TABLE 10

SHELLS FIRED OPENING DAY
Listed By Blinds In The 210 Acre Field

Blind	Geese	Successful Hunter	Total Hunters	Shells Fired
1	2	1	3	17
2	1	1	5	30
3	5	5	7	20
4	6	3	5	15
5	4	2	3	13
6	2	2	5	14
7			6	13
8	3	2	3	6
9	1	1	3	1
10	1	1	3	9
11			3	9
12	4	3	5	12
13	6	3	6	21
14	3	2	3	10
15			3	14
16	8	4	5	21
17			5	13
TOTAL	46	30	73	238 or 3.26 per hunter

Lead Shot on Catahoula Lake and Its Management Implications

By

DEWEY WILLS

Louisiana Wildlife and Fisheries Commission
Ferriday, Louisiana

And

LESLIE L. GLASGOW

School of Forestry and Wildlife Management
Louisiana State University
Baton Rouge, Louisiana

PRESENTED AT THE ANNUAL MEETING

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LEAD SHOT ON CATAHOULA LAKE AND ITS MANAGEMENT IMPLICATIONS

Catahoula Lake is one of the most important waterfowl wintering

areas in the nation. It is the key to waterfowl abundance and hunting success in Central Louisiana. This unique area has been an important wintering ground for many years. Early explorers reported immense flocks of waterfowl on the lake (Dunbar, 1804). Older residents of the area state than Catahoula Lake was an important source of waterfowl during the market hunting era.

Little intensive work has been done on this important waterfowl area. The purpose of this paper is to present a minor segment of a study being conducted jointly by the Louisiana Wildlife and Fisheries Commission and the Louisiana State University School of Forestry and Wildlife Management.

Catahoula Lake has received heavy annual doses of lead pellets from intensive gunning pressure that date back to the days of the muzzle loader. These years of heavy gunning pressure has deposited on the lake bottom tons of lead shot which has caused periodic outbreaks of lead poisoning in waterfowl (Kalmback, 1930; Lynch, 1951; Yancey, 1953). Older hunters in the area report that ducks have frequently died from some malady, believed to be lead poisoning. Lead poisoning is a very serious problem that causes high mortality to waterfowl. Bellrose (1959) reported that approximately 4 per cent of the mallards in the Mississippi Flyway die annually because of lead poisoning. Its severity and frequency of occurrence are apparently increasing (Shillinger and Cottom, 1937; Kortright, 1943; Elder, 1950; Miss. Flyway Council Planning Committee, 1964).

The objectives of this segment of the study were: (1) to determine the number, weight and distribution of lead pellets on Catahoula Lake and (2) to determine the incidence and quantity of lead pellets in lead-sick ducks picked up during a "die-off" on the lake in 1964.

There are many unknowns concerning lead shot on Catahoula Lake. It is anticipated that future detailed studies of lead shot will be made on this lake.

Location and Description

Catahoula Lake is located in Central Louisiana about 20 miles northeast of Alexandria. This important wildlife area is situated on the western edge of the Mississippi River alluvium in the complex Red River backwater area, and is a structural formation. It is a large, shallow, poorly drained, flat, sump area that is subject to drastic seasonal water fluctuations. It is approximately 14 miles long, 3 miles wide and contains about 20,000 acres of open lake bed. At high water the lake bed contains about 30,000 acres. From the tree line to the lowest area in the lake bed, there is a drop in elevation of about three feet. The lake is bounded on the north by land that rises abruptly to a height of 20 to 30 feet above the high water stage and on the south by low land that is subject to annual overflow.

Catahoula Lake is fed by Little River and numerous smaller streams from the north and west. At high water, drainage is to the east and south through Old River, French Fork of Little River, and several small bayous. At low water, the lake drains only through French Fork of Little River. The lake reecives "overflow" or "backwater" from the Red, Black-Ouachita, and Mississippi Rivers. The water level is dependent on the seasonal stages of these rivers. Water gradually rises in these river systems and enters the lake by backing up through the normal drainage channels, as well as over the lowland from a southerly direction.

High water normally prevails from late winter to early summer. The time of flooding and depth of water vary from year to year but generally follow a distinct pattern. A gradual rise in the water level usually begins in November and December, increases sharply in January, remains at a high level through June, then recedes in July. The lake drains to a low water stage about the first of August exposing

approximately 15,000 acres of mud flats. At that time, about 5,000 acres are covered by water normally ranging in depth from 1 to 12 inches. Soils in the lake bed are composed of fine sedimentary clays with occasional sand lenses. When moist, much of the bottom is soft, but when dry, it is extremely hard.

Plants

The lake bed is generally flooded from December through July. The water level fluctuates a great deal during this period and at its peak reaches a depth of 15 to 25 feet. The winter rise and the summer drop are normally gradual. Because of the shallowness of the water and the softness of the bottom, wave action maintains a turbid condition. Few plants are adapted to such a drastic water fluctuation, long period of flooding, and high turbidity; therefore the number of species growing on the lake is limited. Because of the small number of species, interspecific competition is reduced. As a result, the lake is characterized by large acreages of uniform plant types.

Plant zonation, which is pronounced, is correlated with the lake bed contour, the length of time of flooding, and the length of the growing period.

Woody plants that withstand flooding, primarily water elm *(Planera aquatica)* and swamp privet *(Forestiera acuminata)*, form dense stands on the perimeter of the lake. There is some scattered cypress *(Taxodium distichum)*, water locust *(Gleditsia aquatica)* and buttonbush *(Cephalanthus occidentalis)* in this zone. The water elm is slowly advancing into the lake. From 1954 to 1957, the Louisiana Wildlife and Fisheries Commission cleared about 3,000 acres of water elm and swamp privet on the lake edge. Reinvasion by these species has been very slow.

Herbaceous plants make up all the vegetation in the lake bed. The outer contour of the lake which is higher, firmer and dewatered first, has the longest growing season. The first herbaceous plant zone is dominated by chufa *(Cyperus esculentus)*, but it also contains some spikerush *(Eleocharis* sp.), highland pursley *(Ammania coccinea)*, heliotrope *(Heliotropium* sp.) and cockleburr *(Xanthium sp.)*. When this zone is dewatered early, the broad-leaved plants just mentioned spread and occupy a far greater area than normal. Chufa makes up about 85 per cent of the vegetation in this zone.

The next concentric zone is dominated by a mixture of sprangletop *(Leptochloa filiformis)* and teal grass *(Eragrostis repens)*, but it also contains a little chufa.

Millet *(Echinochloa* sp.) does not exhibit the same degree of concentric zonation. Although it is scattered thinly over much of the lake, pure, dense, tall stands occupy the more marshy, seepy areas in which there is some humus in the soil. Millet stands occupy "pockets," rather than concentric zones.

The lowest elevation on which plant growth occurs is covered by extensive stands of bull tongue *(Sagittaria* sp.), mud plantain *(Heternantheria limosa)*, dwarf spikerush *(Eleocharis parvula)*, and scattered water hyssop *(Bacopa rotundifolia)*. True aquatics are excluded from the lake by water depth, period of flooding, and high turbidity. The acreage and the kind of plants occupying the lower zones may vary from year to year but the relative position of each plant species in the zones remain the same.

Utilization

Waterfowl. For an 11-year period from 1949 to 1960, Louisiana Wildlife and Fisheries Commission biologists reported a yearly average usage of 11,348,700 duck days for Catahoula Lake (La. Wildlife and

Fish Comm., 1960). Ducks found in greatest abundance were pintail, mallard, teal, baldpate, and gadwall. Those present in lesser numbers were ringneck, scaup, shoveller, ruddy, canvasback and wood ducks. A few geese and coots were present. Waterfowl species and abundance on the lake are influenced by water levels and migrational movements. They are most abundant in the fall when water levels range from 6 to 8 inches. Under present conditions, the water cycle is highly favorable to the production of two excellent duck foods, chufa and millet. The widespread and intensive rooting by hogs in search of chufa tubers probably creates excellent feeding conditions for ducks by not only exposing tubers but also by tilling the feeding site so that ducks can readily puddle out additional tubers.

Hunting. Between 500 and 600 permanent duck blinds are maintained on the lake. In addition, many people hunt the brushy edges without erecting a blind. It is estimated that 7,000 hunters use the area annually.

Cattle - Hogs - Hay. Thousands of acres of sedges and grasses are produced on the lake bed and provide grazing for many cattle and hogs. Cattle utilization occurs over a 3- to 4-month period during the latter period of the summer, while hog usage extends over a 4- to 5-month period during summer and fall. In addition to providing grazing and forage for livestock, many acres of sedges and grasses are cut and baled for hay. During "low-water" years the lake yields up to 150,000 bales of hay (La. Wildlife and Fish. Comm., 1960).

Fishing. Catahoula Lake provides excellent temporary habitat for sport and commercial fish by increasing available nutrients, establishing large nursery areas, and by initiating a favorable food chain. At high water stages many residents of the area use the Catahoula Lake complex for commercial fishing to supplement their annual income. Annually sport fishermen from all parts of the state take advantage of the high quality fishing found near the channel entrances and exits of the lake and in the connecting bayous.

Oil Production. There are 49 active oil and/or gas wells on the lake bed plus several thousand in the surrounding watersheds. Exploratory drilling is in progress when water conditions permit. Several thousand barrels of salt brine are dumped into the lake daily. Attempts are being made by the Louisiana Stream Control Commisison to correct this situation.

Study Procedure

In the summer of 1963, five sampling transects were laid out across the lake along lines established by the Corps of Engineers to determine elevations of the lake bed. Transects were not of equal length due to the variation in the width of the lake. Soil samples were collected at 300-foot intervals along the transects in the open lake bed by inserting a metal tube having a 3⅞-inch inside diameter to a depth of 8 inches.

Since chufa production samples had been taken to a depth of eight inches, lead shot samples were taken to the same depth. At the beginning of the study, every fifth sample was sliced into two-inch sections. Since so few shot were being found and the extra work required for the operation so great, the slicing of samples was discontinued. As a result, no information was obtained on the depth of shot. In soft areas the sampler could be pressed into the soil by hand, but on hard sites it was necessary to place a board across the top of the tube and drive it into the lake bed with a sledge hammer.

On firm sites a jeep was used to carry equipment and samples, on soft sites they were carried by hand, and on flooded sites they were transported in an airboat. Samples were placed in labeled, plastic sacks.

Lead pellets were recovered by washing the soil samples through a series of screens. Pellets were weighed on a Mettler electric balance to the nearest milligram.

Collection and Examination of Lead-Sick Ducks

An outbreak lead poisoning in ducks on Catahoula Lake was reported in January 1964. Louisiana Wildlife and Fisheries Commission biologists surveyed the lake on February 19 and picked up 34 sick ducks and 1 sick coot. On March 4, biologists of the Commission and game management students from Louisiana State University picked up 83 dead and/or sick ducks. Ducks suffering from lead poisoning were incapable of sustained flight. When flushed, they flew low over the water and soon lit. They were pursued in airboats or conventional outboards and scooped from the water with dip nets. Few dead ducks were found because wave action washed them ashore where they were quickly eaten by hogs.

The ducks were sexed, aged and weighed; then the gizzards were removed for pellet examination. Nearly all the ducks had a green stain on the vent. Many of them had enlarged livers and gall bladders. Several had highly impacted proventriculi and greenish stain on the gizzard lining.

RESULTS AND DISCUSSION

Lead Shot Deposition

A total of 213 samples were collected along the five transect lines. The number and weight of pellets recovered from the samples is presented in Tables 1 and 2. A total of 17.4 square feet were sampled and 12 pellets weighing a total of 0.878 grams were recovered.

Discussion

The 12 pellets, when projected to a unit area basis (Table 3) gave an average of 0.69 pellets per square foot; 6.19 per square yard; or 29,963.9 per acre. Of 24 areas sampled for lead shot in the United States, Bellrose (1959) reported 15 contained less and 7 more than the amount of shot found in this study. As shown in Table 2, there was considerable variation in the number and weight of pellets found on the transects. No pellets were recovered from one transect, approximately 7 per cent from one, about 25 per cent from one and about 33 per cent from each of the other two transects.

Table 1. Pellets recovered by transect from soil samples, Catahoula Lake, 1963.

Transect	No. of samples	No. of pellets	Wt. of pellts (gms.)
A	25	2	0.174
B	47	1	0.079
C	41	4	0.204
D	49	0	0.000
E	51	5	0.421
Total	213	12	0.878

In the fall of 1961, 150 chufa prodduction samples were taken at three widely separated locations on the lake. During this sampling over

Table 2. Number and weight by transect of pelets recover from soil samples, Catahoula Lake, 1963.

Transect	Number			Per Cent of total pellets	Weight			Per Cent of total weight
	Sq. ft.	Sq. yd.	Acre		Sq. ft./gm.	Sq. yd./gm.	Acre/lbs.	
A Stock Lndg.	0.977	8.793	42,558.120	26.95	0.085	0.765	8.160	31.71
B Willow Springs	0.260	2.340	11,325.600	7.17	0.021	0.189	2.017	7.84
C Indian Bayou	1.191	10.719	51,879.960	32.86	0.061	0.549	5.858	22.76
D French Fork								
E Big Bend	1.197	10.773	52,141.320	33.02	0.101	0.909	9.699	37.69

Table 3. Number and weight of lead pellets recovered from soil samles by unit of area, Catahoula Lake, 1963.

Unit of Area	Number of Pellets	Weight of Pellets
Sq. ft.	0.688	0.50 gm.
Sq. yd.	6.194	.450 gm.
Acre	29,963.880	4.833 lbs.

major chufa beds, the following amount of shot was recovered: 0.4 shot per square foot, or 17,729 shot per acre, or 4.4 pounds of shot per acre.

In October 1962, before the opening of duck-hunting season, 84 samples were taken to a depth of 6 inches around what was considered to be one of the oldest active blinds on the lake. Ducks have been hunted from this blind since 1925. On the basis of the number of lead shot recovered from these samples, it was calculated that there were 2.38 pellets per square foot; 21.5 per square yard and 101,302.4 per acre. This is about 3.5 times the number found on the transects.

The number of shot recovered may have been influenced by (1) intensity of hunting, (2) length of time since last hunting occurred on site, (3) type of soil, (4) hog rooting and trampling by cattle, (5) wave action and sedimentation, and (6) the number eaten by ducks. Some of these influences are interacting.

Hunting: Normally, hunting is concentrated in certain areas of the lake because of: (1) the concentration of waterfowl where favorable water and food conditions prevail, (2) the location of hunter access sites and (3) the ease of getting to blinds. During the hunting season most waterfowl on the lake are puddle ducks that feed in shallow water where chufa tubers are plentiful. Usually much of the lake bed is dry; however, when early rains flood the entire basin, there is a shift of both ducks and hunters that is correlated with rising water levels. Therefore, gunning pressure and lead shot deposition on a specific area varies from year to year. The water rise may be abrupt and unpredictable because of heavy rains that occur in surrounding watersheds while the drainage channels are full. Because the topography is flat, a rise of 18-24 inches is sufficient to move ducks and hunters quite a distance. A water depth of 5 to 6 feet inundates the chufa beds too deeply, and nearly all the puddle ducks desert the lake.

Hunter access to the lake is limited to a few all-weather roads. Water in the lake during most hunting seasons is too shallow for the operation of standard outboards, and the use of airboats is prohibited over approximately one-half of the lake; therefore, travel to many blinds is by foot. These difficult travel conditions tend to concentrate hunters in the more accessible areas of the lake.

Lead shot samples were collected in August, approximately 7 months after the hunting season had closed. Also the elapsed time since the last hunting on some sites was not known. Bellrose (1959) has shown the depth to which shot sink is partially a function of the length of time they are present on an area. Since there was considerable time lapse between hunting and collection of samples, some shot may have sunk deeper than 8 inches. Much of the shot deposited in previous years may have sunk below the sampling depth.

Soils. Soils over much of the lake bed are of fine sedimentary materials that become very soft and easily penetrated when flooded. Fan-shaped deposits of sandy "outwash" occur at the mouth of drainages into the lake and for some distance into the lake bed along the edges

of main channels. Stranded low sandy ridges parallel the perimeter of the lake. These sandy areas, which are quite firm, may be overlain by a few inches of silt. A hard clay pan exists at variable depths below the soil surface. The area that retains water throughout the year is extremely "oozy" and difficult to traverse on foot. Variability in soil texture and firmness probably influences the speed and depth to which pellets sink and thereby affects the number recovered.

Hog and Cattle Activity

Each year thousands of hogs feed on the chufas that are produced on Catahoula Lake. The rooting of these hogs in search of chufa tubers almost completely upturns the top layers of soil over large areas of the lake bed. The effect on the availability of shot is probably two-fold. In the sandy and silty areas of the lake bed, hog rooting occurs when the sites are rather dry. Lead shot are probably made less available because the heavier shot tend to sift downward through the disturbed sand and silt particles. However, in those areas of the lake which have heavier clay soils, hog rooting activity may expose and make available to ducks more lead shot. On these sites hogs root to a depth at which the clay is moist and sticky. This activity may tend to return the shot to the surface.

Grasses and sedges which grow in profusion on the lake bed provide very attractive grazing for livestock. Many free-ranging cattle graze on the lake bed for 3 to 4 months annually. On the moist areas of the lake it is common to see cattle bogged to a depth of 12 to 15 inches while grazing. Undoubtedly, this trampling tends to bury shot and make them less available to ducks.

Wave Action and Sedimentation

As mentioned previously, Catahoula Lake is shaped much like a huge oval platter with a vast expanse of open shallow water lying "in line" with prevailing winds. Moderate wave action is a daily occurrence, and violent wave action occurs on windy days. This incessant wave action results in considerable agitation of bottom particles. Because of this constant disturbance, lead pellets, which are heavier than soil particles, probably sink deeper into the lake bottom. Penetration of lead pellets is more rapid and deeper on soft bottoms than on tight clay or sand. This, of course, would make the pellets less available to waterfowl. In some areas having a clay pan that supports lead pellets, constant agitation may erode the surface and carry away the sediment and expose the pellets to waterfowl.

Hog rooting activity makes the bottom more susceptible to disturbance by wave action, and therefore, permits greater quantities of soil to be picked up by the moving water. It is concluded that hog rootings, wave action, and redeposition of silt interact to bury shot deeper into the lake bed.

Sedimentary materials entering the lake from outside sources are limited. There are deposits near the mouths of drainages entering the lake but only a limited amount of fine sediment is carried far into the lake. The depth of the lake has apparently changed little since the time the area was first described by the early explorers, for their descriptions apply equally well today; thus new sedimentary material is believed to be of little consequence in burying lead shot.

Lead Poisoning in Waterfowl

Lead poisoning is known to occur in other places in Louisiana, but is believed to be most serious on Catahoula Lake. The lake produces huge quantities of choice duck foods and is normally very shallow in the fall, consequently it provides excellent habitat for large concentrations of waterfowl. The large numbers of waterfowl attract

many hunters annually; consequently much lead has been deposited on the bottom. These huge concentrations of ducks feeding in shallow water where large quantities of shot are present set the stage for periodic outbreaks of lead poisoning.

Seasonal Occurrence of Lead Poison Outbreaks

Lead poisoning outbreaks on the lake usually do not occur, or are seldom noticed prior to the hunting season. The early fall flights of ducks consist mainly of pintail, teal, gadwall, shoveller and widgeon. Mallards arrive later in the season. The ducks that arrive early are not as persistent puddlers as are the mallards. When the early flights arrive, water in the lake is confined to the shallow, permanently flooded zone that has a soft bottom. New shot has not yet been deposited and shot from previous hunting seasons has probably sunk below the reach of ducks. Since the area occupied by ducks at this time does not produce tuberous plants, they probably do not puddle extensively in the bottom. Because of these reasons pre-hunting season lead-sickness does not normally occur or affects only a few ducks.

During the hunting season the water level of the lake may begin to rise and may flood part or all of the chufa-producing area. Since soils in the chufa-producing area are rather compact, new shot deposited during the hunting season probably remains available to ducks for some time and shot from previous hunting seasons may not have sunk below the reach of ducks. The number of mallards arriving on the lake increases and many of the other species have been present for some time. Ducks may have picked up shot on their southward migration. These factors favor a build-up of lead shot in ducks. Consequently, as the hunting season progresses, lead-sick ducks become more common. Because of their moribund condition they are less alert and are frequently weak fliers. It is likely that hunters harvest a large per cent of these sick ducks. Those that venture to the shore to hide in emergent cover are eaten by hogs. Hunting pressure tends to prevent ducks from feeding intensively over heavily shot areas and temporarily postpones outbreaks of lead poisoning.

The normal water rise begins soon after the close of the hunting season. After the chufa beds are inundated by 5 to 6 feet of water, lead poisoning is not a serious problem. But, when the chufa beds are shallowly flooded for a long period of time during the presence of a large number of ducks, especially mallards, a "die-off" can be expected. "Die-offs" have been most noticeable following the hunting season during those years when the chufa beds are shallowly flooded for an extended period.

Frequency and Magnitude of Occurrence, and Species Affected

Lynch (1951) and Yancey (1953) reported outbreaks of lead poisoning on Catahoula Lake. Local residents state that periodically ducks die in the fall. No doubt some degree of lead poisoning is an annual occurrence, but it reaches epidemic proportions only when the conditions as described in the preceding section, are extremely favorable for an outbreak. The most severe recorded outbreak occurred following the close of the hunting season in January 1953, when an estimated 6,000 to 7,000 ducks died (Yancey, 1953). At that time an estimated 30,000 pintails, 25,000 mallards, 500 green-winged teals and a number of other species were on the lake. It was concluded that 6,000 mallards and 1,000 pintails died. In a 3-day period 243 mallards and 26 pintails were picked up. Not a single incapacitated green-winged teal was found (Yancey, 1953). John Lynch (1951) estimated that no fewer than 1,500 birds died in December 1950. These birds were mostly mallards.

In January 1964, dead ducks were reported on the lake. The causative agent was diagnosed as lead poisoning by John Lynch, U. S. Fish

and Wildlife Service, and Clark Hoffpauer, Louisiana Wildlife and Fisheries Commission (Lynch, 1964). In February 1964, Robert Chabreck and Ted Joanen, Louisiana Wildlife and Fisheries Commission, visited the lake and picked up 24 mallards, 9 pintails, 1 ringneck and 1 coot (included in Table 4). They estimated that 3,325 ducks were sick and that 2,000 had died. Mallards made up about 2/3 of the affected ducks and pintails about 1/3 of the total. A waterfowl inventory of the lake showed that there were approximately 5,000 ringnecks, 140,000 pintails, 120,000 mallards, 2,000 scaups, 900 canvasbacks, 1,500 baldpates, 500 gadwalls, 900 ruddy, 3,000 coots, 350 blue and snow geese and 50 Canada geese. In early March, Wildlife and Fisheries Commission and Louisiana State University personnel visited the lake

Table 4. Species and sex of lead-sick ducks collected on Catahoula Lake, February-March 1964.

Species	Male	Female	Total
Mallards	61	21	82
Pintail	19	11	30
Ringnecks	3	1	4
Baldpate	0	1	1
Total	83	34	117

and picked up 58 mallards, 21 pintails, 3 ringnecks and 1 baldpate (see Table 4). At this time it was estimated that the following waterfowl were present: 85,000 mallards, 100,000 pintails, 2,500 ringnecks, 5,500 scaup, 3,500 canvasbacks, 12,000 baldpate, 1,500 gadwalls, 1,000 ruddy, 1,000 shoveller, 7,000 green-wing teal, 2,000 coot and 35 Canada geese.

Mallards and pintails were the primary ducks affected. Although several other species were present in fair numbers, partically nor was affected. Four ringneck ducks were collected and two decayed carcasses were observed. In 1953 a few scaup and canvasbacks were collected by Yancey. When the ducks were collected on March 4, 1964 there were 1.2 times more pintails than mallards on the lake, yet we recovered 2.7 times as many sick mallards as pintails. Yancey (1953) reported that there were 1.2 times more pintails than mallards on the lake, and that he picked up 9.3 times as many sick mallards. Since mallards puddle more on the bottom than pintails, they evidently come in contact with pellets more frequently than pintails. The other puddle ducks present on the lake apparently fed more on the surface than these two species and ingested little lead. Jordan and Bellrose (1951) reported that ducks that consume small seed were affected less by lead pellets than those that consume larger seed. Captive mallards fed whole grain corn died quicker than those that were fed small grain. Since chufa tubers are about the size of grains of corn, they may cause a similar reaction in ducks that have fed on lead shot.

Incidence and Amount of Ingested Shot

Thirteen per cent of the sick mallards and 17 per cent of the pintails that were examined contained no pellets in their gizzards. Apparently these birds had previously ingested lead pellets but had assimilated or passed them out of their disgestive tracts. Jordan, as

cited by Bellrose (1959) found that 21 per cent of captive mallards that had been fed 1 to 6 shot had no shot in the gizzard at the time of death. The number and weight of pellets per bird is shown in Tables 5 and 6; the number of pellets found per bird ranged from 0 to 21. Thirteen per cent of these birds had no pellets, 45 per cent had 1 to 3 pellets, 37 per cent had 4 to 10 pellets, and 4 per cent had more than 10 pellets. Yancey (1953) reported, in the ducks that he examined, that the number of pellets ranged from 1 to 21, while Lynch (1951) reported that nearly all of the gizzards that he examined contained over 10 pellets, several had over 20, and one had 37 new shot in addition to a few worn ones.

Bellrose (1959) reported that in a 6-state summary of lead poisoning "die-offs" 11 per cent of the birds had no pellets, 55 per cent had 1 to 3 pellets, 28 per cent had 4 to 10 pellets and 6 per cent had 10 or more. The incidence of ingested lead that was found in this study parallels the amounts reported in other lead poison outbreaks.

Weight Loss of Lead-Sick Ducks

Since the digestive system in lead-sick ducks does not function normally, they lose weight. The weight range and weight loss for sick ducks that were collected during this investigation are shown in Tables 7 and 8.

Table 5. Number of pellets recovered per species of ducks, Catahoula Lake, February-March 1964*

No. of Pellets	Mallards		Pintail		Others		Total	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
0	11	13.3	4	16.7	0	00.0	15	13.4
1	15	18.1	5	20.8	2	40.0	22	19.6
2	9	10.8	2	8.3	1	20.0	12	10.7
3	14	16.9	3	12.5	0	00.0	17	15.2
4	6	7.2	2	8.3	1	20.0	9	8.0
5	8	9.6	1	4.2	0	00.0	9	8.0
6	3	3.6	1	4.2	1	20.0	5	4.5
7	5	6.0	1	4.2	0	00.0	6	5.4
8	1	1.2	0	0.0	0	00.0	1	0.9
9	2	2.4	0	0.0	0	00.0	2	1.8
10	8	9.6	2	8.3	0	00.0	10	8.9
11+	1	1.2	3	12.5	0	00.0	4	3.6
Total	83	99.9	24	100.0	5	100.0	112	100.0

* Collected by biologists of the Louisiana Wildlife and Fisheries Commission and Game Management students of Louisiana State University.

Pintails suffered a greater per cent weight loss than mallards. It is probable that pintails are not as susceptible to lead poisoning as mallards; therefore, they lived longer than mallards, fed very little and as a result became very thin.

Water Control

The Louisiana Wild Life and Fisheries Commission, the U. S. Fish and Wildlife Service and the U. S. Corps of Engineers have formulated plans whereby it will be possible to regulate the water level of the lake.

Table 6 Weight of pellets per duck collected on Catahoula Lake, March 1964.

	Mallard		Pintail		Other		Total	
.Wt. of Pellets (gr.)	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per. cent
0 - 0	6	11.5	4	26.7	0	00.0	10	14.1
0 - 1	14	26.9	0	00.0	2	50.0	16	22.5
1 - 2	8	15.4	0	00.0	0	00.0	8	11.3
2 - 3	6	11.5	0	00.0	1	25.0	7	9.9
3 - 4	5	9.6	1	6.7	0	00.0	6	8.5
4 - 5	3	5.8	3	20.0	0	00.0	6	8.5
5 - 6	3	5.8	1	6.7	1	25.0	5	7.0
6 - 7	1	1.9	2	13.3	0	00.0	3	4.2
7 - 8	1	1.9	3	20.0	0	00.0	4	5.6
8 - 9	4	7.7	1	6.7	0	00.0	5	7.0
9 - 10	1	1.9	0	00.0	0	00.0	1	1.4
Total	52	99.9	15	100.1	4	100.0	71	100.0

By comparing the average weight of sick ducks with the weight of ducks killed in Louisiana by hunters, the following per cent weight losses occurred: Mallard drakes 17.9, mallard hens 24.0, pintail drakes 34.6, and pintail hens 31.8.

Table 7. Weight range of lead-sick ducks, Catahoula Lake, February-March 1964

Species	Sex	No.	Per cent	Wt. range lbs.	Ave. wt. lbs.
Mallard	M	61	52.1	1.7—2.9	2.3
Mallard	F	21	17.9	1.3—2.6	1.9
Pintail	M	19	16.2	1.4—2.2	1.7
Pintail	F	11	9.4	1.1—1.8	1.5
Ringneck	M	3	2.6	1.0—1.3	1.1
Ringneck	F	1	0.9	1.0	1.0
Widgeon	M	1	0.9	1.1	1.1
Total		117			

Table 8. Weight of lead-sick ducks, Catahoula Lake, February-March 1964

	Male		Female	
	Normal ducks*	Sick ducks	Normal ducks	Sick ducks
Mallard				
No.	60	61	40	21
Ave. wt. lbs.	2.8	2.3	2.5	1.9
Per cent wt. loss	—	17.9	—	24.0
Pintail				
No.	79	19	23	11
Ave. wt. lbs.	2.6	1.7	2.2	1.5
Per cent wt. loss	—	34.6	—	31.8

* Weights obtained from ducks shot in Louisiana during the 1962-63 hunting season (La. Wild Life and Fisheries Comm., 10th Biennial Report, 1963).

This was necessitated by the U. S. Corps of Engineers' plan to provide navigable waters in the Black-Ouachita Rivers.

The normal drainage of the lake will be blocked by an "overtopping" dam constructed near the confluence of French Fork and Little River. A diversion drainage channel will be dug from the lake to Black River. A control structure on this canal near Catahoula Lake will permit regulation of the water level in the lake. Therefore, it will be possible to avoid water stages at which lead poisoning outbreaks are most serious.

RECOMMENDATIONS

Operation of the water control structure should be under the jurisdiction of an agency that is primarily interested in managing the lake for waterfowl, and one that has qualified technical personnel for the job. The agency should be one that is not easily swayed from carrying out its objectives. Since the U. S. Fish and Wildlife Service has capable personnel available on the Catahoula National Wildlife Refuge, we suggest the structure be operated by this agency.

There is strong sentiment among some local groups to flood the lake permanently for water skiing, to improve sport fishing, to facilitate oil production, and for the development of real estate for recreational purposes. Permanent flooding would eliminate the plants that produce waterfowl food and forage for cattle and hogs. Flooding would destroy the lake's value as a waterfowl habitat. Hence, in order to not only maintain, but also to gain support for continued management of the lake for waterfowl, it is necessary to have a liberal hunting season.

The control structure should be operated in such a manner as to not appreciably alter the natural water cycle that now exists. Early summer dewatering should be maintained to permit the normal production of waterfowl foods, principally chufa and millet. The lake should be dewatered no earlier than July 1 nor later than August 1. An earlier dewatering date would lengthen the growing season thus permitting the invasion of plants that would compete with chufa and millet. A later date would not allow for the maximum production of waterfowl foods. During the summer the number of waterfowl (wood ducks) using the lake is very small; therefore, lead poisoning is not a problem during this period.

If no shot were present on the lake bed, the ideal fall water fluctuation would be a gradual rise until water reached a depth of 6 inches on the perimeter of the open lake bed. This would permit maximum utilization of food by ducks and it would favor hunting. However, this fluctuation is not feasible because it might set the stage for a catastrophic lead poison "die-off" by permitting ducks to feed intensively for an extended period of time over the firmer soil where lead shot seems to be readily available. If water were restricted to the permanently flooded area, it would minimize the chances for any lead poison outbreak but it would result in very poor utilization of the food supply by ducks and also reduce hunting opportunities. Therefore, a compromise must be reached whereby there is little chance for a lead poison outbreak, yet good utilization of the waterfowl food is obtained and ample hunting opportunities are afforded sportsmen.

The low water level should be maintained until 20 to 30 days prior to the opening of the waterfowl season. Flooding should be gradual so that when the season opens, the water level at the perimeter of the open lake bed is about 6 inches. This water level should be maintained throughout the waterfowl season. Immediately following the closing of the season, the lake should be rapidly flooded to a depth of 5 feet at the perimeter.

It is recognized that under this plan maximum utilization may not be made of the waterfowl food supply. Greater utilization might be obtained by maintaining a close watch of the waterfowl on the lake and when lead-poisoning reached a certain level, flood the lake quickly. This,

however, could be a hazardous thing if observers failed to recognize the beginning of an outbreak or if the lake could not be flooded quickly.

John Lynch (1964) suggested that the addition of coarse sand, which is generally absent from the lake, might partially satisfy the grit requirements of waterfowl and tend to reduce the ingestion of lead shot. He further stated that fine sand reduced lead shot in the gizzard quicker than coarse sand. Lynch advised dumping it in the State Waterfowl Rest Area and on the Catahoula National Waterfowl Refuge (no gunning permitted) where it would not become contaminated with shot. He indicated that it would afford "substantial relief" in the Catahoula lead-poisoning problem.

The best solution to the lead poisoning problem is the substitution of a non-toxic type of shot for lead pellets in shells. Although ammunition manufacturers have conducted research to meet this need, they should be encouraged at every opportunity to expand research in this direction. The continued use of lead shot can only accentuate the lead poison problem.

SUMMARY

1. In August 1963, 213 soil samples extending to a depth of 8 inches and covering a total of 17.4 square feet were collected along 5 transects across Catahoula Lake.
2. An examination of these samples for lead shot yielded 12 pellets. When projected to a unit basis, the following number of pellets were present: 0.7 per square foot, 6.2 per square yard or 30,000 per acre.
3. Availability of lead shot to waterfowl is influenced by: (a) intensity of hunting, (b) length of time since last hunting occurred on site, (c) type of soil, (d) hog rooting and trampling by cattle, (e) wave action and sedimentation, (f) amount previously eaten by ducks, and (g) depth of water.
4. A lead poisoning outbreak occurred among ducks in February-March 1964.
5. Mallards were more susceptible than other species of waterfowl.
6. An examination of the gizzards of 117 lead-sick ducks revealed the presence of 0 to 21 pellets per bird. Thirteen per cent had no pellets, 45 per cent had 1 to 3 pellets, 37 per cent had 4 to 10 pellets, and 4 per cent had over 10 pellets.
7. Ducks suffering from lead poisoning were 23.2 per cent lighter in weight than normal ducks.
8. A near-normal water cycle should be maintained on the lake. It is recommended that the lake be gradually flooded to a depth of 6 inches at the perimeter just prior to the waterfowl hunting season; that this depth be maintained to the end of the shooting season, after which the lake should be immediately flooded to a depth of 5 feet at the perimeter.
9. Coarse sand or pea-gravel should be dumped on the two refuge areas on the lake.
10. Ammunition manufacturers should find: (a) a non-toxic substitute for lead pellets, (b) a non-soluble coating for lead shot or, (c) produce a shot that disintegrates quickly.

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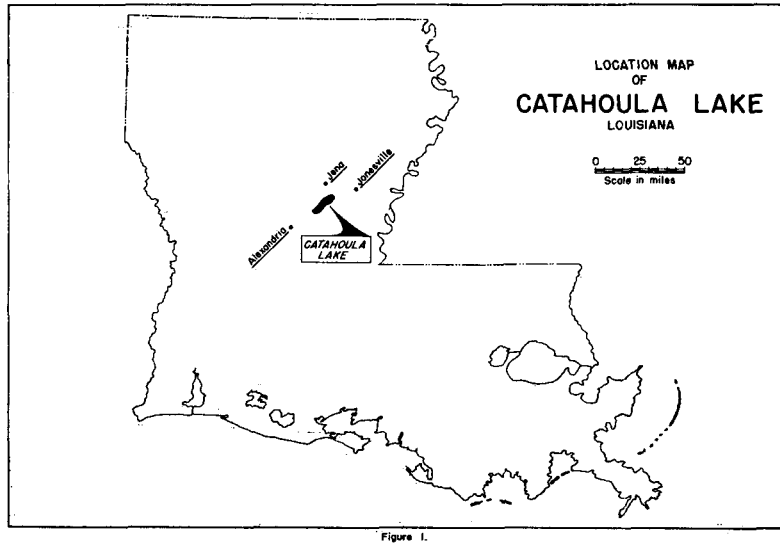
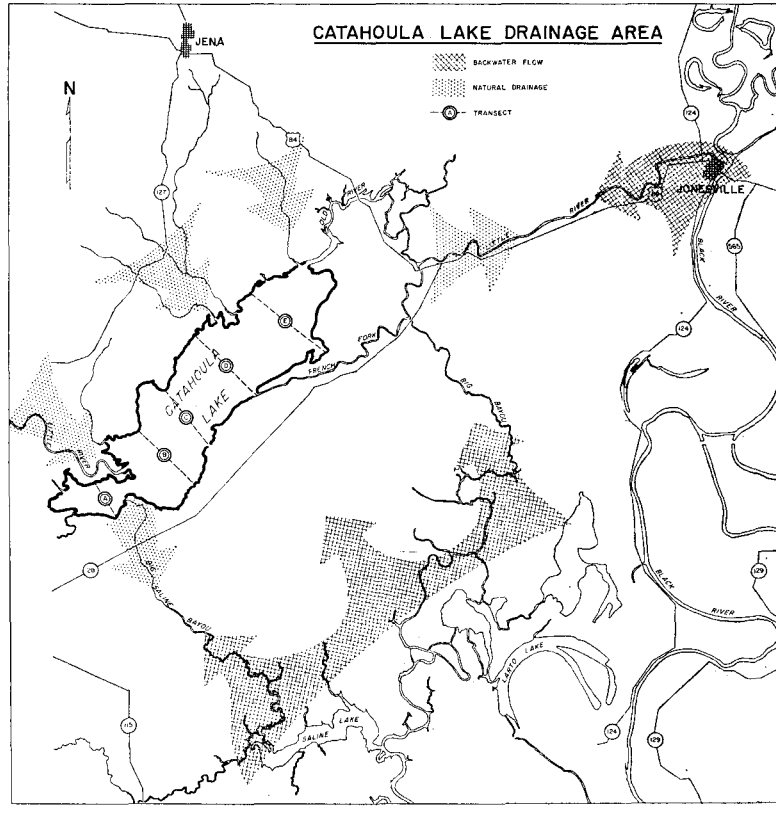
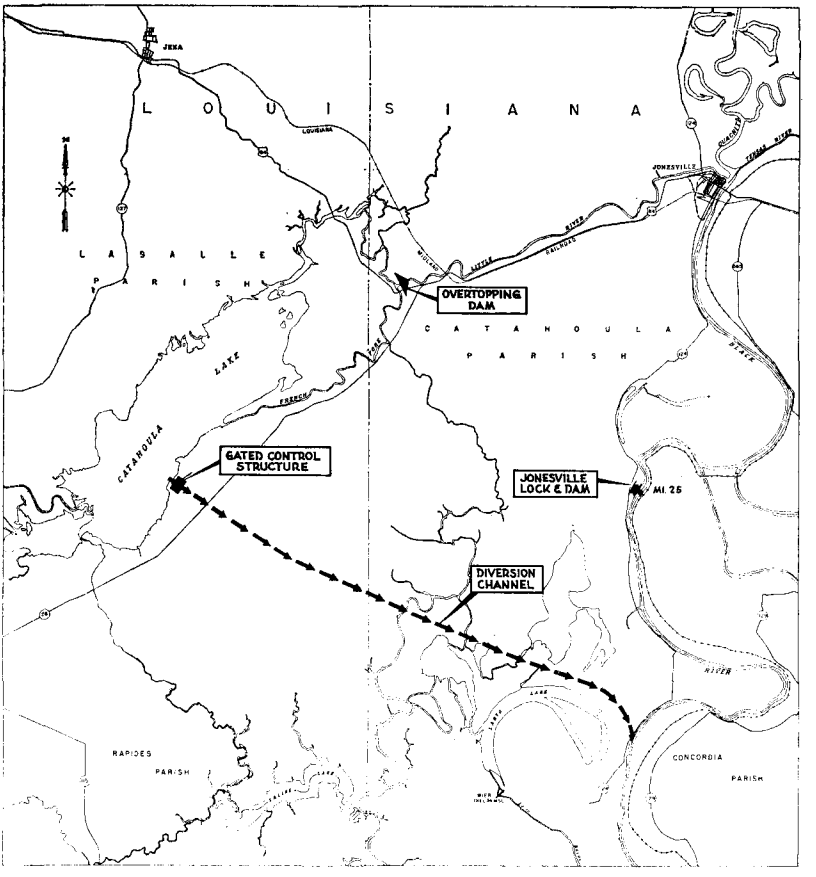

LOCATION MAP
OF
CATAHOULA LAKE
LOUISIANA
0 25 50
Scale in miles
Jena
Jonesville
Alexandria
CATAHOULA LAKE
25

Figure 1.


CATAHOULA LAKE DRAINAGE AREA
BACKWATER FLOW
NATURAL DRAINAGE
TRANSECT
N
JENA
JONESVILLE
CATAHOULA LAKE
LITTLE RIVER
BLACK RIVER
SALINE LAKE
BAYOU LAKE



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