

# Forensic Metal Detectors for Nontoxic Shot Enforcement in Migratory Waterfowl

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*Abstract:* The enforcement of the nontoxic shot regulation for migratory waterfowl has been a continuing problem for wildlife officers due to the problem of apprehending hunters with lead shot shells in their possession. The specialized forensic metal detector allows the wildlife officer to inspect the hunter's daily bag either in the blind or at his vehicle and to determine if the birds contain lead shot pellets, steel shot pellets, no shot pellets (neutral), or a combination of lead shot pellets and steel shot pellets. The forensic metal detector has made a definite difference in the compliance rate for nontoxic shot regulations.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 43:515-522

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The regulation requiring the use of nontoxic shot (NTS) for waterfowl hunting has generated more controversy, pro and con, and created more law enforcement problems for wildlife officers trying to enforce the regulation than any other regulation in recent times. Although not all wildlife officers are involved in the enforcement of migratory bird regulations due to their work area, those who do realize that the violator continues to develop ways to circumvent the NTS requirements. Tennessee's experience covers 2 time periods—1977-80 and 1986-present.

The 1977-80 experience with NTS was one of general opposition to NTS by waterfowl hunters for several reasons: 1) price of steel shot loads, which was higher than comparable lead loaded shotshells; 2) its limited production in sizes other than 12-gauge which resulted in its use being limited to only 12-gauge shotguns; 3) concern that its ballistic performance was inferior to lead; 4) concern that steel would damage shotguns (U.S. Dep. Int. 1988). Additional opposition occurred because some people doubted that lead poisoning caused major losses of waterfowl, and many believed that mandatory use of steel shot would result in crippling losses as large or larger than those caused by lead poisoning (U.S. Dep. Int. 1988).

The United States Fish and Wildlife Service (Service) used the "hotspot" approach to implement NTS requirements in Tennessee and other states during the 1977-80 period. Following a 3-year study of lead incidence in duck gizzards by the Tennessee Wildlife Resources Agency (TWRA) the NTS requirement was dropped

in Tennessee (TWRA, unpubl. data, Tenn. Wildl. Resour. Agency, Nashville 1978, 1979, 1980). Most waterfowl hunters in Tennessee felt that the NTS or "steel shot" issue would never be implemented again.

In 1985 the National Wildlife Federation (NWF) brought suit against the Department of the Interior (Department) in the United States District Court for the Eastern District of California to enjoin the Service from opening the waterfowl season in 22 counties in California unless NTS was required. On 26 August 1985, the court ruled in favor of the NWF (U.S. Dep. Int. 1988). Following this ruling a subsequent lawsuit was filed on 14 February 1986 by the NWF against the Department to impose a ban on all use of lead shot in waterfowl hunting beginning with the 1986 season (U.S. Dep. Int. 1988). A recommendation by the International Association of Fish and Wildlife Agencies resulted in the Service adopting a 5-year phaseout nationwide, by the 1991 season, of the use of lead shot for hunting waterfowl and coots.

The return of NTS to Tennessee in 1986 was received by most waterfowl hunters with the same response it received in 1976. The major difference was that more hunters were voicing opposition since all shotgun gauges were affected. Despite extensive information and education efforts which were combined with limited law enforcement, due to the Garcia decision and other hunting seasons in progress, NTS compliance was estimated to be at an all time low. The compliance rate for the 1987 season was estimated to be approximately 25%–33% by wildlife officers working the NTS counties.

A decision was made in May 1988 to purchase a metal detector designed for wildlife forensics which had the capability to differentiate between lead shot pellets and steel shot pellets. This specialized metal detector would be employed to enforce the NTS regulation during the 1988–89 waterfowl season.

## Methods

Benton County, Tennessee, is an area located in northwestern Tennessee bounded on the east by the Tennessee River and Kentucky Lake and on the northwest half by the Big Sandy River and Kentucky Lake. Part of Benton County is composed of 6 TWRA Wildlife Management Areas (WMA) comprising 18,302-ha, part of the Tennessee National Wildlife Refuge comprising 120,215-ha, and >241-km of shoreline. All of these areas are either managed or hunted extensively for waterfowl. In addition to being a prime waterfowl area and designated as a NTS area, Benton County was also selected for the following reasons:

- 1) hunters had been required to use NTS during the 1977–80 waterfowl seasons and the compliance rate had been low; 2) the compliance rate in 1987 was felt to be at an all time low (<35%) due to hunter opposition and restricted work schedules of wildlife officers; 3) the judicial system in the county is basically pro-wildlife oriented; 4) the wildlife officer assigned to the county is recognized both statewide and nationally as an expert in wildlife forensics and had prior training in the technique of detecting the difference in lead and steel shot pellets.

A Whites Electronics Professional Series Model 4900/D metal detector which had been specially factory modified by Geoquest, Inc. (H. Nicholas, unpubl. rep., Geoquest, Inc., Saddle Brook, N.J. 1988) to detect the differences in lead pellets and steel pellets was utilized in all testing. Control tests were conducted using ducks which had been seized during the previous waterfowl season following guidelines as established by Will (1987a). Pellet areas were located in each bird and each bird necropsied to determine if the pellets were lead or steel as indicated by the specialized metal detector. Additional control tests were performed by shooting control birds with known shot types and then examining the bird without the examiner knowing the type of shot pellet used.

A field-examination of the hunter's daily bag consisted of first performing a positive test using known control samples of lead shot pellets and steel shot pellets to ascertain that the unit was working. Waterfowl were first checked to see if they contained shot pellets and where they were located. Once a bird was found to contain shot the instrument was recalibrated to differentiate between lead and steel pellets. A positive and negative control was then conducted using the control samples of shot to again ascertain the unit was functioning properly. A second reading of the bird was made in the area(s) where shot pellets had been detected first to determine if the pellets were lead, steel, or both.

## Results

A total of 37 groups of waterfowl hunters consisting of 133 individuals were checked during the 1988–89 waterfowl season. The hunters had an aggregated bag limit of 190 ducks consisting of wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos platyrhynchos*), black duck (*A. rubripes*), American wigeon (*A. americana*), gadwall (*A. strepera*), green-winged teal (*A. crecca carolinensis*), redhead (*Aythya americana*), ring-necked duck (*A. collaris*), lesser scaup (*A. affinis*), common goldeneye (*Bucephala clangula americana*), 5 Canada geese (*Branta canadensis*), and 1 eastern fox squirrel (*Sciurus niger*). Table 1 summarizes the hunters checked and the incidence of lead and steel shot while Table 2 contains an area breakdown of lead and steel shot incidence, and Table 3 contains a species breakdown for the incidence of lead and steel shot.

## Discussion

The Whites Electronics Professional Series 4900/D as factory modified by Geoquest, Inc., for wildlife forensics has a unique place in wildlife law enforcement—especially in the enforcement of NTS regulations. Advantages include its relative small size (i.e., unit and hand wand) when compared to the traditional unit with boompole and 10-inch disk, and its mobility in the field since it can be used at a boat landing, in the boat, or in the hunter's blind. The unit is compact and can be placed in the officer's vehicle and continuously carried with him. One disadvantage of the unit, which seems to be inherent with most electrical devices operating on a

**Table 1.** Analysis of hunters and waterfowl checked for nontoxic shot compliance during the 1988-89 season from Benton County, Tennessee.

	<i>N</i>	Percent
Ducks	190	
Shot detected		
Lead	4	2.1
Steel	156	82.8
Neutral	16	8.4
Lead and steel	14	7.4
Hunting groups	37	
Possessing lead shot	6	16.2
Hunters	133	
Arrested for possessing lead shot	11	8.3
Possibly possessing lead shot	24	18.0

battery pack, is that long periods of exposure to cold will weaken the batteries and result in the unit not functioning properly. It is suggested that an extra battery pack be obtained so that an examiner can keep 1 pack inside his coat or shirt, allowing body heat to keep the batteries warm. If necessary, the examiner can switch the battery packs to insure proper functioning of the unit.

Although the testing procedure looks and appears simple, it is a technique which should not be attempted without prior familiarization and training with the testing unit and subsequent practice on known specimens. With proper training and accurate interpretation of the readings, the examiner should be able to determine if the birds contain shot pellets or not and if these pellets are lead only, steel only, or a combination of lead and steel pellets. An advantage of the specialized wildlife

**Table 2.** Analysis by area of hunters and waterfowl checked for nontoxic shot compliance during the 1988-89 season from Benton County, Tennessee.

	<i>Camden</i>		<i>Big Sandy</i>		<i>Danville<sup>a</sup></i>	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Ducks	77		103		10	
Shot detected						
Lead	0	—	3	2.9	1	10.0
Steel	64	83.1	89	86.4	3	30.0
Neutral	6	7.8	10	9.7	0	—
Lead and steel	7	9.1	3	2.9	4	40.0
Hunting groups	15		19		3	
Hunters	43		83		7	
Arrested for possessing lead shot	7	16.3	2	2.4	2	28.6
Possibly possessing lead shot	16	37.2	5	6.0	3	42.9

<sup>a</sup>Five geese were checked and all were positive for steel.

**Table 3.** Analysis by species of waterfowl checked for nontoxic shot and pellet retention during the 1988–89 season from Benton County, Tennessee.

Species (N = 10)	Total (N = 195)		Incidence of detected shot							
			Lead (N = 4)		Steel (N = 161)		Neutral (N = 16)		Lead and Steel (N = 12)	
	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
Mallard	56	29.5	1	1.8	46	82.1	4	7.1	5	8.9
Black duck	11	5.8	0		8	72.7	1	9.0	2	18.2
American wigeon	10	5.3	0		5	50.0	2	20.0	3	30.0
Gadwall	12	6.3	0		11	91.7	1	8.3	0	
Wood duck	42	22.1	0		39	92.9	3	7.1	0	
Lesser scaup	39	20.5	3	7.7	28	71.8	5	12.8	3	7.7
Ring-necked duck	10	5.2	0		10	100.0	0	0	0	
Redhead	3	1.6	0		2	66.7	0	0	1	33.3
Goldeneye	2	1.1	0		2	100.0	0	0	0	
Green-winged teal	5	2.6	0		5	100.0	0	0	0	
Canada goose	5	2.6	0		5	100.0	0	0	0	

forensic metal detector is that if 1 lead pellet and 1 steel pellet are in close proximity (<30mm), the metal detector will give the advantage to the steel pellet and identify both pellets as steel. The identification of a lead pellet as a steel pellet when in close proximity to a steel pellet is due to the internal sensitivity of the unit following modification by Geoquest, Inc. (H. Nicholas, pers. commun.). Since the sensitivity is weighted to steel as opposed to lead, a false negative for lead shot results and is to the hunter's advantage.

Through testing and experience it was found that the examiner should hold each bird in the same hand. The hand holding the bird should be metal free (i.e., no rings or watches or metal pins inserted in bones). One control sample of lead pellets and 1 control sample of steel pellets should be utilized before and during the examination of each bird. The use of positive-negative controls following recalibration of the unit to differentiate between lead and steel pellets is especially critical to insure the unit is recalibrated correctly at the time the suspect bird is checked.

Four years of experience enforcing the NTS regulation prior to the 1988–89 waterfowl season indicated a change in the methods violators used to evade compliance with NTS regulations. 1977–80 violators would be in possession of full boxes of lead shotshells and attempt to hide them among their possessions. Over the years lead shotshells have been found in military ammunition boxes, in boxes marked steel shotshells, in hip boots and chest waders, purses, false bottoms in boats and duck blinds, and every other imaginable place. The current trend is to take only 9–12 lead shotshells to the blind which are then utilized or thrown in the water when an officer approaches. Reduced waterfowl populations and daily bag limits have eliminated the need for full boxes of lead shotshells. Also, the cost to the hunter is reduced if only a few shells are thrown over the side as opposed to a full box. The specialized forensic metal detector gives the officer the advantage of being able to

detect the spent lead pellets in the violator's birds even if he has thrown his shells in the water or exhausted his supply of lead shotshells.

Although many hunters had learned that TWRA officers had a technique to detect whether a duck or goose had been shot with lead pellets or steel pellets, it was not until opening day of the waterfowl season they learned the full potential of the technique. The first hunter checked had 3 lesser scaup which all tested positive for only lead shot pellets. The hunter possessed only steel shotshells. When confronted with the evidence the hunter admitted using lead shotshells.

An examination of test birds and hunters' birds showed that 4 possible situations could be expected: 1) lead shot pellets only, 2) steel shot pellets only, 3) no pellets (neutral), 4) both lead and steel pellets present. Birds identified as neutral were considered to have been shot with steel pellets since steel pellets will often pass completely through a bird. Birds classified as neutral are to the hunter's favor. Take, for example, a group of 3 hunters being checked at the conclusion of their hunt. The hunters each have a limit of 3 ducks; however, 9 ducks are piled on the front of the boat. Based on the 4 possible findings, the following situations were expected to be encountered and the action to be taken in each case was planned. 1) All birds test positive for steel pellets, neutral, or a combination of both. The hunters are free to leave. 2) Some birds test positive for steel pellets and some test positive for both lead and steel pellets in the same birds. The combination of lead and steel pellets in the same bird gives the officer probable cause to do a more thorough search. Depending on the location of the lead and steel pellets, a necropsy of the bird may reveal which pellets were fatal. The necropsy may show that death was instantaneous and refute the hunter's claim that the bird was shot 300–400 meters away at another blind and flew to his blind.

3) Three of the 9 birds test positive for lead pellets only; 1 bird tests positive for both lead and steel pellets and the other 5 birds test positive for only steel pellets. When questioned one of the hunters admits to using lead shotshells and is charged.

4) The same circumstances as situation 3; however, none of the hunters admit using lead shotshells. In this situation, since the hunters have failed to maintain separate bags, the hunters are asked to claim their ducks. If 1 hunter claims the birds possessing only lead shot he is charged. The usual situation (Will 1987*b*), although not observed in Tennessee this year, is that the hunters will claim they do not know which birds are theirs, therefore, all 3 hunters are charged with failure to maintain a separate bag as required by federal and state regulations.

Widespread newspaper and radio coverage following the opening weekend of the waterfowl season, in addition to hunters actually checked, resulted in most hunters being aware that their birds could and would be examined to determine what they had been shot with: lead or steel pellets. Out of 133 hunters checked (Table 1) only 11 (8.3%) were in possession of lead shot. Based on the number of birds checked which contained both lead and steel pellets it was estimated that an additional 13 (9.8%) hunters could have been using lead shotshells for a total of 24 (18.0%) hunters possibly using lead shotshells. This is a dramatic improvement from the year before when an estimated 70%–75% of the hunters were not using NTS.

A breakdown of the areas checked (Table 2) allows the local officer to concentrate his work effort on those areas which have a high percentage of hunters using, or possibly using, lead shotshells based on an examination of birds which contain both lead and steel pellets. A breakdown by species (Table 3) indicates that an equal number of ducks when compared by body size (i.e., large v. small) tested neutral. Will (1987*b*) reported 36.8% of large ducks testing neutral compared to 63.2% of small ducks testing neutral. Ninety-one and six tenths percent of the ducks examined (Table 3) and 100% of the geese examined retained shot pellets. Will (1987*b*) reported 73.0% of the ducks in Illinois retaining shot pellets.

### **Sample of Actual Cases**

#### **Case 1**

Three hunters returned to the landing at the conclusion of their hunt, and one of the hunters was observed hiding something in the boat. Two ducks were checked with the specialized forensic metal detector and tested positive for steel shot. The boat was searched in the area where something had been hidden and an eastern fox squirrel was found. The season was closed on all wildlife except waterfowl on this area. An examination of the squirrel was performed and lead pellets were detected. A necropsy of the squirrel revealed that it had been shot with a copper-coated lead shot. Based on this evidence the hunter's possessions were searched and several copper-coated lead shotshells were found.

#### **Case 2**

Four hunters were checked at the conclusion of their hunt while exiting the WMA. Five ducks were checked; 3 birds contained only steel pellets and 2 birds contained both lead and steel pellets. Based on experience with the metal detector, it was estimated that 1 bird contained approximately 50% lead pellets and 50% steel pellets. The other bird contained approximately 75% lead pellets and 25% steel pellets. The 4 hunters and their bags were searched, but only steel shotshells were found. A search of the hunters' boat revealed 1 lead shotshell in a metal ammunition box and 2 lead shotshells hidden under the floor of the boat. An inspection of the duck blind revealed numerous spent lead shotshell hulls which had been freshly fired. One hunter subsequently claimed the metal ammunition box and was charged, tried, and convicted. Based on the above facts the court ruled that there was more than probable cause to believe the other 3 hunters were in possession of lead shotshells while hunting migratory waterfowl. The court ordered that the other 3 hunters also be charged. The other 3 hunters were charged and subsequently tried and convicted.

### **Conclusions**

The use of specialized metal detectors for wildlife forensics in the enforcement of nontoxic shot regulations is a valid tool which has been accepted by the court

system. The device is small enough that the officer can easily carry it with him in the field or even take it to court. If both lead and steel pellets are found in the bird the officer can use this as probable cause to conduct a more thorough search of the hunter's possessions. Finally, the specialized metal detector will read in favor of the hunter classifying both pellets as steel if lead and steel pellets are in close proximity to each other. If both lead and steel pellets are located in the bird, the officer may be able to determine which pellets are fatal or that there is probable cause to seize the bird and let a wildlife forensic pathologist determine which pellets caused death.

The specialized metal detector for wildlife forensics is no better than the examiner operating the unit. Anyone considering the use of this instrument must remember that proper training, practice on known subjects, and record keeping on the number of tests conducted and their results are required to establish expertise in court. If the examiner has any question or reservation about his test results, the hunter should be given the doubt.

There may be other specialized metal detectors, in addition to the one used in this test, which are capable of detecting shot pellets as small as number 7.5 in waterfowl and telling the examiner whether the pellet is lead or steel. This author does not claim that the specialized metal detector sold by Geoquest, Inc. for wildlife forensic purposes is the only one available; however, it is the only one which has been brought to my attention. The unit is currently being used in Illinois, Kansas, New Jersey, Tennessee, and Canadian wildlife departments.

### Literature Cited

- U.S. Department of the Interior. 1988. A synopsis of the nontoxic shot issue. Pages 317-319 in Final supplemental environmental impact statement: issuance of annual regulations permitting the sport hunting of migratory birds. U.S. Dep. Int., Fish and Wildl. Serv., U.S. Gov. Printing Off., Washington, D.C. 340pp.
- Will, John. 1987a. Metal detector. Detecting lead and steel shot in waterfowl. Ill. Dep. Conserv., Springfield, Ill. April. 2pp.
- . 1987b. Metal detector. Detecting lead and steel shot in waterfowl. Ill. Dep. Conserv., Springfield, Ill. December. 3pp.