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SPENT SHOT INGESTION BY MOURNING DOVES IN INDIANA

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ABSTRACT: Lead toxicity from ingestion of lead shotgun pellets is a potentially serious mortality factor in certain game birds, including mourning doves (*Zenaida macroura*). To evaluate exposure rates, gizzards were examined by radiography from 3,386 mourning doves collected during the 1987 hunting season in Indiana. Of the 153 ingested shotgun pellets found, 11% were steel, coming from 8% of the gizzards containing shot. The overall ingestion rate was 2.5%, and doves from areas specifically managed for doves had similar ingestion rates compared to those taken from unmanaged areas. Ingestion rates among sex and age classes ranged from 1.0% to 3.1% and were not significantly different, except for a greater incidence (4.6%) in younger, immature doves. Although mourning doves have been legally hunted in Indiana only since 1984, ingestion rates were greater than those reported from 3 of 4 studies in states where dove hunting has a long history.

INTRODUCTION

Lead toxicity from ingestion of spent shot is well documented in waterfowl (see Sanderson and Bellrose, 1986). Ingestion of lead shot also had deleterious effects in captive mourning doves (Locke and Bagley, 1967; McConnell, 1968; Buerger, *et al.*, 1986), but impacts on wild populations are unknown. Ingestion rates of lead shot by mourning doves have been the focus of few studies, primarily in the southeastern United States: Maryland (Locke and Bagley, 1967), Alabama (Buerger, *et al.*, 1983), Tennessee (Lewis and Legler, 1968), and Maryland, Virginia, North Carolina, and South Carolina (Kendall and Scanlon, 1979). The rate at which lead shot is ingested by mourning doves needs to be established throughout their range. The purpose of this study was to determine shot ingestion rates of doves in Indiana and to examine factors that influence ingestion rates.

METHODS

Mourning dove gizzards were solicited from natural resources personnel throughout Indiana. Area managers collected the gizzard and 1 wing of each dove from hunters. The location, date, and sex (determined by inspection of the gonads) were noted for each dove. Age (adult, immature, or unknown) was determined by examination of the pattern of molt of primaries and primary coverts (Reeves, *et al.*, 1968).

Doves were collected from the beginning of the 1987 hunting season (1 September) through 29 October. Gizzards were obtained from 26 areas throughout

Table 1. Ingestion rates of spent shot on managed and unmanaged areas of Indiana, fall 1987. Only those areas from which > 50 gizzards were examined are listed individually.

Area	n	Ingestion rate (%)
Managed	2,752	2.5
Atterbury	125	1.6
Crosley	119	3.4
Forest Wildlife	281	1.8
Glendale	272	1.1
Hovey Lake	163	3.7
Jasper-Pulaski	298	2.3
Kingsbury	139	2.2
LaSalle	223	1.8
Minnehaha	170	3.5
Pigeon River	161	3.1
Tri-County	64	1.6
Wilbur Wright	199	2.0
Willow Slough	156	1.3
Winamac	275	3.6
Other (4) [a]	107	5.6
Unmanaged	634	2.4
Daviess Co.	252	3.2
Lawrence Co.	67	1.5
Merom	74	1.4
Orange Co.	139	0.7
Other (4) [a]	102	3.9

[a] Number of areas combined.

Indiana, 18 classified as managed and 8 as unmanaged. Managed areas were planted to specific crops and mowed or disced with the intention of luring doves. Crops most often planted included sunflower, millet, and corn. Densities of spent shot in the soil of 14 fields (not necessarily the same fields from which doves were collected) before the start of the hunting season averaged 3,200 shot/ha and ranged from 0 shot/ha to 8,600 shot/ha (Castrale, 1989). Mean shot densities in these same fields increased to 27,800 shot/ha (range = 2,200 shot/ha to 84,000 shot/ha) after the hunting season. Unmanaged areas were primarily pastures or crop fields (corn, sunflower) that were commercially harvested for grain or silage. Gizzards or gizzard contents were X-rayed with a Faxitron X-ray machine at 65 kvp and 15 sec to 30 sec exposure. Gizzards suspected of containing shot pellets were examined by dissection to determine if shot was present, and, if so, whether it was ingested. When shot was found in gizzard contents, gizzards were examined for holes that would indicate that the pellets had been shot in rather than being ingested. Magnetic and softness properties of shot were used to determine if pellets were steel or lead.

Rates of ingestion among doves differing in age, sex, time period within the hunting season, and managed or unmanaged areas were tested using Chi-square analysis. Categorical data analysis with a log-linear model (3 X 3 X 2 X 2 factorial) was performed with the CATMOD procedure (SAS Institute, Inc., 1988), which tested for

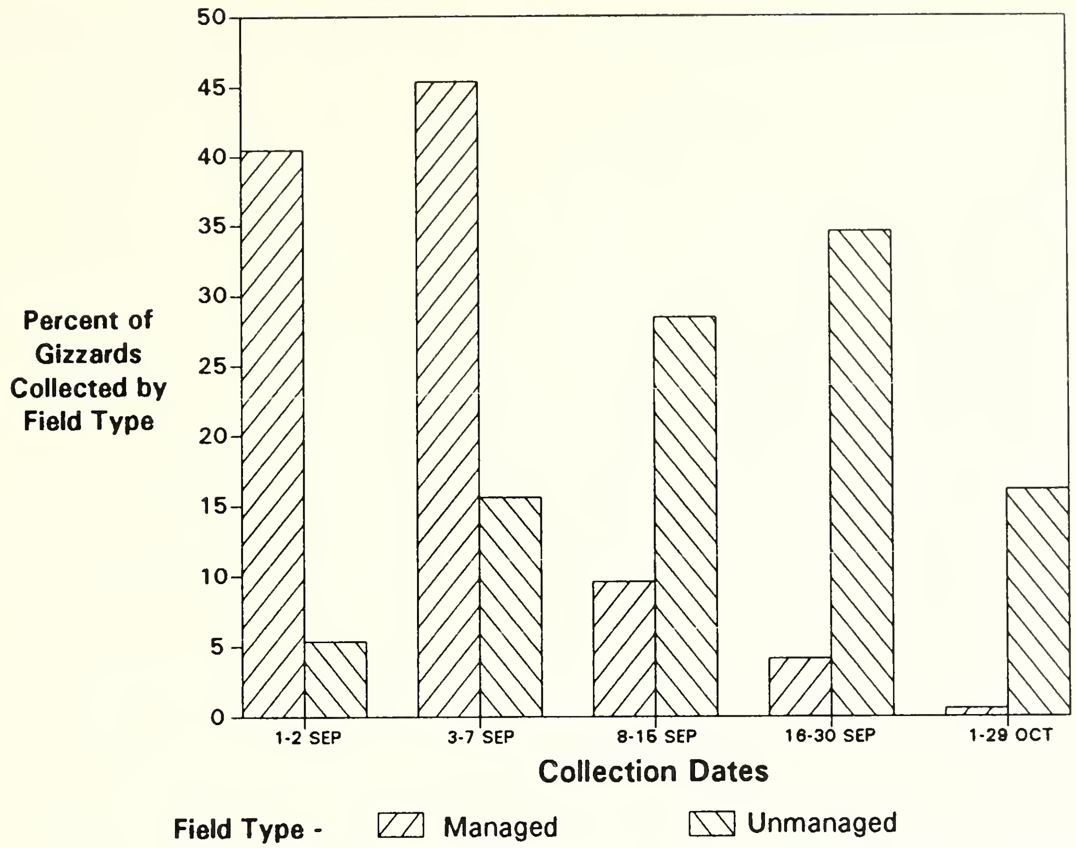

Figure 1. Temporal distribution of mourning dove gizzards collected for analysis of spent shot on managed and unmanaged areas in Indiana in 1987.

significant differences among main effects and their interactions. All 36 combinations of levels had some observations, but those in which the expected values were zero were given an ingestion rate equivalent to 0.1%.

RESULTS

Of 3,386 gizzards examined, 83 (2.5%) contained 153 ingested shot pellets, of which 89% were made of lead. Lead pellets were present in 92% of the gizzards with pellets. Gizzards containing both lead and steel shot were not encountered. Numbers of pellets in gizzards with ingested shot ranged from 1 to 16 and averaged 1.8 pellets. Single pellets were found in 72% of these gizzards, while 6% had more than 5 pellets.

Only 1 area (Hovey Lake) required steel shot for dove hunting. Three of 6 gizzards with shot collected here contained steel shot (13 pellets total), and 3 contained single pieces of lead. Single steel pellets were encounter in gizzards from 4 other areas.

X-raying gizzards prior to examination of contents was superior to direct examination of gizzard contents, as it required less time and was more accurate. Probable lead or steel pellets could be distinguished from grit and seeds by X-ray.

There were few significant differences ($P > 0.05$) in ingestion rates among factors as discussed below.

Area differences. The overall ingestion rate was 2.5% in doves from managed areas (n = 2,752) and ranged from 1.1% to 3.7% (Table 1). Unmanaged areas (n = 634) had an overall ingestion rate of 2.4% with individual areas ranging from 0.7% to 3.2%. Differences in ingestion rates between managed and unmanaged areas were not significant ($chi^2 = 0.02$, 1 df, $P = 0.88$). Gizzards from unmanaged areas were collected later in the hunting season than those from managed areas (Fig. 1).

Sex and age differences. Ingestion rates did not differ among age and sex classes ($chi^2 = 6.41$, 3 df, $P = 0.09$). Rates were 3.1% (n = 921) for immature males, 2.1% (n = 703) for immature females, 1.9% (n = 572) for adult males, and 1.0% (n = 397) for adult females. Overall, males exhibited an ingestion rate of 2.8% (n = 1,600), not significantly different ($chi^2 = 2.59$, 1 df, $P = 0.11$) from that for females (1.8%, n = 1,208). Adults had an ingestion rate of 1.8% (n = 1,191) compared to 2.7% (n = 1,942) for immatures ($chi^2 = 2.46$, 1 df, $P = 0.12$). Among immatures, younger doves (primary feather being replaced number < 4) had a significantly greater ($chi^2 = 11.87$, 1 df, $P < 0.001$) ingestion rate (4.6%, n = 637) than older immatures (1.8%, n = 1,305).

Temporal differences. Ingestion rates increased on managed areas during the latter part of the hunting season (Fig. 2). Before 8 September, the ingestion rate was 2.2% (n = 2,365) and increased significantly ($chi^2 = 5.17$, 1 df, $P = 0.02$) to 4.1% (n = 387) afterwards. This increased prevalence of shot likely resulted from greater availability of shot later in the year. However, this trend was not evident for unmanaged areas, which had relatively constant ingestion rates during both time periods (Fig. 2; $chi^2 = 1.41$, 1 df, $P = 0.23$). During 1-7 September, the ingestion rate was 3.8% (n = 133), while later it was 3.0% (n = 501). However, sample sizes were hardly adequate to establish accurate ingestion rates in unmanaged fields during earlier time periods.

DISCUSSION

Although mourning doves were collected during the fourth year of legal hunting in Indiana, the ingestion rate of 2.5% is similar to or greater than (with 1 exception) rates (1.0% to 6.5%) estimated for areas with long histories of dove hunting and field management (Locke and Bagley, 1967; Lewis and Legler, 1968; Kendall and Scanlon, 1979; Buerger, *et al.,* 1983). Part of this difference may be due to greater detection rates using radiography compared to visual methods. Buerger, *et al.* (1983) reported an ingestion rate of 1% in a sample of 521 doves harvested from a national wildlife refuge in Alabama that was hunted 3 times annually. Lewis and Legler (1968) examined 1,969 gizzards collected from 6 fields in Tennessee. The rate of ingested shot was 1.1% and ranged from 0.0% to 3.0% for individual fields. Kendall and Scanlon (1979) examined 412 doves from 6 game management areas in Maryland, Virginia, North Carolina, and South Carolina. Gizzard and crop examination revealed lead in 2.4% of the doves. Locke and Bagley (1967) found shot in 4 of 62 (6.5%) mourning doves from Maryland.

Previous studies have not reported ingestion of steel shot by mourning doves. Steel shot is more widely used now than when previous studies were conducted.

Although the overall probability of ingesting shot would be greater in managed fields than unmanaged due to greater hunting pressure, the failure to detect these

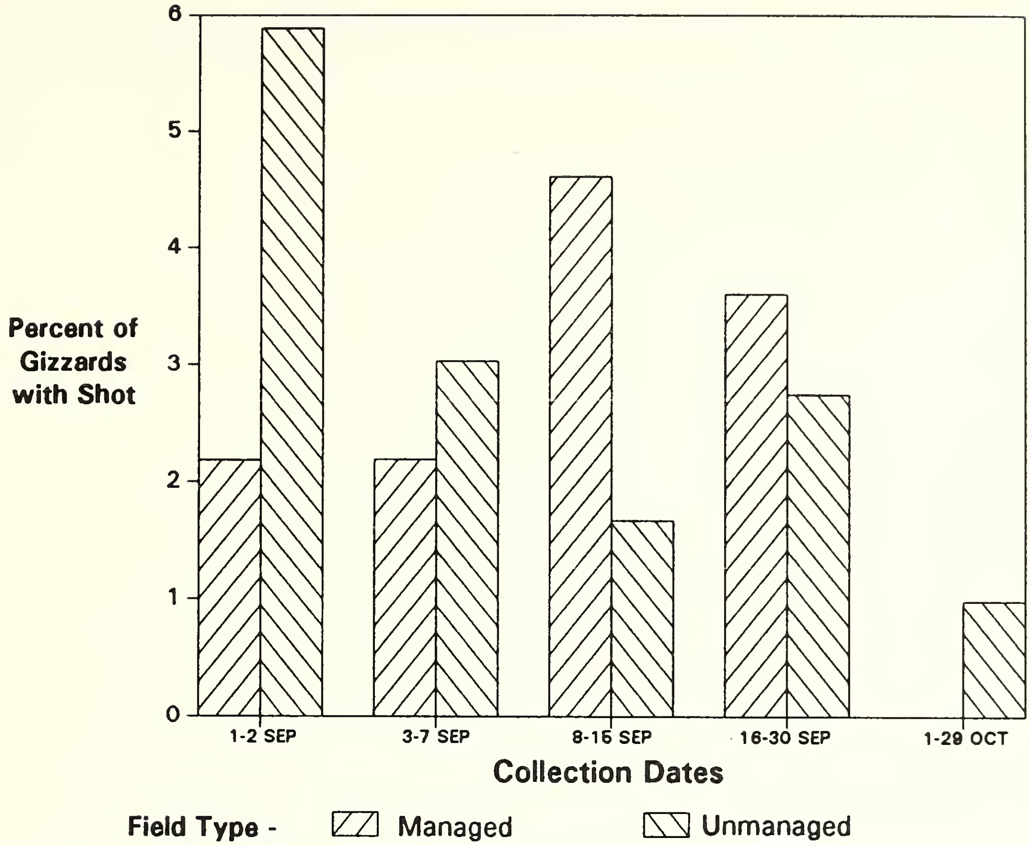

Figure 2. Temporal distribution of spent shot ingestion rates by mourning doves on managed and unmanaged areas in Indiana in 1987.

differences is likely due to two factors. First, doves from unmanaged areas were collected later in the season, when more shot is available. Thus, ingestion rates are greater. Second, doves range widely during autumn, and collecting doves from a particular field does not reveal where they fed previously.

Except for Buerger, *et al.* (1983), factors influencing shot ingestion have not been examined previously. No differences in ingestion rates in 521 doves from Alabama were found between sexes, between ages, or among dates by Buerger, *et al.* (1983). In the present study, age and sex differences were not present, except in young immatures. Lead levels in blood, which indicate recent exposure to environmental lead, was greater in immature mourning doves than in adults (Semel, *et al.*, 1987; Castrale, unpubl. data).

Presence of shot in the gizzard underestimates ingestion of shot by an unknown amount (Friend, 1985). Shot may not be found, because it may be elsewhere in the gastrointestinal tract or because it was overlooked by observers. Shot erosion by the gizzard reduces pellet size and compounds this problem. Doves also void uneroded or partially eroded shot during unknown and variable time periods. Shot was absent in gizzards of dosed doves two to four weeks after ingestion (McConnell, 1968; Castrale, unpubl. data). Thus, ingestion rates based on gizzard analysis are minimum values. George (1987) speculated that ingestion rates may be as high as 16%, based on the level of a blood enzyme (ALAD). ALAD levels remain depressed for several weeks after lead shot can be detected in the gizzard. In spite of these limitations, examination for lead in gizzards is important in that it establishes that spent shotgun pellets may be a significant source of lead that may result in toxicity to mourning doves.

MANAGEMENT IMPLICATIONS

This study demonstrated that a long history of dove hunting and field management was not necessary before ingested shot is frequently detected in mourning doves. Although the impacts of shot ingestion on mourning dove population dynamics are not known, prudent management dictates efforts to minimize, where practical, the probability of doves ingesting shot. A variety of strategies can be pursued, including reducing surface lead through agricultural tillage, altering design of fields to reduce lead deposition in feeding areas, and requiring steel shot (Castrale, 1989)

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LITERATURE CITED

Buerger, T.T., R.E. Mirarchi, and M.E. Lisano. 1986. Effects of lead shot ingestion on captive mourning dove survivability and reproduction. J. Wildl. Manage. 50: 1-8.

__________, L.I. Muller, R.E. Mirarchi, and M.E. Lisano. 1983. Lead shot ingestion in a sample of Alabama mourning doves. J. Alabama Acad. Sci. 54: 119 (abstr.).

Castrale, J.S. 1989. Availability of spent shot in fields managed for mourning dove hunting. Wildl. Soc. Bull. 17: 184-189.

Friend, M. 1985. Interpretation of criteria commonly used to determine lead poisoning problem areas. U.S. Fish Wildl. Serv. Leafl. 2, 4 pp.

George, A.L., III. 1987. Effects of lead shot ingestion on several blood variables and bodyweight in mourning doves. M.S. Thesis, Auburn Univ., Auburn, Alabama, 41 pp.

Kendall, R.J. and P.F. Scanlon. 1979. Lead concentrations in mourning doves collected from middle Atlantic game management areas. Proc. Conf. Southeast. Assoc. Fish Wildl. Agencies 33: 165-172.

Lewis, J.C. and E. Legler, Jr. 1968. Lead shot ingestion by mourning doves and incidence in soil. J. Wildl. Manag. 32: 476-482.

Locke, L.N. and G.E. Bagley. 1967. Lead poisoning in a sample of Maryland mourning doves. J. Wildl. Manag. 31: 515-518.

McConnell, C.A. 1968. Experimental lead poisoning of bobwhite quail, and mourning doves. Proc. Conf. Southeast. Game and Fish Comm. 21: 208-219.

Reeves, H.M., A.D. Geis, and F.C. Kniffen. 1968. Mourning dove capture and banding. U.S. Fish Wildl. Serv. Spec. Sci. Rep. - Wildl. 117, 63 pp.

Sanderson, G.C. and F.C. Bellrose. 1986. A review of the problem of lead poisoning in waterfowl. Illinois Nat. Hist. Surv., 34 pp.

SAS Institute, Inc. 1988. SAS/STAT user's guide. SAS Inst., Inc., Cary, North Carolina, 1028 pp.

Semel, B., G. Bryan, and S. Byers. 1987. Lead shot contamination and lead poisoning on a licensed shooting preserve. Midwest Fish Wildl. Conf. Abstr. 49: 99.