REFERENCES CITED

Atwood, Earl and C. F. Wells. 1960. Waterfowl Harvest in Louisiana, 1959-60 Hunting Season. Bur. of Spts. Fish and Wildl. 5 pp. mimeo.

Bardwell, J. L. 1961. Nutritional Analyses of Pintail and Teal Foods in Southern Louisiana. Masters Thesis. La. St. Univ., Baton Rouge. 70 pp.

Beter, Robert. 1957. A Comparative Winter Food Habit Study of Dabbling Ducks in Southeast Louisiana. Masters Thesis. La. St. Univ., Baton Rouge. 69 pp.

Chamberlain, J. L. 1959. Gulf Coast Marsh Vegetation as food of Wintering Waterfowl. J. Wildl. Mgmt. 23:97-102.

Dillon, O. 1957. Food Habits of Wild Ducks in the Rice-Marsh Transition Area of Louisiana. Proc. of 11th Ann. Conf. SE. Assn. of Game and Fish Comm. 11:114-118.

Martin, A. C. and F. M. Uhler. 1939. Food of the Game Ducks in the United States and Canada. U.S.D.A. Bull. 634. 155 pp.

Kimble, Robert and A. Ensminger. 1959. Duck Food Habits in Southwestern Louisiana Marshes Following a Hurricane. J. Wildl. Mgmt. 23:453-455.

Midwinter, Waterfowl Inventory—State of Louisiana, Jan. 3-8, 1962. Bur. of Spts. Fish and Wildl. and La. Wildl. and Fish Comm. 1p. mimeo.

Smith, M. M. 1951. The Winter Foods of River and Pond Ducks in the Phoenix Area of Plaquemines Parish, Louisiana. Masters Thesis. La. St. Univ., Baton Rouge. 56 pp.

————. 1961. Louisiana Waterfowl Population Study—Final Report, PR Projects W-17R and W-29R. La. Wildl. and Fish. Comm. 47 pp. mimeo.

Singleton, J. R. 1953. Texas Coastal Waterfowl Survey. Texas Game and Fish Comm. F. A. Rpt. Ser. No. 11. 128 pp.

FOOD UTILIZATION BY WATERFOWL IN GREEN TIMBER RESERVOIRS AT NOXUBEE NATIONAL WILDLIFE REFUGE

By DAVID L. HALL

ACKNOWLEDGMENTS

I would like to express my most sincere appreciation to Dr. Denzel Ferguson, who enabled me to obtain this project, and for his guidance and many thoughtful suggestions during the two-year study period. I would also like to thank Mr. John Camp, Mr. John Phares, Mr. Bill Turcotte, and all of the Mississippi Game and Fish Commission personnel for their financial support of this project. A debt of gratitude is due Mr. Burton Webster and all of his staff at Noxubee National Wildlife Refuge for their help in the field.

INTRODUCTION AND STATEMENT OF THE PROBLEM

Management of marshes, reservoirs, and other open and semi-open areas has been discussed at length by various investigators. Waterfowl food preferences are generally known, and the techniques of water manipulation favoring desired food species, whether natural or planted, are in current usage for many types of land, but such is not the case with forest lands. Many timbered areas normally flooded each year, may or may not be utilized by waterfowl, depending upon the time of flooding. The practice of artificially controlling the time and extent of flooding of green-timber areas primarily for waterfowl usage is relatively new and has received little study.

Mallards and wood ducks make extensive use of flooded woodlands provided adequate food is present. Timber stand improvement practices designed to furnish multiple benefits cannot be formulated until further study is made of waterfowl food preferences and utilization in green-timber reservoirs. The value of artificial plantings to supplement natural food in green-timber reservoirs also requires investigation.

In an effort to attract wintering populations of migratory waterfowl, the United States Fish and Wildlife Service, Mississippi Game and Fish Commission, private hunting clubs, and private individuals have recently begun construction of green-timber reservoirs in Mississippi. The success of such developments is largely dependent upon production of abundant mast crops palatable to waterfowl. Profitable management of reservoir lands demands maximum timber production on them. These two widely divergent purposes require that tree species be known which will best satisfy the demands of each. The land manager must know which tree species to favor in altering species composition by selective harvesting or timber stand improvement. Present knowledge of waterfowl food preferences and utilization in the green-timber reservoir habitat is not adequate to guide the formulation of management policies on a scientific basis.

There has been much controversy on the subject of why migratory waterfowl use green-timber reservoirs. Some waterfowl biologists believe ducks are attracted to green-timber reservoirs solely for feeding. Others minimize feeding in favor of resting and protection. This study was conducted to determine the extent of mast in waterfowl diets in green-timber reservoirs.

METHODS AND MATERIALS

Plots

Plots measuring 3 by 10 chains (198 x 600 ft.) were measured with a Silva compass and 100-foot steel tape and temporarily indicated with cotton twine. The boundary lines were later marked with white paint. Two such plots were located in each of the following habitats in 1960, prior to time of flooding (early November):

a. Mature oak stands
b. Mature mixed hardwood stands
c. Mixed second growth stands
d. Cypress bottoms
e. Semi-open areas supporting abundant herbaceous growth

Mast Traps

Thirty-five mast traps were obtained from the Mississippi Game and Fish Commission during the late summer of 1960. These traps (3' x 3') consisted of a wood frame covered at the base with one-quarter inch mesh hardware cloth. The top was covered with one-inch mesh hardware cloth which permitted mast to fall through freely, while prohibiting the passage of leaves and other extraneous materials. Three mast traps were placed on each of seven plots. Tree selection was random to the extent that the past histories of the trees were unknown and acorn fall had not yet started when the traps were put in place. It was necessary to elevate the traps approximately three feet to prevent them from being inundated after the reservoir was filled. The remaining 12 traps were placed under trees in similar ecological sites which were not to be flooded. All traps were placed half the distance between the edge of the crown and the base of the trunk, and were about evenly dispersed between willow *(Quercus phellos)*, water *(Quercus nigra)*, and cherry-bark *(Quercus falcata* var. *pagodafolia)* oaks. Each tree provided with a trap was numbered for future identification and yield tabulation. Mast collections started in early October and continued until completion of acorn fall. Mast collections were taken to the lab in individual sacks, where the following information was recorded:

(1) Number of acorns in each trap by species
(2) Weight of acorns in each trap
(3) Number of sound and unsound acorns in each trap
(4) Other wildlife usage (birds and squirrels)

The number of sound acorns was determined by the floatation method, whereby floating acorns were considered to be unsound.

FIGURE I. TOTAL YIELD OF ACORNS ACCORDING TO SOUND, UNSOUND, AND OTHER WILDLIFE USAGE FROM NOVEMBER 11, 1960 TO JANUARY 3, 1961 (33 MAST TRAPS)

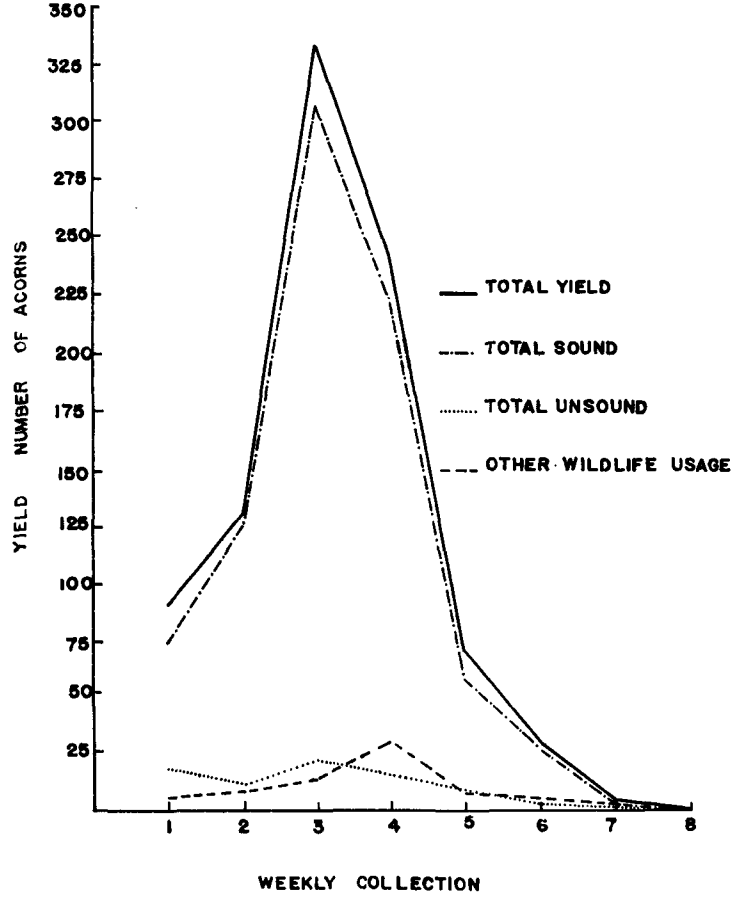
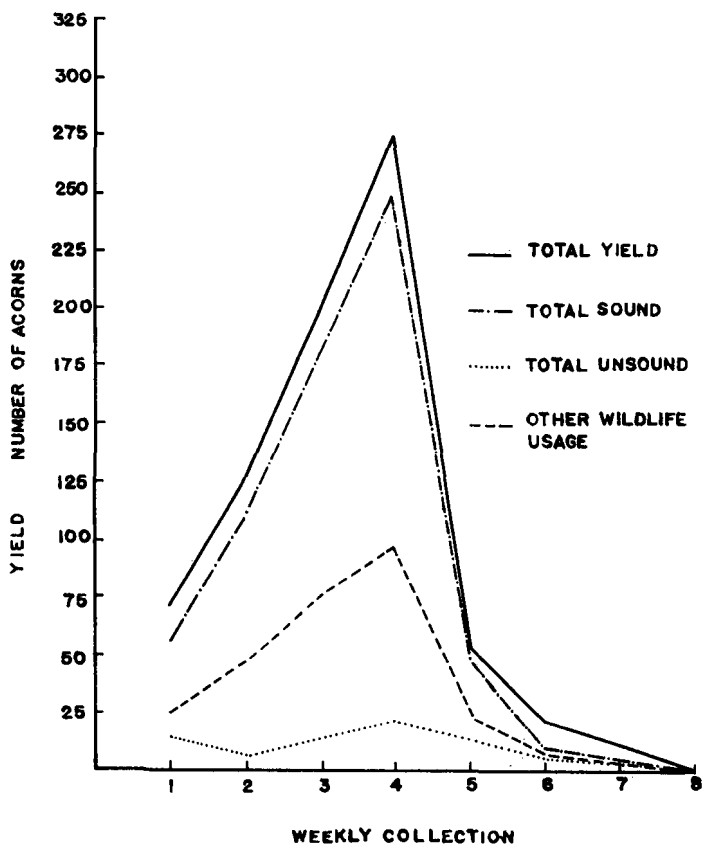


FIGURE II. TOTAL YIELD OF ACORNS ACCORDING TO SOUND, UNSOUND, AND OTHER WILDLIFE USAGE FROM NOVEMBER 8, 1961 TO DECEMBER 27, 1961 (30 MAST TRAPS)



Exclosures

Twelve exclosures (3′ x 3′ x 3′) were constructed by covering pine posts 4 feet in length with one-quarter inch mesh hardware cloth and one inch mesh chicken wire. In order to reduce material costs, six enclosures were covered with one inch chicken wire. These exclosures had the same dimensions as did the mast traps to facilitate comparison. The three-foot high sides prevented ducks from feeding on mast in the exclosure. Since sound acorns sink in water, and the area was flooded during the period of greatest acorn fall, squirrel and bird use was negligible. These data, along with those derived from mast-trap studies, gave a fairly accurate comparison.

An indication of mast utilization was gained by comparing the amount of mast remaining in exclosures, after the water level was lowered, to the amount on similar sized unfenced quadrats.

Experimental Feeders

When the use of mast by mallards was confirmed in finding acorns in the crop of the first bird collected, an attempt to test acorn preference was undertaken. Several experimental acorn feeders were constructed in the form of a floating raft of boards about 4 x 5 feet in size. A screen bottomed trough was located along the mid-line of the raft in such a manner that most of it was submerged.

The trough was divided into compartments, into which five hundred acorns were placed, willow, water, and cherrybark oak acorns being in separate compartments. These feeders were placed in areas throughout the reservoir where high concentrations of ducks occurred.

Stomach Analyses

Permission was granted by the U.S.F.W.S. to collect fifty birds each year with a 22 rifle. This method required stalking large flocks or waiting long periods in a concealed position. Collection with a 22 rifle proved very difficult. If a single duck observed the collector the entire flock was alerted and took flight, the result being that only ten of the desired fifty stomachs were obtained in the 1960-61 season. By using a shotgun with number 7½ shot during the 1961-62 season, twenty-four birds were collected, yielding a total of thirty-four birds for the two-year period.

The crop, stomach, and gizzard were removed from each specimen and placed in a deep freeze along with a tag listing the species, collection date, time of collection, and area of collection. In the early spring of 1962 the specimens were removed from the freezer and sorted as to species and date of collection. The contents of each crop and stomach were removed, screened, and washed. The volume in milliliters was recorded for the total content as well as for the mast or acorn content. The number and species of acorns found in each specimen was also recorded. This data is presented in Table VI.

Millet Planting

In an effort to find the value of supplementary planting of cultivated waterfowl crops in green-timber reservoirs, starr millet was broadcasted at the rate of twenty-five pounds per acre on six different sites scattered throughout the reservoir. The sites were classified as follows:

(1) Mud flats
(2) Broken mud flats
(3) Broken leaf litter
(4) Unbroken leaf litter
(5) Broken and open to free sunlight
(6) Broken and closed to free sunlight (shade)

On May 4, 1961, after the water had been drained from the reservoir, starr millet seeds were broadcasted by hand on the unbroken sites. On the broken sites, a potato hoe was used to scratch the top soil and leaf litter. The planted sites were periodically observed after germination had occurred.

Census of Waterfowl

Periodic duck counts were started in October 1960 when the reservoir was filled to about one-third capacity and were continued throughout the two-year study.

From bird flushings and blind observations, duck counts were made on each of the ten established plots at intervals of about three days. Considerable time was also devoted to observation of duck habits and activities throughout the duration of the study.

RESULTS

Mast Data

In both 1960-61 and 1961-62 willow oak produced the greatest number of acorns per mast trap (3′ x 3′.) Cherrybark oak was lowest in production both years but had the least number of unsound acorns per trap. Willow oak had the highest number of unsound acorns in 1960-61, whereas water oak had the greatest number of unsound acorns in 1961-62. Wildlife usage other than by waterfowl was greatest both years in cherrybark oak, with willow oak being the least preferred mast by squirrels and mast feeding birds (Table III). (In all mast yield tables, mast utilized by wildlife other than waterfowl was included in a category separated from sound and unsound mast.) The low percentage of sound acorns in 1961-62 is a result of heavy wildlife usage prior to the time when mast became available to waterfowl.

TABLE III

TOTAL NUMBER OF ACORNS PER TRAP BY SPECIES OF OAK

	Sound Acorns Per Trap (3′ x 3′)		*Unsound Acorns Per Trap (3′ x 3′)*		*Number of Acorns Per Trap (3′ x 3′) Used by Wildlife Other than Waterfowl*	
	1960-61	1961-62	1960-61	1961-62	1960-61	1961-62
Willow Oak *Quercus phellos*	3.81	28.5	3.6	3.1	1.2	7.4
Water Oak *Quercus nigra*	3.33	1.11	3.3	5.7	1.0	14.2
Cherrybark Oak *Quercus falcata* var. *pagodefolia*	13.0	6.6	1.3	2.3	2.5	20.2

During both years, cherrybark oak mast was highest in percent of sound acorns (80.07% in 1960-61; 40.24% in 1961-62). The latter low percentage was attributed to heavy squirrel and bird utilization. Only 3.62% in 1960-61 and 6.70% in 1961-62 of the cherrybark oak acorns were found to be unsound. The highest percent utilization by wildlife, other than waterfowl, was found in cherrybark oak with 16.31% utilized in 1960-61 and 53.04% utilized in 1961-62. Water oak mast was 17.88% unsound in 1960-61 and 18.18% in 1961-62. Willow oak was found to be the least desired by wildlife with 2.90% utilized in 1960-61 and 17.79% in 1961-62 (Table IV).

TABLE IV

PERCENT OF TOTAL YIELD SOUND, UNSOUND, AND UTILIZED BY OTHER WILDLIFE

	Sound Percent		*Unsound Percent*		*Utilized by Wildlife Other than Waterfowl Percent*	
	1960-61	1961-62	1960-61	1961-62	1960-61	1961-62
Willow Oak	88.58	69.70	8.51	12.71	2.90	17.79
Water Oak	81.30	36.36	17.88	18.18	1.82	45.45
Cherrybark Oak	80.07	40.24	3.62	6.70	16.31	53.04
Average	85.59	54.33	8.02	8.33	6.38	37.33

Yield by individual trees and species of oaks was found to vary from one year to the next. Some trees that produced heavy mast crops in 1960-61 were very poor producers in 1961-62. Others produced practically no mast in the first year but had high yields the second year.

Tree size was found to influence mast yield and size of acorns. Trees 24 inches (d.b.h.) or greater were found to produce heavier mast yields. Crown development was also found to affect acorn production. Trees having moderate to heavy crown development were highest in mast production.

As stated previously, wildlife usage by animals others than waterfowl was very extensive in 1961-62. This can be correlated with the squirrel harvest data from Noxubee Refuge. In 1960, 1,851 squirrel hunting permits were issued with 1,101 returned and 340 unused. A total of 757 hunters killed 3,120 gray squirrels (*Sciurius carolinensis*), 385 fox squirrels (*Sciurius niger*), and crippled and lost 340 for a total of 3,845 killed (5.0 per hunter). In 1961, 1,494 permits were issued, 357 less than in 1960, and 918 hunters killed 4,874 gray squirrels, 391 fox squirrels, and crippled and lost 537 for a total of 5,802 or 6.3 per hunter (Table X). This 1.3 squirrel increase per hunter apparently indicates a larger population in 1961 than in 1960. If squirrel census data could be correlated with mast data for several years, mast production might then be used in making population estimates.

TABLE X

SQUIRREL HUNTING DATA FROM NOXUBEE NATIONAL REFUGE

Year	*Number of Hunters*	*Total Kill*			*Avg. Kill Per Hunter*
		Fox Squirrels	*Gray Squirrels*	*Crippled and Lost*	
1960	757	385	3,120	340	5.0
1961	918	391	4,874	537	6.3

Exclosure Data

A total of 466 acorns was counted in 12 exclosures (3′ x 3′ x 3′). In the corresponding mast traps a total of 568 acorns was counted. On 12 quadrats outside the exclosures, where free waterfowl feeding was permitted, 285 acorns were counted (Table V). Averaging the mast trap and exclosure totals yields 517 as compared to 285 outside the exclosures. Presumably a total of 232 acorns was utilized by waterfowl over an area of 108 square feet; 2.24 acorns per square foot, or 97,474 per acre.

TABLE V

COMPARISON OF NUMBER OF ACORNS FOUND IN EXCLOSURES, MAST TRAPS, AND FREE WATERFOWL FEEDING AREAS

No.	*Species of Oak*	*No. of Acorns in Exclosure (3′ x 3′)*	*No. of Acorns in Corresponding Mast Trap (3′ x 3′)*	*No. of Acorns in Area Exposed to Waterfowl Feeding (3′ x 3′)*
1	*Quercus phellos*	25	22	13
2	*Quercus phellos*	62	56	36
3	*Quercus phellos*	54	60	38
4	*Quercus phellos*	37	112	45
5	*Quercus falcata* var. *pagodefolia*	19	25	9
6	*Quercus falcata* var. *pagodefolia*	56	50	66
7	*Quercus falcata* var. *pagodefolia*	12	25	24
8	*Quercus falcata* var. *pagodefolia*	16	20	7
9	*Quercus falcata* var. *pagodefolia*	20	40	14
10	*Quercus nigra*	80	67	43
11	*Quercus nigra*	53	62	22
12	*Quercus nigra*	32	29	16
	TOTAL	466	568	285

Breaking this data down according to species, willow oak produced 5.9 acorns per square foot or 256,994 per acre. Waterfowl used 37.2% of the willow oak mast which is equivalent to 2.2 acorns per square foot or 95,832 per acre. Cherrybark produced 3.1 acorns per square foot or 135,036 per acre with 16.1%

utilization. Water oak produced 6.0 acorns per square foot or 130,680 per acre of which 50% was utilized (Table VI).

TABLE VI

PRODUCTION AND UTILIZATION OF MAST

Oak Species	*Production in Number of Acorns*		*Utilization in Number of Acorns*		
	Per Sq. Ft.	*Per Acre*	*Per Sq. Ft.*	*Per Acre*	*Percent*
Cherrybark	3.1	135,036	.5	21,780	16.1
Water	6.0	261,360	3.0	130,680	50.0
Willow	5.9	256,994	2.2	95,832	37.3
AVERAGE	5.0	217,796	1.9	82,764	34.5

Water oak was the highest in both production and utilization, with cherrybark being lowest for both attributes. Cherrybark was expected to be lowest in production. (See Figs 3 and 4.) However, data from crop and stomach analyses and experimental feeders indicated that cherrybark ranked highest in utilization. Also to be considered is the fact that in 1961-62, 53.04% of the total sound mast produced by cherrybark was utilized by squirrels and mast feeding birds, leaving only 46.96% available to waterfowl.

These data were subject to several sources of error, the most important of which was the constant flooding of the Noxubee River, washing drifts and piles of acorns and other materials in many places. In areas of severe flooding, the ground was washed clean of all debris. Also, these data assume a degree of randomness which was not attained. Production figures on a per acre basis (Figure 6) are probably higher than the average for the 500-acre reservoir, because these are based on mast traps and exclosures located one-half the distance between the base of the crown and trunk, where mast production would likely be highest. Most areas in the reservoir, however, have a high density of mast producers per acre, thus much of the ground surface is subject to a high mast fall comparable to that recorded. Numbers of acorns per acre (Figure 6) were not converted to pounds per acre because of additional error interjected by the conversion. Acorn size variation within a single species, from trees of different ages, diameters, and crown classes complicate accurate conversion.

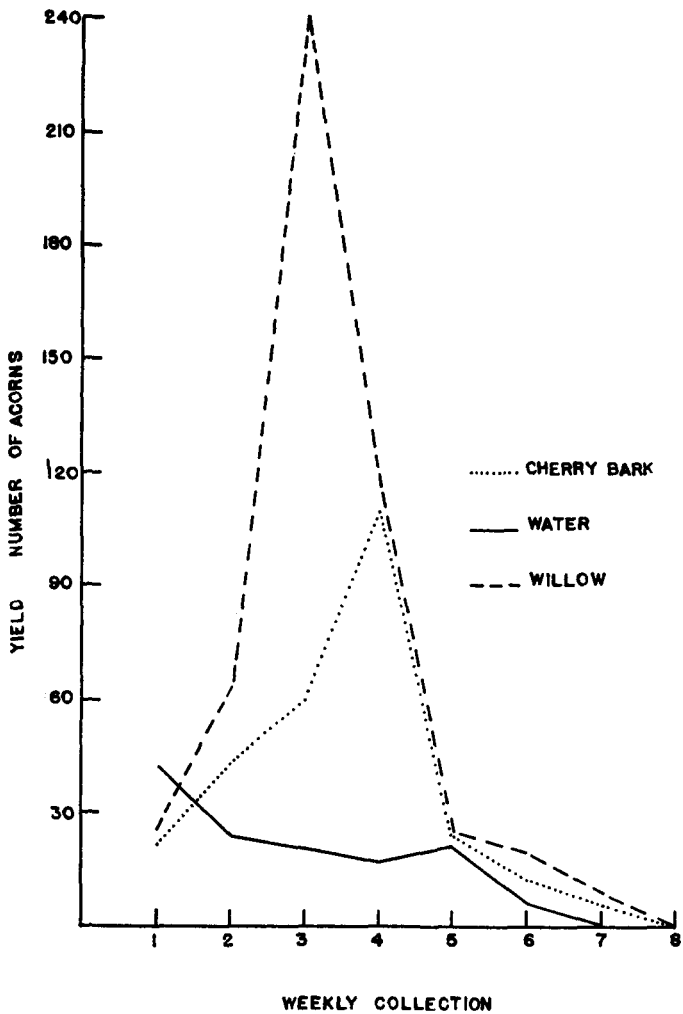
Acorns were counted inside exclosures after the reservoir had drained and dried sufficiently (April). A hard crust of sediment and leaf litter remained after the water had receded. Contrary to the findings of McDermott and Minckler (1961), in 1961 many germinating oak seed or acorns were found beneath this hard silt crust. Several weeks after the counts were made, 66 oak seedlings about 6 inches in height were noted inside one exclosure (3′ x 3′). Apparently scratching the surface litter had created a suitable condition for the germinating oak seeds to continue their development, perhaps by permitting light penertation. No oak seedlings were found outside this exclosure, although germinating acorns were noted under the leaf litter elsewhere.

On March 15, 1962 observation of this exclosure revealed that 60 of the oak seedlings had survived the winter flooding period. In spite of complete submergence for a four-month period, buds were beginning to open, and the seedlings appeared normal in all respects. This finding is an encouraging one in the management of green-timber reservoirs for multiple use, where oak reproduction is desired to maintain all-age forest types. The creation of a suitable seed bed by some means of scratching the leaf litter after the spring drainage holds much promise in obtaining sufficient oak reproduction.

Experimental Acorn Feeders

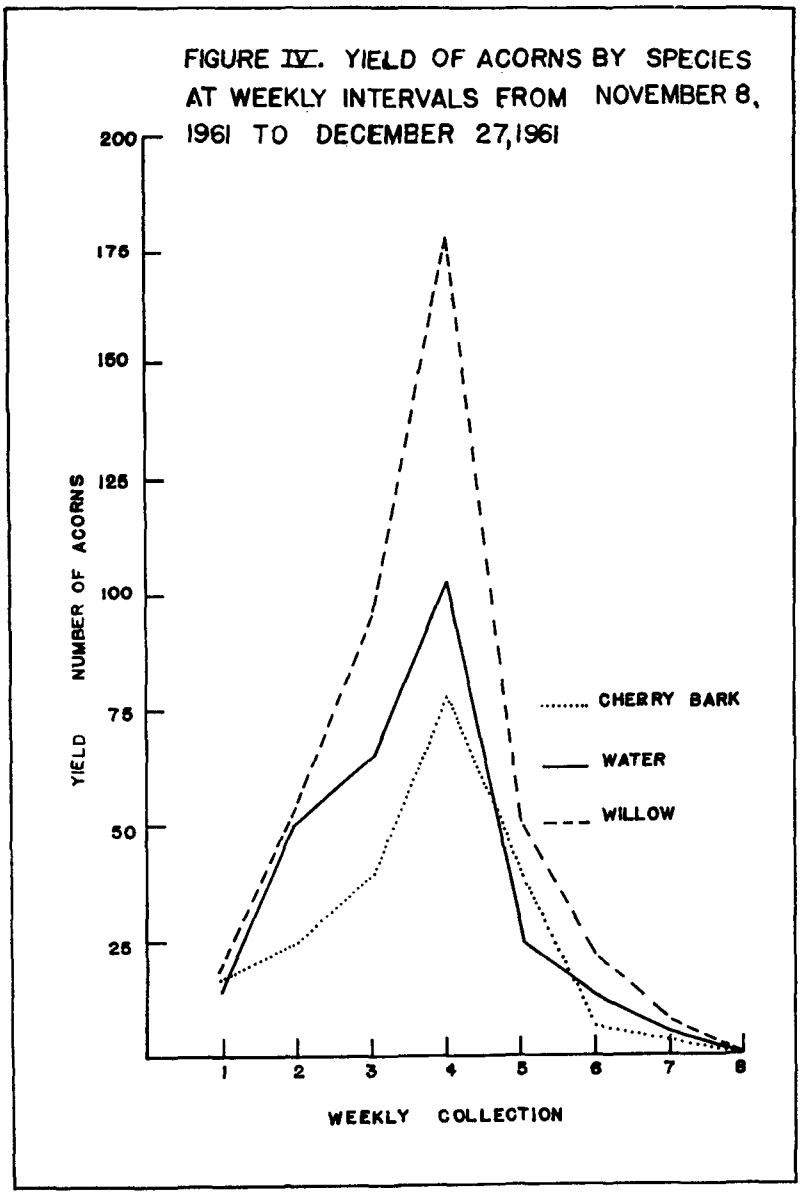
A total of 9,000 acorns of three different species of oaks were placed in three feeders located in various parts of the reservoir. The percent of utilization was similar for water and cherrybark oaks, with 5.8% of the water oak acorns being utilized compared to 5.0% for cherrybark. Only .04% of the willow oak acorns were utilized. This data corresponds with that based on crop and stomach analyses, where willow oak was also lowest in percent of total mast found in both mallards and wood ducks. In the case of mallards, no willow oak mast was found, and in wood ducks, only 10.4% of the total mast consisted of willow

FIGURE III. YIELD OF ACORNS BY SPECIES AT WEEKLY INTERVALS FROM NOVEMBER 11, 1960 TO JANUARY 3, 1961



oak. Data from both crop and stomach analyses and artificial acorn feeders indicate that, of the three specimens of oaks used in this study, cherrybark mast ranks highest in preference with both mallards and wood ducks. Water oak mast ranked second in preference, with willow oak a distant third. However, the percent composition for the three species in the reservoir was not determined.

Mallards were observed with binoculars from well concealed blinds as they used artificial feeders. They were seen walking on the feeder platforms, which were level with the water surface, and were able to remove acorns from the wire



trough located in the center. Ducks also frequented the feeders as resting places and for preening.

Most acorns were ingested whole, but some large cherrybark acorns were cracked and eaten in sections, and the hulls discarded in the trough.

Crop and Stomach Analyses

A total of 34 ducks were collected as previously noted for the purpose of crop and stomach analyses during the two-year study period. Four species of ducks were collected as follows: (1) Mallard (*Anus platyrhynchos platyrhyn-*

chos), (2) Wood Duck (*Aix sponsa*), (3) Ring-necked Duck (*Aythya collaris*), (4) Hooded Merganser (*Mergus cucullatus*).

Of the mallards, 50.0% contained acorns within their crops and/or stomachs (Table VIII). Mallards yielded an average of 5.40 acorns with an average volume of 6.85 milliliters per duck. Two species of acorns were represented in mallard crops and stomachs, with 97.2% of the mast content being cherrybark oak acorns (*Quercus falcata* var. *pagodefolia*), and 2.8% being water oak acorns (*Quercus nigra*). No willow oak acorns (*Quercus phellos*) were found in mallard crops and stomachs (Table VII). Mast was contained in 77.7% of the wood ducks collected. Wood ducks yielded an average of 5.33 acorns per bird with an average volume of 6.44 milliliters. All three oak species were represented as follows: cherrybark (68.7%), water oak (20.9%), and willow oak (10.4%) or the total mast utilized by wood ducks (Table VII). The ring-necked ducks and hooded mergansers collected had consumed no mast. One mosquito fish (*Gambusia affinis*) was found in a hooded merganser stomach. Mergansers were apparently attracted to the reservoir in search of animal foods.

Only a small amount of other natural occurring food material was found in the crops and stomachs. Smartweed was found in greatest amount, with one milliliter being found in a wood duck stomach. Other materials found were bidens, gravel, and feathers.

TABLE VII

COMPARISON OF MALLARD AND WOOD DUCK CROP AND STOMACH CONTENTS

Species	*Avg. No. of Acorns Per Duck*	*Average Total Vol. of Content Per Duck Milliliters*	*Avg. Vol. of Mast Per Duck Milliliters*	*Avg. Vol. of Other Material Per Duck Milliliters*	*Species Preference: Amount Utilized by Species Percent of Number*		
					Cherrybark Oak Acorns	*Water Oak Acorns*	*Willow Oak Acorns*
Mallard *Anas platyrhynchos platyrhynchos*	5.40	7.05	6.85	.17	97.2	2.8	0
Wood Duck *Aix sponsa*	5.33	6.77	6.44	.33	68.7	20.9	10.4

Crop and stomach examinations showed that ducks feeding in the reservoir utilized a very high percentage of mast in their diet. Ducks using the reservoir for rest and cover revealed practically no food materials in their stomachs. The data shows either one of two things, a crop and stomach full of acorns, or a nearly empty crop and stomach containing very little natural occurring plant or animal food material. Of the three species of oak mast found, there was great preference shown for cherrybark oak acorns.

Constant winter flooding of the reservoir by the Noxubee River greatly affected the number of ducks collected for the crop and stomach analyses. Although a total of one hundred ducks was authorized, only thirty-four were secured due to inaccessible roads, high water and accompanying swift currents which restricted collecting. These unavoidable circumstances seriously impeded the entire study.

Millet Planting

All sites planted with starr millet failed to produce suitable waterfowl food. Germination was successful on all sites, but growth was limited to three or four inches before wilting and death. Several factors may have accounted for growth failure, *e. g.*, drought during the early summer, highly acid soils, limited sunlight penetration, and feeding of white-tailed deer.

Fertilized and planted areas one-quarter acre or larger, cleared of all trees, underbrush, and etc., should merit consideration in future green-timber reservoir management. Open fringe areas, such as levees and dams, might also prove suitable for supplementary waterfowl food plantings. This aspect of green-timber reservoir management is a fertile area for additional research.

Waterfowl Census and Habits

Duck counts in the reservoirs revealed a marked decrease in 1961-62 in the number of ducks using the reservoir as compared to the same dates in 1960-61.

TABLE VIII

STOMACH AND CROP ANALYSES DATA

Stomach No.	*Species*	*Vol. of Content Milliliters*	*Vol. of Mast Milliliters*	*No. of Acorns*	*Species*	*Other Material*	*Date of Collection*	*Time of Collection*
1	Mallard	..	..	..	.....	.....	12/ 3/60	3:00 P. M.
2	Mallard	14	14	12	Cherrybark	.....	12/ 3/60	3:00 P. M.
3	Ring-Necked	..	..	..	.....	.....	12/ 8/60	3:30 P. M.
4	Mallard	2.5	2	2	Water oak	Bidens & Gravel	12/ 8/60	2:00 P. M.
5	Wood Duck	..	..	..	.....	.....	12/ 8/60	3:30 P. M.
6	Ring-Necked	..	..	..	.....	.....	12/ 8/60	3:30 P. M.
7	Mallard	..	..	..	.....	.....	12/13/60	2:30 P. M.
8	Mallard	..	..	..	.....	.....	12/13/60	3:30 P. M.
9	Mallard	..	..	..	.....	.....	12/13/60	2:30 P. M.
10	Mallard	..	..	..	.....	.....	12/13/60	3:00 P. M.
11	Mallard	1	1	1	Water oak	.....	12/14/60	4:00 P. M.
12	Mallard	12	12	8	Cherrybark	.....	12/16/60	2:00 P. M.
13	Mallard	23.5	20	17	Cherrybark	Feathers, etc.	12/20/60	3:30 P. M.
14	Wood Duck	..	..	..	.....	.....	11/13/61	2:30 P. M.
15	Merganser	..	..	..	.....	.....	11/13/61	2:00 P. M.
16	Merganser	3	..	..	.....	1 *Gambusia*	11/14/61	10:00 A. M.
17	Wood Duck	13	11	9	Cherrybark	1 leaf hopper, smart weed seed	11/14/61	9:30 A. M.
18	Mallard	..	..	..	.....	.....	11/14/61	9:30 A. M.
19	Wood Duck	5	5	4	Cherrybark	.....	11/14/61	10:00 A. M.
20	Mallard	18	18	14	Cherrybark	.....	11/20/61	10:30 A. M.
21	Wood Duck	6	6	5	Willow oak	.....	11/25/61	10:00 A. M.
22	Mallard	11	11	9	Cherrybark	.....	11/25/61	10:00 A. M.
23	Mallard	5	4	3	Cherrybark	*Bidens* & Feathers	11/25/61	10:00 A. M.
24	Ring-Necked	..	..	..	.....	.....	11/26/61	10:00 A. M.

TABLE VIII—*Continued*

STOMACH AND CROP ANALYSES DATA

Stomach No.	*Species*	*Vol. of Content Milliliters*	*Vol. of Mast Milliliters*	*No. of Acorns*	*Species*	*Other Material*	*Date of Collection*	*Time of Collection*
25	Wood Duck	11	11	10	Water oak		11/26/61	9:30 A. M.
26	Mallard	..	..	..	.....	.....	11/27/61	3:00 P. M.
27	Wood Duck	1	..	..	.....	Smart weed seed	11/28/61	10:00 A. M.
28	Wood Duck	17	17	13	Cherrybark	.....	11/28/61	9:30 A. M.
29	Mallard	28	28	20	Cherrybark	.....	11/28/61	9:30 A. M.
30	Mallard	..	..	..	.....	.....	11/28/61	10:00 A. M.
31	Mallard	..	..	..	.....	.....	11/28/61	2:30 P. M.
32	Mallard	27	27	22	Cherrybark	.....	11/30/61	9:00 A. M.
33	Wood Duck	8	8	7	Water oak	.....	11/30/61	9:00 A. M.
34	Mallard	..	..	..	.....	.....	1/ 9/62	2:00 P. M.

However, there were very few ducks on Noxubee Refuge during the second year. During both years, both mallard and wood duck counts were highest in the mature oak stands (Plate II, Middle). In general, counts were lowest in the cypress bottom sites. Ring-necked duck and hooded merganser counts were fairly constant throughout the five plot types, with the exception of the semi-open areas where ring-necked counts were somewhat higher (Table VIII).

During October and early November, wood duck counts exceeded those of mallards. By the end of November, after the main southward mallard migration, the counts were reversed with mallard numbers exceeding 10,000 per day in the 500-acre reservoir.

In November, mallard and wood ducks concentrated and fed in the eastern end of the reservoir. These concentrations moved westward at intervals as if they were moving in response to depleted food supply. By mid-February the greatest concentrations were at the west end of the reservoir. In areas of great concentrations, mast feeding was indicated by muddy, turbid water after the birds had been flushed.

Large numbers of ducks were noted to remain in the reservoir until long after dark, and hundreds of birds were seen flying in from other areas at sunset. Refuge personnel had been under the assumption that the ducks roosted on the open water of Bluff Lake and used the reservoir area only as a feeding area.

During the two-year study period, no ducks were trapped in the banding pens at the refuge, hence duck movements as indicated by color-markers were not studied. It had been hoped that such observations might reveal if the same ducks frequented both artificial food sources and green-timber reservoirs.

TABLE IX

AVERAGE NUMBER OF DUCKS BY SPECIES USING EACH PLOT (198 x 600 FEET)

Number of Birds Per Day (November-February)

	Mallard			*Wood Duck*			*Ring-Necked*			*Hooded Merganser*		
Plot Type	*Avg.*	*Max.*	*Min.*	*Avg.*	*Max.*	*Min.*	*Avg.*	*Max.*	*Min.*	*Avg.*	*Max.*	*Min.*
Mature Oak Stands	99.3	500	..	35.7	75	..	2.2	30	..	1.1	10	..
Mature Mixed Hardwood Stands	52.4	300	..	10	40	..	..	..	..	..	..	..
Mixed Second Growth Stands	78.7	500	..	20.4	50	..	1.6	15	..	1.5	10	..
Cypress Bottoms	15.3	25	..	12.5	25	..	..	..	..	.8	3	..
Semi-Open Areas	28.7	100	..	.4	5	..	8.3	50	..	1.6	15	..

RECOMMENDATIONS FOR GREEN-TIMBER RESERVOIR MANAGEMENT IN THE SOUTHEASTERN UNITED STATES

(1) Reservoirs should not be constructed near a creek, stream, or river that is subject to overflow or flood during the winter months. Swift currents and flood waters result in water depths inconsistent with safe hunting, with waders, hip boots or even boots, and may cause ducks to evacuate the area. Water transported acorns are less readily utilized by waterfowl.

(2) The area selected should have a source of ducks nearby (refuge, large river or lake, etc.) and an ample water supply for flooding at the proper time.

(3) When constructing a reservoir levee, a spillway should be included in the plans that will handle all excess water that may occur after heavy rainfall. Water overflowing the top of a levee will erode and wash, causing serious damage and expense.

(4) The average depth of flooding should not exceed three feet in early fall (date depending upon geographic location), when the first mallards begin to arrive. A reservoir should not remain flooded over four and one-half successive months.

(5) When managing a reservoir for both waterfowl and timber, cut tree species that do not produce waterfowl foods and those mast producing trees that are low in quality and food value. In general, red and black oaks, having a d.b.h. of 20 inches and larger and a moderate to well developed crown, should be left after a timber harvest.

(6) If oak reproduction is desired, the leaf litter should be broken in early spring after the ground surface has been allowed to dry somewhat.

(7) If the reservoir is to be used for hunting, it should preferably exceed 200 acres in size (depending upon expected hunting pressure). For best hunting success, shooting should be restricted to two or three hunts per week. Constant, heavy shooting may force birds to find other protected areas. When operating reservoirs for public hunting, the number of parties hunting in the reservoir on any given day should be restricted.

SUMMARY

(1) Since the practice of artificially controlling the time and extent of flooding of green-timber areas primarily for waterfowl usage is relatively new and has received little study, a two-year project was undertaken in one of the two 500-acre green-timber reservoirs at Noxubee National Wildlife Refuge, Brooksville, Mississippi to study "Waterfowl Food Utilization in Green-Timber Reservoirs."

(2) The predominant forest type in the reservoir was oak-hickory, classified as medium sawtimber (3,500-8,000 board feet per acre), with 50% or more of the volume being trees 23 inches (diameter breast height) and larger.

(3) The reservoir maintained an average water depth of three feet after flooding in early October and remained at that level until drained in late February or early March.

(4) Two plots measuring 3 by 10 chains (198 x 600 feet) were marked with white paint prior to flooding on each of the following sites; mature oak stands, mature mixed hardwood stands, mixed second growth stands, cypress bottoms, and semi-open areas supporting abundant herbaceous growth.

(5) Mast was collected from traps measuring three feet square which were placed under the crowns of the following species of oaks: cherrybark (*Quercus falcata* var. *pagodafolia*), willow (*Q. phellos*), and water (*Q. nigra*). During both seasons, willow oak produced the greatest yield of mast. Cherrybark produced the lowest percent unsound acorns and received the highest percent utilization by squirrels and mast feeding birds. Yield by individual trees and species of oaks was found to vary from year to year. Tree size and crown development influenced mast production, those trees with dense crowns and a diameter breast height of 20 inches or more producing the greatest mast crop.

(6) In an effort to determine what percent of the total mast crop was utilized by waterfowl, exclosures (3′ x 3′ x 3′) were constructed of one-quarter inch mesh hardware cloth, thus preventing waterfowl feeding in these areas. A comparison of the exclosed areas to areas subject to waterfowl feeding apparently showed that an average of 34.5% of the total sound mast crop was utilized by waterfowl.

(7) Acorn preference tests were undertaken when mast use by mallards had been confirmed. Several experimental acorn feeders were constructed in a form of a floating raft, with a feeder trough located along the mid-line. Water oak mast was found to be the most preferred species with a 5.8% utilization.

(8) A total of 34 ducks were collected for the purpose of crop and stomach analyses during the two-year period. Of the four species of waterfowl using the reservoir, only mallards and wood ducks were found to contain mast in their crops and stomachs. The average number of acorns per duck for wood ducks and mallards was about five with great preference being shown for cherrybark mast. Practically no other natural occurring plant matter was found in any of the ducks examined.

(9) The numbers of birds using the reservoir varied greatly from day to day throughout the fall and winter months. Duck counts were found to be the highest in the mature oak stands for both mallards and wood ducks. Many birds were observed to use the reservoir for roosting.

(10) In an effort to find the value of supplementary plantings of cultivated waterfowl crops in green-timber reservoirs, starr millet was broadcasted at the rate of twenty-five pounds per acre on six different sites. Germination occurred on all sites, but growth was limited to three or four inches prior to wilting and death. Proper supplementary plantings should merit attention in future green-timber reservoir management.

(11) Breaking the hard crust of leaf litter and sediment left in the reservoir after drainage was noted to favor a proliferation of oak seedlings, whereas no

oak reproduction occurred outside these disturbed areas. A year later, after the seedlings had been completely submerged for a four-month winter period, 90% survival was recorded.

(12) White-tailed deer were noted on many occasions using the reservoir during the flooded period. Deer were seen feeding on floating overcup oak mast while standing in water three feet in depth.

BIBLIOGRAPHY

Addy, C. E. and L. G. MacNamara. 1948. Waterfowl Management on Small Areas. Wildlife Management Institute. Washington 5, D. C. 18-29.

Bellrose, Frank C. 1954. The Value of Waterfowl Refuges in Illinois. J. Wildl. Mgt. 18:160-169. Maps.

Broodfoot, W. W. 1958. Study Effects of Impounded Water on Trees. Mississippi Game and Fish. July. 6, 10.

Christisen, Donald M. 1955. Yield of Seed Oaks in the Missouri Ozarks. J. For. 53:6. 439-441.

———— and L. J. Korschgen. 1955 Acorn Yields and Wildlife Usage in Missouri. Trans. 20th N. A. Wildl. Conf. 337-357. Graph.

Coulter, Malcolm W. 1955. Spring Habitat Surveys and Food Habits of Surface Feeding Ducks in Maine. J. Wildl. Mgt. 19:2. 263-267.

Gortner, Ross Aiken. 1934. Lake Vegetation as a Possible Source of Forage. Science. 80:531-533.

Herter, George Leonard and Jacques P. Herter. 1961. *Professional Guide's Manual.* Herter's Inc., Waseca, Minnesota.

Kortright, F. H. 1953. *The Ducks, Geese, and Swans of North America.* Wildlife Management Institute. Washington, D. C. 155-227.

Linduska, Joe. 1962. Mixed Bag. Sports Afield. April P. 96.

Martin, A. C. and F. M. Uhler. 1939. Food of Game Ducks in the United States and Canada. U.S.D.A. Tech. Bull. March. 634.

McAtee, W. L. 1939. Wildfowl Food Plants. Collegiate Press, Inc. Ames, Iowa. 141 pp.

McDermott, R. E. and Leon S. Minckler. 1961. Shooting Area Management of Pin Oak. Trans. 26th N. Amer. Wildl. Nat. Res. Conf. 111-120.

Nelly, William W. 1956. How Long Do Duck Foods Last Underwater? Trans. N. A. Wildl. Conf. 21:191-198.

Petrides, G. A., Paul Parmalee, and J. E. Wood. 1953. Acorn Production in East Texas. J. Wildl. Mgt. 17:380-382.

Steiner, J. Thomas. 1952. Waterfowl in the Delta. Mississippi Game and Fish. 16:11. 3-4. 11 illus.

1954. The Wetlands of Arkansas in Relation to Their Wildlife Value. U.S.F.W.S. Region 4. 26 pp.

1954. The Wetlands of Mississippi in Relation to Their Wildlife Value. U.S.F.W.S. Region 4. 44 pp.

Trippensee, Reuben E. 1953. *Wildlife Management.* McGraw-Hill Book Company, Inc. New York, Toronto, London. 2:191-367.

Webster, B. S. and Eugene Cypert. 1949. Yield and Use by Wildlife of Acorns of Water and Willow Oaks. J. Wildl. Mgt. 12:227-231.