

STATE OF MICHIGAN  
DEPARTMENT OF NATURAL RESOURCES  
WILDLIFE DIVISION  
LANSING, MICHIGAN 48909

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LEAD-STEEL SHOT  
PROGRESS REPORT  
MICHIGAN INGESTION STUDY  
(1976, 1977 & 1978)

by

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(Based on 1976-1977 Report No. 2809 by  
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Each hunting season approximately 3,000 tons of lead shot pellets are deposited in the waters, marshes and lands hunted by the 2,000,000 U. S. waterfowl hunters. The deposition of lead, a heavy metal and an environmental contaminant, has been poisoning from 2-3 million ducks and other waterfowl each year.

Lead poisoning in waterfowl has been recognized for more than a century. Research to find ways to reduce or eliminate the problem was initiated in the late 1930's. Much of the research has focused on finding an acceptable nontoxic substitute for lead. It was not until the late 1960's that an all out effort was made to find a suitable nontoxic substitute for lead. Extensive research and field testing showed that soft steel shot was nontoxic to waterfowl and met the minimum standards for hunting efficiency. To this date, steel shot is the only suitable nontoxic substitute for lead that is widely available to waterfowl hunters. Should other nontoxic materials be developed that meet established shotshell standards, such material(s) will be authorized for use in addition to or as a substitute for steel shot.

A timetable for conversion to nontoxic shot was set into motion in the Atlantic Flyway during the 1976 season. In 1977 and 1978, steel shot was required within the Mississippi Flyway. Steel shot was required in five high harvest areas of Michigan during the 1977 and 1978 waterfowl hunting seasons. Additional areas will be included in 1979 regulations based on analysis of harvest data in relationship to U.S. Fish and Wildlife Service guidelines and as additional supplies of the nontoxic shotshells become available. As part of the planning process to provide background data for decision-making to implement the nontoxic shot program, we needed information on the level of lead shot contamination in the environment and in the birds prior to requiring hunters to use steel shot in Michigan.

The technique of examining gizzards for ingested shot is an acceptable and widely used technique for securing the required information. Utilizing the gizzards of birds harvested by hunters is a good method for sampling the entire state and at the same time assures sample randomness.

A gizzard analysis study was initiated in Michigan during the 1976 waterfowl hunting season and projected to extend through the 1977 and 1978 hunting seasons. Our major objective was to determine the level of lead shot being ingested by waterfowl in Michigan, and to determine the rate at which lead shot becomes unavailable to the birds in areas where nontoxic steel shot is used. During the 1976, 1977 and 1978 seasons, Department biologists collected waterfowl gizzards from hunter-killed birds taken throughout the state. Other waterfowl hunters volunteered or were asked to save gizzards from the birds they harvested, along with a fully feathered wing from each bird. Plastic bags and data sheets were supplied to store the gizzards and to record pertinent data.

After the close of the season in 1976 and 1977, DNR personnel held a series of public workshops with duck hunter groups to examine the gizzards for ingested lead shot pellets. In 1978, some of these workshops were held, however, most of the collected gizzards were examined during the season by Department personnel to speed up the analysis process.

### Preliminary Results

#### 1976

A total of 4,965 waterfowl gizzards were collected and examined (Table 1). This sample was 1.0 percent of the statewide waterfowl harvest. Of the total, 80.6 percent were dabbling ducks, 10.7 percent diving ducks, 8.5 percent geese and 0.2 percent other. The sample was collected in 35 counties of the state. Of the sample, 7.5 percent were collected in the Upper Peninsula, 13.8 percent in the northern half of the Lower Peninsula and the remainder (21.3 percent) in the southern third of the state.

Ingested lead shot was found in 7.7 percent of all the gizzards examined in 1976. In the Upper Peninsula sample, lead shot was found in 7.8 percent of the gizzards (Table 2). In the northern half of the Lower Peninsula, it was 7.6 percent and 7.7 percent for the southern half of the Lower Peninsula.

Table 3 lists the percentage of shot ingestion by the various species of waterfowl. Greater scaup had the highest rate of ingestion (18.5 percent) followed by ringneck with 14.4 percent, lesser scaup with 12.1 percent, black ducks with 12.0 percent, mallard with 9.3 percent and Canada geese 5.0 percent.

Ingestion rates reported by Bellrose for 1938-1954 suggest that Michigan's data are similar to those of the Mississippi Flyway and the United States (Table 3). Our data reinforced Bellrose's thesis that the level of ingestion increases as the season progresses. This occurred in all areas except for Roscommon County. There a high level was noted for birds collected at the beginning of the season. This may be due to bottom soil conditions and residual supplies of lead shot.

### 1977

Steel shot was required for the first time within Michigan on five specified areas during the 1977 hunting season. These five areas account for approximately 40 percent of the harvest and as much as one-half of the total hunting effort. During the season, a total of 4,773 gizzards were collected (Table 1). Of this total, 73 percent were dabbling ducks, 10.3 percent diving ducks, 16.1 percent geese and 0.6 percent other waterfowl. Our sample of gizzards were collected in at least 25 counties, compared with 35 in 1976. Of the total, 79.5 percent were collected in the southern half of the Lower Peninsula, 13.3 percent in the northern half of the Lower Peninsula and 7.2 percent in the Upper Peninsula (Table 2).

The rate of shot ingestion in 1977 was somewhat lower for most species than in 1976, except for ringnecks, black ducks, lesser scaup and Canada geese (Table 3). The differences in rates of ingested shot may be due to the marked decrease in hunting effort and harvest in 1977 as compared to 1976. The USFWS harvest data indicates that Michigan had a 46 percent decrease in waterfowl harvest, 24 percent decline in hunting effort and a 15 percent decline in hunter numbers between the two years. Michigan's state waterfowl stamp sales indicate a decline in waterfowl hunter numbers similar to what the federal report shows. Another factor responsible for the lower harvest was the delayed migration caused by the extremely mild weather across much of the northern portion of North America throughout October and early November.

Of the number of birds examined with ingested shot in 1977, 51 percent had steel shot and 49 percent lead (Table 4). All species except ringnecks had more steel shot than lead. The highest percentage of steel shot was found in gizzards of waterfowl taken on managed waterfowl areas subjected to high hunting pressure.

### 1978

Steel shot was required on the same five specified areas within Michigan during the 1978 hunting season (as in 1977). These five areas account for approximately 40 percent of the harvest and as much as one-half of the total hunting effort. During the season, a total of 3,909 gizzards were collected (Table 1). Of this total, 68 percent were dabbling ducks, 5 percent diving ducks, 26 percent geese and 1 percent other waterfowl. Our sample of gizzards was collected in 16 counties, compared with 35 in 1976 and 25 in 1977. Of the total, 62 percent was collected in the southern half of the Lower Peninsula, 19 percent in the northern half of the Lower Peninsula and 19 percent in the Upper Peninsula (Table 2).

Ingested shot (lead and steel) was found in 6.2 percent of the birds examined. This compares with 6.5 percent in 1977 and 7.7 percent in 1976. The rate of ingested shot was 4.3 percent for the Upper Peninsula, 8.0 percent for the northern half of the Lower Peninsula and 5.9 percent for the southern half of the Lower Peninsula. At the writing of this

report, survey data for the state was not available so a direct comparison in hunting effort, total harvest, etc. cannot be made with the 1976 and 1977 seasons.

Of the 243 birds with ingested shot in 1978, 53.9 percent had steel shot and 49.4 percent had lead (Table 4). The percentages exceed 100 since 10 of the birds had both lead and steel shot in the gizzard.

## Appendix 1

### Procedures for Gathering and Analyzing Gizzard Data Used in Michigan during the 1976, 1977 & 1978 Waterfowl Season

Data collection within Michigan was divided into two parts. The first approach was to request that hunters save gizzards from the birds they harvested and the other was to have biologists collect data during field bag checks.

We worked through Michigan's statewide waterfowl hunters organization where their members saved gizzards from ducks and geese they harvested. The DNR supplied instructional sheets and plastic bags and numbered cards to the hunters. The instructional sheet asked that the hunter remove the gizzard and one fully feathered wing from the bird. He then recorded certain data on a 3" by 5" card and then placed the completed card along with the gizzard in a small plastic bag and then placed the bag and its contents in a larger plastic bag along with the wing. The bag was to be sealed and then placed in a freezer. At the end of the season Department personnel collected the specimens from the hunters.

Gizzards collected by Department biologists were in conjunction with field bag checks throughout the state. We tried to sample birds taken throughout the season. Data on species, sex and age were recorded and each specimen collected was given a specimen number that was enclosed in the plastic bag in which the gizzard was placed, and the same number was recorded on the appropriate line of the data sheet.

After the close of the hunting season the Department held a number of public gizzard analysis sessions throughout the state. Hunters and others representing the public were invited to assist our biologists in examining the gizzards. Gizzards were thawed prior to each meeting. Each gizzard was examined both externally and internally for ingested shot and "shot in" pellets. In 1978, most of the gizzards collected were processed immediately, however, some were saved for analysis at public meetings.

The contents were placed in a small wire mesh sieve and then all loose plant or animal material was floated off in a pan of water. The remaining contents were then put into water in a shallow white enameled pan, and the remaining material carefully examined for shot. A magnet was also used to determine if any material was steel or lead. No chemical analysis of the gizzard lining or contents was made to determine if extremely small particles of lead were present. Our data should be considered to be minimum because we did not test chemically for lead residues or examine with x-ray or fluoroscope.

Table 1.

Sample Size and Percent of Waterfowl with Ingested Shot  
Taken by Michigan Waterfowl Hunters  
During 1976, 1977 and 1978 Hunting Seasons

Species	No. of Birds Examined			% of Birds with Ingested Shot		
	1976	1977	1978	1976	1977	1978
Dabbling Ducks	4,003	3,486	2,674	7.6	6.6	6.6
Diving Ducks	492	494	181	11.0	9.7	14.4
Geese	424	769	1,002	5.0	4.3	3.2
Mergansers	20	23	13	-	-	-
Coots	5	1	39	40.0	-	5.1
Swans	1	-	-	-	-	-
Unknown	20	-	-	10.0	-	-
Total Number of Birds	4,965	4,773	3,909			
Average % of Birds with Ingested Shot				7.7	6.5	6.2

Table 2.

Lead-Steel Shot Ingestion Rates for Waterfowl  
Examined During 1976, 1977 and 1978 Hunting Season in Michigan

County	No. of Birds in Sample			No. of Birds With Ingested Shot			% of Birds with Ingested Shot					
	1976	1977	1978	1976	1977	1978	1976		1977		1978	
				Lead	Steel	Total	Lead	Steel	Lead	Steel	Lead	Total
<b>Region I</b>												
Alger	1	6	-	17	11	1	11.6	1.8	4.9	2.4	-	-
Chippewa	149	162	42	2	1	2	2.9	-	2.8	6.7	2.4	2.4
Delta	69	36	29	4	2	2	8.3	-	3.4	2.8	-	6.9
Houghton	48	51	44	2	1	-	4.0	-	2.3	3.4	-	4.5
Marquette	50	43	-	1	-	-	5.6	-	-	2.3	-	-
Iron	18	-	-	1	-	-	-	-	-	-	-	-
Mackinac	20	-	-	1	-	-	-	-	-	-	-	-
Menominee	18	45	-	3	8	-	16.7	-	16.7	17.8	-	-
Schoolcraft	-	3	-	-	1	-	-	-	33.3	33.3	-	-
<b>Subtotal</b>	<b>373</b>	<b>346</b>	<b>115</b>	<b>27</b>	<b>24</b>	<b>5</b>	<b>7.8</b>		<b>6.9</b>	<b>6.9</b>		<b>4.3</b>
<b>Region II</b>												
Alpena	98	1	-	13	-	-	13.3	-	2.0	3.7	2.0	3.9
Bay	370	493	587	12	29	23	3.0	3.9	2.0	5.9	-	-
Benzie	-	14	-	-	-	-	-	-	-	-	-	-
Cheboygan	28	-	-	2	-	-	7.0	-	-	-	-	-
Clare	-	-	4	-	-	-	-	-	-	-	-	-
Isabella	-	2	-	-	-	-	-	-	-	-	-	-
Missaukee	73	-	-	10	-	-	13.7	-	-	-	-	-
Osceola	8	-	-	1	-	-	12.5	-	-	-	-	-
Oscoda	-	8	-	-	-	-	-	-	-	-	-	-
Roscommon	111	117	88	14	15	21	12.6	1.7	11.1	12.8	2.3	21.6
<b>Subtotal</b>	<b>688</b>	<b>634</b>	<b>679</b>	<b>52</b>	<b>44</b>	<b>54</b>	<b>7.6</b>		<b>6.9</b>	<b>6.9</b>		<b>8.0</b>

Table 2. Continued

County	No. of Birds in Sample			No. of Birds With Ingested Shot			% of Birds With Ingested Shot						
	1976	1977	1978	1976	1977	1978	1976		1977		1978		
				Lead	Steel	Total	Lead	Steel	Lead	Steel	Lead	Steel	Total
Region III													
Allegan	630	884	974	25	30	34	4.0	1.2	0.5	3.4	1.4	2.1	3.4
Barry	26	-	-	2	-	-	7.7	-	-	-	-	-	-
Clinton	3	-	3	-	-	-	-	-	-	-	-	-	-
Gratiot	89	93	64	2	4	3	2.2	3.2	1.1	4.3	-	4.7	4.7
Huron	204	336	-	12	15	-	5.8	3.0	0.6	3.6	-	-	-
Ingham	-	-	3	-	-	-	-	-	-	-	-	-	-
Ionia	3	-	-	2	-	-	66.6	-	-	-	-	-	-
Jackson	-	30	8	-	2	1	-	3.3	3.3	6.6	-	-	-
Kalamazoo	137	26	-	11	-	-	8.0	-	-	-	-	12.5	12.5
Muskegon	60	-	40	1	-	2	1.7	-	-	-	-	5.0	5.0
Kent	15	-	-	1	-	-	-	-	-	-	-	-	-
Livingston	8	14	-	-	3	-	-	-	21.4	21.4	-	-	-
Montcalm	6	-	-	-	-	-	-	-	-	-	-	-	-
Monroe	-	23	-	-	2	-	-	-	8.7	8.7	-	-	-
Oakland	3	12	-	-	1	-	-	-	-	-	-	-	-
Ottawa	3	41	-	-	1	-	-	8.3	-	8.3	-	-	-
Saginaw	838	893	831	-	59	67	10.7	4.3	2.4	2.4	-	-	-
St. Clair	914	679	726	61	59	48	6.6	5.7	3.0	6.6	6.4	2.0	8.0
(Macomb)	-	-	-	-	-	-	-	-	-	8.7	3.0	4.1	6.6
St. Joseph	5	-	-	-	-	-	-	-	-	-	-	-	-
Tuscola	849	607	396	94	46	26	11.1	5.0	2.3	7.3	2.3	4.8	6.6
Washtenaw	69	27	70	-	2	3	-	-	7.4	7.4	1.4	2.9	4.3
Unknown Co.	42	128	-	4	19	-	9.5	-	-	14.8	-	-	-
Subtotal	3,904	3,797	3,115	304	244	184	7.8	-	-	6.4	-	-	5.9
STATEWIDE TOTAL	4,965	4,773	3,909	383	311	243	7.7	-	-	6.5	-	-	6.2

Table 3.

Shot Ingestion Rates for Waterfowl Species Examined  
During 1976, 1977 and 1978 Hunting Seasons in Michigan  
and Compared with 1938-54 Data

	% of Birds With Ingested Shot			1938-1954 Frank Bellrose Data	
	1976	1977	1978	Miss. Flyway	U.S.
				% Ing. Shot	% Ing. Shot
Mallard	9.3	7.8	8.2	8.4	6.8
Black duck	12.0	12.3	5.9	21.0	8.3
Baldpate	2.3	2.6	3.2	1.4	3.1
Wood duck	3.9	2.0	5.3	-	1.6
Redhead	6.1	6.2	22.2	14.1	13.6
Ringneck	14.4	19.0	20.9	17.0	14.1
Lesser scaup	12.1	1.3	7.7	14.9	13.0
Greater scaup	18.5	14.3	25.0	No data	No data
Canada goose	5.0	4.3	3.0	No data	9.8
All ducks except mergansers	8.4	7.0	6.2	8.6	6.7
All waterfowl	7.7	6.5	6.2	-	6.5

Table 4.

Proportions of Gizzards with Ingested Shot Containing Lead or Steel  
(Samples obtained from the 1977 and 1978 Michigan Hunting Seasons)

Species	% of Gizzards Containing Ingested Shot <sup>1</sup>			
	1977		1978	
	Steel	Lead	Steel	Lead
Mallard	58	42	61	42
Black duck	49	51	55	55
Baldpate	50	50	100	-
Wood duck	67	33	33	67
Redhead	-	100	-	100
Ringneck	-	100	17	83
Lesser scaup	50	50	-	100
Greater scaup	50	50	-	100
Canada goose	73	27	60	47
All ducks except mergansers	52	48	54	49
All waterfowl	51	49	54	49

<sup>1</sup>Some gizzards contained both lead and steel shot so percentages total more than 100 in some cases.