish and Wildlife Service 1986, Scheuhammer *et al.* 2002).

There has been little transfer of the rationale for phasing out the use of lead shot to the case for eliminating the use of lead sinkers. Thus, the United States was able to ban the use of lead shot for waterfowl hunting in 1991, but has yet to achieve the same restriction on the use of lead fishing weights, despite the fact that victims of sinker ingestion are also migratory birds, and subject to the same legal protection under The Migratory Bird Treaty. England was able to ban lead sinker use in angling in 1987, but a restriction on lead shot use came much later. In Canada, the agency administering national parks (Parks Canada) banned the use of lead fishing weights in all national parks in 1997. However, none of the Canadian provinces has seen fit to complement this initiative at the level of provincial parks and other provincially regulated waterways, even though the commonly afflicted birds' annual ranges are contiguous across these political jurisdictions.

Thomas (1995, 1997) has identified some of the reasons for this situation. It can be the competitive existence of different governmental agencies that administer waterfowl hunting, upland hunting, angling and fishing in national parks, as in the United States and Canada (Thomas 2003). Another major reason is the perception among many sporting groups that the case for phasing out lead shot has to be made separately, and independently, from the case to reduce use of lead fishing weights. Thomas (1997) has also indicated that there are two different socio-economic constituencies found in game shooting and coarse fishing (that requires lead sinkers), especially in affluent European countries, that would not align on this common issue. Another disconnection is seen among many professionals of avian conservation whose principal focus is on species' population levels in relation to anthropogenic causes of habitat decline, and those whose mandate is to manage populations of shootable and fishable

species. Both groups contend that they are ardent conservationists, but different values and philosophies towards the consumptive use of wild life often separate them. Hunters and anglers view losses from lead toxicosis as a problem for the sporting community to address, as in the case of the British Association for Shooting and Conservation in the UK (Shedden 1992), the Federation of Hunting Associations of the European Community (Lecocq 1992) and the Conseil International de la Chasse (CIC).

The disconnections among policy on lead remediation within Europe are seen in the fact that the European Commission passed a Directive to eliminate the use of lead wheel balance weights in 2005 (European Commission 2002) while the EC decided to take no action to reduce the use of lead shot (CSTEE 2003), notwithstanding the position taken by the Bern Convention or the AEW. In yet another example of this disconnection in policy, the Aarhus Treaty explicitly requires the use of lead-free gasoline in Europe by the year 2005 (von Storch *et al.* 2003). In these cases, different environmental constituencies, with differing environmental values and criteria, are evaluating very distinct examples of lead pollution without regard to a broader, consistent environmental mandate. The European Commission has also passed the Birds Directive (79/409 EEC) to promote conservation of its members' avian biodiversity. However, under this Directive, no concerted action on lead shot pollution was advised, but member Parties were encouraged to set their own independent policy and legislation. The European Commission Habitats Directive (92/43/EEC) contains no mention of lead shot and the toxicosis that arises from its use. However, Article 6(1) deals with taking appropriate management steps to avoid habitat deterioration, and Article 6(2) identifies "statutory measures" as a means to achieve the conservation of species habitats by member parties. Both provisions could be readily equated with the mandatory requirement for non-toxic lead substitutes to prevent deterioration of wetland habitat quality.

Thomas and Guitart (2003a) contend that these examples of a piece-meal approach to lead remediation explain why progress on the phase out of lead shot and sinkers has been so slow and, where found, so inconsistent. These same authors also contend that there is no toxicological difference between the recreational lead pollution from shooting and angling, except that different avian species are the usual victims. Rather, there is a common problem of lead pollution that warrants remediation from the same legal instruments that are applied to the regulation of lead pollution from industry. Thomas and Guitart (2003a) suggested that the spent shot and lost weights of individual sportsmen immediately become the public pollution concerns of society and wildlife, thus warranting broad application of general pollution laws. In this regard, it is interesting to note that the Canadian Minister of Environment announced in 2004 (Environment Canada 2004) an intent to ban importation, manufacture and sale of lead fishing weights under the Canadian Environmental Protection Act, a broad federal law devised to deal with pollution at the national level. This action is consistent with recommendations for federal action on this issue given by the Environment Minister's own Advisory Committee (Caccia 1995, pp. 128–129), and by Twiss and Thomas (1998).

### **Building on existing successes from remediation**

Six years after the United States required the use of non-toxic shot for hunting of waterfowl, Anderson *et al.* (2000) determined the impact of the phasing out of lead

shot on the conservation of waterfowl. These authors reported that the use of non-toxic shot had reduced the prevalence of fatal lead poisoning in Mallard *Anas platyrhynchos* alone by 64%, and estimated a national saving of about 1.4 million waterfowl in 1997. Research by Samuel and Bowers (2000) on the impact of the lead shot ban on Black Duck *Anas rubripes* in the United States corroborates the results of Anderson *et al.* (2000), in that the prevalence of elevated blood lead levels declined by 44% following the ban on lead shot use.

These papers reflect a major reduction in waterfowl lead toxicosis in a short period of time, a reduction that is likely to increase as hunter compliance with the use of non-toxic shot increases. Given the fundamentally similar nature of waterfowl hunting in wetlands throughout the world, it is suggested that the savings realized in the United States could be experienced by other countries that would enact similar bans on the use of lead shot. The United States is the only nation to have evaluated the contribution of its non-toxic shot regulations to waterfowl conservation. The saving of waterfowl from lead poisoning occurs mainly during the autumn–winter seasons (i.e. the time of waterfowl hunting), and represents enhanced survival of birds that have already been recruited into the autumn population. Such birds constitute a real increase in the size of the shootable population available to recreational hunters. Anderson *et al.* (2000) indicated that the savings of waterfowl from lead poisoning also made sense in terms of habitat conservation. These authors equated the amount of wetland habitat required to produce the same saving of waterfowl (based on analyses presented in Norton and Thomas 1994), and revealed that non-toxic shot use by hunters conserved more ducks per year than efforts to reclaim and improve wetland habitats under the North American Waterfowl Management Plan. Moreover, hunting with non-toxic shot over newly acquired, or rehabilitated, wetlands does not leave a toxic residue, thus maintaining wetland habitat quality into the future. This is also consistent with the stated intent of the Ramsar and Bern Conventions.

Another benefit of such bans would be the rapid reduction in secondary lead poisoning of raptorial species. If waterfowl were to be wounded by non-toxic shot, and consumed by avian predators or scavengers, secondary lead poisoning would be prevented (Mateo *et al.* 1997, Clark and Scheuhammer 2003). Thus, one would expect to see the rate of reduction of secondary lead poisoning proceed faster than the reduction of primary lead poisoning, simply because lead shot deposited in wetlands years ago could still be available for ingestion by feeding waterfowl. The rate of recovery of the American Bald Eagle from its endangered status has been rapid in the past decade, but the role of non-toxic shot in preventing secondary lead toxicosis has still to be determined. Similarly, use of non-toxic fishing weights as part of a live bait presentation (i.e. when a live fish or worm is cast with a hook and lead weight attached) could result in a marked reduction in the mortality rate of common loons that ingest lead weights and bait that have broken free from fishing lines.

In southern England, a 1987 ban on the use of lead fishing weights has been met with a welcome reduction in the prevalence of lead toxicosis of Mute Swan *Cygnus olor* (Sears and Hunt 1991). These authors reported that the proportion of deaths attributed to lead ingestion declined from 50% in 1980/1981 to 30% in 1987. This decline was also attended by a rapid reduction in the confirmed number of lead-poisoned swans from 1984 to 1988, as well as a lowering of the mean blood lead level from 127 µg/dl in 1984 to 22 µg/dl in 1987 (Sears and Hunt 1991). However, Perrins



*et al.* (2003) have shown that more than 60% of free-living Mute Swans sampled still contain blood lead levels over 1.21  $\mu\text{mol/l}$ , a sublethal level that poses concern. This is due, presumably, to the residue of lost fishing weights that continue to be ingested.

These studies indicate that investment by the sporting community in non-toxic shot and fishing weights represents a very cost-effective and rapid way of conserving avian populations and their habitats. Moreover, this cost is borne directly by the sporting community, and not by governments.

### **Development of non-toxic substitutes for lead shot and sinkers**

Private industry in North America has responded rapidly to the market for non-toxic lead shot substitutes and, as of 2004, 11 distinct products have been approved unconditionally for hunting waterfowl (Department of the Interior 2004). These non-toxic substitutes for lead shot can be used effectively for hunting all species of waterfowl and upland game. Although these materials have been developed initially for shot, some (e.g. bismuth–tin alloy, tungsten–plastic and stainless steel) are being used as fishing weights (Thomas and Guitart 2003b). In Europe, steel shot is manufactured in seven countries, and other forms of non-toxic shot are marketed wherever its use is mandated by law (Beintema 2001), as in Scandinavian countries and Australia.

### **The need to prevent further avian losses from lead poisoning**

Despite the encouraging picture of reduced lead poisoning presented by Anderson *et al.* (2000) and Samuel and Bowers (2000), avian lead toxicosis still occurs, and will occur so long as discharged lead shot remains available for ingestion. This means that shot in sediments, and especially on hard-bottom lakes, may remain available for many decades to come, even though there are no new annual additions of lead shot. The risk from spent lead shot is cumulative across time, especially where hunting is practised continually in the same restricted locale.

The emphasis on lead reduction has, so far, been placed on wetland habitats because this is where the problem of lead toxicosis is most egregious. This explains why the AEW, the Bern Convention and the OECD have specified wetland habitats as candidate sites for remediation. However, the hunting of waterfowl, especially geese, can take place over agricultural fields as well as wetlands, thus extending the distribution of lead contamination. There is also significant primary and secondary lead poisoning of birds from lead shot deposited on upland or dryland sites (Kendall *et al.* 1996, Mateo *et al.* 1997, Scheuhammer *et al.* 1999, Clark and Scheuhammer 2003) that arises from the hunting of upland game species, such as doves, pheasants, quail, woodcock, partridges, rabbits or hares with lead shot.

The majority of nations that have banned the use of lead shot in hunting have restricted the ban to wetland shooting: only Denmark and The Netherlands have extended the ban to include all hunted species (Beintema 2001). Migratory raptorial species may consume species other than waterfowl (Wayland and Bollinger 1999), and so if the intent is to protect such species, then provision to phase out the use of lead in upland bird hunting is required, and not only at the national level.

The tendency of wildlife agencies to focus only on levels of lead-induced mortality may be understood during the early period of phasing out use of shot and sinkers.

However, for long-lived avian species (e.g. swans and eagles) that may encounter chronic, sublethal levels of lead shot at intervals during their life, the possibility of impairment of behaviours remains a possibility (O'Halloran *et al.* 1989). Canfield *et al.* (2003) presented evidence to show that even low blood levels of lead in children act to impair cognitive functions in the long term. Burger and Gochfeld (2000) found also that lead-contaminated birds are at risk from neurobehavioural impairment, an effect that is dose-related and decreases with age of exposure. These deficits are subtle, and are not reflected in overt mortality statistics, but may still act to lower fitness.

Guitart *et al.* (2002) reported elevated lead levels in 13 species of waterfowl taken by hunters in the Mediterranean regions of Spain. Ten of the species showed high liver lead levels above 5 mg/kg wet weight, in particular Pintail *Anas acuta* and European Pochard *Aythya ferina*. These birds were apparently free-flying at the time of harvest, but contained lead levels that, in human beings, would have produced chronic health impairment. Owen (1996) suggested that over-exploitation of European Pochard in its wintering range combined with lead toxicosis from shot ingestion may have contributed to this species' population decline. Carbone and Owen (1995) reported that females of this species go to more southerly wintering areas than males, and predominate in the Mediterranean area. It is thus possible that the female cohort of European Pochard is experiencing not only higher acute levels of lead toxicosis but also a higher incidence of chronic lead poisoning during the winter months.

There has been a major development of the tourist/hunting industry for doves and pigeons in Argentina, Paraguay, Uruguay, and several other Central American nations in the past decade. This type of hunting is characterized by heavy daily shooting rates (>1,000 cartridges fired per hunter per day) in areas managed to attract and concentrate the target species. Understandably, very heavy lead shot loadings may result in these regions inhabited by pigeons and doves, species known for their propensity to ingest lead shot and succumb to primary lead toxicosis (see the review by Kendall *et al.* 1996). Moreover, if the wounding rates of doves by hunters are similar to those experienced in the United States (Haas 1977), then secondary lead poisoning of local raptors is likely to ensue.

### **Future commitments from the AEWA, and the Bern and Ramsar Conventions**

Since the AEWA and the Bern Convention produced their initial lead advisories, the rationale for eliminating lead use has become more compelling. This is because of the growing empirical evidence of lead toxicosis in birds, a greater public awareness of the issue, and the fact that non-toxic substitutes for both shot and sinkers have generated both a large and rapid saving of wildlife from lead poisoning.

The AEWA and the Bern Convention could revive their international commitment to this aspect of avian conservation by re-activating and expanding their recommendations on the phasing out of lead, especially in view of the secondary lead poisoning of raptors. The Ramsar Convention, at its next Conference of Parties, could include a recommendation for parties to eliminate lead shot and sinker use in wetlands and open waters. This is especially important for Ramsar sites in Europe that are limited in overall number and size, and compromised by continuing lead deposition. The Ramsar Convention could also represent the lead issue in regions of the world where the AEWA and the Bern Convention do not apply. Having these three conventions make

a renewed, consistent statement about the need to move to non-toxic materials would bring their collective powers of persuasion to bear on countries that have, so far, shown little inclination to act, despite ratification. These specific recommendations amplify the view of Moser (1991), who urged that a worldwide ban on the use of lead shot and fishing weights be achieved to reduce the mortality of various species of swans.

Any agreement by a nation to phase out lead shot and sinker use is largely symbolic unless there is a mechanism in place to ensure that individuals cease using these products. In the United States and Canada, the federal management of waterfowl hunting entails the deployment of government conservation officers to enforce compliance with non-toxic regulations. The same applies to angling in these countries. However, in most European countries hunting and fishing are managed privately, and the equivalent of itinerant conservation officers does not exist, thus raising the problem of how to induce human compliance. It is the responsibility of nations that wish to move towards a non-toxic shot and sinker agenda to determine how a legal intent can be converted to a practical reality in the field. In this regard, the Danish example (that prohibits sale of lead products) could become the model for all countries.

This paper has referred to professional disconnections among the hunting, angling and other scientific groups engaged in avian conservation. The hunting and angling constituencies have, generally, displayed a disinclination or inability to resolve by themselves the toxicity problems created by their own sports. We recommend that the international Conventions mentioned above deliberately promote connection among agencies when addressing the lead contamination of wetlands. What begins as one activity of a particular user-group ultimately becomes an issue for entire Parties to resolve (Thomas and Guitart 2003a).

## References

- The AEWA of the Bonn Convention, the Bern Convention, the CBD, and the Ramsar Convention websites are available at: (<http://www.unep-awea.org>), ([http://www.coe.int/t/e/Cultural\\_Co-operation/Environment/Nature\\_and\\_biological\\_diversity/Nature\\_protection/default.asp](http://www.coe.int/t/e/Cultural_Co-operation/Environment/Nature_and_biological_diversity/Nature_protection/default.asp)), (<http://www.biodiv.org>), and (<http://www.ramsar.org/>), respectively.
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