

The air dry content of 11 species of fruit averaged 53 per cent of fresh weight. This compares favorably with browse which ranges from 25 per cent air dry in spring to 50 per cent in winter.

Goodrum (1959) reported that the average annual expected yield of fresh sound fallen acorns on a 14-inch tree, which is approximately one square foot of basal area, was 4.90 pounds for post oak, 6.59 pounds for white oak, 5.90 pounds for blackjack, 1.98 pounds for southern red oak, and 8.19 pounds for water oak. He estimated that for optimum populations of wildlife enough oaks are needed to produce 40.67 pounds per acre. This would be 5 to 20 feet of basal area.

These are average annual production figures, whereas the fruit production data are for the part of the population with some fruit. The variation in extent of fruiting from year to year would cause the average annual fruit production for the whole population to be somewhat lower than reported.

The species for which data are available produced from 20 to 65 pounds per square foot of basal area. Full stands of pine may have 10 to 15 feet of basal area of understory hardwoods. With the proper species and age classes, production of fruit could be several hundred pounds per acre.

Since most oaks require crown space in the canopy, comparable acorn production could not be achieved in the presence of full stands of pine. However, acorns are highly desirable on a wildlife range and they mature when they are most needed.

Much information is needed to fully evaluate the many species which produce fruit in southern forests: Which will produce the most in the least space? How may fruiting be stimulated? How may the more promising species be propagated and managed intensively? What are the relative nutritive values?

The data from Texas may have limited value elsewhere. Certainly it should be checked in other areas. The present objective will be accomplished if interest is stimulated in the fruit crop.

#### SUMMARY

1. The unique aspect of understory hardwoods is their ability to produce quantities of fruit without requiring canopy space in competition with pines.
2. Production of 20 to 65 pounds of fruit per square foot of basal area was found for five species. This compares with 2 to 8 pounds reported for oak species.
3. Fruit production may exceed that of usable deer browse.
4. Counts of fruit and equations for estimating fruit production are reported for several species.

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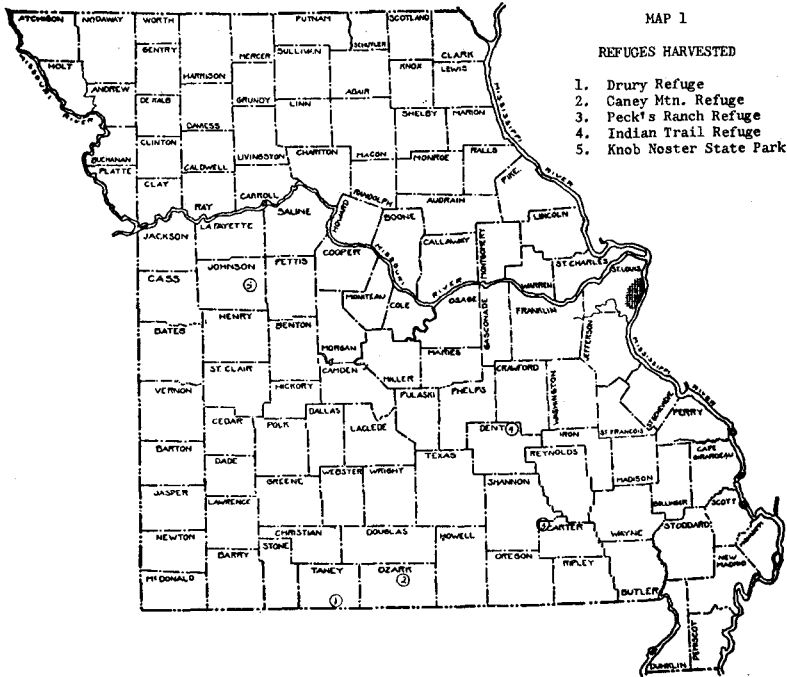
## DEER HARVESTS FROM REFUGE AREAS IN MISSOURI

DEAN A. MURPHY

*Missouri Conservation Commission*

This paper summarizes experiences and data derived during the reduction by hunting of deer populations on five refuge areas in Missouri. These harvests have provided us with our best information on actual densities of deer populations, a knowledge of which is basic to other facets of deer research.

Two of the refuges, Drury and Caney Mountain, are located in the southwestern Ozarks (Map 1). This region is characterized by cedar



glades on the more arid south and west slopes and oak-hickory forests on the other slopes. Soils are of poor quality and very rocky.

Two other refuges, Peck's Ranch and Indian Trail, are located in the central part of the Ozark Plateau. The forest is predominantly oak-hickory, but some oak-shortleaf pine type occurs. These soils are also poor and rocky.

The fifth refuge, Knob Noster State Park, is located in west central Missouri in the Western Prairie Region. Soils are of slightly better quality and less rocky. The region is less forested than the Ozarks Plateau, and there is more cropland in this region than in the Ozarks.

#### *History of Refuges*

Drury (1939) and Indian Trail (1924) were among the earliest refuges established in the state. Both had residual deer populations even during the lowest period in Missouri's deer history, in the early 1930's. Caney Mtn. was established in 1940 and stocked with deer in 1941. These three refuges all supplied deer for the redistribution program (1939-1959). As the deer distribution program was being concluded the primary purpose of the refuges was shifted to production of wild turkeys for trapping and redistribution.

Peck's Ranch was established in 1954. Its sole purpose has been production of turkeys for redistribution. Deer populations have built up in the area because of protection and establishment of food plots.

The deer herd in Knob Noster State Park was established entirely by stocking in 1945-47. There is no active management program for wildlife production on the park, and deer utilize cultivated crops on adjacent farm land.

#### *Chronology of Harvest*

Indian Trail was the first refuge opened to deer hunting. It was opened for three days in 1952 because deer browsing was becoming too heavy. Only half the area (8,120 acres) was opened to hunting; therefore the entire deer population was not removed. A check station was established at the main access to the area, but hunters also had access through several minor trails. Data on hunting pressure and kill are therefore minimum figures. Hunting pressure was 76 hunters per square mile (Table 1) and 23 deer per square mile were harvested.

Caney Mountain Refuge was opened for 3 days in 1953 because of heavy browsing by deer. The entire area (5,527 acres) was hunted. A check station on the only access road collected more complete data than could be obtained on Indian Trail. Hunting pressure was 27 hunters per square mile. The harvest of 16 deer per square mile was thought to be nearly the entire deer population. However, five years later (1958), it was necessary to open the refuge again because the deer were destroying food patches planted for wild turkey. The area was open for 6 days in 1958 and hunting pressure increased to 40 hunters per square mile. Hunters again took most of the population. A harvest of 17 deer per square mile was removed.

Drury Refuge was opened in 1959. The entire refuge (1,877 acres) was opened for 6 days. Deer browsing had been heavy in the refuge for many years (Dalke and Spencer, 1944) and competition with turkeys was acute. Complete data on the harvest was obtained by a check station located on the single access road. Hunting pressure was extreme—200 hunters per square mile. The entire deer population of 99 per square mile was removed.

One half (5,774 acres) of Peck's Ranch was also opened for 6 days in 1959. The purpose of Peck's Ranch is to provide wild turkeys for restocking in other parts of the state. Deer were competing with turkeys for food and were interfering with trapping. A check station on the single access road gathered complete data. Hunting pressure was 83 hunters per square mile. Since only half the area was hunted, the harvest of 22 deer per square mile does not represent the entire population.

Rifles were permitted on all four of the above refuge hunts. Despite the extreme concentration of hunters there were no hunting accidents.

Knob Noster State Park was opened to archers only in 1960. The 3-day season immediately preceded the gun season. Deer utilization of available forage had been heavy since 1953, only 6 years after stocking was completed. A die-off of deer caused by undetermined disease occurred in 1953 and some starvation occurred during unusually heavy snowfall during the winter of 1959-60. One purpose of the special season was to test the ability of archers to thin a deer herd without decimation such as we had experienced on other refuges during gun seasons. A heavy concentration of archers occurred (178 archers per square mile) and they took a surprisingly heavy harvest—26 deer per square mile. The harvest accomplished the purpose of thinning without extermination.

#### *Age and Sex Ratios*

Two questions must be considered in any interpretation of age and sex ratios collected from the harvest: First, "Is the sample representative of the harvest?" Second, "Is the harvest representative of the population?"

Age and sex ratios collected from the refuges should certainly be representative of the harvests because over 90 percent of the known harvest was examined from all areas except Peck's Ranch, where biologists examined 86 percent of the harvest. The question remains, "Is the sample representative of the population?" The Caney Mtn. and Drury harvests removed practically the entire deer population from each area, so these samples should certainly be representative of the population. An unknown percentage of the population was harvested from the other three areas, and here the question remains unanswered.

Age ratios from the three refuges with partial harvest contain a slightly higher percentage of fawns and adult deer than have been found in harvests throughout the any-deer territory (Table 2). Age ratios of the three complete harvests show fewer fawns and a much higher percentage of adults than the partial harvests in the state sample. The adult segment of the complete harvests exceeded 50% in all three cases. This suggests that a deer herd is being over-harvested when the adult segment of the harvest approaches or exceeds 50%. These data apply, of course, to an unshot herd—percentage would be lower in a herd harvested annually. The percentage of old deer (4½ years or older) was considerably higher in all the refuge harvests than in the state average. The highest percentages of old deer were found in the more complete harvests. These data indicate that we were stockpiling deer on the refuges.

Fawn sex ratios for the state and refuges harvests are comparable—both show a slight preponderance of males. Yearling sex ratios from our general any-deer harvests have shown a large preponderance of males. The refuge harvests indicated more even sex ratios or even an excess of yearling females. Adult sex ratios of the any-deer harvests have been slightly in favor of adult males, but on the refuges the harvests ran heavy to adult females. These data suggest greater mobility of yearling and adult males, carrying them out of the refuge where they are subject to harvest. The females are more sedentary and remain in the refuges, producing young and compounding the problem of over-population.

Some indication of lowered nutritional level caused by over-concentration is revealed in data on reproduction and physical development of deer harvested in the refuges. However, sample size is rather small in some classes.

The best evidence of lowered reproductive rate came from Drury Refuge, the area with greatest concentration of deer. Biologists collected ovaries from 24 females. All had ovulated prior to the harvest. Average production as indicated by current corpora lutea was 1.5 fawns per female. This figure is comparable to 1.7 fawns per female for the adjacent county. However, the fawn/doe ratio of the harvest was only .46 fawns per female, about  $\frac{1}{2}$  the ratio indicated the ovaries. Fawn/doe ratios of general any-deer harvests are usually not representative of reproductive success, because of hunter bias against shooting fawns, but the ratio from Drury Refuge certainly is representative because the entire population was taken. These data suggest that excessive fawn mortality occurred between conception and the hunting season. Since we had no reports of fawns dying on the area, it appears that mortality must have occurred in-utero. These data serve to emphasize that reproductive rates obtained from ovarian counts are merely potential rates and may not be at all representative of actual production.

Body weights and antler development of deer are generally considered indicative of range conditions (Hosley-1960). The measurements we use most frequently in Missouri are dressed weights of fawns and yearling antler development. Data from the refuge harvests show that the fawns from the refuges are generally smaller than deer in the surrounding county, but that differences do not vary directly with population density (Table 3). The yearling antler measurements correlate slightly more and may be the better indicators. Sample size, however, precludes any positive correlations.

Forage utilization studies are being conducted on several of the refuges. Deer harvests from the refuges provided the opportunity of correlating known densities of deer with forage utilization (Table 4). The refuges have also provided data on the effects of deer utilization on preferred forage species.

Percentages of plants browsed as given in Table 4 are the average of 2 years preceding the harvest. This average is used to eliminate as much as possible the variation in acorn crop which affect utilization of woods browse in Missouri.

Utilization of the preferred winter browse species on the refuges was quite heavy. However, despite the yearly removal of substantial amounts of annual growth from the preferred species, we have been unable to demonstrate destructive browsing of these species. Preferred species included: Coralberry (*Symphoricarpos orbiculatus*), Smooth sumac (*Rhus glabra*), Dwarf sumac (*Rhus copallina*), Aromatic sumac (*Rhus aromatica*), Sassafras (*Sassafras albidum*) Red cedar (*Juniperus virginiana*), Low blueberry (*Vaccinium vacillaus*) and Shortleaf pine (*Pinus echinata*).

Lay (1956) suggested that quality of forage may be so low on some southern deer ranges that over-stocking may occur before a browse line can be demonstrated or before a change in vegetational composition occurs. His suggestion appears to apply to winter deer range in southern Missouri.

Unusually deep snow, up to 24 inches, fell on Knob Noster during March 1960, and persisted for over three weeks. Deer utilized all available preferred foods and browsed some non-preferred species quite heavily. Non-preferred species which were browsed heavily included: Oaks (*Quercus* sp.)—73% of trees browsed, Persimmon (*Diospyros vir-*

*ginia*)—74%, Dogwood (*Cornus* sp.)—50%, and Redbud (*Cercis canadensis*)—44%. These species are seldom browsed on moderately stocked deer range in Missouri. Quality of these foods was insufficient to meet the increased energy demands caused by the snow and some starvation occurred. Utilization of these species on other ranges in Missouri may serve as a better indication of deer over-population than will utilization of preferred species.

We have not been able to demonstrate destructive utilization of winter browse species, but we have found destructive browsing of summer browse species. It appears that in Missouri and possibly in other southern states, the summer browse species may be the best indicators of over-utilization (Dunkeson, 1955).

Decreasing numbers and thrift of summer browse species caused by over-utilization has been demonstrated on Drury Refuge and Knob Noster State Park. Species which have decreased are: Wild grape (*Vitis* sp.), New Jersey Tea (*Caenothus americana*), Wild hydrangea (*Hydrangea arborescens*), and American (*Ulmus americana*). These species are all shrub forms except elm, which assumes a shrubby form with severe browsing.

Decreases in preferred species of perennial forbs due to deer browsing could not be demonstrated even under the most severe browsing.

It appears that the 16-17 deer per square mile which were harvested from Caney Mtn. Refuge approaches the maximum density of deer which Ozarks range can support in a normal year. This density would exceed the carrying capacity in a year of acorn failure and deer management in the Missouri Ozarks should be aimed at maintaining a deer density below this level.

#### SUMMARY

Deer were harvested from five refuges in Missouri. Four refuges in southern Missouri were harvested by gun hunters. Hunting pressures as high as 200 hunters per square mile were experienced. Deer harvests as high as 99 per square mile were taken.

One refuge in western Missouri was opened to archers only. Opening day pressure was 178 archers per square mile. The archers removed 26 deer per square mile and succeeded in thinning the herd without exterminating it as gun hunters did on other refuges.

Age ratios of the harvests indicated that deer were being stockpiled on the refuges. Age ratios from refuges where the complete population was harvested suggest that over-harvest of the herd is indicated when the adult segment approaches 50% of the harvest.

Sex ratios of the harvests indicated that yearling and adult females are more sedentary than males and thus remained in the refuges, producing young and compounding over-population.

Reproductive data from one refuge showed that counts of current corpora lutea indicated a potential reproduction which was nearly 3 times as great as the actual production.

Comparison of dressed weights of fawns and antler development of yearling deer harvested on the refuges was compared with similar data from counties surrounding the refuges. Yearling antler measure correlated more closely with population density and thus are more sensitive to range conditions than are fawn weights.

Destructive browsing of preferred winter browse species was not found even on the refuges having the most dense populations. However, destructive browsing of preferred summer browse species was demonstrated. The summer browse species are better indicators of range deterioration than are the winter species in Missouri.

Non-preferred winter browse species were heavily utilized during a period of unusually deep snow. These species may prove most useful as indicators of over-stocked range.

It appears that 16 deer per square mile is about the maximum carrying capacity for Missouri Ozarks range.

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TABLE 1  
HARVEST STATISTICS FROM REFUGES IN MISSOURI

Refuge	Year	Acres Hunted	Maximum Hunters		Total Deer Kill	Deer Kill Per Sq. Mi.
			No. Hunters Per Day	Per Sq. Mi.		
Indian Trail	1952	8,120	969	76	293	23
Caney Mtn.	1953	5,527	232	27	140	16
Caney Mtn.	1958	5,527	347	40	150	17
Drury	1959	1,877	589	201	291	99
Peck Ranch	1959	5,774	750	83	197	22
Knob Noster	1960	3,300	921	179	136	26

TABLE 2  
COMPOSITION OF REFUGE HARVESTS

	State Aver.	Indian Trail	Peck Ranch	Knob Noster	Caney Mt. 1953	Caney Mt. 1958	Mt. Drury
<i>Age Distribution</i>							
Fawns	34%	38%	35%	40%	27%	33%	23%
Yearlings	29	21	24	17	21	14	19
Adults	37	41	41	43	52	53	57
Dear 4½ yrs. and over	6	12	9	13	19	19	17
<i>Sex Ratios (% Males)</i>							
Fawns	53	42	53	53	59	54	53
Yearlings	66	28	38	65	52	52	38
Adults	55	24	34	27	43	27	34

TABLE 3  
COMPARISON OF WINTER BROWSE UTILIZATION AND DENSITY OF HARVEST

Refuge	Harvest Per Square Mile	Total No. Plants	Percent of Plants Browsed
Drury	99	871	93%
Knob Noster	26	1134	89%
Indian Trail	23	689	95%
Peck Ranch	22	734	90%
Caney Mtn. '58	17	1064	46%
Caney Mtn. '53	16	793	67%

TABLE 4  
COMPARISON OF PHYSICAL DEVELOPMENT REFUGE AND SURROUNDING COUNTY

Refuge	Harvest Per Sq. Mi.	Yearling Antler Measurements				
		Dressed Wt. of Fawns	Beam Circum. % Unforked			
	Refuge County	Refuge County	Refuge County			
Drury	99	41 lbs.	57	62	75	27
Knob Noster	26	44	46	56	59	33
Indian Trail	23	58*	60*	53	61	47
Peck Ranch	22	46	45	59	53	21
Caney Mtn. '58	17	43	46	49	52	60
Caney Mtn. '53	16	37	46	49	51	56

\* Dec. season—all others in Nov.