Companies Giving Special Consideration to Game in Cutting Operations	104
Companies Planting Game Food Species	44
Acres Planted	8,637
Average Big Game Kill on Industry Lands	127,490

* * *

Use of Lands for Hunting

Acreage Closed to Hunting, Exclusive of Game Refuges (5.8 per cent of total area)	2,635,037
Acreage in Game Refuges (1.9 per cent of total area)	891,277
Acreage Open in Season (92.4 per cent of total area)	42,737,538

* * *

Use of Lands for Fishing

Acres of Industrial Lands Open to Fishing (96.3 per cent of total area)	44,567,341
Miles of Lakes and Streams Open to Anglers	55,928

* * *

Companies Taking Steps to Improve Fishing	41
Companies Stocking Streams	22
Artificial Lakes Built by Industry	228

ACORNS IN THE DIET OF WILDLIFE

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INTRODUCTION

There is a paucity of knowledge of the nutritive values of wild feed stuffs as well as the basic food requirements of wildlife species. The main purpose here is to summarize known nutritive values of acorns from southern oaks and to report the results of acorn water content determinations. Additionally, the number of oaks by species and size classes required per acre to sustain given levels of game species is also listed. This information is essential in coordinating wildlife needs with the timber stand improvement program in the southern pine region.

IMPORTANCE OF ACORNS

The fact that acorns are one of the main foods of wildlife in the southern states is convincing proof of their importance. One hundred and eighty-five species of wildlife are known to feed on acorns (8 and 19). It is common knowledge that most game animals feed avidly on acorns. However, many non-game species are also heavy users of acorns, including woodpeckers, crows, bluejays, and a variety of rodents. Furthermore, feral domestic hogs and sometimes cattle and goats are serious competitors of wildlife for acorns (14 and 15).

The importance of acorns in the diet of southern quail has not been generally recognized. Analysis of 6,589 quail crops collected over an eight-year period during the months of November through February each year in the longleaf pine woodland revealed that acorns made up from 5 to 39 percent by volume of all food consumed with a yearly average of 15.8 percent (14 and 16).

Acorns are sought by wildlife as long as they are available. They are extracted from litter by game species long after they have fallen. During years of good crops they are available to most game animals for about eight months or longer. Squirrels bury the nuts in the ground, making them available all year (15 and 16). Squirrel stomach analyses substantiate this statement (6).

NUTRITIVE CONTENT

Acorns are high in nutritive content, especially carbohydrates and fats (3, 5, 8, 13, 19 and 21). Foods high in these energy nutrients are needed by wildlife in fall and early winter in the South to put them in good condition for the lean times of winter. Good condition in wild animals during the reproductive season is also conducive to a high rate of productivity and survival of young.

WATER CONTENT AND ACORNS PER POUND

The amount of moisture in a food item directly affects its nutrient content. To determine the nutritive value of a food, it is first necessary to determine the percent of water, and therefore dry matters. Furthermore, it is common practice to base diet determinations on a dry matter or air-dry basis which is often standardized at the 15 percent moisture level.

The water content of several acorn species reported by a few workers (reference numbers shown within parentheses in first column of Table I) varies from four to 65 percent. The chemical analyses of these acorns were done at various stages of desiccation and do not depict the water content of fresh acorns. The percentage figures of the nutrients shown in Table I, therefore, are based on dry matter so that a better comparison may be made.

After collecting the fresh acorns they were weighed immediately and then fumigated to kill any weevil larvae that may be present. After fumigation they were placed in wire baskets in the laboratory. They were weighed again every 14 days and at the end of 30 days they were coarsely ground.

The water content of acorns shown in Table II was determined by heating one pound of the ground acorns in a forced draft over at 105 degrees centigrade and 29 pounds pressure for five hours.

The number of acorns per pound is shown under three moisture conditions: (1) Fresh acorns, 1 to 5 days after falling from the tree. (2) After 30 days under room conditions. (3) After oven drying and standardizing to the 15 percent moisture level (standard air-dry weight).

The number of acorns per pound is based on the average collected from 20 trees of each species, with about one-quarter pound taken from each tree. Most acorns vary greatly in size within a species. Therefore, it is important in determining acorn yields to know the average number of acorns per pound on a fresh, air-dry, and dry matter basis (Table II).

Acorns held 30 days under normally heated room conditions roughly approximated those at the 15 percent moisture level, when all species were considered. However, there was some variation among species (Table II).

Acorns of the white oak group contained a higher percentage of water than those of the black oak group. The highest water content of fresh acorns was found in cow oak, with 56.6 percent, and the lowest in water oak, with 26.5 percent.

This information suggests that fewer pounds of acorns of the black oak group may be required in the wildlife diet that acorns of the white oak group. However, white oak acorns appear to be favored by game. This may be due to their lower tannin content. Red oak acorns (*Quereus falcata*) are less palatable to caged fox squirrels than other acorns and it has been assumed that this is due to the relatively high tannin content of red oak (2).

ACORN YIELDS AND FOOD REQUIREMENTS

In timber stand improvement work where wildlife is considered, it is important that we know what to expect in the way of average acorn yield for various species and size classes. Acorn yields for six species were studied for a seven-year period. The data show the expected acorn yields from trees by two-inch diameter classes (Table III). These data coupled with information on the food requirements of wild animals give us a good basis for estimating the pounds of acorns needed to support given densities of game species.

The food requirements for a number of game species have been determined (Table IV). Nichol (14) and French, *et al.* (4), did this for white-tailed deer.

Uhlig (18), and Hawkins (7) have done it for the gray squirrel. Baumgartner (1) and Baumgras (2) have reported on the food intake of the fox squirrel. Schemnitz (17) and Mosby and Handley (10) have presented data useful in estimating the food requirements of the wild turkey. Michael and Beckwith (11) found that a total of 10 grams of food was necessary to sustain an adult quail over a 24-hour period. Reid and Goodrum (15) found that quail consume an average of 5.9 grams of air-dry acorns daily as long as they are available.

Based on information in these reports, we present Table IV, which depicts this estimated intake of acorns and the number of pounds needed per acre per animal for given animal densities over a 180-day period. Although more research is needed to supply gaps in our information, we nevertheless, believe our estimates are conservative.

Data in Tables III and IV eliminate much of the guesswork in computing how many trees of certain species and size class are needed to satisfy the needs of wildlife. Our studies have shown that 48 percent of all acorns produced are not usable or available to ground feeding wildlife. Twenty-four percent are ruined by acorn weevils and fungi and another 24 percent are taken by arborsal feeders, including those taken from the tree by squirrels (15 and 16). This means that total acorn production must be about 92 percent greater than the figures shown in Table IV. In the case of squirrels, it is estimated that half of the acorns eaten are taken from the tree and half from the ground. Thus the total production of sound fallen fresh and air-dry acorns must be at least 40.67 and 24.18 pounds respectively, to provide the amounts needed per acre for the five game species listed for 180 days. This, of course, assumes that the rations include acorns in the proportions shown in Table IV.

To date, the main goal in the hardwood removal program has been to take out the bigger trees, which unfortunately are the heaviest mast producers. We believe it is good conservation to spare an adequate number of the bigger trees, for any error made now will require from 20 to 75 years to correct. It takes that long to grow a good mast producer.

SUMMARY AND DISCUSSION

Oak mast is one of the most important wildlife foods in the South. It ranks high in nutritive content as well as volume and frequency of consumption, and it is available for long periods.

Being high in carbohydrates and fats, it is one of the best foods on which game can fatten and thus condition themselves for the lean winter months.

To determine the value of acorns in basic wildlife rations or diets, it is necessary to know the moisture content. This information is presented for several oak species.

Acorns are available in significant quantity to most southern game species for six months of the year. Based on currently available data on food requirements and average yearly acorn yields for several oaks, five game species need about 57 and 34 pounds of acorns, fresh and air-dry, respectively, to satisfy their requirements for 180 days. This, of course, assumes that the rations include acorns in the proportions shown in Table IV.

This poundage may be provided by an average of four 18-inch water oaks or eight 22-inch postoaks per acre. But usually more than one oak species occurs on most areas, so the number and size of trees needed will depend upon what is available as to size and species. The presence of several species will lessen the chance of a complete crop failure, for if one species fails another will likely produce. Tables III and IV may be used to determine the pounds of acorns needed and the size and species of oaks necessary to produce the mast to feed a full stocking of the five game animals listed.

The larger oaks are the best mast producers, and if these are removed it may take from 20 to 75 years to replace them.

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TABLE I

APPROXIMATE CHEMICAL ANALYSIS OF SOME SOUTHERN OAK ACORNS

Species	*	Percent of Dry Matter: Protein †	Fat †	Nitrogen Free Extract †	Crude Fiber †	% Ash †	Percent Calcium ‡	Percent Phosphorus ‡
WHITE OAK GROUP:								
Q. alba	(11)	4.80	3.60	70.90	17.50	2.50	. . .	. . .
"	(7)	6.73	5.67	67.25	17.38	3.19	(0.19)	(0.14)
"	(20)	6.25	6.32	82.32	2.47	2.64	(Tr.)	(0.16)
"	(18)	7.42	6.81	58.40	24.81	2.56	. . .	. . .
Q. alba and stellata	(12)	5.40	6.00	67.40	18.60	2.60	. . .	. . .
Q. Michauxii	(11)	3.94	2.28	74.84	16.39	2.54	. . .	. . .
Q. stellata	(4)	8.31	7.09	78.07	3.93	2.60	. . .	. . .
"	(11)	5.48	4.90	70.00	16.69	2.92	. . .	. . .
"	(7)	5.15	5.74	66.74	19.46	2.97	(0.40)	(0.11)
"	(11)	4.83	7.60	65.23	19.61	2.78	(0.38)	(0.10)
Q. virginiana	(2)	7.85	2.57	61.56	23.11	4.90	(0.86)	(0.15)
"	(4)	5.72	8.65	81.09	2.38	2.16	. . .	. . .
"	(7)	5.22	8.59	67.95	16.71	1.71	(0.18)	(0.08)
BLACK OAK GROUP:								
Q. falcata	(4)	7.91	22.54	63.79	2.82	2.93	. . .	. . .
"	(11)	4.14	6.44	55.58	30.60	3.22	(0.43)	(0.08)
"	(7)	4.20	15.57	57.73	20.60	1.92	. . .	. . .
Q. incana	(4)	7.70	32.67	41.52	15.95	2.15	. . .	. . .
"	(11)	6.83	16.07	57.03	17.25	2.55	. . .	. . .
"	(7)	5.92	12.66	67.06	12.52	1.84	(0.33)	(0.99)
Q. marylandica	(4)	8.29	27.14	49.71	11.87	2.97	. . .	. . .
"	(11)	5.91	6.49	58.40	26.42	2.78	. . .	. . .
"	(7)	6.29	10.66	60.11	20.94	2.00	(0.37)	(0.09)
"	(7)	5.75	17.73	53.03	21.79	1.76	(0.36)	(0.09)
Q. nigra	(4)	5.94	27.26	58.18	6.36	2.24	. . .	. . .
"	(7)	3.67	20.86	54.82	18.99	1.67	(0.30)	(0.04)
"	(7)	3.97	21.79	54.16	18.87	1.23	(0.21)	(0.06)
"	(7)	4.27	22.83	54.17	17.60	1.15	(0.29)	(0.08)
Q. phellos	(4)	5.66	30.40	55.54	5.86	2.54	. . .	. . .
"	(11)	3.94	9.66	58.71	25.54	2.15	. . .	. . .
"	(7)	4.93	21.86	52.79	18.63	1.79	(0.69)	(0.08)
"	(7)	4.61	22.99	52.84	18.28	1.35	(0.29)	(0.08)
"	(7)	4.20	19.61	54.74	19.36	2.09	(0.30)	(0.02)
"	(7)	5.08	18.52	55.87	18.82	13.37	(1.71)	(0.07)

* Authority.

† Figures based on dry matter only. Percent of water of authors varied widely.

‡ Calcium and phosphorus figures included in "ash" column.

Table II

Acorns Per Pound and Approximate Water Content of Some Oak Species

Species	1956 Acorns Per Pound				1957 Acorns Per Pound				1958 Acorns Per Pound				Average All Years Acorns Per Pound			
	Fresh	After 30 Days at Room Cond.	Air-Dry	Percent Water Fresh Acorns	Fresh	After 30 Days at Room Cond.	Air-Dry	Percent Water Fresh Acorns	Fresh	After 30 Days at Room Cond.	Air-Dry	Percent Water Fresh Acorns	Fresh	30 Days	Air-Dry	Percent Water Fresh Acorns
WHITE OAKS:																
Postoak	269	355	358	36.2	185	268	256	39.9	193	284.9	269.4	39.0	216	302.6	294.5	38.3
White Oak	138.5	210.6	217.2	45.8	...	...	...	...	82.7	159.0	152.8	54.0	110.6	184.5	185	49.9
Cow Oak	...	...	..	...	...	...	...	...	53.6	106.7	105	56.6	53.6	106.7	105	56.6
Overcup	115	161.2	190	48.6	97.8	131	145.4	42.8	...	...	...	...	106.4	146.1	167.7	45.7
Liveoak	399	536	542	37.4	329	503	531	47.2	...	...	...	...	364	519.5	536.5	42.3
BLACK OAKS:																
Southern Red	288	...	...	...	331	426	403	30.2	286	363.2	347.3	30.0	301.7	394.6	375.1	30.1
Blackjack	...	...	...	...	230	292	277	29.4	191	255.9	245.2	33.9	210.5	273.9	261.1	31.6
Sandjack	...	...	...	...	241	304	287	28.5	195	247	232.7	28.7	218	275.5	259.8	28.6
Water Oak	...	...	...	...	383	409	441	26.2	299	371.3	348.0	26.8	341	390.1	394.5	26.5
Willow Oak	...	...	...	...	...	...	...	...	407	519	589	29.3	407	519	589	29.3
Black Oak	...	...	...	...	...	...	...	...	128.3	176.2	167	34.8	128.3	176.2	167	34.8
Shummard's Oak	...	...	...	...	...	...	...	...	100	142	143	40.6	100	142	143	40.6
Average, White Oak Group													170.2	251.9	257.7	46.6
Average, Black Oak Group													295.6	370.6	375.9	29.2

TABLE III

EXPECTED YIELD OF FRESH AND AIR-DRY ACORNS IN POUNDS BY 2-INCH DIAMETER CLASSES PER TREE

Diam. Inches	*Postoak* No. Nuts	*Postoak* Pounds Fresh	*Postoak* Pounds Air-Dry	*White Oak* No. Nuts	*White Oak* Pounds Fresh	*White Oak* Pounds Air-Dry	*Blackjack* No. Nuts	*Blackjack* Pounds Fresh	*Blackjack* Pounds Air-Dry	*Sandjack* No. Nuts	*Sandjack* Pounds Fresh	*Sandjack* Pounds Air-Dry	*Sou. Red Oak* No. Nuts	*Sou. Red Oak* Pounds Fresh	*Sou. Red Oak* Pounds Air-Dry	*Water Oak* No. Nuts	*Water Oak* Pounds Fresh	*Water Oak* Pounds Air-Dry
4	40	.18	.13	....	....	....	....	....	....	230	1.65	.88	....	....	....	....	....	....
6	210	.97	.71	....	....	....	....	....	....	545	2.49	2.08	....	....	....	....	....	....
8	380	1.75	1.29	40	.36	.21	120	.56	.46	857	3.92	3.29	....	....	....	225	.66	.57
10	550	1.54	1.86	270	2.44	1.46	490	2.32	1.87	1,165	5.33	4.45	140	.46	.37	1,075	3.14	2.72
12	720	3.33	2.44	500	4.51	2.70	865	4.10	3.31	....	....	....	300	.99	.80	1,950	5.70	4.93
14	890	4.11	3.02	730	6.59	3.94	1,245	5.90	4.76	....	....	....	600	1.98	1.60	2,800	8.19	7.08
16	1,060	4.90	3.59	960	8.66	5.18	1,620	7.68	6.19	....	....	....	1,080	3.57	2.87	3,700	10.83	9.36
18	1,230	5.68	4.17	1,195	10.78	6.45	2,000	9.48	7.64	....	....	....	1,680	6.15	4.94	4,550	13.31	11.51
20	1,395	6.44	4.72	1,425	12.86	7.69	2,280	10.81	8.71	....	....	....	3,040	10.06	8.09	5,450	15.95	13.78
22	1,560	7.21	5.29	1,660	14.98	8.95	2,760	13.08	10.55	....	....	....	4,700	15.55	12.50	6,350	18.58	16.06
24	....	....	....	1,890	17.05	10.19	3,125	14.80	11.94	....	....	....	6,940	22.96	18.46	7,250	21.22	18.34
26	....	....	....	2,105	18.99	11.35	....	....	....	....	....	....	9,140	30.24	24.32	....	....	....

TABLE IV

APPROXIMATE POUNDS OF FRESH AND AIR-DRY ACORNS REQUIRED BY SOME GAME ANIMALS

	Estimated Daily Intake		*Pounds Required Per Animal—180 Days*		*Acres Per Animal*	*Pounds Per Acre Needed for 180 Days*	
	Fresh	*Air-Dry*	*Fresh*	*Air-Dry*		*Fresh*	*Air-Dry*
White-Tailed Deer	½ Diet of 5# 2.50	½ Diet of 3# 1.50	450.00	270.00	20	22.50	13.50
Gray Squirrel	¾ Diet of 0.20# 0.22	¾ Diet of 0.16# 0.12	39.06	21.60	2	19.53	10.80
Fox Squirrel	¾ Diet of 0.30# 0.22	¾ Diet of 0.19# 0.14	39.96	25.20	3	13.32	8.40
Turkey	¾ Diet of 0.50# 0.38	¾ Diet of 0.31# 0.23	67.50	41.40	50	1.35	0.83
Quail	½ Diet of 0.02# 0.01	½ Diet of 0.01# 0.01	1.98	1.26	5	0.39	0.25
TOTALS	3.32	1.20	598.50	359.46	..	57.09	33.78
LESS POUNDS TAKEN BY SQUIRRELS IN TREE						16.42	9.60
POUNDS OF SOUND FALLED ACORNS NEEDED—See Text for Discussion						40.67	24.18