



# Lead from Spent Ammunition: A Source of Poisoning in Bald Eagles

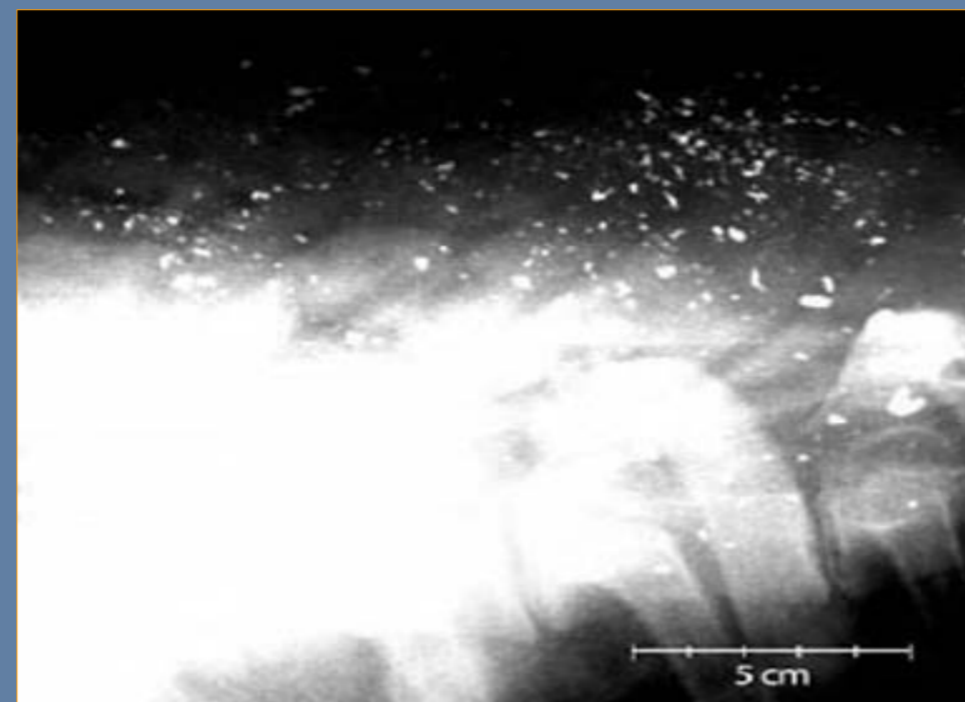
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## INTRODUCTION

A 12-year (1996-2008) retrospective study of lead poisoning in bald eagles (*Haliaeetus leucocephalus*) was conducted to test the hypothesis that spent lead from ammunition, present in the carcasses and gutpiles of white-tailed deer, represents an important source of lead exposure. Sample size consisted of n=300 lead poisoning cases from 1,150 eagles admitted.



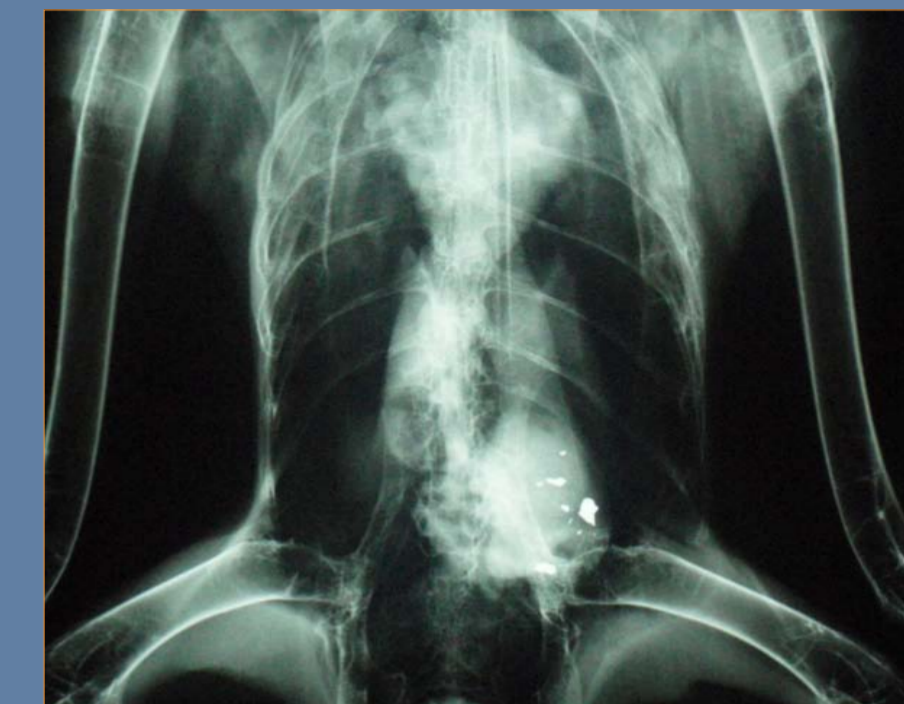
Lead-based ammunition used for deer hunting fragments heavily upon impact.



This radiograph of a rifle-killed deer, shows how the lead from ammunition fragments and disperses in the deer.



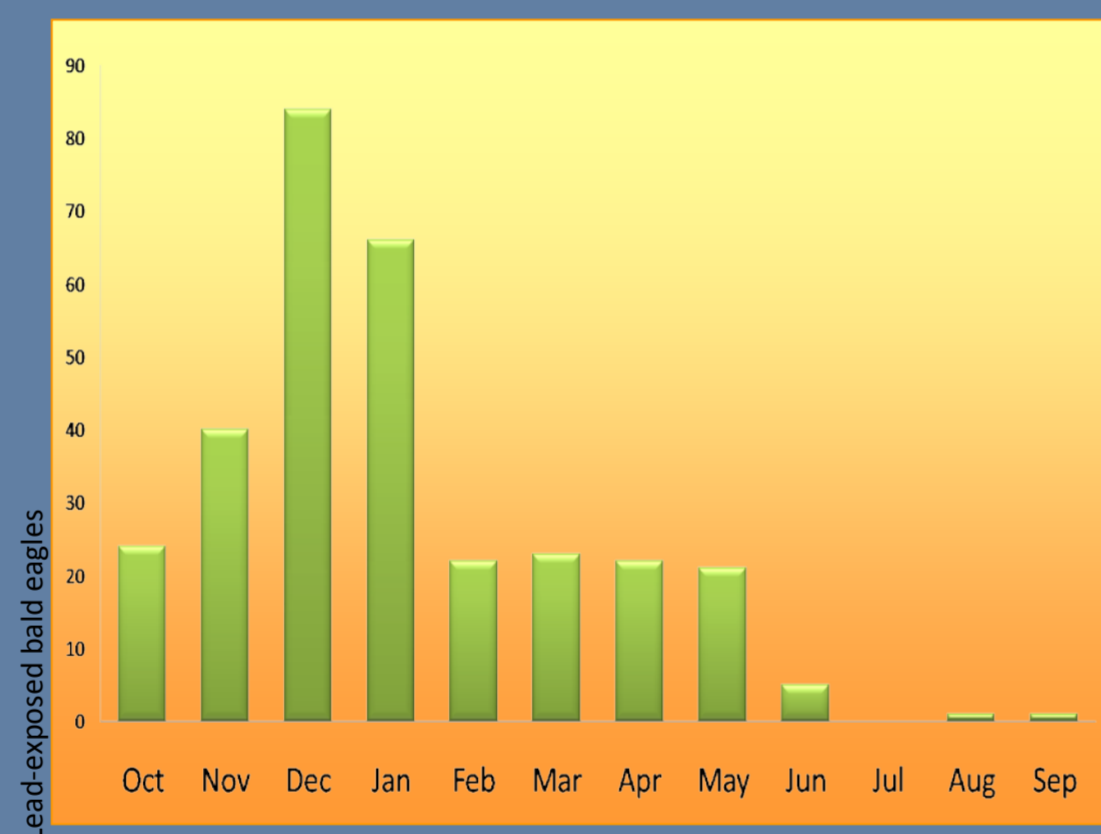
Bald eagles ingest lead fragments while scavenging on deer carcasses and gutpiles.



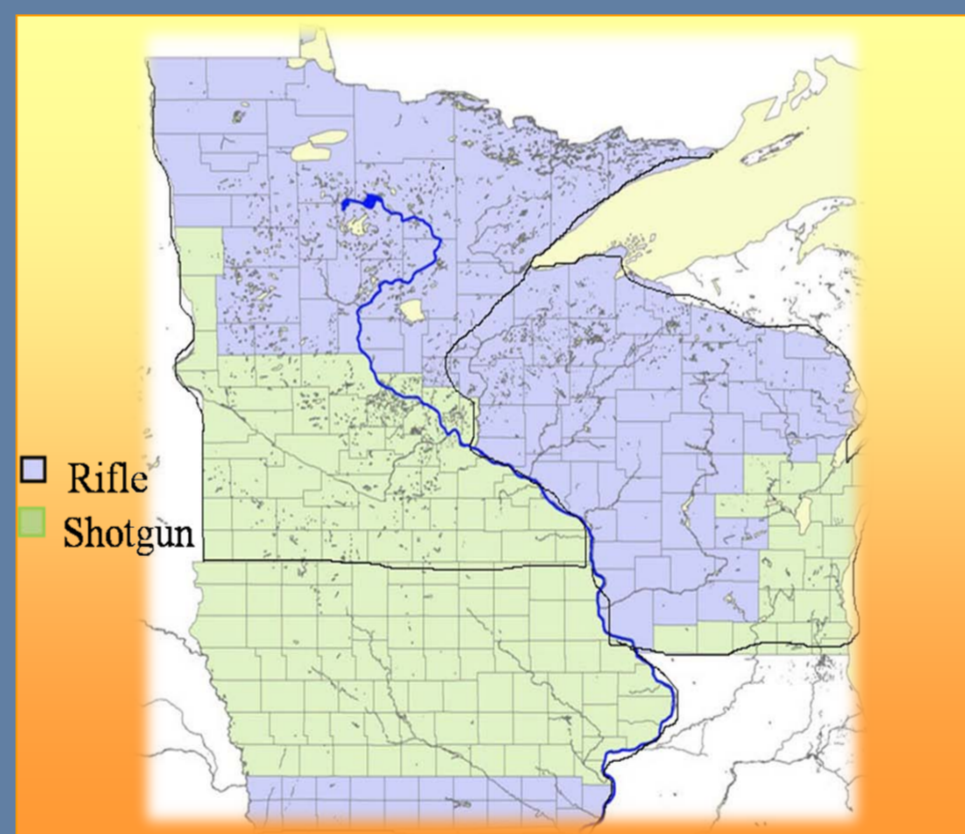
A radiograph of a lead-exposed bald eagle shows ingested lead fragments.

## METHODOLOGY

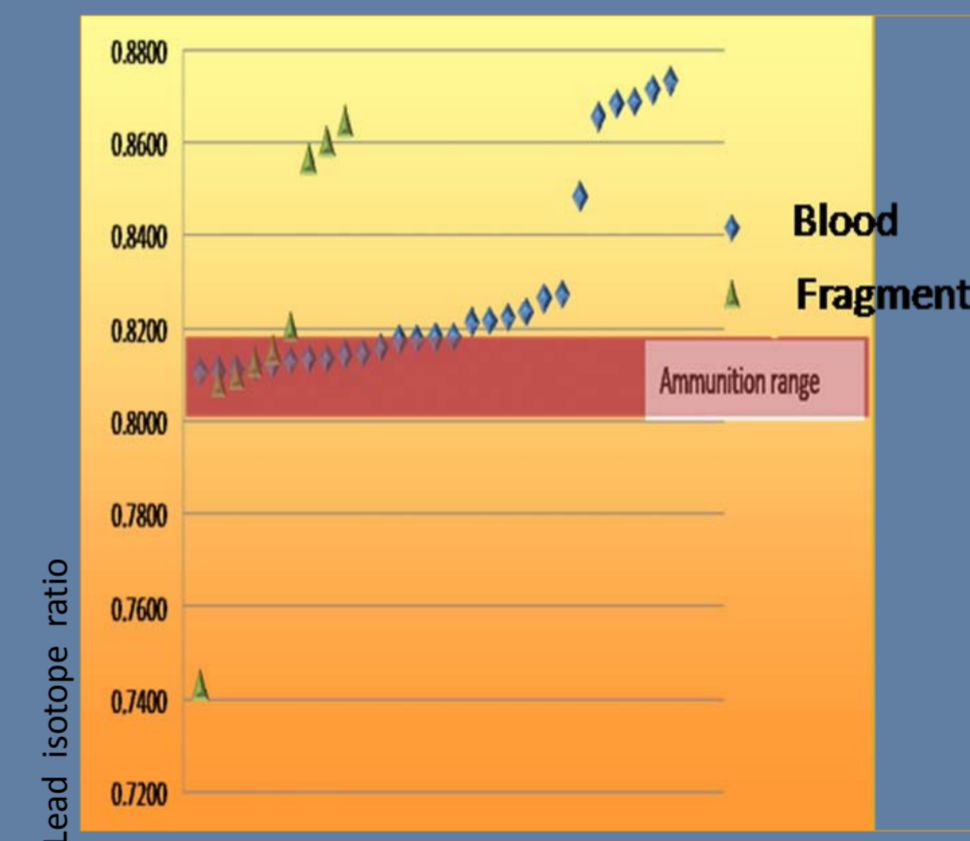
Four epidemiological parameters were analyzed: 1) seasonal prevalence and relationship with deer hunting season; 2) correlation of the animal recovery location with deer hunting zones; 3) lead isotope ratio analysis of metal fragments recovered from the gastrointestinal tract of lead-exposed bald eagles and whole blood; and 4) comparison of kidney copper concentration.



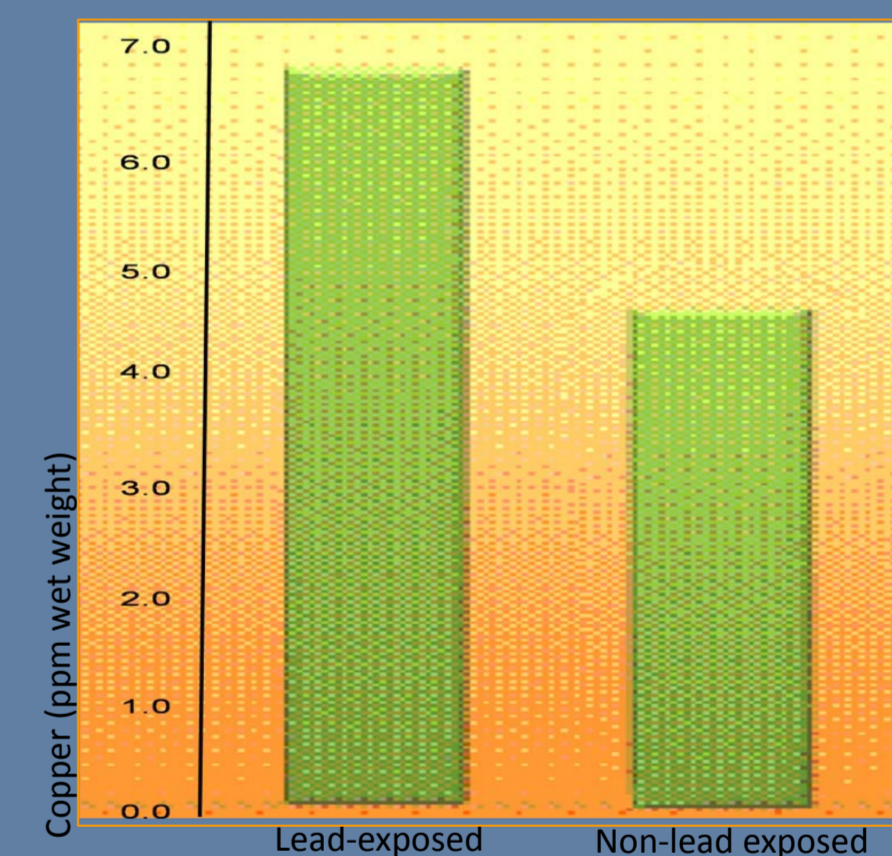
Prevalence of lead poisoning in bald eagles admitted by month



Deer hunting zones by firearm type in Minnesota, Wisconsin, and Iowa



Lead isotope ratio of blood and metal fragments from lead-exposed eagles



Mean kidney copper concentration comparing lead-exposed vs. non-lead exposed bald eagles

## CONCLUSIONS

The results from these four diverse epidemiological parameters strongly support the hypothesis that spent lead from ammunition, present in deer remains, represents an important source of lead exposure and poisoning for bald eagles.

We established a significant seasonal association ( $p < 0.01$ ) between deer hunting season and the incidence of eagle poisoning. The majority of cases occurred during late fall and early winter.

A significant geographical association was established ( $p < 0.01$ ) between deer hunting zones and eagle poisoning. A greater number of poisoned bald eagles were recovered from the rifle zone, where more bullet fragmentation is expected.

The lead isotope ratio analysis revealed that the majority of the blood and fragment samples from lead-exposed eagles were within the isotope ratio from ammunition samples reported by Church et al. (2006).

The kidney copper concentration was significantly higher in lead-exposed eagles ( $p = 0.002$ ) implying the ingestion of fragments from copper-jacketed lead bullets.

References:  
Church ME, et al. Ammunition is the principal source of lead accumulated by California condors re-introduced to the wild. Environ Sci Technol 2006; Oct 1;40(19):6143-50.  
Hunt WG, et al. Bullet fragments in deer remains: Implications for lead exposure in avian scavengers. Wildl Soc Bull 2006;34(1):167-70.  
Redig PT, Smith DR, Cruz-Martinez L. Potential sources of lead exposure for bald eagles: A retrospective study. The Peregrine Fund; 2009.