

all size classes in bayous, canals and shallow impoundments on the refuge.

Alligators were located at night using a small boat, an outboard motor and a headlight. An alligator was then captured by slowly maneuvering the boat up to the animal and placing a snare, mounted on a stout pole, around its neck then quickly tightening the snare. Alligators less than six feet long were captured and placed in regular burlap sacks until tagged. Alligators over six feet long were captured and immediately towed to the bank, marked, measured then released.

Two methods were used to mark alligators for future identification. The first method was by toe clipping and removing or notching dorsal scutes along the posterior portion of the tail. Clipping certain toes and certain dorsal tail scutes, each properly coded, provided over 3,000 separate marks. In addition to the mark, a self-piercing metal tag was attached to the alligator's tail, thus providing a double check on identification. Alligators recaptured after three years were easily identified.

Determining the sex of alligators was done by examining for the presence or absence of the penis character. The penis will protrude from the cloaca of the male when pressure is applied beneath the pelvic. The little finger was inserted into the cloaca of large specimens and if a male the penis could be felt.

ACKNOWLEDGMENTS

The writer gratefully acknowledges the assistance of Clark M. Hoffpauir, Louisiana Wildlife and Fisheries Commission, and Leslie L. Glasgow, Louisiana State University, in developing the techniques herein described.

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WATERFOWL MANAGEMENT ON TWO U. S. ARMY CORPS OF ENGINEERS MULTIPLE PURPOSE RESERVOIRS IN MIDDLE TENNESSEE

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ABSTRACT

The evolution and success of a State waterfowl management program on federally purchased perimeter lands on the Old Hickory and Cheatham Lock and Dam Projects in Middle Tennessee are described. Basic development upon operations' initiation (Old Hickory 1957 and Cheatham 1959) and early project years consisted of provision of quantities of suitable agricultural foods on upland areas adjacent to the reservoirs. Beginning in 1959 on Old Hickory and 1960 on Cheatham, the program was materially altered from that above to one centered upon the construction and operation of twenty-four small seasonal sub-impoundments. These varying in size from six to 200 surface acres are annually drained, cultivated for food production and subsequently reflooded prior to the beginning of the fall migration period. A marked increase in wintering waterfowl and consequently hunting opportunity occurred following the establishment of water management, even in the face of declining state and flyway populations. Changes in population numbers and periods of build up relative to the development programs are documented. Other principle aspects of management and approximate costs of construction and operation of the water control systems are discussed.

INTRODUCTION

Natural, high-quality waterfowl habitat in Tennessee is basically limited to the extensive areas of hardwoods and swamps in the bottomlands of the Mississippi River and of its three major tributaries in the western portion of the state. However, large wintering concentrations of over 300,000 ducks (during the mid-fifties) and 30,000 Canada geese have been built up on man-made habitat in other parts of the state through combined efforts of the Tennessee Game and Fish Commission and the United States Fish and Wildlife Service. These wintering populations have been generally the results of habitat development programs on perimeter lands acquired from Tennessee Valley Authority by transfer or license on their power, navigation and flood control reservoirs (Wiebe, 1950).

In more recent years additional wildlife management potential on federally owned lands and waters in Tennessee has been brought about by implementation of comprehensive plans for the development of the water resources of the Cumberland River by the Corps of Engineers. The two state waterfowl management areas described in this paper are situated on the completed Old Hickory and Cheatham Lock and Dam Projects on lands acquired in fee by the Corps and licensed to the Game and Fish Commission.

DESCRIPTION OF PROJECTS

The topography of the terrain surrounding the Old Hickory and Cheatham Reservoirs is composed of rolling hill lands typical of the Highland Rim and Nashville Basin physiographic provinces. The reservoirs and the Cumberland River form a rather narrow, often meandering course through the uplands. The flood plain is flat to gently rolling, varying in width from 3500 to 5200 feet on main portions of Cheatham and from 1320 to 3960 feet on Old Hickory. Since the lands available for wildlife management are basically those purchased for flood storage above permanent pool and are within the existing flood plain, it can be readily seen that these waterfowl projects are long and relatively narrow. The state management area on Cheatham is located in the main part of the reservoir beginning at the dam and extending upstream eight miles. The Old Hickory area is on the extreme upstream portion of the reservoir beginning 30 river miles from the dam. The portions of the lakes within both management areas are basically composed of only the original river and tributary channels, and adjoining scattered shallow sloughs, thus resulting in numerous islands and peninsulas. The remaining sections of bottomland are characterized by low, flat depressions formed between natural levees of the old river bank and the surrounding uplands. The soils of the flood plain are fertile and of alluvial origin, consisting mainly of sandy and clay loams. Because of their fertility, most of the lands were cleared years ago for intensive agriculture. Timber remains only in fencerows except for several small blocks on the Cheatham project. Specific descriptions of each of the reservoirs and the respective waterfowl areas are as follows:

The Cheatham Lock and Dam located in Cheatham, Dickson, and Davidson Counties was authorized in 1946, construction was initiated in 1950, and full pool of 7,450 surface acres was reached in 1956. The primary purposes of the reservoir are navigation and power. The normal pool level fluctuates almost daily between the elevations of 383.5 and 385.0 feet. The waterfowl project on the reservoir is approximately eight river miles long, and includes 1,891 acres of land and 831 acres of permanent water area. The project consists basically of six major land units (varying in size from 99 to 500 acres) and related adjoining shallow backwater slough areas of up to 200 surface acres; all located in rather close proximity to each other. Some natural attraction to waterfowl is provided by the presence of submerged aquatics, primarily coontail (*Ceratophyllum demersum*), and in some years by a very narrow lake margin of moist soil plants such as rice cut grass (*Leersia oryzoides*), wild millet (*Echinochloa* spp.), smartweed (*Polygonum* spp.), and sedges (primarily *Cyperus* spp.). However, due to unknown reasons, the submerged aquatics are disappearing.

The Old Hickory Lock and Dam situated essentially in Davidson, Wilson, Trousdale, and Sumner Counties was authorized in 1946, construction was begun in 1952, and full permanent pool of 22,500 surface acres was reached in January, 1957. The major purposes of the reservoir are navigation, power and flood control. Normal pool elevations during the year vary between 443.5 and 445.0 feet. The waterfowl project on the reservoir is approximately 23 river miles long (over 11 air miles) and includes 2,290 acres of land and 1,238 acres of permanent water. Continuous blocks of perimeter lands suitable for development are rather scattered, narrow and relatively small, thus eliminating some potential and making development somewhat difficult. Natural waterfowl attraction insofar as aquatic foods are concerned is practically nil with only a very narrow edge (varying from 0 to 10 feet in width) of rice cut grass, smartweed, and sedges on the shoreline of the reservoir.

MANAGEMENT PROGRAM

Because of the estimated potential of these areas for waterfowl management, the immediate response of migrant waterfowl to the reservoirs during the years of gradual lake impounding, and the critical need of public waterfowl hunting opportunity in the mid-state region, intensive development programs were begun by the state upon receipt of the lands (Old Hickory in 1957, Cheatham in 1959). Although development of wintering populations of waterfowl and subsequent hunting were the primary objectives, small game (especially dove) has been considered in the overall program. Management has consisted primarily of the formation of refuge areas, production of suitable agricultural waterfowl foods, water control, and hunter regulation.

Refuges

Three refuge areas were formed in 1955 and 1956 on Old Hickory, and are as follows: (1) Lock No. 5 Refuge—This primary refuge (provision of both protection and food) is situated on the extreme upstream portion of the area and comprises 400 acres of land and 405 acres of water. This refuge unit is utilized by 80-90 per cent of the waterfowl on the reservoir. (2) Camp Boxwell Refuge—A small, important 160-acre rest area which is located in a lime-sink pothole adjacent to the main reservoir and approximately 12 air miles downstream from Lock No. 5. (3) Old Hickory Refuge—A large open water area which totals 3,000 acres and is adjacent to the dam (waterfowl use nil). The Pardue Pond Refuge, established on Cheatham in 1959, consists of approximately 380 acres of land bisected by a shallow 65-acre slough.

Food Production

Development of waterfowl food was begun on Old Hickory in 1957 and on Cheatham in 1960. The foods developed have primarily been corn, buckwheat, milo and the various millets (German, Japanese and browntop) for grain and wheat, annual rye grass and ladino clover for browse. In general, this work (kind and variety of crops, method and time of planting, etc.) is basically the same as that utilized for years by both the Tennessee Waterfowl Management Project and the United States Fish and Wildlife Service Refuges in Region No. 4 and as that described by Givens and Atkeson (1959). Food production has been carried out through a combination of sharecropping and force account on Old Hickory and almost exclusively by sharecropping on Cheatham. An average of approximately 550 acres on Old Hickory and 260 acres on Cheatham has been annually cropped exclusively for waterfowl use (not including acreage of sharecrop harvest waste).

Because of past experience on other projects in obtaining good dry-land feeding by waterfowl, food development on Old Hickory during the two years prior to subimpounding consisted solely of intensive planting of almost all suitable lands, especially islands, peninsulas and the larger blocks of bottomland adjacent to backwater areas. After the establishment of water control facilities, the cropping programs were changed materially. Force account operations were switched almost exclusively to intensive development of the subimpoundments, thereby

shifting the bulk of the total work load to permit farming. Prior to 1959, over 75 per cent of total food production was carried out by state equipment and personnel, after this time only 35 per cent.

Where possible, depending on pool topography, full cultivation of the subimpoundments has included zoned planting to insure maximum grain yields, attraction, and availability of foods to waterfowl. Principally, this has consisted of planting low-ear placement varieties of corn in the deeper portions, and millet and/or buckwheat in the shallow sections to be flooded to a depth of 18 inches or less. In addition, an effort is made to obtain mechanically harvested permit fields of corn immediately adjacent to the winter flooding site. The requirement of a short, low-ear placement corn for the shallow pools has been partially fulfilled through the use of a dwarf hybrid corn, Pfister Brachylytic No. 12145. In some of the lower situated subimpoundment sites having heavy, poorly drained soils or during periods of above average summer precipitation, Japanese millet is used almost exclusively. During the past two years, excellent results have been obtained with this plant by sowing presoaked seed in a flooded pool and then draining. In addition to the grain crops mentioned above, three trials have been made of partially flooded growths of annual rye grass. This limited experience has indicated that this technique may be of value in attracting pintail and baldpate. In some cases, good stands of smartweed and wild millet have been obtained primarily by a combination of draw-down in late April and early May, followed by fallow discing. However, due to the sporadic success, lack of time available for research on the problem, and the critical need for annual high yields, this means of food production has not been fully pursued.

Water Control

After two years of very poor dry-land food utilization on the Old Hickory project, surveys were begun to ascertain the potential of the areas for water management. This work indicated that the general topography (low flat basins between the natural levees on the river bank and surrounding uplands) and the soils of the areas were suited for economical development of small, shallow subimpoundments. Thus, subimpoundments were introduced in 1959 on Old Hickory to be operated on an annual schedule of draining, cultivating and reflooding. With the initiation of development on Cheatham in 1960, construction and operation of similar pools were begun. This development was distributed over a period of three years on each project. These subimpoundments are similar to facilities on Sardis Reservoir as described by Bumsted (1954). The primary objectives of the work were: (1) to provide high-quality attraction to waterfowl in order to stop and hold migrants earlier in the fall and establish higher wintering populations, and (2) to develop better opportunity and distribution of hunting by creating good waterfowl-use patterns and additional hunting sites.

To date, 18 subimpoundments have been constructed on Old Hickory (totalling 342 surface acres) and six on Cheatham (totalling 545 surface acres). Those on Old Hickory are small, ranging from six to 40 surface acres (averaging 19), and are not well distributed due to lack of suitable sites over total project. The Cheatham sites are larger, averaging 91 surface acres (ranging in size from 30 to 200 acres), and are well distributed with one per each major land unit. When fully flooded, most of these pools on both projects are shallow, averaging approximately one foot in depth. However, in attempting to obtain maximum surface area, some of the sites were developed with deeper sections which have been ideally utilized for both corn production and open water areas. The latter has seemingly been important for full attraction to waterfowl.

Water control facilities, except for one site, consist of low earth dams (average length of 177 linear yards, 8 to 10 foot crown, 3:1 or greater slope); corrugated steel drain culverts; and simple drop-inlet or slide-gate structure. The largest water control unit (consisting of winter pool of 200 surface acres) required diking a deep slough channel and installing a large concrete drop-inlet structure. This structure was so designed to permit boat access during the fishing season. Upon

completion, all earth work (dikes, spillways, diversion and pumping ditches) was seeded with fescue for sod cover.

Except in a few instances when the Commission's heavy equipment was committed on other areas, all of the water control development was constructed by force account. The estimated construction cost per surface acre of subimpoundment on Old Hickory was \$31.00 and on Cheatham \$25.00. Costs and general specifications of this work are presented in Table I.

TABLE I
Specifications and Costs of Construction and Annual Pumping Requirements and Operation Costs for Subimpoundments on Cheatham and Old Hickory Waterfowl Management Areas

ITEMS	CHEATHAM	OLD HICKORY
Specifications and Costs of Construction		
No. of subimpoundments	6	18
Total surface acres	545	342
Average surface acres	90.9	19
Total linear yards of dike	1893	2368
Average length of dike (linear yards)	315	131
Average height of dike (feet)	4.5	3.5
Total cubic yard of fill	25,600	21,300
Total cost	\$13,563.00	\$10,519.00
Average cost per surface acre	\$ 25.00	\$ 31.00
Annual Pumping Requirements and Operation Costs		
Total surface acres pumped	385	342
Pumping operation (hours)	1105	782
*Total costs	\$ 1,580.00	\$ 1,600.00
Cost per surface acre	\$ 4.10	\$ 4.60

*Including pump operation, salaries and wages, miscellaneous equipment operation, etc.

Due to the lack of sufficient watershed adjoining most of the impoundments, fall flooding is basically accomplished through the use of high-capacity pumping equipment. Because of relatively large total head requirements (TDH of 40 to 80 feet), small pond size, and scattered distribution, two barge-mounted 4200 gpm centrifugal pumps are used on Old Hickory. Except for two units which are flooded through a combination of flap gate manipulation and stream diversion, permanently installed low head axial flow equipment is used on Cheatham (varying in size from 4,000 to 10,000 gpm).

Fall and winter flooding on both projects is generally scheduled to provide several sites of inundated foods in time to attract the first major migration which occurs during the second week of November. This is normally accomplished by complete flooding of refuge ponds and by partial flooding of a few of the larger shooting pools. The remainder are flooded just prior to the opening of the season (smaller ones last to prevent eat outs). Repumping is required during periods of below normal fall and winter precipitation, or for impoundments having soils of higher sand composition. However, this is not usually necessary with normal rainfall. In many cases renewed and often heavy duck utilization has occurred immediately after reflooding.

Two of the impoundments (one on each project) consist of diked-off areas of the permanent pool. These have been operated on a dewatering basis at approximately the same costs as the regular sites on higher elevations. Dewatering on these units is delayed until late July (approaching the dry part of growing season), thereby almost eliminating the necessity of continuous pumping.

Approximately 780 hours of pumping are necessary each year on Old Hickory and 1100 on Cheatham. Total estimated annual costs of pumping, including salaries and labor, other equipment operation, etc., for each project are as follows: Old Hickory \$1,600.00 and Cheatham \$1,580.00. (Table I)

Hunter Management

As competition for hot spots has developed, gradual control of hunters has been made. The first management step was registration of blinds with a suggested minimum spacing of 200 yards. This was followed by the existing system of designated hunting sites marked in the field by project personnel. These locations are allotted annually by a drawing to hunters who must build their own blinds and remove them from the project at the end of the season. All of the sites are spaced a minimum of 200 yards apart and are specifically located to provide good hunting opportunity. There are 112 blind locations on the Old Hickory area and 50 on Cheatham. To insure use by the general hunting public a regulation was placed into effect in 1961 whereby the blind builder has daily priority to the blind up to 8:00 A.M. If the permittee does not use the site by this time, it is open to the general public for the remainder of the day. One timbered 70-acre subimpoundment on Cheatham is excluded from this system. This unit is left open for wading-type hunting and is quite popular. A regulation limiting daily shooting hours (sunrise to 2:00 P.M.) was approved by the Commission for these projects for the forthcoming 1963-1964 season as a further means of management to improve hunting.

RESULTS OF MANAGEMENT

For comparative purposes, the data on waterfowl use and hunting success is presented in two basic periods. Period I represents the early years of gradual flooding of the main reservoir and initial two years of waterfowl project operation on Old Hickory, and three years of gradual flooding of the main reservoir and the subsequent years prior to project establishment on Cheatham. Period II represents the years during which time subimpoundments were in operation.

Generally, the number of ducks as determined in bi-weekly inventories on the two projects has progressively increased earlier and formed higher concentrations during each year of Period II. The following comparisons of Period II over Period I may also be made. Average annual fall and winter utilization of the areas computed by duck-day use (October 15 through February 15) has increased by 73 per cent on Old Hickory and 222 per cent on Cheatham (Table II). Of more importance insofar as hunting is concerned, the average annual numbers of ducks present during an average Tennessee waterfowl season of 52 days (within mid-November-mid-January) have increased 93 per cent on Old Hickory and 260 per cent on Cheatham (Table II and Figures 1 and 2).

Mallard, black duck, wood duck, pintail, baldpate, ringneck, green-wing teal, and gadwall are the primary ducks which have utilized the projects. Mallards and blacks are by far the most numerous, comprising about 90 per cent of the total (in an approximate ratio of three mallard to one black).

Although Canada geese migrate through the region, little success has been made in holding this species. However, a small group of 20 on Old Hickory and of 40 on Cheatham did remain through the winters of 1961 and 1962.

Duck-use patterns (distribution) on the projects have changed and improved following subimpounding. This was very evident during the 1962-1963 season (extremely low hunting pressure) when the impoundments, and in some cases adjoining habitat, received heavy sustained utilization.

The collection of complete data on hunting pressure and kill has not been possible due to lack of personnel, numerous access sites, and rather long distances involved in travel over the area. Because of these limiting factors, investigations have been restricted to periodic bag-check surveys in an attempt to establish an annual index of relative kill success (kill/man day). However, these indices, with the exception of that of 1962, are open to serious question since the work was not conducted in a similar manner or rate of intensity. This is especially true for the Cheatham Project where the amount of check effort has been very limited. The average duck kill per hunter effort as de-

TABLE II

DUCK POPULATION DATA—OLD HICKORY AND CHEATHAM WATERFOWL MANAGEMENT AREAS AND STATEWIDE

AREA	MIGRATION PERIOD							ANNUAL AVERAGES				
	1954-55	1955-56	1956-57	1957 ³ -58	1958-59	1959 ⁴ -60	1960 ⁵ -61	1961-62	1962-63	Prior Subimp.	After Subimp. Increase	Percent Increase
Old Hickory												
Winter Duck												
Use ¹	141,600	327,280	699,240	533,160	545,280	486,480	704,040	857,040	1,060,000	449,312	776,890	73%
Ave. Hunting												
Season Pop. ²	885	1,540	6,741	5,312	6,241	5,228	7,433	7,697	11,306	4,102	7,916	93%
Cheatham												
Winter Duck												
Use ¹	64,560	93,600	35,400	47,400	27,120	31,080	100,920	121,560	260,000	49,860	160,827	222%
Ave. Hunting												
Season Pop. ²	509	240	290	484	240	290	790	1,174	1,736	342	1,233	260%
Statewide												
Winter Duck												
Use ¹ (In												
Millions)	28.5	37.7	44.6	40.2	40.2	22.8	24.8	23.3	25.6	—	—	—
Ave. Hunting												
Season Pop. ²	—	—	—	—	—	—	—	—	—	—	—	—

¹ Based on duck day use for period of October 15 through February 15.

² Based on average hunting season length of 52 days beginning in late November and extending to mid-January.

³ Establishment of Old Hickory Project (general operations not including subimpounding).

⁴ Initiation of subimpounding on Old Hickory Project and establishment of Cheatham Project (no development during the year).

⁵ Initiation of subimpounding on Cheatham Project.

terminated by these surveys for the comparative periods of management for each area is as follows: Old Hickory—Period I .68, Period II .81; Cheatham—Period I .72, Period II .69. This indicates a slightly increased average kill success on Old Hickory and a slight decrease on Cheatham following subimpounding. The implied trend on Cheatham is in direct conflict with that indicated by opinions of field personnel, Corps Reservoir employees and hunters.

Intensive, systematized bag-check studies were begun in 1962 in an attempt to determine total kill and hunting pressure as well as an accurate kill index. Based on the results of these investigations, the estimated minimum number of man-days of hunting and ducks harvested on the project during the 1962-1963 season are as follows: Old Hickory—900 man-days, 600 ducks killed; Cheatham—375 man-days, 300 ducks killed. This is probably the lowest kill and hunter use ever experienced since the completion of these Lock and Dam Projects. The restrictive

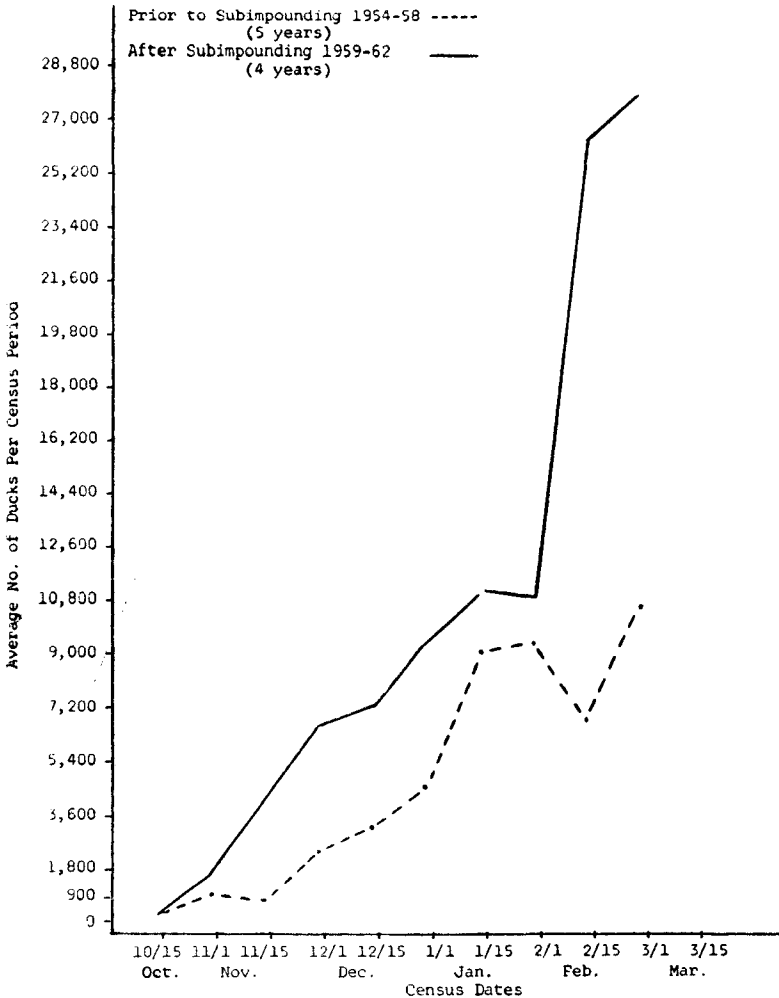


Figure 1. Average duck populations prior to and after subimpounding, Old Hickory Waterfowl Management Area.

regulations and resulting greatly decreased hunting pressure were responsible. Waterfowl utilized the areas heavily throughout the gun season (an average of over 11,000 ducks on Old Hickory) thus enabling the few participating hunters to bag their limit of one mallard or black duck with ease.

The primary species harvested on Old Hickory are mallards and black ducks, comprising a four-year average of 70 per cent and 11 per cent, respectively, of the total bag. The kill on Cheatham has consisted essentially of 33 per cent mallard, 26 per cent wood duck, and 11 per cent black duck. The percentage of mallard in the kill on both areas has declined during the past two seasons due to the establishment of flyway-wide species management regulations.

Of primary importance to future success of these projects have been the observed changes in hunting opportunity which has occurred following the establishment of the subimpounding program. Hunting opportunity has been enhanced during the years following the establishment of water management due to increased numbers of waterfowl during the gun season, improved total area usage and flight patterns, and creation of additional blind sites in the highly attractive subimpoundments (30 extra blind locations on Old Hickory and 20 on Cheatham). Kill success and hunter use has been considerably higher in the ponds. An example of this being a recorded minimum 1960 season kill of 116 ducks (2.6 per man-day) from a blind situated in one of the subimpoundments which received rather heavy sustained duck usage.

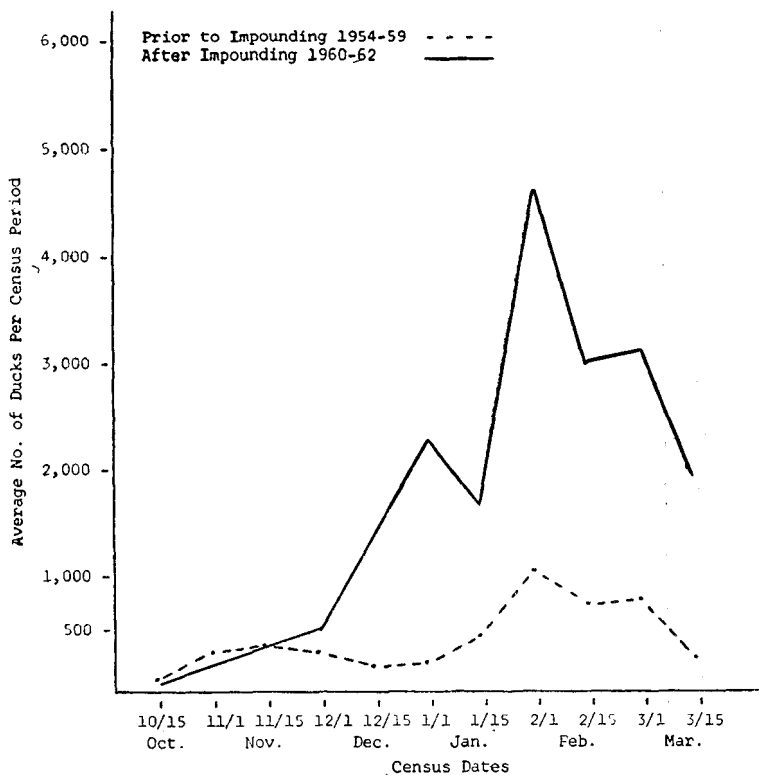


Figure 2. Average duck populations prior to and after subimpounding, Cheatham Waterfowl Management Area.

DISCUSSION

Waterfowl management programs on Cheatham and Old Hickory Reservoirs have generally resulted in increased fall and winter duck populations in spite of limitations imposed by poor location in regard to major flyways, by small total project areas, and by relatively limited amounts of lands suitable for development. The marked increases in wintering populations have occurred following the initiation and intensive operation of water control facilities. A population comparison can be made on Old Hickory between the two years of poor success with upland feeding areas and the earlier concentration and annual increases during the years following subimpoundments.

The relative number of birds using Cheatham has increased strongly, but, in total, this population is still relatively low in comparison to that of Old Hickory. The late completion of water control facilities (over half not made fully operative until 1962); delayed flooding, often into mid-December due to repeated pump failures; and refuge harassment are probably the factors responsible. However, the immediate and continued improvement of the waterfowl population under the existing difficulties seems to indicate the potential of the project.

The response of the duck population both in number and in total area utilization has significantly increased and resulted in improved hunting opportunity. However, since the improvements (ducks and harvest potential) have basically occurred during the years coinciding with basically low or declining population levels of the flyway and other state projects, related restrictive federal regulations, and general loss of interest by waterfowlers, only partial use of the total potential of available hunting recreation has been realized. The 1962-63 season estimates of total harvest and hunting pressure on the projects are mute testimony to this fact; however, record demands for blind sites for the forthcoming 1963-1964 season would indicate that the trend of low hunter interest on these projects will probably change abruptly. Word of the relatively good waterfowl use of the areas during the winter of 1962 has spread rapidly. These, plus the prospects for an improved fall flight, have probably been the factors involved in renewed hunter interest in this section. The expected increase of pressure should provide an excellent test of the amount and quality of hunting which the projects have to offer.

The experience gained on these areas, especially as related to construction and operation of small subimpoundments, has proven of value in evaluating, planning and developing other waterfowl potential in Tennessee. Similar work has been initiated on two other State areas and is scheduled for a proposed project on a new Corps of Engineers Lock and Dam development which is presently under construction. In addition, it should prove of future value in encouraging and assisting interested individuals and groups in private development and management of waterfowl habitat.

SUMMARY

1. Waterfowl management programs were established by the Tennessee Game and Fish Commission on the perimeter lands of the U. S. Corps of Engineers' Old Hickory (1957) and Cheatham (1959) Lock and Dam Projects located in Middle Tennessee.
2. Management has consisted basically of the formation of refuges, development of suitable agricultural waterfowl foods, construction and operation of water control facilities (subimpoundments) and provision of limited hunter controls.
3. A system of 24 small seasonal subimpoundments, varying in size from 6-200 surface acres, was established after initial trials of intensive planting of upland dry feeding sites proved of poor value in attracting and holding waterfowl. The average construction costs per surface acre of subimpoundment were \$25.00 on Cheatham and \$31.00 on Old Hickory.

4. Following initiation of subimpounding, duck populations increased significantly (especially during period of the average gun season), concentrated earlier and better utilized the total project areas. Average annual fall and winter usage increased 73% (93% during average gun season) on Cheatham. These buildups have occurred during the years of generally low or declining state and flyway populations.
5. Hunting opportunity has been expanded and improved due to the response of the duck populations and increased numbers of quality hunting sites.
6. The experience gained on these projects, especially in regard to water management, should prove of future value in both state and private development of wintering habitat for waterfowl.

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RENESTING AND MULTIPLE BROODING STUDIES OF MARKED CLAPPER RAILS

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Presented at the Seventeenth Annual Conference of the
Southeastern Association of Game and Fish Commissioners
September 30 - October 2, 1963
Hot Springs, Arkansas

Renesting is a recognized phenomenon of clapper rail (*Rallus longirostris*) breeding biology. The occurrence of multiple brooding in this species is not so well recognized; contradictory statements about multiple brooding appear in the clapper rail literature. This paper presents renesting and multiple brooding data based on observations of marked birds. The extent of renesting and multiple brooding, and their significance to clapper rail production are discussed and evaluated.

The renesting tendencies of the clapper rail have been recognized since the days of Audubon (Bent, 1926). Later observers (Sprunt and Chamberlain, 1949; Kozicky and Schmidt, 1949; Stewart, 1951; Schmidt and McLain, 1951; Oney, 1954; Sprunt, 1954; and Adams and Quay, 1958) have concurred with this viewpoint.

The clapper rail is reported to be a two-brooded species by many observers (Wayne, 1910; May, in Forbush, 1939; Sprunt and Chamberlain, op. cit.; Schmidt and McLain, op. cit.; and Sprunt, 1954). Only the observations of Schmidt and McLain in New Jersey were based on marked individuals, though the number of rails marked and observed was not stated in their paper. Forbush (1929) had suggested earlier that the clapper rail might be two-brooded in southern states.