Transition to Non-toxic Gunshot Use in Olympic Shooting: Policy Implications for IOC and UNEP in Resolving an Environmental Problem

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Abstract Olympic shooters discharge, annually, thousands of tons of lead shot which pose toxic risks to animals and may pollute both surface and ground waters. Non-toxic steel shot is an acceptable and effective substitute, but International Shooting Sports Federation (ISSF) rules prevent its adoption. The present policy and rules of the ISSF on lead shot use contravene the International Olympic Committee (IOC) Charter position on environmental protection. The United Nations Environment Programme (UNEP), a formal Olympic partner on environmental protection, has no stated policy on contamination from lead ammunition, despite having declared lead a Priority Area for remedial action, and is pressing to remove lead from the global human environment. The IOC Sport and Environment Commission and UNEP could examine the continued use of lead shot ammunition and advise the IOC Executive Board on appropriate changes in policy and rules that could halt the massive lead shot contamination of shooting range environments world-wide.

Keywords Olympic Games · UNEP · Shooting · Lead · Toxicity · Policy

INTRODUCTION

The ubiquity and physico-chemical properties of lead enabled it to be used in many applications for several millennia, despite knowledge of its toxic effects upon human and environmental health (Nriagu 1983; Lessler 1988). The arms industry developed around the favorable ballistic properties of lead, and continues as military, police, and recreational shooting and hunting. Major issues of lead exposure and toxicosis of wildlife that ingest spent lead ammunition, and lead contamination from shooting

ranges, are well-documented (Sorvari et al. 2006; Sorvari 2007, 2011), and remediation has begun in a few jurisdictions (Table 1).

The Olympic Games comprise several shotgun shooting disciplines (mens' and womens' skeet and trap, and mens' double trap) in which traditional lead gunshot is fired at moving clay targets. The International Shooting Sports Federation (ISSF 2012) is the representative agency to the International Olympic Committee (IOC), whose international regulations are implemented in each nation by a national shooting body. Athletes whose shooting skills are high enough to enable them to participate in the Olympic Games represent, world-wide, a small minority of the aspiring Olympic clay target shooters.¹ Becoming a serious Olympic contender, and maintaining world-class proficiency in any of the five disciplines requires that shooters fire about one thousand cartridges each week. This amounts to approximately 1.3 tonnes² of lead shot deposited, annually, by each Olympic shooter in the environment of each shooting range. Discharged lead gunshot is rarely recovered at shooting ranges due to the difficulty and costs (see Fig. 1), and poses environmental risks (Ahmad et al. 2012), especially to animals that ingest the shot and are exposed to the toxic effects of lead (Vyas et al. 2000; Adriano 2001; Hui 2002; Migliorini et al. 2005). Non-toxic substitutes for lead gunshot have been in existence for more than 20 years, and in cartridges designed for clay target shooting events for at least 10 years.

¹ The number of qualifiers shooting at the 2012 Olympic Games were: Mens' Double Trap 24, Mens' Trap 34, Mens' Skeet 36, Womens' Trap 22, Womens' Skeet 17.

² Based on one cartridge containing 24.5 g of lead shot and 1000 cartridges fired per week for 52 weeks.

Table 1 Summary of uses of lead in all types of shooting and sport angling, together with the documented environmental problems generated by their use, and remediation undertaken

Type of lead use	Environmental concern	Remediation undertaken	References
Military and police bullets	Contamination of ground water and drinking water from shooting ranges	“Green Ammo”: Use of lead-free bullets in some US training and operations	Bogard et al. (1999), Picatinny Arsenal (2010)
Rifle bullets used in sport hunting. Bullets fragment, and lead particles enter the organs and meat	Lead exposure of scavengers from ingesting discarded offal. Lead exposure of humans who consume game meat	California bans all lead bullets/slugs in range of endangered California condor (<i>Gymnogyps californianus</i>) in 2007	Thomas (2009), Watson et al. (2009)
Gunshot used in hunting over wetlands, and hunting waterfowl	Extensive lead poisoning of birds that ingest spent shot, and their predators	Regulated bans on use of lead shot in various countries, beginning in 1991	Beintema (2008)
Use of gunshot for hunting game in upland areas	Extensive poisoning of upland species that ingest shot and die, including predators and scavengers	Regulated ban on all uses of lead shot by Denmark, The Netherlands, and 26 US states	Thomas (2009), Thomas and Guitart (2005), Fisher et al. (2006)
Gunshot used in trap and skeet shooting, and other clay target events at shooting ranges	Documented lead exposure of birds, mammals, and soil biota, and contamination of ground water	No regulation in any jurisdiction, except for Denmark, The Netherlands, and Sweden	Avery and Watson (2009), Thomas and Guitart (2010), Sorvari (2011)
Lead sinkers used in sport angling	Acute lead poisoning of fish-eating birds, swans, and other aquatic avian species	Regulated ban on lead sinkers in 4 US states, all Canadian national parks, and English rivers	Sears and Hunt (1991), Thomas (2003)

The IOC has a policy of conducting its Games and the events they admit in an environmentally conscious, sustainable, manner in partnership with the United Nations Environment Programme (UNEP). The IOC has permanent observer status at the United Nations since 2009 (Bousfield and Montsion 2012). Environment is the Third Dimension of Olympism, as stipulated in Rule 2 of the Olympic Charter (IOC 2012). Since 1995, the IOC Sport and Environment Commission has been advising the IOC Executive Board on all matters of environmental protection. Thus the continued use of lead gunshot by athletes counters this stated policy, not only during the actual Olympic events but by contenders and practicing national qualifiers during the 4-year intervals.

In this paper, we review the nature of the environmental problems presented by discharged lead gunshot at shooting ranges, and we identify the acceptable non-toxic substitutes for lead shot. The policy options for the IOC and UNEP are presented, indicating what regulation of lead-free shot would mean for agencies overseeing Olympic shooting disciplines. This paper is directed at the various policy makers at the international and national levels who control this form of recreational shooting.

BACKGROUND TO THE ISSUE

It could be contended that the IOC is unaware of the lead contamination at shooting ranges from discharged shot. However, the IOC was alerted to this issue from 1993 to 2000, through correspondence with Mr. J. A. Samaranch

(then President of the IOC), the former Sports Director of the IOC, and the present authors. The International Shooting Union (UIT: it became the ISSF in 1998) was asked by the IOC in 1993 to investigate the continued use of lead shot in Olympic disciplines. Their report to the IOC confused health risks to human shooters and range visitors with environmental health, it confused indoor rifle and pistol shooting with outdoor shotgun shooting, and contended that

... the whole topic of lead and other heavy metals is one where emotion rules and logic does not apply³.

The position of the UIT in 1993 was that efforts to clean up lead and reduce its deposition were underway, and that a transition to steel shot use was not possible because of shot quality concerns (see footnote 4). Subsequent correspondence with the IOC on the topic was met by the stated position of the IOC in 1999 that discharged lead gunshot from Olympic shooting disciplines presented only a minor toxic threat to environments, and that use of non-toxic shot was not warranted.⁴

The ISSF oversees shotgun shooting events at venues other than the Olympic Games, namely, the ISSF World Shooting Championships, the ISSF World Cup, and the Pan American Games. These events feature the same five shooting disciplines as the Olympic Games. The ISSF also

³ Correspondence between the President and Secretary General of the UIT and the President of the IOC, December 4, 1993. Correspondence is on file with V.G. Thomas, and is available on request.

⁴ Correspondence from J. Samaranch to authors, August 10, 1999, on file with V.G. Thomas, and is available on request.

represents rifle and pistol shooting disciplines in which solid lead bullets (and pellets) are fired at targets. This source of lead does not pose an environmental risk because the spent bullets are fired into traps from which the lead can be removed and recycled. The European Shooting Confederation (ESC) also administers shotgun shooting events, and is aware of the lead shot toxicity issue. However, it has also not been prepared to phase out the use of lead shot cartridges, citing

Several countries have banned or will prohibit the use of lead shots for all purposes, however without any scientifically good reason (European Shooting Confederation 2012).

The World Forum on The Future of Sport Shooting Activities (WFSA), with which the ISSF and the ESC are not affiliated, conducted a World Symposium on Lead in Ammunition in 2004 to examine the risks posed by use of lead ammunition and how to use lead shot sustainably (WFSA 2004). While recognizing that environmental exposure and toxic risks arise from shooting with lead ammunition, the Forum contended that lead from shooting could be managed, and favored investment in terrain

modifications of ranges to contain discharged shot, rather than adopt lead-free ammunition (Ceccarelli and Rosi 2004). Thus there is awareness of the issue among the international agencies representing sport shooting, but little inclination to embark on remediation, despite the enormous body of scientific literature on the environmental risks posed by spent lead shot at ranges.

Denmark, Sweden, and The Netherlands prohibited the use of lead gunshot for clay target shooting in 1996, 2002, and 2004, respectively. However, these nations still allow qualified national Olympic trap and skeet shooters to practice with lead shot cartridges on special ranges to comply with current ISSF and Olympic regulations. The IOC's rules take precedence over national sporting rules.

NATURE OF ENVIRONMENTAL RISKS POSED BY DISCHARGED LEAD SHOT AT SHOOTING RANGES

The five shooting events in the actual Olympic Games are now conducted in modern facilities where it is possible to recover and recycle the spent lead shot. However, most

Fig. 1 Residues of shotgun cartridges (a) and lead shot (b) in an old and abandoned shooting range in Molins de Rei, Barcelona, Spain, in 2009. Situated inside the limits of the Natural Park of Collserola, it was cleaned during 2010–2012. Photos: R. Guitart

Olympic shooting contenders and qualifiers across the world do not practice at such facilities, especially in developing countries. Outdoor shooting ranges are necessarily large in area (Sorvari et al. 2006) and may comprise wetlands, woodlands, and uneven ground that preclude recovery of spent lead shot, even if it were attempted (Darling and Thomas 2003). The distribution of lead shot is quite predictable from the fixed shooting stations that are the basis of skeet and trap ranges, and may extend up to 180 m from the firing line. This means that the lead loading in the shot fall-out zones may be exceptionally high (Fig. 1). The older and more heavily used the ranges are, the heavier the lead soil loadings, and the greater the risk of lead exposure to wildlife, soil, and water, especially where acidic soils prevail (Stansley et al. 1992; Manninen and Tanskanen 1993; Sorvari et al. 2006). Metal pollution at shooting ranges is not confined to lead. Elemental arsenic and antimony are added to lead shot during manufacture (Sorvari 2011). These metals may be released to the environment with the degradation of discharged shot and contribute to environmental risk if assimilated (Wan et al. 2013).

Many shooting ranges cater to both shotgun and rifle shooting. Published studies on the lead loading of soils of shooting ranges generally have not distinguished between the contributions of lead from shot and that from spent rifle bullets. Estimates of the total lead that falls into the environment, annually, from all recreational shooting in several nations are provided by (Ahmad et al. 2012, Tables 14.1 and 14.2). The estimates indicate that many thousands of tons of gunshot are deposited, annually, in the environments of North American and European nations, much of which is on shooting ranges. It is not possible to indicate how much lead derives from Olympic shooting disciplines, as distinct from other clay target shooting sports. The following literature review is confined to studies performed on ranges that feature clay target shooting.

Unlike game hunting, where lead shot may be scattered over a wide geographic region, shooting ranges present extremely localized point sources of lead contamination, with higher lead loadings. Discharged lead shot that falls on the ground does not degrade rapidly, and may remain there for centuries (Jørgensen and Willems 1987). Shot that has fallen on land or in water fallout zones can be ingested directly by birds that mistake it for seeds or grit (Roscoe et al. 1989; Vyas et al. 2000, 2001; Lewis et al. 2001). Small mammals and frogs may also show signs of lead exposure, presumably from lead contamination of their plant and animal diets (Ma 1989; Stansley and Roscoe 1996; Lewis et al. 2001). Lead shot that remains on the surface of soil will, eventually, become oxidized on the surface and form carbonated fragments that, in turn, may be ingested by earthworms, mollusks, and some soil

arthropods (Hui 2002; Booth et al. 2003; Labare et al. 2004; Migliorini et al. 2004, 2005; Darling and Thomas 2005; Rantalainen et al. 2006), and so pass lead into local food webs.

Lead from spent shot can become solubilized and be taken up by some plants, especially where soil chemistry and properties enhance lead shot degradation rates (Sorvari 2007). Agricultural soils adjacent to a Czech trap shooting range were heavily contaminated by lead that passed into cereal crops roots (Chrastný et al. 2010). Lead transferred from shotgun pellets at a shooting was mobilized in the acid soils of Finland into lingonberries (*Vaccinium vitis-idaea*) at levels exceeding food safety regulations (Manninen and Tanskanen 1993). Soil removed from a clay target shooting range in New Zealand contained very high levels of extractable lead that were able to pass into agricultural crops planted in them. This resulted in lead levels in leaves exceeding maximum permissible levels in foods (Rooney et al. 1999).

The risks from lead exposure at outdoor ranges are generally far greater for the health of the environment than humans (Sorvari 2007), and depend largely upon topographic and chemical soil–water properties of the range. The chemical factors that determine the mobility of lead from shot have been researched extensively. There is a high possibility of solubilized lead entering surface waters and moving off-range in shooting range sites that have high precipitation, are based on acid sandy soils, and contain no organic matter to adsorb transformed lead products (Darling and Thomas 2003; Sorvari 2007). The roles of soil organic matter to adsorb soluble lead and pH are critical in determining mobility (Lin et al. 1995; Lee et al. 1998; Sauvé et al. 1998; Rooney et al. 2007; Takamatsu et al. 2010). The organic matter in soils is a major determinant of the initial weathering of lead shot to oxide, hydroxide, and carbonate derivatives, and subsequent movements of transformed lead in soil water (Zheng et al. 2011). Whether dissolved lead will enter adjacent waters and beyond depends very much upon the hydrological characteristics of shooting ranges as well as the above-mentioned features of soils. Where ground water is at less than 1 m below contaminated soil, there is a risk to water quality caused by downward migration of lead (Murray et al. 1997). Stansley et al. (1992) reported that dissolved lead from clay target ranges was more likely to be mobilized into adjacent waters as their pH moved from alkaline to acid.

THE NATURE AND AVAILABILITY OF ACCEPTABLE LEAD GUNSHOT SUBSTITUTES

Of all the government-approved, non-toxic substitutes for lead gunshot, steel (soft iron) shot is the most likely

candidate material to be used in the Olympic shotgun disciplines. This is based on the enormous volume of cartridges fired by competitors, the parity with prices for lead cartridges, the suitability of steel shot to be used in trap and skeet events, and the ease of substitution for lead shot in conventional 12 and 20 gauge shotgun cartridges. Steel shot cartridges are now made by all major (approximately 16) ammunition makers in North America and Europe (Thomas and Guitart 2010).

ISSF regulations stipulate that 70 mm length cartridges fired in trap and skeet events contain a maximum of 24.5 g of shot whose diameter not exceed 2.6 mm. The same regulations stipulate that the shot be made of lead, lead alloy, or other ISSF-approved materials (ISSF 2012). Shot made from steel is not approved by the ISSF. Steel shot cartridges already marketed by the leading cartridge makers approximate these conditions (Table 2). It is simple to load steel shot of these dimensions into conventional 70 mm 12 gauge and 20 gauge cartridges without generating pressure problems. Given the lower density of steel shot versus lead shot, it is necessary to use steel shot of a larger diameter than the lead equivalent, coupled with an increase in shot velocity, to achieve the same ballistic efficiency and effective range. Thus a shot diameter of 2.6 mm might be advisable for Olympic trap shooting, in which targets may be broken at a longer distance than in skeet shooting. The ISSF regulations would, already, allow pellets of this diameter to be used (ISSF 2012). The maximum allowable velocity of steel shot cartridges, as set by the International Proof Commission is 425 m/s (Government of Victoria 2011). A velocity of 390 m/s

(for example) would equate with the same velocity of many lead shot cartridges, and still enable steel shot cartridges to perform well at the distances that trap and skeet targets are usually hit. Table 2 shows the array of steel shot cartridges presently available on international markets for clay target shooting, and how close they approximate to ISSF regulations for lead shot ammunition. However, it is the ISSF that must determine the exact specifications of any cartridge used in these shooting games, but, given the experience of the ammunition makers, it would be a simple matter to produce high quality cartridges designed for these events.

Olympic skeet and trap shooting regulations do not stipulate which gauge of shotgun can be used, only the shot load. Consequently, 12 gauge guns dominate the events because of the higher number of shot that can be fired at each target compared to those fired from 20 gauge guns. This facilitates the use of 12 gauge cartridges for Olympic shooting events. However, for those competitors who prefer to use 20 gauge cartridges in skeet or trap events, 20 gauge loads in steel shot are currently available (Table 2).

Detractors from the use of steel shot cartridges argue that damage to the choke of barrels could occur. That is a possibility with heavy magnum steel cartridge loads with large diameter shot (>3.6 mm) fired through barrels with abrupt large choke constrictions (i.e., full and extra full choke). However, such cartridges designed for long distance waterfowl hunting would never be admissible for Olympic events. Both the shot loads and the shot size of cartridges suited for Olympic shooting would permit ready passage of steel shot through any choke constriction. Skeet shooting uses the smallest barrel choke constriction of any

Table 2 Characteristics of steel shot shotgun cartridges for clay target shooting made by major international cartridge companies in 12 and 20 gauge (ga). Velocity of shot is given as feet per second (fps), and meters per second (mps). All cartridges are 70 mm in length, as required by ISSF rules

Company and cartridge gauge	Shot mass (oz and g)	Shot size (English) and diameter (mm)	Muzzle velocity (fps and mps)
<i>Kent Gamebore</i>			
12 ga	1 oz 28.4 g	#7 (2.4 mm)	1290 fps: 393 mps
12 ga	7/8 oz 24.8 g	#7 (2.4 mm)	1350 fps: 451 mps
20 ga	7/8 oz 24.8 g	#7 (2.4 mm)	1215 fps: 370 mps
<i>Federal</i>			
12 ga	1 oz 28.4 g	#6,7 (2.6, 2.4 mm)	1375 fps: 419 mps
12 ga	11/8 oz 31.9 g	#7 (2.4 mm)	1145 fps: 349 mps
20 ga	3/4 oz 21.5 g	#7 (2.4 mm)	1210 fps: 369 mps
<i>Winchester</i>			
12 ga	1 oz 28.4 g	#7 (2.4 mm)	1325 fps: 404 mps
20 ga	3/4 oz 21.5 g	#7 (2.4 mm)	1325 fps: 404 mps
<i>Remington</i>			
12 ga	1 oz 28.4 g	#7 (2.4 mm)	1325 fps: 404 mps
20 ga	3/4 oz 21.5 g	#7 (2.4 mm)	1325 fps: 404 mps
<i>Rio Cartridges</i>			
12 ga	1 oz 28.4 g	#7 (2.4 mm)	1325 fps: 404 mps
20 ga	7/8 oz 24.8 g	#7 (2.4 mm)	1325 fps: 404 mps

event, so this concern does not exist. Trap shooting requires choke constrictions, and small steel shot of diameter 2.5–2.6 mm can be used in existing guns designed for lead shot cartridges. Modern competitive trap shotguns are designed with removable choke tubes of different choke constrictions, allowing competitors to select the choke constriction that gives them the optimal shot pattern at the distance they usually break clay targets. Coated steel shot, unlike lead shot, can also be retrieved easily from the fallout zones of shooting ranges using portable magnetic machinery, and be recycled, or possibly re-used. The wide-scale adoption of steel shot at shooting ranges would also have a further benefit, namely the elimination of arsenic and antimony release to the environment (Wan et al. 2013).

Olympic shooting qualifiers of most nations are supported financially by their national Olympic committees, and are often sponsored by cartridge makers and shotgun makers. Thus the costs of making a steel shot transition to individual shooters are not an issue, especially given the current parity of the prices of lead shot and steel shot cartridges. Furthermore, should there be a broader adoption of steel shot ammunition for these shooting events, prices would decline further, consistent with an economy of scale and greater competition among makers.

DISCUSSION

Policy Implications for the IOC, UNEP, and Shooting Regulatory Agencies

An international environmental toxic risk associated with lead has been documented scientifically; the sources of the point contamination have been identified precisely, together with the agents responsible; non-toxic substitutes for the lead shot are readily available that allow continuation of the games with minimal change; and a framework for regulating the use of the substitute metal exists.

The position of the IOC Executive Board is critical because its policy is able to influence the policy of the ISSF on phase out of lead shot in Olympic shooting. Given the history of the IOC's deliberations on this matter, the IOC Charter's endorsement of environmental protection, and the enormous body of scientific literature on the toxic risks posed by spent lead shot, it is important for the IOC Sport and Environment Commission to re-examine the ISSF rules on the use of lead gunshot and to advise appropriately on IOC policy. The IOC Executive Board has policy options:

- do nothing and continue to act contrary to its Charter position and stated interests in global environmental protection

- rule on the use of lead-free shot in Olympic disciplines, consistent with its own and UNEP's environmental policies, and require compliance from the ISSF
- rule on a requirement for the use of lead-free shot in Olympic disciplines and allow the ISSF to take all shotgun shooting events out of future Olympic Games.

The IOC acts in cooperation with the UNEP in pursuing its environmental sustainability objectives (UNEP 2012a). UNEP has also to examine its position on the use of lead shot as a representative on the IOC Sport and Environment Commission. UNEP has a large international programme dealing with harmful substances and hazardous waste, and lead is one of its Priority Areas (UNEP 2006, 2012b). However, while UNEP is pursuing international action to eliminate lead in paint, fuels, and batteries, it has yet to recognize the importance of dealing with the environmental effects of lead from discharged sporting ammunition, as detailed in Watson et al. (2009). It is possible that this oversight stems from the partitioning of scientific interests into the toxic effects of substances into separate human and environmental sectors (Thomas 2010), but it can be corrected. A transition to the use of steel shot cartridges in Olympic shooting disciplines is necessary to be consistent with UNEP's operating principles on lead (UNEP 2006, 2012b).

UNEP is also the UN Agency responsible for the 1983 Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals), a major component of which is the African–Eurasian Waterbird Agreement (AEWA) (Thomas and Guitart 2005). The AEWA has, for a number of years, been attempting to achieve a ban on the use of lead shot for hunting birds among the Parties to this Agreement. Although much of the mortality of waterbirds from lead poisoning is due to hunting over wetlands (Beintema 2008), the discharge of gunshot from over wetlands clay target shooting can pose risks of lead exposure to waterbirds (Roscoe et al. 1989). Thus, consistency of UNEP's policy on lead is required. To be concerned about lead from fuels, batteries, and paint and human health, one also should be concerned about lead ammunition discharge and wildlife's health.

This inconsistency in UNEP policy is reinforced by the September, 2012, UNEP report *Global Chemicals Outlook: Towards Sound Management of Chemicals* (UNEP 2012c), in which lead is highlighted as a chemical of concern in wheel weights, batteries, paints and fuels, but not mentioned in terms of the tonnages released by sport shooting. Point 2 of this report's General Recommendations reads:

Regulate and reduce use of chemicals of highest concern and substitute with safer alternatives.

This is to conform with the Strategic Approach to International Chemical Management under the Johannesburg

Plan of Implementation whose goal is to use chemicals in ways that minimize significant deleterious impacts on environmental and human health by 2020 (UNEP 2012c). In the case of lead release from sport shooting, both the substitute and the regulatory options have been identified, clearly, in the present paper, enabling remediation to be achieved well before 2020.

A progressive change in ISSF rules on the permissibility of steel shot would, in a top-down manner, likely affect the rules governing trap and skeet shooting in other international games regulated by the ISSF. It is also possible that such a change would be adopted by the ESC, so as to achieve consistency in ammunition shooting regulations at the international level. The voluntary use of steel shot by competitors is not an option because the ISSF has not approved steel shot. Moreover, having a situation in which both lead shot and steel shot ammunition were allowed for a given discipline would, likely, be unacceptable because of perceived advantages of one shot type over another.

Were steel shot ammunition to be required for international shotgun shooting by the ISSF and the ESC, such regulation need not induce changes for nationally regulated trap and skeet shooting competitions, which could continue to use lead shot ammunition.

A change in the ISSF rules specifying the characteristics (maximum shot mass, acceptable shot sizes) of steel shot cartridges would need to be developed in consultation with ammunition makers. Reference to Table 2 indicates that all the makers list a 12 gauge 1 oz (28.4 g) cartridge load that exceeds the current ISSF 24.5 g maximum limit for lead. However, one maker already lists a steel load with 24.8 g of shot, so other makers could follow, should the need arise, and provide what the ISSF may deem acceptable. The 20 gauge loads listed in Table 2 would already qualify, were steel shot allowed.

Suitable substitutes for lead shot cartridges already exist at the international level, and their costs and effectiveness are not obstacles to a transition. Competitors required to use steel shot would have three years in which to practice and adjust to the minor differences in cartridge characteristics before the next Olympic Games. Should the ISSF rule on an end to use of lead shot, the major cartridge makers in Europe and the USA would have ample time in which to increase the rate of manufacture and distribution of cartridges made according to ISSF specifications. However, for industry to invest in the greater production of steel shot cartridges of this type, there must be an assurance of market demand that only an ISSF rule change can provide.

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