National Rifle Association of America
Institute for Legislative Action
11250 Waples Mill Road
Fairfax, Virginia 22030

June 14, 2007

Richard B. Rogers, President
California Fish and Game Commission
1416 Ninth Street
Sacramento, California 95814

Dear President Rogers:

The National Rifle Association (NRA) requests that the enclosed report entitled "Summary of Science for Ammunition as the Source of Lead in Condors" be included in the public comment record on the issue of amending the state's hunting regulations to require non-lead ammunition for big game hunting in areas inhabited by free-ranging condors.

Advocates of a lead ammunition ban have attempted to make a scientific case that links the lead poisoning problem in free-ranging condors to the ingestion by condors of spent lead ammunition found in the carcasses and gutpiles of animals killed by hunters. They claim that the ban will reduce the potential risk to the condor of lead poisoning as a result of big game hunting.

Given the enormous impact that a lead ammunition ban would have on our hunter-members, the NRA asked two highly respected scientists to review the data that have been presented to the Commission. These scientists have had years of practical experience working on issues related to lead ammunition in the environment. They conclude that the claim that lead ammunition is a major source of elevated lead in condors is not supported by the scientific data presented. If there is no link, there can be no expectation that banning the use of lead ammunition will reduce blood lead levels in condors.

On its website, the Commission states that it follows the path of sound and enlightened resource management. We believe that to mean that California's resource management decisions are based on sound science. While we share the concerns for the successful recovery of the California condor and the desire to eliminate obstacles to that goal, there are too many unanswered questions, assumptions, and anecdotal information to justify a ban on lead ammunition. The only assured outcome is that the ban will make it difficult, if not impossible, for hunters to continue to hunt in areas where the ban applies and it will reduce hunter-generated revenue that is important to wildlife conservation and the economies of local communities.

Sincerely,

Susan Recce

Susan Recce, Director
Wildlife, Conservation and Natural Resources

SUMMARY OF SCIENCE FOR AMMUNITION AS THE SOURCE OF LEAD IN CONDORS

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SUMMARY OF SCIENCE FOR AMMUNITION AS THE SOURCE OF LEAD IN CONDORS

The basis for the bill presently before the California legislature to ban lead ammunition is that it may be a major source of lead to condors, and if so, the ban is intended to protect the condors by reducing their exposure to lead. From a scientific perspective, the bill is based on the following hypothesis.

Hypothesis: Ammunition is the major source of elevated lead in condors.

This hypothesis, and therefore the basis for the bill, depends on a series of supporting sub-hypotheses or links in a supporting "logic chain", each of which can be evaluated scientifically. For the hypothesis to be correct, all the links in the logic chain must be strong. If any link in the chain is not supportable, the chain is weak and the conclusion (the hypothesis) is not supported. The science supporting each link in the logic chain has been examined to determine the strength of the science supporting the hypothesis and therefore, the bill. The findings for each sub-hypothesis, or link in the logic chain, are summarized below, and discussed in more detail in on the following pages.

Logic Link 1: Condors are adversely affected by elevated lead in their tissues. Several research papers show that many free-flying condors have higher concentrations of lead in their blood than pre-released condors, although there are notable exceptions. There are fewer data and the evidence is less compelling for lead in other tissues. There is less compelling evidence that condors are adversely affected by the lead in their tissues. Scientific support for this logic link is moderately strong.

Logic Link 2: Lead ammunition is used in condor range. There is no doubt that lead ammunition is widely used for hunting in the range of condors in California, both from scientific research and commonly available information. Scientific support for this logic link is very strong.

Logic Link 3: Condors ingest lead ammunition in sufficient amounts to account for the lead in their tissues. Scientific papers commonly present the speculation that condors ingest lead ammunition in the dead animals and offal they feed on. However, there has been very little scientific investigation of actual ingestion of lead ammunition by condors, and there is no documentation or direct evidence of such ingestion. Most scientific papers acknowledge the possibility of other sources of lead to condors, and acknowledge that ingestion of lead ammunition in food is largely speculation. Scientific support for this logic link is very weak.

Logic Link 4: Lead in the tissues of condors can be traced to ammunition. This is has been investigated by examining lead isotope ratios in the blood of condors, background environmental samples, and ammunition; if lead isotope ratios in condors are the same as and unique to ammunition, then ammunition lead is the source of the lead in condors. One major paper claims to have documented such a relationship and thus shown that ammunition is a major source of lead to condors. However, further scientific investigation shows that this paper overlooked important data in the sources of some of its information. When all data are considered, they clearly show the lead isotope ratios in condors (1) vary widely, (2) are not different from background lead ratios in the California environment, and (3) are not unique to ammunition. Scientific support for this logic link is nonexistent, and in fact, the scientific evidence indicates that this link is not true.

CONCLUSION: Therefore, the hypothesis is rejected because of lack of support for logic links 3 & 4, ammunition has not been shown to be the source of elevated lead in condors, and in fact, the scientific evidence (logic link 4) indicates ammunition is NOT a major source of lead in condors. Therefore, the hypothesis and the bill based on it are not supported by the available scientific evidence.

SUMMARY OF SCIENCE FOR AMMUNITION AS THE SOURCE OF LEAD IN CONDORS

INTRODUCTION

There is a controversy regarding the potential adverse effects that lead may be having upon free-ranging California condors (*Gymnogyps californianus).* The primary source of the lead is thought to be bullets, bullet fragments, and shot from hunting and nuisance species control. As condors are primarily scavengers, it is postulated that they ingest lead from the carcasses of lost game animals and "gut piles" from field dressing, and discarded nuisance species. Therefore, the California legislature is currently considering a bill to ban lead ammunition, intended to protect the condors by reducing their exposure to lead.

From a scientific perspective, the bill is based on the following hypothesis.

Hypothesis: Ammunition is the major source of elevated lead in condors.

Ideally, hypotheses are based on quantitative empirical data and stated in such a way that they can be tested statistically and accepted or rejected (declared false) based on the results. However, formal hypothesis testing is not always possible, usually because of inadequate or incomplete empirical data, and this is true of the hypothesis on which the bill is based. In such cases, a less-quantitative but equally rigorous approach may be employed that considers both quantitative data and non-quantitative evidence. Such hypotheses are accepted or rejected based on weight of evidence. The hypothesis that is the basis for the bill is of this type, as is our evaluation of it.

The hypothesis that is the basis for the bill depends on a series of supporting sub-hypotheses or links in a supporting "logic chain", each of which can be evaluated scientifically. For the hypothesis to be correct, all the sub-hypotheses or links in the logic chain must be strong. If any link in the chain is not supportable, the chain is weak and the conclusion (the hypothesis) is not supported. This paper summarizes the science supporting each sub-hypothesis or link in the logic chain, and by doing so shows the strength of the science supporting the hypothesis and therefore, the bill. The supporting hypotheses, or links in the logic chain, are presented here and discussed below.

1. Condors are adversely affected by elevated lead in their tissues.

2. Lead ammunition is used in the condors' range.

3. Condors ingest lead ammunition in sufficient amounts to account for the lead in their tissues.

4. Lead from ingested ammunition is incorporated into the condors' physiological processes.

The hypothesis can be supported scientifically only if the scientific support for each of these sub-hypotheses or links in the supporting logic chain is strong.

DISCUSSION

Logic Link 1: Condors are adversely affected by elevated lead in their tissues.

This logic link has two components: condors contain elevated lead in their tissues, and they are adversely affected by this lead. These components are addressed below.

Condors contain elevated lead in their tissues.

There is no doubt that many free-flying condors contain substantially higher lead in their tissues than pre-release condors. There is little doubt on this point, even though some individual birds are clear exceptions. For example, Church et al. (2006) present concentrations of lead in the blood of pre-release and free-flying condors with the following results:

- 9 pre-release condors with blood lead ranging from 21.3 to 34.5 ng/mL
- 18 free-flying condors with blood lead ranging from 28.0 to 977 ng/mL, distributed as follows:
  - 2 condors with blood lead of 28.0 and 39.6 ng/mL
  - 16 condors with blood lead ranging from 61.2 to 977 ng/mL

Condors are adversely affected by the lead in their tissues.

There are data to support this component of the logic link, although the lead concentrations that are adverse are not precisely established and effects vary considerably among condors. For example:

- Johnson et al. (2007) "consider" <20 ug/dl of lead in condor blood to be background and 20-59 ug/dl "indicate" elevated exposure, "suggest" that birds "may" be clinically affected at concentrations of 60-90 ug/dl and that acute toxicity occurs above 100 ug/dl. The terms consider, indicate, suggest, and may show clearly the uncertainty in the statement.
- Fry (2003) reports that of 41 free-flying condor deaths in Arizona and California, lead toxicity was documented as the cause of death in 12%.
- Fry (2003) reports that during the period 1970 to 1980 at least three condors died of exposure to lead, but does not say how lead was determined to be the cause of death.
- Johnson et al. (2007) report that of 18 dead free-flying condors the cause of death could not be determined but that lead is believed to be the primary cause of death in three of the birds(emphasis added). If the cause could not be determined, the attribution to lead is speculation, and that speculation attributes death to lead in 3 of 18, or 17% of these condors.

Johnson et al. (2007) provide an extensive list of chronic/sublethal effects of lead poisoning in "birds", but provide no evidence as to which of these many effects actually occur in condors. In addition, some of the effects are highly subjective. For example, "clinical depression" is listed as an effect, but its diagnoses is subjective in humans and would seem much more so in birds. Numerous authors have shown that generalizations between different genera and species are fraught with peril unless thoroughly documented and validated with empirical data, and this applies to generalizing from "birds" to condors. Similarly, the possibility of substantial differences due to sex, age, nutritional state, disease, previous exposure to lead and other contaminants, etc. must be recognized. It is also important to recognize that the presence of lead in body tissues, *per se*, does not implicate lead as the causative agent of adverse health effects.

Logic Link 2: Lead ammunition is used in condor range.

There is no doubt from both scientific research and commonly available information that lead ammunition is widely used for hunting in the range of condors in California. For example, in the eight-county range of condors in California in 2000 Fry (2003) estimated hunting take of over 100,000 game animals, 30,000 "gut piles" from deer and wild pigs, over 10,000 coyote carcasses, and an unknown number of "lost" game animals. Much of this was undoubtedly with lead ammunition.

Logic Link 3: Condors ingest lead ammunition in sufficient amounts to account for the lead in their tissues.

It is not likely one single source contributes all the lead in condor tissues. The real issue is whether lead ammunition is a major source of the lead in condor tissues.

There is no doubt that there are lead fragments in gut piles, lost game, and discarded nuisance species. What needs to be known is the contribution of these sources to the body burden of a condor as the birds are competing with other scavengers and decay organisms.

Because of their feeding habits, it is unlikely that condors selectively avoid lead ammunition or fragments when feeding. Condors do not characteristically regurgitate bone fragments and other solid objects they ingest, and presumably would not regurgitate ingested ammunition. Hence, it is possible for lead ammunition in condor food to enter their gastrointestinal tract. It might then be absorbed into the body, or it might be excreted with feces with little or no absorption. The degree of absorption will depend on a number of factors, including the amount of lead, its surface area, the amount of food in the gastrointestinal tract, the physiological condition of the bird, age, and other factors.

Even though ammunition ingestion with food is possible, the evidence for this is largely circumstantial and anecdotal. Fry (2003) estimated hunting take of over 100,000 game animals, 30,000 "gut piles" from deer and wild pigs, over 10,000 coyote carcasses, and an unknown number of "lost" game animals in 2000 in the eight-county range of condors in California. While this indicates extensive use of lead ammunition for hunting in condor range in California, Fry (2003) provided no data and no indirect evidence that ammunition in game animals was actually ingested by condors. Neither Fry (2003) nor other authors make any attempt to:

- demonstrate that condors actually ingest ammunition from lost game animals
- determine the frequency with which gut piles contain lead ammunition that could be ingested by condors, although many authors presume this occurs
- determine the frequency with which condors actually ingest ammunition from gut piles, although many authors presume this occurs
- estimate the quantity of lead condors actually ingest from lost game animals or gut piles

These are important data gaps, without which it is impossible to determine whether condors ingest lead ammunition in sufficient amounts to account for the lead in their tissues.

We also question whether the prevalence of gut piles determined prior to the publication of the Fry document in early 2003 is relevant today, as field dressing is largely a thing of the past that was used when it was necessary to manually drag animals long distances. The gut pile estimate above suggests that thirty percent of game animals are field dressed, which seems excessive today; with the proliferation of all terrain and four-wheel drive vehicles, more and more animals are removed intact from the field for processing.

Fry (2003) acknowledges that the frequent consumption of lost animals and gut piles by condors has never been documented, nor has the degree of lead contamination in these and animal carcasses been investigated, and therefore he cannot definitively state that these remains are the principle sources of lead exposure to condors. He speculates that alternate sources of lead are less important than lead from hunting bullets, but offers no data or indirect evidence in support of this speculation.

The California Department of Fish and Game (2007) discusses lead in cattle as a potential source of lead, as dead cattle are widely utilized by condors as a food source. They state that lead poisoning is one of the most common causes of cattle poisoning around the world, including California, and that lead toxicosis sometimes kills large numbers of animals in a herd. The main sources of lead in cattle is from batteries, lead sheathing, etc. that cattle find in fields at sites of dumps or old buildings.

Johnson et al. (2007) notes that lead is being deposited in the environment in the form of lead from ammunition through hunting and other shooting activities but also notes (page 46) that "While there may be other sources of lead besides ammunition that contribute to condor exposure, we currently lack data on these other sources" (emphasis added). However, Jackson et al. (2004) report that increasing lead levels from an unknown source were detected in cores from a pristine area in Okefenokee Swamp, GA, prior to the advent of leaded gasoline and continued to increase after the use of leaded gasoline ceased.

Fry (2003), California Department of Fish and Game (2007), and Johnson et al. (2007) fall prey to the intuitive assumption that the lead level in condors should increase after release as they are exposed to lead, presumably by consuming lead ammunition in carcasses and offal. Fry's (2003) Figures 6 and 7 invalidate this assumption, showing that blood lead levels increase and decrease in a virtually random pattern through time after condor release. Fry (2003) concludes that the decreases, which he considers counterintuitive, cannot be explained, and may only represent random variations. However, plausible explanations include depuration between exposures as in

Fry's (2003) Figure 12, and the fact that blood lead levels are not reliable indicators of long-term lead exposure history.

Logic Link 4: Lead in the tissues of condors can be traced to ammunition.

This has been addressed by examining lead isotope ratios in the blood of condors, background environmental samples, and ammunition; ratios in condors matching ratios in ammunition but not other lead sources would point to ammunition as the source of lead in condors.

Church et al. (2006) found that the ratio of lead isotopes $^{207}Pb/^{206}Pb$ in a small sample of ammunition was approximately 0.81. Using a statistical model, they calculated that the isotopic ratio from ammunition predominated in "most" free-flying condors with elevated blood lead levels and 77% of the condors sampled were consistent with the model. As seen in their Figure 1, a number of birds with calculated ammunition lead isotope ratios do not exhibit elevated blood lead levels. They conclude that "... the primary sources of lead in released condors are low background environmental lead in their diet and elevated levels of lead from ammunition, the latter most likely originating from the inadvertent ingestion of spent ammunition fragments embedded within mammal carcasses and offal piles."

Church et al. (2006) base much of their conclusions on background lead and ammunition lead having different isotope ratios. Saba (2007) demonstrates that their conclusions flow from several flawed assertions about both background lead and ammunition lead. We have independently examined Saba's (2007) work and concur with his findings, as demonstrated below.

The first flawed assertion concerns the isotopic ratio of background lead in the environment. Church et al. (2006) generated seven data points for $^{207}Pb/^{206}Pb$ lead isotope ratios in background samples from California. They also reported five other data points from four different publications of other authors. Based on this information, they concluded that background $^{207}Pb/^{206}Pb$ lead isotope ratios ranged only from 0.8253 to 0.8394. However, examination of two of the other publications shows that they selectively reported only a single datum from a much larger data set presented by the authors, and that had they reported the authors' entire data sets they would have shown that background $^{207}Pb/^{206}Pb$ lead isotope ratios actually ranged much more widely. Table 1 shows the data generated by Church et al. (2006), the single datum of Erel et al. (1991), and the single datum of Dunlap et al. (2000) they selected to report that gave the background $^{207}Pb/^{206}Pb$ lead isotope ratio range from 0.8253 to 0.8394. Table 1 also shows the 11 data points from Erel et al. (1991) and the 10 data points from Dunlap et al. (2000) that Church et al. (2006) inexplicably chose <u>not</u> to report. When all the data of Church et al. (2006), Erel et al. (1991), and Dunlap et al. (2000) are considered, it is clear that the California background $^{207}Pb/^{206}Pb$ lead isotope ratio actually ranges from 0.7541 to 0.8453, considerably greater than presented by Church et al. (2006).

The second flawed assertion concerns the isotopic ratio of lead in ammunition. Church et al. (2006) generated 18 data points for $^{207}Pb/^{206}Pb$ lead isotope ratios in two brands of rifle and shotgun ammunition, and concluded that $^{207}Pb/^{206}Pb$ lead isotope ratios ranged only from 0.8054 to 0.8175. However, a paper they cited for other purposes contained relevant data on $^{207}Pb/^{206}Pb$

lead isotope ratios in 22 brands of shotgun ammunition that they chose to not report. Table 2 shows the lead ammunition isotope ratios generated by Church et al. (2006), as well as the 19 lead ammunition isotope ratios from Scheuhammer and Templeton (1998) that they had but chose to not report. Table 2 shows that when all the $^{207}Pb/^{206}Pb$ lead ammunition isotope ratios available to Church et al. (2006) are considered, it is clear that the ratios actually range from 0.7870 to 0.9320, considerably greater than presented by Church et al. (2006).

Tables 1 and 2 make several points very clear:

- The data selected for reporting by Church et al. (2006) gives a very different impression of lead isotope ratios than the entire data known to them.

- California background ratios and ammunition ratios vary widely and overlap substantially, making it impossible to distinguish ammunition lead from lead from California background sources.

- The lead isotope ratios in condors vary much less and are all within the range of both background and ammunition, making the source of lead in condors impossible to determine from the available $^{207}Pb/^{206}Pb$ lead isotope ratio data.

It is noteworthy that Dr. Robert Riseborough, one of the co-authors of Church et al. (2006), made the following statement more recently in the California Department of Fish and Game (2007):

> "Ammunition with other sources with different isotope ratios may be used in California but at the present time, until other isotope ratios are recorded in additional ammunition samples, the data base does not permit a conclusion about ammunition source or sources of the lead when the isotope ratio is below 0.807 or above 0.820. Conversely, since much of the lead used for ammunition manufacture is recycled, i.e., from batteries, other products containing lead may also have ratios within this range. An isotope ratio between 0.807 and 0.820 is therefore consistent with an ammunition source, but lead within this range could have a source other than ammunition."

Finally, the data presented in Church et al. (2006) indicate that the elevated lead levels in the blood of condors originate from a source of lead with a very narrow range of $^{207}Pb/^{206}Pb$ lead isotope ratios. This result would exclude ammunition as the source of lead in the blood of condors because lead from ammunition has a much broader range of $^{207}Pb/^{206}Pb$ lead isotope ratios that would be reflected in the blood if ammunition were the source.

CONCLUSION

Therefore, the hypothesis that ammunition is the major source of elevated lead in condors is rejected because of lack of support for logic links 3 & 4, and ammunition has been shown not to be the source of elevated lead in condors.

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TABLE 1. Lead Isotope Ratios ($^{207}Pb/^{206}Pb$) in Background Environmental Samples and Condor Blood,
Sampling and analysis details can be found in the source documents.

	$^{207}Pb/^{206}Pb$	
Background Environmental Media	**Media**	**Blood of Free-Flying Condors**
Data generated by Church et al. (2006)		
Dairy calf, Monterey County CA	0.8394	0.8122
Dairy calf, Monterey County CA	0.8388	0.8195
Dairy calf, Kern County CA	0.8253	0.8238
Dairy calf, Kern County CA	0.8343	0.8257
Mule deer, Monterey County CA	0.8338	0.8126
Mule deer, Ventura County CA	0.8345	0.8220
Sea lion, Monterey County CA	0.8361	0.8387
		0.8402
		0.8101
		0.8214
		0.8112
		0.8146
		0.8214
		0.8281
		0.8182
		0.8129
		0.8308
		0.8307
Data from Erel et al. (1991) reported by Church et al. (2006)		
Sierra Nevada atmospheric dust (same description in Erel 1991)	0.8403	
Sierra Nevada snow-fed lake water ("Lake water, spring" in Erel 1991)	0.8453	
Data from Dunlap et al. (2000) reported by Church et al. (2006)		
Sacramento/San Joaquin river water (average of 4 values from Dunlap et al. (2000)	0.8338	
Data from Erel et al. (1991) ***not reported*** by Church et al. (2006)		
Groundwater, meadow, autumn	0.7819	
Stream water, cascades 1, autumn	0.8019	
Stream water cascades 2, autumn	0.8006	
Stream water, meadow, autumn	0.7874	
Stream water, lower cascades, autumn	0.7710	
Stream water, lower cascades, spring	0.8210	
Roaring River, autumn	0.7911	
Soil 30 cm deep	0.8000	
Sugarloaf soil	0.7541	
Sugarloaf rock	0.8170	
Paradise rock	0.8230	
Data from Dunlap et al. (2000) ***not reported*** by Church et al. (2006)		
Sediment 1 below Malakof mine	0.8054	
Sediment 2 below Malakof mine	0.8163	

Sacramento River water, filtered	0.8343	
Sacramento River water, unfiltered	0.8339	
San Joaquin River water, filtered	0.8328	
San Joaquin River water, unfiltered	0.8336	
Sediment 1 below Malakof mine	0.8054	
Sediment 2 below Malakof mine	0.8163	
Sediment 1 below Malakof mine	0.8054	
Sediment 2 below Malakof mine	0.8163	
Summary statistics of data generated and reported by Church et al. (2006)		
Minimum	0.8253	0.8101
Maximum	0.8394	0.8402
Average	0.8352	0.8219
Median	0.8353	0.8214
Summary statistics of ***all*** data, including data ***not reported*** by Church et al. (2006)		
Minimum	0.7541	0.8101
Maximum	0.8453	0.8402
Average	0.8172	0.8219
Median	0.8220	0.8214

Church, M.E., et al. 2006. *Ammunition is the Principle Source of Lead Accumulated by California Condors Re-introduced to the Wild.* Environmental Science & Technology, Vol. 40:6143-6150. Blood data are from free-flying condors sampled varying times after release to the wild.

Erel, Y., et al. 1991. *Natural Levels of Lead and Cadmium in a Remote Mountain Stream.* Geochemica et Cosmochemica Acta, Vol. 55:707-719. All samples are from the Moraine Creek watershed, Kings Canyon National Park, California. Lead isotope rations reported by these authors as $^{206}Pb/^{207}Pb$ were converted here to $^{207}Pb/^{206}Pb$ to allow direct comparison to data reported by Church et al. (2006).

Dunlap, c. e., et al. 2000. *Past Leaded Gasoline Emissions as a Nonpoint Source Tracer in Riparian Systems: A Study of River Inputs to San Francisco Bay.* Environmental Science & Technology, Vol. 34:1211-1215. Lead isotope rations reported by these authors as $^{206}Pb/^{207}Pb$ were converted here to $^{207}Pb/^{206}Pb$ to allow direct comparison to data reported by Church et al. (2006).

TABLE 2. Lead Isotope Ratios ($^{207}Pb/^{206}Pb$) in Condor Blood and Lead Ammunition
Sampling and analysis details can be found in the source documents.

	$^{207}Pb/^{206}Pb$	
Ammunition Source	**Ammunition**	**Blood of Free-Flying Condors**
Data generated by Church et al. (2006)		
Remington .270	0.8169	0.8122
Remington .270	0.8172	0.8195
Winchester .270	0.8134	0.8238
Winchester .280	0.8105	0.8257
Remington .308	0.8085	0.8126
Remington 30-06	0.8054	0.8220
Remington 30-06	0.8175	0.8387
Remington 30-06	0.8149	0.8402
Winchester 30-06	0.8154	0.8101
Winchester 30-30	0.8145	0.8214
Winchester 30-30	0.8108	0.8112
Remington 30-30	0.8130	0.8146
Remington 30-30	0.8163	0.8214
Remington 30-30	0.8089	0.8281
Remington 30-30	0.8170	0.8182
Remington 12 ga	0.8146	0.8129
Remington 12 ga	0.8125	0.8308
Winchester 12 ga	0.8137	0.8307
Data available to Church et al. (2006) from Scheuhammer & Templeton (1998) but ***not reported***		
Shotshell sample 1	0.9320	
Shotshell sample 2	0.8980	
Shotshell sample 3	0.8930	
Shotshell sample 4	0.8890	
Shotshell sample 5	0.8840	
Shotshell sample 6	0.8790	
Shotshell sample 7	0.8760	
Shotshell sample 8	0.8680	
Shotshell sample 9	0.8610	
Shotshell sample 10	0.8600	
Shotshell sample 11	0.8470	
Shotshell sample 12	0.8410	
Shotshell sample 13	0.8330	
Shotshell sample 14	0.8300	
Shotshell sample 15	0.8200	
Shotshell sample 16	0.8160	
Shotshell sample 17	0.8110	
Shotshell sample 18	0.8070	
Shotshell sample 19	0.7870	

Summary statistics of data generated by Church et al. (2006)

Minimum	0.8054	0.8101
Maximum	0.8175	0.8402
Average	0.8134	0.8219
Median	0.8141	0.8214

Summary statistics of all data available to Church et al. (2006), including data ***not reported***

Minimum	0.7870	0.8101
Maximum	0.9320	0.8402
Average	0.8344	0.8219
Median	0.8169	0.8214

Church, M.E., et al. 2006. *Ammunition is the Principle Source of Lead Accumulated by California Condors Re-introduced to the Wild*. Environmental Science & Technology, Vol. 40:6143-6150. Blood data are from free-flying condors sampled varying times after release to the wild.

Scheuhammer, A. M. and D. M. Templeton. 1998. *Use of Stable Isotope Ratios to Distinguish Sources of Lead Exposure in Wild Birds*. Ecotoxicology, Vol. 7:37-42. The authors presented their data graphically rather than in tables; data are approximations read from graphs. Ammunition data are from 22 brands of shotshells (shot sizes unspecified) and shot of unknown origin taken from 17 birds of various species; the 19 distinct data points distinguishable on the graph are presented here. Lead isotope rations reported by these authors as $^{206}Pb/^{207}Pb$ were converted here to $^{207}Pb/^{206}Pb$ to allow direct comparison to data reported by Church et al. (2006).

THOMAS D. WRIGHT

Dr. Wright is a native of Temple, TX and was born in 1936.He received a B.A. from the University of Texas/Austin in 1961 with a double major in zoology and geology. He received his M.S. in fisheries and limnology from the University of Wisconsin/Madison in 1964 and his Ph. D. in Zoology and Geology from the University of Wisconsin/Madison in 1968. He served on the faculty of Cornell University, the University of Virginia (Virginia Institute of Marine Science), and Michigan Technological University (1969-1977) In 1979, he accepted employment at the Engineer Research and Development Center at the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi where he managed multi-million dollar projects, supervised a staff of 35 and conducted research on a wide variety of topics including contaminated sediments and regulatory approaches in the solution of environmental problems. He retired in 1976 as a Senior Aquatic Ecologist. He was active in environmental litigation and published over 150 articles papers, and books. He is a Certified Fishery Scientist by the American Fisheries Society and a Certified Environmental Professional by the National Association of Environmental Professionals. He is currently active as an independent environmental consultant. A detailed resume and list of publications is available upon request.

Biographical Summary
Richard K. Peddicord

Richard K. "Dick" Peddicord holds a Ph. D. in environmental science from the University of Virginia. He has 35 years experience in assessment and management of environmental risks, with particular emphasis on all aspects of environmental issues at outdoor shooting ranges. He developed a guidance manual on environmental aspects of construction and management of outdoor shooting ranges that constitutes National Shooting Sports Foundation (NSSF) guidance on "best management practices" for use at ranges. He developed a "user friendly" computerized application of that guidance to aide ranges in preparing their own site-specific Environmental Stewardship Plans. Dr. Peddicord was invited by the U.S. Environmental Protection Agency (EPA) to be a scientific peer reviewer of their "*Best Management Practices for Lead at Outdoor Shooting Ranges*" that is now national EPA policy for lead management. As a subcontractor to the U. S. EPA, he assessed technologies for reclaiming lead from outdoor shooting ranges for recycling. He has evaluated environmental impacts and developed appropriate management actions in California and across the United States related to Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and Clean Water Act (CWA) issues at outdoor shooting ranges. He recently completed a review of the scientific literature on effects of lead ammunition on non-waterfowl birds in Europe. He was an invited speaker and participant at the World Symposium on Lead in Ammunition, sponsored by the World Forum on the Future of Sport Shooting Activities. Dr. Peddicord appeared as an expert witness on potential environmental impacts and appropriate assessment and management of environmental impacts at outdoor shooting ranges before the U. S. House Committee on Resources. Dr. Peddicord is the author of over 60 national and international scientific papers, reports, and presentations dealing with assessment and management of contaminants in the environment, including ten specifically addressing shooting range issues.