dangerous circumstances. While being weighed, a 215 pound boar severely lacerated the legs of one handler, cutting through his boots, when the hog escaped his restraining ropes and attacked. The possibility of injury by a hog to the trappers is almost nonexistent when the animal is immobilized with Cap-Chur-Barb.

The drugs, nicotine and Trilafon, were not satisfactory for immobilizing trapped hogs. A high mortality occurred with nicotine while Trilafon, a tranquilizer, still required the hog to be restrained by ropes and straps.

The wide margin of safety in Cap-Chur-Barb is the big factor in handling trapped hogs without mortality, and there has never been an occasion for administering the antidote. Only one person is required to handle an immobilized animal. The disadvantage of the drug is its prolonged action which renders the trap inoperative until recovery and release of the animal.

SUMMARY

Two types of traps were used for trapping the European wild hog, a permanent pen and a portable chain-linked trap.

Cap-Chur-Barb, a barbiturate type drug, used at the rate of 500 mg/15 pounds of body weight has immobilized 105 trapped European wild hogs without mortality.

ACKNOWLEDGMENTS

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PRELIMINARY X-RAY STUDIES OF DEER PRODUCTIVITY NEAR CROSSVILLE, TENNESSEE

By JAMES C. LEWIS
Tennessee Game and Fish Commission

ABSTRACT

Handling techniques for *x*-raying trapped doe deer are described. Myothesia was used as an anaesthetic at the rate of 1.5 cc. per 5 pounds body weight. A portable *x*-ray machine with maximum output of 30 MA and 80 KV was used to *x*-ray eight dead and forty-eight live deer. Pictures were made of yearling deer (12-14 cm. width) at 0.5 second exposure time, 36-inch focal-film distance, 25 milliamps and 65 kilovolts. Machine settings were the same for older deer, except kilovoltage, which increased 2 kilovolts per cm. of deer width.

Radiographs indicated that 52 deer contained an average of 0.83 fetus and none of the 23 yearlings were shown to be pregnant. The adult does averaged 1.5 fetuses. Aging of fetal images on the *x*-ray is discussed. Evidence of prenatal mortality was not found.

INTRODUCTION

The ability to predict the annual fawn crop is necessary for good deer herd management. Variations in productivity are related to age composition of the

herd and range conditions (Severinghaus and Cheatum, 1956:100). Techniques commonly used to determine herd productivity are ovarian analysis (Cheatum, 1949), fetal counts (McDowell, 1959), and field observations of adult deer:-fawn ratios. Ovarian analysis is commonly used where does are part of the legal fall harvest or where suitable samples can be collected from road kills and miscellaneous sources. In some states, (Brown, 1957; Noble, 1960) deer have been collected specifically to make fetal counts and examine ovaries.

In areas without doe hunts opportunities for obtaining dead does may be infrequent. Public sentiment or low deer populations may prevent collecting adequate samples of productivity data by shooting does. In such areas, productivity data has been lacking except for field observations of adult deer:fawn ratios. The difference between potential (*in utero*) and observed ratios is important but information which is not generally available.

This paper presents techniques and preliminary results of deer productivity studies using radiography. Trapping was conducted on the 80,000 acre Catoosa Wildlife Management Area, 13 miles north of Crossville, Tennessee. This area is part of the Cumberland Plateau Physiographic Division. Objectives of the study are to find techniques suitable for determining the deer herd productivity by *x*-raying wild trapped deer, to evaluate prenatal mortality, to study variations in annual productivity, and to check the feasibility of aging fetuses by measuring *x*-ray pictures.

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LITERATURE

Recently radiography was presented as a technique in deer productivity studies in Michigan (Verme *et al.*, 1959). They explored the feasibility of determining pregnancy and at what stage of gestation they could discern fetuses. They *x*-rayed 17 dead and 19 live, captive, experimental does but radiographs of ten live deer ". . . were of poor quality for undetermined reasons and were not useable". A General Electric portable unit capable of 65 kilovolts and 15 milliamps was used; however, they felt ". . . . a more powerful *x*-ray unit would be desirable". (Verme *et al.*, 1959:2). The exposure time used was 1.3 seconds at a 30-inch focal film distance.

They reported little difficulty in holding deer during the short time needed to complete the picture but used pentobarbital sodium to calm a few deer with reasonably satisfactory results. Based on their study, "Pregnancy and number of young can be determined in live deer with considerable certainty from the mid-point (100th day) of gestation onward".

Verme (*et al.*, 1959:2) spoke of fetuses 66 to 105 days old and said "Under ideal situations . . . fetal counts may be reasonably valid as early as the 66th day".

RADIOGRAPHIC EQUIPMENT USED

Based on the Michigan studies, we chose a larger Westinghouse machine with a maximum output of 30 milliamps (MA) and 80 Kilovolts (KV). As KV settings increase, the quantity and quality of *x*-rays increase. MA and exposure time directly determine the number of *x*-rays emitted. This portable machine, five 14 by 17-inch non-grid Keleket cassettes with Patterson, par-speed screens, drying racks and a film box were acquired at no cost from the Tennessee Department of Public Health. The machine and accessory equipment was used on TB *x*-ray buses in the 1930's and was replaced by modern diagnostic equipment. Similar used equipment is probably in storage in many states.

The portable power unit and developing tank were army surplus equipment. A cassette, darkroom timer, film viewer, protective clothing, developer and fixer solutions, and Dupont 508 X-tra fast medical film were purchased. The total expenditures were $550, including replacement of the used x-ray tube ($240). Film costs approximately $0.75 per sheet. Radiographic work was a sideline to trapping for collection of other biological data and therefore labor costs are not included.

TECHNIQUES DEVELOPED

Beginning in March of 1961, white-tailed deer were captured in Michigan-type deer traps. In two mid-March to mid-April trapping sessions, with salt as the bait, 55 and 99 trap nights were required per capture. From April 30 to May 10, 1962, only 5.7 trap nights were required per deer. In February, 1962, using corn as bait, our trapping efforts were unsuccessful. In the future we expect to trap in late April and May.

Does were moved from the trap into a transfer crate and weighed using a portable tripod and beam balance scales. We attempted handling deer without an anaesthetic; however, with only a two man crew it was hard on both man and beast. Movement of the deer and fetus should be minimized to insure a clear x-ray picture. For these reasons and to facilitate dental examination, Myothesia (Secobarbital Sodium and Mephenesin, S. E. Massengill Co., Bristol, Tennessee) was administered. The manufacturers rate it ". . . highly as a skeletal relaxant, it passes the placental barrier, and produces smooth induction on awakening with virtually no side reactions, as is sometimes observed with pentobarbital sodium".

One man held the deer's head at one top door of the transfer crate, while the second man reached through the other door in the top of the crate and administered Myothesia intraperitoneally. One and one-half cc. per 5 pounds of body weight gave satisfactory narcosis in approximately 20 minutes, however, variations among individual deer made the reaction to narcosis somewhat unpredictable. Attempts at intravenous injections in the jugular vein were unsuccessful due to inability to hit the vein of a struggling deer. Sixteen gauge, 2 inch needles and 30 cc. syringes were used.

Initially, all equipment was hauled along the trap line and assembled at each capture point. Later the machine was set up permanently in a building on the Catoosa Wildlife Area and the deer hauled to it.

Deer were tagged and aged by dental examination (Severinghaus, 1949), with the aid of jaw spreaders and a dental mirror. They were laid on their side beneath the tubehead and positioned so that the femur and spine would border two edges of the picture. The teats of all deer were checked for lactation since the trapping of a doe that had dropped her fawns seemed possible.

Penetrating ability of the x-rays varies directly with KV. As deer density or width increases, kilovoltage must be increased. Width is the vertical measurement made just anterior to the pelvic girdle when the deer is laying on its side. Proper machine settings for KV cannot be judged by the deer's weight. For example, a 113 pound doe had a width of 23 cm. while a doe weighing 143 pounds had a width of 18 cm.

The focal-film distance first used was 30 inches. Later a radiographic cone was added to the tubehead to reduce scattering of x-rays and improve definition of the picture. For a full picture the cone required increasing the focal-film distance to 36 inches and hence the KV had to be increased.

For larger deer, when we are forced to use our maximum settings, the 30-inch focal-film distance provides a more satisfactory picture.

Yearling does on the area average 87 pounds and 12 to 14 cm. in width in May. Usable x-ray pictures were made at 36-inch focal film distance, 0.5 second exposure time, 25 MA and 65 KV. Settings were the same for older deer, except kilovoltage, which increased 2 kilovolts per cm. of deer width. For the largest doe trapped (166 pounds and 23 cm. width) we used the maximum MA and KV settings. For deer of this size, exposure time should be increased slightly to insure proper penetration of the rays.

After *x*-raying, the anaesthetized deer were placed in a dry spot and left alone to recover. Deer were not lost to predation during the recovery period which varied from 3 to 12 hours.

Fetuses from autopsied deer were aged using the chart by Armstrong (1950) for aging of northern white-tailed deer (*Odocoileus virginianus borealis* Miller). Native deer were almost extinct and the herd built up from a release of 324 deer; most of them purchased from Wisconsin. The size of the Catoose Area's deer is thought to be more typical of the northern white-tail. A gestation period of 201 days was used (Severinghaus and Cheatum, 1956:95).

Estimated age of the fetuses *x*-rayed was 108 to 156 days, which means the forehead-rump measurement was from 224 mm. (8.8 inches) to 385 mm. (15 inches). The 14 by 17 inch film cassette is the largest available, consequently, when the fetus nears 140 days old it becomes difficult to include all skeletal extremities on the film.

Milliamp seconds (MAS) is a measure of exposure to radiation. Our maximum settings of 22 MAS (30 MA, ¾ sec.) were small compared to the 250 MAS exposure given humans for vertical diagnostic films of pregnancy. There is no reason to suspect that exposure to these levels of radiation will harm fetus or adult. Lead-lined aprons and gloves were worn by the operators for protection and a film badge service was used to determine radiation exposure. Other precautionary measures are discussed by Verme (*et al.*, 1959:3).

Films were developed by the project leader using standard techniques. Plans have been made to construct darkroom facilities on the wildlife area so film can be developed while we have the does available for further study.

PRODUCTIVITY DATA

Eighty *x*-rays were taken of eight dead and 48 live deer. The 52 animals for which usable *x*-rays were available averaged 0.83 fetuses (Table 1). The eight dead deer were autopsied after *x*-raying and results of these films were verified as four twins, two singletons, and two not pregnant.

Radiographs of the 23 yearlings did not indicate pregnancy. From a small series of fetuses collected locally (Table 2) it appears that the peak of parturition might be around the second week of June. Most fetuses would be 100 days old or older by March 1 and should have been visible on film at that time. Five of the 52 deer were *x*-rayed between March 21 and 30, seven in April and 40 in May. It seems that most fetuses would have been large enough to detect if the yearlings had been pregnant.

Films of four of the autopsied deer were used for aging by *x*-ray. After correction for magnification the films underestimated fetus age by –33, –41, –51, and –14 days. Films for aging fetuses must be of high quality so that the skeletal extremities are distinct. I consider head height (anterior edge of jawbone to posterior edge of skull) the most accurate measurement because the skull is generally the clearest fetal skeletal structure (dense ossified bone) in the picture. Eventually a correction factor may allow us to convert skeletal measurements to the actual measurements of Armstrong's chart.

TABLE 1

DEER PRODUCTIVITY DATA BASED ON RADIOGRAPHS
CATOOSA W. M. A., 1961-62

Doe Age	*No. Does x-rayed*	*No. Fetuses*	*Average No. Fetus/Doe*
1	23	0	.00:1
2	10	10	1.0:1
3	10	16	1.6:1
4	7	14	2.0:1
5	1	1	1.0:1
6	0	0	....
7	1	2	2.0:1
Total	52	43	0.83:1

Evidence of prenatal mortality or abnormal development was not found on the films. Fetal death in humans can be detected on *x*-ray films by sharp tissue

outlines, sharp angulation of the spinal column, mummified appearance of the fetus and by taking pictures of the same individual over a several weeks period (Meschan, 1956).

TABLE 2

AGE OF FETUSES COLLECTED FROM ACCIDENTALLY OR ILLEGALLY KILLED DOES, CATOOSA W.M.A. CROSSVLLE, TENNESSEE, 1961-1962

Date	*Fetus Age (Days)*	*Calculated Birth Date*	*Calculated Breeding Date*
4-16	169	5-18	10-29
5-31	born 2 days	5-29	11- 9
4- 4	140	6- 4	11-15
5-10	174	6- 6	11-17
5- 9	171	6- 8	11-19
5- 5	158	6-17	11-28
5-15	154	7- 1	12-12
6- 3	170	7- 4	12-15
4-26	87	8-18	1-29
3-30	49	8-29	2- 9

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