

T H E C A S E

Lead fragments in the stomach of a bald eagle show up as white splotches in this X-ray image.

F O R C O P P E R



Research uncovers problems with lead bullets for deer hunting and points to **copper bullets** as a practical alternative.

LEFT: COURTESY OF THE RAPTOR CENTER. RIGHT: RICHARD HAMILTON SMITH.



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A male bald eagle found in Clearwater County suffers from lead poisoning (above) as it awaits an examination by The Raptor Center's veterinarians. Due to severe neurological problems and high blood lead levels, this eagle was euthanized.



very year an average of 120 sick and injured bald eagles show up at the University of Minnesota's Raptor Center in cardboard boxes and pet crates. Some are dead on arrival. One quarter are seizing, convulsing, and blind—visible symptoms of acute lead poisoning. These eagles are mercifully euthanized on the spot. The fate of the other eagles depends on the extent of their injuries and how much lead they've ingested. In a good year, 30 eagles might recover and be released.

The timing of bald eagle admissions to the medical treatment center is one clue to the source of lead poisoning. Between No-

vember and January, more sick and injured bald eagles turn up than at any other time of the year, according to Dr. Pat Redig, a veterinarian and co-founder of The Raptor Center. The beginning of this spike in admissions coincides with the onset of Minnesota's firearms deer season, which typically starts the first weekend of November and lasts as long as three weeks. Over the course of the firearms season, some 450,000 hunters harvest more than 150,000 deer. The entrails from those deer are typically left afield, where bald eagles and other scavenging birds and mammals eat them.

"Ten days after deer season opens, we start

getting eagles in. It just happens that quickly," says Redig, who has been a clinician at the center since 1974.

This seasonal pattern prompted University of Minnesota researchers to investigate whether lead poisoning in bald eagles was connected to their consumption of lead-tainted deer remains. The study, published in 2012, relied on data from 1,277 sick or injured bald eagles admitted to The Raptor Center between January 1996 and December 2009. Blood tests showed lethal levels of lead in 334 eagles. Birds from the northern half of the state, where most hunters use rifles, were almost twice as likely to have elevated levels of lead than birds from the southern half, where hunters are restricted to shotguns and muzzleloaders.

The Raptor Center researchers believe the higher incidence of lead poisoning in the rifle zone has to do with bullet design, composition, and velocity. The rifle bullets most widely used by deer hunters are made with a lead core encased in a thin jacket of copper. These projectiles travel at thousands of feet per second and are designed so the soft lead core mushrooms and expands upon impact. A well-placed shot causes a large wound channel and a quick, humane kill. Unfortunately, the lead core splinters on impact and sends tiny fragments of lead into surrounding tissues.

Hypothesizing that scavenging eagles could also pick up fragmented copper from the jacket of a rifle bullet, The Raptor Center analyzed



Lead fragments in the stomach of a bald eagle.

Longtime Puzzle

There's a long history to solving the mystery of lead poisoning in Minnesota birds.

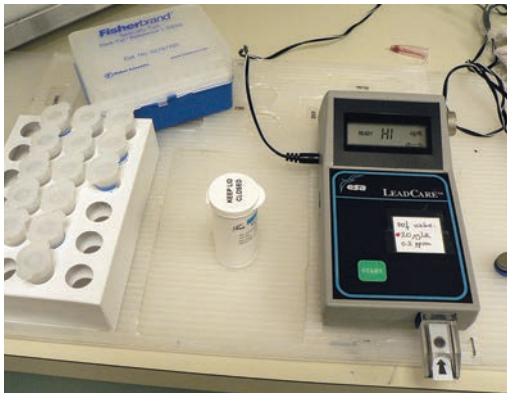
In 1977, after observing hundreds of Canada geese dying each year at Lac qui Parle Wildlife Management Area, the DNR's Carrol Henderson had a hunch that the cause was lead poisoning. Eagles were dying at the WMA too. Eagles were only beginning to recover from near extinction caused by the pesticide DDT, which the United States had banned five years earlier.

The U.S. Fish and Wildlife Service gave Henderson \$9,000 to find out why geese and eagles were dying. Henderson, in collaboration with Dr. Dan Frenzel at the University of Minnesota and The Raptor Center's Dr. Pat Redig, determined geese were being poisoned from eating lead shotgun pellets in crop fields where they were being hunted. And they suspected eagles, in turn, were dying from eating lead-poisoned geese.

With the federally protected bald eagle in mind, DNR Commissioner Joe Alexander and wildlife chief Roger Holmes made the contentious decision to phase out lead shot for waterfowl hunting. The state ban took full effect in 1987. A federal ban followed in 1991. Canadian waterfowl hunters have been required to use nontoxic shot since 1999.

Once lead was no longer being slung from duck and goose blinds, the number of waterfowl dying of lead poisoning dropped. Henderson expected the number of dying and dead eagles to go down as well. "It didn't happen," he says. "We were really puzzled by this."

As it turned out, waterfowl crippled or poisoned by lead shot were masking another source: lead in deer gut piles that become readily available to eagles every November.



A lead-poisoned eagle (top) may undergo chelation, a treatment that uses a compound of other elements to remove poisonous metals. When sick or injured eagles arrive at The Raptor Center, clinicians use a device (above) to measure blood lead levels. If those levels exceed 0.65 parts per million, treatment is rarely successful.

89 eagles for the presence of copper. Measurable levels of copper were found in 63 eagles. Those 63 eagles also had elevated blood lead levels. For a bald eagle, a fatal dose of lead is 85 milligrams—about as much as two No. 6 shotgun pellets.

Lead is a neurotoxin. When vertebrates ingest it, they incorporate this metal into their vital tissues because their bodies mistake it for calcium. Because of lead's insidious nature, the United States has largely eliminated its use in paint, in plumbing, and as a gasoline additive. However, lead is still widely used in ammunition and fishing tackle, due to its low cost, effectiveness, and availability.

An effective, nontoxic alternative is available for deer hunters: copper bullets. Redig and Carrol Henderson, nongame wildlife program supervisor at the Department of Natural Resources, would like to see more hunters make the switch to copper. They are not suggesting that we need legislation to outlaw lead rifle ammunition for deer hunting. Instead, they hope Minnesota's deer hunters will consider this choice for the sake of our national symbol and, perhaps, for the health of their families.

Fragmentation Test. Results of a 2008 study done by the DNR suggest that inadvertent ingestion of lead isn't limited to scavengers of deer remains. In 2007 Minnesota and North Dakota impounded thousands of pounds of venison

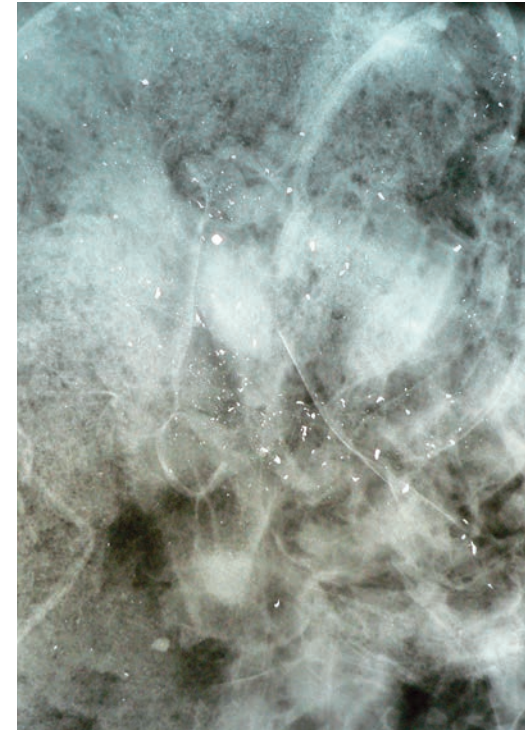
donated to food shelves following the discovery that some meat, especially ground venison, contained small fragments of lead. Public concern prompted the DNR bullet fragmentation study, which used 72 previously euthanized sheep as surrogates for white-tailed deer.

Researchers fired four different lead rifle bullets, 12-gauge lead shotgun slugs, two different muzzle-loader bullets, and one all-copper rifle bullet. All sheep were shot from a range of 100 meters just behind the front shoulder to represent the typical shot through vital organs that hunters try to achieve. The sheep were then gutted and skinned, a carbon fiber tube was inserted through the wound channel, and the carcasses were X-rayed to determine the number and spread of the fragments. Three additional sheep were shot in the pelvic region to simulate a bad shot that hits heavy bone.

Lead-core rifle bullets designed to rapidly expand deposited the most lead as they traveled through the sheep carcasses. Depending on the design, these bullets left 82 to 141 lead fragments 9 to 11 inches away from the wound channel. In one carcass, a fragment was found 14 inches away from the exit wound.

Shotgun slugs left an average of 28 lead fragments as far away as 5 inches from the wound channels. The heavier 300-grain muzzleloader bullet showed fragmentation similar to that of lead shotgun slugs.

The all-copper rifle bullets showed



Lead particles show up as white flecks (top) in this X-ray of viscera taken from a euthanized sheep that was shot as part of a DNR study of lead bullet fragmentation. When fired into a series of water jugs, the lead in a standard copper-jacketed bullet (above) splinters into shards and fine particles.

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TOP: COURTESY OF THE RAPTOR CENTER. BOTTOM: COURTESY OF INSTITUTE FOR WILDLIFE STUDIES.

little to no fragmentation. When fragmentation did occur, pieces of nontoxic copper were less than an inch from the exit wound.

In the sheep shot in the hindquarters, regardless of lead projectile, the DNR study concluded that fragmentation was so pronounced that a hunter would likely not want to consume any of the meat. However, even with proper shot placement, a key takeaway from the study was that routine trimming around the wound channel isn't likely to remove all the lead fragments.

The DNR study was not intended to determine whether the residual lead found in venison is harmful to human health, but University of Minnesota School of Public Health professor and former state epidemiologist Dr. Michael Osterholm thinks hunters should draw their own conclusions.

Looking at the physical evidence of the DNR study, Osterholm says, "The real problem is that the lead particles are so small they would never be detected by the palate. If you think about the health effects of lead in children, that's exactly the same kind of lead they get from lead paint. From a physical standpoint, there is every reason to be concerned.

"I think it would be really unfortunate if [advising caution on lead ammunition] is taken as somehow anti-hunting, anti-guns, or anti-bullets any more than hunter safety is anti-hunting," says Osterholm. "I'm very pro hunter. We need these animal species hunted. They provide nutritious and otherwise wholesome protein for families around our state. We just need to make sure it's as safe as possible."

Making the Switch. Steve Stucker, a lifelong deer hunter and a DNR ornitholo-

gist, bagged his first deer with copper ammunition last season. He says taking personal responsibility for eagles was one reason for making the switch, but the possibility of lead ending up in family meals was a greater consideration.

"Even though I thought the risk was fairly minimal, if there is any, even the tiniest possibility that lead could be in there, having a young daughter, why take any kind of risk at all when it's so easy to just buy copper ammunition?" asks Stucker.

Copper bullets kill deer effectively, but hunters who decide to use them will likely need to make some adjustments, says Ryan Bronson, conservation manager at Minnesota's Federal Premium Ammunition.


Because most rifling is designed with a lead-core bullet in mind, hunters experimenting with copper should try a lighter bullet, says Bronson. The reason is that copper is lighter than lead, so an equivalent weight copper bullet must be longer. And the longer a bullet is, the faster it has to spin inside a rifle barrel to stabilize, he explains.

"So if you traditionally shoot a 165-grain, .30-caliber bullet in lead, you may want to consider a 150-grain copper bullet," says Bronson, who notes that lighter weight doesn't translate into less knock-down power. "The key thing to remember with a copper bullet is generally the whole bullet stays together. It will penetrate well even with a smaller bullet." Retention of bullet weight and deeper penetration is why copper began gaining popularity a decade ago with hunters of big African game such as Cape buffalo, according to Bronson.

"When people have a frustration with the copper bullet on deer-sized animals, it's that it punches right through, and the bul-

let ends up putting a lot of energy into the ground on the other side of the animal," he says. On the other hand, copper bullets "are always going to stay together, so they are always going to penetrate. If you're putting it through a shoulder or putting it through bone, it's going to bust through that bone because it all stays together. It's going to keep carrying on into the vitals and hopefully deliver the energy."

Last year Minnesota Deer Hunters Association executive director Mark Johnson announced in *Whitetails*, the organization's magazine, that he was making the switch to copper. "My primary reason was ballistics and accuracy," says Johnson, who was pleased with copper's performance in his .280-caliber rifle. "The decision to use lead or copper should be a hunter's prerogative. But from my own standpoint, if I can use something that is more accurate and something that is friendlier to the environment, then I'm going to do that. If it costs a little more, that's not a big consideration to me."

Henderson hopes the reason for switching to copper will become clear to more hunters. "Any responsible sportsperson, any responsible hunter, should care about eagles as much as they do about deer and be able to enjoy eagles without thinking they might be leaving a toxic pile of guts in the woods for them to eat," he says. "If hunters can adapt to copper, it's a great thing for them, and it's a great thing for the image of hunting." 



Copper rifle ammunition is roughly twice the price of standard lead ammunition, but unlike a lead rifle bullet, an all-copper bullet (top) stays in one piece upon impact. Nontoxic copper bullets are effective at killing deer. DNR area wildlife manager Tom Rusch (above) has used copper ammunition to harvest three deer, including this large buck. In every instance, Rusch says, the deer he shot with copper bullets have dropped in their tracks.

TOP: COURTESY OF INSTITUTE FOR WILDLIFE STUDIES. BOTTOM: DAWN PLATTNER.