Getting the Lead Out

Condors and Hunters in Arizona

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This female condor was a successful breeder that produced a chick in the wild in 2004. During the 2006 breeding season she abandoned her nest after her mate was brought into captivity for lead poisoning. He recovered after several months, but she tragically died of lead poisoning a few months after he was returned to the wild.

If you are a hunter in Arizona's Kaibab Plateau, chances are you also are part of the effort to recover an amazing bird of great distinction. The California condor is one of North America's largest birds, with an average wingspan topping nine feet and body weight averaging 18 to 20 pounds. The condor is extremely rare, occupying only a few rugged areas in California, Arizona, Utah, and Mexico's Baja California. It is the only surviving member of its genus, *Gymnogyps*. That it survives at all is extraordinary, considering its close brush with extinction in the last quarter century.

The condor's survival story is briefly recounted in Winifred Kessler's column in this issue of *Fair Chase*. In a nutshell, in 1985 there remained only one breeding pair in the wild. Fearing the bird's extinction, the federal government in 1987 brought the last free-roaming condor into captivity. The plan, which has succeeded, was to breed the 22 captive condors and release their young into the wild. Thus far condors have been reintroduced to parts of their historic range in central and southern California, northern Arizona and southern Utah, and northern Baja California. Of the 332 condors in all, 156 are living in the wild.

Condors Land in Arizona

Captive-bred condors were first reintroduced into Arizona in December of 1996. For a couple of years the birds mostly remained at the release sight and fed on the beef carcasses that were provided to them. By 1999 the birds were foraging on their own, feeding on deer, elk, and coyote carcasses. They were captured periodically for health checks, and biologists started finding evidence of lead exposure. The more time the birds spent away from the release site, the more prevalent the lead exposure became.

The first lead poisoning mortalities occurred in 2000. Lead poisoning soon became the leading cause of death, with 12 confirmed cases. Lead exposure cases now exceed 300, with 50 to 95 percent of the birds testing positive each year. Without treatment, many more would likely die. Biologists capture the birds and subject them to chelation, a treatment that helps reduce the dangerously high levels of lead in the condor's blood. Computer models have verified what biologists already suspected: a wild condor population cannot be sustained with the current levels of lead exposure.

How are so many condors exposed to lead? Biologists knew that lead poisoning was killing condors back in the 1980s when the birds were close to extinction, but did not have scientific evidence identifying the source of this lead. Lead poisoning surfaced again

after the birds were reintroduced into California and Arizona. By this time, however, we had the technology and know-how to obtain solid scientific evidence. In 2002 the Arizona Game and Fish Department (GFD) joined forces with The Peregrine Fund, a private organization that tracks the daily movements of condors in Arizona and Utah. The partners set out to identify the source of lead exposure.

After years of research, we—the Arizona GFD and the Peregrine Fund—are confident that the main culprit is lead from spent ammunition. And you are probably thinking, "This just doesn't seem plausible." Trust me; I was a skeptic too. How are so many condors ingesting lead bullets? If there's an entrance and exit wound, where is the lead coming from? We realized that many questions needed to be answered before we could understand the situation. If we were going to enlist the help and cooperation of Arizona hunters, a solid case would be essential. So let's examine the stream of evidence to see if you, too, will find it convincing.

Building the Scientific Case

Let's start with what researchers knew from the examination of sick and dead condors. X-rays revealed the presence of metal fragments and pellets in their digestive tracts, which led scientists to suspect lead shot and bullet fragments as the main sources of lead. Later tests would verify this. But at this early point, researchers needed to determine how the birds were ingesting spent ammunition and what could be done to prevent it.

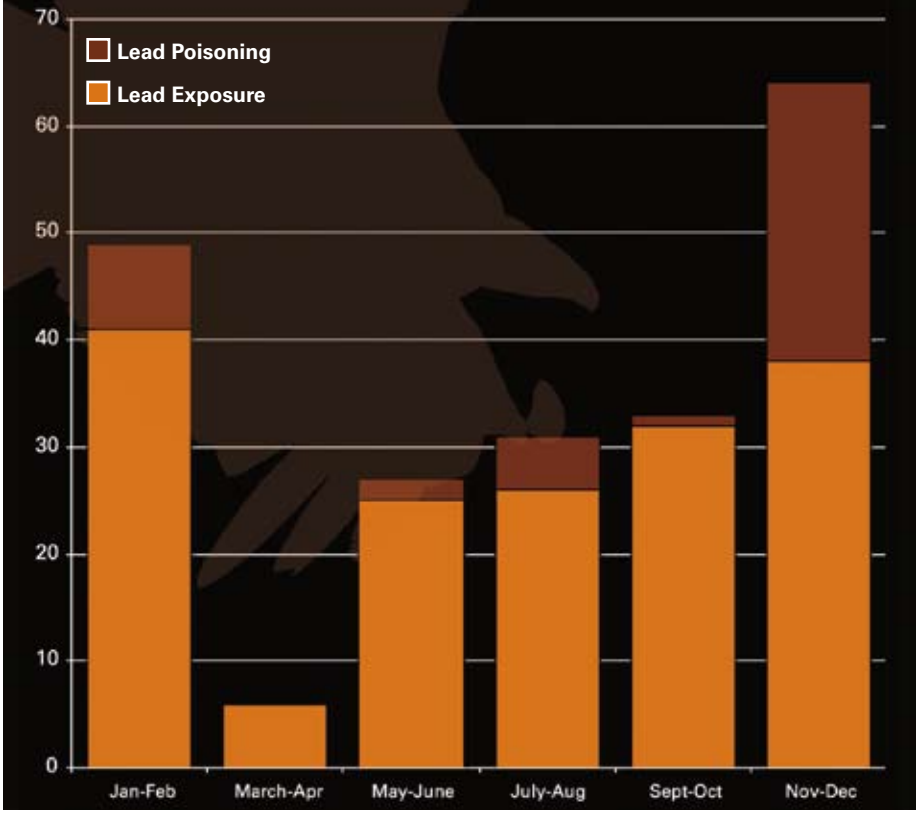
First, research focused on the seasonality of lead exposure. Although exposure occurred year-round, it was clear that the greatest number of exposures and the highest blood-lead levels occurred during November of each year (see Figure 1). Researchers knew the birds were ingesting the lead, so where were they feeding during November? Visual observations and telemetry studies indicated that the condors concentrated each November on the Kaibab Plateau where 500-700 mule deer were then being harvested (see Figure 2). Visual observations confirmed that the condors were feeding on the carcasses of unrecovered deer and gut piles. From these observations, biologists knew when and how condors were being exposed to lead.

The next step was to determine how much lead there is in deer carcasses and gut piles. Studies have shown that spent copper-jacketed lead bullets retain anywhere from 60 percent to 90 percent of their weight, but what does that translate to in a deer carcass? This was answered by x-raying 38 hunter-harvested deer and counting the bullet fragments in each. These tests found that 100 percent of the deer shot with copper-jacketed lead bullets contained bullet fragments regardless of whether the bullet remained in the carcass or passed through (see Figure 3). Some carcasses contained as many as 700 fragments, and bullet fragments were found up to six inches from the wound channel. What about the gut piles? Bullet fragments were found in 90 percent of gut piles, with some containing up to 500 fragments (see Figure 4). This makes sense if you think about it, as most hunters take vital organ shots. Therefore, when a deer is field-dressed, the majority of the lead fragments end up in the gut piles left behind.

Still think your lead bullet doesn't leave fragments? It's true that not all lead bullets are created equal, so researchers tested several different bullets in ballistics gelatin, with some faring better than others. But all did fragment significantly, unlike the copper bullets which retained almost 100 percent of their weight.

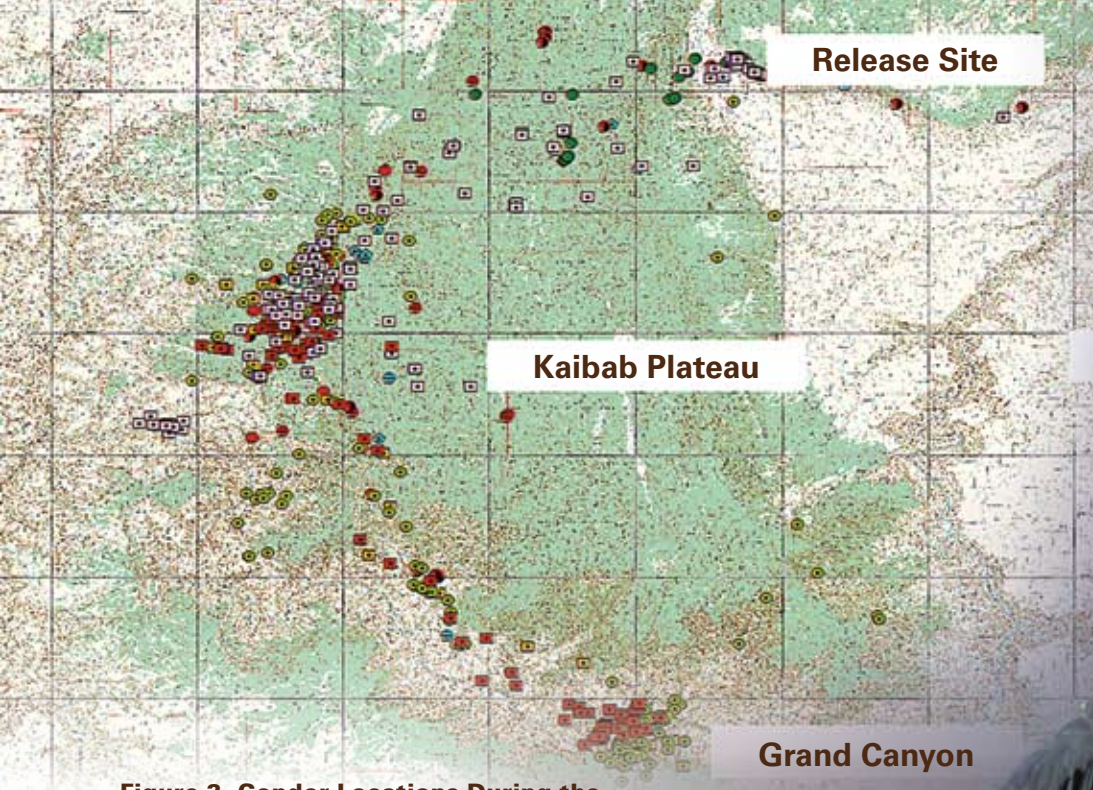
Let's do the math. Conservatively, wounding losses account for 15 to 35 deer carcasses on the Kaibab each November. This doesn't seem like many, but if all were harvested with lead bullets, it creates a serious potential for lead exposure. Now let's add in those gut piles. Condors feast on them every hunting season and researchers estimate that the gut piles of 90 percent of deer killed with lead-based bullets contain lead fragments. That translates to 450–650 lead-tainted gut piles that are available to condors each November. With only 60 condors in the Arizona population, that's almost 10 gut piles per condor. I'd say that constitutes a severe lead exposure threat.

Figure 1. Seasonality of Condor Lead Exposure. Year-round testing of condor blood samples reveal that the highest levels of lead poisoning and the greatest number of lead exposures occur during November and December each year. "Lead exposure" is defined as blood lead levels between15 and 59 micrograms/deciliter and "lead poisoning" is defined as blood lead levels of 60 micrograms/deciliter or greater (levels that in adult humans can cause neurological, cardiac, renal, gastrointestinal, and reproductive disorders). Condors test below 10 micrograms per deciliter before they are released into the wild.



But wait, there's more.

For the last study, the Arizona GFD contracted with the University of Arizona to conduct a lead isotope analysis of the lead found in condor blood and digestive tracts. Although this study has not yet been published, preliminary data eliminates background environmental lead as the source of lead exposure in condors, as some have suggested. It also matches the lead found in condor blood and digestive



This female condor was a successful breeder that produced one chick in the wild in 2004 but died of lead poisoning in 2006.

Figure 2. Condor Locations During the Kaibab Deer Hunting Season.
A satellite telemetry study concluded that condors concentrate on the Kaibab Plateau each November during the deer hunting season. In this map depicting locations during November 2006, each color represents a different condor. Data indicate concentrations on the west side of the Kaibab Plateau every November since 2002, the same time when hundreds of deer are harvested by hunters. Visual observations have confirmed that condors feed on wounding loss deer and gut piles during this period.

Figures 3 & 4. X-ray of Deer Carcass and Gut Pile Containing Lead Bullet Fragments.
In the x-ray below left of a deer, hundreds of small but toxic lead bullet fragments are visible as bright white spots. A study of 40 hunter-killed deer determined that 100% of the carcasses contained bullet fragments, numbering up to 700, when deer were shot with copper-jacketed lead bullets—whether or not the bullet passed through or remained in the carcass. In the x-ray of a deer gut pile (below right), hundreds of small but toxic lead bullet fragments are visible as bright white spots. A study of 40 hunter-killed deer determined that 90% of the gut piles contained bullet fragments, numbering up to 500 fragments, when deer were shot with copper-jacketed lead bullets. Conversely, deer shot with sold copper bullets contained few to no bullet fragments.

Figure 5. Commercially Available Loaded Non-lead Rifle Ammunition. Although non-lead rifle ammunition represents less than 10% of the market, copper bullets like the Barnes Triple Shock X-bullet (TSX) and Nosler E-tip bullet are loaded in most common rifle calibers. Solid copper bullets are more expensive than most copper-jacketed lead bullets, however their performance is praised by hunters and shooting magazines. Non-lead ammunition is also available for muzzleloaders, shotguns, and pistols.

Ammunition Manufacturer	Loaded Non-Lead Bullet	Available Calibers
Federal Premium	Barnes TSX, MRX, and Tipped TSX; Speer TNT Green	222 Rem., 223 Rem., 22-250 Rem., 243 Win., 25-06 Rem., 270 Win., 270 W.S.M., 7mm-08 Rem., 280 Rem., 7mm Rem. Mag., 7mm W.S.M., 308 Win., 30-06 Spring., 300 Win. Mag., 300 W.S.M., 300 H&H Mag., 300 R.U.M., 300 Wby Mag., 338 Fed., 338 Win. Mag.
Winchester E-tip	Nosler E-tip	223 Rem., 25-06 Rem., 270 Win., 7mm Rem. Mag., 308 Win., 30-06 Spring., 300 Win. Mag.
Black Hills Gold	Barnes TSX and Varmint Grenade	223 Rem., 25-06 Rem., 270 Win., 7mm Rem. Mag., 308 Win., 30-06 Spring., 300 Win. Mag.
Weatherby	Barnes Triple Shock X-bullet	240 Wby., 257 Wby., 270 Wby., 7mm Wby., 300 Wby., 30-378 Wby., 340 Wby., 338-378 Wby.
Cor-bon	Barnes Triple Shock X-bullet	223 Rem., 22-250 Rem., 243 Win., 25-06 Rem., 270 Win., 270 W.S.M., 270 Wby., 280 Rem., 7mm Rem., 7mm R.U.M., 30 Carbine, 30/30 Win., 308 Win., 30-06 Spring., 300 W.S.M., 300 RU.M., 300 Wby.

tracts to lead from ammunition. Yes, it is possible that there are other sources of lead in the condor's environment, but I think the weight of all the data leads us to an inescapable conclusion: The overwhelming majority of condor lead poisoning is linked to the ingestion of spent ammunition found in game carcasses and gut piles. If you still doubt this connection, I invite you to come out and work with us during the November hunting season to see for yourself. You can also visit *www.azgfd.gov/condor* to read about these studies in more detail.

Hunters Step Up

With the linkage between lead ammunition and lead poisoning in condors firmly established by research, we moved onto the next step. This was to work with the hunting community to reduce lead exposure in condors. This effort commenced in 2003 when the Arizona GFD surveyed hunters to find out what they knew about the problem and how willing they were to help. We learned that only about 20 percent of Arizona deer hunters were aware of the problem. In contrast, up to 90 percent were willing to take some voluntary lead reduction actions while hunting in condor range. This shouldn't be surprising to anyone since sportsmen are America's original and enduring wildlife conservationists.

The GFD was confident that the keys to solving this problem were education and cooperation, and therefore, implemented a voluntary lead-reduction program within the condor range of Arizona. We approached local sportsmen's groups and asked for their help. To date, the Arizona Deer Association, Arizona Elk Society, Arizona Antelope Foundation, Arizona Desert Bighorn Sheep Society, and the Arizona chapter of the National Wild Turkey Federation all support voluntary lead-reduction actions by hunters within condor range. National organizations including the Boone and Crockett Club, Sporting Arms and Ammunition Manufacturer's Institute, National Shooting Sports Foundation, Wildlife Management Institute, and the International Hunter Education Association also support these efforts. Lead-reduction actions entail either using non-lead ammunition (see Figure 5) when hunting all game, or removing entire gut piles and game carcasses from the field, including varmints and small game.

The hunter education campaign the GFD launched in 2003 has expanded each year. Individual letters are sent out to each big-game hunter within condor range. A full page in the hunting regulations is devoted to the condor lead reduction message. Information is posted on the Department's condor web page. Educational brochures and DVDs are circulated to hunters. Media coverage of the issue is encouraged. The Department hosts educational booths at sportsman's expos and wildlife fairs. Presentations are given to hunting groups as well as the general public. Each year since 2005, more than 10,000 Arizonans have heard the message encouraging voluntary lead reduction.

Incentives Work

We all know that change is difficult. With that in mind, the Department decided to expedite sportsmen's transition to non-lead ammunition by providing it free to hunters within the core condor range. Since 2005, the Department has offered free non-lead ammunition to approximately 2,000 deer, sheep, pronghorn, and buffalo hunters each year. Hunters are eligible for either two free boxes of loaded cartridges or one box of bullets for reloading. Non-lead muzzleloader

Two condors soar over the Vermilion Cliffs in northern Arizona. Condor reintroduction efforts have been quite successful except for ongoing problems with lead poisoning. Biologists believe that with voluntary lead reduction actions by hunters, lead exposure in condors can be significantly reduced.

ammunition is also offered. The program costs approximately $100,000 annually and is funded by state lottery revenue and Indian gaming funds.

Before the free ammunition program began, the Department estimated that less than four percent of successful Kaibab deer hunters used non-lead ammunition. Thanks to the free ammunition program that number rose to 50 percent in 2005. By 2006, 60 percent of these hunters were either using non-lead ammunition or removing their gut piles from the field. In 2007, that number grew to over 80 percent! Although only 60 percent of the hunters used non-lead ammo in 2007, another 20 percent removed their gut piles from the field, thus accounting for the significant increase in voluntary compliance.

How did we convince 170 hunters to pack out their gut piles? A raffle, of course! Hunters using lead ammunition were asked to turn in their gut piles at the check station and in return were entered into a raffle for a $500 Cabela's gift certificate. Sometimes thinking outside the ammo box really does work.

More Challenges Ahead

Although the free non-lead ammunition program has been quite successful, there have been some significant obstacles along the way. The most notable is the lack of non-lead ammunition available to hunters. Because copper bullets are commercially loaded only in the most common rifle calibers, many hunters cannot obtain loaded cartridges for their rifles. In addition, the overall supply of loaded non-lead ammunition has been insufficient during all three years of the free ammunition program. For whatever reason, manufacturers and retailers cannot keep enough ammo on the shelves. In 2007 approximately 200 Arizona hunters who wanted to use non-lead ammunition could not obtain it anywhere. We've been working more closely with manufacturers and retailers to ensure that hunters can obtain non-lead ammo in 2008, but demand still seems to exceed supply.

Another obstacle has been the ability of hunters to identify non-lead rifle ammunition. I've heard many hunters say "I already use non-lead bullets" only to find out they don't realize that their copper-jacketed bullet has a lead core. Many other hunters attempt to buy non-lead ammo but have a difficult time recognizing it on store shelves. Most packaging does not clearly indicate if the bullet is lead-cored or all-copper. This year the Department has worked with retail partners Sportsman's Warehouse and Cabela's to help steer hunters in the right direction. Non-lead ammunition is clearly displayed at the end of the ammunition aisle in all Arizona Sportsman's Warehouse and Cabela's stores with a prominent sign educating hunters on the environmental benefits of this ammunition. One thing that has become clear is that hunters overwhelmingly like the all-copper expanding bullets. Results of our post-season questionnaires indicate that the copper bullets performed as well or better than lead-based bullets. This is not surprising; magazine articles were saying the same thing well before the issue of condor lead poisoning came up. Our tests show that all-copper bullets have good in-flight ballistics and accuracy; they mushroom well and show excellent penetration.

Even so, some people think an immediate lead ammunition ban in Arizona is the only way to solve this problem. For them I pose these questions: Do you think a ban that isn't fully supported by the hunting community and is very difficult to enforce will garner a higher compliance rate? What about the hunters who can't find non-lead ammunition due to the shortage and lack of available calibers? Wildlife managers learned many lessons from the ban on lead shot for waterfowl hunting. Shouldn't we incorporate these lessons into current lead-reduction efforts?

I wish this story had a happy ending, but unfortunately we haven't solved the condor lead exposure problem yet. Although no condors died of lead poisoning from the 2007 hunting season and blood-lead levels decreased, the majority of birds still tested positive for lead exposure last year. It seems that condors were still able to locate the 100 or so gut piles that did contain lead. Lead exposure from our neighboring state of Utah is also a significant factor. Each year more and more condors forage in Utah during the deer season, and several lead poisoning events have been linked to the Utah hunting season. So although an 80 percent voluntary compliance rate in Arizona is something the hunting community should be extremely proud of, until Utah also initiates lead reduction efforts, we won't know what level of voluntary compliance is needed to significantly reduce lead exposure in condors. Fortunately, Utah's Division of Wildlife Resources is working to implement a voluntary program similar to that in Arizona; however, funding is limited.

Here in Arizona we'll keep working with hunters, ammunition manufacturers, and retailers until we reach our goal of a self-sustaining condor population. Of course we can't accomplish this without the help of the state's hunter-conservationists. ■