December 10, 1973

To the Graduate Council:

I am submitting herewith a thesis written by Larry Elliott Safley entitled "Wildlife Management Guide for the Chuck Swan Wildlife Management Area." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife Management.

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WILDLIFE MANAGEMENT GUIDE FOR THE CHUCK SWAN WILDLIFE MANAGEMENT AREA

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Larry Elliott Safley

March 1974

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I also thank my wife and family for their patience and help while preparing for and writing this manuscript.

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ABSTRACT

The purpose of this management guide was to point out management techniques applicable to the wildlife species found on the Chuck Swan Wildlife Management Area, Union and Campbell counties, Tennessee. These techniques were discussed in two ways. First, programs designed for individual species were reviewed to allow those in charge of the administration of the area the opportunity to consider specific management programs for one or more of the game species inhabiting the area. The second approach involved the review of habitat management techniques without mentioning particular game species.

The information presented originated from three sources. Published literature was reviewed to locate applicable management techniques for the game species hunted on the area. Published and unpublished data on file in the offices of the Tennessee Game and Fish Commission were reviewed to determine past and present programs. The third source of information was based on the experiences of the author on the area while employed by the Commission as a game biologist.

Results of these reviews indicated that more wildlife-oriented management can be performed on the management area than is now being done. This management improvement involves smaller and more scattered timber sales while employing a more varied program of timber management to increase yields of timber and wildlife. The agricultural program should also be altered to include the development of non-agricultural crops. The distribution of the openings should also involve a more random and scattered pattern.

Opportunities are available for developing complementary recreational outlets on the management area. Such areas include picnicking and camping areas, caves, and historical sites consisting of remains of early settlements. Trails, helpful in providing hunter access into the more remote areas, can also provide access into and from these potential visitor-use centers. These developments are secondary to the primary use of the area- wildlife management and associated wildlife recreational activities such as photography, nature study, and hunting.

Because of the possibility of conflicts between the management programs of wildlife and forestry management, there is an important need for frequent meetings between the Game and Fish Commission and the Division of Forestry to discuss management programs. During these meetings, programs can be explained and evaluated in order to gain the most advantage of each program for the agencies involved.

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CHAPTER I

INTRODUCTION

"The conservation goal of America's third century as a nation must be the development and protection of a quality environment which serves both the demands of nature for ecological balance and the demands of man for social and psychological balance" (U.S.D.I., 1969). To accomplish the goal of development and protection of a quality environment requires at least three broad steps: (1) recognizing the need for such development, (2) formulating a management plan or guideline which considers this need in the light of available resources, and (3) applying the concepts included in the plan or guideline to the area of concern. Realizing that any plan will need periodic revision as a result of new developments and imputs, annual reviews of the program are recommended while considering the current priorities as related to the available resources.

Twenty-one areas in Tennessee totaling over one million acres are managed by the Tennessee Game and Fish Commission for wildlife management and public recreation. These areas received 768,000 outdoor recreation trips in 1972-1973. Thirty-seven percent of these trips involved hunting and fishing, 17 percent camping and picnicking, and 47 percent sightseeing (unpublished report, Tennessee Game and Fish Commission, 1973). Wise management requires that plans be formulated and followed which favor the prime intents of the areas while providing non-conflicting provisions for secondary recreational pursuits. Only one wildlife plan

has been written to date, that being for Catoosa Wildlife Management Area in Cumberland, Fentress and Morgan counties; the plan is not presently being followed completely.

There has not been a wildlife plan or guide developed for the Chuck Swan Wildlife Management Area (WMA). In the past the annual program has been largely determined according to the available manpower and funds. To a lesser extent the desires of the central office of the Tennessee Game and Fish Commission and the interests of the area manager have influenced the work scheduled and accomplished on the area. Goals were many times determined for the immediate future and were short-lived and narrow in scope.

Estimated outdoor recreation trips for the Chuck Swan WMA totaled 35,360 visitor-days in 1972-1973. Thirty-three percent of these visits were to hunt and fish, 27 percent for camping and picknicking, and 40 percent for sight-seeing (unpublished report, Tennessee Game and Fish Commission, 1973).

Administration of the area is through the Tennessee Game and Fish Commission and the Tennessee Department of Conservation, Division of Forestry. Under this cooperative program, the Commission manages the wildlife and the Division of Forestry manages the timber. The lack of meetings between these two agencies has allowed conflicting and self-defeating programs to exist on the area. Deer have browsed newly planted pine seedlings set out in wildlife openings, roads were rutted and made impassable in the winter by logging trucks, and sawmills have been located in browse and pasture fields without the approval of the Commission. Oak and beech timber that had previously produced considerable

mast crops have been clear-cut and hickory has been girdled to eliminate it from timber stands.

Conflicts between Commission programs have also resulted in mismanagement of the area. Openings, planted entirely to agricultural crops, have been concentrated along well-traveled roads rather than being scattered throughout the area. Natural openings have similarly been planted entirely to pasture rather than maintaining a portion of them in a natural vegetation condition.

The above noted conflicts of timber and wildlife management reflect the absence of management goals and poor communication between the two responsible agencies. The following wildlife management guide with its discussion of the natural resources of the area should be helpful in developing an orderly management plan for the wildlife, timber, and recreational resources of the area and provide the basic materials necessary for a more permanent and detailed plan. Many of the principles discussed will be applicable to other areas of similar characteristics and intents.

The objective of the guide will be to itemize some of the major natural resources present on the area and to suggest management procedures which will best coordinate these resources with the wildlife production and utilization. This approach should result in increased recreational opportunity while improving the wildlife habitat and timber harvest.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

A. LOCATION

The Chuck Swan WMA is located thirty-five miles northwest of Knoxville, Tennessee, on the Union and Campbell county line. The area is a 24,831 acre peninsula between the Clinch and Powell rivers on Norris Reservoir. Access to the area is by secondary road west of State Highway 33, ten miles north of Maynardville, Tennessee, in Union County.

Major nearby towns include LaFollette in Campbell County (15 miles west), Tazewell in Claiborne County (18 miles northeast), and Maynardville in Union County (8 miles south).

The Clinch-Powell region is rurally oriented with the following population figures noted for the three counties in the 1973 World Almanac: Campbell--26,045; Claiborne--19,420; and Union--9,072.

B. GEOLOGY AND SOILS

The Chuck Swan WMA lies within the dolomitic hill area of the Norris Reservoir watershed. It is underlain by cherty and sandy dolomitic limestone of the Knox formation (U.S.D.A., 1953). Characteristic of the area are the smooth well-rounded hills and the narrow steep-sided V-shaped valleys. The flood plains and terraces of the Clinch and Powell rivers have been flooded by Norris Reservoir. Limestone sinks are common throughout the area, especially on the Clinch River side of the peninsula.

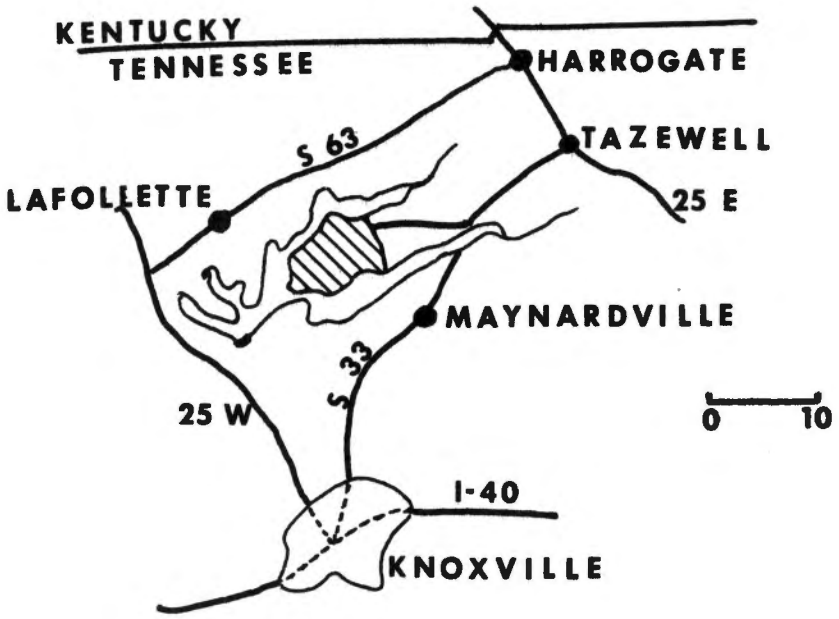


FIGURE 1. Location of the Chuck Swan Wildlife Management Area.

Elevations range from 1,000 feet along the reservoir shoreline to 1,680 feet on Weaver Knob.

The soils are generally low in fertility, low in organic matter and strongly acid. Surface drainage is rapid and internal drainage is variable between good and rapid according to the soil type (Table 1).

C. CLIMATE

The climate of the Norris Reservoir area is temperate and continental. Summers are long and winters are short and open. The mean winter temperature is 36 degrees and the mean summer temperature is 73 degrees. The average frost free period is 173 days and extends from April 25 to October 16. The average annual precipitation is 50.21 inches evenly distributed through winter, spring, and summer. The highest mean monthly rainfall (5.22 inches) falls in March and the lowest (2.97 inches) falls in October. Many times the summer rains fall as torrential downpours and are accompanied by lightning. Snowfall averages 10.4 inches and does not remain on the ground for any extended periods (U.S.D.A., 1953).

D. EARLY DEVELOPMENT OF THE AREA

The area now included within the boundaries of the Chuck Swan WMA was first settled in the late 1770's or early 1780's. Sharps Station, now inundated by Norris Reservoir, was located on the Clinch River across from Lost Creek Cemetery. It was built in 1784 and was to become the center of the first recognized settlement. The founders of this station came from Haw Valley in Orange County, North Carolina. Later

TABLE 1. Acreages of the Five Crop Management Classes on the Chuck Swan WMA.

Class	Acres	Percent of Area	Recommended Use
1	170	0.8	Good to excellent for crops and pasture
2	2,050	8.2	Fair to good for cropland, fair to excellent for pasture
3	4,850	19.5	Poor to fair for cropland, fair to good for pasture
4	6,000	24.1	Poor cropland, poor to good for pasture
5	11,800	47.4	Very poor cropland and pasture

SOURCE: U.S.D.A., 1953.

on other small settlements developed as the original community expanded and the population increased. For the next 150 years the region was a typical farming community with varying amounts of cropland, pasture, and woodland (Thomas, 1969).

Foundations of buildings, remnants of log outbuildings, cisterns, old road locations and cemeteries are scattered throughout the area. According to information received from the Tennessee Valley Authority, there are forty-one cemeteries in the area (Gerhardt, 1965).

During the period just prior to the construction of Norris Dam, the Tennessee Valley Authority purchased most of the land making up the management area. This purchase was considered appropriate considering the second alternative of building a bridge across the reservoir to connect all of the residents of Campbell County with an access route to the county seat. At the time of the purchase, there were approximately 2,400 residents on the 531 tracts of land (Lewis and Safley, 1967).

There are presently 435 acres of land remaining in private ownership within the management area. These holdings are owned by seven families, none of whom reside on the property (Figure 2).

The Tennessee Valley Authority transferred the land to the State in 1952 for development as a demonstration area of coordinated land use integrating forestry, fish and wildlife, and recreation potentials of the area. A fee of $6,498 was paid by the State to TVA for this transfer (Tennessee Valley Authority, 1952). Mr. Chuck Swan, for whom the area is presently named, was Commissioner of Conservation at the time of this transfer and was instrumental in designating the area for the above use. Management of the area's resources was delegated to the

KEY:
A. M. Cooper - L. Stairs (Central Peninsula Gun Club)
B. Mrs. T. Hammer et al.
C. H. Nelson et al.
D. I. Nelson
E. C. Hatmaker
F. H. Nelson, M. Nelson, C. Nelson
G. H. Nelson, M. Nelson, C. Nelson, B. Lonas
H. A. Henegar

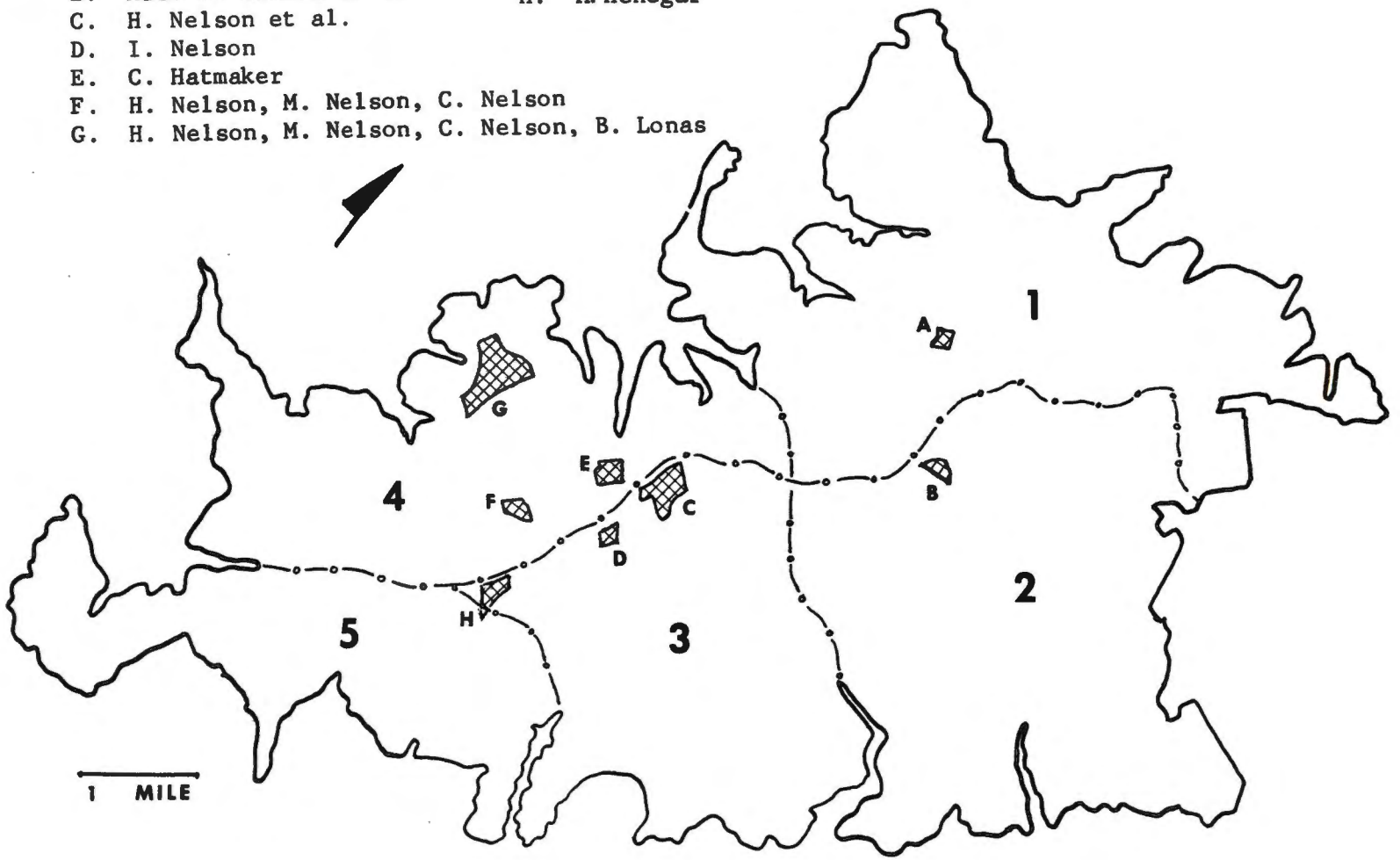


FIGURE 2. Location of interior holdings and management compartment boundaries, Chuck Swan WMA.

Tennessee Game and Fish Commission and the Division of Forestry, Department of Conservation, an arrangement being followed at this time.

E. LOCAL BUSINESS ENTERPRISES

No business enterprise in the nearby region depends on the wildlife or forestry activities of the area. However, several small grocery stores, motels and restaurants do realize a small portion of their annual income during the managed hunts on the area. A survey of nearby businesses in 1968 by the author indicated their annual incomes from hunter-related sales averaged between $750 and $1,500. No improved camping areas have been developed in the surrounding area although four or five landowners do allow hunters to camp on some of their lands during the hunts for a fee of $2.00 to $3.00 per night per camp. No water or electrical facilities are available at these sites.

Twelve boatdocks on Norris Reservoir in the vicinity of the area provide access during the small game hunts (Figure 3). In addition to launching fees and boat rental service, the docks offer necessary permits for hunting on the area. Information from many of the docks indicate that very little actual income is realized during these hunts. The availability of permits is considered a service to regular and potential customers of the docks. Access through the docks to the area is not allowed during the big game or turkey hunts.

F. PAST HABITAT IMPROVEMENT ACTIVITIES

Previous habitat management has been directed toward agricultural crops, pasture, and deer browse improvement. The major emphasis has been

KEY:
A. Straight Branch
B. Flat Hollow
C. Rogers
D. Powder Mill
E. Alder Spring
F. Shanghai
G. Rainbow Marina
H. Sequoyah
I. Stardust
J. Andersonville
K. Hickory Star
L. Lakeview

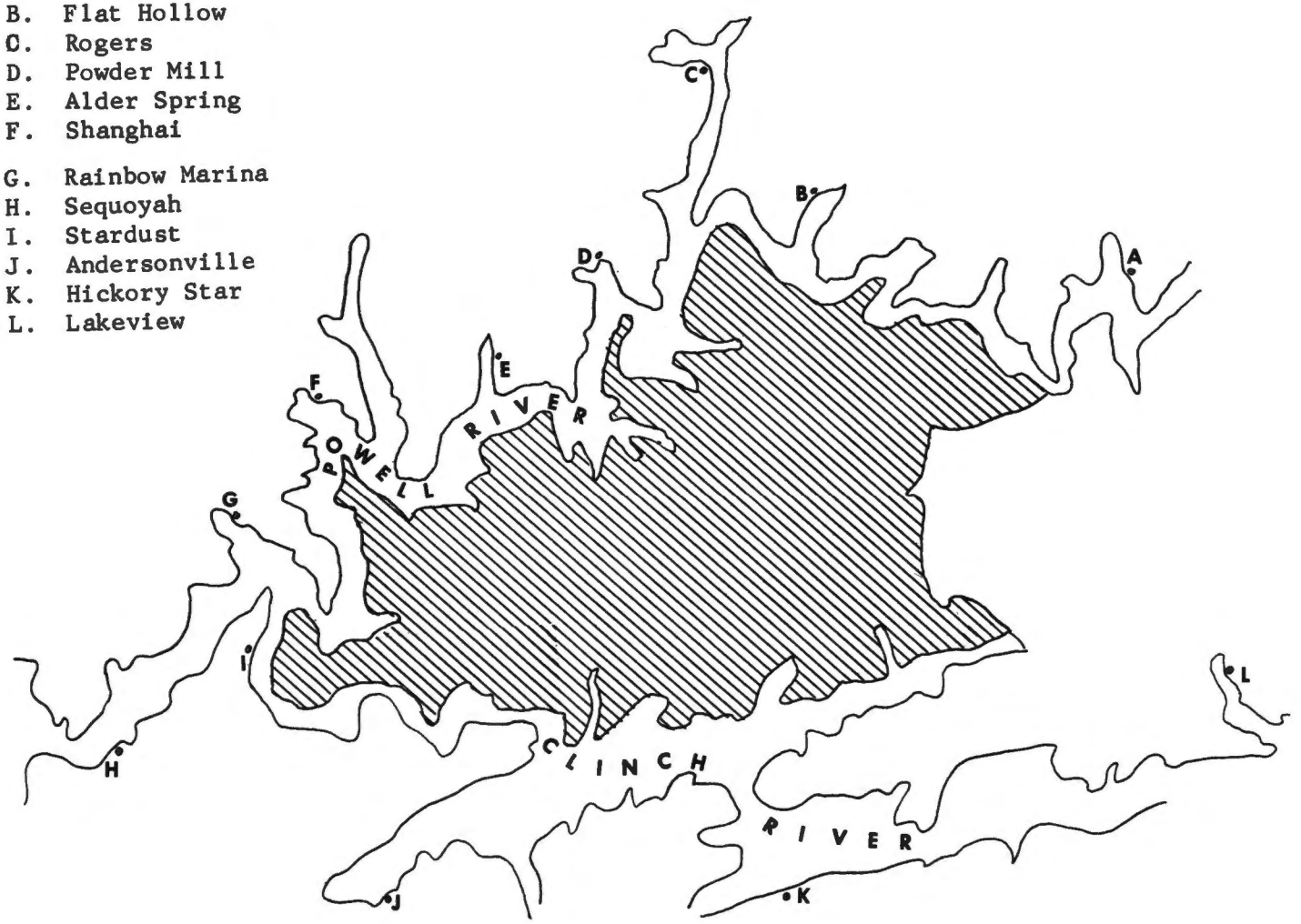


FIGURE 3. Location of boat docks on Norris Reservoir in vicinity of Chuck Swan WMA.

centered around deer management and habitat improvement, recognizing that other species of game might benefit to some degree from such activities. In some respects the above has not been entirely true as natural openings have been converted to agricultural crops and pine plantations. Some wildlife benefits have been credited to previous timber harvest operations in the form of increased deer browse production. However, in many of these areas much of the valuable mast producing timber has been harvested without adequate oak-hickory-beech reproduction being present in the cutting unit to provide for future stands of these important mast producers.

There are approximately 126 fields or open areas totaling 1,300 acres on the area. Many of the fields have been in an open condition since their original development in the 1780's. Several other fields were re-established after they had reverted to a brush condition following the purchase of the area by TVA (Figures 4, 5, 6, 7, 8).

Agricultural crops are planted on a four to five year rotation. The rotation sequence follows a schedule of annual seed mixture, a period of idleness for two years, winter pasture, corn, and concluding with winter pasture. This rotation has been repeated for over fifteen years as budget and manpower levels allowed. Little maintenance is necessary except for periodic clipping and top-dressing with lime and fertilizer. Approximately 600 to 800 acres are planted or in some way worked each year.

A program was initiated in 1969 which provided that those fields to be planted to winter pasture would be made available to local farmers for harvesting the hay the following summer. The charge to the farmer

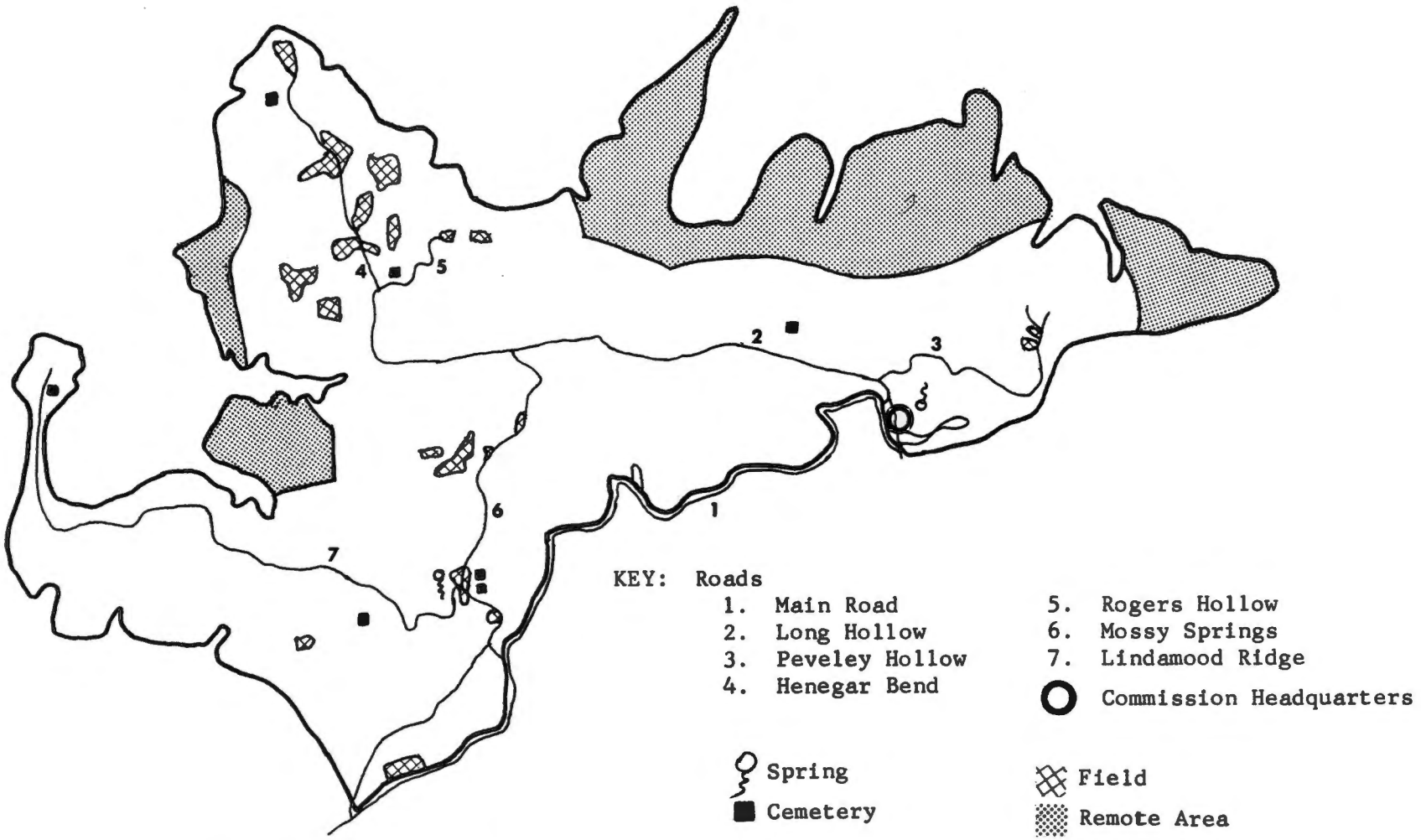


FIGURE 4. Location of fields, roads, and commission headquarters, Compartment 1.

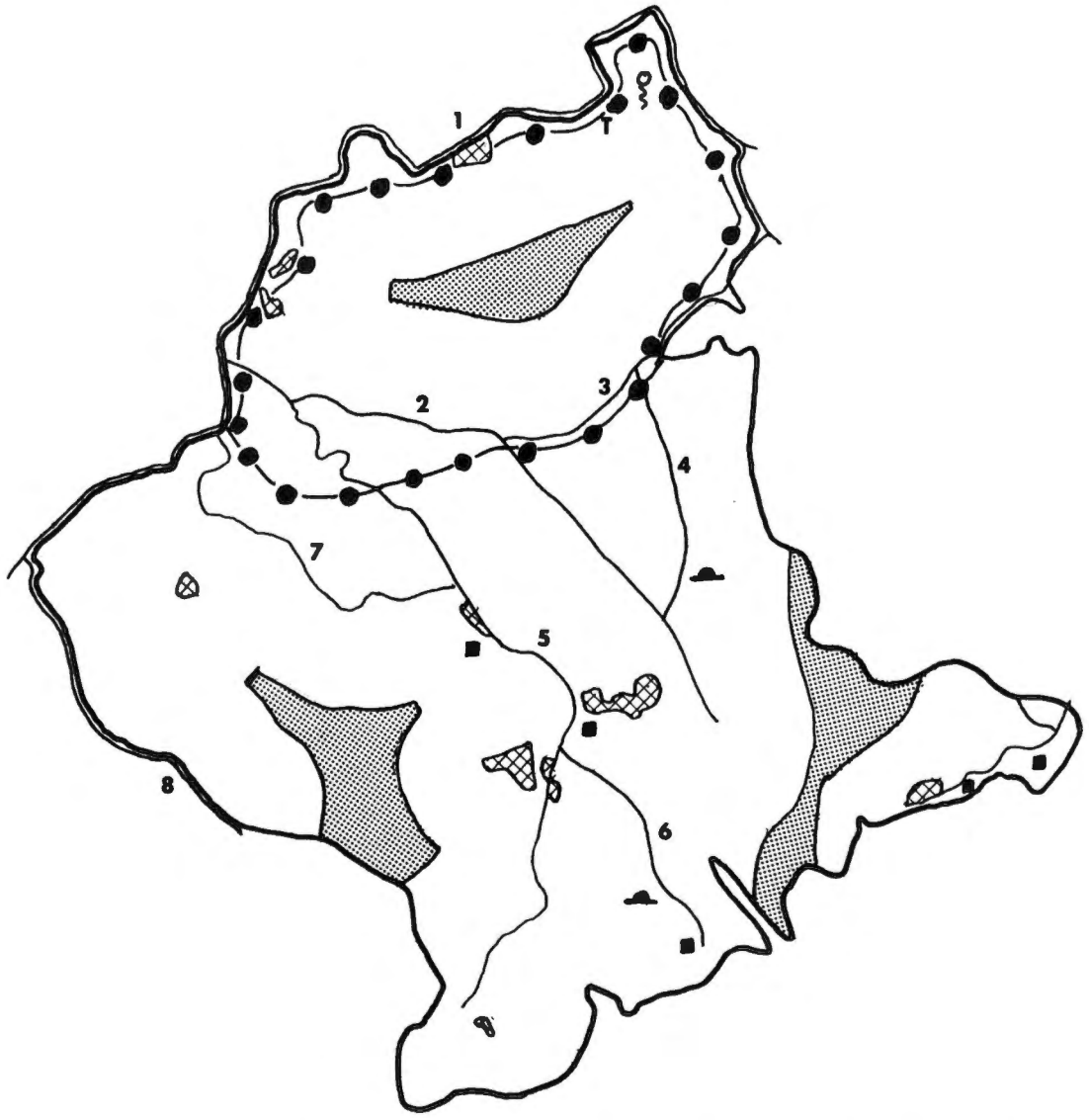


FIGURE 5. Location of fields, roads, fire tower, and White Hollow Watershed, Compartment 2.

KEY: Roads

1. Main Road	5. Rice Erwin
2. White Creek	6. Lost Creek
3. Roe Hollow	7. Knob
4. Dog Hollow	8. Clear Creek

T Fire Tower — Field

Spring — Remote Area

Cave — White Hollow Watershed

Cemetery

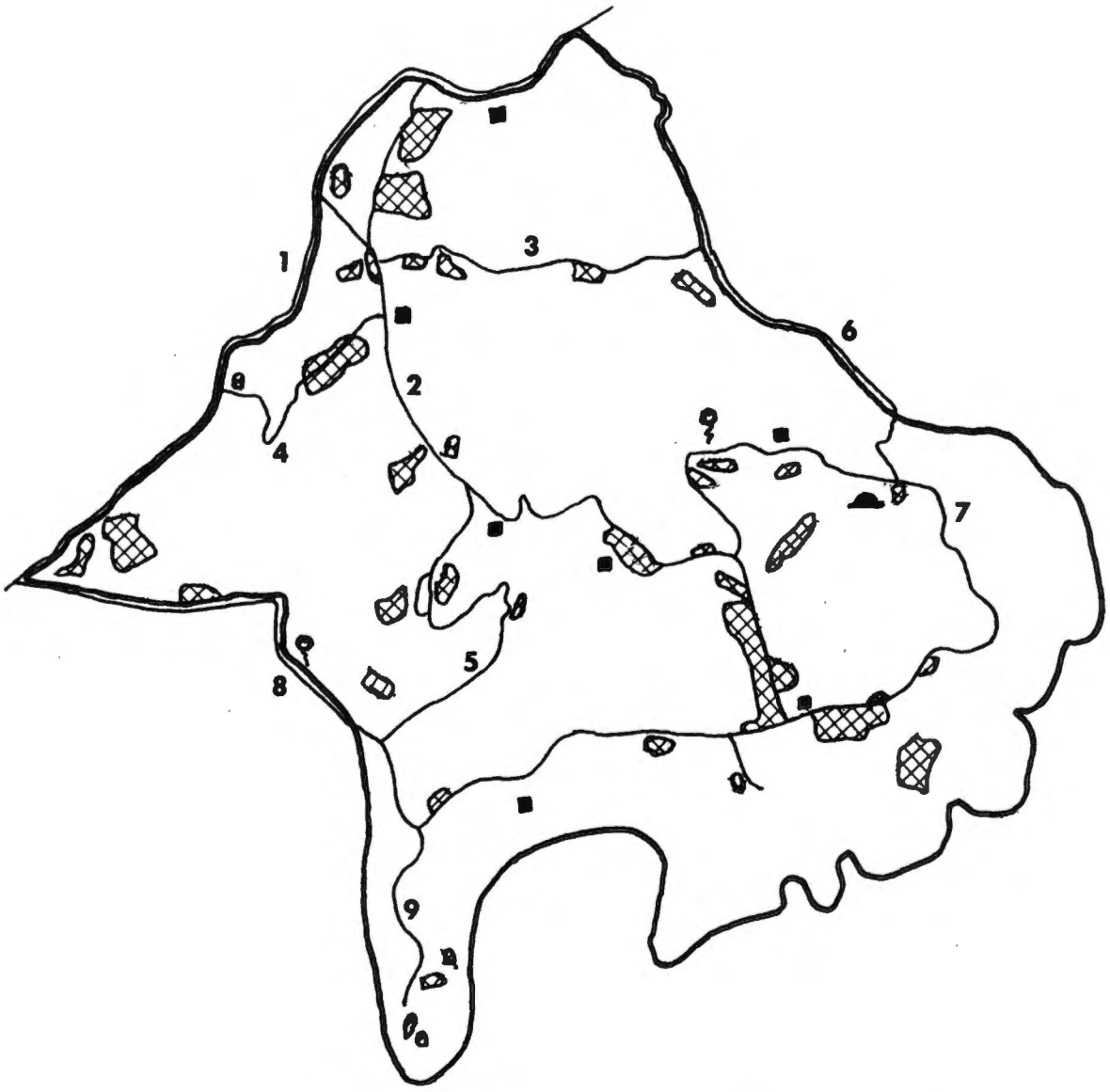


FIGURE 6. Location of fields and roads, Compartment 3.

KEY: Roads

1. Main Road
2. Oaks Chapel
3. Pond Hollow
4. Nelson
5. Robert Henegar
6. Clear Creek
7. Levi Evans
8. Big Springs
9. Marble Quarry

Spring
Cave
Cemetery
Field
Remote Area

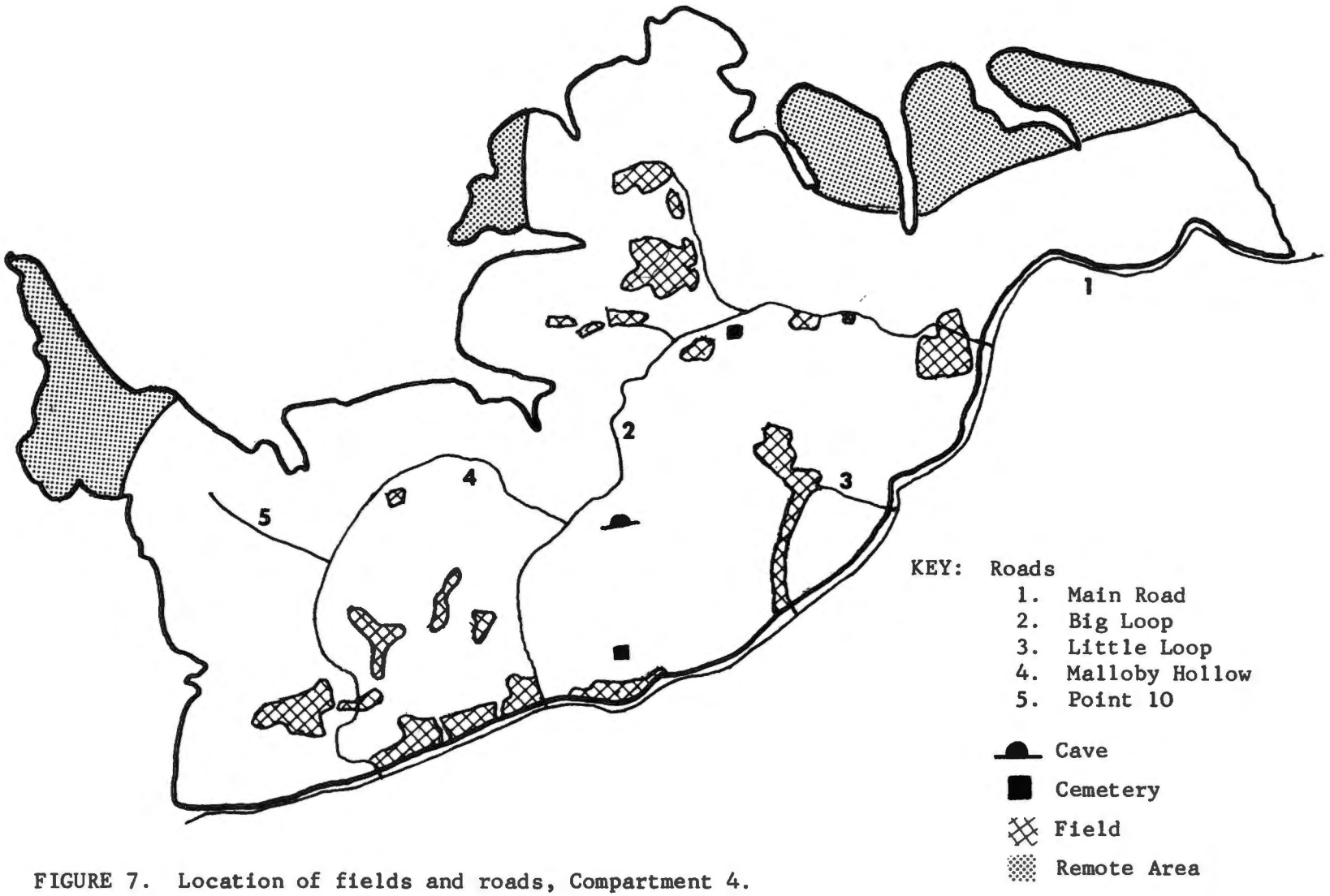


FIGURE 7. Location of fields and roads, Compartment 4.

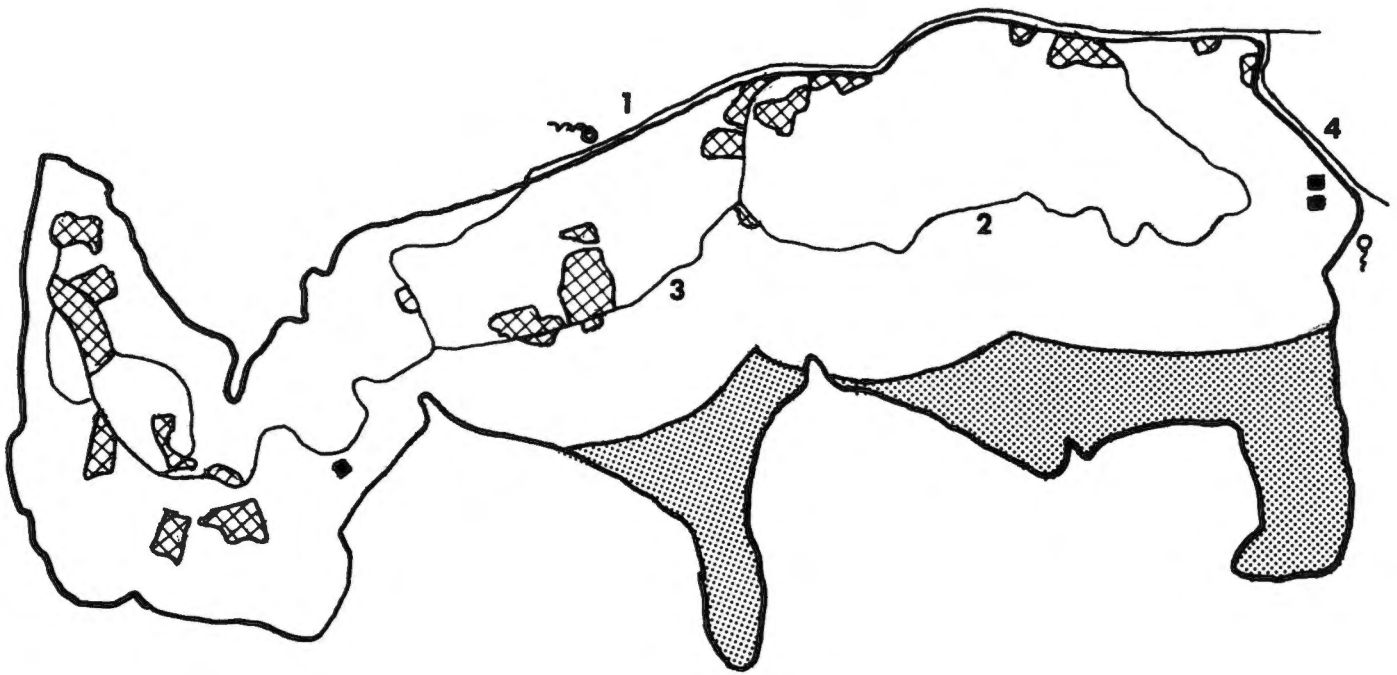


FIGURE 8. Location of fields and roads, Compartment 5.

KEY: Roads
1. Main Road
2. Bear Ridge
3. Back Valley
4. Big Springs

Spring
Cemetery
Field
Remote Area

was the price of commercial fertilizer necessary for optimum growth. The time of mowing by the farmer was set by the area manager to guarantee that no serious wildlife conflicts developed such as the destruction of game bird nests. This program of cost-sharing the costs of pasture development is a vital part of the previously outlined crop rotation program.

The major deer habitat management program started in 1959. Early work involved employing an eight-man crew to partially cut through hardwood saplings and push them over. By only notching the main stem of the sapling, the top was not killed and it continued to produce browse. Considerable sprouting occurred along the main stem of the plant also. Approximately 100 acres were treated in this manner, most of which were along the road rights-of-way and turnoffs.

A Case 310 crawler tractor was purchased for the area in late 1959 and used in the place of the eight-man crew. With the blade riding at ground level, the vegetation was pushed over leaving part of the root system in the ground. This method was considered too slow and expensive for the amount of browse produced.

An International TD-18 crawler tractor was borrowed from the Catoosa WMA in 1960 to replace the Case 310 crawler. Areas approaching twenty acres were treated in an eight-hour day and required only two men to be present during the operation, one to operate the crawler and one for safety reasons. Again the blade was set at ground level during the improvement operation. When the effectiveness of this larger crawler tractor was realized, an International TD-20 was purchased for the area and the TD-18 was returned to its station. Approximately 1,600

acres have been treated since the start of the intensive browse improvement program.

Sprouting resulting from the partial uprooting of the plant is concentrated along the main stem and around the root collar. Several random checks by the author have indicated production of ten to twelve times the amount of deer browse of untreated plots. This increase occurs during the first four to five years following treatment. After the above time period, the production decreases to only three times the original amount. If allowed to remain untended, the browse production will eventually approach the amount of browse characteristic of untreated plots. This loss of browse results from the plant growing out of the reach of deer. All browse plots have been treated at least twice and some three times since 1959.

Correspondence with the Division of Forestry has failed to provide definitive maps of those areas that have been logged for either sawtimber or pulpwood. General location maps have indicated that timber sales have been made in the drainages of White and Clear creeks and in the northeast corner of the management area. In addition to this harvest, all of the small pine plantations were thinned by 1972. Monies collected from these sales have been placed in the General Fund of the State.

Browse production in the logged areas is dependent on the understory present and the severity of the cut. With abundant understory and heavy removal of overstory, the browse production has been very good. In thick pine plantations, with little understory, the amount of browse production following thinning has been minimal.

G. PERSONNEL, STRUCTURES, EQUIPMENT, AND BUDGET

The Chuck Swan WMA is staffed by an Area Manager and two Area Aides. Conservation Officers in the neighboring counties regularly assist with law enforcement activities and patrol work. Biologists are frequently assigned to the area to assist in the collection of biological data. The programs recommended should not require additional personnel.

Personnel responsible for the timber management of the area are under the direction of the Division of Forestry, Department of Conservation.

Buildings owned by the Commission include the Area Manager's residence, one bunkhouse, one storage shed, and one checking station. One additional structure is recommended to house vehicles. A bath house in each camping area is also recommended when the water system is improved to permit an adequate water supply for such use.

Equipment includes a complete complement of farm machinery with two farm tractors and one crawler tractor. Additional equipment recommended includes the necessary machinery and vehicles for the operation of a gravel quarry. This will include a front-end loader and one truck.

The budget has averaged over $27,600 per year for the last five years. State funds have averaged over $7,300 and Federal Aide funds over $20,300 during this period. Increases will be necessary to meet inflation and to purchase additional equipment.

CHAPTER III

SOURCES AND USE OF INFORMATION

Information included in this manuscript has come from three sources: (1) literature published in various texts and journals; (2) records, published and unpublished, on file in the offices of the Game and Fish Commission; and (3) experiences of the author on the area while employed by the Commission since 1958 as a game biologist.

While reviewing the literature pertaining to the management of specific game animals, an attempt was made to include only those practices which would be applicable to the management of the Chuck Swan WMA. It may be assumed that although originating in areas outside of this region, the principles noted also apply to this management area.

Discussions with the present area manager and the two previous managers have indicated the presence of weak and sometimes conflicting programs. The development of a sound management program should meet these problems by offering applicable management techniques resulting in the development of quality wildlife habitat.

These guidelines are so designed that their contents may be used in two ways. First, referring to the literature review, the guidelines specifically point out management techniques which are applicable to the individual wildlife species. A second use involves the management of the habitat resources. Persons responsible for managing the area can use the section most appropriate to the management problem under consideration.

CHAPTER IV

RECOMMENDED MANAGEMENT PRACTICES

A. LITERATURE REVIEW

White-Tailed Deer (Odocoileus virginianus)

Fourteen white-tailed deer from the Pisgah National Forest in North Carolina were released on the Chuck Swan WMA in 1937 by the Tennessee Valley Authority. The animals were descendants of deer stocked from New York (Odocoileus virginianus borealis) and from the coastal areas of North Carolina (O. v. virginianus) and Florida (O. v. osceola) (Lewis and Safley, 1967).

Herd growth was slow until the early 1950's when protection and improved habitat conditions promoted rapid herd growth. Numbering 800 animals in 1950, the population peaked at 5,000 animals in 1957. Managed hunts, first scheduled in 1950, were for bucks only until 1953 when the range was showing signs of overbrowsing. Either-sex hunts were scheduled that year to bring the herd down within the carrying capacity of the area, a system still used when the range indicates the deer herd has exceeded its food supply (Table 2).

Information contributing to the recommendation for either-sex hunting includes decreasing average weights, smaller antlers and fewer atretic corpora lutea scars in the female's ovaries. This information, when used with the various range surveys, provides the basic information necessary to hunt recommendations.

TABLE 2. Number of Hunters, Type of Hunt, Deer Killed, and Hunter Success for the Chuck Swan WMA.

Year	Type of Hunt	No. of Hunters	Deer Killed			Hunter Success
			Females	Males	Total	
1950	Gun	190		79	79	41.6
1951	Gun	302		90	90	29.8
1952	Gun	480		122	122	25.4
1953	Gun	775	194	284	478	61.7
1954	Gun	871	207	365	572	65.7
1955	Gun	1,149	379	451	830	72.2
1956	Gun	2,245	424	602	1,026	45.7
	Archery	464	6	5	11	2.4
1957	Gun	3,680	673	670	1,343	36.5
	Archery	1,030	10	12	22	2.1
1958	Gun	3,588	482	436	918	25.6
	Archery	1,577	9	10	19	1.2
1959	Gun	3,158	275	302	577	18.3
	Archery	1,449	3	10	13	.9
1960	Gun	3,000	69	252	321	10.7
	Archery	944	4	4	8	.8
1961	Gun	1,962		174	174	8.9
	Archery	608	6	11	17	2.8
1962	Gun	1,795		224	224	12.5
	Archery	627	6	16	22	3.5
1963	Gun	1,662		247	247	14.9
	Archery	795	14	13	27	3.4
1964	Gun	2,428	283	381	664	27.4
	Archery	1,211	40	40	80	6.6
1965	Gun	1,918		230	230	8.3
	Archery	2,037	57	52	109	4.4

TABLE 2 (continued).

Year	Type of Hunt	No. of Hunters	Deer Killed			Hunter Success
			Females	Males	Total	
1966	Gun	1,656		226	226	13.6
	Muzzleloader	216	29	22	51	23.6
	Archery	2,282	63	65	128	5.6
1967	Gun	724		139	139	19.2
	Muzzleloader	1,122	133	131	264	23.5
	Archery	3,132	52	60	112	3.6
1968	Gun	2,055	62	137	199	9.7
	Muzzleloader	635	20	41	61	9.6
	Women Only	246	66	33	99	40.2
	Archery	4,442	107	71	178	4.0
1969	Gun	1,242		154	154	12.4
	Muzzleloader	229		36	36	15.7
	Women Only	97		9	9	9.3
	Archery	1,195		39	39	3.3
1970	Gun	2,241	347	368	715	31.9
	Muzzleloader	864	76	137	213	24.7
	Women Only	247	31	20	51	20.7
	Archery	4,257	83	96	179	4.2
1971	Gun	2,163		191	191	8.8
	Muzzleloader	833		84	84	10.1
	Women Only	265	24	30	54	20.4
	Archery	4,504	91	103	194	4.3
1972	Gun	2,148		127	127	5.9
	Muzzleloader	939		38	38	4.0
	Women Only	310	22	28	50	16.1
	Archery	5,179	143	116	259	5.0
TOTALS	Gun	41,432	3,395	6,251	9,646	23.3
	Muzzleloader	4,838	258	489	747	15.4
	Women Only	1,165	143	120	263	22.6
	Archery	35,733	694	723	1,417	4.0
		83,168	4,490	7,583	12,073	14.5

The present deer population is approximately 2,700 animals, or one deer per nine acres of habitat. Surveys made since 1970 indicate a static or slightly decreasing deer population. No excessive browsing has been recorded for any of the basic groups of deer food, although decreasing average weights and lowering doe:fawn ratios suggest poorer food quality than a few years ago. Recent timber harvests involving heavy cutting in hardwood stands should improve these conditions.

Maximum deer populations should not exceed one deer per ten acres of habitat over a long period of time. Past surveys have indicated that when densities exceed this limit there is overbrowsing of the preferred deer foods. If this condition is permitted to continue, the range will deteriorate and may require five or more years to recover to its previous quality. At these recommended density levels, an average of 500 to 600 animals can be removed from the area annually. These figures assume a reproductive rate of 1.5 fawns per breeding doe and an annual herd increment of 25 percent. As the quality of the deer habitat improves, reproductive rates should improve resulting in populations higher than those noted. It will then be necessary to increase the harvest, either by hunting or removal from the area for release in areas without a deer population at that time.

Deer food preference is determined by the vegetation available in the area in question. Highly preferred browse species on one area may be eaten infrequently on another area. This preference is related to the palatability and/or availability. There are general food preference categories that appear applicable to all areas. Those categories appearing on the Chuck Swan WMA are listed in Table 3.

TABLE 3. Seasonal Forage Crops Eaten by Deer.

Season	Season
SPRING Green desiduous leaves of woody plants Grasses and sedges Succulent green woody stems Dominant items: Yellow poplar fruits, green leaves Acorns Apple fruits Green leaves of sourwood, legumes, honeysuckle, sassafras, blackberry	SUMMER Green leaves of deciduous woody plants Fungi (mushrooms) Green herbaceous stems and leaves Dominant items: Stems and leaves of legumes Green leaves of red maple, oak, dogwood, sourwood, honeysuckle, sassafras
FALL Oak mast Fruits of apple, persimmon, grape Green leaves of honeysuckle Grasses, sedges, fungi	WINTER Oak mast Dried deciduous leaves of woody plants Green herbaceous stems and leaves Grasses and sedges Mushrooms Hardened woody stems

SOURCE: Harlow and Hooper, 1971.

In the study of Harlow and Hooper, hardened woody stems occurred in the deer's diet in the lowest volume and with the least frequency. Green leaves of woody plants were rated the highest in both volume and frequency. Forbs, grasses and sedges, fungi (mushrooms) and dried leaves equalled the amount of green woody plant leaves eaten.

Segelquist and Pennington (1968) noted that the proportion of browse in the diet was directly related to the availability of other foods--the higher the browse occurrence in the diet, the more limited the availability of other foods. They stated that browse will provide food for deer for several years but reproduction, physical condition and even survival may be adversely affected as the percent of browse increased in the diet. Hosley (1956) noted similar points and included increased parsitism and disease resulting from inadequate food supplies. Smaller antler development is also characteristic of areas with inadequate food supplies.

Lay (1969) noted that woody browse makes up less than one-half of the deer's diet, green leaves and twigs accounting for a higher percentage of foods eaten. Other foods mentioned included herbage such as broad-leaved vegetation, fruits such as acorns and apples, various vines, mushrooms and other fungi, and various agricultural crops such as oats and rye grass.

Deer do not generally need surface water except during hot weather and, in the case of does, during lactation. Wet areas also offer a variety of herbaceous food plants along the shores and shallow portions of the pond or stream (U.S.F.S., 1971; Cahalane, 1961).

Many times deer habitat will benefit from any forest management practice which includes the removal of trees. However, deer management may be difficult in areas where there is a high economic return for wood products. Forest management may be so intensive that non-commercial vegetation will be eliminated. Much of this non-commercial growth is deer food. In areas of low to moderate returns, both deer and forest products can be benefited at the same time. Patton and McGinnes (1964) said that even the lightest cuts of timber (30 percent of basal area) can increase browse from ten to thirty pounds dry weight per acre after one year. Usually newly created browse will be available for up to four years, declining rapidly after the fifth year. An April survey of several browse plots on the area indicated available browse totaled 600 to 700 pounds wet-weight per acre by the fourth year and declined to less than 200 pounds per acre by the sixth year (Lewis and Safley, 1967).

Forest openings are important to a productive deer herd. In addition to offering an area for loafing, bedding and sunning, such openings may produce thirty-two times more fruit and seven times more browse than plants in a sawtimber stand of southern pines. Some of the fruiting plants reported were dogwood, strawberry bush, and Japanese honeysuckle (Halls and Alcaniz, 1968). Blair (1969) observed that more fruit was produced in openings with moderate amounts of mixed timber and less was produced in pine stands. Management implications from a study by McGinnes (1969) indicated that openings less than 1,600 feet across would best coordinate deer habitat improvement with timber management.

Thinnings provide good forest growth and improve wildlife habitat conditions. There is an obvious response in browse and forage production

following such operations, the extent being related to the intensity of the thinning and the understory present. The production of grasses, forbs and browse is inversely related to the overstory density. To provide browse in the middle and late years of a pine plantation, non-mast or non-fruit producing trees may be felled to keep browse within the reach of deer (Blair, 1967). Care is needed when weeding the stand to avoid eliminating valuable fruit, mast or browse producing plants (Hosley, 1956).

Uneven-age forest management, when accomplished by single tree selection or selective cutting, provides maximum mast production and pleasing esthetics but does not allow for optimum browse or herbage production (Sander and Clark, 1971). Even if there is a diverse woody understory, the lack of openings with herbaceous growth will create less-than-optimum habitat conditions. Additionally, unless care is taken, selective cutting may create conditions contrary to what is considered productive wildlife habitat (Speake, 1970).

Long rotations, such as those associated with hardwood stands, lend themselves to thinning operations. The technique offers flexibility to maintain the stand structure to fit wildlife and forest resources. Light selective cuts benefit mast production. Short rotations utilized in pine management may start with considerable browse, then as the pine seedlings gain height, the browse will be shaded out of the stand; limited browse that may be left is generally of poor quality. A short rotation program generally requires the removal of oaks before the optimum mast production age is attained (Goodrum, 1969). Blair (1969) reported that more mast was produced per tree in an

uncrowded canopy but more mast was produced per acre where trees were dense.

Carter and Dow (1969) stated that partial cuttings and frequent cutting cycle intervals are needed to provide adequate deer habitat conditions. Seed tree or shelterwood cuts are adaptable to such programs.

Shelterwood cutting programs can result in high mast production and will provide more browse and herbage production than single tree selection. Because of the programs involved in this type of timber removal (cutting the overstory after the reproduction has advanced to the sapling stage), shelterwood cuttings are highly effective at maintaining oak and hickory stands (Sander and Clark, 1971).

Removal of timber by clear-cutting or group selection methods will result in a wide diversity of habitat and good edge conditions. Herbaceous and browse growth is rapid and plentiful, and if done adjoining a mature stand of oak timber, will result in a balanced habitat. This technique does require advanced growth of oak and hickory reproduction if these species are desired in the mature stand. Group selection is less objectionable esthetically than clear-cutting large areas (Sander and Clark, 1971).

One method of easing the impact of the standard clear-cut involves leaving some of the dead, crooked and otherwise cull trees standing until the new forest is in the sapling stage. At that time, if it is considered necessary and desirable, the unwanted trees may be felled. This method is referred to as an "esthetic clear-cut." Results from the Coweeta Forest indicate initial growth is suppressed in this type of clear-cut.

No type of cutting practice will provide for new oak seedlings following a timber harvest unless present at the time of harvest. The oak complement of the stand is fixed at the time of harvest. In some areas, both oaks and hickories may have died back prior to cutting, but following harvest, again resume growth. Yellow poplar does not necessarily come up from new seed but may develop from seed that has dropped and remained on the ground for as long as four years. It is therefore unnecessary to leave yellow poplar seed trees in a cutting area.

Generally clear-cuts should not be so small that browsing by the deer herd present will eliminate the preferred browse or seedlings nor so large that the browse is allowed to become dense and unattractive to wildlife. It may be desirable to perform heavy selective cutting or modify the dimensions of the cutting unit should large areas need to be harvested. Long and narrow areas have more edge as compared to square or circular plots (Speake, 1970; Harlow and Downing, 1969).

Harlow and Downing have suggested further that twenty-one acre clear-cuts are a desirable compromise between cuts of one to fifty acres. Small, scattered clear-cuts will provide maximum mixtures of stand types, ages, species and treatments (Goodrum, 1969). Such components with scattered openings will produce more food for a longer period of time for deer than large blocks of even-age timber. Palatability of browse appears to be higher in heavy cuts than in light or moderate cuts.

Assuming 25 percent of the unit is cut every twenty years, there will be 25 percent of the area in timber less than twenty years old,

25 percent of the area in timber twenty to sixty years old, and 50 percent of the area in timber sixty to one hundred years old. The above schedule should reach the browse production goal with a balance of available mast (Shaw and Ripley, 1965).

Understandably, maximum production of browse in an area does not mean that deer prefer all of the browse produced. Much of the production will be in the lower preference tables such as emergency and starvation foods (U.S.F.S., 1970).

Controlled burning may accomplish several favorable results in deer habitat management. Shrauder and Miller (1969) note the following desirable responses from a controlled burning program.

1. Reduction of undesirable woody vegetation.
2. Lowering the height of browse within the reach of deer.
3. Improvement of the nutrient quality of browse.
4. Increased production of desirable herbaceous vegetation under semi-open overstory conditions.
5. Encouragement of fruit and berry production under sparse overstories.

Under dense stand conditions, understory oaks will not produce mast and will be taking up space that would be better utilized by various shade-tolerant fruit and mast producing vegetation. Summer burns may be utilized in such instances to remove the less productive oaks. These burns will kill from 50 to 70 percent of the understory vegetation and should not be used after the proper reduction of vegetation has been accomplished.

Protein and phosphoric acid levels, both critically low in the fall and winter months in the southeast, can be increased by controlled burning.

This is especially true in the drier areas. High intensity fires give beneficial results over a longer period than low intensity fires, although there will be little difference after two years.

Shrauder and Miller also noted that winter burns are preferred to increase legume production in semi-shady areas and to increase woody plants and grass in open areas. Controlled burning during the winter seldom kills plants and animals nor destroys nests. Additionally, no harmful effects result to the soil quality if the soil is damp. Desirable plants sprouting after a burn include dogwood, strawberry bush, honeysuckle, blackgum and greenbriars.

The frequency of burning should be determined by the amount of fuel available and the results desired for the area. Generally a light four-year prescribed burn rotation is the most beneficial for understory vegetative growth and mast production. Areas within 150 feet of a stream and mast-producing stands under pole size should be protected from the fire program.

Lewis et al. (1964) noted that forbs show good response to burning, especially following an August burn. However, a burn at this time does leave more soil exposed resulting in possible soil erosion. Higher forb production was maintained at least through three years compared to control plots. Legumes also showed a significant increase on all burns with more preferred than unpreferred species growing in the burned area. Browse increased in palatability, at least for the first year. Burns after March produced fewer sprouts than burns prior to the date. Survival of vegetation was also lower on the drier south slopes than on the north slopes.

Shrauder and Miller (1969), while giving guidelines to the effectiveness of a burn, noted that favorable operations resulted in no discoloration of the crown foliage and the scorching on the tree bole was no higher than eighteen inches from the ground.

Blair (1969), in writing on the influences of timber stand density to food and cover for deer, mentioned the contribution of moderate litter cover on the forest floor to stabilize surface temperatures and to restrict water loss via evaporation. Heavier amounts of litter will substantially reduce plant growth and reduce the quality of the deer habitat.

Eastern Wild Turkey (Meleagris gallopavo)

Eighty-eight game farm turkeys were released on the Chuck Swan WMA from 1948 through 1950. The releases for the three years involved twenty, thirty-five, and thirty-three birds, respectively. The birds were raised on the Buffalo Springs Game Farm in Grainger County. No known survival or reproduction resulted from these releases (Schultz, 1955).

Twenty-three wild trapped birds were released on the area between 1954 and 1956. These birds were trapped on the Ocoee WMA in the south-eastern corner of the state in the Cherokee National Forest. Individual releases included two hens in March, 1954; one gobbler in February, 1955; one hen in August and one gobbler, two hens, and one of unknown sex on October, 1955; and three gobblers and twelve hens in the spring of 1956 (personal communication, John Murray, Tennessee Game and Fish Commission, 1973).

The turkey population increased dramatically from 1957 until 1962 when the population reached 300 birds. A spring gobbler-only hunt that year, the first turkey hunt scheduled on the area, resulted in a harvest of six birds by 141 hunters. The number of hunters and the birds harvested continued to increase until 1967 when 48 birds were checked out with 863 persons hunting on the area. The kill was down considerably the next two years, only 13 and 16 birds being harvested. It was thought at that time the harvest in 1967 had been too heavy for the population present. It was known in 1967 that several birds were lost by the hunters, the exact count estimated at twenty or more birds (Table 4).

Estimates based on current brood and flock counts and harvest information indicate the population is increasing and exhibits a density of approximately nine birds per square mile. The total population for the area is presently 300 to 400 birds. The rate of increase is expected to level off as a result of recent detrimental timber harvests in prime mast producing areas.

New and improved turkey habitat management programs are expected to result in population increases to levels approaching 15 to 20 birds per square mile. These levels will permit using the area as a source of wild birds for introduction into areas not having a turkey population. Using the area as a stocking source will prevent the scheduling of fall hunting for turkeys.

Bailey (1951) reports that turkey are in competition for food and habitat with deer, raccoon, squirrel, and grouse. Populations in West Virginia averaged one bird per 200 acres in the winter and one

TABLE 4. Turkey Hunting Success on the Chuck Swan WMA During Spring (Gobbler Only) Hunts.

Year	No. of Hunters	No. of Turkey Killed	Hunter Success	Kill Per Square Mile
1962	141	6	4.3	.15
1963	306	17	5.6	.44
1964	541	18	3.3	.46
1965	666	19	2.9	.49
1966	745	21	2.8	.54
1967	863	48	5.6	1.24
1968	772	13	1.7	.34
1969	667	16	2.4	.41
1970	551	12	2.2	.31
1971	586	28	4.8	.72
1972	740	38	5.1	.98
TOTAL	6,578	239	3.6	.56 (11 year average)

bird per 125 acres in the fall. The U. S. Forest Service (1971) notes populations of one bird per 20 to 400 acres and a management objective of one bird per 64 acres. The report lists a home range of 640 acres. Lewis (1963) reports Michigan home ranges of 683 acres for males, 435 acres for females, and 492 acres for mixed flocks. Dalke (1946) gives a carrying capacity of five birds per square mile.

Optimum turkey range may be any large, well-watered forested area with a variety of timber types of which 50 percent is in hardwood. One-half of the hardwoods should be mature oaks of the small mast species. Well distributed clearings that support rank growths of native grasses, legumes, and plants that produce succulent fruits should be scattered throughout the forested area. Openings may constitute 5 to 50 percent of the area (Wheeler, 1948; Mosby and Handley, 1943). Present wildlife management guidelines for national forests in the south recommend one opening of one to five acres per 160 acres (U.S.F.S., 1971; Hewitt, 1967).

Two major opportunities for management are available for turkeys on the area. The first, either natural or maintained forest openings, appears to have the greater potential for the Tennessee Game and Fish Commission's turkey management program. The second opportunity involves timber management of both hardwoods and softwoods, management for turkeys being a byproduct of timber management.

Natural forest openings provide considerable food that is not found under closed canopy forests. Various wild grasses and weeds, berries, forage and insects are available during the warm seasons of the year (Hewitt, 1967; Webb, 1963).

In addition to food production, natural openings are utilized as the centers of nesting and brooding areas. Nests are usually established near openings where the incubating hen may go for feeding and loitering purposes. Later, the poults will be led into such areas for bugging and foraging. Because of this latter use, care must be taken not to encourage openings away from protective brood cover areas. Dense stands of cedar and brushy areas offer adequate protection for poults (Hewitt, 1967; Hoffman, 1962).

Usually one such opening per 160 acres is sufficient for good turkey habitat. The size of the opening should be between one and five acres. Old roads and log landings are acceptable substitutes for natural openings (Shaw, 1959; Holbrook, 1967; U.S.F.S., 1971; Hewitt, 1967). If deer are present, the opening may need to be larger to accommodate the additional grazing (Arner and Davison, 1963).

To ensure an adequate number of openings, additional areas may need to be established in a scattered pattern throughout the area. Optimum acreages and numbers of such areas are the same as that of natural openings. The openings should be established away from human interference and adjacent to protective cover.

Openings should be located on level terrain (less than 4 percent slope) with fertile soils. Fertilizer and lime should be applied according to a soil sample analysis to maintain plant vigor and succulence. As with natural openings, maintenance may be limited to periodic discing.

Food patches are especially valuable in years with limited mast production. They should not be over two acres nor total more than 1 percent of the area. Areas managed under the even-age management

principle also require the establishment of food plots (Halls and Stransky, 1968). Although spring and summer movements are more behavioral than environmental, the availability of food appears to govern much of the turkey's activity during the winter (Ellis and Lewis, 1967). For this reason, turkey food patches should be those that produce late-season crops. Corn, winter wheat, oats, Austrian peas, vetch and millets are recommended for this purpose.

Hoffman (1962) has reported that oats is best for food plots followed by barley, corn, and wheat. With adequate natural or cultivated foods, winter feeding is not necessary. Hewitt (1967) lists a variety of cultivated or pasture crops for small plantings. Included in his list are Kentucky 31 fescue, velvet grass, oats, browntop millet, chufa, winter wheat, lespedezas, and white Dutch, ladino and crimson clovers. Gardner and Arner (1968) report that chufa and clover plots are worthwhile management objectives, particularly in the pine forest areas of southeastern United States. Hillestad and Speake (1970) found that spring and summer range of hens with poults centered around permanent pasture and open woodlots.

Bush lespedezas, blight resistant chestnuts and many natural foods may be planted and/or encouraged. Some of these natural foods include grapes, sumac, greenbriar, sassafras, and dogwood (Bailey, 1951; Wheeler, 1948).

Winter feeding may be necessary in the event that natural or cultivated foods are not adequate. Corn, oat hay, wheat, and buckwheat have been reported by Bailey (1951) as satisfactory for this purpose. As a precautionary note, it may be necessary to precondition the turkeys

to the availability of feeding stations by establishing such sites before the critical period arrives. Gardner and Arner (1968) noted that commercial feeds are of little value for increased fecundity or survival.

The second major opportunity for applied turkey management concerns the management of the timber crop. Under the present division of responsibilities on the area, both the Division of Forestry and the Game and Fish Commission will have an imput into this program. A sound forest management policy directed toward mixed species and ages of timber and high quality sawlogs with a long rotation is best for the area and its timber and wildlife products (Hewitt, 1967).

Since oak mast is the preferred natural turkey food, rotations should be at least eighty years. Shorter rotations reduce the range quality because much of the area would be in stands of five to thirty years old which do not produce adequate mast crops. U. S. Forest Service standards call for a variety of mast trees with a total basal area of 8,800 square feet per square mile. This figure assumes a production of 3.5 pounds of mast per square foot and normal populations of other wildlife that feed on mast (U.S.F.S., 1971).

Shaw (1959) recommends group selection guidelines for a timber harvest program. These selection areas can be further modified to create natural or managed openings of one to five acres where herbaceous vegetation can be planted. In addition to group selection recommendations, he further suggests protecting clumps of three to ten trees of mature oak, cherry, and gum within the cutting area.

Thinnings and intermediate cuts allow great flexibility in maintaining an area for both wildlife and timber. The first thinning will

determine the timber type that is desired and later thinnings will encourage an increase of mast and wood production. It is possible to perpetuate the mast component of the stand in a dominant or codominant crown class with this schedule of cutting programs (Holbrook, 1967).

Holbrook suggests that thinnings will also insure a variety of understory but noncommercial vegetation. The recommendation is thin to 60 or 70 percent stocking and seek three to four thinnings per 90 year rotation.

Cutting too much of the timber in an area can result in increased understory vegetation which detracts from the value of the area for turkeys. Holbrook noted that regeneration cuts will eliminate the area from turkey habitat until mast production begins, possibly as long as 25 years.

The visual result of a properly thinned area with its limited understory will resemble a park. Turkeys will use such areas for feeding and loafing. Removal of the less desirable species with a DBH of four or less inches can benefit both timber and turkey production. The crown growth should not be disturbed to create a shaded condition (Bailey, 1951).

Strode (1957) recommends an average of 18.8 mast trees per acre in longleaf pine areas. Scattering these trees is better than leaving clumps of oaks. If 50 or more trees are present, thinning will open up the overstory giving more light penetration to the understory. Competition between those trees remaining will also be lessened. The value of the area for turkey is hurt if less than eighteen trees per acre are left.

Bailey (1951) notes that clear-cutting is bad for turkeys, selective cutting being more adaptable to turkey management. Turkeys do not fully utilize clear-cuts wider than 200 yards and will restrict their activities to the fringe areas. It is better to cut several small scattered areas during any one cutting season. Mature hardwood and other food producing vegetation in small clumps should be excluded during the cutting program. On large treatment areas, these exclusions should approximate 15 to 20 acres. Small plots of pines will provide roosting areas and protective cover.

Stands with a predominance of pines may be burned to remove understory vegetation and litter. This technique will stimulate fruiting-type vegetation and succulent greens. Brush may also be removed by this method or with chemicals and heavy equipment. Chemicals should not be used except as a last resort due to potential wildlife poisoning. Hardwoods should not be burned unless they are to be eliminated. Small clumps of hardwoods in pine stands should be protected by establishing a fire lane around them. Burning done in December, January, and February will encourage legumes. Summer burns favor grasses, usually not highly desirable in a turkey management program (U.S.F.S., 1971). No area should be burned more than once every third year (Arner and Davison, 1963).

Pines may be considered as an exclusion when located within a hardwood stand. As noted earlier, pines offer roosting sites, especially when overmature. Immature pine and cedar thickets and dense pole and sapling stands are used by turkeys for escape cover. They are also utilized during periods of inclimate weather (Hewitt, 1967; U.S.F.S., 1971; Hoffman, 1962).

Turkeys readily seek water in hot dry weather. Water sources may be springs, streams, ponds or lakes and should be available at the rate of one source per square mile. Stream improvement activities may increase the availability of water while improving the stream for fish (Holbrook, 1967; Hoffman, 1962; Edminister, 1954). A nesting hen should have water within 400 feet of her nest (Arner and Davison, 1963).

Predation normally will not hold down a healthy, productive flock of turkeys in adequate habitat. However, in a high-use hunting area such as the Chuck Swan WMA, it may be desirable to perform some limited and periodic predator control. When possible, controls should be included as a public activity. Poaching is not considered a serious problem due to the secretive habits of the birds.

Holbrook has condensed the basic requirements for turkey management down to two items--ample stands of mixed hardwoods for feeding and loafing areas and scattered stands of conifers for roosting. Expanded, these guidelines include favoring hardwoods on hardwood sites; leaving not less than 200 square feet of basal area per forty acres in oak, hickory, and/or beech; slashing down rather than poisoning root crowns of dogwood and other food producing vegetation; and using long cutting rotations.

Lay (1959) lists additional management practices which include well distributed water sources, minimum human interference, limiting livestock grazing, well distributed clearings, encouraging fruit and seed producing vegetation and grass, maintaining areas in open understory, and planting cool season grasses and legumes to supplement periodic mast shortages.

Gray Squirrel (Sciurus carolinensis)

Gray squirrel densities have fluctuated from an estimated low of one squirrel per three and one-half acres to an estimated high of one squirrel per three-fourths acre. These figures were determined from infrequent random surveys through squirrel habitat. Harvest data, collected between 1954 and 1963, indicate annual harvests between 1,300 and 4,750 animals for the area (Table 5).

The present population is declining as a result of heavy timber harvests of oak and beech timber. Recovery of some of the sites will require as many as thirty or more years to attain former mast producing capabilities.

Squirrels can offer more opportunity for public recreation than any of the other game species on the area. This potential is related to the possibility of long hunting seasons which will not seriously affect the breeding population potential of the area and the relatively simple management requirements.

Nixon et al. (1968) reports that population densities of 0.47 to 1.28 squirrels per acre can be expected in average habitat. The objective of the U. S. Forest Service (1971) is one squirrel per two acres in the southern Appalachians. Mosby (1969) indicates that 40 percent of the population may be harvested without causing a decline in the population the following year. He cautions that population estimates need to approach some degree of accuracy to reduce the chance of over-harvest.

Annual fluctuations of the population are the results of varying numbers of juveniles entering the population and adult movements into and out of the area. Adult populations of squirrels do not vary to any

TABLE 5. Small Game Harvested on the Chuck Swan WMA, 1954 - 1963.

Year	Hunters	Squirrel	Rabbit	Raccoon Opossum	Quail	Grouse
1954	2,451	4,751	199	70	120	2
1955	2,827	4,604	309	66	313	0
1956	2,112	2,512	109	78	116	1
1957	2,174	3,598	66	104	140	2
1958	1,829	1,301	58	75	83	7
1959	1,791	1,861	40	158	47	2
1960	1,521	3,326	14	96	0	3
1961	1,511	3,205	0	121	0	15
1962	1,645	1,484	43	85	0	9
1963	1,504	1,658	38	68	146	5

great degree from one year to the next, their numbers reflecting the juvenile segment entering the breeding population. In years of lower than average or decreasing populations the juvenile male:female ratio will favor males. Decreasing populations may be represented by a kill of less than 62 percent juveniles (Uhlig, 1956).

Much of the cause of reduction of young entering the population may be related to reduced fall and winter foods, particularly the hard mast component. Late spring frosts may kill mast while in the flower stage creating a decreased food crop in the fall. This reduction of fall foods will result in lowered reproductive rates, lighter body weights, and increased dispersal and/or mortality of the brood stock, particularly of the subadults (Nixon and McClain, 1969). Allen (1943) reported that a loss of the mast crop in the 1930's reduced the gray squirrel population over a large area in Wisconsin, some of that area reporting a scarcity of these animals as late as 1943.

Gray squirrel management should begin with the first step of good forestry--inventories of the standing and potential stock of trees. During this step it is desirable to identify key factors such as den trees, both dead and living, and large and small stands of mast producing trees (Madson, 1964).

The seasonal food habits of gray squirrels are generally related to the availability of foods rather than the physiological changes within the animal. In fall and winter the major foods include acorns, hickory nuts, beechnuts, black walnut, tulip poplar samaras, buckeye nuts, and grass blades. In spring the food list includes those items listed above plus oak flowers, fungi, green plant material, and insects.

Summertime foods include fruits, berries, mushrooms, tree seeds and larvae and cocoons of insects. Hard mast, when available, is readily eaten. Hickory nuts, beechnuts and acorns may make up 70 percent of the volume of foods consumed (Nixon et al., 1968).

In addition to those forest foods noted above, gray squirrels may raid fields for such items as corn, small grains, vegetables (peas and beans) and buds and catkins of various trees (Cahalane, 1961; Nixon et al., 1968).

Hard mast makes up three-fourths of the diet from September through March. Thirty to forty pounds of mast per squirrel are required for this 210 day period. Gray squirrels will consume their own weight each week (U.S.F.S., 1971; Nixon et al., 1968).

Goodrum et al. (1971) have noted that generally acorn yields increased as the tree matured. The largest production was in those trees tallied in the 40-49 year class up to those in the 90-99 year class. Older trees may become decadent and die. Yields also increased with increased bole diameters and increased crown diameters. These production increases will vary according to individual tree characteristics, differences in site quality and the amount of shading, either from near-by trees or from the individual tree itself. No relationship was noted between rainfall and seed production.

Madson (1964) stated that in addition to more food being produced by middle-aged or mature trees there was also the possibility of more den trees being available in such trees.

Pine stands are not good gray squirrel habitats. For this reason it is advised to identify and save hardwood stands of five or more

acres occurring in such areas. Conversion of hardwood stands to pine forests will eliminate such areas from squirrel habitat (U.S.F.S., 1971).

Late spring frosts may kill the current white oak mast production while it is still in the flower stage. Late frosts will also seriously affect the red oak mast crop which would become available one year later. However, in the case of red oaks, emergency measures can be followed which would limit the animal population to the amount of food available.

Gray squirrels show no preference toward red or white oaks. Therefore, if a choice must be made between white or red oaks, red oaks such as northern and southern red and black oaks should be favored over the less dependable white oaks. However, it is best to have some of each to insure a variety of mast (Nixon et al., 1968).

Goodrum et al. (1971) noted that there was some production in each of eighteen years of an acorn production study. Low production in one species was compensated for by higher production in another species. Southern red oaks had one good crop in four years, blackjack oak one in five years, and white and post oaks one in two years. Nixon et al. (1968) has stated that Appalachian oak stands average annually 146 pounds of oak mast per acre.

The lack of surface water will not limit the use of an area by gray squirrels although they will use free water when available (U.S.F.SS., 1971). Surface water may be necessary during drought conditions.

Considering the above information the following management guidelines are suggested.

1. Long timber rotations should be favored. Rotations of 80 years will result in 50 percent of the area being in squirrel habitat. Sixty year rotations will result in 30 percent of the area in squirrel habitat and 100 year rotations will result in 60 percent of the area in squirrel habitat (U.S.F.S., 1971).

2. Prior to the regeneration cuts, identify and protect den trees to a density of at least two per five acres (U.S.F.S., 1971). Madson (1964) recommends two to three per acre. Should dens be scarce, gray squirrels will utilize artificial denning structures. Burger (1969) suggests that artificial dens in areas lacking adequate dens will aid in the survival of the young until their first winter and all squirrels from winter to winter.

3. Under an even-age management program, aim for a basal area of nine to eighteen square feet per acre of beech, elm, hickory, maple and/or buckeye. With the present market characteristics, less emphasis is placed on these species, all of which produce good gray squirrel foods. If timber is the prime resource of the site, these trees should be kept as crop trees until rotation age following clear cuts. Because of higher market values, oaks, black walnut and tulip poplar will usually be well represented. Under uneven age timber management adequate foods are usually available.

4. Prior to the harvest cut oak reproduction must be present in the understory (U.S.F.S., 1971).

5. Identify and protect key areas such as grape tangles, mast-bearing trees in pine stands and clumps of oaks of different species in pine stands (U.S.F.S., 1971).

6. Leave one elm or mulberry tree per acre of oak-hickory forest; four to six hickories per acre of timber; divide the oaks present between red and white oaks. These guidelines are more easily applied to areas to be selectively cut and must be specifically noted in areas to be clear-cut (Madson, 1964).

7. Avoid animal grazing, wide spread clear-cuts and fires in hardwood timber stands.

8. In years of mast failure, seasons may be extended and bag limits increased. Should the need arise that feeding programs are requested and considered proper, feeders filled with cheap scratch feed may be used (Davison, 1964).

Ruffed Grouse (Bonasa umbellus)

Information obtained from many of the older hunters who have hunted grouse in the Clinch-Powell region for many years indicate that the grouse population was high from the early 1940's until the early 1950's on the management area. Populations, estimated at over 200 birds at that time, developed as the pastures and woodlots were revegetated following overgrazing by the livestock that was present in the 1930's.

Ruffed grouse have been decreasing since the mid-1950's. Present populations are estimated at less than 150 birds. This decrease has occurred as a result of second growth timber maturing and shading out the understory vegetation (Table 5, page 45).

Populations should increase as the habitat conditions are improved. This increase will result not so much from specific grouse management but result from the management directed toward other species.

As noted by Bump (1947), intensive cover management for grouse is seldom justified.

The key to ruffed grouse habitat is the interspersion of openings and many diverse stands of vegetative cover in a relatively small area of 160 acres. Young sprout growth and pioneering herbaceous vegetation are characteristic of the small clearings. Because of this diversity, there may be a need for the use of more than one soil type and elevation. Mature timber should be nearby to complete the varied vegetative nature of the site (Allison, 1966; Moulton, 1968; Madson, 1969; Hazel, 1953; U.S.F.S., 1971).

Nesting cover includes fairly dense second growth hardwood timber with sparse undergrowth within one to two hundred feet of an opening. Brood cover involves the presence of lush forbs, grasses and low shrubs which will provide food and cover and a strata for insects. Such areas should be 1,200 to 1,600 feet apart and be the focal point for any specific ruffed grouse habitat development (U.S.F.S., 1971; Allison, 1966; Chambers and Sharp, 1958; Bump et al., 1947).

Evergreens are used for winter cover and roosting. Conifers may be low growing; young pine in a thicket configuration will provide adequate cover. Such areas may be provided as a block within a hardwood stand and be located 1,200 to 1,600 feet apart. Five acres or more may be so designated (U.S.F.S., 1971; Allison, 1966). Dorney (1959) noted that hardwoods with intermingled conifers were used more in the winter than either pure hardwoods or conifers.

Food habits are seasonal and are related to the differences in species of vegetation present in the area. Listed below are the

seasonal food habits noted by Grange (1948) and Bump et al. (1947).

Winter: buds and catkins, acorns, green material.

Spring: flowers (especially those with large amounts of pollen), catkins, strawberry, sumac, cinquefoil, succulent grasses, insects.

Summer: fruits (berries, cherries, grapes), insects, greens, sedges, smartweeds.

Fall: hardy greens, clover (white, alsike, red), dandelion, acorns. Considerable feeding on miscellaneous vegetation is done in overgrown fields.

Grange further noted that most of the animal matter consumed was ants (Formica and Camponotus) and grasshoppers (Melanoplus). Cultivated crops included buckwheat, corn, barley, oats, sorghum, millet and rye. Bailey (Shaw, 1959) also included wheat and ladino clover as ruffed grouse foods.

Korschgen (1966) itemized the principle foods of Missouri ruffed grouse in the following order: green leafy materials, hophornbeam, acorns, wild grapes, tick trefoils, bush clovers, Korean lespedeza, ferns, and sedges. Fifteen percent of the food came from high canopy trees, 45 percent from understory shrubs, vines and brambles, and 40 percent came from herbaceous forbs and grasses. These data emphasize the need for a mixed vegetative type.

It should be noted that food availability and hunting are generally not limiting factors of ruffed grouse populations. In most instances the scarcity of cover, such as brood cover, is the key item that is holding back the population (Shaw, 1963; U.S.F.S., 1971).

Surface water is not a limiting factor to ruffed grouse habitat requirements (U.S.F.S., 1971).

Because diversity and interspersion of vegetative cover is so important to optimum ruffed grouse habitat, timber programs resulting in such conditions are preferred. Various conflicts between forest and ruffed grouse habitat management include monotypic forests, loss of openings caused by planting seedlings, conversion of hardwood or mixed hardwood-pine stands to pine and a tendency to work larger areas.

Good ruffed grouse habitat results from timber management programs that encourage continuous young growth with considerable edge, a reduction of dense overstory to allow understory growth, and the maintenance of access roads and trails (Moulton, 1968).

The following guidelines are suggested for ruffed grouse habitat improvement:

1. A majority of the management activity should be in the transition zone between lowland and upland areas. Lowlands should be undisturbed. The transition zone should have 40 to 45 year rotation forest management with isolated islands of food-bearing trees excluded from the cutting program. With this type of management, the zone will provide good habitat conditions for adults and their brooks (Berner and Gysel, 1969).

2. Group selection or small clear cuts result in better habitat conditions than those from selective cuts. Stands cut on 60 to 100 year rotations similarly are bad for ruffed grouse use (Edminister, 1954; Allison, 1966; U.S.F.S., 1971).

3. Use intensive timber stand improvement (T.S.I.) guidelines in dense pole stands for opening up the overstory to allow for ground vegetation growth (Allison, 1966).

4. Openings and fields should be scattered and irregular shaped. Allow borders to develop heavy brush, using T.S.I. procedures if necessary.

5. The period for optimum ruffed grouse use in clear-cuts is the first seven to eight years. Use will drop after this time unless the stand is rejuvenated. T.S.I. operations may be utilized to improve the condition of the site (Sharp, 1963).

6. Broods will remain in a relatively small area, consistently using clearings that are six to seven years old when present. There may be little or no use of weedy areas until at least three years old. Similarly, mature stands with no understory will be little used. Scatter brood areas out at 1,200 to 1,600 foot intervals (Porath and Vohs, 1972).

7. Use controlled burning in needy areas where a "no-cut" timber policy is present. Burning will control forest growth; stimulate new food supplies such as legumes, smartweeds, tick trefoils, sedges, grasses and berries; provide better availability to foods by removing ground litter; clear land of dead brush and grass; control possible insect parasites and disease organisms; and break down vegetative matter into its basic elements and minerals (Grange, 1948).

8. Plant roads and landings to clovers and green winter vegetation. Roads may be daylighted back one-half chain or a distance equal to the height of the neighboring timber. Encourage dense shrub

borders along roads and trails similar to that around openings (Madson, 1969; U.S.F.S., 1971).

9. Openings should be scattered, 1,400 to 1,600 feet apart and be 100 to 200 feet in diameter or in long narrow strips. Blackberry, sumac and viburnum should cover one-third to one-half of the area, the remainder in herbaceous growth (Berner and Cysel, 1969).

10. Plantings of cultivated crops for ruffed grouse are not recommended since these plantings are not used enough to justify the expense (Edminster, 1954).

Raccoon (Procyon lotor)

Information is limited concerning early raccoon populations on the management area. Reports would indicate that the population did not show a dramatic increase until the area was purchased by TVA and protection was made available. Managed hunts resulted in harvests of 66 to 158 animals until 1962 when range conditions and possible over-harvest caused a decrease in the population. The season was closed in 1965 and remained closed until 1971 when the raccoon population recovered throughout the area (Table 5, page 45).

The future of the raccoon population on the area will depend on the recognition of habitat and protecting it during timber cutting programs plus maintaining complementary agricultural programs. Anticipated harvests should approach 100 to 125 animals annually.

Johnson (1970) has reported that habitat deficiencies are the major limiting factors of raccoon populations. No special management program may be required for this game species, however, if the area is

under a varied habitat management program. The adaptive character of raccoons permits them to take advantage of developments designed for other species such as deer, turkey, or gray squirrel.

The raccoon is an omnivorous feeder, utilizing both plant and animal matter for food. Aquatic animal food items include crayfish, water insects, snails, frogs, and fish. Upland food items include insects, earthworms, spiders, small ground nesting birds and their eggs and broods, turtles, grubs and mice.

Plant foods include persimmons, pokeweed berries, grapes, plums, haws, cherries, hackberries, blackberries, dogwood berries, acorns, grass and sedge seeds, greenbriar fruits, red cedar berries, black gum and beechnuts (Sonenshine and Winslow, 1972; Berner and Gysel, 1967; Cahalane, 1961; Johnson, 1970; Brooks, 1959; Schwartz and Schwartz, 1959).

Cultivated foods include chufa and corn, the latter rated as highly preferred. The highest populations of raccoons in Kansas are in those areas of the state where corn is grown (Stains, 1956).

In addition to area management which considers the availability of the varied food items noted above, the provision for denning sites has the next highest priority for raccoon management. Dens may be either in trees or in burrows.

Butterfield (1954) noted that groundhogs and raccoons may use the same hole as a refuge site, as a den and even perhaps as a brood den. With an adequate number of such sites tree dens may not be used. Raccoons have been known to evict groundhogs from their selected burrows. Stains (1956) related that more ground dens than tree dens are used in

Kansas due to the scarcity of suitable trees.

Artificial dens may be provided in the event natural dens are not available. Since females stay close to their den sites and the males search for them, it is advisable that an adequate supply of scattered dens be available for optimum reproduction (Brooks, 1959).

Schwartz (1959) reports that denning sites include hollow trees, groundhog burrows, caves, crevices in rocky ledges, under tree roots, squirrel nests and even haystacks. The best trees for tree dens are oak, sycamore, maple, and elm because of their rotting characteristics.

Basic characteristics of tree cavities used for dens are little precipitation and wind in the cavity and more stable internal temperatures than those outside the den. No relationship with food or water seems to exist (Berner and Gysel, 1967).

Additional recommendations include preserving natural, arboreal refuges such as large poplars and bottomland oaks. Swampy areas and nonpolluted streams should be maintained to provide food variety to upland foods (Johnson, 1970).

Hunting and dog training period regulations should be enforced which aid in preserving the family unit until breakup, usually in late November and December.

The use of fire should be restricted to those areas without natural or artificial denning areas. Feeding areas such as marshland and streamside borders should also be avoided.

Hollow trees should not be removed from an area within 300 feet of a stream or watered area. Such areas are highly valued by a female for brooding young, and the presence of denning sites increases this

attractiveness. One hollow tree per acre is the objective for providing denning sites.

Eastern Cottontail Rabbit (Sylvilagus floridanus)

According to early landowners of the area, rabbit populations were considerably higher in the 1930's than at the present time. The decrease has occurred as fields reverted to dense brush and later to an open hardwood sapling and pole stage (Table 5, page 45).

The present rabbit population is confined to the larger non-forested areas with brush, pasture and grain crops in close association with each other. Early spring deer census routes have recorded as many as fifteen rabbit observations for a twenty-mile route. However, hunter success is low during the fall hunts. Some limited field work indicates that the rabbits in the area at that time are utilizing dense browse plots and are not easily located by the hunters.

Future rabbit hunting should improve considerably with improved habitat conditions. Breaking up extensive browse plots, more diversified cropping programs, and early opening of the hunting season will contribute to improved hunting conditions. However, since the area is best managed for forest game, intensive habitat management for rabbits is not recommended.

Winter, a time of food scarcity, is the critical season for rabbit populations. Dried and green leaves and stems of herbs and grasses and waste grains are utilized for food at that time. Buds, twigs, bark and sprouts are consumed during periods of snow cover. Moth pupae, snails and even dead animals may be eaten during periods of extreme

food shortage. Cultivated crops, such as red and Ladino clover, alfalfa, soy beans, winter wheat and rye, are eaten when available (Schwartz and Schwartz, 1968).

Because the rabbit's food habits involve so many different species of vegetation, it is generally only necessary to provide cover for protection from predators and severe weather. Protection areas should be in close proximity to food supplies, particularly winter feeding areas, to be most effective.

Bushong (1959) suggests cutting and windrowing sprouts or limbs along field borders, letting grasses and weeds grow up through them. Dense woodlots should be opened up with the openings seeded to sericea lespedeza. Pines, when five to six feet tall, may be cut down to a two-foot stump for cover. Other areas where cover may be developed include field borders and corners, gullies and rockpiles. To further enhance the area, one-eighth acre plots of grain sorghum may be scattered near cover. The site of such plantings should be rotated each year, the previous site being allowed to revert to weedy grasses and forbs.

Nesting cover is described as grassy plots near heavy cover. Such areas should be in grass-clover mixtures which will provide food as well as nesting cover. Escape cover involves well distributed brushpiles along field borders and in field corners. Such piles should be built over a solid substrate (rolls of wire, culverts) and be twelve to fifteen feet in diameter and five feet high (Sadler, 1964; Madson, 1959).

Additional management measures include planting field borders with sericea lespedeza or mixed grasses, maintaining honeysuckle and blackberry thickets, and developing clumps of food and cover in open areas

of large acreage. Brushpiles within recently cutover land with considerable stump sprouting will be beneficial in the winter. Because of the year around value of brushpiles to most wildlife, none should be burned or destroyed.

Bobwhite Quail (Colinus virginianus)

The bobwhite quail population increased substantially following the purchase of the area by TVA. Pastures, formerly overgrazed by cattle, reverted to a grownup condition which included various legumes and annual weeds. The understory in the scattered woodlots also improved as the cattle were removed from the area. The quail population responded by producing more and bigger covies.

Quail populations were static in the early 1950's until the habitat started deteriorating as previously productive areas became overgrown with hardwood brush which crowded out necessary food plants. By 1958, the available habitat was limited to a few of the interior holdings and a few large Commission-managed open areas. No birds were harvested from 1960 until 1963 when 500 birds were stocked in the area. Approximately 125 of the 146 birds harvested were from this release (Table 5, page 45).

Although improved management of the open areas will benefit quail, no great increase in the population or hunting success is anticipated. Intensive management for quail is not recommended since only 5 percent of the area can be considered potential habitat.

Food habit studies indicate quail are capable of utilizing naturally grown vegetation to great advantage for year-around food

supplies. Green vegetation, fruits, insects and various weed seeds are consumed during the spring and summer months. Fall and winter foods include waste grain, maturing annual weed seeds, ragweeds and legumes (Wood, 1967).

Sanford (1964) noted that 80 percent of the quail's diet consisted of seeds of annual plants and 20 percent was made up of perennial weed seeds. He also mentioned the importance of waste grains such as corn, soy beans, grain sorghum, Korean Lespedeza, fruits, and berries.

Nesting cover consists of grassy areas in close association with breaks in the local cover pattern. Such areas would include field borders, clearings, roadsides, and gullies. Hayfields may also be used for nesting sites, such sites being located near the edge of the field (Kabat and Thompson, 1963).

Kabat and Thompson further noted that quail populations had disappeared from some areas in Wisconsin when the ratio of hedgerow length to farm acreage decreased to one mile of hedgerow, six feet wide, per 650 acres of farmland. At one mile per 450 acres there had been an average of twenty-three birds per mile of hedgerow. They observed that pines up to ten years old offered good roosting cover. Heavy grass with some open area also offered good roosting sites.

Management of quail in many instances may be refraining from doing anything to a particular piece of ground for a period of time. In such weedy, sparsely brushed areas, periodic fertilizing and discing may be necessary. Such activity should be designed to encourage annual weeds and to control perennial vegetation. Areas of this characteristic should be one to two acres and adjacent to cultivated fields.

Wood (1967) has also mentioned the following management practices for quail.

1. Establish scattered brushpiles which allow grasses and weeds to grow up through them.

2. Grassy fencerows and field borders are improved with living brushy material. Such areas would include small trees that have been cut part way through and pushed over parallel to the field border.

3. Food patches which are cultivated only once to allow the planted crop a head start over natural weeds are valuable winter feeding areas. Leaving the outside three or four rows of a grain field or fifty feet around the perimeter of a hayfield will accomplish the same benefit as well as providing nesting and roosting cover.

B. TIMBER MANAGEMENT

Most wildlife species are a product of the edge--that area where two or more vegetative types meet. Such situations may be as obvious as the meeting of a pine plantation and a mature hardwood stand or as subtle as the meeting of two different age classes of the same timber species. Because edge is so important to wildlife populations, the intent of the forest management program on this area should be to provide a maximum mixture of species and stands of suitable size and age in close proximity to each other.

To best accomplish the foregoing conditions will require an adequate forest inventory that locates and describes the various timber stands on the area. Such inventories should include the species of

trees present, their ages and densities and their general condition. Notes regarding ground story vegetation should also be made a part of the record as well as noting the occurrence of key wildlife features such as den trees and fruit and berry producing vegetation in relatively large clumps. From these records will evolve a plan for managing the area that is complementary to both timber and wildlife.

There are many methods for removing a timber crop from the land, each method resulting in a habitat condition unlike that of other methods. Examples of timber regeneration methods applicable to the Chuck Swan WMA include single tree selection, group selection, shelterwood cutting and clear-cutting. Within these classifications are development programs involving thinnings and weedings which may be grouped under the broad classification of timber stand improvement (T.S.I.). An area the size of Chuck Swan WMA with its important resources of timber and wildlife will require the use of many different timber cutting programs. The following habitat management guidelines are condensations of management techniques noted earlier for specific game species.

Long rotations are recommended for those stands best suited for mature crops of mast producing timber such as oak, hickory, and beech. Periodic thinnings and other improvement cuts will be necessary to maintain high mast production in these stands. Harvest guidelines are related to stand structure and require care not to remove only the best quality timber leaving timber of poor or less desirable stock.

In areas managed by long rotation programs, ground vegetation will be scarce and cover will be at a premium. Mast production should be abundant. Such areas should be adjacent to areas of relatively short

rotations to insure that a variety of food and cover is present.

Cuttings made in immature timber stands in order to stimulate the growth of the trees that remain and to increase the total yield of useful material from the stand are termed thinnings. The amount of understory vegetation (browse and herbage) that develops in the area and the length of time it is present is dependent upon the methods followed while thinning the stand (Smith, 1962).

Low thinning consists of removing trees in the lower crown classes, favoring the dominant and thrifty co-dominant trees. Because the stand is not opened up enough to allow sunlight into the ground level, this method is not recommended in areas of limited understory browse or herbage production. It may be applicable in areas of mast production.

Crown thinning involves removing trees from the upper crown classes to open up the canopy and favor the development of the most promising trees of these same classes. More light reaches the forest floor with this thinning method resulting in more browse and herbage production. The length of time that browse and herbage will be available is less than the following methods.

Selection thinning calls for the removal of dominant trees in order to stimulate the growth of the trees in the lower classes. If not carefully used, this thinning method can result in "high grading" the stand. A program of repeated selective thinnings can maintain an adequate amount of browse and herbage.

The last general method of thinning, termed mechanical thinning, addresses itself to predetermined spacing of retained trees without considering their position in the canopy. When the cutting pattern is

in strips, considerable browse and herbage can develop. This method is particularly appropriate in young stands that have not been previously thinned and are densely crowded. Using a crawler tractor, strips the width of the dozer blade are knocked down leaving a strip two to three feet wide to form the crop of trees. Future thinnings would then follow one of the previously noted methods.

A system involving more than one of the above noted thinning methods may be required in stands that are irregular in age, density, or composition.

It is during the thinning operation that "islands" of food and cover in addition to that developed by thinning are recognized and maintained within the mature stand. Such areas should be approximately five acres and involve both hardwood and softwood species. Timber stand improvement programs should recognize the following information to accomplish the best mast production results (U.S.F.S., 1971):

1. The larger the crown diameter, generally the higher the yield of mast.

2. Trees with vigorous expanding crowns produce better than trees suffering from crown dieback.

3. Trees on moist, fertile soils produce mast better than those on infertile, droughty sites.

4. Although insects, fire and injury may temporarily stimulate mast yields, the result is generally short-lived and production will ultimately decrease.

5. Not all species nor representatives of the same species produce mast each year. Mixtures of several mast-bearing species are recommended in each stand.

6. Remove stunted, poor form, low vigor and damaged trees except mast trees should remain in the area. Remove poor producers and retain those trees that are good producers.

7. Favor dominant stems except to preserve off-season food producing timber.

As the overstory vegetation matures according to size and numbers of available harvested trees, the timber harvest should be directed toward individual trees. The selected trees should be removed with a minimum of damage to those trees remaining (U.S.F.S., 1971). The frequency of thinning operations will depend on changes in rate of growth (yield) and will vary from one site to another (Smith, 1962). Maximum size of stands under long rotation programs should be 100 acres.

The forest management term "selective system" is applied to any silvicultural program aimed at the creation or maintenance of uneven-aged timber stands. Selective methods are used for the regeneration of such stands (Smith, 1962).

Single tree selection involves the removal of individually selected trees from the timber stand as they attain maturity. Following the removal of a mature tree, numerous seedlings become established. By the time the seedlings reach sapling size their numbers have been reduced to less than fifteen. By thinning or natural competition, one tree is again left by the end of the rotation period.

Since the above sequence develops in a scattered program in an uneven-aged stand, removal of the mature trees is difficult without injuring the young growth. Ground story vegetation will also be scarce due to canopy closure although mast production will be good in hardwood stands.

Two modifications of single tree selection can alleviate these disadvantages. The group selection method is particularly appropriate

for hardwoods and involves removing in a scattered pattern small blocks of trees from the stand. This harvest will result in groups of even-age timber. These blocks are usually less than ten acres. Browse is abundant during the early ages. Mast production may be available in the adjoining uncut areas. Since all of the trees in a block are removed, damage to those trees remaining is minimized.

The second modification is the strip-selection method. In both single-tree and group selection method, the mature timber is scattered throughout the stand. In this modification the mature timber is concentrated in one strip. Removal of the harvested trees is through the next cutting area, thus protecting the young timber. Adequate browse and mast crops are also provided with this modification.

Suggested rotation age for selective cutting in hardwoods is 100 years and for pines 25 to 40 years with cutting cycles of 10 or 20 years. Key areas, such as pines in a hardwood stand or hardwoods in a pine stand, should be recognized and protected.

Short rotation timber harvest is generally recommended for those stands where pine predominates. Sites under this management program will result initially in abundant browse and cover for seven to nine years before the understory vegetation becomes scarce. Future thinnings will be necessary to maintain the wildlife values.

Pure pine stands should not exceed 50 acres. If larger, such stands should include five-acre islands of hardwood vegetation for browse and fruit production. Small openings in or adjacent to such areas are also recommended at a rate of one such area for each pine stand.

The development of small stands of pure pine is recommended where large areas of pure hardwood predominate. These small stands should be at least five acres but no more than ten acres and be managed under a sawlog management program. Such areas are intended as cover in the early stages and as turkey roosting sites as they reach maturity.

The shelterwood method of timber management involves the gradual removal of the entire stand in a series of partial cuttings which extend over a fraction of the rotation. Natural reproduction grows under the protection of the older stand until released to give the new crop the full use of the land (Smith, 1962).

The method may involve three cutting sequences. The first cut, seed cutting, opens up the stand and prepares it for regeneration. Undesirable trees are removed, leaving desirable seed producers to establish the new stand. A second cut, removal cutting, removes the overstory in favor of the regeneration. There may be more than one removal cut, the last one called the final cut.

Shelterwood management will result in a more or less even-age stand. Because of the forester's frequent contact with the stand, it is adaptable to developing mast-producing hardwoods. Browse is also present, at least during the early stages.

Clear-cutting implies that virtually all trees in an area are removed from the area. An area cut in this manner is left bare and will eventually develop into an even-age forest. Reproduction comes from artificially seeding or planting and from natural invasion via seed from outside the area or from trees felled in the harvest operation. Reproduction may also develop as sprout growth from stumps (Smith, 1962).

Areas to be stocked by wind-disseminated seed should be no wider than five times the height of the adjacent timber from which the seed will be obtained. Heavy-seeded species, such as oak and hickory, will not reseed an area properly. The complement of these trees in the cutting area is therefore fixed at the time of harvest.

Browse and herbage production is high during the first few years following a clear-cutting operation. Mast will not be available for 25 to 40 years.

Areas to be cut should be small, less than 35 acres, and scattered, one cutting unit per 160 acres. Adjacent stands should not be cut in consecutive cutting operations. The rotation age of hardwoods is 80 to 100 years.

To provide an "esthetically" pleasing clear-cutting operation, some cull or otherwise inferior timber may be left standing until the understory is established according to recommended densities and a minimum height of 10 feet. At that time the portion of the stand left standing may be cut. Leave trees would number one or two per acre. Other guidelines relating to clear-cutting include irregular cutting unit boundaries and the protection of key areas such as small islands of mast-producing timber and fruit-producing vegetation within the clear-cut area. Den trees should be protected as well as small dense stands of pine. No clear-cut area should border on a road to protect the esthetics of the area and to limit slash from reaching the roadside ditches. A minimum buffer zone of 100 feet is recommended.

The seed tree cutting method is similar to clear-cutting except that certain trees, called seed trees, are left standing singly or in

groups for the purpose of furnishing seed to restock the area naturally. These few trees are either removed or left standing after the new stand is established. The seed production of a species and the physical character of the trees in the stand will determine the number of trees to be left, usually two to ten per acre (Smith, 1962).

Browse is abundant during the first few years of a seed-tree cutting program. Because of the limited overstory, its development may be suppressed and it will be available for a longer period of time. Mast crops are also available if the seed trees are mast-bearing species. Esthetically, a timber stand under this type of management is less disturbing than a stand that has been totally clear-cut and is recommended.

C. NATURAL OPENINGS

The few scattered natural openings will require only limited management to maintain their attractiveness in a wildlife management program. Periodic clipping and the removal of invading brush may be necessary to accomplish this result. It is recommended that controlled burning be investigated for these purposes.

Any management activity within a natural opening should be confined to those periods when nesting and brooding of young is not in progress. This period for maintenance activity will usually occur after mid-July or early August.

Natural openings should be less than 1,600 feet across the long axis of the site. At least one such area of about five acres should occur within each 160 acre unit. Vegetation in these areas should be herbaceous and favor the annuals. Dense cover nearby is also suggested

for protective cover and additional food plants. Openings may be created by topping the overstory vegetation in areas where there are grape tangles, fruit orchards, honeysuckle patches, and grassy meadows.

If natural openings in high quality plants are not available at the rate suggested, it will be necessary to create such areas by agricultural methods.

D. AGRICULTURAL PROGRAMS

Previous agricultural programs have involved considerable acreages for wildlife food plots and pastures with the resulting openings entirely under an agricultural program. Little or no consideration has been given to natural vegetation such as annual weed and herbaceous growth. The following suggestions, although not reducing the amount of area involved in openings, does recommend less agricultural crops and more natural foods with less time and expense required for maintenance.

Openings in excess of one acre should be divided into two segments--one for the planting of agricultural crops and one for the development of natural herbaceous vegetation. These segments need not be in one unit but may be in strips or in small blocks. Annuals are preferred on the natural portion of the area. Periodic clipping and/or burning will be necessary to maintain the natural area in its productive state. The shape of the opening is related to the height of the surrounding vegetation. Areas should be of a shape to allow early morning and late afternoon sunlight to reach the opening.

The agricultural crop rotation should cover a period of five to eight years and should generally follow this order of events:

1. Annual seed mixture or solid plots (milo, millet, buckwheat, field peas, Korean lespedeza are suggested).
2. Remain fallow except for clipping in strips.
3. Pasture including clover and a grass (clipped periodically).
4. Grain crops such as corn or milo (no cultivation or harvest).
5. Pasture managed as above.

Distribution of the above areas should be at a rate of one plot per 160 acres. The areas should be in planting stages that will result in a scattered distribution of the five stages throughout the area. This distribution will result in a variety of foods being offered at any given time. In areas of high quality turkey and ruffed grouse range, such openings should be scattered 1,200 to 1,600 feet apart. Surrounding vegetation should include mast-bearing vegetation and dense protective cover.

Fields that are presently in broom sedge (Andropogon sp.) should be developed into more production areas by applications of fertilizer and lime with periodic discing. If controlled burning proves feasible, small patches may be burned to further limit the amount of broom sedge.

Fields planted to winter wheat for green pasture are best managed for mourning dove feeding and hunting areas. Large fields should include strips of corn totaling not more than 25 percent nor less than 10 percent of the total area of the field. A border around the field would be maintained in native annual weeds. Harvesting should be delayed until the seed heads of the wheat will shatter extensively. Browntop millet should also be included in the cropping program.

E. CONTROLLED BURNING

Controlled burning operations are not recommended in hardwood stands except to limit the stand density and to develop natural openings. Formerly established browse plots may be treated by burning to improve their attractiveness to all wildlife. Pine plantations may also be lightly burned to improve the site for herbaceous vegetation.

Initially, it is suggested that a controlled burn feasibility study be conducted on sites not exceeding five acres. The study should consider the cost involved and the results obtained, including the loss and gain of vegetation and the damage to soil nutrients. Fire protection considerations include the construction of fire lines around the area to be burned and enlisting the assistance of the Division of Forestry during the time of burning operation. The timing of the burning is noted in the sections concerning white-tailed deer and wild turkey. Legumes are to be encouraged over grass species for these areas. If results prove satisfactory, controlled burning should be included in the management program.

F. ROAD AND TRAIL SYSTEMS

Presently there are approximately 80 miles of mainline, all-season roads and 150 to 200 miles of dry-weather jeep roads and trails on the management area (Figures 4 through 8, pages 13 through 17, respectively). Even under those broad classifications there are some roads that are temporarily "off limits" due to their soft or slippery conditions for a short time following heavy rainfall. It is suggested that such roads

be either closed or identified to warn visitors of the impassable condition until improvements are made.

It is not recommended at this time that additional permanent roads be constructed on the area. Relatively few areas are inaccessable to automobiles. This recommendation does not prohibit the construction of necessary logging roads, but it does suggest that following the timber harvest and necessary followup these roads should be planted to grass or allowed to revert back to a native vegetative cover. When the area must be re-entered at a later date, the roads may then be re-established. The initial construction of these road networks requires that their location be determined to best fit the present and future needs of the area.

Road maintenance is limited to infrequent trips by the Division of Forestry's roadgrader and the Commission's bulldozer at the present time. Available time, manpower, and funds are governing factors in determining the number of times a particular section of road will be worked. It is therefore suggested that increased emphasis be made to the permanent maintenance of the road system, particularly those sections of mainline road. This maintenance will include placing gravel in low wet areas and installing metal culverts in areas subject to heavy surface water and ditch overflow. Some of these road repairs may be best met by relocation the road around such areas. It is also recommended that a small gravel quarry be located on the area and the necessary equipment made available to perform regular road maintenance. Environmental damage must be kept at a minimum at the quarry site.

No trails have been specifically designated for the area although a broad trail classification has been applied to many of the abandoned pulpwood roads. As additional areas are logged and as previously logged areas are re-entered, more such trail classifications may be determined.

Since the general pattern of the pulpwood road systems on the Chuck Swan WMA is a network of narrow roads totaling over 150 miles, it is suggested that such systems be mapped with the thought of establishing a trail network. The governing guideline for establishing such a trail system will be to provide trail access to much of the rougher area utilizing old pulpwood roads when available. Following the mapping and selection of applicable roads for the trail system, it would then be appropriate to designate these trails on the ground by providing trail signs for use by the hiker. Such routes should include return trails offering a "loop" pattern rather than requiring the users to return on the same trail. No motorized vehicles would be allowed to use these designated trils.

A trail system could offer many opportunities for educating the public in the sciences of timber and wildlife management in addition to offering hunter access. Selfguided trails are particularly appropriate for this program. Some of the areas that could be indicated include wildlife habitats, timber management programs as well as natural and scenic areas. Small placards would point out various vegetative species and communities that are particularly important to forest wildlife. Initially, only one such area is recommended for establishment, that being near the checking station.

Maintenance of the above trail system could be done by various outside interests such as Boy Scouts, childrens groups, and service organizations. Such activity would include maintaining a daylight area of ten feet and controlling water runoff to prevent soil erosion.

G. PROTECTION OF POTENTIAL RECREATIONAL AREAS

There are several mini-recreation areas within the wildlife management area that will require the application of special land management practices. Such areas include caves, springs, streams, and the shoreline of Norris Lake. Other areas needing special protection or development include cemeteries, old house sites, and camping and picnicking areas.

Special management programs are required to protect such areas from irrepairable damage that would degrade their value as a recreation site for the future. Additionally, as in the case of cemeteries, certain State and Federal laws would apply for their protection and maintenance. It is recommended that until development as a recreation site, management of these areas will complement the wildlife habitat of the neighboring area by encouraging mast production.

Caves

At least four cave systems are located within the management area. Other minor caves exist in the various rock outcroppings but the degree of visitor use is minimal.

Panther Cave is a system of two caves, one extending 410 feet and the second running for 260 feet into the ridge. These two caves are

located 2,500 feet east of the junction of Big Loop and Crumley Hollow roads (Barr, 1961, page 95) (Figure 7, page 16).

Oaks Cave involves over 1,225 feet of passageway and includes an old niter hopper dating back to World War I at the end of one of the tunnels. The cave entrance is located under the road at the junction of Levi Evans and Clear Creek roads, approximately eight-tenths of a mile east of the Oaks Chapel "T" (Barr, 1961, page 448) (Figure 6, page 15).

A third cave, much smaller than the two noted above is located north of the Lost Creek Cemetery approximately 300 feet. This cave has been mentioned by several former residents of the area as a storage area for vegetables and fruit by residents of the early nearby community of Lost Creek (Figure 5, page 14).

A fourth cave, Big Cave, is located approximately 1,600 feet up Ellison Hollow from its junction with White Creek. No known history or records of size are known for this formation (Figure 5).

Each of these natural land formations offers an opportunity for designation as a natural area and should be protected from destruction by indiscriminate surface management. In order to preserve their uniqueness, it is suggested that an area of twenty acres around each cave be protected from intensive timber harvest and all land clearing and/or agricultural operations. Any timber harvest should be for sanitary reasons and not so extensive as to destroy the local recreational quality.

Other recommended management practices include the following (Barr, 1961, page 56):

1. Discourage the removal of cave formations, relics of the past or animals found in the cave.
2. Discourage the covering of walls or dripstone formations with names, dates, or directional signals.
3. Encourage the removal of all trash from the caves. Trash barrels should be provided along the access roads to help alleviate this problem.

Springs, Streams, Ponds

There are four active springs, three major creek systems and two prominent ponds on the area. These water areas and their locations are as follows:

Springs

Mossy Springs - junction of Mossy Springs and Linamood roads. Compartment 1 (Figure 4, page 13).

Levi Evans Springs - Levi Evans road near Oaks Cemetery. Compartment 3 (Figure 6, page 15).

Big Spring - approximately 1,200 feet up Big Spring Hollow near the road. Within the lake area of this hollow is an artesian well which is visible when the lake level is low. Compartments 3-4 (Figures 6 and 7, pages 15 and 16, respectively).

Miscellaneous Springs - between the main road the the lakeshore in Phillips Branch. Compartments 4-5 (Figures 7 and 8, pages 16 and 17, respectively).

Two springs at the checking station. One 200 yards north Compartment 1, a second 75 yards south

Compartment 2 (Figures 4 and 5, pages 13 and 14, respectively).

Creek Systems

Big Spring - boundary line between Compartments 4 and 5 (Figures 7 and 8, pages 16 and 17, respectively).

Clear Creek - boundary line between Compartments 2 and 3 (Figures 5 and 6, pages 14 and 15, respectively).

White Creek - center of Compartment 2 (Figure 5, page 14).

Ponds

Logger Shack Pond - located in Compartment 4, west of Big Loop road approximately 2,500 feet from the main road (Figure 7, page 16).

Levi Evans Pond - located in Compartment 3 downstream from Levi Evans Spring (Figure 6, page 15).

Several other water areas are noted on contour maps of the area but most are wet-weather streams only. Many of the water courses terminate in limestone sinks with no known outlets. Soil types are such that surface water readily percolates into the ground.

Management of such areas requires a system of protection of the adjacent vegetation. This protection will preclude timber sale operations or agricultural work in the vicinity. Such disturbance could possibly disrupt the stream course foundation causing a subterranean loss of water. These areas provide a substrate for many vegetative species preferred by wildlife for food.

The area to be protected will depend on the slope of the terrain, the vegetative cover now present and the soil characteristics. It is

suggested that the minimum protective zone for springs be 100 feet and for streams and ponds 150 feet.

Lakeshore

Three boundaries of the Chuck Swan WMA are along the shoreline of Norris Lake. As such, the boundary of the area fluctuates with the lake level. Because of the extreme annual fluctuations of the lake, there is little or no shoreline vegetation. This cleared condition and the possibility of observing wild animals attracts many visitors to the area via water access.

To alleviate the problems associated with this relatively unchecked visitor activity, it is suggested that a zone of one-fourth mile be established around the area's perimeter using the 1,034 foot elevation line as a base. No land surface disturbance would be allowed in this buffer zone to prevent wildlife concentration areas such as key feeding areas, loafing areas and nesting and brooding habitat. This recommendation does not prevent the removal of diseased vegetation that could contribute to major vegetative losses.

Camping and Picnicking Areas

Two areas are designated at the present time as campgrounds, both being located east of the checking station. Neither area is supplied with water or electricity. Pit toilets are located within each area. No camping is allowed within the WMA west of the checking station except on private land (see Purchase of Interior Holdings).

It is recommended that the road system in both camping areas be improved by providing a solid rock base and filling in low wet areas.

The one-lane roads now present should be widened to provide parking spaces without disrupting the traffic flow. Areas now devoid of vegetation should be planted in sod-forming grasses. The water system, presently inadequate during heavy visitor use periods, should be redesigned to permit the installation of water outlets in both campgrounds. Eventually bath houses featuring metered faucets should be built. This luxury would be maintained with a daily fee charged to cover the cost of maintenance.

At least one additional camping area is suggested according to present use data. This development should be located near the main entrance to facilitate adequate control of those using the area. The most logical site would be the private property located between the two camping areas. Visitor use could be spread over a larger area with this new site and would result in less concentrated use.

No picnic areas have been designated within the management area. Present policies permit this activity throughout the area. No recommendation is suggested to change this policy at this time, although it should be realized that in the future more controls may be needed. These controls would require that picnicking be restricted to certain areas which will concentrate activity and litter. Weather-resistant plastic garbage bags may be required until these restrictions are required.

If picnic areas are established, consideration must be given to the availability of potable water, sanitation facilities, easy access and parking areas. Conflicts with other management programs must be minimized. Public health officials should be consulted before starting these developments.

Historical Sites

Discussions with various employees of TVA have indicated that there are over forty cemeteries on the WMA. These cemeteries include from one to over two hundred grave sites. Many are marked with the original grave stones. Upkeep has been accomplished by descendents of those buried in the cemetery. Access is provided and maintained by the Commission (Figures 4 through 8, pages 13 through 17, respectively). In conjunction with these cemeteries are the remains of several house sites, most presently reduced to a few rotten timbers, stone foundations and nearby cisterns. Each year several visits are made to such areas by former residents or their descendents.

It is recommended that whenever possible and according to transfer agreements such areas should be protected from destructive activities by visitors and land management programs. The various building materials, such as hand hewn logs and stone foundations and fireplaces, should remain on the area as evidence to the early settlement of the area. Exceptions would be the modification of those structures that present a safety factor to those visiting the site or the use of the materials for the construction of visitor-oriented buildings on the area.

H. PURCHASE OF INTERIOR HOLDINGS

Seven interior holdings totaling 435 acres are located within the management area. These holdings involve seven landowners, none of which live on the area. The lands are presently used for cattle grazing, private hunting areas where fees are charged for hunting privileges, limited amounts of farming, and as an economic investment. Several areas

are heavily used for camping during the managed hunts. The Central Peninsula Gun Club, with a restricted membership, is located on one tract. Access to these private holdings is not restricted providing visiting hunters use the most direct route to and from the private land (Figure 2, page 9).

Serious problems related to these private holdings have developed during the last five years. These problems relate to illegal hunting on the managed area and the encouragement of camping on the private lands during the managed hunts. Vehicular travel is common at all times throughout the year on the entire area, much of which is related to those individuals using the private lands for hunting and/or camping.

It is recommended that all private holdings be purchased by the Commission to provide more uniform and effective management and control of the management area. Appraisals should be made and fair market values established for each tract of land. Condemnation proceedings are not recommended unless necessary. Further, appraisals and purchases of all lands should be made at once and not extended over a long period of time.

Since most of the lands are not now in productive wildlife habitat, it is suggested that as the lands are purchased management programs should be developed for the areas and implemented at the earliest date. Following the purchase of the interior holdings and the State owns all of the lands in the area, access should be controlled to provide optimum management conditions for the area. This may require complete closure of the area from sundown until sunup except for managed hunts held during those hours.

I. FISHERIES MANAGEMENT

Sport or commercial fishing is not available on the Chuck Swan WMA at the present time. Applicable water is absent within the confines of the area. It is recommended that the policy of no fishing on the area above the reservoir boundary be continued. Streams should be managed for their contribution as a spawning site for the fish present in Norris Reservoir.

Approximately 300,000 rainbow trout eggs were placed in Clear and White Creeks by the Fisheries Division of the Commission between 1959 and 1962. Later checks indicated that 95 percent of these eggs hatched but survival was limited (Table 6). Infrequently large fish are reported near the mouths of the two creeks and small fish have been noted farther up the streams. The carrying capacity of the streams is considered to be low at this time (Personal Communication, L. Price Wilkins).

To improve these two streams for spawning possibilities, it is suggested that stream improvement structures be constructed using rock and timber available on the area. The construction labor may be from various groups such as sportsmen's clubs and youth groups. The work should be under the direction of a trout biologist from the Commission.

Additional fisheries management is possible through timber management in the various watersheds. Such management should consider erosion control, protection of the streamside borders and water quality control. Protection will also benefit other water-dependent plants and animals.

Soil conditions and geology of the area prevent the development of fishing ponds and lakes. Percolation is too rapid throughout the area

TABLE 6. Past Rainbow Trout Stocking Records for White Creek and Clear Creek on Chuck Swan WMA.

Date	Creek	No. of Eyed Eggs	No. and Size of Fish
2/20/59	White	100,000	-
3/5/59	White	-	25,000, 3"
2/11/60	White	50,000	-
3/30/60	White	-	25,000, 3"
?	Clear	7,500+	-
2/28/61	White	-	25,000, 5" - 9"
2/15/62	White	100,000	-
3/30/62	White	-	500, 8" - 11"
?	Clear	7,500+	-
TOTAL	White	250,000	75,000
	Clear	15,000+	-

SOURCE: Tennessee Game and Fish Commission.

and sites of adequate size are not available. Priorities for this type of development are low since fishing is permitted in Norris Reservoir from the management area shoreline.

J. PREDATOR CONTROL

Predator control is not recommended as a regular management program on the area. In most instances predators (and predation) should be considered an asset to the animal life found on the area. As the various predator populations increase in number, the following considerations should be made and evaluated before control programs are initiated (Latham, 1950; Latham, 1951).

1. What are the population densities of the predator and prey populations?
2. What is the total impact of the predator population on the prey species?
3. Is there a detrimental effect of the predators on public health and recreational opportunity?
4. If the influence of predators is detrimental to public health and recreational opportunity, can specific control measures be applied to those species causing the detrimental condition? Are the control measures long-term or temporary?
5. If control programs are determined necessary, can public recreation be offered with satisfactory results? Can non-target species be protected from injury during the control program?

Predators are opportunists and prey on those animals most easily caught. Intensive management for one species may subject a second species to increased exposure to predation or create optimum habitat conditions for one or more destructive predators. By offering a complex and varied habitat, there will be less chance for these situations to occur. Understanding the needs of the various game and non-game species will assist in anticipating potential predation problems and making the necessary plans to avoid excessive wildlife losses.

If predator control is ever necessary, it should be accomplished through public recreation whenever possible. Such controls may be by trapping or by hunting. If policy does not provide for effective controls to be realized in this manner, then selective measures may be necessary which may involve the use of chemicals and/or sterilants. Indiscriminate use of any control measure is not recommended under this guideline.

Several wildlife species found on the Chuck Swan WMA might be included in a listing of predators under certain conditions. Raccoons, actually a desirable game animal, have been reported as nest predators in some areas. Red and gray foxes prey extensively on small rodents, but will also pursue turkey and small game. Hawks and owls exhibit similar feeding habits. Bobcats may prey on young deer, although the impact would be minimal because of their limited numbers on the area. Skunks, opossums and various snakes destroy nests when found, but also consume grubs, mice, rats and other potentially serious pests to an agricultural program. Because of these predator qualities, indiscriminate control programs are to be avoided.

The major exceptions to the above recommendations involves dog and feral house cat control. Whenever possible such animals should be caught and returned to their owners. If determined that the animals are ownerless or if the problem with individual animals continues, it may be necessary to employ controls of a more permanent nature.

K. RARE AND ENDANGERED PLANTS AND ANIMALS

No rare or endangered plants or animals are known to be present on the Chuck Swan WMA. There have been a few reports of bald eagles nesting and/or frequenting the Clinch and Powell rivers nearby but no nests have been reported by those working on the area.

It is suggested that those charged with the responsibility of the management of the area should be receptive to special management techniques when plants or animals in either of these categories are identified as present.

L. RESEARCH ACTIVITIES

Considerable research and survey activity is conducted on the Chuck Swan WMA each year to determine the conditions of the range and the game animals. Most of these activities are directed toward those factors which have an influence on the setting of the following hunting seasons.

Range surveys by the district biologist and area personnel include oak mast production and browse utilization by deer. Oak mast surveys are conducted twice each year--early in the fruiting period and again in the late summer. Production is determined by locating on a random

traverse ten to twenty representatives of the various oak species, recording the percent of crown and percent of twigs bearing acorns and the number of acorns for each twig. Broad classifications of poor, fair, medium, good and excellent are assigned to each species from these data.

Browse surveys are conducted by the district game biologist in the late winter prior to the spring "green-up" period. Surveys are made in ten random localities where browse plants are identified and checked for deer browsing intensity. Data are recorded which would indicate the percent of annual growth taken by deer through the fall and winter seasons and prior to the spring growing season. To further refine these data the plants are grouped according to a preference table--preferred, commonly used and starvation or emergency foods.

Roadside censuses by game management personnel are infrequently conducted along a predetermined twenty mile route. All game animals are recorded according to their sex, age, and/or condition. This census is usually run in the early spring after the fields have started their early spring growth and before the timber vegetation starts its growth. When conducted in the late afternoon, the deer are usually concentrated around the green fields rather than the still-dormant forested areas and are easily observed.

Random surveys by the area personnel are also conducted during the year to determine production trends for deer and turkey. Data are recorded which include the numbers of young, peak reproductive period and condition of young and brood stock. Although not precise, these data do offer population trends and reproductive success indices.

Most of the biological data collections are made during the managed hunts and are generally directed toward deer and turkey. Few data are collected during the small game hunts. Data collections are made at the checking station by research biologists and area personnel. Information collected from deer include sex, age, weight, presence of anomalies, location of kill, antler characteristics of the males and the reproductive tracts of the females. Turkey data include age (adult or juvenile), weight and beard length.

Some limited research has been conducted on white-tailed deer by research biologists of the Commission and the Southeastern Cooperative Wildlife Disease Unit, The University of Georgia, in Athens. Topics for this research have included brainworm infestations, internal and external parasites, food habits and the presence of brucellosis and leptospirosis according to blood sample analysis.

Evidence of internal and external parasites is generally reported as negative. Brainworm infestations have been nominal and blood analysis has been recorded as negative for the two noted diseases. These favorable results are to be expected with diversified habitat conditions.

A cooperative agreement between the Commission, the Division of Forestry and the Tennessee Valley Authority involves the management of the timber and ground cover within the 1,750 acre White Hollow Watershed in Compartment 2 (Figure 5, page 14). The TVA operates a weir and stream gauge on lower White Creek where sediment loads and water velocities are related back to precipitation and vegetative disturbances. Under the agreement, the State agencies will not perform any activity in the watershed without prior approval of the TVA. Recently a small timber

sale and two wildlife openings were approved and developed in the watershed. It is strongly recommended that this agreement be maintained and various data developed to indicate the influences of timber removal on water quality.

Following are other recommendations for research activities on the Chuck Swan WMA. Such activity should be performed by the Commission, the Division of Forestry and/or various colleges and universities in the area.

1. Continue collecting biological data at the checking station.
2. Continue conducting range surveys to determine browse and mast production parameters.
3. Establish programs that will improve the determination of various population densities and trends.
4. Determine key wildlife food plants and habitats to facilitate rapid range evaluation and direct attention to underdeveloped habitats.
5. Investigate methods of improving the quality and quantity of wildlife food plants.
6. Investigate the influences of timber management programs on wildlife populations and their habitats.
7. Determine natural plant successions following various vegetative manipulation activities. Consider possible techniques for maintaining the succession at the preferred levels for various game species.
8. Develop a master map of vegetative cover types. Using plastic overlays, illustrate timber sales operations and habitat

management programs in these cover types. This map should accurately locate the area boundary and the road and trail network.

9. Determine relationship between mast production and wildlife population trends. Determine what management programs will increase and improve mast production and quality.
10. Perform sampling procedures which will determine hunter attitudes, harvest rates, distances traveled, and other related sociological information.

M. SPECIFIC MANAGEMENT RECOMMENDATIONS FOR THE FIVE MANAGEMENT AREA COMPARTMENTS

Figure 2, page 9, illustrates the location of the five management compartments on the management area. These units were originally established to facilitate hunter distribution during the hunts which would prevent unsafe hunter concentrations and to distribute the deer harvest throughout the management area. It was later realized that the hunters were distributing themselves in a safe manner without the compartment assignment. Marking the location of the successful deer kills on a map indicated that the deer harvest was also randomly distributed and not concentrated in a few areas. Hunters are not now assigned to a hunting compartment but are allowed to hunt in the areas of their choice.

While reviewing the following specific compartmental management recommendations, it is suggested that management practices covered earlier in this chapter be referred to for more complete descriptions of various programs. In essence, the following ideas are offered to guide the

manager toward specific programs of habitat management as opposed to management programs for particular species.

Compartment 1 (6,393 Acres)

Twenty-three fields, totaling 184 acres, are presently being managed in this compartment (Figure 4, page 13). These developments are concentrated in the Henegar Bend section and along the main and Mossy Springs roads. Additional fields (130 acres) are recommended in the Lindamood Ridge section, between the main and Mossy Springs roads and in the section north of the Long Hollow Road. Presently established fields will require modification to provide native annual vegetation, either as strips or as blocks within the tended area. One field in the Henegar Bend section is recommended for mourning dove management. Winter wheat and corn are suggested crops for this development. No development is suggested within one-fourth mile of the area boundary.

Evidence of turkey use is common in the Lindamood Ridge section and in the small valley three-fourths mile north of Mossy Springs. It is recommended that clear-cutting of timber be limited and selective cutting programs favoring mast trees be encouraged in the region west of Mossy Springs from the main road north to Long Hollow. New fields should be planted in grasses, legumes and/or small grains. The remainder of the compartment should use a combination of clear-cutting adjacent to selective cuts favoring mast trees.

Access is generally good except for the point south of Long Hollow, the extreme western portion of Henegar Bend and along the northeast boundary of the compartment. No additional roads are recommended, but marked trails should be built into these three areas.

Application of special management programs include those areas around Mossy Springs and six cemeteries.

Compartment 2 (6,218 Acres)

The White Hollow Watershed Project (1,740 acres), initiated by TVA in 1935, is located in this compartment. The study attempts to relate precipitation patterns and vegetative cover with water runoff and water quality. At the start of the study the area had been overgrazed and the timber excessively harvested. As originally planned, the policy of complete protection would be altered to allow supervised timber harvest and wildlife habitat improvement following vegetative recovery and watershed stability. This change in policy occurred in 1969. No habitat development work is suggested in this study area without prior approval of TVA to maintain the continuity of the research project (Figure 5, page 14).

This compartment is highly deficient in wildlife openings. Only eleven fields (126 acres) are being maintained at this time, these being concentrated in the Rice Erwin-Lost Creek section and along the main road. The development of additional fields (100 acres) is recommended provided such developments do not conflict with the White Hollow project. One field in Lost Creek and one in Rice Erwin are suggested for mourning dove development using winter wheat and corn. No additional developments are recommended within one-fourth mile of the area boundary.

The western half of the area is recommended for turkey and squirrel habitat improvement involving selective timber harvest favoring mast producing trees. If clear-cuts are made, it is suggested that an

adjacent area of at least an equal size be selectively cut. Specific turkey management has been discussed earlier in this chapter.

Access is fair in this compartment. Two "islands" and the southeast corner of the compartment are outside the one-half mile access zone. Trails off of Knob Road, Clear Creek Road, Rice Erwin Road, and the main road are recommended to provide this access. One new road off of Rice Erwin Road is recommended to provide access into the corner of the compartment. A gate is suggested on Dog Hollow Road at the area boundary to prevent access into the area at this point. Closing this entrance would require visitors to enter the compartment through the main entrance.

Application of special management programs include those areas around White Creek, Big Cave, Lost Creek Cave, Lost Creek Church foundation and six cemeteries.

Compartment 3 (4,300 Acres)

This compartment is next to the smallest of the five compartments and has the highest percentage of area in openings. No new fields are suggested. Forty-five fields, totaling 326 acres, are scattered throughout the area with minor concentrations in the sections of Oaks Chapel-Levi Evans Springs and the intersection of the main road and Levi Evans Road (Figure 6, page 15). One field in each section is recommended for mourning dove management using winter wheat and corn as food crops. Other fields should be managed to develop portions of them in native annual vegetation as described in the agricultural program section.

Timber management recommendations include combinations of clear-cuts and selective cuts throughout the compartment.

No additional road access is recommended, although trails may be built into those areas not now easily reached by roads. Trail priorities are low when considered with the needs in other compartments.

Application of special management programs include those areas around Oaks Chapel Cave, Clear Creek, Big Spring (creek and spring), and eight cemeteries.

Compartment 4 (4,738 Acres)

Twenty-one fields, totaling 400 acres, are maintained in this compartment (Figure 7, page 16). No additional fields are recommended, but present fields should be modified to include native annual vegetation as discussed in the section on agricultural programs. The major concentration of fields is along the main road between the west end of the Big Loop Road and the Malloby Hollow Road. One field should be managed as a mourning dove feeding area using winter wheat and corn. No new developments are recommended within one-fourth mile of the boundary.

Timber management in the compartment should involve selective cutting programs with small clear-cuts scattered throughout the area. Long rotations should be favored within and bordering the Big Loop section whenever possible to improve the turkey and squirrel habitat now present in the compartment.

Road access is good except for two areas along the northern shoreline boundary. Trails are suggested for access into these areas. No new roads are recommended.

Application of special management programs involve those areas around Panther Cave and two cemeteries.

Compartment 5 (3,182 Acres)

Twenty-six fields, totaling 290 acres are maintained in this compartment. Field concentrations are in the Forks of the River (western point) and along the western half of Back Valley. Additional fields (40 acres) are recommended in the eastern portion of the compartment. The Bear Ridge section should be given high priority for these developments (Figure 8, page 17). In addition to encouraging annual weed growth in portions of the existing fields, one field in the Forks of the River section should be managed for mourning doves. No additional development is recommended within one-fourth mile of the boundary.

Timber management should include both clear-cuts and selective harvest programs throughout the compartment, especially in the Bear Ridge section.

Access can be improved by building trails into the southeast section of the compartment. Trails heads would be located along Bear Ridge Road and Big Spring Road.

Application of special management programs include those areas around Big Spring (creek and artisian well) and two cemeteries.

N. MANAGED HUNTS

One of the obvious conclusions of an efficient wildlife management program is the development and/or maintenance of productive wildlife populations which contribute to recreational programs. One recreational pursuit is managed hunting.

Managed hunts must be scheduled and conducted to remove only the biological surplus of animals while protecting that portion of the population needed for reproduction purposes. This recommendation implies that the required harvest will be determined after wildlife surveys have determined the population trends and range surveys have determined the habitat conditions. When the number of animals in excess of the brood stock has been established, managed hunts will be scheduled which will permit as many hunters as possible to participate in the hunting season. Dramatic fluctuations in populations and harvest are to be avoided.

Managed hunting on the area has developed into a group recreational activity. This is especially true for the managed archery hunts. To continue this trend, it is suggested that the Junior Archery hunts be modified to permit the adult advisor to participate in the hunting as well as offering guidance to the young hunter. This recommendation may create additional law violations, such as the advisor bagging two animals, but the opportunity of offering the young hunter a participating position rather than a special position is thought to be proper. This recommendation will also encourage greater participation by the hunters.

Rules and regulations should be reviewed to determine if they are applicable to the area and are necessary for its maintenance. Too few regulations will result in violations and the destruction of a pleasant hunt by the non-violating hunter. Too many restrictions can create similar results by requiring law enforcement activity in areas of nebulous value while violations of a more serious nature are occurring. The non-violating hunter, while trying to obey the various rules, can lose sight of the reason for being on the area--outdoor recreation.

It is further suggested that during the managed turkey hunts vehicle traffic into the more remote areas be maintained at a minimum level. This will require closing some of the one-way secondary roads. This recommendation will encourage quiet, undisturbed hunting. Roads that are not maintained and have been allowed to revert to a grownup condition should be closed to vehicle traffic at all times and reclassified as access trails.

Small game hunting should be permitted during the statewide season when it does not conflict with managed deer hunts. Access should be permitted through the boat docks to give opportunity for a larger number of hunters to participate.

CHAPTER V

SUMMARY

1. The Chuck Swan Wildlife Management Area is a 24,831 acre peninsula on Norris Reservoir in Union and Campbell counties in the Clinch-Powell river basin in eastern Tennessee.

2. The area is 88 percent forested; the soils are poor; the climate is moderate.

3. White-tailed deer, eastern wild turkey, gray squirrel, ruffed grouse, and raccoon are the major wildlife species inhabiting the area. Cottontail rabbit, bobwhite quail, and eastern mourning dove are also present but are limited in numbers.

4. Current management benefiting wildlife populations is the result of cooperative programs between the Tennessee Game and Fish Commission and the Tennessee Department of Conservation, Division of Forestry.

5. Programs which have been detrimental to wildlife include overpopulations of game species resulting in overuse of the available habitat, agricultural programs which do not include native annual vegetation, extensive timber harvest in areas with high mast-producing capabilities, and the loss of habitat by the construction of mills and log landing areas in wildlife openings.

6. Forest management will have the greatest impact on the vegetative community. Such management will also provide the most wildlife food and cover in the area. Agricultural programs will supplement the

wildlife habitat produced by forest management by producing annual herbaceous vegetation and various fruits.

7. The following recommendations are viewed as necessary guidelines for the future orderly management of the Chuck Swan Wildlife Management Area:

A. Vegetative management should provide mixtures of ages, species and treatments which will result in a diverse and interspersed vegetative community.

B. Selective cutting programs are recommended for the development of mast producing timber. Periodic thinnings will be required to accomplish this goal. Stands should be at least 50 acres but no more than 100 acres. Exceptions to this would include smaller stands maintained as an inclusion in areas under long or short rotation management.

C. Short rotations are recommended for areas suited for and maintained in pine. Periodic thinning will assist in maintaining the deer browse and wildlife cover components of the site. Maximum stand size should be no more than 50 acres. Small areas under short rotation management are recommended as inclusions in stands managed under other programs.

D. Shelterwood management is recommended in hardwood areas where the hardwood understory is understocked. Guidelines include limiting the initial harvest to open up the overstory, thus allowing the ground vegetation to develop.

E. Clear-cutting programs are recommended in areas of mature timber with limited understory vegetation. Size of cutting

areas should be no greater than 35 acres with no more than one such area per 160 acres. Rotation ages are from 80 to 100 years for hardwoods to provide substantial mast crops.

F. Some few areas should be protected from intensive timbering operations and agricultural developments to protect their recreational qualities. Included in this recommendation are caves, old house foundations, cemeteries and streamside zones. Development of mast production would be the key management program on these sites.

G. Agricultural programs in openings are suggested to complement the several timber management programs. Such areas will include natural vegetation and several agricultural crops. Recommended average size of openings is five acres and one such site per 160 acres. When an area is planted, some portion of the opening should remain in natural, non-agricultural vegetation.

H. Controlled burning should be studied to determine if applicable in the management program of the area. Vegetative response should be determined as well as damage to the site and the environment. Legumes and forbs are preferred over grasses.

I. Present access into most areas is good, only a small percentage of the area is more than one-half mile from present access routes. However, additional trails are recommended for access into remaining remote areas. Self-guided trails for visitors are also recommended to illustrate management programs.

J. All remaining private holdings must be purchased to provide more uniform management of the area.

K. Stream improvement, under the direction of the Commission's trout biologist, is recommended for White and Clear Creeks. The streams should be managed for natural spawning of Norris Reservoir's fish populations. No fishing should be permitted in either stream.

L. Free-running dogs and feral house cats should be controlled at all times. Other predator controls are recommended if serious conflicts with the various recreational programs develop.

M. The area should be made more available for basic and applied research to various individuals and groups. Research programs and data collection operations now conducted should continue with some additional expansion.

N. The area should be open to public recreation to the extent that no serious conflicts develop which would interfer with the management programs of the Game and Fish Commission or the Division of Forestry.

O. Regular meetings (at least annually) between the two administrating agencies should not only be highly recommended but required to prevent conflicts between the two management programs.

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