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Lead Poisoning of Northern Pintail Ducks Feeding in a Tidal Meadow Contaminated with Shot from a Trap and Skeet Range

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Lead poisoning of waterfowl from the ingestion of lead shot is well documented and widespread throughout the United States. Research and remedial regulations have focused on waterfowl hunting as the major source of this lead shot. A calculated 3000 tons of spent pellets were deposited annually by waterfowl hunters from 1965 to 1971 (USFWS 1985a).

Mortalities of cattle from ingestion of silage contaminated with lead shot from trap shooting have been documented in the United States, the United Kingdom and Ireland (Howard and Braum 1980, Frape and Pringle 1984, Rice et al 1987). Although ingestion of lead shot by cattle grazing on silage from a trap range was documented in Denmark, no mortalities were reported (Clausen et al 1981).

This paper describes lead poisoning of northern pintail ducks (Anas acuta) from ingestion of lead shot deposited on a tidal meadow as the result of trap and skeet shooting. This is the first published report linking trap and skeet shooting with lead poisoning of waterfowl. It also describes and evaluates the management procedures taken to prevent the poisonings.

MATERIALS AND METHODS

Forty pintails were collected on Raccoon Creek and adjacent tidal meadows between Bridgeport and Swedesboro, New Jersey from 2/25/86 to 3/19/86. Twenty-nine were moribund and easily captured with a hand net. One pintail, which appeared weak, was captured by shooting. Ten dead ducks were also collected.

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A heparinized blood sample (3/4 mL) was taken from the brachial vein of live ducks. Erythrocytic protoporphyrin IX (PP) was measured using a modified hematofluorometer (AVIV Associates, Lakewood, NJ) according to the methods of Roscoe and coworkers (1979). Blood lead concentrations were determined by a modification of the method of Fernandez (1975). Samples of heparinized whole blood were diluted tenfold with a 0.1% aqueous solution of Triton X-100 (Fisher Scientific Co., Springfield, NJ). Duplicate 10 µL aliquots of the diluted samples were analyzed by flameless atomic absorption spectrophotometry. Bovine blood proficiency testing samples (Centers for Disease Control, Atlanta, GA) were analyzed along with the waterfowl blood samples as a check on the accuracy of the method. Hemoglobin concentration (Hb) was measured (g/dL) on a hemoglobinometer (American Optical, Buffalo, NY). Packed cell volume (PVC) was measured and the mean corpuscular hemoglobin concentration (g%) was calculated (MCHC = Hb/PCV). Moribund ducks were subjected to euthanasia immediately following blood collection. These birds as well as those found dead or shot were necropsied.

Shot numbers, shot sizes and seed types observed in sediment samples (100) from four hunting blinds in the vicinity of the pintail mortality were compared to those observed in sediment samples (25) at the trap and skeet range and to the gizzard contents of the necropsied pintails. This was done to develop evidence for the source of the lead shot found in the pintail gizzards. Sediment core samples were collected at random in the area of greatest shot fall (90 - 150 yrds from the shooting point) using a polyvinylchloride pipe (5cm id) with a collar attached to limit substrate penetration depth to 7.5cm (Quist and Kirby 1978). The bottom of the sample was marked and each 7.5 cm core was cut into 3 equal (2.5cm) layers. Each layer was washed through a window screen seive. The recovered pellets were counted and the density (no./acre) to a depth of 7.5cm was calculated from the sample core surface area (78.5cm).

Remedial procedures involved the immediate cessation of shooting lead shot at the range and operation of a timed propane scare gun adjacent to the tidal marsh in front of the trap and skeet houses until the staging pintails migrated north. Evaluation of the long-term effectiveness of this management strategy required weekly surveys of the Raccoon Creek and adjacent tidal meadows in March of 1987 when the pintails returned and the propane gun was no longer in operation. Sheltered areas found to harbor weak, sick pintails in 1986 were examined in 1987 for evidence of mortality. The trap

and skeet range tidal meadow was also monitored at this time to document use by feeding pintails and any obvious changes in vegetation or shot visibility and appearance. Any changes in shot availability at the range due to settling or siltation were measured by comparing the distribution of shot in the layers of 25 sediment samples collected in March 1986 and again in March 1987. A Chi-square analysis was performed to test the null hypothesis that the depth distribution of shot did not vary between years.

RESULTS AND DISCUSSION

In late February, when up to 10,000 pintails stage on Raccoon Creek in preparation for further northward migration, a trapper observed dead and moribund pintails on the creek in Bridgeport, NJ. His notification of the NJ Division of Fish, Game and Wildlife prompted a search of the area resulting in the collection of 1 dead and 3 moribund pintail ducks.

Clinical symptoms of these birds included bile stained pericloacal feathers, fatigue following a brief pursuit and an inability to fly while retaining the ability to swim and walk.

The two birds (1,2) which reached the pathology laboratory alive had blood lead concentrations exceeding 18 ppm (Table 1), which is well above the 0.2 ppm threshold for elevated blood lead concentration in waterfowl (USFWS 1985b). The blood protoporphyrin (PP) concentrations for these birds were above 930 µg/dL. Experimentally lead shot poisoned mallard ducks (Anas platyrhynchos) with blood PP concentrations above 500 µg/dL display the same clinical symptoms described for the pintails in this case (Roscoe et al 1979). Anemia was pronounced in these pintails which had mean corpuscular hemoglobin concentrations (MCHC) below 23 g%. The mean MCHC of mallards 8 days after dosing with 8 number 4 lead shot was 26 g% compared to 31 g% for undosed birds (Roscoe et al 1979).

At necropsy all four pintails appeared in good flesh with no pectoral muscle atrophy. A viscous dark green bile distended the gall bladder and stained the eroded desquamating gizzard mucosa, the intestine and pericloacal feathers. Liver atrophy was noted in one bird. The blood appeared watery in all four birds. The gizzards and proventriculi contained but were not impacted with seeds of wildrice (Zizania aquatica), southern waterhemp (Acnida cuspidata), marshpepper smartweed (Polygonum hydropiper) and yellow waterlily (Nymphaea mexicana). All four gizzards contained lead

Table 1 Clinical values and number of ingested shot for 40 lead poisoned pintails (Anas acuta) collected from Raccoon Creek, Bridgeport, NJ. from 2/25/86 to 3/19/86. Pintails which were dead upon submission are listed last.

SP	SHOT (No.)	BLOOD Pb(ppm)	BLOOD PP(µg/dL)	PCV (%)	Hb (g/dL)	MCHC (g%)
1	37	21.2	952	28	6.5	23
2	15	18.9	931	36	8.0	22
5	24	6.6	623	42	9.5	23
6	78	4.4	634	43	7.0	16
7	10	4.6	464	48	12.5	26
8	38	3.0	569	25	9.5	38
9	20	1.7	381	51	5.5	11
10	20	4.0	441	50	12.5	25
11	62	6.1	422	34	9.0	27
12	43	6.4	552	40	6.0	15
13	67	4.0	815	17	8.5	50
14	39	3.9	462	20	<4.0	20
15	--	5.9	581	27	4.0	15
16	20	3.0	928	47	7.0	15
21	76	9.3	683	33	8.0	24
22	1	1.9	616	35	8.5	24
24	251	3.9	507	20	4.5	23
25	28	3.0	1052	37	7.5	20
26	62	3.6	417	30	6.0	20
30	11	4.1	830	44	9.0	21
34	14	3.8	507	36	9.5	26
35	16	2.9	429	37	11.0	30
36	7	1.2	947	40	11.0	28
37	6	1.2	297	43	12.5	29
38	5	3.4	969	30	8.0	27
39	19	1.9	195	36	11.0	31
40	0	3.9	531	42	11.0	26
3	55	---	--	--	---	--
4	88	---	--	--	---	--
17	33	---	--	--	---	--
18	51	---	--	--	---	--
19	41	---	--	--	---	--
20	35	---	--	--	---	--
23	52	---	--	--	---	--
27	20	---	--	--	---	--
28	14	---	--	--	---	--
29	42	---	--	--	---	--
31	27	---	--	--	---	--
32	37	---	--	--	---	--
33	20	---	--	--	---	--

shotgun pellets (15 to 88) in various states of wear, many of which retained their spherical shape. All spherical shot were smaller than size 7 1/2.

The clinical symptoms were typical of experimentally and spontaneously lead poisoned waterfowl (Wobeser, 1981). The clinical and gross pathology in the absence of emaciation was suggestive of acute lead poisoning. The rapid course of the disease was not only consistent with the large dose of lead shot in the gizzards (USFWS 1985), but also with the grain diet which tends to enhance the toxicity of ingested lead (Jordan 1968). Shot sizes (6 to 4) larger than those found in the pintail gizzards are usually used for waterfowl hunting in New Jersey. The average number of pellets found in gizzards of black ducks (Anas rubripes) and mallards which ingest shot in New Jerseys' hunted marshes is 1.8 with a range of 1 to 18 (Roscoe et al. 1983. lead poisoning. photocopy. PR Project W-58-R6 job IVB. NJ Div Fish Game Wildl, Trenton, NJ. 10pp).

The shot numbers, shot size and acute course of the poisoning lead to the hypothesis that a trap and/or skeet range was the source of the lead shot ingested by the ducks and that it was near the site of the sick and dead birds. A search of Raccoon Creek detected a trap and skeet range at Swedesboro, approximately 3 miles upstream from most of the pintail mortalities. Over 250 pintails were observed feeding in the 20 acre tidal meadow directly below 5 skeet houses and an olympic bunker trap house containing 5 automatic traps. Some pintails were landing between rounds of shooting. Feather remains of one pintail were found on the meadow in front of the range.

Shiny black waterhemp and smartweed seeds were abundant and could be readily seen scattered among the similar size (2 mm dia.), shiny dark grey, newly deposited lead shot on range meadow sediments. The similarity of the shot and seeds was so striking that we hypothesized the birds were visually selecting new shot as well as waterhemp and smartweed seeds. Older shot at the range was characterized by a white-grey non-reflective oxidized surface. Larger (6 mm dia) mustard colored yellow waterlily seeds and elongate wildrice seeds which did not resemble the shot were also present in the tidal debris surrounding the range meadow. Eighty-five percent (34/40) of the poisoned pintails collected had one or more of the 4 species of seeds found at the range in their gizzards. This lent further support to the hypothesis that the ducks ingested the shot at the range.

Every sediment core sample from the range meadow

contained lead shot. The top 7.5 cm of sediment, easily within reach of the feeding pintails, contained 87,816,960 lead shot per acre. This shot density is 4,396 times greater than the shot density (19,977 shot/acre) at the hunting blinds along Raccoon Creek. Only 1 lead shot was found in 100 sediment samples collected at these blinds. These findings also support the hypothesis that the source of the numerous lead shot ingested by the poisoned pintails was the severely contaminated range meadow.

Following the examinations of the first 4 pintails, 36 more were collected along Raccoon Creek during weekly searches from late February to mid March. An inspection of Raccoon Creek was conducted one week after a scare gun was installed and shooting on the range ceased. While 1,000 pintails were still present on the tidal meadows downstream from the range no moribund or dead birds were observed. By the beginning of April most staging pintails had migrated north and no more poisoned birds could be located.

A juvenile bald eagle (Haliaeetus leucocephalus) was one of several predatory birds observed on the meadows during our collection of lead poisoned pintails. Lead poisoning of 105 bald eagles, primarily from ingesting shot embedded in or ingested by waterfowl and other prey, has been documented by the National Wildlife Health Center (USFWS 1985a) and represented an additional impetus to rapidly terminate the pintail poisonings.

The mean number of lead shot recovered from the gizzards of poisoned pintails was 38 (0 -251)(Table 1). Very few of these birds were emaciated. Most had bile distending the gall bladder and staining the eroded or desquamating gizzard mucosa. Impaction of the proventriculus and esophagus with food occurred in only 4 birds.

The data from this study indicate spontaneously poisoned pintails with blood lead concentrations of 1.2 ppm or higher are debilitated with muscular weakness and inability to fly as evidenced by hand net capture. These birds were anemic characterized by an elevated mean blood PP concentration of 620 µg/dL, a mean PCV of 36, a mean hemoglobin concentration of 8.4 g/dL, and a mean MCHC of 24 g%.

No lead poisoned pintails were found in the 1987 survey in spite of the return of 3,000 birds to the staging marshes of Raccoon Creek. Pintails were seen feeding at the trap and skeet range meadows and no changes in vegetation or seed types were observed. No new shiny

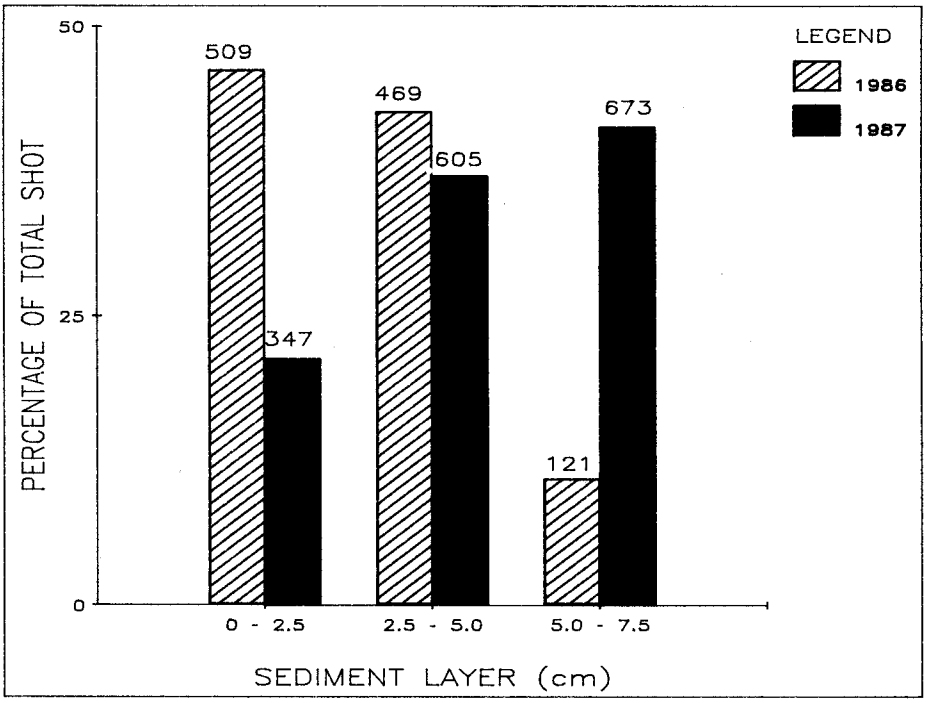

Figure 1. Changes in shot distribution in sediments of a trap and skeet range in Swedesboro, NJ following cessation of shot deposition. Values above the bars are the total numbers of shot in 25 samples.

shot was visible on the meadow surface and only small numbers of oxidized shot were exposed in a few tide eroded areas. Sediment samples indicated the large amounts of shot were still present, but apparrently had settled from the 0 - 2.5 cm layer to the 2.5 - 5.0 cm and 5.0 - 7.5 cm layers (Figure 1). The Chi-square test showed a highly significant (χ =342.9 P<0.001) difference in the depth distribution of the shot between March 1986 and March 1987. Bellrose (1959) found that in soft bottom soil, like the tidal meadow in this study, most seeded lead shot settled to the 2.5 - 5.0 cm layer within 1 year. Siltation may also have played a role in covering surface shot at the range meadow.

The altered appearance of oxidized shot combined with reduced visibility and availability from settling and/or siltation appears to have terminated the lead poisoning of pintails at the trap and skeet range. The short term management procedure which stopped lead shot

deposition and hazed birds away from the contaminated site, followed by a permanent ban on deposition of lead shot in the meadow, substantially reduced the lead poisoning hazard so that more environmentally disruptive measures, such as meadow mining, were unnecessary. The use of steel shot was recommended as one means for continued range operation.

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