Lead Issues at National Park Service Units: Identifying Potential Sources and Minimizing Exposure

National Park Service Office of Public Health

Lead has been a long-standing public health issue, particularly with the introduction of lead in gasoline and paint and use of it in lead pipes in the past. Children have been considered particularly vulnerable to the effects of lead exposure because of their developing nervous system; however, adults can also be physically affected by lead exposure. Because there are ways to minimize exposure and lessen lead's harmful effects on the public's health, understanding sources of lead and how exposure occurs are ways to begin to understand an individual's risk to lead and ways that risk can be reduced.

The following document explores not only common lead issues within the general population but also park-specific lead issues and ways to reduce lead exposure and minimize its impact on human health. In order to address potential lead exposure issues, this document is divided into three sections: general lead information, potential sources of lead exposure at national parks, and NPS efforts to reduce lead exposure.

I. General lead information

Lead is a naturally occurring heavy metal that is blue-gray in color and is found in the earth's crust. Certain properties of lead, such as its low melting point, density, and corrosion resistance, have made it a popular metal for thousands of years, from Ancient Roman times when lead was used for plumbing to more recently, when lead was added to paint and gasoline to enhance performance (ATSDR 2007c). In the past three centuries, lead has increased in the environment by a thousandfold, primarily due to human activity, such as production of lead batteries by the automobile industry (ATSDR 2007a, 2007c). Lead can be released into the environment through mining and by factories that produce lead and lead alloys, and by facilities that release lead compounds into the air through the burning of coal, oil and waste. Prior to the banning of leaded gasoline, vehicle exhaust was the predominant contributor of lead in the environment (ATSDR 2007c). Although lead has many desirable properties and has been used in a variety of consumer products, it can have an adverse effect on the system and organs of the human body, particularly in children who are still undergoing neurological and physical development (ATSDR 2007c). In order to reduce lead in the environment and

The George Wright Forum, vol. 28, no. 1, pp. 80–94 (2011).

ISSN 0732-4715. Please direct all permission requests to info@georgewright.org.

exposure to humans, federal agencies issue laws, rules, guidance, and recommendations that monitor the use of lead in commercial products.

Common human exposures to lead in the general population

The greatest likelihood of human exposure to lead still comes from historical use of lead as an additive in gasoline and from its use as a pigment in paints and other coatings. Lead as an additive in gasoline was slowly phased out and completely banned in 1995, whereas lead in paint was banned in 1978 for residential and consumer uses. Even though lead cannot currently be found in gasoline and new paint, human exposure continues because once lead has been released into the environment (e.g., through car exhaust pipes), it does not degrade into other substances and continues to persist in soil and in paint dust within buildings (ATSDR 2007c).

Nationally, lead paint continues to be the primary source of environmental exposure to lead, primarily through disturbances to old paint in the home, such as during renovation; through deterioration that can result in peeling, chipping, and chalking of paint; and by means of friction to parts of a home, such as doors and windows (ATSDR 2007b). Outside of homes, lead paint can mix with dust and soil and re-enter the home. Settled lead dust can re-enter the environment when there is a lot of traffic or activity in the home, such as vacuuming or sweeping (USEPA et al. 2003). However, lead-based paint which is in good condition is generally considered not a hazard (USEPA et al. 2003).

Aside from that which is found in the home environment, lead dust can also be produced from artificial turf, particularly from turf made from nylon or a nylon/polyethylene blend that has been well used, showing signs of weathering and visibly dusty (CDC 2009). Inadvertent exposure in indoor settings can occur when children put their hands in their mouths after playing, crawling around on floors, or touching toys which have been contaminated with lead, though the Consumer Production Safety Modernization Act (2008) currently bans children's products that contain more than a trace amount of lead (USEPA et al. 2003).

A potential exposure to lead is from air. Because of the phase-out of lead in gasoline, air emissions of lead from the transportation sector, and particularly the automotive sector, have greatly declined over the past two decades. Today, industrial processes, mostly metals processing, are the major contributor of lead emissions to the air. The highest air concentrations of lead are usually found near lead smelters, while other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers (USEPA 2009c).

Another potential human exposure to lead is through drinking water, and even though the amount of lead in pipes and plumbing fittings has been regulated by the US Environmental Protection Agency (USEPA) since 1988, possible exposure can still occur from corroding pipes and fixtures or solder that contains lead (ATSDR 2007c). On average, USEPA estimates lead in drinking water contributes to 10–20% of total lead exposure in children (USEPA 1993). In homes built prior to 1930, plumbing is likely to contain at least some lead pipes, and in new homes, lead solder with copper pipes have replaced lead pipes but contamination of household water from the solder and new brass faucets and fittings can still contribute to the leaching of lead into water (USEPA 1993).

Intentional use of lead in products such as remedies and cosmetics still occurs today (ATSDR 2007a). Alternative medicines used by East Indian, Indian, Middle Eastern, West Asian, and Hispanic cultures may contain large amounts of lead and other heavy metals that are thought to cure certain ailments (CDC 2009). Lead may be unintentionally added in food through production and processing (e.g., use of grinding or cutting equipment, the planting of vegetables in contaminated soil, being added in certain candy ingredients such as chili powder and tamarind), packaging (e.g., lead-soldered cans, wrappers of imported candies), and storage (e.g., of food or beverages in a container contaminated with lead) (ATSDR 2007a; CDC 2009).

In an occupational setting, the most common way workers are exposed to lead is through inhaling and ingesting lead-contaminated dusts and fumes. Workers that take part in lead smelting, refining, and manufacturing are at the highest risk for adult lead exposure, though other opportunities for occupational exposure occur among those working in battery manufacturing plants, construction (including renovation activities), rubber products and plastics industries, soldering, steel welding and cutting operations, bridge maintenance and repair work, municipal waste incinerator work, radiator repair, and the pottery/ceramics industry (ATSDR 2007a, 2007c).

Routes of exposure and absorption of lead

People are exposed to lead through three avenues: inhalation, ingestion, and dermal contact (ATSDR 2007a). Inhalation of lead in the ambient air through aerosols of particulates (usually dust) that can be deposited in the respiratory tract is the primary route of occupational exposures (ATSDR 2007a; OSHA 2008). Almost all inhaled lead is absorbed, compared with 20–70% of lead that is ingested, with children more likely than adults to absorb at a greater percentage (ATSDR 2007a). In the general population, lead exposure occurs mostly through ingestion. Among children, the major means of exposure is ingestion of lead paint by way of hand-to-mouth. Other ways people may be exposed to lead through ingestion is through contaminated food, water, alcohol, and alternative medicines. Dermal exposure through the skin is a more likely route of exposure for workers rather than in the general population (ATSDR 2007a).

Once lead enters the body through the lungs, it disperses to other parts of the body through the blood system. When lead is swallowed, it enters the stomach where the acid breaks it down into absorbable components. The amount of lead absorbed into the blood system is dependent on a person's age, how well the particles are dissolved in the stomach, and when they ate their last meal. In general, children will absorb a greater proportion of lead into their bloodstream compared with adults who have ingested the same amount. The blood system distributes the lead to soft tissues and organs; after several weeks, it is deposited in the bones and teeth. Once lead is distributed to the organs, about 99% of that absorbed by an adult will leave as waste, whereas only 32% of lead taken in by a child will be eliminated from his or her body (ATSDR 2007a).

Children under the age of six are considered the most vulnerable to exposure to lead because they are undergoing rapid neurological and physical development and engage in frequent hand-to-mouth behavior. In addition, pregnant women are at significant risk for

adverse effects of lead (OSHA 2008). Lead exposure in the uterus can result in delays or impairment of neurological development; neurobehavioral deficits, including IQ deficits; low birth weight; and, in girls, low gestational age, growth retardation, and delayed sexual maturation (ASTDR 2008). However, lead exposure can also affect children older than six, as well as adults, by means of cardiovascular, renal, and neurological effects (USEPA 2006).

Lead toxicity in the human body: Toxicity levels and symptoms

Lead exposure affects the body's organs and systems to different degrees. The severity of symptoms of lead poisoning is dependent on amount of exposure (NIEHS 2005). Although lead toxicity could affect any part of the human system or organs, the areas most vulnerable are the developing nervous system, the blood and cardiovascular systems, and the kidneys (ATSDR 2007a).

High levels of exposure to lead in adults (i.e., concentrations of 100–120 micrograms per deciliter [μg/dL] of blood) are thought to lead to encephalopathy and alterations in brain function, with precursor symptoms including dullness, irritability, poor attention span, muscle tremors, and loss of memory (ATSDR 2007b). Blood levels ranging from 40 to 120 μg/dL have been observed in lead-exposed workers, which resulting effects that include depression/mood changes, headaches, decreased cognitive performance, decreased reaction time, decreased visual motor performance, dizziness, fatigue, forgetfulness, problems with concentration, increased nervousness, irritability, lethargy, impotence, reduced IQ scores, malaise, and paresthesia (ATSDR 2007c). A decrease in kidney function has been observed on a consistent basis in populations having concentrations of less than 20 μg/dL, and even in populations having concentrations of less than 10 μg/dL (ATSDR 2007b). A 2004 study showed that lifetime exposure to lead can increase the chances of cataract development (NIEHS 2005).

Infants and young children with lead levels of 10 μg/dL or greater are considered to be at risk for substantial health effects (ATSDR 2008). When lead levels are above an action level of 10 μg/dL—that at which the Centers for Disease Control and Prevention (CDC) recommend environmental and education intervention—anemia, neurological impairment, effects on the renal system, colic, and impaired metabolism of vitamin D may occur (ATSDR 2007a, 2008). Children with blood lead concentrations of less than 10 μg /dL are not currently considered as having an exposure to lead, although recent studies have shown that side effects still occur around 5 μg/dL (Landrigan 2000; Murata et al 2009). Pooled analysis results derived from seven prospective epidemiologic studies estimated a decline of 6.2 points on a full IQ scale is concurrent to an increase in blood lead levels from 1 to 10 μg/dL (USEPA 2006). Although these findings suggest that it may be necessary to lower the current action level for children, there are other considerations, such as the accuracy of measuring levels below 10 μg/dL and the desire to focus resources where potential adverse effects are greatest (CDC 2005b). Blood lead levels above 10–14 μg/dL require specific action be taken by health departments in most states, and levels of 15–44 μg/dL are considered significant exposures (NewYork State Department of Health 2009). Blood lead levels that are ≥45 μg/dl can cause mental retardation, coma, convulsions, or death (ATSDR 2007a; CDC 2009; NY State Department of Health 2009).

II. Potential sources of exposure at National Park Service units

Potential means of lead exposure at parks can include common pathways, such as working or living in areas with lead pipes and lead paint, but also through others, such as through hunting (recreational and subsistence), angling, and exposure at firing ranges. Hunting and angling are recreational activities that some visitors may participate in, while use of firing ranges is typically an occupational activity for law enforcement (LE) rangers. Employees who use indoor and outdoor firing ranges for practice and training requirements may have additional exposures at non-NPS firing ranges outside the park. Apart from employees who utilize firing ranges, maintenance workers who work in facilities, particularly older housing and historic buildings with lead paint, or who engage in other activities such as lead soldering, may also be at risk for potential lead exposure.

Historic buildings, employee housing, and other facilities

Lead-based paint can be found in older homes and historic buildings built prior to 1978. It is extremely important to recognize that older buildings and other park facilities, such as bridges painted with lead-based paint, are potential hazards to employees and their families, particularly children (HUD 2007).

Much of the employee housing in the parks was built prior to 1978, when use of lead-based paint was still legal. However, lead-based paint in housing is only a concern if the lead-based paint is deteriorated or has been disturbed, such as through renovation, repair, or painting activities. It is important that these activities be conducted by a USEPA-certified firm with properly trained and certified renovators. In addition, lead-based paint abatement should be conducted by trained and certified professionals.

The residential Lead-Based Paint Hazard Reduction Act of 1992 (also known as Title X of the Housing and Community Development Act) requires sellers, landlords, and agents to provide information concerning the hazards of lead-based paint, symptoms and treatment of lead-based paint poisoning, precautions to be taken to avoid poisoning, and maintenance and removal techniques (HUD 2007) to potential purchasers or tenants of "target housing" (that which was constructed prior to 1978; ATSDR 2007c). However, there are exceptions to this rule: housing for elderly or disabled persons, unless a child of less than 6 years of age is expected to reside in the dwelling; and dwellings without bedrooms, such as studio/efficiency apartments, individual room rentals, dormitories, and military barracks (ATSDR 2007c).

Hunting

Lead was made illegal for hunting waterfowl in 1991, but it continues to be a popular metal used in bullets marketed for big- and small-game hunting, upland bird hunting, and varmint hunting. In October 2007, California banned the use of lead ammunition in areas considered to be habitat for California condors. In addition, other types of lead ammunition, such as lead bullets, are still used for the harvesting of large game in the United States (Tsuji et al. 2009).

Hunters who form their own lead bullets risk exposure through inhalation of fumes while melting the lead and through inhalation of vapors upon firing. Melting the lead at

home can also result in exposures to children and other residents. People who conduct these activities, as well as their families, may be at risk from lead poisoning. In addition, there is a potential exposure by ingesting game meat that comes from an animal shot with lead ammunition, which can fragment into many tiny pieces when it enters an animal's body (Hunt et al 2004; Hunt et al 2009). Other published studies have documented elevated blood lead concentrations in consumers of meat hunted with lead bullets (Tsuji et al. 2008, 2009; Avery and Watson 2009; Kosnett 2009). In a CDC study examining the relationship between blood lead levels and wild game consumption among 742 participants residing in North Dakota, ranging from 2 to 92 years of age, not only did persons who consumed wild game exhibit higher blood lead levels than those who did not, but those who ingested larger portions of "other game" (e.g., moose, elk, etc.) had significantly higher blood levels (Iqbal et al. 2009).

Indoor and outdoor firing ranges

Indoor firing ranges have been the subject of several studies of occupational lead toxicity, which have documented elevated blood lead levels and associated adverse health effects in the employees and instructors at ranges (Landrigan et al. 1976; Smith 1976; Anderson et al. 1977; Fischbein et al. 1979; Novotny et al. 1987; Valway et al. 1989). These studies indicate lead exposure at firing ranges occurs primarily through inhalation of lead particulates suspended in the range air. The major source of airborne lead is in the breathing area of the shooter resulting from the ignition of the primer material containing lead styphnate and because the gun barrel and the bullet do not always align exactly, the shearing of lead particulates off of the bullet as it passes through the weapon (Valway et al. 1989).

There are currently 276 NPS firearms instructors and approximately 1,900 LE officers (roughly 1,440 permanent and 460 seasonal LE staff; NPS Firearm Program manager). The NPS internal website on outdoor firing range management states that "the majority of the toxic chemicals releases at NPS units are from the use of lead ammunition at outdoor small arms firing ranges" (National Park Service 2008). Since 2003, NPS has required all parks to calculate and report the amount of lead released to the environment at outdoor firing ranges regardless of whether or not these releases are reportable to USEPA under its Toxic Release Inventory Program (whose regulations require that lead releases of greater than 100 pounds be reported to USEPA).

The NPS Sustainable Operations and Climate Change Branch has been collecting lead release and non-lead ("green") ammunition data electronically through a web-based survey called the *Annual Lead Release/Green Ammunition Use Survey* (NPS 2009). The results of these surveys indicate a trend toward increasing use of green ammunition and a continual decline in the use of leaded ammunition since 2003 (NPS 2009). This decline in the use of leaded ammunition can be attributed to a policy change affecting NPS LE officers. In July 2006, the NPS associate director for visitor and resource protection sent a memorandum to the field approving LE officers to conduct all firearm practice and qualification with nontoxic, lead-free, frangible ("green") ammunition. After October 1, 2007, only green ammunition was to be purchased for training purposes. The stated purpose of the order was to begin the process of phasing out the use of leaded ammunition for firearms qualifications and

practice due to the highly toxic nature of the lead and the potential adverse impacts on human health and the environment. In November 2007, the associate director sent a memorandum to the field requiring NPS LE officers to discontinue use of leaded ammunition for all qualification and training by October 1, 2008. In response to safety concerns from NPS LE officers, current policy allows one qualification each year with the lead ammunition they carry on duty.

The NPS Risk Management Division created policy guidelines to address various types of lead exposures, including those at firing ranges (RM 50 B Health Policy Guidelines, Section 4.9: Lead Exposure Control, last updated June 21, 2005). The document identifies requirements and responsibilities to reduce lead exposure based on regulations of the Occupational Safety and Health Administration (OSHA), USEPA, and the Department of Housing and Urban Development (HUD). Appendix E of the RM 50 B document identifies sources of exposure and specific guidelines for reducing lead exposure dust at firing ranges.

Angling

Lead exposure in anglers can occur in handling and making lead jigs or sinkers, and through accidental ingestion (Goddard et al. 2008; Pokras and Kneeland 2008). If a lead sinker is swallowed, the amount of lead absorbed in the system depends on how long the sinker has stayed in the stomach (Goddard et al. 2008). In the past 20 years, US states, such as Vermont, New York, Maine, Massachusetts, New Hampshire, and other countries, such as Great Britain, Denmark, and Canada, have passed legislation restricting the use of certain types of lead fishing gear (Pokras and Kneeland 2009). Making lead sinkers at home provides another source for exposure both to the person making the sinker and children and other residents because the lead needs to be melted in order to form the sinkers and fumes can be inhaled during the process (Goddard et al. 2008; Watson 2009).

Reducing exposure at National Park Service units

The Department of Health and Human Services (DHHS) has concluded that lead and lead compounds are anticipated to be human carcinogens based on evidence from studies in humans and sufficient evidence from studies in experimental animals (ATSDR 2007c). Since 1980, federal and state regulatory standards have helped to minimize or eliminate the amount of lead in consumer-based products and occupational settings (ATSDR 2008). NPS, specifically, has implemented initiatives and issued guidance to parks to help further reduce lead in the environment.

III. NPS efforts toward reducing lead exposure

NPS's efforts towards lead reduction include the Visitor and Resource Protection Program's efforts in keeping account of and reducing the use of lead ammunition through the NPS lead control policies; the Natural Resource Program's initiative to reduce and eventually eliminate lead ammunition and lead fishing tackle in natural resource activities in parks; and the Office of Public's Health's water survey work to comply with the Safe Drinking Water Act and USEPA's Lead and Copper Rule (LCR; USEPA 2009b). Through individual and interoffice efforts, NPS is informing visitors and employees of the hazards of lead in the environment and workplace.

The NPS lead exposure control policy is divided into two sections: worker requirements for protection against lead exposure, and requirements for lead-based paint management for housing and building occupants. Subsections detail specific information about practice and guidance for reducing lead exposure in the park, with emphasis on regulations issued by OSHA, USEPA, and HUD. In practice, this document should be used in conjunction with applicable regulations of state and local jurisdiction. The NPS policy states that a program of lead management, including worker and facility occupant exposure protection, will be implemented in each park where lead hazards exist.

Historic buildings, employee housing, and other facilities

Circumstances where an employee or volunteer may be occupationally exposed to lead, including construction work, are addressed in NPS policy.

Lead in drinking water

Safe levels of chemicals in drinking water are determined by the Safe Drinking Water Act (SDWA), which was passed in 1974. The SDWA set the maximum contaminant level goal for lead, which is based on potential health risks and exposure to humans, at zero. The action level for lead is 15 parts per billion (ppb); once that level is exceeded, then the water supplier is responsible for reducing the amount of lead through corrosion control and notifying its customers about ways they can lower their exposure to lead, as well as even possibly providing the public with alternative drinking water supplies. Section 1417 of the SDWA prohibits the use of pipe and plumbing fittings or fixtures that are made from lead after August 6, 1998; however, this law excludes the use of pipes in manufacturing or industrial processing (USEPA 2009a).

The LCR is another USEPA rule regulating lead in drinking water, primarily through plumbing materials; it was established in 1991. The LCR, as part of the SDWA, applies to all community water systems as well as non-transient, non-community water systems and regulates lead and copper in drinking water through the following four basic requirements:

- Water suppliers must have a treatment system to control for corrosion in plumbing;
- Permissible tap water levels of lead and copper need to be established for customers with lead service lines or lead-based solder in their plumbing system;
- Source water should not be the source of any significant level of lead; and
- If the lead action level of 15 ppb is exceeded, then suppliers are required to provide education and outreach to the customers on lead and ways they can reduce their exposure to it (USEPA 2009b).

The SDWA and the LCR apply to public water systems; however, NPS also has many individual non-public water systems (e.g., those in ranger houses and individual wells) that are not covered by the SDWA or the LCR.

Hunting

International and domestic studies have shown elevated lead levels in humans consuming large and small game hunted with lead ammunition (Tranel and Kimmel 2008; Tsuji et al.

2008, 2009; Cornatzer et al. 2009; Hunt et al. 2009; Kosnett 2009). Modeling of regular consumption of game meat in adults and children found elevated blood lead levels compared with background levels, especially among the latter group (Kosnett 2009). Because non-lead alternatives exist (e.g., shell-shot is available in steel, bismuth, tungsten, and tin; bullets are available in copper), use of non-toxic ammunition could reduce lead exposure impacts on human health (Tranel and Kimmel 2008; Hunt et al. 2009; Kosnett 2009). Currently, the US Fish and Wildlife Service approves the use of 11 types of non-toxic shell-shot with various material compositions (Tranel and Kimmel 2008).

In terms of lead ingestion, risk is dependent on how much lead is consumed and the frequency of exposure; therefore, limiting the total amount of lead exposure reduces harm (North Dakota Department of Health 2008). Factors that increase dietary lead exposure from spent lead bullet fragments in wild game include the frequency and amount of hunted game that a person consumes, the age of the person consuming the meat, the degree of bullet fragmentation, the path which the bullet enters the wildlife, the care with which the meat surrounding the bullet wound is removed, and any acidic treatments of the meat that would dissolve the lead (such as coating the carcass with vinegar or use of acidic marinades in cooking), which can increase exposure (Hunt et al. 2009; Kosnett 2009).

Results from research studies on the degree of lead contamination in large and small animals are not consistent (Johansen et al. 2005; Tsuiji et al. 2009). The variability in findings regarding the extent of lead contamination in tissues of large-game mammals can be explained by various factors: lead ammunition fragment distribution is heterogeneous within an animal; the distance from which the prey was shot determines the amount of tissue contamination; the site where the bullet entered the tissue is important; and lastly, further fragmentation can occurred due to the bullet hitting something hard (e.g., bone). All these factors need to be considered (Tsuiji et al. 2009). There is expected to be a higher incidence of lead bullet fragments in ground venison than in loins or roasts because meat trimmed away from the bullet channel can contain more fragments. Variation in lead concentrations in small animals such as birds is large, most likely due to the shooting skill of the hunter. Birds where the hunter has not destroyed the body in killing it will have less lead exposure when consumed (Johansen et al. 2005).

At times, the muscle game tissue around the wound channel is not discarded, but rather is used in burger, stews, and sausages; thus, it is recommended that the tissue around the wound channel be removed during food preparation (Minnesota Department of Natural Resources 2007; North Dakota Department of Health 2008; Wisconsin Department of Natural Resources 2008). Animals hunted with lead ammunition can have lead fragments embedded in their meat far from the entry wound as well (Tranel and Kimmel 2008) and small lead particles may be further distributed during processing and grinding of meat (North Dakota Department of Health 2008). When preparing venison, avoiding vinegar and other acidic substances is suggested, as acids can make lead more soluble and more readily absorbed in the body. Also, when processing, minimizing the batching of multiple deer is thought to reduce cross-contamination (Wisconsin Department of Natural Resources 2008).

Guidelines have been suggested by the North Dakota Department of Health to limit the amount of lead in ground venison or venison sausage. Suggestions in reducing exposure

include determining the path of the bullet and if it had penetrated the bone; trimming far from the wound channel and discarding meat that is bruised, discolored, or contaminated with hair, dirt, bone fragments, or grass; when in doubt, consider cutting the venison into chops to reduce the amount of lead entering the grinder; and finally, check the grinder for lead fragments (North Dakota Department of Health 2008).

Indoor and outdoor firing ranges

As with hunters, one way of reducing lead exposure among those who use indoor and outdoor firing ranges is to use lead-free ammunition. Copper or nylon-clad bullets and non-lead primers are recommended in RM 50 B. Another strategy is through engineering controls that can be used to minimize employee exposure in indoor firing ranges by ensuring that buildings are properly ventilated and cleaned of dust or spent bullets. Air sampling is a method to monitor exposure levels in the air at firing ranges. OSHA requires employers of workers who are occupationally exposed to a toxic or hazardous substance to institute engineering controls and work practices that maintain or reduce exposure to a level that is at or below the permissible exposure limit established for the substance. For occupational exposures to lead, the employer must use engineering controls and work practices to achieve an occupational exposure of 50 μg/m3 or lower, based on an 8-hour time-weighted average (OSHA2008; 29 CFR 1910.1025).

In addition, employee education can reduce the hazards of lead exposure. Personal protective equipment can be used, in addition to providing on-site hand-washing and showering facilities. Clothes worn at the range can contribute to "take-home lead," which is avoided by showering and/or changing clothing before returning home. RM 50 B contains specific information about lead dust in firing ranges, steps to minimize lead absorption, and how lead dust exposure and take-home lead can be reduced.

Employees exposed to lead at work can be periodically monitored and asked to be assessed for blood and zinc protoporphyrin or free erythrocyte protoporphyrin levels. Medical surveillance under the supervision of a licensed physician may be made available to employees who have been exposed to lead above the action level for 30 days or more per year.

Prior to July 2006, NPS LE officers fired lead ammunition for all training and qualifications. Today, NPS LE officers fire green ammunition for all training and all but one qualification each year, whether they use an indoor or an outdoor range. The result is a reduction in lead exposure for the LE officer as well as a reduction in take-home lead.

Angling

Anglers can avoid risk of lead exposure by using fishing gear that does not contain lead compounds. Use of non-lead gear will reduce the amount of lead that is deposited into the aquatic ecosystem from unrecovered lead compounds, which can leach into the waterways (Goddard et al. 2008). Use of lead fishing sinkers has been routine, but use of non-toxic substitutes can reduce lead exposure to anglers and the environment. Alternative materials used in the making of sinkers include ceramics, tin, brass, and steel. Sinkers made from these materials are larger because they are not as dense as lead (Goddard et al. 2008). Currently, certain

parks prohibit the use of leaded fishing tackle. Prior to visiting a specific park, anglers should visit the respective park website to find out rules on the use and possession of lead fishing gear.

Acknowledgments

The following provided information or assisted in reviewing this document for technical accuracy. Opinions and recommendations contained in this document are solely those of the NPS Office of Public Health and are not necessarily endorsed by the following organizations or individuals: Centers for Disease Control and Prevention; Gretchen Giannelli, NPS, Risk Management; Chuck Higgins, NPS, Office of Public Health; Sarah Elizabeth Keyes, NPS, Office of Public Health; Jill Kinney, NPS, Federal Law Enforcement Training Center; Adam Kramer, NPS, Office of Public Health; Joe Winkelmaier, NPS, Office of Public Health; Elaine Leslie, NPS, Biological Resource Management Division; Kirsten Leong, NPS, Biological Resource Management Division; Mike May, NPS, Risk Management; Jim Petterson, NPS, Pinnacles National Monument; Bob Reiss, NPS, Office of Public Health; Fred Sturniolo, NPS, Park Facility Management Division; Dave Trevino, NPS, Biological Resource Management Division; Mike Quinn, NPS, Risk Management; Tom Smith, NPS, Environmental Compliance and Response Branch, US Environmental Protection Agency; David Wong, NPS, Office of Public Health.

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[Ed. note: This paper is an abridged version of the NPS Office of Public Health's Science Guidance no. 04-0160.]

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> Defenders of the short-sighted men who in their greed and selfishness will, if permitted, rob our country of half its charm by their reckless extermination of all useful and beautiful wild things sometimes seek to champion them by saying the "the game belongs to the people." So it does; and not merely to the people now alive, but to the unborn people. The "greatest good for the greatest number" applies to the number within the womb of time, compared to which those now alive form but an insignificant fraction. Our duty to the whole, including the unborn generations, bids us restrain an unprincipled present-day minority from wasting the heritage of these unborn generations. The movement for the conservation of wild life and the larger movement for the conservation of all our natural resources are essentially democratic in spirit, purpose, and method.
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> — Theodore Roosevelt, *A Book-Lover's Holidays in the Open,* 1916