To the Graduate Council:

I am submitting herewith a thesis written by Curtis I. Taylor entitled "Movements, Activities, and Survival of Translocated Raccoons in East Tennessee." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Michael R. Pelton, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

Thesis
79
.T363
cop. 2

MOVEMENTS, ACTIVITIES, AND SURVIVAL OF TRANSLOCATED RACCOONS IN EAST TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Curtis I. Taylor

June 1979

1390072

ACKNOWLEDGMENTS

Appreciation is extended to Dr. Michael R. Pelton, Associate Professor of Forestry, Wildlife, and Fisheries, The University of Tennessee, Knoxville, who served as my major professor and coordinator of the raccoon project. Thanks are also expressed to Dr. Boyd L. Dearden, Associate Professor of Forestry, Wildlife and Fisheries; Dr. Ralph W. Dimmick, Associate Professor of Forestry, Wildlife, and Fisheries; and Dr. James L. Byford, Wildlife Extension Specialist and Associate Head of the Department of Forestry, Wildlife, and Fisheries who served on my committee.

Special thanks are extended to William G. Minser III, Wildlife Research Associate, Department of Forestry, Wildlife, and Fisheries for his valuable advice and assistance in field work. I am indebted to the many Wildlife Officers, Biologists, and pilot Dick Stark of the Tennessee Wildlife Resources Agency for their cooperation and assistance during the study. Department of Biology personnel, Memphis State University, are thanked for their trapping efforts.

Financial support for this study was provided by the Federal Aid to Wildlife Restoration Project No. W-46-4 of the Tennessee Wildlife Resources Agency and the Department of Forestry, Wildlife, and Fisheries, Agricultural Experiment Station, The University of Tennessee, Knoxville.

ABSTRACT

A study of the movements, activities, and survival of translocated raccoons (Procyon lotor) was conducted from March 1977 to November 1978 in portions of Blount and Loudon Counties, eastern Tennessee. From July 1975 to May 1978, 286 raccoons live-trapped in West Tennessee were ear-tagged and released in the study area. Seventeen of these animals were equipped with radio transmitters.

As of November 1978, 29 (10.1%) of the raccoons were recovered, after an average time of 344 days (range = 2 to 1207 days) in the field. Illegal kills comprised 41.4% of all tag returns. Of 11 females recovered after 1 breeding season, 7 (63.6%) had apparently given birth to offspring while in the study area. Nine recovered raccoons had gained an average of 1.14 kg (29% increase) in weight over a mean period of 432 days. During a 4-night experimental hunt, 46 hunting parties harvested 19 raccoons, 6 of which (32%) were transplanted animals.

The average minimum dispersal for all raccoons was 3.8 km over a mean period of 294 days. There was no significant relationship between the number of days to recovery and dispersal distances. Dispersal of males was not significantly greater than that of females. Dispersal directions were randomly distributed.

Home ranges were calculated from approximately 1500 radio locations recorded over 630 days for 14 of the 17 radio monitored raccoons, Three methods of home range estimation were used: Minimal polygon, convex polygon, and a bivariate home range model (ellipse). Differences and advantages of each method are discussed. Home ranges of males were

significantly larger than those of females, but home ranges of translocated raccoons were not significantly larger than those reported for resident raccoons in the same area. Minimal polygon home ranges averaged 106.4 ha; convex polygon ranges averaged 226.05 ha; and elliptical areas averaged 383.75 ha at the 95% confidence interval and 290.16 ha at the 90% confidence interval.

Raccoons released in areas containing large pastures and intensive illegal hunting or dog training activities established significantly larger home ranges. The influence of intensive human disturbances on raccoon movements are discussed.

Approximately 5000 activity readings were used to analyze activity patterns. During adjustment to the new area, translocated raccoons were significantly more active and exhibited greater movements at all times of the day than during post-adjustment periods following release in the study area. After a 30-day adjustment period, raccoons were most active from 2101 to 0300 hours EST. Least active times were from 1201 to 1500 hours EST. Males were significantly more active and moved significantly farther over a 24-hour period than females.

Of 328 den sites and day beds located, 70% were tree dens, 21% were ground dens, and 10% were gray squirrel (Sciurus carolinesis) leaf nests. No preference for individual tree species was evident. The advantages of the 3 types of den sites are discussed. The linear distance moved between consecutive den sites averaged 623 m and was significantly larger for males than females.

Of approximately 1500 radio locations, 71.4% were recorded in forest habitat, 15.7% in edge habitat, 7.1% in old-field situations, and

0.9% in agricultural row crops. Differences in habitat utilization appeared more related to habitat availability than preference.

Conclusions were that the translocation of raccoons for population restoration is a valid wildlife management technique, provided that suitable habitat exists, the resident raccoon population is low, and illegal hunting and dog training-related mortality can be controlled. Other management implications and recommendations are discussed.

TABLE OF CONTENTS

CHAPTER Page

I. INTRODUCTION....1

II. STUDY AREA DESCRIPTION....5
Study Area Selection....5
Location and Size of Area....5
Topography....7
Water Sources....7
Soil....9
Climate....9
Forest Cover....10
Agricultural Land Use....13
Edge Habitat....14
Human Population....14
Raccoon Management....15

III. MATERIALS AND METHODS....18
Trapping....18
Tagging and Handling....20
Aging....21
Radio Telemetry....22
Release Sites....24
Controlled Hunts....25
Public Relations....26
Data Analysis....27

IV. RESULTS....30
Tag Returns....30
Dispersal....35
Radio Telemetry....36
Home range size....39
Home range overlap....45
Comparison of methods of home range estimation....50
Home range dimensions....52
Twenty-four Hour movements....54
Dispersal....55
Composite movement....57
Activity....58
Denning....64
Quota Hunt....68
Habitat Utilization....71

V. DISCUSSION....74
Tag Returns....74
Physical Change....77
Dispersal....78
Comparison of Methods of Home Range Estimation....81

CHAPTER Page
Home Range....85
Home range dimensions....90
Home range overlap....91
Twenty-Four Movements....92
Comparison of Release Sites....93
Comparison of Release Seasons....96
Human Influence on Movements....100
Activity....105
Habitat Utilization....107
Denning....108
Tree dens....108
Ground dens....109
Leaf nests....111
Den site characteristics....112
Quota Hunt....114

VI. CONCLUSIONS....117

VII. SUMMARY....119

VIII. MANAGEMENT IMPLICATIONS....124

LITERATURE CITED....127

APPENDIX....135

VITA....178

LIST OF TABLES

TABLE		PAGE
1.	Weight Changes of 9 Translocated West Tennessee Raccoons Between Release and Recovery Dates	34
2.	Survival of 17 West Tennessee Raccoons Radio-Collared and Released in Blount and Loudon Counties, East Tennessee.	37
3.	Mean Home Range Sizes of West Tennessee Raccoons Released During 4 Seasons and at 3 Different Locations in Blount and Loudon Counties, East Tennessee	41
4.	Statistical Rank of Mean Home Ranges of 14 Translocated Raccoons as Calculated by 6 Methods of Home Range Estimation	51
5.	Mean Home Range Dimensions for 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee	53
6.	Mean Dispersal Characteristics of 17 West Tennessee Raccoons Equipped with Radio Transmitters and Released in Blount and Loudon Counties, East Tennessee.....	56
7.	Average Distances Between Den or Daytime Resting Sites for 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee (Based on 150 Observations)	67
8.	Raccoon Hunter Success During an Experimental Hunt Held in Portions of Blount and Loudon Counties, Tennessee	69
9.	Kill Statistics for Successful Raccoon Hunters During An Experimental Hunt Held in Portions of Blount and Loudon Counties, Tennessee	70
10.	Raccoon Hunter Response to Questionnaires Distributed During an Experimental Hunt Held in Portions of Blount and Loudon Counties, Tennessee	72
11.	Tag Returns Reported for Raccoons Released in Unfamiliar Territory	75
12.	Dispersal Distances from Release Sites Reported for Raccoons Translocated to Unfamiliar Areas	79
13.	West Tennessee Raccoons Ear-Tagged and Released in Blount and Loudon Counties, 16 July 1975 Through 5 May 1978	154
14.	Tag Returns of 29 West Tennessee Raccoons Released 16 July 1975 Through 5 May 1978 in Blount and Loudon Counties, East Tennessee	156

TABLE PAGE

15. Sex, Age, and Weight of 17 West Tennessee Raccoons Radio-Collared and Released in Blount and Loudon Counties from 10 March 1977 to 5 May 1978..... 159

16. Home Range Estimates for 14 West Tennessee Raccoons Fitted with Radio Transmitters and Released in Blount and Loudon Counties, East Tennessee 161

17. Average Minimum 24-Hour Movements of 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee (Based on Approximately 1000 Movements) 163

18. Dispersal characteristics of 17 West Tennessee Raccoons Equipped with Radio-Transmitters and Released in Blount and Loudon Counties, Tennessee 165

19. Physical Parameters of 60 Den Sites Recorded for 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee 167

20. Physical Characteristics of 19 Raccoons Killed During an Experimental Hunt Held in Portions of Blount and Loudon Counties, Tennessee 170

21. Habitat Utilization Recorded from Approximately 1500 Radio Locations of 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee 172

22. Stream Utilization by 14 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee 174

23. Analysis of Elliptical Home Range Estimates Based on Normality in the Distribution of Locational Points 176

LIST OF FIGURES

FIGURE PAGE

1. Location of the Experimental Raccoon Study Area in Blount, Loudon, and Monroe Counties, East Tennessee.....6

2. Location of Release Sites for Radio-Collared Raccoons in Blount and Loudon Counties, East Tennessee.....8

3. Distribution of Forest Cover Types in Portions of Blount and Loudon Counties, East Tennessee.....11

4. Location of Raccoon Trapping Areas and the Study Area in Tennessee.....19

5. Monthly Distribution of Tag Returns for West Tennessee Raccoons Released and Recovered in Blount and Loudon Counties, East Tennessee.....32

6. Seasonal Distribution of Tag Returns for West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee and Recovered by 3 Methods.....33

7. Seasonal Distribution of Radio-Telemetry Efforts for 17 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee (Illegally Killed Raccoons Denoted by A).....40

8. Home Range Overlap in Convex Polygon Areas for West Tennessee Raccoons Released and Radio-Monitored in the Lotterdale Knox Region, Loudon County, East Tennessee.....46

9. Home Range Overlap in Convex Polygon Areas for West Tennessee Raccoons Released and Radio-Monitored in the Alexander Knox Region, Blount and Loudon Counties, East Tennessee.....47

10. Home Range Overlap in Convex Polygon Areas for West Tennessee Raccoons Released and Radio-Monitored in the Glendale-Little Tennessee River Region, Loudon County, East Tennessee.....48

11. Activity patterns of 17 West Tennessee Raccoons During a 30-day Adjustment Period Following Release in Blount and Loudon Counties, East Tennessee (Values Above Bars Indicate Sample Size).....59

12. Male and Female Activity Patterns of West Tennessee Raccoons During a 30-day Adjustment Period Following Release in Blount and Loudon Counties, East Tennessee (Values Above Bars Indicate Sample Size).....61

FIGURE PAGE

13. Activity Patterns of 14 West Tennessee Raccoons After 30 Days Adjustment to Release Areas in Blount and Loudon Counties, East Tennessee (Values Above Bars Indicate Sample Size).....62

14. Male and Female Activity Patterns of West Tennessee Raccoons After 30 Days Adjustment to Release Areas in Blount and Loudon Counties, East Tennessee (Values Above Bars Indicate Sample Size).....63

15. Frequency of 3 Den Types Located by Radio-Telemetry for 17 West Tennessee Raccoons Released in Blount and Loudon Counties, East Tennessee (Values Above Bars Indicate Sample Size).....65

16. Convex Polygon Home Ranges of 1 Male (Y29) and 2 Female (Y36 and Y38) Raccoons Released in Loudon County, Tennessee and Radio-Monitored for 183, 33, and 150 Days, Respectively.....137

17. Convex Polygon Home Range of Raccoon Number Y37 (Adult Male) Released in Loudon County, Tennessee and Radio-Monitored for 91 Days.....139

18. Convex Polygon Home Range of Raccoon Number Y40 (Adult Male) Released in Loudon County, Tennessee and Radio-Monitored for 144 Days.....141

19. Convex Polygon Home Range of Raccoon Number Y42 (Adult Male) Released in Blount County, Tennessee and Radio-Monitored for 179 Days.....143

20. Convex Polygon Home Range of Raccoon Number Y45 (Adult Female) Released in Blount County, Tennessee and Radio-Monitored for 96 Days.....144

21. Convex Polygon Home Range of Raccoon Number Y48 (Adult Female) Released in Blount County, Tennessee and Radio-Monitored for 180 Days.....146

22. Convex Polygon Home Range of Raccoon Number Y49 (Adult Male) Released in Blount County, Tennessee and Radio-Monitored for 178 Days.....147

23. Convex Polygon Home Ranges of Raccoon Numbers Y51, Y52, and Y53 (Adult Females) Released in Loudon County, Tennessee and Radio-Monitored for 84, 257, and 80 Days, Respectively.....149

FIGURE PAGE
24. Convex Polygon Home Range of Racccon Number Y54 (Adult Female) Released in Loudon County, Tennessee and Radio-Monitored for 108 Days.....151

25. Convex Polygon Home Range of Raccoon Number Y55 (Adult Female) Released in Loudon County, Tennessee and Radio-Monitored for 200 Days.....153

CHAPTER I

INTRODUCTION

Transplanting game species from areas where they are plentiful to suitable but unoccupied or understocked habitats for population restoration has historically been a successful wildlife management technique. This practice is used extensively by wildlife agencies across the United States, and many upland game species, including the raccoon (Procyon lotor), have been established into new or former ranges (Cottam 1956). Numerous attempts have been made over the past 50 years to restore or establish viable raccoon populations throughout the U.S. and other countries (Johnson 1970).

The raccoon is considered an adaptable species, able to thrive and increase in numbers even as man continues environmental modifications. Natural range extensions, as far north as Manitoba, have been reported for the raccoon in recent years (Sutton 1964). However, translocation efforts have exhibited varying results, with most researchers reporting substantial dispersal and poor survival for stocked raccoons (Giles 1943, Butterfield 1944, Ellis 1964, and Johnson 1970). Stuewer (1943a), working with pen-raised raccoons in Michigan, reported a maximum dispersal distance of 9.7 km from release sites over a 2 year period, while Nelson (1955) stated that raccoons trapped in the Coastal Plain Region and released in the Piedmont Region of South Carolina traveled distances ranging from 32.2 km to 289.6 km over a 4-year time span.

While the total number of raccoon hunters in Tennessee has slightly declined over the past 30 years, the number of raccoon hunters

in East Tennessee has more than tripled since the 1950's (TWRA 1970, 1971). In addition, the number of racoon hunting trips per season in East Tennessee has also increased from an average of 2.2 per season in 1951 to an estimated 17.6 per season in 1969. This increase in hunting pressure, coupled with reductions in habitat, has resulted in lower hunter success. East Tennessee hunters averaged only 0.08 raccoons per hour in 1974 as compared with 0.16 in 1969 (Whitehead 1975).

Faced with declining success rates, local raccoon hunters and hunter clubs have initiated their own management programs, based primarily on stocking and legislative action. Each year East Tennessee raccoon hunters import thousands of raccoons from Georgia, Florida, and Texas for stocking purposes (Jerry Webb, personal communication). The fate of these animals is largely unknown but, if they follow the same wide dispersal and poor survival patterns found by Wright (1977) in Kentucky, it appears that they do little to improve local raccoon populations or hunter harvests. Johnson (1970) stated that importations of raccoons from these coastal areas may even depress resident populations, since diseases and parasites may be introduced into areas in which they were absent. High density Coastal Plain raccoon populations offer hunters with an excellent source of animals for stocking projects, but these areas are also the most common focal points for canine distemper and other infectious diseases. In 1976, the Center for Disease Control stated that 91.6% of all cases of rabies reported in raccoons in the U.S. occurred in Georgia and Florida (Morbidity and Mortality Weekly Report 1977).

Realizing the potential for disease transmission through stocked raccoons, the State of Tennessee prohibited the importation of raccoons

from Georgia and Florida and imposed stiff penalties for violations of the act. With the supply of raccoons diminished, individual raccoon hunters and well-organized raccoon hunting clubs voiced strong opposition to the state's intervention in their "raccoon management." The Tennessee Wildlife Resources Agency (TWRA) was then confronted with their plight, which included declining hunter success, a perceptible overall decline in raccoon populations in East Tennessee, limitations on private stocking projects, and the TWRA's apparent lack of interest in the raccoon and raccoon hunters.

Numerous hunter complaints and a general deficiency of information concerning raccoon biology in Tennessee resulted in the TWRA initiating a statewide Raccoon Status and Management Investigation Program in 1975, with the objectives listed as: (1) to determine the status of the raccoon and raccoon hunting in Tennessee, (2) to develop proven management practices to increase and maintain adequate raccoon populations, and (3) to develop an orderly system to regulate, evaluate, and minimize the risk of raccoon importation by private groups (Whitehead 1975).

Under this management investigation program, an intensive 3-phase project, in cooperation with the Department of Forestry, Wildlife, and Fisheries, University of Tennessee (UT), Knoxville, was established in East Tennessee. The objectives of 2 phases of this project were: to delineate the habitat characteristics of a large area typical of raccoon habitat of eastern Tennessee and to determine the population density and distribution of resident raccoons on the area (Warr 1978), and to determine the movement ecology of resident raccoons on the area before, during, and after introduction of other raccoons (Hardy 1979).

The third and final phase of the TWRA-UT project consisted of this investigation. Since some information was available concerning dispersal, movements, and survival of raccoons translocated from coastal areas, animals for this study were to be trapped from high density areas in West Tennessee.

This study was then initiated with the following objectives: (1) to determine the movement ecology of transplanted raccoons in East Tennessee, (2) evaluate raccoon restocking techniques, and (3) evaluate restocking efforts in terms of survival and reproduction.

CHAPTER II

STUDY AREA DESCRIPTION

I. STUDY AREA SELECTION

The study area utilized for this investigation was part of a larger area selected by the Tennessee Wildlife Resources Agency (TWRA) in conjunction with the East Tennessee Coon Hunters Association, Blount County, Tennessee. The larger area was officially designated as an Experimental Raccoon Study Area by TWRA and includes portions of Blount, Loudon, and Monroe Counties. The area contains 52,084 ha and is considered typical of raccoon habitat found in much of eastern Tennessee (Figure 1). The above area was divided into 2 sections; a control section of 28,344 ha situated in the foothills of the Unaka Mountain province in Blount and Monroe Counties, and a restoration section of 23,740 ha in which this study was conducted. A more detailed description of the larger area is presented by Warr (1978).

II. LOCATION AND SIZE OF AREA

The restoration area is located in the northwest portion of Blount County and the southeastern end of Loudon County, Tennessee. This area is in both the Little Tennessee and the Tennessee River Valley regions. These 2 river valleys comprise a large portion of the Ridge and Valley physiographic province.

The study area boundaries include 30.8 km of the Little Tennessee River to the west, 9.3 km of the Tennessee River (Watts Bar and Fort Loudon Lakes) to the north, 9.6 km of Federal Aid Secondary (FAS)

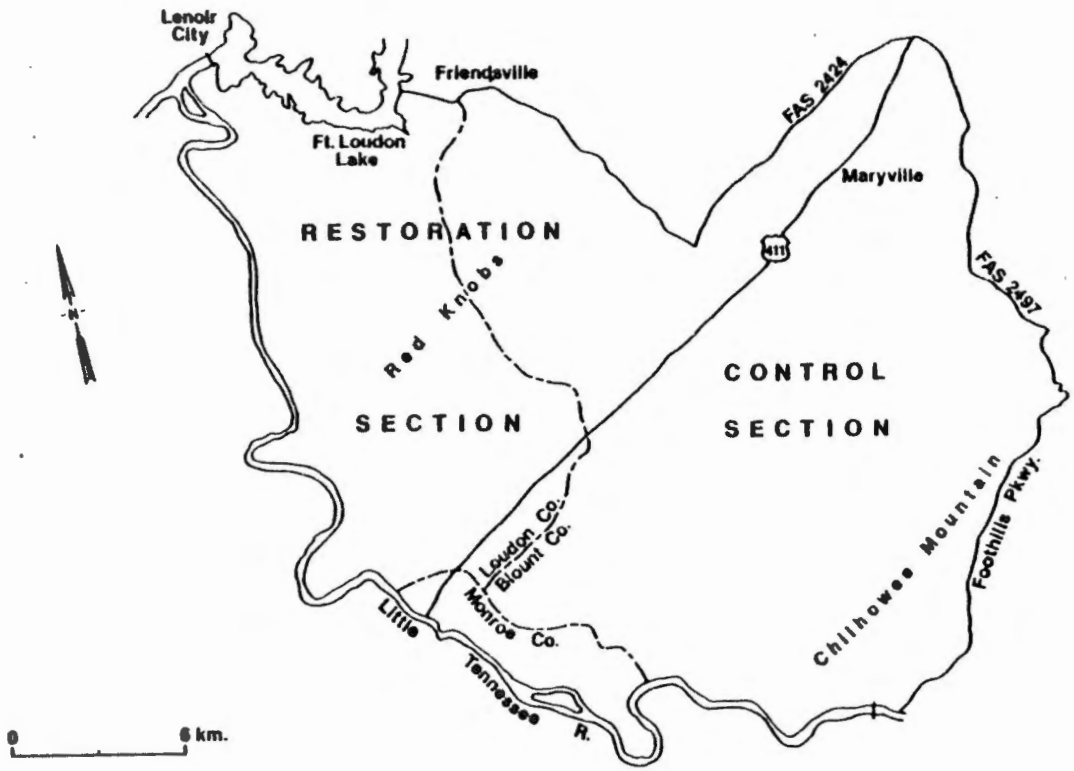


Figure 1. Location of the experimental raccoon study area in Blount, Loudon, and Monroe Counties, East Tennessee.

highway 2424 and 8.9 km of FAS 2560 to the east, and 27.2 km of highway U.S. 411 to the south. U.S. 411 is also used as the boundary in separating the restoration section from the control section.

III. TOPOGRAPHY

The area is characterized by low, roughly parallel ridges separated by gently rolling valleys. This ridge and valley complex is oriented in a southwest-northeast direction with elevations ranging from 218 to 400 m. The lower elevations are consistently located along the Little Tennessee River with the majority of the higher locations occurring in a 14.9 x 2.2 km ridge system known locally as the Red Knobs (Figure 2).

IV. WATER SOURCES

Drainage occurs through a dendritic pattern of small streams. These streams are characterized by high turbidity, slow rates of flow with few waterfalls or rapids, and are typical of East Tennessee streams found within the Ridge and Valley physiographic province. There are 157.5 km of this type stream in the study area, 131.9 km of which drain into the 30.8 km of the Little Tennessee River. Two streams of 25.6 km drain into the 9.2 km of the Tennessee River (Fort Loudon Lake) bordering the study area.

In addition to streams, the study area contains a number of small ponds. These "farm ponds," generally less than 1.0 ha in size, are distributed throughout the area. They are primarily maintained for livestock and irrigation purposes. Some contain viable aquatic communities, including populations of fish and frog species.

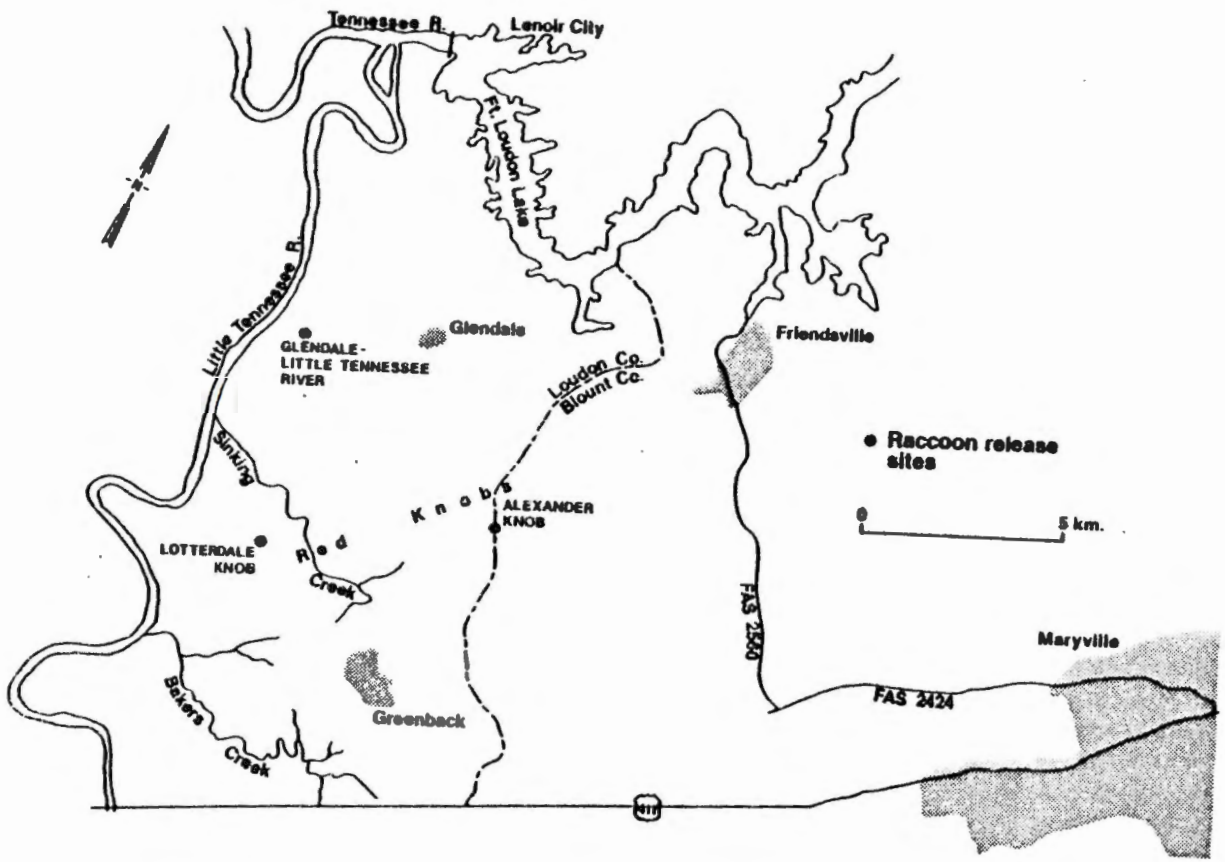


Figure 2. Location of release sites for radio-collared raccoons in Blount and Loudon Counties, East Tennessee.

V. SOIL

Soil characteristics are primarily influenced by the topography and geology found in the Ridge and Valley physiographic province. Ridge soils are typically stoney and infertile, as they are in the Rockland-Talbott-Lindside to Tellico-Alcoa-Neubert associations (Elder 1959, 1961). Soils found in the lowland valley however, are underlain by limestone and more soluble shales, and are therefore fairly productive. Soils of this type are in the Fullerton-Clarksville-Bolton, Fullerton-Greendale-Dewey, or Sequoia-Litz-Lindside associations (Elder 1959, 1961). Soil types along the Little Tennessee River are generally derived from alluvial sediments and are considered the most fertile. These well drained soils are of the Waynesboro-Cumberland-Emory association (Elder 1959, 1961). Agricultural crop production in the study area is primarily limited to these level river bottom and valley soil types with some crops planted on the less fertile, flat ridge crests.

VI. CLIMATE

Climatic conditions follow those found in much of the Tennessee Valley, and are characterized by mild, humid-temperate situations. Average temperatures range from a low of 1.3 °C (December-January) to a high of 24.6 °C (July) with a variation in 24-hour temperatures of approximately 11.1 °C (Elder 1959, 1961).

The Little Tennessee River watershed receives the highest amount of rainfall in the eastern U.S., averaging 136 cm annually with 32.8 cm of this occurring as snowfall. But snow accumulations of more than

10.2 cm are rare, with measurable amounts of snow cover lasting approximately 1 week. With this high amount of precipitation, many small, intermittent, or wet-weather creeks contain water during much of the year. Based on agricultural needs, precipitation is favorably distributed and in ample amounts for most crop production. The highest rate of precipitation is during winter, with additional peaks occurring in late spring to early summer (Deardorff 1976).

The frost-free period in the study area is approximately 191 days, extending from 14 April to 25 October (Elder 1959, 1961). Frost damage to valley and cove vegetation is common, with that on ridge crests less affected.

VII. FOREST COVER

Three broad forest cover types, as based on U.S. Geological Survey (USGS) classifications for land use and cover, are found within the study area; deciduous forest land (Hardwoods), mixed forest land (Mixed), and evergreen forest land (Coniferous).

Approximately 9500 ha (40%) of the study area are forested, with Mixed forest land comprising 76% of the forest cover (Figure 3). These mixed stands are of the Oak-Hickory-Pine association and consist primarily of white oak (Quercus alba), northern red oak (Q. rubra), southern red oak (Q. falcata), black oak (Q. velutina), chestnut oak (Q. prinus), shagbark hickory (Carya ovata), mockernut hickory (C. tomentosa), shortleaf pine (Pinus echinata), and Virginia pine (P. virginiana). This association is mainly found in the Red Knobs ridge system, which contains the largest continuous block of forest habitat. Although generally

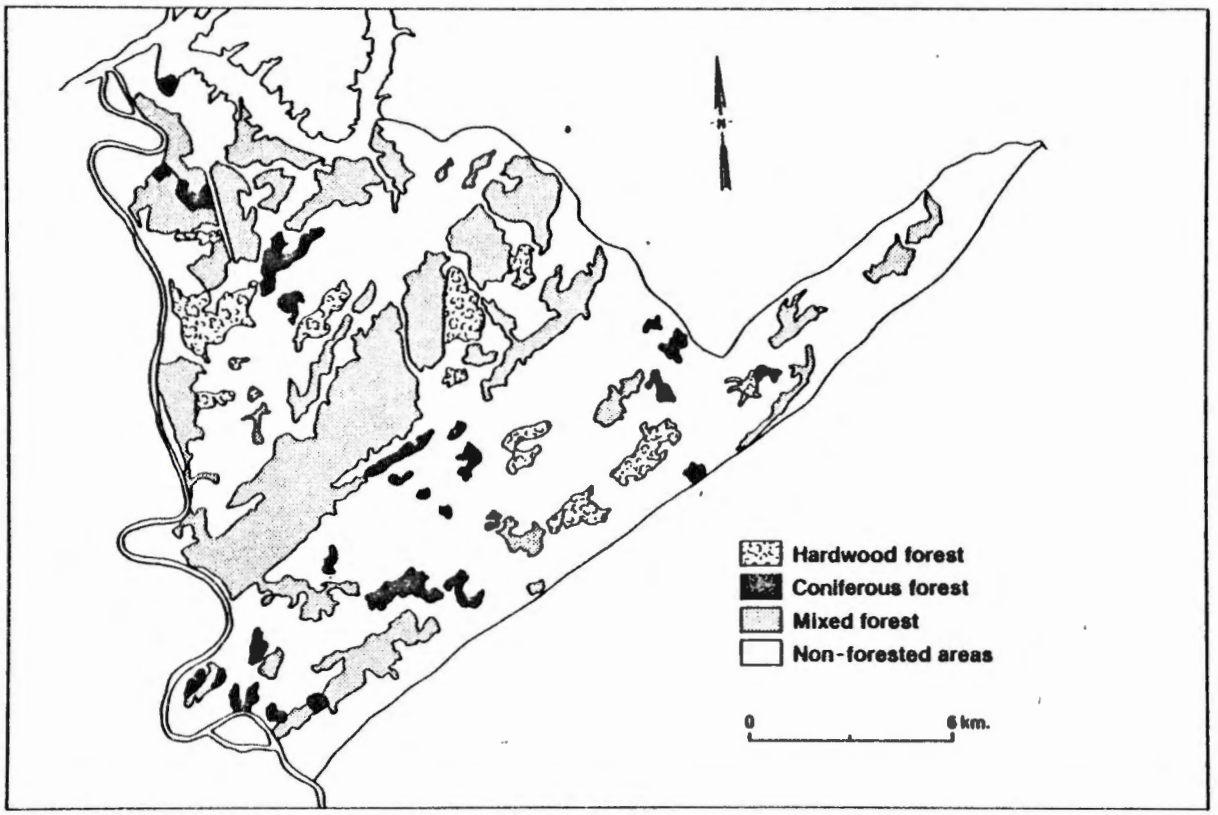


Figure 3. Distribution of forest cover types in portions of Blount and Loudon Counties, East Tennessee.

classified as Mixed forest, Hardwood stands (Oak-Hickory) are the dominant cover type on north facing slopes while Coniferous stands and true Mixed stands are found on the drier, south facing slopes of the ridge system.

All forest types in the Red Knobs ridge system are second to third growth stands, as they have been intensively logged in past years. Hardwood stands are generally classified as small sawtimber stands, but in some small, less intensively logged sections, hardwood stands reach the large sawtimber class (TVA 1971, 1973). Coniferous stands are most frequently cut and best fit the pole timber classification, with some stands reaching the small sawtimber stage.

Forest cover outside the Red Knobs ridge system is primarily restricted to small woodlots of less than 200 ha, interspersed with agricultural lands. Timber stands in these areas are mainly Hardwoods followed by Coniferous with some Mixed stands. The hardwood timber of both the Hardwood and Mixed forest associations in these small "farm woodlots" reach greater dimensions than that of the Red Knobs and are generally in the large sawtimber class. But Coniferous forest stands are still in the pole to small sawtimber classifications (TVA 1971, 1973).

These farm woodlots also contain most of the permanent streams in the study area. Along these stream courses, white oak and sycamore (Plantanus occidentalis) are the predominant tree species followed by sweetgum (Liquidumbar styraciflua), box elder (Acer negundo), ash (Fraxinus sp.), and black willow (Salix nigra).

However, it must be noted that much of the forest cover along stream banks was eliminated by the Tennessee Valley Authority (TVA) in

preparation for the completion of the Tellico Lake Project. All standing timber along the Little Tennessee River and its tributaries was clear-cut from waters edge back to the maximum flood level at the 248 m elevation mark. The impact on forest cover along the major Little Tennessee River tributaries was significant. An estimated 1400 ha of the study area is included in the TVA project. Some clear-cuts follow the stream course for as much as much as 8 km.

VIII. AGRICULTURAL LAND USE

With only 40% of the study area in forest, agricultural land use patterns are an important factor in the total habitat configuration. Agricultural operations are characterized by numerous small farms, classified as part-time, in that less than 50% of the owners devote their full time toward farming (Blount County, Tennessee, State Planning Commission 1970).

Pasture lands incorporate the largest proportion of the available agricultural land in the study area. These pastures are usually located either in areas too steep or stoney for cultivation, or on poorly drained bottomland soils. Orchardgrass, timothy, and fescue comprise the majority of pasture vegetation (Warr 1978).

Hay production is the second most important agricultural land use in the study area. Similar to pasture lands, hay crops are often grown on poorer soils and sites less desirable for intensive cultivation. Vegetation in these hay fields is primarily lespedeza, red clover, or orchardgrass.

The remaining portions of agricultural lands are generally located in the fertile river bottoms and level valleys. These areas

are more intensively cultivated, primarily used for corn, soybean, and tobacco production.

Corn and soybean production markedly decreased in the study area following the implementation of the Tellico Lake project, as all bottomlands slated for flooding were purchased by TVA. But, after a U.S. Supreme Court order stopped completion of the project, some of these lands were leased to former owners and put back into cultivation.

IX. EDGE HABITAT

Edge, or ecotonal areas, and old-field situations are also important habitat types within the study area. Many of the agricultural lands evolve into edge situations before forest vegetation becomes predominant. Some less productive pasture and hay fields abandoned by farmers in past years support prime old-field communities of annual weeds, greenbrier (Smilax sp.) and blackberry (Rubus sp.) thickets and dense red cedar (Juniperus virginiana) stands. However, the largest single block of ecotonal habitat exists along the Little Tennessee River as a result of the clear-cutting operations of the TVA.

X. HUMAN POPULATION

As with most of rural eastern Tennessee, the human population of the study area is large and evenly distributed. Over 87,000 people live in Blount and Loudon counties at an average density of 41.15 people per km^2 (Tennessee Statistical Abstract 1974). Approximately 70% of the population is classified as rural with only 2 communities, Friendsville (pop. 575) and Greenback (pop. 285), located in the

study area (U.S. Census 1970). The remaining non-rural inhabitants are located in a small section of the city of Maryville included in the study area boundaries.

Associated with the large human population, most of this rural area is easily accessible by automobile. Approximately 376 km of paved and gravel-base roads traverse the study area. In addition to maintained county and state routes, many old logging and farm roads, as well as powerline and gasline rights-of-way, provide access to forested areas. Only the interior portions of the Red Knobs ridge system are not readily accessible by 4-wheel drive vehicles.

XI. RACCOON MANAGEMENT

Prior to the implementation of the raccoon management and investigation projects in portions of Blount, Loudon, and Monroe Counties, the raccoon hunting season in eastern Tennessee historically lasted from the second weekend in October until the second weekend in February (120 days). Daily bag limit was 1 raccoon per person per night with no season limit. Raccoon dog training season, which allowed hunters to chase but not kill raccoons, was open 30 days prior to the hunting season in Blount County, and year-round in Loudon County.

Dog training seasons are largely regulated by county legislation entitled Private Acts, and often vary for each county. Private Acts are drafted by the county's state legislator under recommendations of the residents and then introduced into the State Legislature which usually passes them into law. These laws supersede management

regulations as set by the TWRA and essentially prohibit the agency from adequately controlling raccoon dog training seasons.

After the creation of the Experimental Raccoon Study Area, the raccoon and opossum (Didelphis virginiana) hunting and dog training seasons were closed in those portions of Blount, Loudon, and Monroe Counties included in the experimental area. Trapping seasons for all species in this area were also closed. However, the year-round dog training season in the Loudon County portion of the study area was reopened by Private Act legislation introduced and passed in the State Legislature. This Private Act was drafted by the Loudon County legislator after local raccoon hunters objected to the TWRA's closing of the season. The TWRA was unable to overrule this legislation and the Loudon County portion of the study area reamined open to year-round dog training (and a possible increase of illegal hunting) during all phases of the raccoon management investigations.

Two local raccoon hunting clubs provided most of the raccoon "management" in the study area prior to this investigation. The East Tennessee Coon Hunters Association (Blount County) and the Loudon County Coon Hunters Association frequently purchased raccoons from out-of-state and released them in favorite hunting locations. However, the importation of raccoons from Georgia and Florida was prohibited by law after the initiation of the raccoon management investigations. Since these 2 states were the primary suppliers of raccoons, local stocking projects decreased somewhat, but many hunting clubs found other sources or continued to import raccoons illegally from these 2 states. These raccoon hunting clubs also played an important role in the passing of Private Act legislation regulating raccoon harvest and season length.

An evaluation of the raccoon population in the study area was conducted by Warr (1978), who stated that raccoon numbers were too low for a reliable estimate of the population to be calculated. After 3,928 trap nights, Warr (1978) reported captures of 309 opossum, 39 cats, 30 dogs, and only 32 individual raccoons.

CHAPTER III

MATERIALS AND METHODS

I. TRAPPING

Collapsible, 12 ga wire live-traps, weighing 4.1 kg each and measuring 25.4 x 30.5 x 81.3 cm (No. 207, Tomahawk Live Trap Co.) were used to capture West Tennessee raccoons. Traps were baited with a variety of baits including sardines, fresh fish, and corn. Trapping was conducted by TWRA and Memphis State University, Department of Biology personnel during all seasons of the year. Most of the trapping effort occurred on the Meeman-Shelby State Park and Forest, Shelby County, Tennessee, and on the Hatchie National Wildlife Refuge, Haywood County, Tennessee (Figure 4).

The 4680 ha Hatchie National Wildlife Refuge contains 81% bottomland hardwood timber, 11% agricultural land, 4% upland mixed timber, and 3% lakes and streams (Cook 1977). Major timber types in the lowland areas (elevation 88 to 114 m) are Swamp Chestnut-Cherrybark oak (Quercus michauxii-Q. falcata var. pagodaefolia) and Sweetgum-Nuttall Oak-Willow Oak (Liquidumbar styraciflua-Q. nuttalli-Q. phellos) with Oak-Hickory-Pine stands primarily found on upland sites. All timber stands are second growth with an average age of 60 years (small to large sawtimber classification)(Stewart 1976). Agricultural crops are grown on the area under a cooperative farming arrangement, along with numerous food plots of milo, millet, and buckwheat (Cook 1977).

Raccoon densities on the refuge are considered high, with 200 hunters harvesting an estimated 200 raccoons during a 11-night season

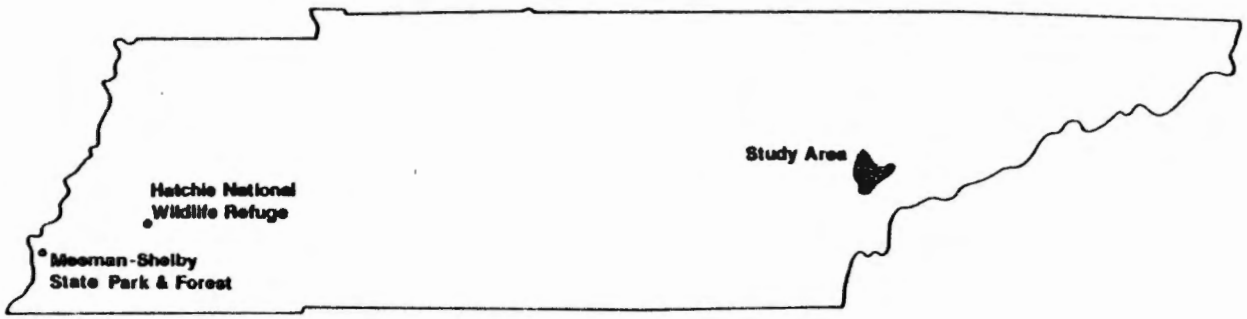


Figure 4. Location of raccoon trapping areas and the study area in Tennessee.

annually. Dog training is prohibited outside the 11-night season.

The 5224 ha Meeman-Shelby State Park and Forest is maintained as a state wildlife management area by the TWRA. Approximately 52% of the area is located on the Mississippi River Flood Plain and forest cover types are similar to those found on the Hatchie National Wildlife Refuge. On the higher bluff sites (92 to 107 m), Beech-Oak-Hickory becomes the dominant forest cover type (Welborn 1975).

Raccoon densities on the area are estimated at 1 raccoon per 2.93 ha (Don Allsbrooks, unpublished data). Raccoon hunting was permitted on 23 nights during 1978. This area also does not allow dog training outside of the regular hunting season.

II. TAGGING AND HANDLING

Captured raccoons were held in small pens or cages with food and water until 6 or more had been obtained. They were then transferred by truck to the Agricultural Campus, University of Tennessee, Knoxville for tagging.

All raccoons receiving only ear tags were handled without the use of immobilizing agents. A long-handled, metal pole rigged with a cable noose was used to remove the animals from the holding pens and transfer them to a special tagging cage. This tagging cage consisted of a wire live-trap equipped with a movable wooden floor. When engaged, the wooden floor pushed the raccoon upward in a flattened position against the wire mesh trap cover. In this position, the raccoon's ears were readily accessible for tagging.

The raccoons were given 2 ear tags; 1 numbered, plastic Standard Rototag (No. C1635N, NASCO), and 1 numbered, metal Monel tag (No. 4,

National Band Co.). In addition to the number, the metal ear tag was also marked "Notify TWRA." Both tags were affixed to the base of the front of the ear to lessen the chance of tag loss.

After tagging, the raccoons were returned to the holding pens by the use of the cable noose and pole. While restrained in the noose, information on the animal's sex, reproductive status, estimated weight, and age (juvenile or adult) was recorded along with tag numbers.

Raccoons equipped with radio transmitters were first immobilized with Sernylan (Phencyclidine hydrochloride) to facilitate handling and prevent possible injury to both animal and investigator (Montgomery 1964, Harthoorn 1965, Seal and Erickson 1969, Bailey 1971, Dean et al. 1973, Keeler 1978). The drug was administered intramuscularly with a disposable, plastic, 1 cc tuberculin syringe at a dosage of 0.66 mg/kg (Warr 1978). Estimated weights were used to calculate the dosage of Sernylan for each raccoon.

Once the raccoon was immobilized, a spring scale graduated to 0.1 kg was used to determine the actual weight of the animal. Standard mammal measurements were recorded in millimeters along with a subjective consideration of the raccoon's physical condition based on apparent fat reserves and pelage appearance (Warr 1978). Any presence of injury, deformation, scars, or other obvious maladies was also recorded.

III. AGING

The age of immobilized raccoons and dead raccoons found in the study area was determined by a combination of methods based on dental characteristics. The tooth wear method as described by Grau et al. (1970)

placed raccoons into 5 broad age classes and was considered a reliable, accurate technique. Ages of juvenile raccoons (age class I) were further separated by the tooth eruption technique described by Montgomery (1964).

Reproductive status of females was recorded according to the method described by Stuewer (1943b), utilizing the teats to determine whether the animal had previously bore young or was presently lactating. Mature and immature males were separated by body weight (Johnson 1970) and by descent of the testes (Keeler 1978).

IV. RADIO TELEMETRY

Selected raccoons were fitted with radio transmitter collars operating in the 150.850 to 151.450 MHz range (Wildlife Materials, Inc.). The transmitter package weighed approximately 120 g and was powered by a Lithium battery (expected life 370 $\pm$ 74 days). The battery and transmitter were sealed in plastic or dental epoxy and were affixed to a hard plastic base plate. The curvature of this plastic base plate was designed to conform to that of a raccoon's neck. The radio signal was broadcast through a 200 mm external antenna attached to the base of the transmitter and reinforced by two metal springs set in dental epoxy. From this point of attachment, the antenna extended above the animal's body.

The transmitter was also equipped with a mercury switch-activity monitor which, when activated by head and neck movement, triggered an appreciable change in the signal rate (average of 90 beats/min. to average of 210 beats/min.) and often the signal strength. A raccoon

was considered active when the signal rate changed at least twice during a 1 minute time span.

The transmitter package was attached to a nylon webbing collar for further adjustment of the package to individual raccoons. This nylon webbing collar was adjusted for neck size and fastened together with small screws, lock washers, and nuts. Similarly attached to the webbing was a 7.5 x 2.0 cm brass plate bearing the address and telephone number of the Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville. Enough space was left under the collar to allow the raccoon additional growth, but not enough to enable it to remove the collar. The adjustable nylon webbing collar in addition to the curvature of the plastic base plate allowed custom fitting of the transmitter package to each individual raccoon. After the collars were attached to the raccoons, the animals were held in separate cages until the effects of the immobilizing drug had diminished.

The radio-receiving equipment consisted of a portable, 24-channel tracking receiver, operating in the 150.850 to 151.450 MHz range (Model TRX-24, Wildlife Materials, Inc.), and a hand-held, directional, 2-element "H" antenna (Telonics, Inc.). A 4-element Yagi antenna was sometimes used at the onset of the study but proved less effective and sensitive than the "H" design antenna. Signal strength peaks and receiver meter readings were used to determine directional azimuths which were read with a hand-held compass (Type 15, Silva, Inc.)

A minimum of 3 azimuths were taken from known map points to determine the location of the radio-collared raccoons. Azimuths were triangulated in the field on 1:24,000 scale U.S. Geological Survey

(USGS) topographical maps to exclude inaccurate radio locations resulting from signal bounce in uneven topography and dense vegetation. Locations were later reduced to an east and north coordinate, based on a 10 x 10 cm grid system plotted on 1:24,000 scale USGS topographic maps, and recorded on computer cards. Time of day and activity status (active or inactive) of the raccoon were also recorded for each radio fix.

After release, attempts were made to locate the translocated raccoons at least once daily. Diel activity and movement patterns were taken periodically, in addition to night locations, to insure accurate activity and home range information. Aerial searches using the TWRA's single engine airplane were conducted when ground surveys failed to locate an animal.

Tree den and daytime resting sites were obtained by tracking the raccoon's radio sginal to its exact location. When these sites were located, information as to type (tree den, ground den, etc.), distance to water, distance to agricultural crops, crop type, and distance to human inhabitance were recorded. Tree dens were determined as to species and dbh and height measured. "Walking in" on den sites also served as an accuracy check on triangulation techniques.

V. RELEASE SITES

Release sites for the translocated raccoons were selected prior to liberation of the animals in the study area. Only those areas with at least 150 ha or more of contiguous Hardwood-Mixed forest and a minimum of 1 permanent stream or water source were considered as release sites. These sites were selected from topographic maps and

aerial observation. Each site was then investigated in the field for potential raccoon habitat. Also an attempt was made to avoid areas known for high illegal hunting pressure, based on information obtained from TWRA field personnel and local residents. Three major areas within the study area met most of these criteria and were used for all releases of radio-equipped raccoons (Figure 2, page 8).

After the animals were ear-tagged, and radio-collared raccoons had recovered from the immobilization process, they were transported by truck from the Agricultural Campus to the release site. Every effort was made to keep the releases secret to avoid illegal hunting mortality. Whenever possible, back roads were used while in transit to release sites. Releases were made on old roads and trails, away from houses. However, permission was obtained from cooperating landowners prior to releasing raccoons on their property.

Once at the release site, the raccoons were freed from the cages as quickly as possible in groups of 15 or less, depending upon the size and quality of the habitat immediately surrounding the release site. Releases were made from June 1975 through May 1978.

VI. CONTROLLED HUNTS

In an effort to obtain dispersal and survival information on those raccoons released in the study area without radio collars, a controlled, or quota hunt was held on 3-4 and 10-11 November, 1978. The number of hunters allowed to participate in the hunt was limited to 50 parties of 2 hunters each, with 25 parties per hunt. Prospective hunters were required to register in person for a random drawing on

15 October, 1978 at the Blount and Loudon County courthouses. At the time of registration, hunters were required to present a valid hunting license. Prior to the registration date, information concerning hunt dates and sign-up dates was publicized over local radio broadcasts and in newspapers. After the computer drawing, successful applicants were notified by mail.

Hunting was limited from sunset to 0300 hours and hunters were required to report to 1 of 2 check stations prior to and after hunting. Harvest was limited to 1 raccoon per party per hunt. Maps were provided at each checking station for successful hunters to locate the area in which their kill was made. In addition to kill data, all hunters were asked to provide information regarding other aspects of their hunt.

VII. PUBLIC RELATIONS

Throughout the duration of the study, slide-talk programs explaining the raccoon project were presented to various sportsmens' groups within and surrounding the study area. The investigator frequently attended local raccoon hunting club meetings in an attempt to obtain better cooperation between these clubs and researchers. These clubs were also given progress reports during all phases of the raccoon research in Blount, Loudon, and Monroe Counties. Efforts were made to emphasize the importance of halting individual raccoon club stocking programs in the study area. Raccoon hunters were also asked to refrain from utilizing the study area for field trial events and dog training activities, and to return any ear tags or radio collars which they might "find."

VIII. DATA ANALYSIS

To determine home range sizes of the translocated raccoons, 3 methods were employed; the convex polygon, minimal polygon, and a bivariate home range model.

The convex or maximum polygon home range estimate was obtained by determining the area within a convex polygon formed by connecting the outermost radio locations for each raccoon.

The minimal polygon estimate was derived by measuring the area within the polygon formed by connecting the adjacent, outer locations, so as to include as small an area as possible (after Jennrich and Turner 1969), but still including all location points.

The bivariate home range model, or elliptical method (Koeppel et al. 1975), determined probabilistic home range size from statistical analysis of the scatter of location points (Sokal and Rohlf 1969: 526-532). This model was based on the formula:

$$A = 2\pi F_{\alpha}(2, n-2) \frac{n-1}{n-2} (S_1^2 S_2^2 - S_{12}^2)^{1/2} \quad .$$

Using the notation of Sokal and Rohlf (1969: 528-531), $\underline{A}$ represents the home range area. The number of locations points (n) for each raccoon were plotted on 2 perpendicular axes with S_1^2 representing the variance in the vertical direction and S_2^2 represented the variance in the horizontal direction. The notation S_{12} was the covariance, with F_{α} obtained from a table of the F-distribution for the proportional area $1 - \alpha$. The formula was based on 2 and $n - 2$ degrees of freedom, which supposedly removes biases interjected by small sample sizes (Madden and Marcus 1978).

The resulting home range model was a mathematically determined ellipse which enclosed 95% (95% confidence interval) of the raccoon's projected home range. This elliptical home range was also calculated at the 90, 75, and 50% confidence intervals.

In addition to home range estimates, raccoon locational data were used to determine dispersal from release points and daily movement information. The straight-line distance between the release point and the nearest home range boundary (as calculated by the convex polygon) was termed minimum dispersal. Maximum dispersal was defined as the linear distance from the release site to the farthest location recorded during the entire monitoring period for each raccoon.

Minimum 24-hour movement information was obtained from location data recorded during diel tracking periods and den site investigations. These movements were defined as the minimum straight-line distance between the 2 extreme locations recorded over a 24-hour period, or as the minimum distance between 2 consecutive bedding sites (Fritzell 1978).

In addition to the bivariate home range model, several other statistical methods were used to analyze data collected during this investigation. The single classification (Model II) ANOVA, Student-Newman Keuls procedure, the least significant range procedure, and t-test of the difference between means were all used to analyze variation in home ranges, movements, and activity data between different raccoon release times, release locations, age classes, and sexes. The t-test for paired comparisons was used to identify variations in values calculated by different home range estimation techniques. Chi-square

analysis was used to identify goodness of fit or random properties of data in cases where this type procedure was applicable. The signif icance level $P > .10$ was used with all these tests in rejecting the null hypothesis. Linear regression correlation models were utilized to analyze relationships between various measurements such as home range size, dispersal distance, and number of days monitored. The significance level for the regression analysis procedure was set at $P > .05$, and any relationship tested was not considered significant if the correlation coefficients did not meet the significance standards as found in Rohlf and Sokal (1969: 224-225).

CHAPTER IV

RESULTS

I. TAG RETURNS

From 16 July 1975 to 5 May 1978, 286 West Tennessee raccoons (131 males, 155 females) were ear-tagged and released in the study area (Table 13, Appendix). There were 139 raccoons (65 males, 74 females) released July through August 1975 and 147 (66 males, 81 females) released from March 1977 to May 1978.

Of the 286 ear-tagged raccoons, 29 (10.1%) were recovered as of 11 November 1978 (Table 14, Appendix). Recoveries for the 29 raccoons (13 males, 16 females) consisted of 41.4% (12) illegal kills, 24.1% (7) live-trap recaptures, 17.2% (5) legal kills, and 17.2% found dead in the study area.

The average number of days to recovery (days in the field) for all 29 raccoons was 344 days (range = 2 to 1207). Raccoons recovered from releases in 1975 (11) survived an average of 610 days before recovery, while those recovered from the 1977-78 releases (18), lasted an average of 181 days in the field. Those raccoons found dead in the study area survived an average of 83 days (range = 18 to 187) after release. Of the raccoons found dead, 2 were killed by automobiles, and 3 were classified as "natural" deaths. Those raccoons illegally killed survived for a mean time of 324 days (range = 2 to 1091) following release. The ear-tagged raccoons recaptured in live-trapping efforts were caught after a mean of 352 days (range = 72 to 727) after release. Raccoons taken during

the 4-night legal hunt in November 1978 remained in the field an average of 597 days (range = 337 to 1207 days) following release.

Tag returns during winter (28%) and summer (31%) were significantly higher ($P > .02$) than returns accumulated during the remaining seasons (Figure 5). Tag returns from illegally killed and recaptured raccoons were also significantly greater ($P > .001$) during summer and winter than at any other time (Figure 6). Dead raccoons were most often found ($P > .001$) during winter and spring. All tag returns from legally killed animals were obtained during the fall hunt.

Of the 16 females recovered from release efforts, 11 (56.2%) survived through at least 1 breeding season. Examination of the teats (as described by Steuwer (1943b) of these 11 raccoons revealed that 7 (63.6%) had apparently given birth to offspring while in the study area. All male raccoons recovered were classified as adults.

Weight changes between release and recovery times were recorded for 9 animals (2 males, 7 females). All but 1 of these animals exhibited an appreciable weight gain. This group of raccoons consisted of 5 adult females, 2 juvenile females, and 2 adult males (Table 1). Release weights for all the raccoons averaged 2.75 kg and ranged from 1.36 to 3.85 kg, while recovery weights ranged from 2.30 to 6.13 kg with a mean of 3.89 kg. Weight changes ranged from -0.40 to 2.95 kg with a mean of 1.14 kg (29% increase) and were recorded over an average time period of 432 days (2.6 g/days).

Adult females had a mean weight of 3.04 kg (2.27 to 3.85 kg) prior to release and weighed an average of 3.63 kg (range = 2.30 to 4.80 kg) when recovered, thereby exhibiting an overall increase in

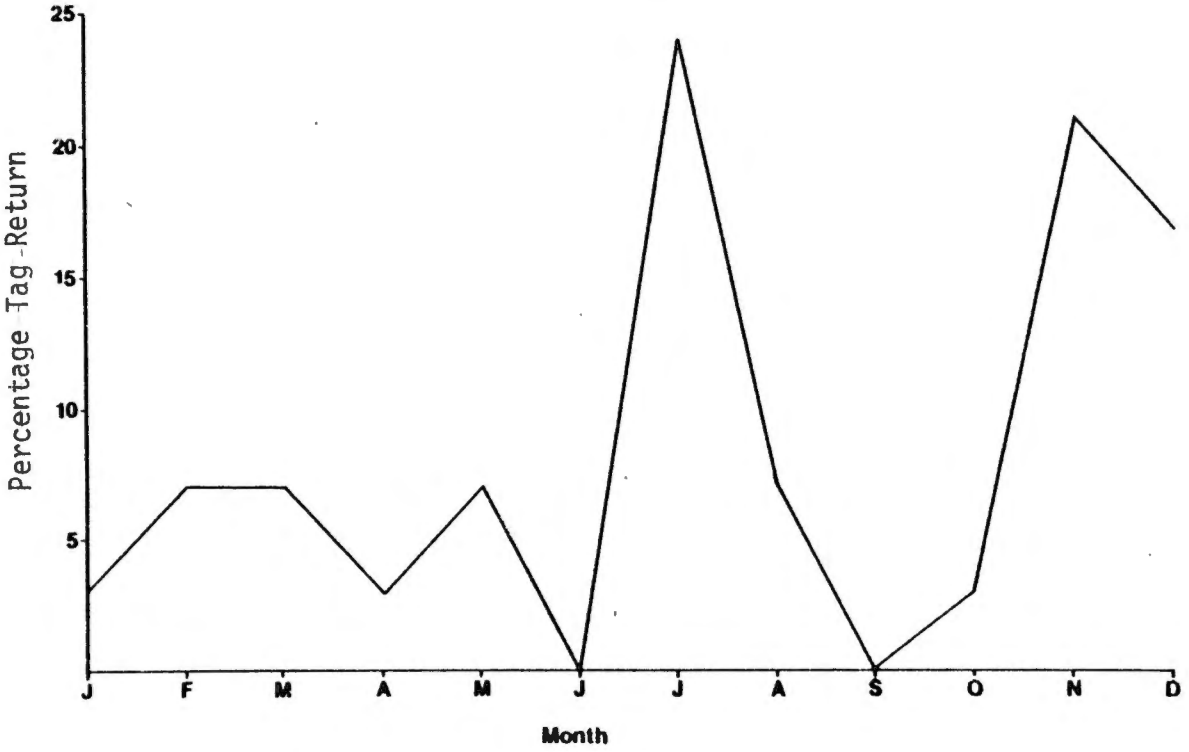


Figure 5. Monthly distribution of tag returns for West Tennessee raccoons released and recovered in Blount and Loudon Counties, East Tennessee.

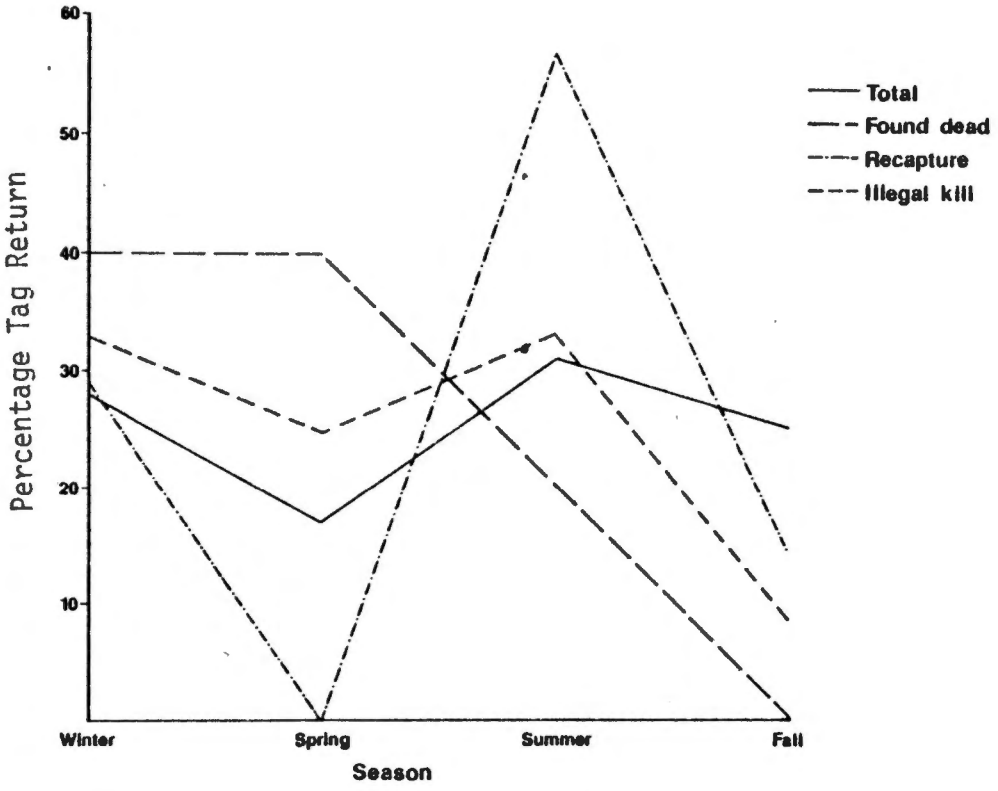


Figure 6. Seasonal distribution of tag returns for West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee, and recovered by 3 methods.

TABLE 1. Weight changes of 9 translocated West Tennessee raccoons between release and recovery dates.

Tag number Metal	Plastic	Sex	Release age[a]	Release weight (kg)	Recovery weight (kg)	Weight change (kg) (%)	Days to recovery
T2945	--	F	J	1.82	2.85	+ 1.03 (36.1)	147
257	R54	F	J	1.36	3.63	+ 2.27 (63.0)	447
T3132	--	F	A	3.18	3.21	+ 0.03 (1.0)	1207
T3166	R20	F	A	3.18	3.55	+ 0.37 (10.0)	339
T4051	Y51	F	A	3.85	4.31	+ 0.46 (11.0)	337
268	RY83	F	A	2.27	4.80	+ 2.53 (53.0)	458
T4054	Y53	F	A	2.70	2.30	- 0.40 (-17.0)	80
T3113	--	M	A	3.18	4.20	+ 1.02 (24.0)	365
- -	B57	M	A	3.18	6.13	+ 2.95 (48.0)	505
			$\bar{X}$	2.75	3.89	+ 1.14 (29.0)	431.7

[a]Juvenile or adult.

weight of 16% over a mean time in the field of 484 days (1.2 g/day). Juvenile females weighed an average of 1.59 kg when released and 3.24 kg when recovered, with an average increase in body weight of 51% during a mean of 297 days in the study area (5.6 g/day). The mean weight of adult males prior to release was 3.18 kg and 5.17 kg upon recovery. During their average stay in the field of 435 days, they exhibited an average increase in body weight of 38% (1.99 kg or 4.8 g/day).

Dispersal

The average linear dispersal distance (release site to recovery point) for the 29 tag returns was 4.9 km (median = 2.1 km) over an average of 344 days that they remained in the study area (Table 14, Appendix). The greatest linear distance traveled was by a male (B82) released 7 July 1977 and illegally killed 2 November 1977 (119 days) at a location 37.1 km from the release site. Of the 29 raccoons, 21 (72%) moved less than the average distance of 4.9 km from the release site. There was no significant relationship ($P > .10$) between dispersal distance and the number of days to recovery. Mean dispersal distance for males alone was 6.8 km, while that of females was 3.4 km. Although the mean dispersal distance for males was nearly twice that of females, there was no significant difference ($P > .10$). Average days to recovery for males was 241 days and for females, 427 days; again, there was no significant difference between males and females. Dispersal direction for the 29 raccoons was random, with 31% dispersing northward, 27.6% southward, 17.2% eastward, and 24.1% heading westward.

II. RADIO TELEMETRY

From 10 March 1977 to 5 May 1978, 17 West Tennessee raccoons (6 males, 11 females) were equipped with radio transmitter collars and released in the study area (Table 15, Appendix). These 17 raccoons were monitored for a total of 1985 days (mean = 116.8 days) during which time approximately 5000 radio fixes resulted in 1481 radio locations, with a mean of 87 locations per raccoon (Table 2).

However, 3 raccoons were killed before adequate home range information was obtained. Raccoon Y28 was killed by a vehicle 18 days after release, while Y57 and Y58 were illegally killed 2 days following their release in the study area. The remaining 14 raccoons (5 males, 9 females) were monitored for a total of 1963 days (mean = 140.2 days) during which time 1464 radio locations (mean = 104 locations per raccoon) were recorded.

These 14 raccoons consisted of 1 class I male, 3 class II males, 1 class III male, 2 class I females, 4 class II females, 2 class IV females, and 1 class V female. Weights ranged from 2.9 to 5.0 kg with an average of 3.85 kg. All animals were in good to fair physical condition when released.

From the 17 raccoons released, 9 (52.6%) were monitored until the battery in the radio-collared expired (average of 164.3 days and 132 locations), 4 (23.5%) were illegally killed, 3 (17.6%) were found dead (1 of which was a road kill), and 1 (5.8%) removed the radio collar after release.

Of the 14 raccoons tracked for at least 1 month, 9 (64.3%) were monitored until the transmitter battery expired, 2 (14.3%) were illegal

TABLE 2. Survival of 17 West Tennessee raccoons radio-collared and released in Blount and Loudon Counties, East Tennessee.

Raccoon number	Sex	Release date	Release site	Days monitored	Number of locations	Fate
Y28	F	3-11-77	Lotterdale Knob	18	11	Road kill
Y29	M	3-10-77	Lotterdale Knob	183	155	Transmitter failed
Y36	F	3-10-77	Lotterdale Knob	33	30	Illegal kill
Y37	M	4-9-77	Lotterdale Knob	91	67	Transmitter failed
Y38	F	4-9-77	Lotterdale Knob	150	122	Transmitter failed
Y40	M	4-9-77	Lotterdale Knob	144	96	Transmitter failed
Y42	M	6-25-77	Alexander Knob	179	60	Illegal kill
Y45	F	6-25-77	Alexander Knob	96	75	Transmitter failed
Y48	F	6-25-77	Alexander Knob	180	126	Transmitter failed
Y49	M	6-25-77	Alexander Knob	178	141	Transmitter failed
Y51	F	12-3-77	Glendale-Little Tennessee River	84	48	Removed collar
Y52	F	12-3-77	Glendale-Little Tennessee River	257	261	Transmitter failed

TABLE 2. Continued

Raccoon number	Sex	Release date	Release site	Days monitored	Number of locations	Fate
Y53	F	12-3-77	Glendale-Little Tennessee River	80	58	Natural death
Y54	F	12-3-77	Glendale-Little Tennessee River	108	75	Natural death
Y55	F	5-5-78	Glendale-Little Tennessee River	200	150	Transmitting[a]
Y57	M	5-5-78	Glendale-Little Tennessee River	1	2	Illegal kill
Y58	F	5-5-78	Glendale-Little Tennessee River	2	3	Illegal kill
				$\bar{X}$ 116.8	87.1	

[a]Transmitter functioning as of November 1978.

kills, 2 were found dead in the field, and 1 (7.1%) removed its radio-collar after 84 days in the field.

Radio-tracking efforts were distributed over a 21-month period, from 10 March 1977 to 12 November 1978 (Figure 7). Transmittered animals were released 10 March 1977 (3) and 9 April 1977 (3) in the Lotterdale Knob area, 25 June 1977 (4) in the Alexander Knob area, and 3 December 1977 (4) and 5 May 1978 (3) in the Glendale-Little Tennessee River region. Seasonal tracking efforts consisted of 13 raccoons monitored during spring, 10 in summer, 7 in fall, and 7 during winter.

Home Range Size

The average home range size for all raccoons during all seasons was 106.41 ha (range = 8.06 to 398.74 ha) as estimated by the minimal polygon method. The maximum polygon method yielded an average home range of 226.05 ha (range = 18.63 to 765.65 ha) (Table 16, Appendix). The elliptical home ranges calculated at the 95% confidence interval averaged 383.75 ha (range = 26.04 to 1385.48 ha). There was no significant relationship ($P > .05$) between the number of days monitored or the number of locations recorded and home range sizes as estimated by all methods.

The mean elliptical home range size for the 5 radio-monitored males during all seasons, was 655.86 ha (range = 99.59 to 1385.48 ha) as estimated at the 95% confidence interval (Table 3). The convex polygon method yielded an average male home range size of 364.36 ha (range = 140.28 to 765.65 ha) while the mean home range size for males as determined by the minimal polygon method was 178.69 ha (range = 46.56 to 398.74 ha). Average male home ranges calculated by all

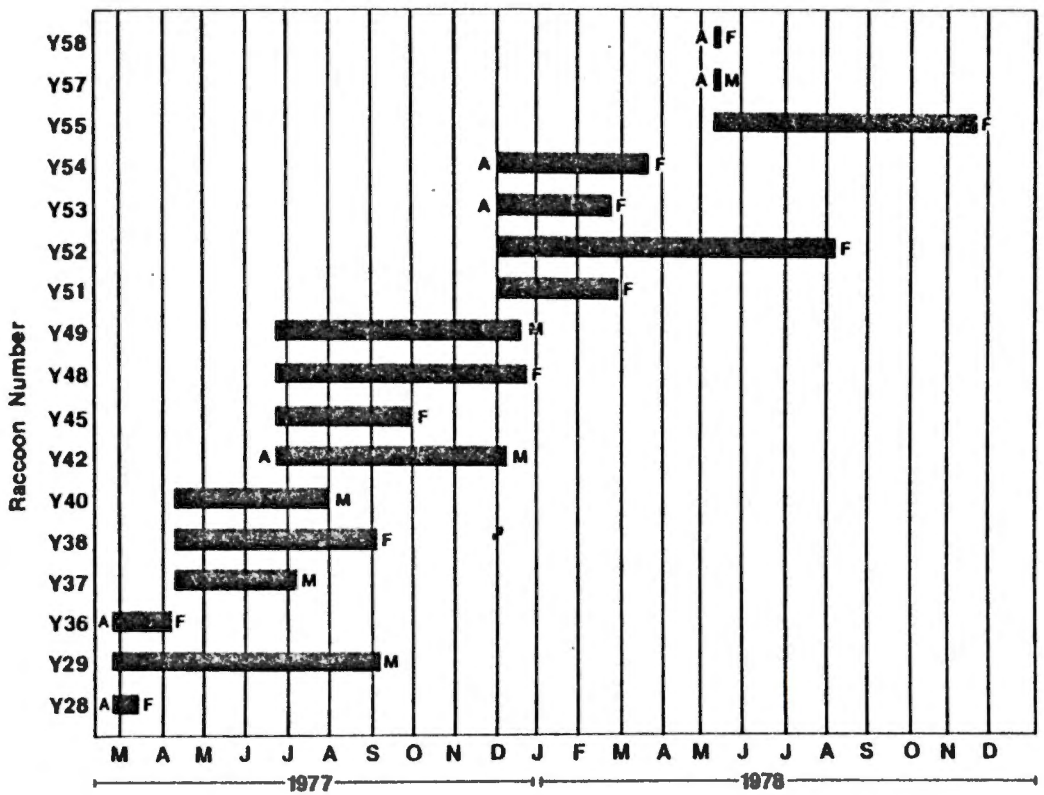


Figure 7. Seasonal distribution of radio-telemetry efforts for 17 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee (illegally killed raccoons denoted by A).

TABLE 3. Mean home range sizes of West Tennessee raccoons released during 4 seasons and at 3 different locations in Blount and Loudon Counties, East Tennessee.

Group	Sample size	95% Confidence interval ellipse	Convex polygon	Minimal polygon
Sex				
Males	7	655.86	364.48	178.69
Females	11	210.60	137.99	60.42
Release season				
Spring	5	526.93	350.95	176.92
Summer	6	584.11	307.43	134.47
Fall	5	93.27	47.88	28.42
Winter	2	150.94	115.11	40.94
Release location				
Lotterdale Knob	5	551.85	376.30	179.52
Alexander Knob	6	584.11	307.43	134.47
Glendale-Little Tennessee River	7	91.95	48.98	30.14

methods were significantly larger ($P > .05$) than those of females calculated by the same methods. There was no significant relationship ($P > .05$) between the number of days monitored or the number of locations recorded and home range size for male raccoons.

For the 9 radio-collared females, the elliptical method gave an average home range estimate of 210.60 ha (range = 26.04 to 770.81 ha) at the 95% confidence interval. The maximum polygon method resulted in an average home range size for females of 137.99 ha (range = 18.63 to 454.68 ha) with the minimal polygon estimate averaging 60.42 ha (range = 8.06 to 186.37 ha). Again, there was no significant relationship ($P > .05$) between the number of days monitored or the number of locations recorded and home range size for female raccoons.

There was no significant variation ($P > .10$) between the home range sizes of different age class raccoons.

The 5 raccoons (2 males, 3 females) released during spring months (20 March - 20 June) established home ranges averaging 526.93 ha (range = 76.63 to 1385.48 ha), as estimated by the elliptical method at the 95% confidence interval (Table 3). The maximum polygon estimate of average home range sizes for raccoons released in spring was 350.95 ha (range = 38.04 to 765.65 ha) with a minimal polygon method average of 176.92 ha (range = 24.98 to 398.74 ha).

For the 4 raccoons released in summer (21 June - 22 September (2 males, 2 females), the 95% confidence interval ellipse averaged 584.11 ha (range = 260.78 to 770.81 ha). The maximum polygon estimate gave a mean home range size of 307.43 ha (range = 140.28 to 454.68 ha) while the minimal polygon estimate home ranges averaged 134.47 ha (range = 46.56 to 217.59 ha).

Five female raccoons released in fall (23 September-21 December) established home ranges varying from 26.04 to 271.57 ha as calculated by the elliptical technique at the 95% confidence interval. The maximum polygon average home range estimate for raccoons released in this same season was 47.88 ha (range 18.63 to 70.50 ha) while minimal polygon estimates averaged 28.42 ha (range = 8.06 to 47.08 ha).

Of the 3 raccoons released during winter, only 2 (1 male, 1 female) survived long enough to establish home ranges. These 2 areas averaged 150.94 ha (95% confidende interval ellipse), 115.11 ha (maximum polygon), and 40.94 ha (minimal polygon).

Those raccoons released during the fall season established home ranges, as calculated by each method, that were significantly smaller than those home ranges established by raccoons released during summer months. Significance levels for this comparison varied between home range estimation techniques. For the elliptical estimates (95% confidence interval), fall-established home ranges were significantly smaller than summer established areas at $P > .001$, while maximum and minimal polygon fall estimates were significantly smaller than those for summer at $P > .01$ and $P > .02$ respectively. There was no significant difference ($P > .10$) between home ranges, as derived by all estimation methods, established by raccoons released during spring and those established by raccoons released during summer. However, only the maximum polygon estimation method gave home ranges for fall released raccoons that were significantly ($P > .10$) smaller than those ranges established by raccoons released in spring. Home ranges established

by raccoons released in winter (22 December - 19 March) were not included in the statistical analysis because of the small sample size.

When reduced to actual release months, only those home ranges established by raccoons released in June and December were comparable, due to small sample sizes for other release months. Home ranges established by raccoons released in December were significantly smaller than those of animals released in June. Significance levels for the 95% confidence interval comparisons were $P > .001$, and $P > .01$ for maximum and minimal polygon areas. Mean home range sizes for December released animals were 93.27 ha (95% confidence interval), 47.88 ha (maximum polygon), and 32.12 ha (minimal polygon). Raccoons released in June established home ranges averaging 584.11 ha (95% confidence interval), 307.43 ha (maximum polygon, and 147.23 ha (minimal polygon).

Home ranges calculated by the 95% confidence interval ellipse for raccoons released in the Glendale-Little Tennessee River area were significantly smaller than similarly estimated mean range of raccoons released in the Lotterdale Knob area ($P > .01$) and in the Alexander Knob region ($P > .001$)(Table 3). Using these same home range estimates, there was no significant ($P > .10$) difference between mean ranges of raccoons released near Lotterdale Knob and Alexander Knob. Maximum polygon estimates for raccoons released in the Glendale-Little Tennessee River area were also significantly smaller than for raccoons released near Lotterdale Knob and Alexander Knob at $P > .02$ and $P > .001$, respectively. Minimal polygon estimates for raccoons released in the Glendale-Little Tennessee River area were significantly smaller at $P > .10$ and $P > .01$ than the same type home range estimates for raccoons released in the

Lotterdale Knob and Alexander Knob areas, respectively. For maximum and minimal polygon home range estimates, there was no significant difference ($P > .10$) between established ranges of raccoons released in the Lotterdale Knob and Alexander Knob areas.

Sample size limitations did not allow statistical analysis of differences between home ranges of raccoons released during different seasons at the same release sites, or between raccoons released at varying locations during the same season. All summer releases were made in the Alexander Knob area, fall releases were made in the Glendale-Little Tennessee River region, winter releases were made in the Lotterdale Knob area, and spring releases were divided between the Lotterdale Knob and Glendale-Little Tennessee River areas. Home ranges from the Lotterdale Knob area were comprised of 3 spring and 2 winter releases, Glendale-Little Tennessee River ranges consisted of 5 fall and 2 spring releases, while again, all Alexander Knob releases were made during summer.

Home Range Overlap

Of the 14 raccoons, 6 (42.9%) established home ranges (convex polygon) that overlapped with at least 2 other translocated individuals, while 3 (21.4%) overlapped with 4 other raccoons, 2 (14.3%) overlapped with 1 other animal, and 1 (7.1%) overlapped with 3 other raccoons (Figures 8, 9, and 10). Only 2 (14.3%) of the translocated raccoons established home ranges that did not encounter at least one other individuals home range.

With males alone, 2 (40%) had home ranges overlapping 4 other raccoons, 1 (20%) overlapping 3 and 2 other individuals, while 1 of the

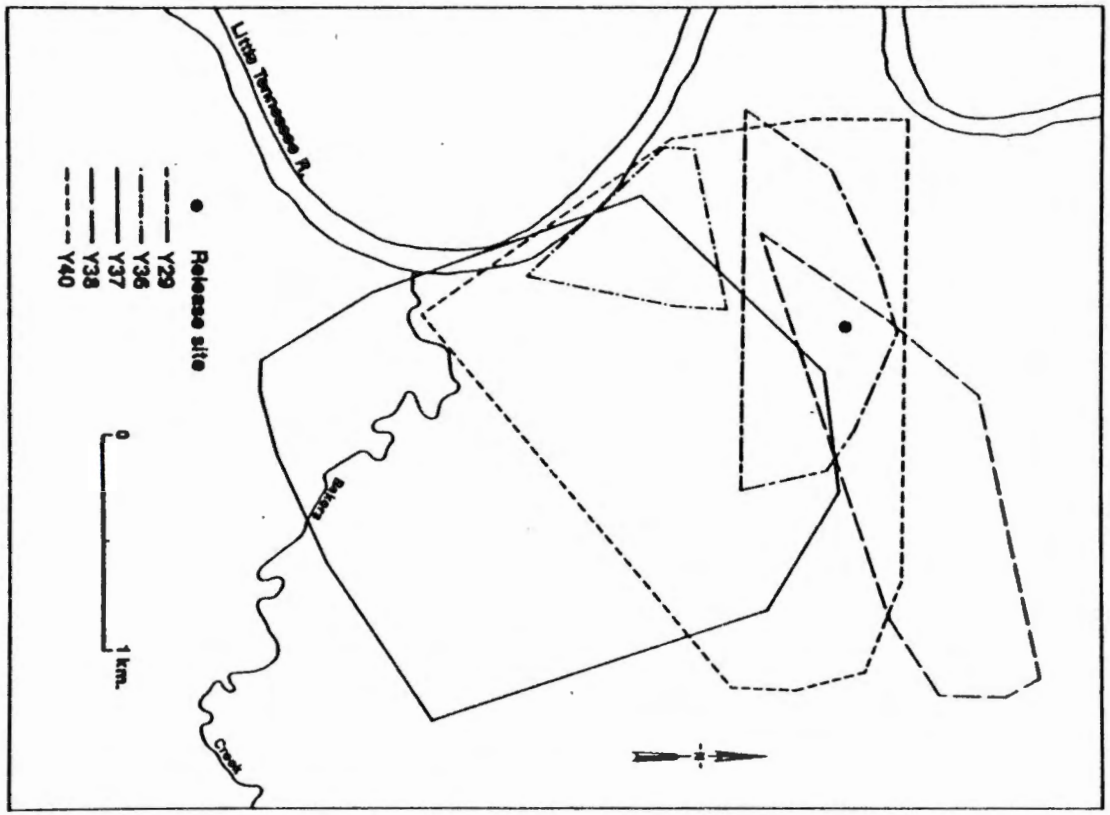


Figure 8. Home range overlap in convex polygon areas for West Tennessee raccoons released and radio-monitored in the Lotterdale Knob region, Loudon County, East Tennessee.

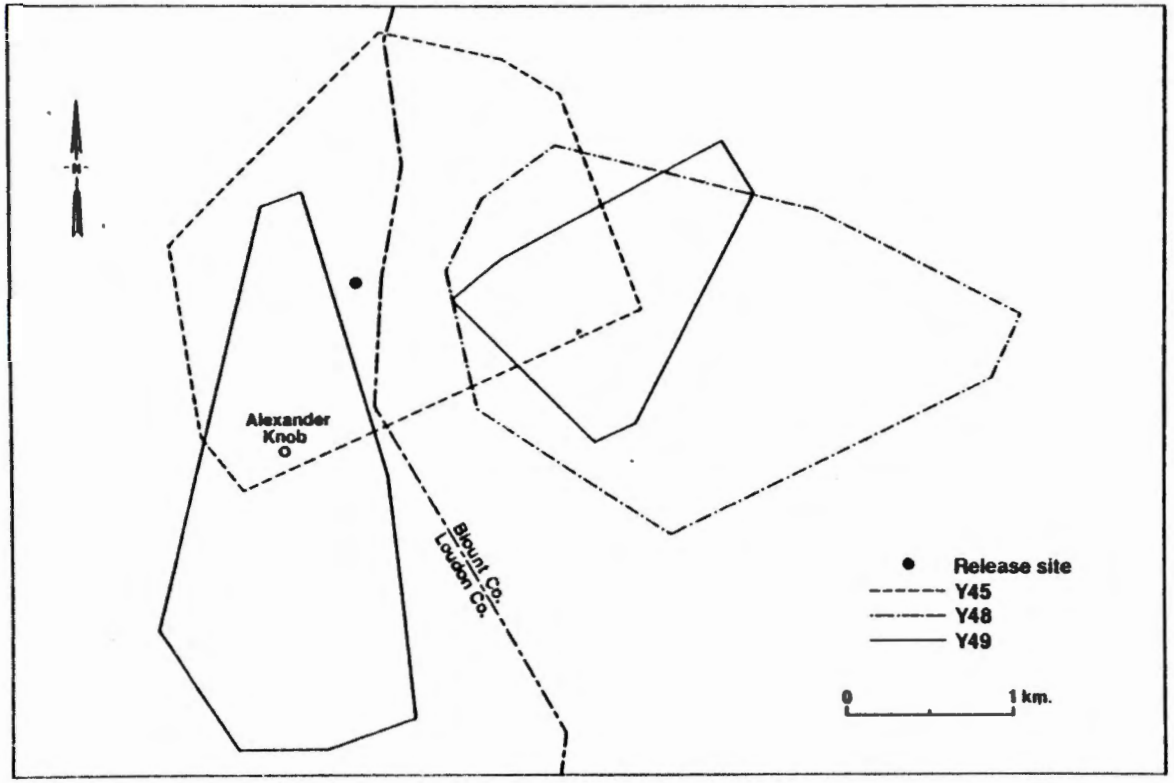


Figure 9. Home range overlap in convex polygon areas for West Tennessee raccoons released and radio-monitored in the Alexander Knob region, Blount and Loudon Counties, East Tennessee.

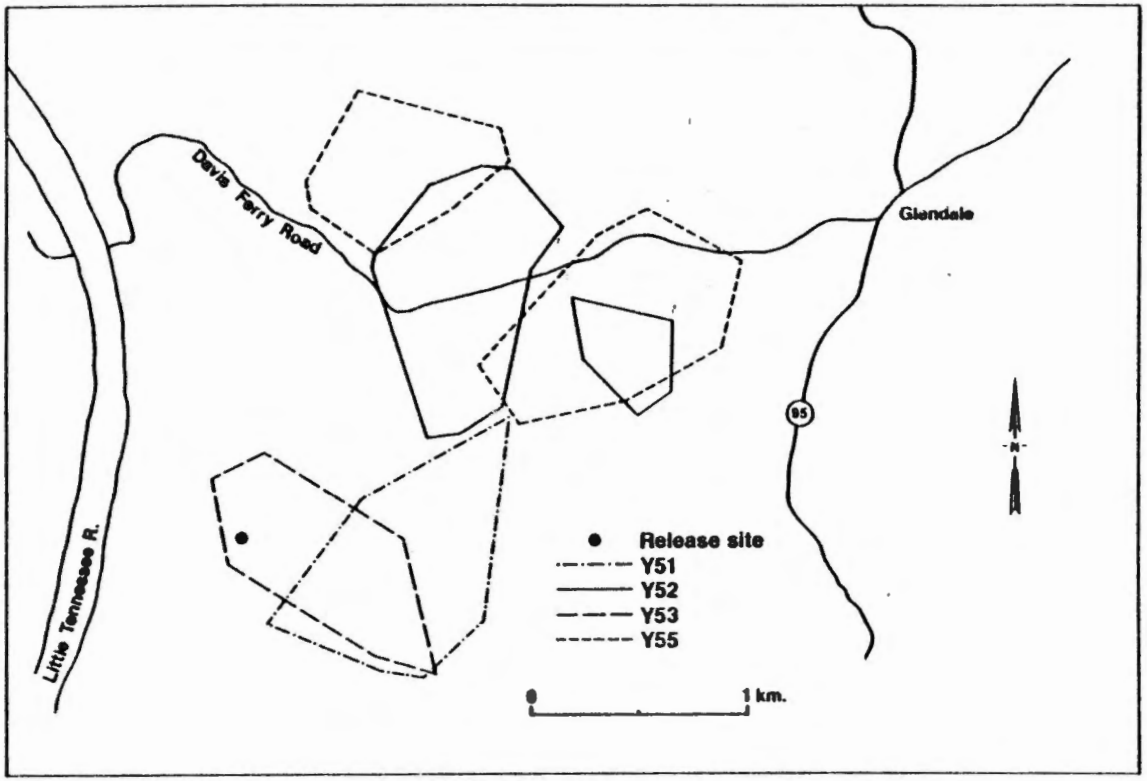


Figure 10. Home range overlap in convex polygon areas for West Tennessee raccoons released and radio-monitored in the Glendale-Little Tennessee River region, Loudon County, East Tennessee.

male home ranges did not come in contact with another raccoons range (male or female). Females alone had 5 (55.6%) of their home ranges overlapping with 2 other individuals, 2 (22.2%) overlapping with 1 other individual, and 1 (11.1%) overlapping with 4 other raccoon home areas. Only 1 female established a home range that did not cross another transplanted raccoon's home area. Differences in home range overlap between male and female raccoons were not significant.

Raccoons released in the Lotterdale Knob area established home ranges that had a significantly greater number overlapping than did raccoons released in the Alexander Knob area ($P > .02$) and in the Glendale-Little Tennessee River region ($P > .01$). Home ranges of raccoons released in the Lotterdale Knob area overlapped, on the average, with 3.4 other individuals, while raccoons released in the Alexander Knob and Glendale-Little Tennessee River areas overlapped with an average of 1.5 and 1.2 other individuals, respectively. There was no significant difference in home range overlap between individuals released in the Alexander Knob and Glendale-Little Tennessee River area.

Raccoons released in spring also established significantly more home ranges with overlap than did summer released ($P > .05$) and fall released ($P > .01$) raccoons. Those animals released during spring established home ranges that overlapped with a mean of 3.5 other raccoons, while home ranges of raccoons released in summer overlapped with an average of 1.5 other individuals and ranges of animals released in fall overlapped with a mean of 1.0 other animals. There was no significant difference in the number of home ranges that overlapped between raccoons released in summer and fall. Sample size

deficiencies prevented the inclusion of home range overlap of raccoons released during winter in statistical analysis.

Raccoons of age class I established a significantly greater ($P > .05$) number of home ranges overlapping other individuals than did raccoons of age class III and older. Raccoons of age class I had home ranges that encountered an average of 3 other individuals while those animals of age class II overlapped with a mean of 2.29 other raccoons, and animals in age class III and older had home ranges crossing an average of 1.0 other individuals. There was no significant variation in the number of overlapping home ranges established between raccoons in age classes I and II, or II and III and older.

Comparison of Methods of Home Range Estimation

Home range estimates for the 14 transplanted raccoons were calculated by 3 techniques; minimal polygon method, convex (maximum) polygon method, and a bivariate home range model (ellipse method). The ellipse method calculated home range size at different confidence intervals; 95%, 90%, 75%, and 50%.

The home range areas predicted by the 95% confidence interval ellipse area were significantly greater ($P > .01$) than all other estimates (Table 4). Elliptical areas calculated at the 90% confidence interval were significantly greater ($P > .05$) than the 75 and 50% confidence interval ellipse, minimal polygon, and the maximum polygon estimates. The 75% confidence interval ellipse home ranges were significantly greater ($P > .01$) than the 50% confidence interval areas, and minimal polygon estimates. Maximum polygon home range estimates were significantly greater ($P > .001$) than the minimal polygon estimates.

TABLE 4. Statistical rank of mean home ranges of 14 translocated raccoons as calculated by 6 methods of home range estimation.

	95% Confidence interval ellipse	90% Confidence interval ellipse	Convex Polygon	75% Confidence interval ellipse	Minimal Polygon	50% Confidence interval/ellipse
Mean home range estimates (ha)	383.75	290.16	226.05	171.39	106.41	84.33
Range (ha)	26.04-1385.48	19.65-1051.51	18.92-765.65	11.62-624.80	8.06-398.74	5.69-308.53

The 50% confidence interval ellipse areas were significantly smaller ($P > .10$) than the minimal polygon home ranges.

There was a significant ($P > .05$) positive relationship between maximum polygon and 90% confidence ellipse areas ($r = .92$), and maximum polygon and 95% confidence ellipse estimates ($r = .91$). Minimal polygon home range estimates were positively correlated with the 90% confidence interval ellipse ($r = .90$) and 95% confidence interval ellipse ($r = .89$) areas.

Home Range Dimensions

Home range dimensions, as calculated from maximum polygon estimates, ranged from 600.9 to 4326.1 m in length (mean = 2185.7 m) and from 384.5 to 2811.9 m in width (mean = 1156.3 m) (Table 5). The average length dimension for males was significantly larger ($P > .01$) than that for females. Males average home range width measurements were also significantly greater ($P > .02$) than that recorded for females.

Home range dimensions of those raccoons released in the Glendale-Little Tennessee River region were significantly smaller ($P > .001$) than those animals released in the Lotterdale Knob or Alexander Knob areas. There was no significant difference ($P > .10$) between home range dimensions of raccoons released in the Lotterdale Knob and Alexander Knob regions.

Home range dimensions of raccoons released during spring were significantly greater ($P > .10$) than those of raccoons released during fall, as were those recorded for raccoons released in summer, at $P > .01$.

TABLE 5. Mean home range dimensions for 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee.

Group	Sample sizes	Home range dimensions (m)[a] Length	Width
Sex			
Males	7	3035.1	1627.4
Females	11	1645.1	856.5
Release location			
Lotterdale Knob	5	2912.9	1629.5
Alexander Knob	6	2791.9	1430.0
Glendale-Little Tennessee River	7	1146.6	583.7
Release season			
Spring	5	2523.5	1499.7
Summer	6	2791.9	1430.0
Fall	5	1163.0	538.4
Winter	2	2078.8	1021.4

[a]Measured from convex polygon home range estimates.

There was no significant difference ($P > .10$) between home range dimensions of raccoons released in spring and summer. Home range length and width dimensions for raccoons released in winter were not included in statistical analysis because of small sample size.

24-Hour Movements

Minimum 24-hour movements were recorded for 14 raccoons (5 males, 9 females) during all seasons of the year (Table 17, Appendix). Average minimum distance moved during a 24-hour period was 554.71 m for all raccoons. Males alone averaged 920.7 m during a 24-hour period and traveled significantly farther ($P > .001$) than females whose minimum 24-hour movements averaged 351.4 m. There was no significant difference between minimum 24-hour movements of raccoons of different age classes, release sites, or release times.

However, minimum 24-hour movements for all raccoons during the adjustment period (1 month following release) were significantly larger ($P > .005$) than the 24-hour movements recorded for all raccoons during the post-adjustment period. During the adjustment period, minimum 24-hour movements for all raccoons averaged 632.1 m (males mean = 901.1 m, females mean = 591.7 m) while movements in the post-adjustment period averaged 554.7 m during a 24-hour period.

During the adjustment period alone, there was no significant difference ($P > .10$) in minimum 24-hour movements between raccoons of different sexes, release sites, or release times.

There was a significant correlation ($P > .05$, $r = .89$) between minimum 24-hour movements (adjustment period) and home range size as

determined by the elliptical home range model at the 95% confidence interval.

Dispersal

The average minimum dispersal from release site to home range boundary (as calculated by the convex polygon method) for the 17 radio-collared raccoons released in the study area was 1.32 km (range = 0.00 to 6.63 km) (Table 18, Appendix). Of the 17 animals, 3 did not survive long enough to establish a home range and their dispersal was measured from the release point to the location of the kill. These 3 raccoons had a mean minimum dispersal of 2.21 km over an average period of 5 days. The remaining 14 radio-monitored raccoons had an average dispersal of 1.46 km (median = 1.06 km) over a mean time of 6.9 days. There was no correlation between minimum dispersal distance and the number of days monitored or number of locations recorded.

Males minimum dispersal distances were statistically equal to those recorded for females (Table 6). There was no significant variation ($P > .10$) in minimum dispersal distances between raccoons released in the Lotterdale Knob, Alexander Knob, or Glendale-Little Tennessee River areas. There was also no significant variation in minimum dispersal distances between raccoons released during spring, summer, or fall. Minimum dispersal distances for animals released during winter were not included in the statistical analysis due to small sample size.

Variation in minimum dispersal distances for raccoons of different age classes was also not significant. Mean minimum dispersal distance for age class I raccoons was 0.72 km, 1.84 km for age class III and older raccoons.

TABLE 6. Mean dispersal characteristics of 17 West Tennessee raccoons equipped with radio transmitters and released in Blount and Loudon Counties, East Tennessee.

Group	Sample size	Minimum dispersal (km)	Maximum dispersal (km)
Sex			
Males	7	0.92	3.63
Females	11	1.78	3.15
Release location			
Lotterdale Knob	6	1.37	2.40
Alexander Knob	6	1.14	4.03
Glendale-Little Tennessee River	6	1.49	3.68
Release season			
Spring	4	0.61	2.84
Summer	6	1.14	4.03
Fall	5	1.93	3.92
Winter	3	2.58	1.69(n=2)

Dispersal directions for all radio-collared raccoons was significantly skewed ($P > .05$) toward the northeast (Table 18, Appendix). Dispersal directions for male raccoons alone however, proved random, while females alone were significantly skewed ($P > .05$) toward the northeast. There was no significant variation in dispersal directions between raccoons of different release sites, release seasons, or age classes.

The average linear maximum dispersal distance for the 14 radio-monitored raccoons, measured from the release site to the outermost location, was 3.32 km (range = 1.03 to 11.15 km) over a mean period of 140.2 days (range = 33 to 257 days). Males alone had an average maximum dispersal distance of 3.63 km which was not significantly different than that for females (mean = 3.15 km).

Maximum dispersal distance for raccoons released in the Lotterdale Knob, Alexander Knob, or Glendale-Little Tennessee River areas were statistically equal (Table 6).

No significant variation in maximum dispersal distances was found between raccoons released during spring or fall. Winter releases were again not included in statistical analysis due to small sample size.

Variations in maximum dispersal distances for different age class raccoons also showed no significance, with mean maximum dispersal distances of 2.20 km for age class I, 3.90 km for age class II, and 3.15 km for raccoons age class III and older.

Composite Movement

The mean minimum dispersal distance for ear-tagged (21) and

radio-monitored (17) raccoons released in the study area from 1975 to 1978 was 3.8 km over an average period of 293.8 days. Males alone had an average minimum dispersal distance of 5.3 km over a mean period of 227.8 days. Female dispersal distances were not significantly different from those of males and averaged 2.6 km over 344.7 days. There was also no significant difference in the number of days over which dispersal was monitored between males and females. There was no significant relationship between the number of days recorded and dispersal distance for all raccoons, males alone, or females alone. Dispersal directions for the 38 translocated raccoons proved random, as did directions for males and females alone.

III. ACTIVITY

Activity patterns of 17 translocated raccoons (6 males, 11 females) were monitored over a 21 month period beginning March 1977 and ending November 1978. Approximately 5000 radio-fixes, recorded during varying time intervals and diel tracking efforts, were used to analyze activity patterns. Raccoon activity was analyzed during 2 different time periods: an adjustment period of 30 days following the raccoon's release, and a post-adjustment period, which consisted of the remaining activity data.

Activity patterns for all raccoons during the adjustment period peaked during 2101 to 2400 hours EST, with 94% of the radio-fixes recorded in this time interval indiciating that the animal was active (Figure 11). The majority of activity occurred during the 6-hour interval 1801 to 2400 hours EST. Females were significantly ($P > .05$) more active than males in all time intervals during the adjustment

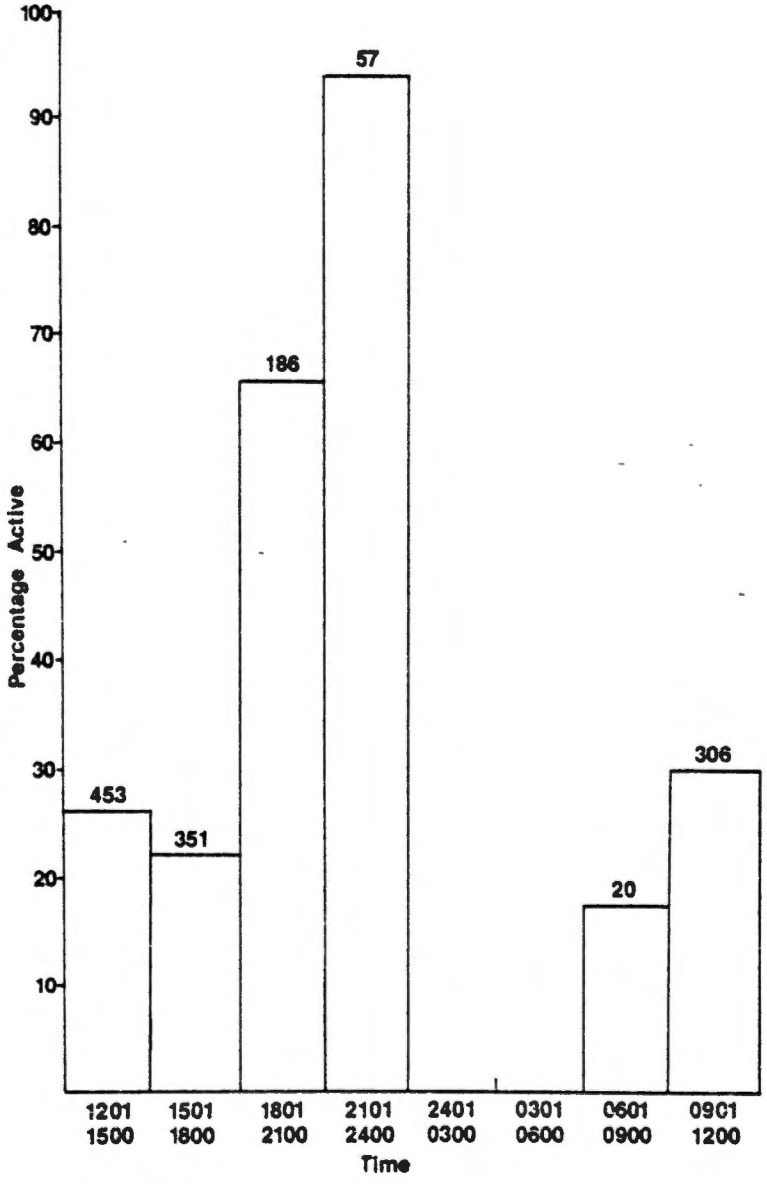


Figure 11. Activity patterns of 17 West Tennessee raccoons during a 30-day adjustment period following release in Blount and Loudon Counties, East Tennessee (values above bars indicate sample size).

period (Figure 12). Raccoon activity in the adjustment period was significantly higher ($P > .005$) during all time intervals for those raccoons released in the Alexander Knob region than for those animals released at Lotterdale Knob or Glendale-Little Tennessee River areas. Raccoons in age class II were significantly less active ($P > .005$) during a 24-hour period than raccoons in age classes I or III and older. However, there was no significiant difference in activity patterns between raccoons in age class I and III and older. Also, raccoons released in late fall were significantly more active ($P > .005$) during 24-hour periods in the adjustment period than raccoons released at any other time. Those animals released in spring were the least active.

In the post-adjustment period, after the raccoons had established a home range, activity peaked from 2101 to 0300 hours EST (Figure 13). The 3-hour periods 1801 to 2100 and 0301 to 0600 hours EST on either side of the activity peak were also significantly active times, with 57 and 61% of the radio-fixes active, respectively. The lowest percentage of activity occurred from 1201 to 1500 hours EST (11%), followed by 1501 to 1800 hours EST (14%) and 0901 to 1200 hours EST (16%).

During the post-adjustment period, males were significantly more active ($P > .005$) than females at all time intervals samples (Figure 14). Of the release sites, raccoons with home ranges in the Glendale-Little Tennessee River area were significantly less active ($P > .005$), especially during midday, than those raccoons with ranges in the Alexander Knob or Lotterdale Knob areas. Those raccoons in the Lotterdale Knob region were significantly more active ($P > .005$) during a 24-hour period than raccoons in other areas.

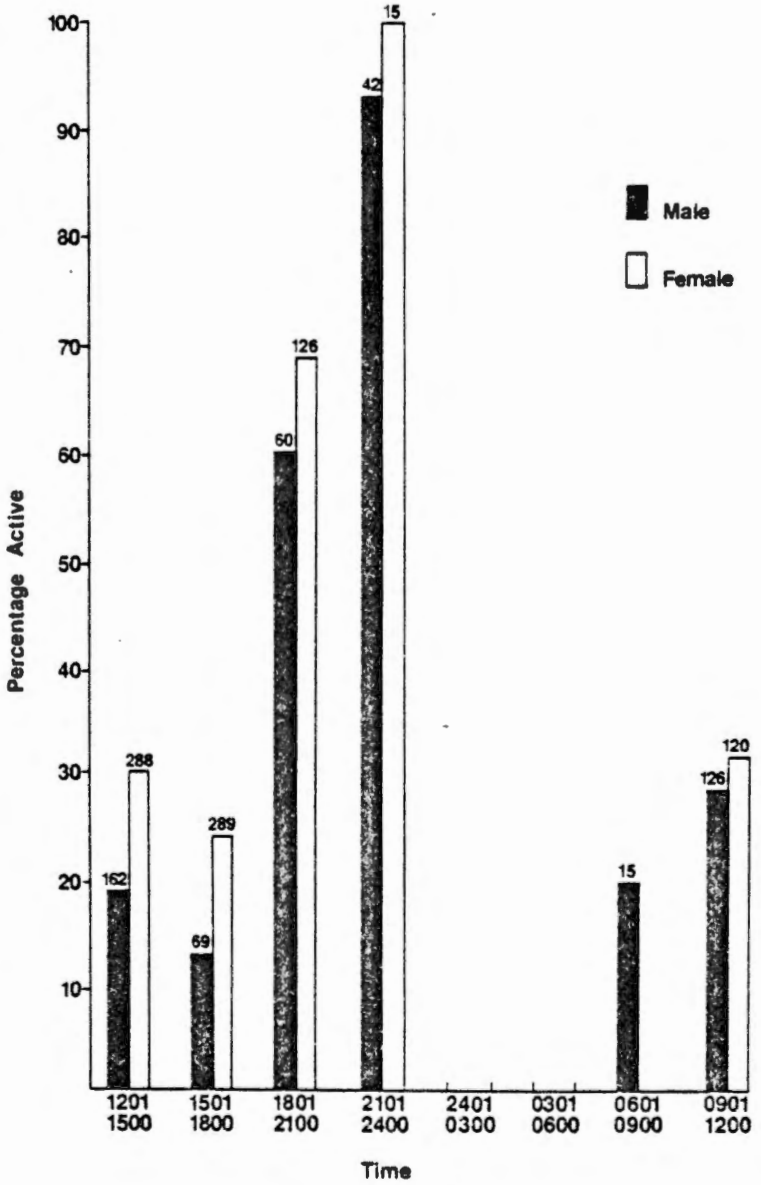


Figure 12. Male and female activity patterns of West Tennessee raccoons during a 30-day adjustment period following release in Blount and Loudon Counties, East Tennessee (values above bars indicate sample size).

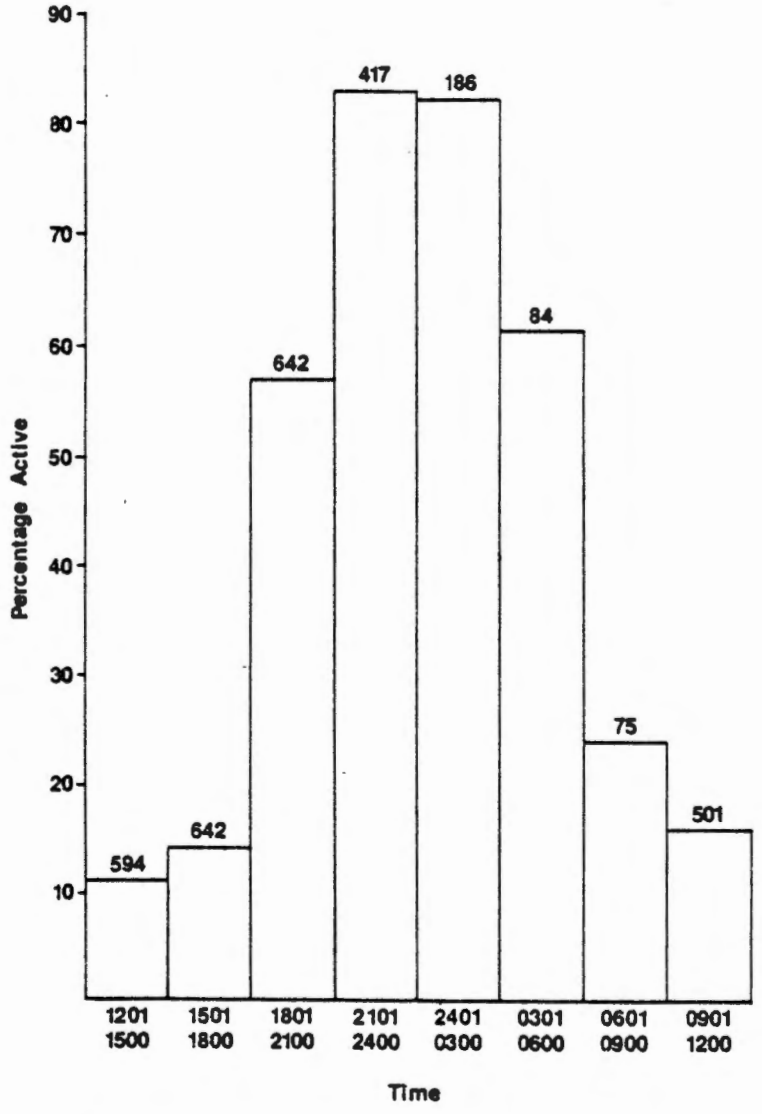


Figure 13. Activity patterns of 17 West Tennessee raccoons after 30 days adjustment to release areas in Blount and Loudon Counties, East Tennessee (values above bars indicate sample size).

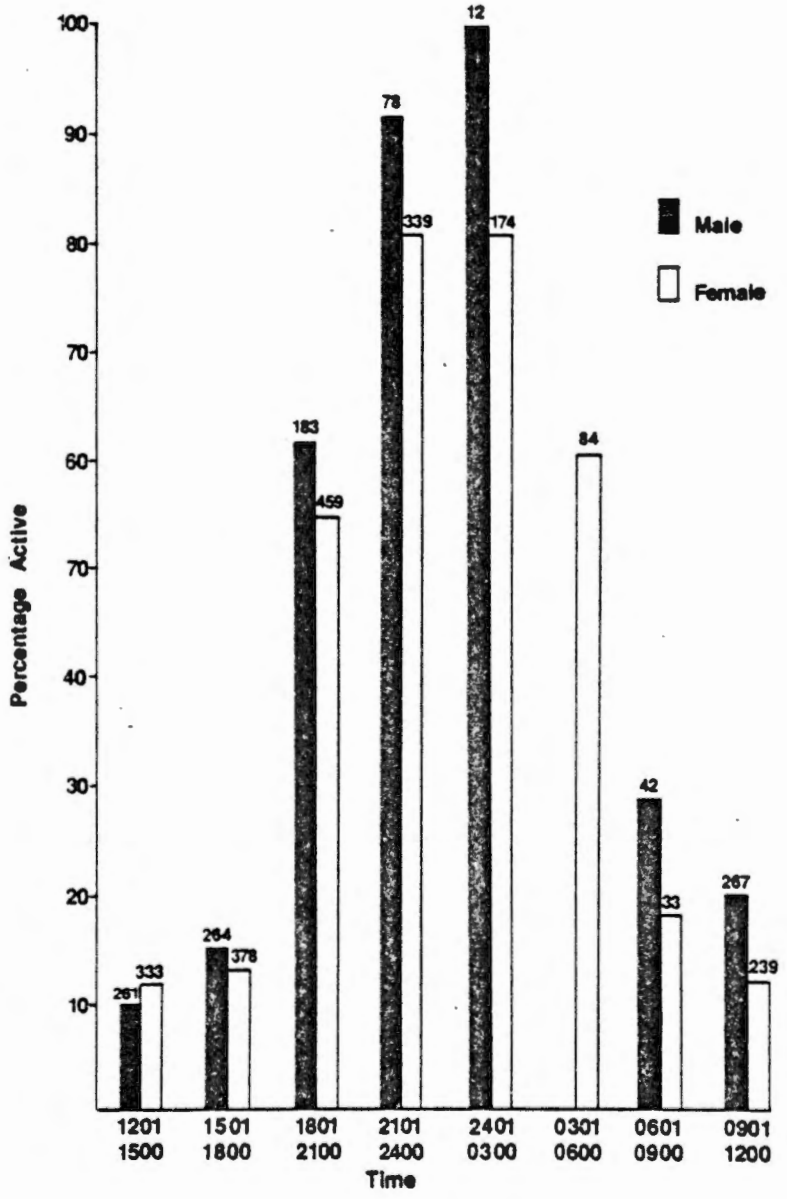


Figure 14. Male and female activity patterns of West Tennessee raccoons after 30 days adjustment to release areas in Blount and Loudon Counties, East Tennessee (values above bars indicate sample size).

In comparing activity patterns between adjustment and post-adjustment periods, all raccoons were significantly ($P > .005$) more active over a 24-hour period during the adjustment phase than they were during the post-adjustment phase. Female raccoons were also significantly ($P > .005$) more active at all time intervals sampled during the adjustment period. Activity patterns for male raccoons for adjustment and post-adjustment periods were also significantly ($P > .01$) different, mainly during midday. All age classes had significantly different ($P > .005$) activity patterns in the adjustment and post-adjustment phases.

IV. DENNING

During the 21 months the radio transmittered raccoons were monitored, 328 den sites or day beds were recorded. Of these 328 sites, 70% (228) were tree dens, 21% were ground dens, and 10% were gray squirrel (Sciurus caroliniensis) leaf nests (Figure 15).

Tree dens were most frequently recorded ($P > .005$) in white oak (25.9%), followed by black oak (19.7%), red oak (12.3%), and mockernut hickory (9.2%). Sycamore and eastern red cedar were the least frequently recorded, comprising only 2.6% each of the total tree den sites located.

Of the 68 ground dens recorded, 45.6% were rock dens, 39.7% were ground burrows, and 14.7% were located underneath tree stumps.

From the 328 den sites, 60 individual sites were measured for 6 parameters characterizing the den location (Table 18, Appendix). For the tree dens analyzed, 50 trees of 12 species were recorded, with

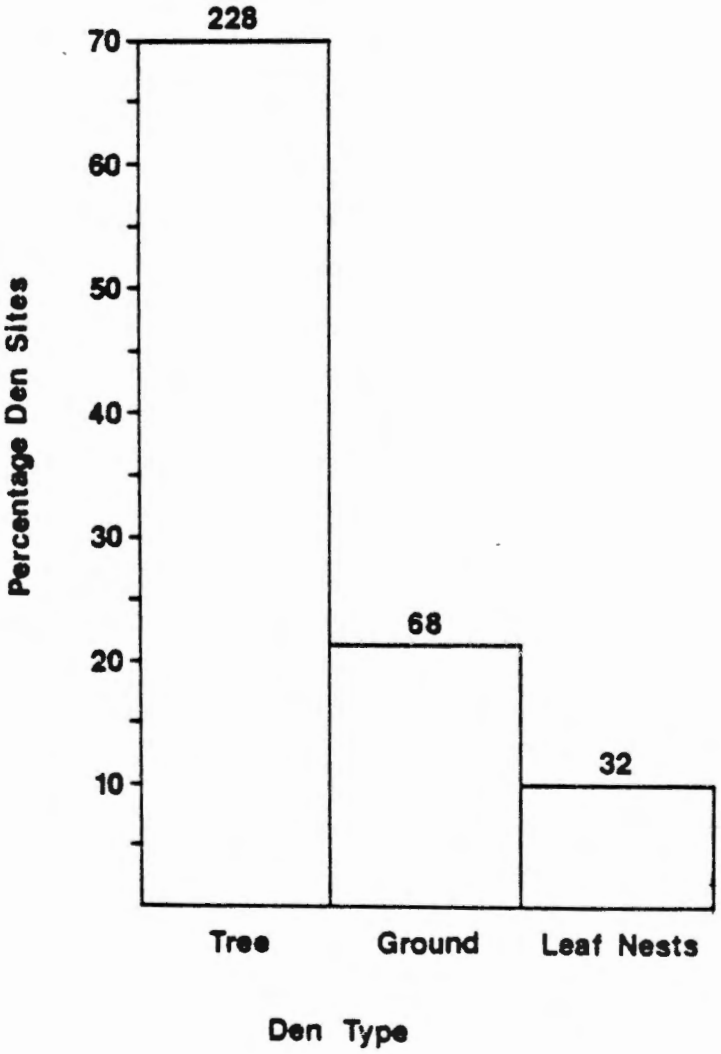


Figure 15. Frequency of 3 den types located by radio-telemetry for 17 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee (values above bars indicate sample size).

an average dbh of 57.6 cm (range 21 to 127 cm) and average height of 14.2 m (range 8 to 23 m). In addition to tree dens, 10 different ground dens were also investigated.

All den sites were located an average of 105 m from a water source, 260 m from an agricultural crop, and 603 m from a human inhabitance (Table 12, Appendix). A further breakdown of the distance from agricultural crops revealed that dens were located an average of 245 m from pasture and hay fields, and 274 m from corn and soybean fields.

The average linear distance between den sites for individual raccoons was 774 m. There was no significant relationship between the average distance between den locations and home range size as calculated by the elliptical, minimal polygon, or maximum polygon methods. The average linear distance between den sites for males was significantly larger ($P > .10$) than that for females (Table 7).

Raccoons in the Lotterdale Knob area had a mean distance between den sites that was significantly larger than those observed for animals in the Alexander Knob and Glendale-Little Tennessee River areas (Table 7).

The average linear distance moved between consecutive den sites for all raccoons was 623 m. The mean distance moved for males was significantly larger ($P > .10$) than the same distance moved for females (Table 7). There was a significant ($P > .05$), positive correlation between the average linear distance moved between consecutive dens and home range size as calculated by the elliptical model ($r = .96$ for home range estimates at the 95% confidence interval), maximum polygon method ($r = .96$), and by the minimal polygon method ($r = .98$). Raccoons in the Lotterdale Knob area had an average linear distance

TABLE 7. Average distances between den or daytime resting sites for 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee (based on 150 observations).

Group	Sample size	Mean distance between sites (m)	Mean distance between consecutive sites (m)
Sex			
Males	5	967	1041
Females	9	542	204
Release location			
Lotterdale Knob	5	1099	795
Alexander Knob	4	480	761
Glendale-Little Tennessee River	5	461	290
Release season			
Spring	4	1156	908
Summer	4	480	761
Fall	4	430	286
Winter	2	726	321

moved between consecutive den sites which was significantly larger ($P > .01$) than that reported for raccoons in the Glendale-Little Tennessee River area.

V. QUOTA HUNT

A total of 46 parties (average of 2 hunters per party) participated in the controlled hunt held in the study area on 3-4, 10-11 November 1978. Of these 46 hunting parties, 19 (41%) harvested 1 raccoon (Table 8). All hunting groups hunted a total of 115.5 hours, or an average of 2.51 hours hunted per party, with an average kill of 0.17 raccoons per hour. The successful hunting parties alone hunted an average of 2.49 hours per night, with a harvest of 0.40 raccoons per hour (Table 9).

The 19 raccoons killed included 3 class I males, 5 class II males, 1 class III male, 4 class I females, 5 class II females, and 1 class III female. The total kill by age class alone was comprised of 10 (53%) age class II animals, 7 (37%) age class I animals, and 2 (11%) age class III raccoons. The average weight of the harvested raccoons was 3.91 kg; other measurements are listed in the Appendix, Table 20.

Of the raccoons killed during the controlled hunt, 6 (32%) were ear-tagged animals that had been released in the study area. The tagged raccoons killed included 1 class II male, 1 class III male, 3 class II females, and 1 class III female. Non-tagged, "native" raccoons killed during the hunt consisted of 3 class I males, 4 class II males, 4 class I females, and 2 class II females.

In addition to kill data, hunters were asked to answer a short questionnaire. When asked if they had used the study area for dog

TABLE 8. Raccoon hunter success during an experimental hunt held in portions of Blount and Loudon Counties, Tennessee.

Hunt date	Number of hunting parties	Number successful	Percentage success	Number of hours hunted	Raccoon kill/hour
11-3-78	13	6	46	31.0	0.19
11-4-78	10	4	40	24.7	0.16
11-10-78	15	3	20	38.0	0.08
11-11-78	8	6	75	21.5	0.28
Total	46	19	41	115.2	0.17

TABLE 9. Kill statistics for successful raccoon hunters during an experimental hunt held in portions of Blount and Loudon Counties, Tennessee.

Hunt date	Number killed	Number of hours hunted	Kill/hour
11-3-78	6	12.7	0.47
11-4-78	4	11.0	0.36
11-10-78	3	6.5	0.46
11-11-78	6	17.0	0.35
Total	19	47.2	0.40

training purposes in the past 3 years, 72% of the hunters answered yes (Table 10). The average number of dogs used was 2.7 per hunting party. Hunters reported an average of 2 "strikes" per hunt, "treeing" an average of 0.26 opossums and 1.42 raccoons per hunt. Of the hunters surveyed, 52.6% hunted in the Alexander Knob area, 36.8% hunted in the Lotterdale Knob area, and 10.5% hunted in the Glendale-Little Tennessee River region.

VI. HABITAT UTILIZATION

Approximately 1500 radio-locations for 14 translocated raccoons monitored over a 21 month period were used to evaluate habitat utilization. Of the total radio-locations recorded, 71.4% were located in forest cover, 15.7% in edge habitat, 7.1% in abandoned or hay fields, 4.9% in agricultural row crop fields, and 0.9% were located in pasture lands. Also, 18.5% of these locations were within 50 m of a stream, river, or pond. Of the 4.9% of the locations recorded in row crop fields, 94.1% were located in corn fields and 6.3% in soybean fields (Table 21, Appendix).

Stream, river, or pond locations were divided into different types, depending upon their associated cover types, with 67.1% of the radio-locations recorded along water sources within forested habitats, 17.4% near water sources in edge habitat, and 1.6% along water associated with pasture situations.

Habitat utilization between male and female raccoons differed significantly ($P > .10$), with a higher percentage of animals located in non-forested habitats for females than for males which had 80.3% of their locations recorded in forested areas. Similarly, females utilized water

TABLE 10. Raccoon hunter response to questionnaires distributed during an experimental hunt held in portions of Blount and Loudon Counties, Tennessee.

Question	Response		
	Yes	No	Percent yes
Have you "hunted" in the study area in the past 3 years?	26	10	72
	Number	Number of parties	$\bar{X}$
How many dogs did you hunt with?	51	19	2.7
How many "strikes" did the dogs make?	38	19	2.0
How many raccoons did you "tree?"	27	19	1.4
How many opossums did you "tree?"	10	39	0.3
	Lotterdale Knob area	Alexander Knob area	Glendale-Little Tennessee River
What area did you hunt?	7 (36.8%)	10 (52.6%)	2 (10.5%)

sources associated with non-forested habitats at a significantly higher ($P > .005$) rate than did males (Table 22, Appendix).

There was also significant variation in habitat utilization between raccoons released in different areas. Those raccoons released in the Alexander Knob area had a significantly higher ($P > .005$) utilization of forested area than did raccoons released in the Glendale-Little Tennessee River and Lotterdale Knob areas. There was no significant difference in habitat utilization between raccoons released in the Glendale-Little Tennessee River and Lotterdale Knob regions. However, water sources associated with forest cover were utilized more commonly by raccoons released in the Lotterdale Knob region than by animals released in the Glendale-Little Tennessee River and Alexander Knob areas. Water sources with old-field habitats were used more commonly by raccoons released in the Alexander Knob region.

CHAPTER V

DISCUSSION

I. TAG RETURNS

In recent years, raccoon restoration projects in the Southeast have reported varying results, with tag return data primarily used to measure the success or failure of translocation efforts (Table 11). It must be noted however, that in all these investigations tagged raccoons were liberated in areas with unrestricted hunting during open seasons. Recoveries of tagged animals were largely dependent upon the cooperation of hunters harvesting tagged animals in reporting their kills to game and fish agencies. This dependence on voluntary tag returns by hunters probably does not yield a sufficiently large sample size with which to quantify success or failure of a stocking program (Stuewer 1943a). Wright (1977) stated that cooperation from county raccoon clubs and hunters in eastern Kentucky varied from excellent to poor, with only 2 counties falling within the excellent category. He further stated that 41% of all raccoon releases were made in these counties and that 86% of all tag returns were reported from these same areas. Of the 1368 raccoons released in other areas, only 0.5% were reported harvested by hunters over a 2-year period even though an extensive public relations campaign was conducted to inform hunters of the importance of reporting kills of tagged raccoons.

Clements (1972) reported that 25% of 40 tag recoveries were from non-hunting mortality over a 1 year period. These recoveries represented

TABLE 11. Tag returns reported for raccoons released in unfamiliar territory.

Researcher	Origin of raccoons	Area of release	Number released	Numbers recovered	(percentage)	Time interval
Giles (1943)	Southeast Arkansas	Arkansas	256	19	(7.4)	59 days
Stuewer (1943a)	pen-reared	Michigan	70	34	(47.1)	2 years
Kellner (1954)	East Virginia	Southwest Virginia	101	2	(1.9)	12 hunting seasons
Nelson (1955)	South Carolina Coastal Plain	South Carolina Piedmont	789	14	(1.8)	4 hunting seasons
Johnson (1970)	Alabama	Alabama	178	3	(1.7)	6 hunting seasons
Clements (1972)	East Virginia	Southwest Virginia	186	40	(21.5)	1 hunting season
Frampton (1974)	South Carolina	South Carolina	103	14	(13.6)	$\bar{X}$ = 203 days
Wright (1977)	Ohio	East Kentucky	52	0	0	2 years
Wright (1977)	South Florida	East Kentucky	1750	13	(0.7)	2 years
Wright (1977)	East Virginia	East Kentucky	307	17	(5.5)	2 years
Wright (1977)	West Kentucky	East Kentucky	125	11	(8.8)	2 years
Wright (1977)	Texas	East Kentucky	76	1	(1.3)	2 years
Wright (1977)	Total	East Kentucky	2310	42	(1.8)	2 years
Taylor (1979)	West Tennessee	East Tennessee	286	29	(10.1)	$\bar{X}$ = 344 days

only 5.4% of all tagged raccoons. Wright (1977) reported an additional 37 tag returns from non-hunting mortality. He also stated that of 1925 raccoon hunters checked by Conservation Officers during dog training season, 36% were found in violation of game laws, and of these 78% involved illegal acts such as carrying a firearm or other implement which could have resulted in the illegal harvest of raccoons. It seems highly unlikely that any tagged raccoons illegally killed would be reported by the poacher to a fish and game agency.

During this investigation, the release of translocated raccoons was not intended to provide immediate hunting in the study area. The majority of the past translocation studies were primarily designed to measure the effectiveness of raccoon stocking programs as implemented by local raccoon hunting clubs. In terms of additional input into hunter harvest, these studies sufficiently proved that these local stocking efforts did little to improve raccoon populations or hunting. It was the intent of this translocation effort to restore a huntable population in an area of drastically low raccoon density, not promote "put-and-take" raccoon management. Warr (1978) after 3,928 trap nights effort, stated that raccoon densities in Blount and Loudon Counties were low, so low in fact that a reliable estimate of the population size was impossible. As in any other restoration program such as wild turkey (Meleagris gallopavo) or white-tailed deer (Odocoileus virginianus), the hunting season was closed in the study area to allow the few resident animals to increase and to decrease mortality of stocked individuals, allowing them to settle in the area and hopefully to provide additional input into the total raccoon population through reproduction. Tag returns in this study therefore, were considered as

indicators of survival rather than a measure of the effectiveness of stocking in increasing hunter kill. The 10.1% tag recovery reported for this study was still higher than those reported for most other investigations except for Clements (1972), and Stuewer (1943a) who used pen-reared raccoons.

The average number of days to recovery indicated that raccoons released in 1975 had survived through at least 1 breeding season and had the opportunity to contribute to the total population increment. In addition, the tagged animals recovered during the 4-night controlled hunt had survived an average of 597 days within the study area. Of 16 translocated female raccoons recovered, 11 (56.2%) were in the study area for at least one breeding season; 7 (63.6%) had apparently given birth to offspring. Using mean litter size as determined by Woods (1978) for eastern Tennessee (2.8), then these 7 females could have added 18 raccoons to the population, and if 56.2% of all females released in the study area survived through 1 breeding season with 63.6% successfully reproducing, then the potential addition to the study area population was approximately 138 animals. However, of these 138 raccoons, it is possible that 57 (41.4%) would be illegally killed before they reached sexual maturity.

II. PHYSICAL CHANGE

Changes in the physical condition of raccoons between release and recovery periods has been used in previous translocation efforts as an indicator of the animal's success in adapting to unfamiliar environments. Weight gains exhibited by the translocated West Tennessee raccoons

in this investigation indicated that they had adjusted to the eastern Tennessee habitat types. If the translocation process was detrimental to the health of these raccoons, it seems likely that a larger percentage of the animals would have been recovered in a more debilitated condition. Frampton (1974) in South Carolina, reported an overall weight gain of 28.3% (mean = 1.30 kg) over an average period of 148 days for Coastal Plain raccoons released in the Piedmont region. Nettles and Martin (1978) stated that the generally poor condition of raccoons released by hunter clubs was possibly a factor contributing to the low survivorship reported by other translocation studies. They further stated that the physical condition of raccoons live-trapped by game biologists and released in unfamiliar habitats were in significantly better condition than those animals purchased by hunter clubs and were thus better suited to adjust to new areas. It seems that this was the case with raccoons released in this study. Their better physical condition at the time of release may account for the higher survival, fecundity, and weight gains than those reported for other raccoon stocking projects.

III. DISPERSAL

Dispersal from release sites has been used to measure the effectiveness of raccoon restoration programs. As with recovery rates, reported dispersal distances vary among investigations (Table 12). The minimal dispersal of raccoons from release sites reported by this study can only be indicative of a successful stocking attempt. While dispersal distances for radio-monitored raccoons were most accurate,

TABLE 12. Dispersal distances from release sites reported for raccoons translocated to unfamiliar areas.

Researcher	Sample size	Time interval	Average minimum dispersal (km)	Range (km)
Giles (1943)	19	1 hunting season	25.6	3.2-120.7
Stuewer (1943a)	27	2 years	4.0	0 - 9.7
McLaughlin (1953)	4	1 hunting season	4.6	3.2- 5.6
Kellner (1954)	2	12 hunting seasons	22.9	12.1- 33.8
Nelson (1955)	12	4 hunting seasons	64.9	32.2-289.6
Johnson (1970)	1	2 years	4.8	--
Clements (1972)	40	1 hunting season	4.0	1.0- 28.9
Frampton (1974)	61	23 hunting seasons	37.3	2.5-259
Wright (1977)	53	2 hunting seasons	12.4	0.8- 32.4
Taylor (1979)	38	$\overline{X}$ = 294 days	3.8	0.0- 37.1

distances determined from tag returns covered a much longer time span. However, it should not be assumed that dispersal distances increased over time, since no significant relationship existed between the number of days to recovery or the number of days monitored and dispersal distances. This was also reported by Frampton (1974) and Nelson (1955).

Frampton (1974) and Wright (1977) both stated that the movements of released raccoons may depend upon the similarity between the original habitat and the release habitat. Dispersal distances for raccoons taken from coastal marshes such as south Florida, then released in woodland habitat, exhibited greater dispersal from release areas, apparently wandering in search of familiar food items (Giles 1943, Kellner 1953, Frampton and Webb 1973, and Wright 1977).

Dispersal distances were not significantly different between males and females as also reported by Frampton (1974) and Wright (1977). Giles (1943) stated that males wandered farther than females but these differences were not tested statistically. In any case, dispersal distances of the translocated West Tennessee raccoon indicated that average movements away from actual release sites were negligible and movements out of the immediate release area were essentially non-existent. Nine of the 14 transmittered raccoons established home ranges that encompassed the release site and 3 ear-tagged raccoons were recovered a maximum of 2.16 km from their release site after a period of over 3 years in the field.

In regard to these data, it must be concluded that on the average, the translocated animals remained near enough to release sites and for sufficiently long enough periods to be considered as resident animals,

contributing to the overall density and distribution of raccoons in the study area.

Dispersal direction for recovered, ear-tagged raccoons was random, however, radio-monitored female raccoons exhibited a tendency to disperse in a northeasterly direction. This deviation from the random dispersal found for all raccoons was more a result of the release location than a "homing" type instinct (Frampton 1974). Three of the 5 females dispersing in a northeasterly direction were all released at the Alexander Knob site in the Red Knobs ridge system. This system and it's stream courses are also oriented in a northeast-southwest direction. The northeasterly dispersal of the 3 females released in this area stemmed from their movements following the streams and ridge progressions (Giles 1943). When included with dispersal direction of tag returns and radio-monitored males, dispersal directions became randomly distributed, as also reported by Giles (1943), Frampton (1974), and Wright (1977).

IV. COMPARISON OF METHODS OF HOME RANGE ESTIMATION

The 3 methods of home range estimation represented 2 types of area evaluation: graphical (convex and minimal polygon methods), and probabilistic (ellipse). The 3 methods produced somewhat varying home range sizes, but each method also varied in purpose, estimating technique, and basic assumptions.

Since by design, the minimal polygon method projects the area actually utilized by raccoons during radio monitoring efforts, these estimates were naturally the smallest, averaging 106.41 ha for all raccoons. But this area could not be representative of the animal's

total range unless locations were continuously recorded during the entire tracking period. Nonetheless, this estimate, partly because of the large sample sizes ($\bar{X}$ number of locations per raccoon = 104.6), was a satisfactory measure of the minimum amount of area required to support raccoons released in habitat types as found within the study area during all seasons. This minimum land estimate is probably applicable to other areas in eastern Tennessee since the study area was selected as typical of much of the rural sections in the eastern part of the state. In comparison with the probabilistic home range estimates, the minimal polygon home ranges were areas in which one would only have from 50 to 75% probability of locating the translocated raccoon at any given time.

The convex or maximum polygon estimates projected a significantly larger area ($\bar{X}$ = 226.05 ha) which contained areas and habitats that the raccoons were assumed, by the investigator, to have utilized during the tracking period, based on the position and frequency of known locations. Again because of the large number of locations and days monitored, this 226.05 ha area would seem a satisfactory estimate of the area utilized by translocated West Tennessee raccoons in the study area. Also, this estimate was nearly equal to the mean home range (238.77 ha) calculated from all 3 methods. Based on the elliptical estimates, the average convex polygon home range encompassed from 75 to 90% of the area in which the translocated raccoons could be found.

Not only does the convex polygon method include the known, or minimal area utilized, but it also incorporates habitat most likely utilized but not documented in the sample size. However, this method

is most subject to biases interjected by the investigator who may wrongly assume that an animal never utilized a certain area because sampling techniques failed to disclose the particular location. Some researchers also discard sample locations when using the convex polygon method. Ables (1969) describes this as an "atypical habitat elimination" technique and speculated that more realistic home range estimates resulted from the subjective appraisal by the researcher. While this may or may not be true, the technique, as a comparative method, leaves much to be desired.

The probabilistic, bivariate home range model, or elliptical model, assumes that the position of each radio-location was a random, non-biased sample of an animals' use of its total range. Unlike the preceding graphical methods, the elliptical model was not primarily based on a small percentage of locations scattered around the periphery of the animals' range and no subjective considerations concerning "probable use" areas are required of the investigator (Jennrich and Turner 1969, Koeppl et al. 1975). Marcus and Madden (1978) also stated that by using the elliptical model estimates, an area could be projected within which one would have to search in order to have $1-\alpha$ probability of finding the animal (in this study, 95, 90, 75, and 50%).

One problem with this method however, stems from the assumption that an animals' use of its home range will be represented by a normal distribution, i.e., animals are presumed to show maximum use of a central area and proportionately less use of their travel ranges beyond these central areas. Koeppl et al. (1975) realized this problem and through examination of the skewness and kurtosis of the locational

scatter, gave a statistical test for determining the severity of deviation from a normal distribution. This allows interpretation of the elliptical model as an over/underestimator of home range sizes. The interpretations of the skewness and kurtosis for the estimated home ranges of the 14 translocated raccoons are given in the Appendix, Table 23.

The home range sizes projected by the elliptical model at the 95% confidence interval were generally the largest of the estimates. However, in 4 cases the convex polygon home range exceeded the elliptical estimate, primarily due to an unusual concentration of locations in and around den sites. Nonetheless, the average area required to locate 1 of the translocated raccoons with probability of 95 and 90% would be 383.75 and 290.16 ha, respectively. It is also possible to state, with 95 and 90% certainty, that the translocated raccoons released in the study area remained in areas averaging 383.75 and 290.16 ha, respectively.

Although White (1978) stated that the elliptical method did not seem to accurately project the home ranges of translocated ruffed grouse (Bonasa umbellus) in Tennessee, the method was considered useful in this translocation attempt in that confidence limits could be applied to areas estimated as raccoon home ranges. In light of the reported failures of past raccoon relocation efforts, it was increasingly important to be able to predict an area in which stocked animals could be located at any given time with 95% certainty. This method also provides future investigators with home range estimates calculated without the potential biases present in graphical methods.

V. HOME RANGE

Early investigations relied on tag returns from hunter kills to determine movements of stocked animals. With the advent of radio telemetry, additional detail and locations were added to movement information. However, frequent equipment failure often aborted attempts at determining home range size for transplanted raccoons. Clements (1972) was able to monitor 9 stocked raccoons in southwest Virginia for an average of only 13 days (range = 1 to 80 days) and was unable to estimate home range size. Although Frampton (1974) followed 12 Coastal Plain raccoons released in the Piedmont Region of South Carolina for an average of 35 days, and recorded a mean of 29.3 locations per animal, he did not attempt to calculate home range size. Likewise, Wright (1977) in eastern Kentucky monitored 12 translocated south Florida raccoons over an average of 65 days and did not report any home range estimates. This investigation is the first to report home range size for translocated raccoons, and therefore it was not possible to compare these results with restocking efforts in other areas.

In comparison with home range estimates for "resident" or "native" raccoons, the home ranges of translocated West Tennessee raccoons were not significantly different than home ranges reported for the native raccoons in the study area. Hardy (1979) reported that home range sizes for native raccoons in the Red Knobs ridge system that averaged 427 ha (95% ellipse) and 214.7 ha (convex polygon). Allsbrooks (unpublished data) radio-monitored raccoons on the Meeman-Shelby Forest trapping area, and reported mean home ranges of 18.63 for all raccoons, 20.83 ha for males, and 15.70 ha for females. These home ranges were

significantly smaller ($P > .01$) than those established by raccoons trapped from the area and released in the study area. They were also significantly smaller than home ranges reported for resident animals on the study area. It appears that the differences in home range size between West Tennessee raccoons and East Tennessee animals can be attributed to better quality habitat and higher population densities found in West Tennessee. Ellis (1964) found that in areas with quality habitat and high population density, raccoons move less and occupy smaller home ranges. Work done by Keeler (1978) in the Great Smoky Mountains National Park (GSMNP) further suggests that the statement by Ellis (1964) may hold for Tennessee raccoon populations. From trapping data, Keeler (1978) calculated home ranges averaging 31.0 ha for males and 11.3 ha for females; densities in the Cades Cove area of the GSMNP were reported at 1 raccoon per 17.5 ha as compared with 1 raccoon per 2.93 ha in West Tennessee (Allsbrooks unpublished data).

However, the home ranges reported for the Meeman-Shelby Forest raccoons do not appear directly comparable to estimates for the translocated animals. Locations used to calculate home range size for the West Tennessee raccoons were obtained through a different sampling scheme than was utilized in this study. Researchers on the Meeman-Shelby Forest area obtained locations during "diel-like" tracking efforts spaced at week or more intervals, whereas locations in this study were taken on consecutive days during the life of the raccoon and/or transmitter in addition to diel tracking. Garshelis (1978), in working with black bears (Ursus americanus) in the GSMNP, found that intensive radiotracking on a yearly basis gave more accurate home range estimates than

did several years of seasonal or intermittent tracking. Also, home range estimates for this investigation were generally based on a larger number of locations than those reported for the Shelby Forest raccoons. Therefore, the home ranges found by Allsbrooks (unpublished data) seem unrealistically small, and may not give a true representation of actual home range size.

Johnson (1970), working in an Alabama river-swamp habitat, reported a mean home range size of 64.9 ha for 2 males and 1 female monitored over an average period of approximately 100 days. He further stated that the raccoons in east-central Alabama appeared to have small, shifting centers of activity, probably related to food supply, with much larger home range areas consisting of these activity centers. Recording locations intensively over a short term basis may reveal only a few of these small activity centers, resulting in home range estimates that do not reflect the actual area within which raccoons may be familiar. This appeared to be the case with some of the home ranges reported by Allsbrooks (unpublished data) since he estimated mean winter ranges for females at 0.29 ha (95% ellipse).

Whatever the case, the fact that, following their release into the study area, the translocated raccoons established home ranges essentially equal to those reported for resident raccoons in the same area, indicated that they were sufficiently able to adjust to the new habitat and become part of the total raccoon population. Similar results have been reported for raccoon translocation efforts outside the United States. In the Eastern Hemisphere, Aliev and Sanderson (1966) and Redford (1962), reported that from 1243 raccoons released during 1936-1958 at 26 different

locations, raccoon populations increased to an estimated 40,000 to 50,000 in the U.S.S.R. and from 4,000 to 5,000 in the Federal Republic of Germany. In another introduction effort, 8 raccoons were released in 1941 on Singa Island, Alaska, and as of February 1947, 32 raccoons, supposedly the progeny of the initial stocking attempt, had been trapped on Singa Island and the adjacent El Capital Island (Scheffer 1947).

Area estimates for both translocated and resident animals in the study area were considerably larger than those reported by most investigators. Hayne (1949) stated that home range was subject to many physical and biological factors. Variations in these areas may be expected between raccoons of different sexes, age classes, population densities, and habitat types (Stuewer 1943a, Ellis 1964, and Geis 1966). It must also be noted that some variation in home range sizes can be expected, since the accuracy of these measurements largely depends upon the number of locations per animal over time, the precision of the technique employed to obtain the locations, and the method of analyzing the collected data (Frampton 1974). Unfortunately, no single method of determining home range measurements for raccoon, or mammals in general, has been universally accepted and employed, making most comparative attempts impossible.

Utilizing ear-tag and toe-clip techniques to obtain raccoon movement data Stuewer (1943a) reported home ranges of 203.7 ha for adult males, 108.5 ha for adult females and juvenile males, and 43.0 ha for juvenile females. These areas were represented by circles calculated from the maximum distances between observations or capture points.

Using an automatic tracking system, Sunquist (1967) monitored an adult female and 3 yearling for 8 days on the Cedar Creek Natural History Area in Minnesota. He reported home ranges from 64 to 95.6 ha, while Schnell (1970) stated that home ranges for Minnesota raccoons varied from 153.1 to 477.1 ha ($\bar{X}$ = 307.8 ha) during April thru November. Schneider et al. (1971), also working in Minnesota determined circular home ranges for 5 adults and 11 juveniles averaging 3.2 km in diameter. Ellis (1964) monitored 7 raccoons in Illinois for period of up to 18 days, and reported average home ranges of 54.7 ha and 68.1 ha. Urban (1970) monitored 9 raccoons over an average period of 3 months in fall and spring and reported mean home range size of 49 ha. He also stated that home range size varied between raccoons of different sex and age classes. Lehman (1977) found mean home ranges of 11.06 ha for adult females, 57.65 ha for adult males, 6.21 ha for yearling females, 6.08 ha for yearling males, 4.64 ha for juvenile females, and 5.69 ha for juvenile males in a waterfowl marsh in Indiana. These home ranges were derived for 61 raccoons trapped at 4 or more locations over a 5-year period. He also reported home ranges from telemetry data, which varied from 11.74 ha to 27.94 ha for an adult male, 2 adult females, a yearling female, and a juvenile female. However, these ranges were computed from 672 locations recorded over a total of 49 nights ($\bar{X}$ = 4.9 tracking nights per raccoon). In a prairie pothole waterfowl area, Fritzell (1978) reported a mean home range size of 2560 ha for 9 adult males, 1139 ha for yearling males, 806 ha for 7 pregnant females, and 656 ha for 8 yearling females. These minimum area estimates (Mohr 1947) were calculated from 5739 locations recorded during April-July 1973 through

1975. In an urban situation, raccoons were found to have a mean home range of 8.3 ha (Cauley and Schinner 1973).

Home Range Dimensions

Home range dimensions for the 14 translocated raccoons averaged 2.2 km in length and 1.2 km in width, with home range dimensions of males significantly larger than those for females. Stuewer (1943a) reported mean home range dimensions of 1.6, 1.1, 1.1, and 0.8 km for adult males, adult females, juvenile males, and juvenile females, respectively. Butterfield (1944) recaptured 91 raccoons over a 2 year period in Ohio and stated that movements within a home range did not exceed 0.4 km. Leuth (1962) in Alabama found that the distance between recapture sites of 448 raccoons averaged 1.3 km with a maximum distance of 8.2 km. Johnson (1970) reported these same distances averaged 1.27 km in Alabama. Schneider et al. (1971) determined the spring and fall movements of raccoons in Minnesota and found average home range diameters of 3.2 km for 5 adults and 11 juveniles. Cunningham (1962) reported an average distance between extreme capture locations of 0.48 km for males and 0.34 km for female raccoons. In Tennessee, Woods (1978) found an average distance between capture sites of 0.84 km for juvenile males, 0.68 km for juvenile females, 1.22 km for adult males, and 1.00 km for adult females on the Chuck Swan Wildlife Management Area. Hardy (1979) stated that home range lengths for resident raccoon in the study area averaged 2.5 km for males and 1.9 km for females. These distances were not significantly different than those reported for the introduced West Tennessee raccoons. It appears that home range dimensions were

merely reflections of the actual home range area and were therefore subject to variations influencing home range size.

Home Range Overlap

Home ranges of the translocated raccoons exhibited considerable overlap. Only 2 (14.3%) of the released raccoons established home ranges that did not encounter at least 1 other radio-monitored range. It was possible that these 2 home ranges overlapped with ear tagged or resident raccoons however. Translocated raccoons released in the Red Knobs section of the study area occupied areas known to contain resident raccoons but the 2 "cohorts" were not monitored at the same time periods.

Hardy (1979) also reported extensive overlap of radio monitored resident raccoons in the Blount and Loudon County study area. Stuewer (1943a) and Geis (1966) stated that there was no indication of territoriality between male, female, or juvenile raccons and suggested that the animals had considerable overlap in their ranges. Mech et al. (1966) also reported extensive overlap occurring in daytime resting areas but postulated a minimum spacing distance between resting sites of 122 m. Johnson (1970) observed considerable overlapping of home ranges with no regard to sex or age classes. He further stated that even though raccoons were concentrated around food sources in winter, no territoriality as such existed, but small "feeding territories" (Tevis 1947) were defended, primarily by adult males.

In this investigation it appeared that home range overlap was an indication of food source availability and distribution. In the limited raccoon habitat found in the study area, the translocated

raccoons were forced to occupy feeding areas with other individuals or move into less desirable habitats.

VI. TWENTY-FOUR HOUR MOVEMENTS

As with home range information, 24-hour movements have not previously been reported for translocated raccoons. Minimum 24-hour movements obtained during this study exhibited significant variation between sexes and adjustment/post-adjustment periods. Frampton (1974) stated that stocked raccoons remained relatively close to the release site for several days, but he did not report actual 24-hour movements. Stuewer (1943a) reported approximately the same results for pen-raised raccoons released in Michigan. On the other hand, Giles (1943), Butterfield (1944), Nelson (1955), and Johnson (1970) stated that translocated raccoons normally traveled great distances following release in unfamiliar territory.

Since in this study the translocated raccoons remained within the study area and successfully established home ranges, it seems that the increased travel during the adjustment period reflected exploratory movements for food sources and refuge sites. Once these items were located within the animals' home range, it was no longer necessary for the raccoons to continuously make extended trips in and around the release areas. During longer nightly forages in the adjustment period, raccoons became more vulnerable to dog training and illegal hunting activities. Greater mobility has been cited as a significant factor determining the harvest of raccoons by sex and age groups (Stuewer 1943a, Johnson 1970, and Woods 1978).

The longer movements by males during the post-adjustment period were reflected in the larger home range sizes for males. Hardy (1979) reported average 24-hour movements of native raccoons in the study area of 655.6 m for all raccoons, 756.4 m for males, and 557.4 m for females. Greater mobility by males has been documented by many investigators (Stuewer 1943a, Ellis 1964, Geis 1966, Johnson 1970, and Schneider et al 1971).

VII. COMPARISON OF RELEASE SITES

Translocated raccoons released at 3 different locations within the study area exhibited significant variations in several movement-behavioral parameters. While minimum and maximum dispersal distances, dispersal directions, and 24-hour movements did not vary between release sites, there were significant differences in home range size (as calculated by all 3 methods), home range dimensions, distances between dens, distances moved between consecutive dens, activity patterns, and habitat utilization. In all comparisons among release sites, there were no significant differences in sample sizes, i.e., number of locations, and number of days monitored.

Raccoons released in the Alexander Knob and Lotterdale Knob area established larger home ranges and were generally more active, especially during midday, than those raccoons released in the Glendale-Little Tennessee River area. Animals released in the Lotterdale Knob area established home ranges with significantly more overlap, had a larger average distance between den sites, and had a larger average movement between consecutive den sites than raccoons released at Alexander Knob or at the Glendale-Little Tennessee River location. Raccoons released

at the Alexander Knob site utilized forested habitats at a significantly higher rate than did animals released at the other 2 sites.

The Lotterdale Knob and Alexander Knob release sites were located in the Red Knobs ridge system and had somewhat similar habitat configurations. Both areas were characterized by relatively large tracts of contiguous forest bordered by pasture and agricultural cropland, although cropland was more prevalent around the Alexander Knob region. The Glendale-Little Tennessee River region was comprised of smaller forest tracts, or "farm woodlots," interspersed with open farmland and edge situations. The diversity and juxtaposition of habitat types in this region probably resulted in a greater diversity of food sources.

With this greater diversity, the overall availability of food items would seem to be increased. Johnson (1970) stated that as food availability shifted between areas, raccoons shifted their activity centers to follow the changing food supplies. Assuming this was also the case in the study area, then the raccoons would have moved farther to follow food sources in the Red Knobs ridge system than in the more diverse Glendale-Little Tennessee River region. In addition, the Red Knobs area contained greater proportions of large blocks of pasture lands and coniferous forest than did the Glendale-Little Tennessee River area. Data on habitat utilization indicated that these pastures did not offer food items attractive to the translocated raccoons, as supported by Schultz (1956). With food sources apparently less abundant and concentrated in widely scattered areas, the Alexander Knob and Lotterdale Knob area raccoons had to establish larger home ranges, have more range overlap, be more active, have more scattered den sites, and move farther

between dens than raccoons in the Glendale-Little Tennessee River area. It also seems that as the diversity and availability of food items decreased even more from the Alexander Knob area to the Lotterdale Knob site, some additional variations in movement-activity characteristics become significant.

Another important factor which may have contributed to the differences in movement and activity parameters was variations in the degree of disturbances between the 3 release areas. Dog training and illegal hunting activities in the study area were primarily concentrated in the Red Knobs ridge system. While the study area was opened for 4 nights of controlled hunting, 89.4% of the hunters surveyed hunted in the Lotterdale Knob-Alexander Knob vicinities while only 10.5% hunted in the Glendale-Little Tennessee River area. Hunter density and distribution observed in the study area indicated that the Red Knob area was a well known "hot spot" for dog training and illegal hunting activities, especially after news of the raccoon releases were made public. During night time tracking efforts, only 1 party of hunters (dog training) was observed in the Glendale-Little Tennessee River area. Local hunters reported "treeing" both transmittered and ear tagged translocated raccoons on numerous occasions around the Lotterdale Knob and Alexander Knob release sites. Hunting pressure in these 2 release areas was not an occasional phenomenon, but instead became excessively heavy, especially on weekends and almost nightly during summer and early fall prior to the opening of the regular raccoon season in other counties.

Hardy (1979) stated that movements of resident raccoons in the study area became increasingly greater and erratic during this time and

suggested that this steady harassment was a significant factor influencing these movement patterns. It also appeared that harassment occurring through most of the night resulted in the translocated raccoons in the Red Knobs area shifting some of their feeding activity to daylight hours, as was suggested by the activity data.

In addition to harassment from hunting dogs, there was an extremely high potential for harassment from feral and free-roaming dogs within the Red Knobs ridge system. Warr (1978) observed an average of 5 dogs per day over a 14 month trapping period, directly confronting these animals on 67 occasions while checking trap lines. He also stated that dogs were the third most frequently captured species, surpassed only by the number of opossum and cat captures. Wing (1940) found that feral and free-roaming dogs in northeastern Tennessee were quite effective in their foraging abilities, and suggested that the predominance of hunting-dog blood in local dog populations increased the prey catching effectiveness. Preble (1940) further stated that in Ohio, free roaming dog predation may account for as much as 20% of the annual raccoon mortality. The problem of all dog harassment has become so severe in the study area that it appears as an important limiting factor on the raccoon population (Warr 1978).

VIII. COMPARISON OF RELEASE SEASONS

Translocated raccoons released in the study area during different seasons also exhibited significant variations in movement-behavioral characteristics. These variations, as with those for raccoons released at different locations, could primarily be explained by food availability and disturbance characteristics.

Fall-released raccoons (3 December 1977) were introduced into a situation characterized by a limited diversity in food items but not a limited food abundance. During 1977 mast crops in the study area were rated good to excellent, with an abundance of both white oak (Leucobalanus) and red oak group (Erythrobalanus) acorns (TWRA 1977). With this type of mast crop, food sources were plentiful and concentrated in most forest stands. Since raccoons were obtained from bottomland hardwood forests and had undoubtedly utilized mast as a food source, they were able to locate food supplies quickly and without extensive wandering. In addition, as mast supplies became depleted in 1 stand only a minimal movement or activity shift (Johnson 1970) was required to locate another mast source. Since the study area contained a low native raccoon population (Warr 1978) and did not contain deer or turkey, competition for the mast crop was limited. Johnson (1970) reported that mast, especially acorns, was 1 of the more important foods for Alabama raccoons during late fall and early winter. Stuewer (1943a) stated that the stomachs and scat of 6 raccoons collected in Michigan during fall contained 100% acorns and movement-feeding activity during this time was almost exclusively confined to mast producing woodlots.

Summer-released raccoons were also liberated during a time of food abundance, but unlike fall, the diversity of food items was much greater. Natural fruits, primarily blackberries, and insects including grasshoppers and beetles were readily available at this time. Johnson (1970), in summarizing June food habits of Alabama raccoons, found that natural fruits made up 96% of the plant foods taken and that beetles and grasshoppers were the first and second most frequently occurring insect food items, respectively.

With the abundance and diversity of food items, the translocated raccoons may have "wandered" or "explored" the area more, since acquiring food did not restrict their movement to certain habitat types. After the raccoons established a home range, they did not utilize all sections of these large areas with the same frequency, but still these areas were part of the "area of familiarity" as described by Johnson (1970). Johnson also described a similar situation, and stated that the area of general familiarity of most Alabama raccoons included large areas that were revisited infrequently or not at all, depending on seasons or food availability.

Spring-released raccoons were also faced with a food availability situation that could have influenced home range size. Johnson (1970) stated that late winter-early spring was a time of hunger and food scarcity for raccoons, with insects commonly occurring as the only food item present, and even then on a limited basis. As spring progressed, insects became more abundant and provided the only natural food available until summer fruits appeared. Johnson (1970) also reported extensive movement and activity shifts for 2 raccoons during this period, suggesting that the animals might be utilizing their entire "area of familiarity" to secure food. Scat collected from den sites of translocated raccoons in the study area at this time indicated that food items were comprised almost exclusively of insects. Night time locations were consistently obtained in or around small creeks and "spring seeps." Examination of these habitats revealed the presence of many insects such as beetles and centipedes in addition to some invertebrate organisms. Walls (1964) and Bailey and Rinell (1968) described these spring seeps as principal winter-early spring feeding grounds of

wild turkey and stated that since these seeps did not freeze, they provided food items such as mast, seeds, tubers, insects, salamanders, and worms when other food sources had been depleted or were unavailable due to snow or ice. Although the study area contained a number of these seeps, they were often distributed over a large area and if the food items at 1 seep were consumed, considerable movement, or an extension of the area of general familiarity, to the next seep would be necessary. This appeared to cause the translocated raccoons to establish considerably larger home ranges in order to satisfy their food requirements.

The influence of dog training and illegal hunting activities on the translocated raccoons might also explain some of the variations in home range characteristics between raccoons released during different seasons. As previously stated, the intensity of these activities often become excessive, due to the relatively small amount of refuge habitat and the large number of raccoon hunting enthusiasts in the study area. From observations recorded during tracking efforts, it was apparent that these legal and illegal hunting activities were most prevalent during summer and fall. This hunting distribution was also noted by Wright (1977). Spring dog training-illegal hunting activities often became intensive as weather permitted.

Raccoons released in summer were not only faced with the task of finding food sources and refuge sites, but were also forced to elude dogs and poachers while in unfamiliar territory. It seems highly probable that the high level of disturbance may have added to the movements and resulting home range sizes of raccoons, in that the animals not only searched for areas with suitable food supplies, but areas that also

contained refuge sites. Fall-released raccoons on the other hand, were faced with much less disturbance. After hunting seasons opened in adjacent counties, many hunters shifted their activities into regions where raccoons could be harvested, which, according to local hunters, added to the experience necessary to train a raccoon dog. In addition, as hunting seasons opened for other game species, some of the attention from raccoon hunting (dog training) was diverted, decreasing the hunting pressure. It appeared that as long as the translocated raccoons could find adequate food and cover, they remained in or around the release site until dog training activities and poaching became intensive enough to hinder nightly foraging movements.

IX. HUMAN INFLUENCE ON MOVEMENTS

During the 21-month radio tracking period, it was possible to determine the effect of human related disturbances on the movements and home range establishment of the translocated raccoons. These disturbances were of 2 types: dog training or illegal hunting activity, and a logging operation. For simplicity, dog training and illegal hunting will be condensed to merely dog training, although the 2 terms often become synonymous. Although some researchers have suggested that disturbances from year-round hunting or dog training influenced the movements and activity of raccoons in the southeast (Johnson 1970, Wright 1977, Warr 1978, and Woods 1978), there has been little data to substantiate this. With the aid of radio telemetry, it was possible to evaluate the short and long terms effects of intensive dog training activities since hunters and/or poachers were not aware of the researchers presence and did not curtail their activities.

Home range shifts and abnormal movements of 4 translocated raccoons were directly attributable to disturbances stemming from dog training activities. During 9-13 June 1977, raccoon Y29 (male) and Y36 (female) were subjected to nightly harassment from dog training efforts within their home ranges in the Lotterdale Knob area. These home ranges had been established for 3 months (Y29) and 2.5 months (Y36) and no abnormal shifts had been recorded during these periods. On 14 June 1977 the raccoons were located 1.6 km and 1.3 km away from the nearest boundary of their traditional home ranges. Hunters did not return to this area on subsequent nights and on 16 June both raccoons returned to their normal home ranges. These animals were monitored until September when their transmitters failed and during this period, never repeated these movements outside the previously established home ranges.

Raccoon numbers Y42 and Y49 encountered similar intensive hunting pressure in the Alexander Knob area. Raccoon Y42 had established a home range in a combination of small woodlots and corn fields. Here it was most susceptible to harassment from hunters allowing their dogs to utilize the extensive road system in searching for scent trails. This area soon became a hot spot for summertime hunting, especially after information concerning the stocking program and resulting hunting success had spread among local raccoon hunters.

Although food was abundant in this area, Y42 dispersed from this home range approximately 2 km and established a new, much larger range encompassing both north and south shores of Fort Loudon Lake. Food was less available in this area as much of the forest cover was pine, which

according to McKeever (1959) provides less than nominal food items. Consequently, the raccoon was forced to increase its foraging movements and traversed the lake, a distance of approximately 600 m. This trip was made at least 12 times until the raccoon was illegally killed on the south side of the lake in Loudon County in December 1977.

Raccoon Y49 established a home range in the more remote section of the Alexander Knob area and did not encounter hunter activity until mid October 1977. This raccoon was "treed" on 3 known occasions in 4 nights. After the third time, the raccoon shifted its activity center approximately 700 m across the county line to another watershed where it remained until the transmitter failed and it could no longer be located. This section of woodland contained 2 abandoned quarry sites which provided excellent refuge sites in the form of large rock piles. Although this watershed was located in Blount County and the training season was closed, hunters entered the area on several occasions. Each time the dogs began barking in the vicinity of Y49, the raccoon moved directly to the quarry site and entered the rock pile. This quarry region was occupied by another translocated raccoon and a resident radio collared raccoon, both of which also relied on the quarry site as a refuge area. This "planned escape behavior" has also been documented by Whitney and Underwood (1952), Cunningham (1962), and Johnson (1970). The use of rock dens as refuge sites during intensive hunting pressure has also been cited by Giles (1942). Contrary to the opinions of the majority of raccoon hunters, who strongly advocate year-round dog training seasons, these data indicate that intensive dog training activities can influence the movement patterns of raccoons as

historically suspected by many investigators. Training seasons should be as carefully established and regulated as the seasons allowing harvest of raccoons.

In addition to altering movements or triggering home range shifts, dog training activities often resulted in illegal raccoon mortality. During this investigation, 12 translocated raccoons were killed during supposedly legal dog training hunts. Only 4 of the 12 (33%) illegally killed animals were found in the field; information on the remaining 8 was received anonymously from local raccoon hunters who claimed to have collected the ear tags from other hunters in the area. They further indicated knowledge of additional kills of translocated animals but could not obtain the ear tags or other information. Warr (1978) and Hardy (1979) also reported illegal raccoon mortality from dog training activities in the Blount, Loudon, and Monroe Counties study area.

In this investigation, illegal kills comprised 41.4% of all tag recoveries, but it appears that this type mortality was much more common than the data indicated. The data reported here should be considered the minimal loss to illegal hunting since researchers in the study area were merely "lucky" in determining known illegal kills from animals abandoned in the field and from informants. Many local residents reported knowledge of illegal kills, with numbers reported as high as 20 translocated raccoons per poacher, but again, without the actual ear tags these reports could not be considered factual. However, the known illegal mortality rate was great enough to strongly suggest that dog-training--illegal hunting should be considered as a primary limiting factor on

raccoon populations in the study area and possibly in much of eastern Tennessee. In 1977, 15% of all game violations in the state of Tennessee involved raccoon hunters (TWRA 1978, personal communication). Only violations concerning deer hunting outnumbered those involving raccoon hunting. Considering the extra effort necessary to apprehend illegal raccoon hunters in relation to other small game hunters, these statistics become increasingly important in the management of raccoon populations.

The detrimental effects of intensive hunting pressure and over harvest on raccoon populations has been well documented and many investigators report this type of mortality as a primary limiting factor (Brown and Bellrose 1943, Stuewer 1943a, Stains 1956, Atkeson and Hulse 1953, Cunningham 1962, Leuth 1962, Caldwell 1963, Kelly 1967, and Johnson 1970). The consequences of combined legal and illegal mortality becomes paramount in the management of small, localized raccoon populations in less than optimum habitat types as occur in much of eastern Tennessee.

A small logging operation was also observed to influence the movements of 2 translocated animals. Raccoon numbers Y52 and Y55 established home ranges centering around a small woodlot bordered by agricultural land in the Glendale-Little Tennessee River region prior to the logging operation. Number Y52 had remained in this woodlot for approximately 180 days while Y55 had occupied the area for 50 days.

After the logging began, both Y55 and Y52 shifted their movements and daytime resting sites to the eastern end of their ranges, away from the immediate cutting activity. Cutting and skidding activities

encompassed the entire woodlot after 3 weeks. The raccoons continued to forage in the cut-over woods at night although they returned to the edge of the woodlot to spend the daylight hours. After 1 additional week, both animals crossed an extensive pasture into an adjacent woodlot and, in the remaining 100 days of monitoring, did not return to the cut-over woods.

The logging of the small woodlot was typical of timber "management" practiced by many landowners. Only the largest trees, primarily hardwoods, were harvested, and a once productive raccoon habitat was converted into a pine stand. The effect of logging practices on raccoon movement has not appeared in past literature. In a related study, Sunquist (1967) reported that after a prescribed burn, raccoon foraging activities decreased but the animals continued to use the area as a travel lane. However, he monitored movements only over an 8-day period. Many other investigations have reported the importance of conserving tree dens as a raccoon management technique (Stuewer 1943a, Kellner 1953, McLaughlin 1953, Johnson 1970, and Clements 1972). The status of the small farm woodlots found in much of eastern Tennessee will greatly influence the raccoon population in the future. If habitat continues to decrease, hunting pressure will become increasingly heavy in the remaining habitats and localized raccoon populations may suffer.

X. ACTIVITY

Increased activity during the adjustment period probably reflected exploratory movements of the transplanted raccoons in locating food sources, suitable den sites, and water sources. Tester (1971)

suggested that the effects of handling and radio-collaring animals may last for as long as 2 weeks after release and therefore animals could not be expected to behave in a "normal" manner. Frampton (1974) stated that raccoons released in unfamiliar territory remained within 2 km of the release sites for approximately 1 week before dispersal or "normal" movements occurred. He further stated that several of the raccoons returned to release sites or "familiar" areas and established home ranges after dispersal or adjustment periods. Although Frampton (1974) did not report the time interval required for home range establishment, the translocated raccoons in this investigation began returning to "familiar areas" within an average of 6.9 days. However, even after this period, the raccoons continued activity patterns contrary to traditional nocturnal sequences reported for "normal" raccoons.

With some of this additional activity occurring during daylight hours, the animals were exposed to increased predation, not only from man, but from free-ranging dogs and feral dogs as well. Nichols and Whitehead (1978) found a free-roaming dog population of an estimated 2.3 dogs per km^2 in a rural area of eastern Tennessee and further stated that over 50% of the translocated deer in this area were lost directly or indirectly due to dog harassment.

From the statements by Tester (1971) and Frampton (1974), it appears that the 30-day adjustment period was sufficiently long enough to absorb any significant amount of "abnormal" or adjustive behavior. Therefore, activity data obtained after this adjustment period was considered a true representation of the activity patterns of translocated raccoons established in previously unfamiliar areas.

Activity patterns recorded for the translocated raccoons were essentially equal to those reported by Hardy (1979) for native raccoons in the study area. He stated that activity was usually initiated after sunset and continued through 2400 hours EST, but continued at a lower frequency until sunrise. Native raccoons also exhibited reductions in activity after sunrise with the period of 1200 to 1800 hours EST as the least active. Cunningham (1962) also reported little to no activity or movements during this time period for raccoon on the Savannah River Plant, South Carolina. Schneider et al. (1971) reported seasonal variations in activity periods of raccoons in Minnesota, with inactive and cessation of movements determined more by sunset and sunrise other than by actual time intervals. During summer months, the translocated raccoons often became active prior to sunset and ended around sunrise, thereby increasing activity periods into daylight hours to compensate with the shorter periods of darkness. Johnson (1970) also observed activity at pre-sunset hours and stated that the raccoons utilized this time to locate and feed upon insects such as grasshoppers in edge and old-field situations. Sharp and Sharp (1956) stated that at a feeding station in Kansas, raccoon activity decreased through the night but seemed to peak from 2030 to 2100 hours with lesser peaks from 2330 to 0030 and 0130 to 0330 hours.

XI. HABITAT UTILIZATION

The relative abundance of raccoons in varying habitat types has been reported for several areas in the southeast. McKeever (1959), working in southwest Georgia and northwest Florida, stated that capture

success of raccoons was highest in bottomland hardwoods, intermediate in cultivated land, old-field situations, and upland hardwoods, slightly lower in mixed pine-hardwoods, and lowest in pine forests. Caldwell (1963) rated north-central Florida raccoon habitat types, stating that swamps were the most productive followed by farmlands, hammocks, sandhills, and flatwoods (pine). In this study, swamps were not present in the study area and upland forest associated with agricultural land was the predominate raccoon habitat type. Pasture land and pine forest were the only habitat types that the translocated raccoons seemed to avoid, with only 0.9% of all locations recorded in pasture land and no locations recorded for pure pine stands. Stream utilization for the translocated raccoons followed the same pattern, with streams traversing pasture lands exhibiting the least frequent utilization. These findings were in agreement with those for native raccoons in the study area and with those of Yeager and Rennels (1943), Ateknson and Hulse (1953), and Lehman (1977). However, it must be noted that nearly all past studies were conducted in areas with considerable aquatic habitats consisting of swamps, marshes, or flood plain hardwoods. If the aquatic habitats were removed, then the next most frequently utilized habitat became upland hardwoods and farmland, as reported in this study.

XII. DENNING

Tree Dens

From the 328 dens, characteristics of 50 trees of 12 species were recorded. These trees had a mean dbh of 57.6 cm and an average height of 14.2 m. Hardy (1979) found an average height of 15 m and a mean dbh

of 54 cm for 30 den trees utilized by resident raccoons in the study area. However, these tree measurements were more a reflection of the timber stand characteristics and past logging practices in the study area rather than selectivity of tree dens by the resident and translocated raccoons. Preble (1940) reported that of 45 raccoon tree dens measured in central Ohio, 52% were American elm (Ulmus americana) and American beech, with a mean height of 18 m and average dbh of 72 cm. In Michigan, Berner (1965) located 9 tree dens, 5 (55%) of which were basswood (Tilia americana), which averaged 64 cm dbh. Stuewer (1943a) investigated 34 Michigan tree dens, 66% of which were red maple (Acer rubra), and reported a mean height of 8.4 m and average dbh of 72.3 cm. The high utilization of elm, red maple, and beech tree dens by raccons in northern latitudes was attributed to the rapid cavity formation of these species (Baumgartner 1939). Although the formation of natural cavities occurs less rapidly in oaks, the increased resistance to decay produces a longer lived denning cavity. Hardy (1979) reported that 53% of the tree dens located for resident raccoons in the study area were oaks, followed by hickories. However, Stuewer (1943a) stated that tree species probably meant little to raccoons in the selection of tree dens. In this investigation, it appeared that raccoons would occupy any tree containing a cavity of suitable dimensions.

Ground Dens

Stuewer (1943a) reported that the type of den site (tree, ground, etc.) varied with the geographic region and availability of den sites. Although tree dens were most frequently recorded, ground dens on abandoned quarry sites seemed to be the preferred den type when they

were available. These rock dens provided much more protection from illegal hunters and dog harassment than did tree cavities. The illegal hunts monitored indicated that the raccoons were well aware of the protection of the rock piles as refuge sites. The raccoons were also found in these rock and ground dens at times other than in chase situations.

The use of rocky crevices and ground burrows as den or refuge sites has been well documented in the literature, appearing most frequently for raccoons in Iowa (Giles 1940), California (Grinnel et al. 1937), Indiana and Texas (Stuewer 1943a). Giles (1940) also reported a preference for rock dens in a heavily hunted area. Shirer and Fitch (1970) stated that in Iowa, more than 50% of the den sites were rock outcrops as compared to tree dens.

Ground dens excluding rock outcrops and quarry sites were also important as den sites in the study area. Heaviest utilization of this type den occurred during late winter and early spring, as unseasonably cold winter weather brought night temperatures down to -20 °C on several occasions. It was possible that these ground burrows offered better protection from the severe temperatures than did tree cavities as 1trans-located raccoon in a tree den was found dead, apparently from exposure, during the cold period while another survived in a ground burrow approximately 900 m away. The surviving raccoon remained in the burrow for the duration of winter weather. Berner and Gysel (1967) stated that the preference in den sites was determined by microclimatic factors. The most important characteristics of den sites as described by their study were: the amount of precipitation and wind allowed inside the den

cavity, and the stability of the internal temperature as compared to the external temperatures. In this study, the numerous fox dens and elaborate groundhog (Marmota monax) burrows offered ideal winter den sites for raccoons. Most ground dens were abandoned groundhog burrows although 1 dead groundhog was found at the entrance to a burrow which had recently been occupied by a translocated female raccoon.

Leaf Nests

Observations of raccoons utilizing gray squirrel leaf nests were restricted to late spring through early fall. During summer especially, it appeared that the raccoons preferred the leaf nests, since these nests were cooler and contained fewer insect pests (Goodrum 1961, and Madson 1964). Close observation of raccoons in these nests indicated that the animals apparently felt secure in them since only a few were aroused from sleep or exhibited any activity upon the investigators approach. The selection of leaf nests as daytime resting sites by raccoons was also reported by Twichell and Dill (1949), Mech et al. (1966), Johnson (1970), Shirrer and Fitch (1970), and Schneider et al. (1971). Some hunters in the study area expressed concern for raccoons dwelling in these leaf nests, claiming that a significant number of raccoons were shot from these sites by early season squirrel hunters and illegal raccoon hunters. However, of the 33 occasions raccoons were located in leaf nests, only 4 were readily visible from the ground. Unless a significant number of squirrel hunters frequently practice indiscriminate shooting of leaf nests, then this type mortality would seem to be insignificant if not non-existent.

Den Site Characteristics

Linear distances measured from den sites to water sources, agricultural crops, and human inhabitances seemed to reflect the characteristics of the habitat rather than a strategic selection of dens by the translocated raccoons. Hardy (1979) reported that for resident raccoons in the study area, the average distance from den sites to water was 128 m and 237 m to an agricultural field. These distances were not significantly different from those reported for the stocked animals. However, it was interesting to note that native raccoons established dens much farther on the average (1039 m), from a human inhabitance than did translocated individuals. This discrepancy in distances may reflect some learning process in native raccoons; associating houses with disturbances from man and dogs. Several of the translocated raccoons selected den sites within 200 m of a house, while none of the residents den sites were located in such close proximity to houses.

Stuewer (1943a), Cabalka et al. (1953), and Dorney (1954) all reported that a permanent source of water was an important component of raccoon habitat. Stuewer (1943a) stated that in Michigan, the average distance from dens to water was 124 m, with a maximum of 365 m. However, Berner (1965) found no significant correlation between the distance from dens to water and the frequency or amount of den utilization. With 157.5 km of streams, 2 major river systems, and numerous farm ponds, it seems unlikely that water availability had any influence upon den site selection by the translocated raccoons.

Many investigators have reported the importance of corn as a food item for raccoons (Giles 1939, 1940, Preble 1940, Whitney and Underwood

1952, and Geis 1966). Production of corn in the study area is limited, thus it would seem that the raccoons would establish den sites in relation to these food sources, especially during summer months when corn begins to ripen and the sugar content is highest (Martin et al. 1976). However, this was not apparent during this study. On the average, dens were located approximately the same distance from corn and soybean fields as they were from pasture lands. Berner and Gysel (1967) also encountered this situation and found that location of the den site was not necessarily related to the availability of food. In the Southeast, Johnson (1970) further stated that corn did not appear to be an important food source when compared to the amount of other plant foods eaten, primarily naturally occurring fruits such as acorns, persimmons (Diospyros virginiana), and privet (Ligustrum vulgare) which consistently comprised 50 to 80% of the food volume consumed April to November.

The literature contains little information as to the importance of soybeans as a raccoon food item. Lehman (1977) reported that in Indiana, soybean fields were of minor importance as a food source, but these fields were occasionally used in August and September by raccoons feeding on the abundance of crickets (Gryllidae) and grasshoppers (Locustidae). He further stated that although these soybean fields supported large populations of insects, the density of the plant cover may have restricted the movements of young raccoons through the area.

Since the average linear distances between den sites for all translocated raccoons was not significantly correlated with home range sizes, it appears that den sites were not evenly distributed throughout the animal's home range. Johnson (1970) also found that dens and

refuge sites were often located in certain areas within the animal's home range.

XIII. QUOTA HUNT

The 4-night hunt held in the study area was a final measure of the effectiveness of the raccoon translocation process. The 41% hunter success, the average kill of 0.17 raccoons per hour for all hunters, and the 32% tag return of translocated individuals were all indicative of a successful restocking effort. Hunter success and kill per hour during the quota hunt equalled those reported for statewide raccoon hunters in 1969. On TWRA's Chuck Swan (WMA) in eastern Tennessee, Woods (1978) reported a hunter success of 21.3% over 9 nights of hunting. He also reported an average of 2.9 dogs per hunter as compared with 2.7 dogs per hunter party for the quota hunt in this study. Only Stuewer (1943a) reported a tag return of stocked raccoons (42.8%) comparable to the 32% return for this study. However, he released pen-reared raccoons and utilized an entire fall hunting season to recover the tags in the same year that they were released.

The age structure of raccoons taken on the hunt: 7 class I, 10 class II, and 2 class III, reflected the input of translocated individuals into the population since 7 of the 13 native raccoons killed (54%) were juveniles and no native age class III animals were killed. Woods (1978) also reported an unusually large kill of juveniles on the Chuck Swan WMA, with 75% of the total kill comprised of juvenile raccoons. Other researchers have reported kill statistics similar to those found for the total kill of stocked and native raccoons during the

4-night hunt. Cunningham (1962), hunting with dogs, reported a capture of 25% juveniles while Caldwell (1963) reported that 37% of the raccoons obtained by dog hunting in north-central Florida were juveniles. Johnson (1970) found that juveniles comprised from 34 to 47% of the kill over 8 years of hunting in 3 different areas of Alabama. He further stated that hunting with dogs during the first hours of darkness may bias the kill toward juveniles.

In addition, although sample size was limited, it was apparent from the kill data that the native raccoon population in the study area had not substantially increased even though the raccoon hunting (taking) season was closed for 3 years. The kill of native raccoons was comprised of approximately the same number of juveniles as adults, indicative of a stable to declining population (Smith 1974). This further indicates that raccoon mortality from dog training and illegal hunting activities may be an important limiting factor on raccoon populations under intensive pressure such as in eastern Tennessee. It was also possible that some of the juveniles collected during the hunt were the progeny of translocated raccoons, since 63.6% of the females recovered after at least 1 breeding season had apparently given birth to young while in the study area. If this was the case, then the population would appear stable to increasing with the percentage of juveniles killed greater than the percentage of adult stocked raccoons killed. Whatever the situation, after only 2 complete breeding seasons (1976 and 1977), the population of resident raccoons, translocated raccoons, and their progenies did not seem large enough to warrant the opening of an unrestricted hunting season in the study area within the near future.

Closure of the year-round training season in Loudon County portion of the study area would be advantageous in accelerating population growth also.

From the sex ratio of raccoons killed during the hunt, 1 male:1.11 female, it appeared that males and females were equally susceptible to hunting with dogs. Johnson (1970) found that adult males were less vulnerable to hunting than adult females, since females traveling with young leave more scent than an individual male, thereby increasing their changes of their trail being discovered by a dog. Stuewer (1943a) stated that juvenile males were most susceptible to hunting in the fall due to the greater activity after the break-up of family groups. However, in this study, neither case seems valid since the hunt date was after most family groups should have been dissolved (Stuewer 1943a).

CHAPTER VI

CONCLUSIONS

Movement, activity, and survival characteristics of raccoons released in Blount and Loudon Counties indicated that this relocation attempt was successful in establishing West Tennessee raccoons in East Tennessee habitats. Dispersal distances from release sites were minimal, with only 2 animals known to have traveled outside the study area. Relatively high survival rates allowed the raccoons to establish home ranges and provide input into the total raccoon population. Examination of recovered females indicated that substantial reproduction had occurred in the study area. Weight gains observed in recovered raccoons also indicated that the West Tennessee raccoons had sufficiently adapted to the habitat types found in the study area.

The fact that the movement, activity, and denning parameters of the translocated raccoons were similar to those reported for resident raccoons in the same area further indicated the adapability of the raccoon and the success of the translocation efforts. Information collected during the 4 nights of experimental hunting demonstrated that, even after 3 years, released raccoons had remained near the release sites and were available to hunters, an important aspect to consider where management commitments are concerned.

In reviewing past raccoon restoration efforts, it appears that 3 factors were primarily responsible for the success of this translocation attempt: (1) raccoons slated for translocation were live-trapped from areas which contained a food base similar to the release area,

(2) the resident raccoon population within the study area was low, and (3) raccoons were released under closed hunting (taking) season conditions. Many investigators have stated that 1 of the principal factors contributing to the failure of raccoon restoration programs was the significant differences in habitat types between capture sites and release sites (Johnson 1970, Clements 1972, Frampton 1974, and Wright 1978). It has also been stated that raccoons stocked in areas already containing moderate resident raccoon populations are immediately disadvantaged, as the desirable habitats would already be occupied by other individuals (Frampton 1974). By closing the hunting season prior to, during, and after releases were made, the potential survival of transplanted raccoons was increased, since the primary mortality in raccoon populations can be attributed to hunting (Stuewer 1943a, Atkenson and Hulse 1953, Twitchell and Dill 1949, Cunningham 1962, Caldwell 1963, Johnson 1970, and Woods 1978).

However, it is important to note that illegal hunting constituted 41.4% of all known mortality for the transplanted raccoons. No raccoon population, native or stocked, can be expected to increase or remain stable under these conditions, especially in less than optimum habitats such as those occurring in eastern Tennessee.

CHAPTER VII

SUMMARY

1. A study of the movements and activity of translocated raccoons was conducted in eastern Tennessee from March 1977 to November 1978. Objectives were to determine the movement ecology of released raccoons, to evaluate restocking techniques, and to evaluate restocking efforts in terms of survival and reproduction.

2. From July 1975 to May 1978, 269 raccoons captured in Shelby and Haywood counties, western Tennessee were ear-tagged and released in portions of Blount and Loudon Counties, eastern Tennessee. An additional 17 raccoons were equipped with radio transmitters and released in the area.

3. Of the 286 raccoons released, 29 (10.1%) were recovered as of November 1978 after an average period of 344 days (range = 2 to 1207) in the field. Tag recoveries were comprised of 41.4% illegal kills, 24.1% live-trap recaptures, 17.2% legal kills, and 17.2% found dead (road kills or natural deaths).

4. Of the 17 radio monitored raccoons, 9 (52.9%) were monitored until the battery in the radio collar expired ($\overline{X}$ = 164 days and 132 locations), 4 (23.5%) were illegally killed, 3 (17.6%) were found dead (1 road kill and 2 natural deaths), and 1 (5.8%) was able to remove the radio collar after 84 days in the field.

5. Dispersal information was obtained from 38 raccoons (21 ear tag recoveries and 17 radio monitored animals). The average dispersal distance was 3.8 km over a mean period of 294 days. Dispersal of males

was not significantly different from females, nor was there any significant relationship between the number of days the raccoon was in the field and dispersal distances. Dispersal direction was random. The average dispersal was less than that reported for other translocation studies.

6. Of 11 female raccoons recovered after at least 1 breeding season, 7 (63.6%) had apparently given birth to offspring while in the study area. Released raccoons gained an average of 1.14 kg (29% increase) over a mean time of 432 days, indicating that the animals sufficiently adapted to the new area.

7. Home ranges for 14 translocated raccoons were based on a total of 1464 locations recorded over approximately 630 days. Home range areas were calculated by 3 methods: minimal polygon, maximum polygon, and a bivariate home range model (elliptical method). Minimal polygon home ranges averaged 106.4 ha and were considered the minimum amount of area necessary to support a translocated raccoon in the study area. Maximum polygon estimates averaged 226.05 ha and reflected the amount of area that the raccoon was known to have used during the period it was monitored. Elliptical home range estimates were calculated at 95 and 90% confidence intervals and averaged 383.75 and 290.16 ha, respectively. These home ranges reflected the amount of area the raccoon most likely used (with 95 and 90% probabilities), based on the distribution and frequency of locations recorded during the tracking period.

8. Home ranges for males were significantly larger than those of females, as reported by other investigators. Ranges of the

translocated raccoons were not significantly different from those calculated for resident raccoons in the same area, further suggesting the successfulness of the translocation efforts.

9. The raccoons released during fall and those released in the Glendale-Little Tennessee River area established significantly smaller home ranges than animals released during other seasons or at other locations. These smaller home ranges were the result of better quality habitat, greater food availability and abundance, and less illegal hunting and dog training activities.

10. Intensive dog training, illegal hunting, and logging activities were observed to influence raccoon activity, movements, and home range. These influences resulted in major shifts of activity centers, increased dispersal from release sites, and reestablishment of home ranges. It was recommended that present dog training seasons in the study area be abolished.

11. Raccoons were found to be significantly more active at all times of the day during the first 30 days following their release in the study area. After this initial 30 days, 24-hour movements decreased and activity became primarily nocturnal. The increase in movements and activity following release reflect an adjustment period in which the animals search for food sources and refuge sites. During this period they seem most vulnerable to predation by free-roaming dogs and illegal hunters. It was recommended that in future raccoon restoration projects, law enforcement activities be increased around release areas during the adjustment phase.

12. After the adjustment period, raccoons were most active from 2101 to 0300 hours EST. Least active times were from 1201 to 1500 hours EST. Males were significantly more active than females which was consistent with the larger home ranges of males. Raccoons in the Glendale-Little Tennessee River area were significantly less active than raccoons in the Red Knobs. These differences were attributed to the smaller amounts of dog training activity in the Glendale-Little Tennessee River area.

13. During the 21 month radio tracking period, 328 den sites and day beds were recorded. Of these sites, 70% were tree dens, 21% were ground dens, and 10% were gray squirrel leaf nests. Tree dens were most frequently recorded in white oaks (25.9%). Sycamore and eastern red cedar were the least frequently utilized tree dens. No preference for individual tree species was evident. Further analysis of 60 individual den sites included 50 trees of 12 species and 10 ground dens. Tree dens had an average dbh of 57.6 cm and a mean height of 14.2 m. All den sites were located an average of 105 m from water, 256 m from an agricultural crop, and 603 m from a human inhabitance. These distances reflected habitat configuration rather than a strategic preference of den sites.

14. The linear distance moved between consecutive den sites averaged 623 m. The distance for males was significantly larger than females, and followed patterns reported by other investigators. These distances were significantly correlated with home range size as calculated by all 3 methods.

15. An experimental 4-night hunt was held in the study area on 3-4 and 10-11 November 1978. A total of 46 hunting parties harvested 19 raccoons for a 41.4% hunter success. Hunter success and the kill per hour equaled that reported for statewide raccoon hunters. Of the 19 raccoons killed, 6 (32%) were ear tagged animals. This represents one of the highest recovery rates of transplanted raccoon in the literature. It was also possible that immature raccoons harvested during this hunt (7) were the progeny of translocated animals. Of the hunters surveyed, 89.4% hunted in the Red Knobs area and 10.5% hunted in the Glendale-Little Tennessee River area. Also, 72% of the hunters admitted using the study area for dog training purposes during the introduction of the West Tennessee raccoons.

16. Of approximately 1500 radio locations, 71.4% were recorded in forest habitat, 15.7% in edge habitat, 7.1% in old field situations, and 4.9% in agricultural row crops. Raccoons in the Glendale-Little Tennessee River area more frequently utilized non-forested habitats than did raccoons in the Red Knobs area. Differences in habitat utilization appeared more related to habitat availability than preference.

CHAPTER VIII

MANAGEMENT IMPLICATIONS

The restocking of raccoons, or any game species, as a management practice is justified only to establish a minimum number of breeding animals in areas where the resident population has been extripated or depressed by factors not related to existing habitat parameters. This practice cannot be expected to immediately increase the huntable population of raccoons, nor should it be used as an annual population maintenance ("put-and-take") program to provide hunters with a harvestable surplus of raccoons.

In areas where resident raccoon populations are low, but suitable habitat still exists, management programs should first entail protection of the animals during breeding and young-rearing periods, manipulation of the environment to provide more optimum habitat, and regulation of the hunting seasons and bag limits to insure a harvest of only the surplus animals. Raccoon translocation becomes a viable management alternative only if the resident population has been depressed to such a low level that these other techniques cannot provide the desired results in a reasonable length of time.

Recent studies have provided insight into methods which proved less than adequate as raccoon restoration techniques. This information, combined with data obtained during this investigation, establishes enough guidelines to allow the proposal of a biologically-sound raccoon restocking technique. Before actually releasing raccoons into an area, the presence of a low native raccoon population should be confirmed by

means other than reports from dissatisfied raccoon hunters. Cooperation of landowners and sportsmen in and around the area scheduled for releases is essential. Hunting and dog training seasons must be closed and strictly enforced to insure maximum survival of released animals. In locating a source of raccoons for stocking purposes, choose an area with habitat similar to the release site and identify any disease or parasite which may be introduced into the release area. Raccoons should not be transferred from areas which are common focal points for canine distemper or rabies. Schedule releases for late summer-fall and avoid areas known for their illegal hunting activities. Distribute releases over a wide area, with approximately 1 raccoon released per 50 ha of quality habitat. To further increase survival potential, avoid publicizing release locations or release dates. After initial releases, increase the enforcement of closed season regulations. To allow a substantial recovery of the raccoon population, the hunting and dog training season should probably remain closed for a minimum of 5 years. Once the population has recovered, seasons may be reopened only on a limited basis, with opening dates not earlier than December with no additional dog training periods.

In any event, restocking efforts must be conducted by state wildlife agencies and the stocking programs implemented by raccoon hunter clubs prohibited. Animals released by these organizations have historically failed to improve raccoon populations since they are usually in poor condition (Nettles and Martin 1978), show poor survival once in the field (Wright 1977), and may introduce disease and parasites from endemic areas into regions in which they were previously absent (Johnson 1970, and Schaffer et al. 1978). It would also be advantageous,

for both resident and transplanted raccoons, if dog training seasons were abolished except during the regular hunting season, since illegal hunting mortality and continued harassment appear to be a serious limiting factor for raccoons in limited habitats such as found in rural East Tennessee (Wright 1977, Warr 1978, and Hardy 1979).

LITERATURE CITED

LITERATURE CITED

Ables, E. D. 1969. Activity studies of red foxes in southern Wisconsin. J. Wildl. Manage. 33:145-153.

Aliev. F. F., and G. C. Sanderson. 1966. Distribution and status of the raccoon in the Soviet Union. J. Wildl. Manage. 30:497-502.

Atkeson, T. Z., and D. C. Hulse. 1953. Trapping versus hight hunting for controlling raccoons and oppossums within sanctuaries. J. Wildl. Manage. 17:159-162.

Bailey, R. W., and K. T. Rinell. 1968. History and management of the wild turkey in West Virginia. W. Va. Dept. Nat. Res., Div. of Wildlife, Charleston, WV. Bulletin No. 6. 59pp.

Bailey, T. N. 1971. Immobilization of bobcats, coyotes, and badgers with phencyclidine hydrochloride. J. Wildl. Manage. 35:847-849.

Baumgartner, L. L. 1939. Fox squirrel dens. J. Mammal. 6:280-281.

Berner, A. 1965. Ecological evaluation of large tree cavities and ground burrows and their use by raccoons. M.S. Thesis. Michigan State Univ., East Lansing. 83pp.

_____, and L. W. Gysel. 1967. Raccoon use of large tree cavities and ground burrows. J. Wildl. Manage. 31:706-714.

Blount County, Tennessee State Planning Commission. 1970. Comprehensive plan, Blount, Loudon, and Monroe counties. Rept. No. ET-SA-5-70. Parts 1 and 2. 170pp.

Brown, L. G., and F. C. Bellrose, Jr. 1943. Use of nesting boxes for wood ducks by other wildlife. J. Wild. Manage. 7:293-306.

Butterfield, R. T. 1944. Populations, hunting pressure, and movements of Ohio raccoons. Trans. N. Am. Wildl. Conf. 9:344-397.

Cabalka, J. L., R. R. Costa, and G. O. Hendrickson. 1953. Ecology of the raccoon in central Iowa. Proc. Iowa Acad. Sci. 60:616-620.

Caldwell, J. A. 1963. An investigation of raccoons in North Central Florida. M.S. Thesis. Univ. Florida, Gainesville, 107pp.

Cauley, D., and J. R. Schinner. 1973. The Cincinnati raccoons. Natural History. 82:58-60.

Clements, R. J. 1972. Raccoon movements as an indicator of transplant stocking effectiveness and socio-economic aspects of raccoon hunting. M.S. Thesis. Virginia Polytechnic Inst. and State Univ., Blacksburg. 172pp.

Cook, J. R. 1977. Annual narrative report, Hatchie National Wildlife Refuge, Brownsville, Tennessee. U.S. Dept. Interior, Natl. Wildl. Ref. System. 16pp.

Cottam, C. 1956. The problem of wildlife introduction--its' successes and failures. 46th Conv. Internat. Assn. Game and Fish Conserv. Comm. pp. 94-111.

Cunningham, E. R. 1962. A study of the eastern raccoon on the Atomic Energy Commission Savannah River Plant. M.S. Thesis. Univ. Georgia, Athens. 55pp.

Dean, R., W. W. Hines, and D. C. Church. 1973. Immobilizing free-roaming and captive deer with phencyclidine hydrochloride. J. Wildl. Manage. 37:82-86.

Deardorff, J. L. 1976. Blount County: 1990. A land use plan and policy for Blount County, Tennessee. Tennessee State Planning Office, Nashville. 244pp.

Dorney, R. S. 1954. Ecology of marsh raccoons. J. Wildl. Manage. 18:217-255.

Elder, J. A. 1959. Soil Survey, Blount County, Tennessee. U.S.D.A. Soil Survey Series 1953, No. 7:119pp.

_____. 1961. Soil Survey, Loudon County, Tennessee. U.S.D.A. Soil Survey Series 1958, No. 2:113pp.

Ellis, R. J. 1964. Tracking raccoons by radio. J. Wild. Manage. 28:363-368.

Frampton, J. E. 1974. Movement, physical change, and mortality of raccoons released in unfamiliar territory. S.C. Wildl. and Marine Res. Dept., Div. Game and Freshwater Fish. Statewide Wildl. Res. Proj. No. W-38-10. 110pp.

_____, and L. G. Webb. 1973. Preliminary report on the movement and fate of raccoons released in unfamiliar territory. Proc. Ann. Conf. S.E. Assn. Fish and Wildl. Agencies. 27:170-183.

Fritzell, E. K. 1978. Habitat use by prairie raccoons during the waterfowl breeding season. J. Wildl. Manage. 42:118-127.

Garshelis, D. L. 1978. Movement ecology and activity behavior of black bears in the Great Smoky Mountains National Park. M.S. Thesis. Univ. of Tenn., Knoxville. 117pp.

Geis, G. L. 1966. Mobility and behavior of raccoons in eastern South Dakota. M.S. Thesis. South Dakota State Univ., Brookings. 40pp.

Giles, L. W. 1939. Fall food habits of the raccoon in central Iowa. J. Mammal. 20:68-70.

_____. 1940. Food habits of the raccoon in eastern Iowa. J. Wildl. Manage. 4:375-382.

_____. 1942. Utilization of rock exposures for dens and escape cover by raccoons. Am. Midl. Nat. 27:171-176.

_____. 1943. Evidences of raccoon mobility obtained by tagging. J. Wildl. Manage. 7:235.

Goodrum, P. D. 1961. The gray squirrel in Texas. Texas Parks and Wildl. Dept., Bulletin No. 42. 43pp.

Grau, G. A., G. C. Sanderson, and J. P. Rogers. 1970. Age determination of raccoons. J. Wildl. Manage. 34:364-372.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-bearing mammals of California. Vol. I. Univ. California Press, Berkeley. 376pp.

Hardy, G. H. 1979. Movement ecology of resident raccoons in East Tennessee. M.S. Thesis. Univ. of Tenn., Knoxville. 82pp.

Harthoorn, A. M. 1965. Application of pharmacological and physiological principles in restraint of wild animals. Wildl. Monog. 14.

Hayne, D. W. 1949. Calculation of size of home range. J. Mammal. 30:1-18.

Jennrich, R. I., and F. B. Turner. 1969. Measurement of noncircular home range. J. Theoret. Biol. 22:227-237.

Johnson, A. S. 1970. Biology of the raccoon (Procyon lotor varius Nelson and Goldman) in Alabama. Agric. Exp. Sta. Auburn Univ. Bulletin No. 402, 148pp.

Keeler, E. W. 1978. Some aspects of the natural history of the raccoon (Procyon lotor) in Cades Cove, The Great Smoky Mountains National Park. M.S. Thesis. Univ. Tennessee, Knoxville. 81pp.

Kellner, W. C. 1953. Factors influencing the raccoon and its management in Southwest Virginia. M.S. Thesis. Virginia Polytechnic Inst., Blacksburg, 81pp.

Kelly, W. F. 1967. Game kill survey. Pp 95B-132B In Annual Prog. Rept., Fed. Aid in Wildl. Restoration. Alabama Dept. Cons., Montgomery.

Koeppl, J. W., N. A. Slade, and R. S. Hoffman. 1975. A bivariate home range model with possible application to ethological data analysis. J. Mammal. 56:81-90.

Lehman, L. E. 1977. Population ecology of the raccoon on the Jasper-Pulaski wildlife study area. Indiana Dept. Nat. Res., Div. Fish and Wildl. PR Bulletin No. 9. 97pp.

Lueth, F. X. 1962. Alabama's predator studies. Proc. Ann. Conf. S.E. Fish and Game Agencies. 16:167-171.

McKeever, S. 1959. Relative abundance of twelve southeastern mammals in six vegetative types. Am. Midl. Nat. 62:222-226.

McLaughlin, J. H. 1953. Factors influencing the raccoon and its management in Southwestern Virginia. M.S. Thesis. Virginia Polytechnic Inst., Blacksburg. 56pp.

Madden, R., and L. F. Marcus. 1978. Use of the F-distribution in calculating bivariate normal home ranges. J. Mammal. 59:870-871.

Madson, J. 1964. Gray and fox squirrels. Olin Mathieson Chemical Corp., Cons. Dept., East Alton, IL. 112pp.

Martin, J. H., W. H. Lenoard, and D. L. Stamp. 1976. Principles of field crop production. Macmillan Publishing Co., Inc., New York. 1118pp.

Mech, L. D., J. R. Tester, and D. W. Warner. 1966. Fall daytime resting habits of raccoons as determined by telemetry. J. Mammal. 47:450-466.

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37:223-249.

Montgomery, G. C. 1964. Tooth eruption in preweaned raccoons. J. Wildl. Manage. 33:154-159.

Morbidity and Mortality Weekly Report. 1977. Annual summary 1976. U.S. Dept. H.E.W, Public Health Service, Center for Disease Control, Atlanta, GA. H.E.W. Pub. No. (CDC) 77-8241, Vol. 25:53.

Nelson, F. P. 1955. The place of stocking in game management. South Carolina Wildl. 2:2-3.

Nettles, V. F., and W. M. Martin. 1978. General physical parameters and health characteristics of translocated raccoons. Proc. Annu. Conf. S.E. Assoc. Fish and Wildl. Agencies 32:(in press).

Nichols, R. G., and C. J. Whitehead. 1978. Investigations into the effects of dog harrassment on relocated white-tailed deer. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies. 32:(in press).

Preble, N. A. 1940. The status and management of raccoon in central Ohio. M.S. Thesis. Ohio State Univ., Columbus. 149pp.

Redford, P. 1962. Raccoon in the U.S.S.R. J. Mammal. 43:541-542.

Rohlf, F. J., and R. R. Sokal. 1969. Statistical tables. W. H. Freeman and Company, San Francisco, CA. 253pp.

Schaffer, G. D., W. L. Hanson, W. R. Davidson, and V. F. Nettles. 1978. Hematotropoic parasites of translocated raccoons in the southeast. JAVMA 173:1148-1151.

Scheffer, V. B. 1947. Raccoons transplanted in Alaska. J. Wildl. Manage. 11:444-448.

Schneider, D. G., L. D. Mech, and J. R. Tester. 1971. An eight-month radio tracking study of raccoon families. Bull. Ecol. Soc. of Am. 47:149-150.

Schnell, J. H. 1970. Rest site selection by radio-tagged raccoons. Minn. Acad. Sci. 36:83-88.

Schultz, V. 1956. Status of the raccoon in Tennessee. J. Tenn. Acad. Sci. 31:263-267.

Seal, U. S., and A. W. Erickson. 1969. Immobilation of carnivora and other mammals with phencyclidine and promazine. Proc. Fed. Am. Soc. for Exp. Biol. 28:1410-1419.

Sharp, W. M., and L. H. Sharp. 1956. Nocturnal movements and behavior of wild raccoons at a winter feeding station. J. Mammal. 37:170-177.

Shirer, H. W., and H. S. Fitch. 1970. Comparison from radio tracking of movements and denning habits of the raccoon, striped skunk, and opossum in northeastern Kansas. J. Mammal. 51:491-503.

Smith, R. L. 1974. Ecology and field biology. Harper and Row, New York, NY. 850pp.

Sokal, R. R., and F. J. Rohlf. 1969. Biometry. W. H. Freeman and Co., San Francisco, CA. 776pp.

Stains, H. J. 1956. The raccoon in Kansas, natural history, management, and economic importance. Univ. of Kansas Mus. Nat. Hist. and State Biol. Survey. Misc. Publ. No. 10. 76pp.

Stewart, C. A. 1976. Forest management plan, Hatchie National Wildlife Refuge, Brownsville, Tennessee. U.S. Dept. Interior, Natl. Wildl. Ref. System. 168pp.

Stuewer, F. W. 1943a. Raccoons: their habits and management in Michigan. Ecol. Monogr. 13:203-257.

_____. 1943b. Reproduction of raccoons in Michigan. J. Wildl. Manage. 7:60-73.

Sunquist, M. E. 1967. Effects of fire on raccoon behavior. J. Wild. Manage. 48:673-674.

Sutton, R. W. 1964. Range extension of raccoon in Manitoba. J. Mammal. 45:311-312.

Tester, J. R. 1971 Interpretation of ecological and behavioral data on wild animals obtained by telemetry with special reference to errors and uncertainties. Symposium on Biotelemetry, Pretoria, South Africa. November 1971. 383-408.

Tevis, L. Jr. 1947. Summer activities of California raccoons. J. Mammal. 28:323-332.

TVA. 1971. Forest inventory statistics. Blount-Sevier County unit, East Tennessee. Div. Forestry, Fish., and Wildl. Development, Norris, TN. 19pp.

___. 1973. Forest inventory statistics. Loudon-Roane County unit, East Tennessee. Div. Forestry, Fish., and Wildl. Development, Norris, TN. 20pp.

Twitchell, A. R., and H. H. Dill. 1949. One hundred raccoons from one hundred and two acres. J. Mammal. 30:130-133.

Tennessee Statistical Abstract. 1974. The University of Tennessee Center for Business and Economic Research. Knoxville, TN, 705pp.

Tennessee Wildlife Resources Agency. 1970. Hunting and fishing demand and harvest inventory. Planning Report No. 4. Nashville, TN. 46 pp.

_____. 1971. Hunting and fishing demand, habitat and participation standards, 1951-1990. Planning Report No. 7. Nashville, TN. 51pp.

_____. 1977. Forest game harvest data and range surveys, 1977-1978. TWRA Tech, Report 77-14. Nashville, TN, 194pp.

Urban, D. 1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. J. Wildl. Manage. 34:372-382.

U.S. Census. 1970. Census of the population. Vol. 1, Characteristics of the population. U.S. Government Printing Office, Washington, DC.

Walls, D. T. 1964. Wild turkey brood range requirements and contributions of spring seeps to the winter range, Cameron County, PA. Proc. N.E. Fish and Wildl. Conf., Hartford, CN. 105-119.

Warr, E. L. 1978. Evaluation of the habitat, density, and distribution of a raccoon population in East Tennessee. M.S. Thesis. Univ. of Tennessee, Knoxville, 121pp.

Welborn, T. C. 1975. Some physiological parameters and gastrointestinal helminths of the gray squirrel (Sciurus carolinensis) in Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 84pp.

White, D. W. 1978. Evaluation of a ruffed grouse restoration attempt in western Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville, 85pp.

Whitehead, C. J. 1975. 1975-1976 Wildlife research program. Tennessee Wildlife Resources Agency, Nashville. 113pp.

Whitney, L. F., and A. B. Underwood. 1952. The raccoon. Practical Sci. Publ. Co., Orange, CN. 177pp.

Wing. L. 1940. A game survey in northeastern Tennessee. J. Tenn. Acad. Sci. 15:309-320.

Woods, J. W. 1978. Population characteristics of raccoons (Procyon lotor) on the Chuck Swan Wildlife Management Area, Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 93pp.

Wright, G. A. 1977. Dispersal and survival of translocated raccoons in Kentucky. Proc. Ann. Conf. S.E. Assn. Fish and Wildl. Agencies. 31:(in press).

Yeager, L. E., and R. G. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois river bottom lands. J. Wildl. Manage. 7:45-60.

APPENDIX

APPENDIX

SUMMARY OF INDIVIDUAL MOVEMENTS

Raccoon Number Y28

Y28 was an age class II female weighing 4.5 kg when released 11 March 1977 at the Lotterdale Knob site. It was fitted with radio transmitter frequency 150.905 MHz. For the next 6 days it was located in small forest tracks adjacent to the Little Tennessee River. On 21 March 1977 it returned to the release site then began its dispersal route again. It was killed by a car on 28 March 1977 7.3 linear km from the release site after 18 days in the field. Since it was located only 11 times during this period, no home range estimate was made.

Raccoon Number Y29

Y29 was an age class I male weighing 3.3 kg when released 10 March 1977 at the Lotterdale Knob site. Its radio transmitter frequency was 151.010. It established a home range which encompassed the release site and the animal was never located farther than 1.44 km from the actual release site (Figure 16). Most of the raccoon's movement occurred along streams and in hardwood stands within the Lotterdale Knob watershed. This area was also occupied by raccoon number Y38. Intensive summer dog training activity pushed these raccoons outside their normal ranges for 2 nights. After this brief excursion, Y29 was never located farther than 1 km from the release site. The transmitter failed after 183 days during which time the raccoon was located on 155 occasions.

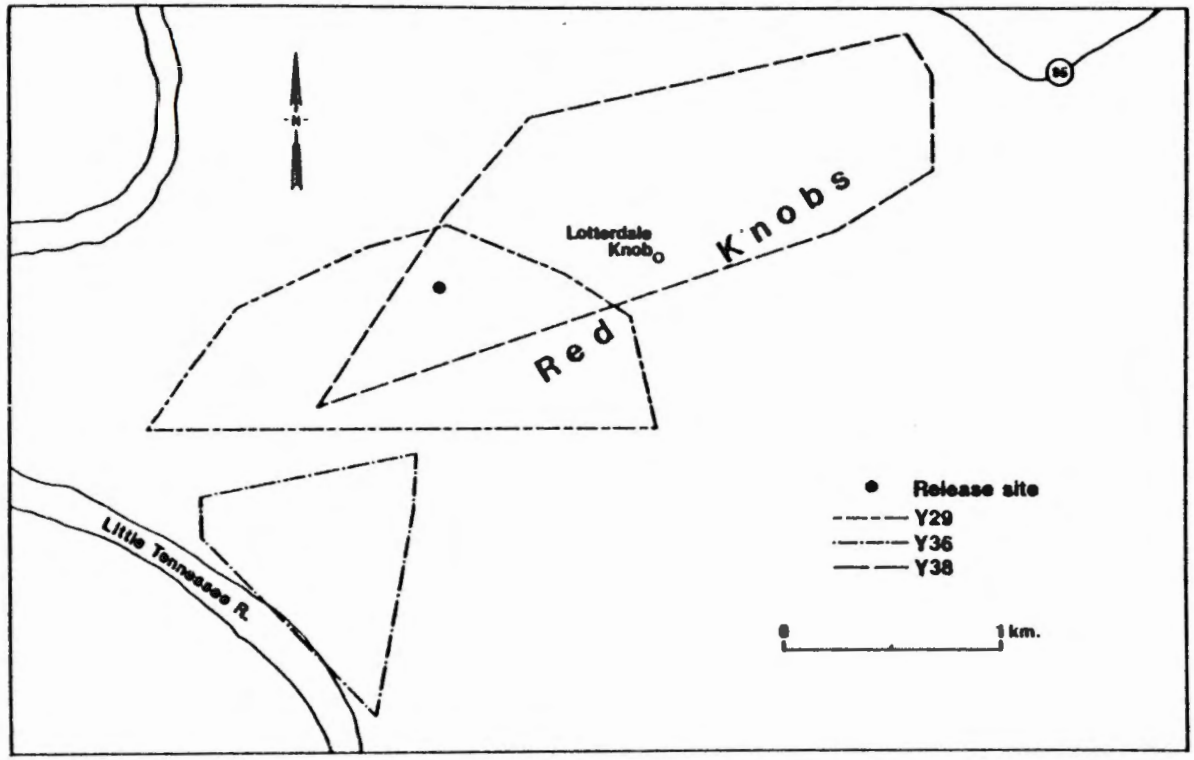


Figure 16. Convex polygon home ranges of 1 male (Y29) and 2 female (Y36 and Y38) raccoons released in Loudon County, Tennessee and radio-monitored for 183, 33, and 150 days, respectively.

Raccoon Number Y36

Y36 was an age class II female weighing 4.1 kg when released at the Lotterdale Knob site on 10 March 1977. The transmitter frequency given to this animal was 151.157 MHz. For the next 12 days, Y36 remained within 900 m of the release site and stayed in close proximity to Y29. On 23 March 1977 it moved approximately 800 m from its last location to a hardwood stand along the Little Tennessee River. It remained in this area and established a home range (Figure 16). The raccoon was found shot in the head with a .22 caliber bullet along the river bank on 11 April 1977. The radio collar was still intact and attached to the animal but both had been run over and pushed into the mud by what appeared to be a pickup truck. During the 33 days Y36 was in the field, it was located 30 times.

Raccoon Number Y37

Y37 was an age class II male weighing 4.1 kg when released 9 April 1977 at the Lotterdale Knob site. Its radio transmitter frequency was 151.085 MHz. For the next 8 days following release, it remained in the Lotterdale Knob watershed approximately 400 m from the actual release site. The raccoon then gradually expanded its range over the next month to include Negro Hollow and some smaller woodlots mixed with pasturelands to the south. The resulting home range was the largest of the raccoons monitored (Figure 17). This large area was traversed almost entirely at biweekly intervals. The transmitter failed after 91 days during which time 61 locations were recorded.

Raccoon Number Y38

Y38 was an age class I female weighing 3.2 kg when released

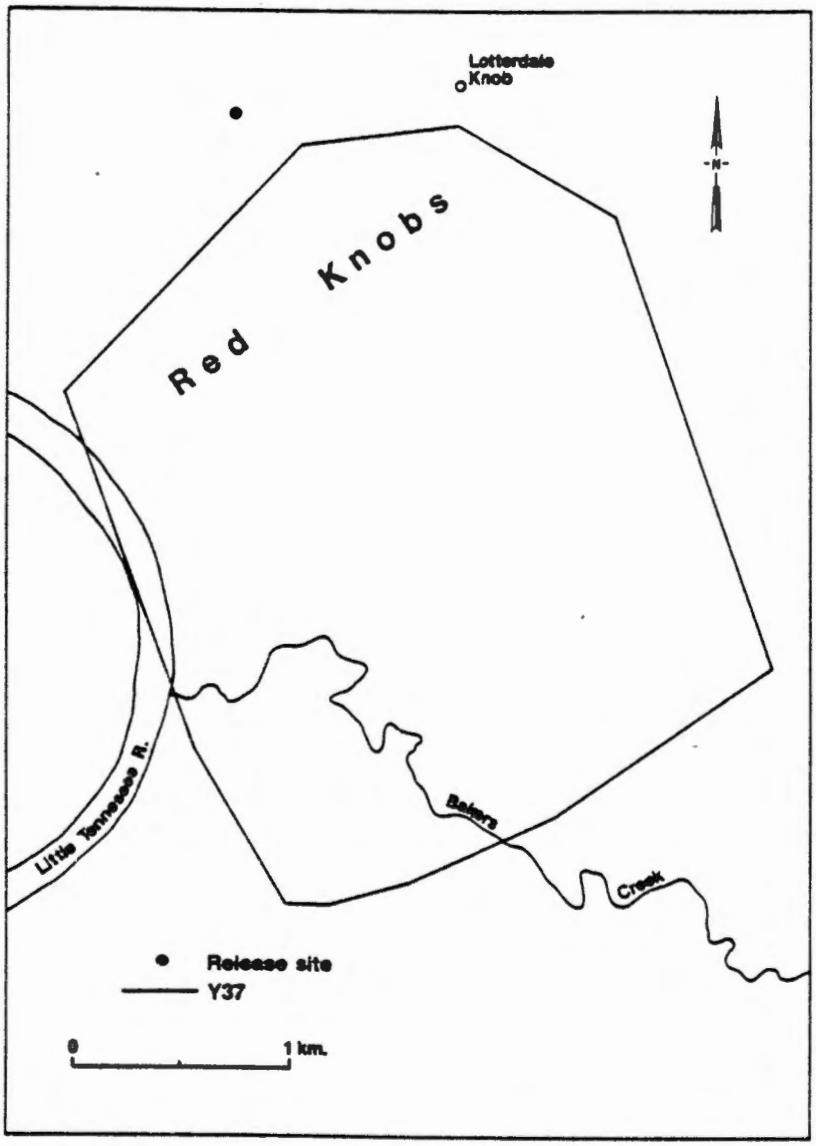


Figure 17. Convex polygon home range of raccoon number Y37 (adult male) released in Loudon County, Tennessee and radio-monitored for 91 days.

9 April 1977 at the Lotterdale Knob site. Its radio transmitter frequency was 150.932 MHz. The raccoon remained within 500 m of the release area and gradually extended its range northwesterly along the Red Knobs ridge system (Figure 16). Nightly movements were concentrated along small creeks originating in the ridges and following along the borders of old field situations and cropland. These areas were also utilized by Y29, and the 2 animals were often located within 100 m of each other. As with Y29, this raccoon also abandoned its "normal" home range during intensive dog training activities, but returned to the area after these activities subsided. This raccoon inhabited the immediately vicinity of Lotterdale Knob throughout the remainder of the tracking period and was located 122 times during the 150 days the transmitter functioned.

Raccoon Number Y40

Y40 was an age class II female weighing 3.7 kg when released 9 April 1977 at the Lotterdale Knob site. Its transmitter frequency was 151.110 MHz. This animal did not have claws or phlanges on the hind feet, apparently due to a birth defect. Nevertheless, it was located numerous times inside tree dens 5-7 m from the ground and exhibited no handicap in movements. Y40 denned with Y37 for 3 days after release, then moved from the release site to the Negro Hollow area where it established a home range that eventually encompassed both Lotterdale Knob, Negro Hollow, and woodlots to the south (Figure 18). This home range was the second largest as calculated by all methods. Y40 was located on 96 occasions during the 144 days which the transmitter was functional.

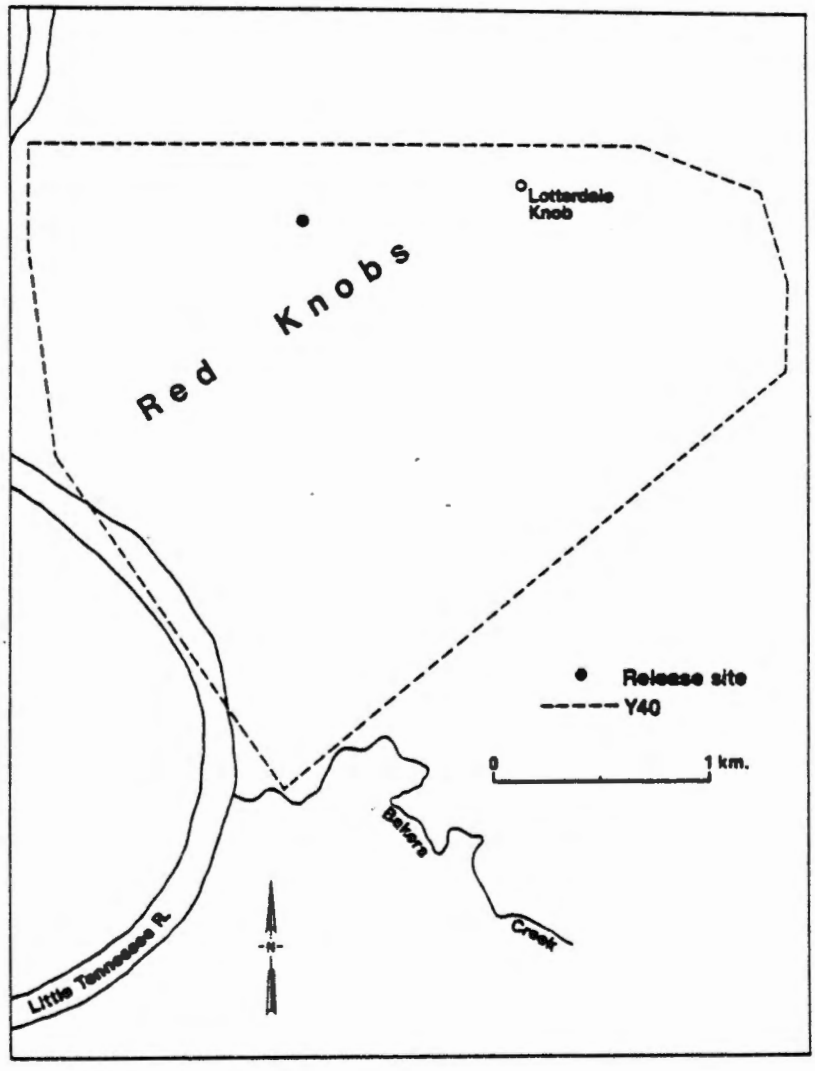


Figure 18. Convex polygon home range of raccoon number Y40 (adult male) released in Loudon County, Tennessee and radio-monitored for 144 days.

Raccoon Number Y42

Y42 was an age class III male weighing 4.2 kg when released 25 June 1977 at the Alexander Knob site. It was given radio transmitter frequency 151.130 MHz. The raccoon remained near the release site for 20 days during which time dog training activities were intensive. After this period it moved approximately 3.6 km to woodlots bordering Fort Loudon Lake. During subsequent tracking efforts, Y42 was known to have crossed the 600 m lake on 12 occasions. Its home range encompassed both sides of the lake (Figure 19). This raccoon was illegally killed after 179 days in the field during which time 60 locations were recorded.

Raccoon Number Y45

Y45 was an age class V female weighing 3.9 kg when released 25 June 1977 at the Alexander Knob site. It was fitted with radio transmitter frequency 151.690 MHz. Following release, Y45 moved approximately 1.1 km to a series of small woodlots, corn fields, and pasture lands. Movements and denning were centered around this area, and a home range was established that extended to the Cloyd Creek slough of Fort Loudon Lake (Figure 20). This raccoon was monitored for 96 days and 75 locations were recorded during that time. It was possible that Y45 was illegally killed during dog training activities, but the reports from local residents were unconfirmed.

Raccoon Number Y48

Y48 was an age Class II female weighing 4.6 kg when released 25 June 1977 at the Alexander Knob site. It was located in a small

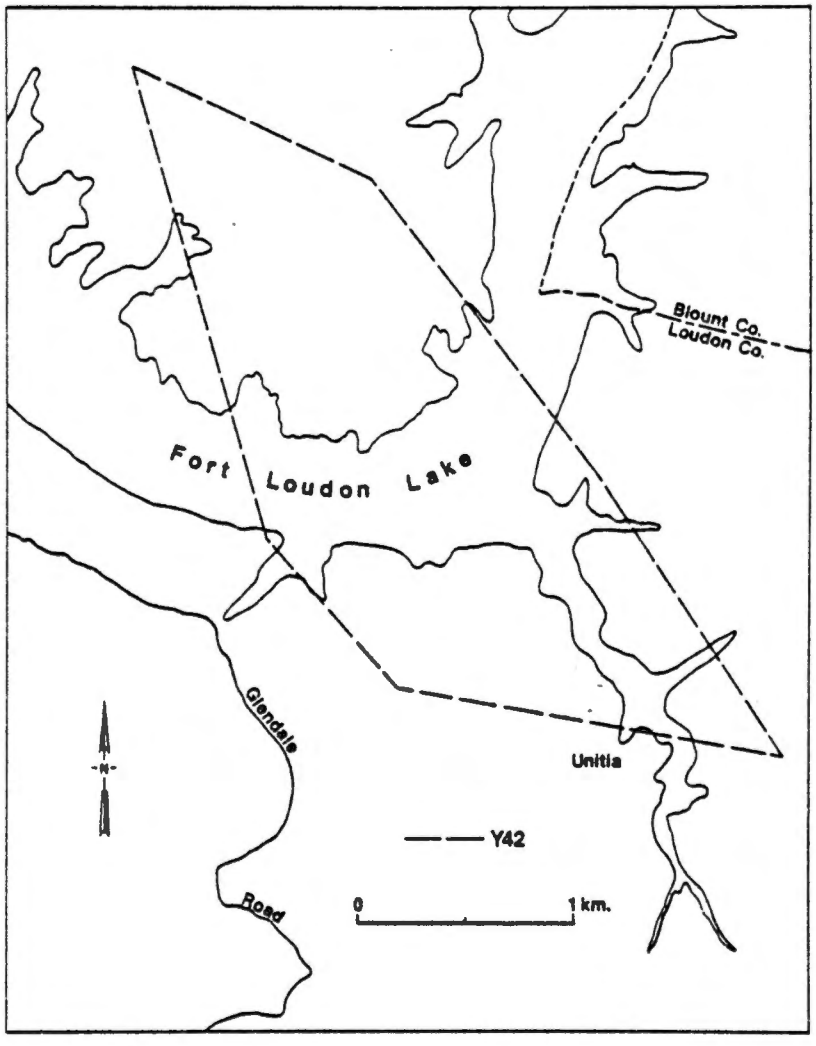


Figure 19. Convex polygon home range of raccoon number Y42 (adult male) released in Blount County, Tennessee and radio-monitored for 179 days.

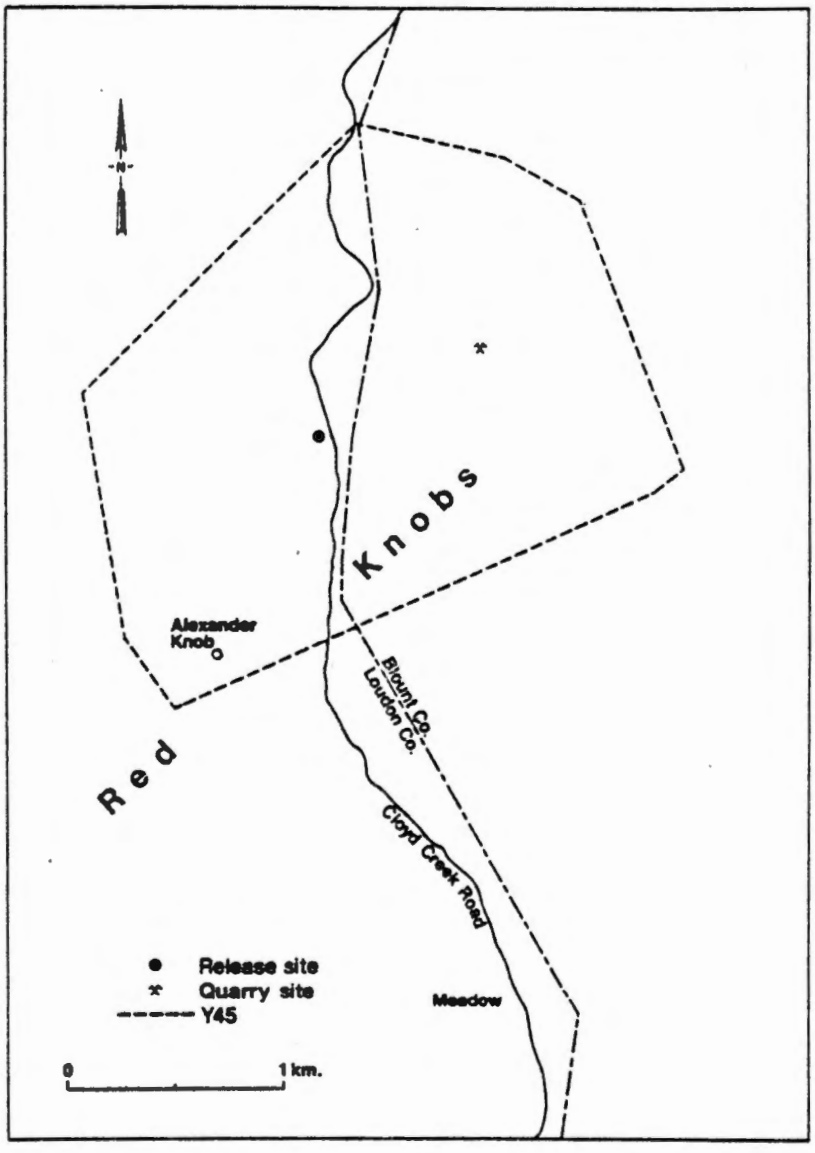


Figure 20. Convex polygon home range of raccoon number Y45 (adult female) released in Blount County, Tennessee and radio-monitored for 96 days.

woodlot 100 m from the release site for 3 days, after which it moved approximately 500 m into an adjacent woodlot containing 2 abandoned quarries (Figure 21). Den sites were often located in and around rock piles at these quarries. Y48 stayed in this area for 180 days at which time the transmitter no longer was functional. A total of 126 locations were recorded for this animal.

Raccoon Number Y49

Y49 was an age class II female weighing 5.0 kg when released at the Alexander Knob site on 25 June 1977. It was fitted with radio transmitter frequency 151.960 MHz. This animal remained in the Alexander Knob watershed, establishing a home range encompassing the release site (Figure 22). In mid October dog training activities increased and Y45 was reportedly "treed" on several occasions. Movement during this period extended outside the home range and into an adjacent forest tract containing the 2 abandoned quarries. By the last week in October, all denning and foraging activities were centered in this new woodlot, with the majority of dens located in the quarry rock piles. Another raccoon, Y48, also inhabited this section of woodland. Y49 never returned to the Alexander Knob home range during the remainder of the tracking period. A total of 141 locations were recorded for this raccoon during the 178 days the transmitter was functional.

Raccoon Number Y51

Y51 was an age class II female weighing 3.8 kg when released 3 December 1977 at the Glendale-Little Tennessee River site. It was equipped with radio transmitter number 151.360 MHz. It established

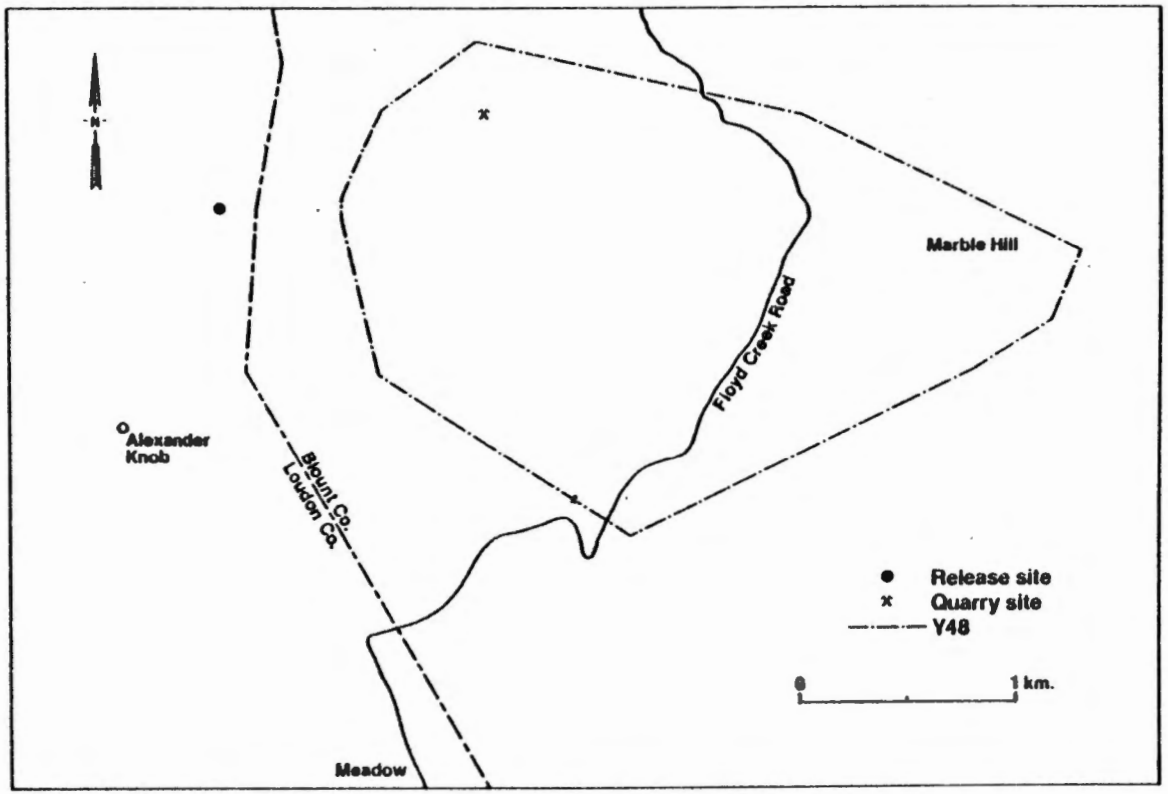


Figure 21. Convex polygon home range of raccoon number Y42 (adult female) released in Blount County, Tennessee and radio-monitored for 180 days.

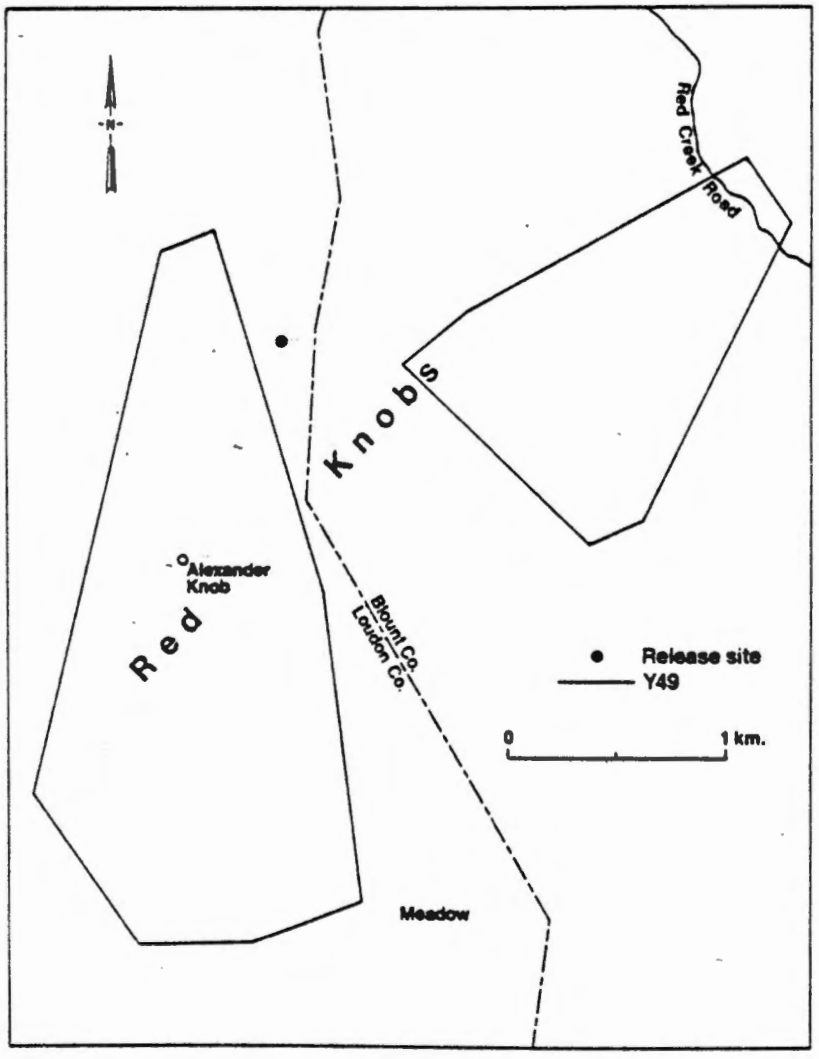


Figure 22. Convex polygon home ranges of raccoon number Y49 (adult male) released in Blount County, Tennessee and radio-monitored for 178 days.

a home range near the release site and movements were concentrated in a small farm woodlot adjacent to Coytee Creek (Figure 23). It was located on 48 occasions during the 84-day monitoring period. The raccoon removed the radio-collar on the 85th day in the field. Y51 was killed during the legal 4 night hunt 500 m from the release site on 10 November 1978.

Raccoon Number Y52

Y52 was an age class IV female weighing 3.4 kg when released 3 December 1977 at the Glendale-Little Tennessee River site. It carried radio transmitter frequency 151.258 MHz. Following release, the raccoon moved approximately 1.4 km to a farm woodlot bordered by agricultural cropland and a TVA powerline. It remained in this woodlot through mid-May, foraging primarily in edge or ecotonal situations (Figure 23). Seat collected at its den sites revealed that passerine birds and chickens from a nearby farm, comprised a significant portion of the diet during winter and early spring. Y52 was observed raiding a chicken coop on 3 occasions, all between 0300 and 0430 hours EST. Logging activities in the farm woodlot triggered a dispersal into another woodlot approximately 300 m away. Y52 was located in this woodlot until the transmitter failed in mid-September. A total of 261 locations were recorded for this raccoon over a 257 day period. Attempts to retrap Y52 and replace the radio collar were unsuccessful, although the raccoon visited the live-trap every night they were set.

Raccoon Number Y53

Y53 was an age class IV female weighing 3.0 kg when released

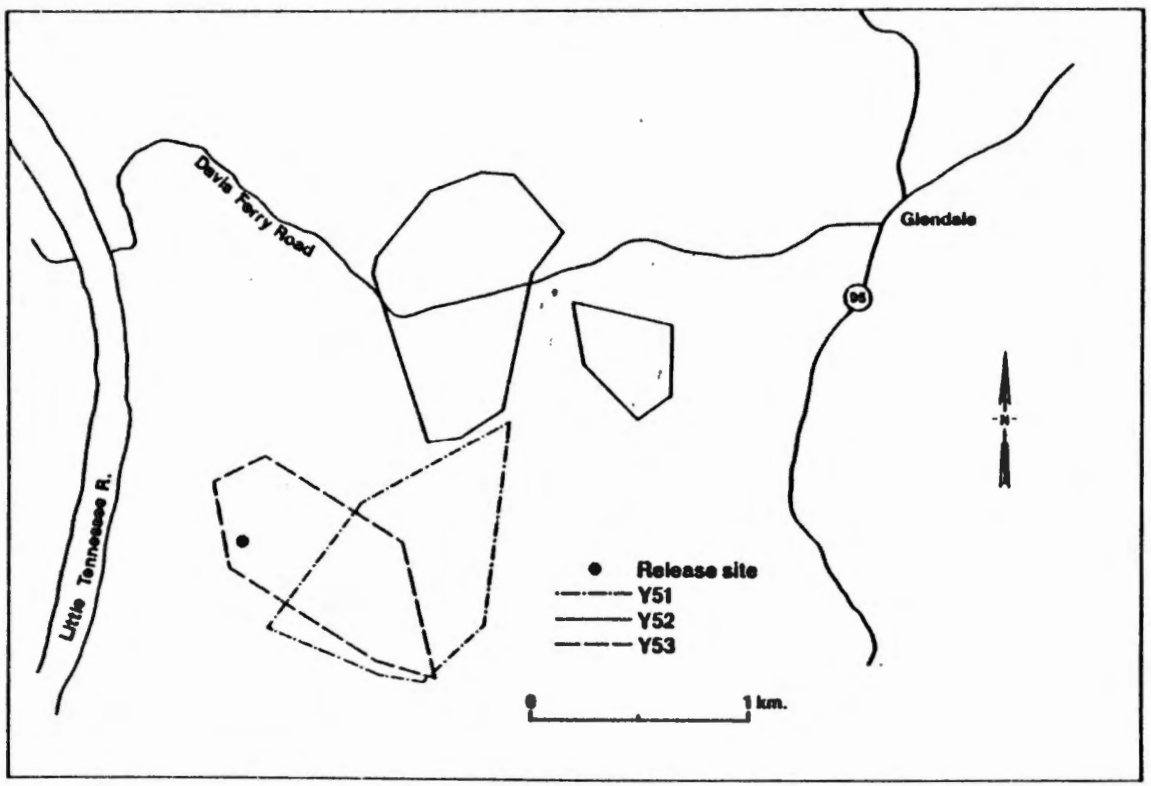


Figure 23. Convex polygon home ranges of raccoon numbers Y51, Y52, and Y53 (adult females) released in Loudon County, Tennessee and radio-monitored for 84, 257, and 80 days, respectively.

3 December 1977 at the Glendale-Little Tennessee River site. Its transmitter frequency was 151.315 MHz. After release Y53 was not known to move farther than 200 m from the release site (Figure 23). During unseasonably cold weather in mid February, Y53 was found dead in a small tree den apparently due to exposure and related complications. It was located 58 times during the 80 days it was in the field.

Raccoon Number Y54

Y54 was an age class II female weighing 4.6 kg when released 3 December 1977 at the Glendale-Little Tennessee River site. It was given radio transmitter frequency 151.420 MHz. After release, Y54 began moving northward along the bank of the Little Tennessee River. It gradually followed this course for 20 days until it reached the Tellico Dam just above the confluence of the Little Tennessee and Tennessee Rivers, approximately 6.0 linear km from the release site (Figure 24). It remained in this woodlot and established a home range. Y54 was found dead 20 March 1978 after the subfreezing temperatures of February had subsided. The raccoon had lost approximately 0.5 kg in weight and was in poor general condition. It was located 75 times during the 108 days it was in the field.

Raccoon Number Y55

Y55 was an age class I female weighing 2.9 kg when released 5 May 1978 at the Glendale-Little Tennessee River site. Its transmitter frequency was 151.346 MHz. Y55 followed the dispersal pattern of Y52, and also abandoned the first farm woodlot when logging activity encompassed the entire area. It moved to the same woodlot as Y52 and

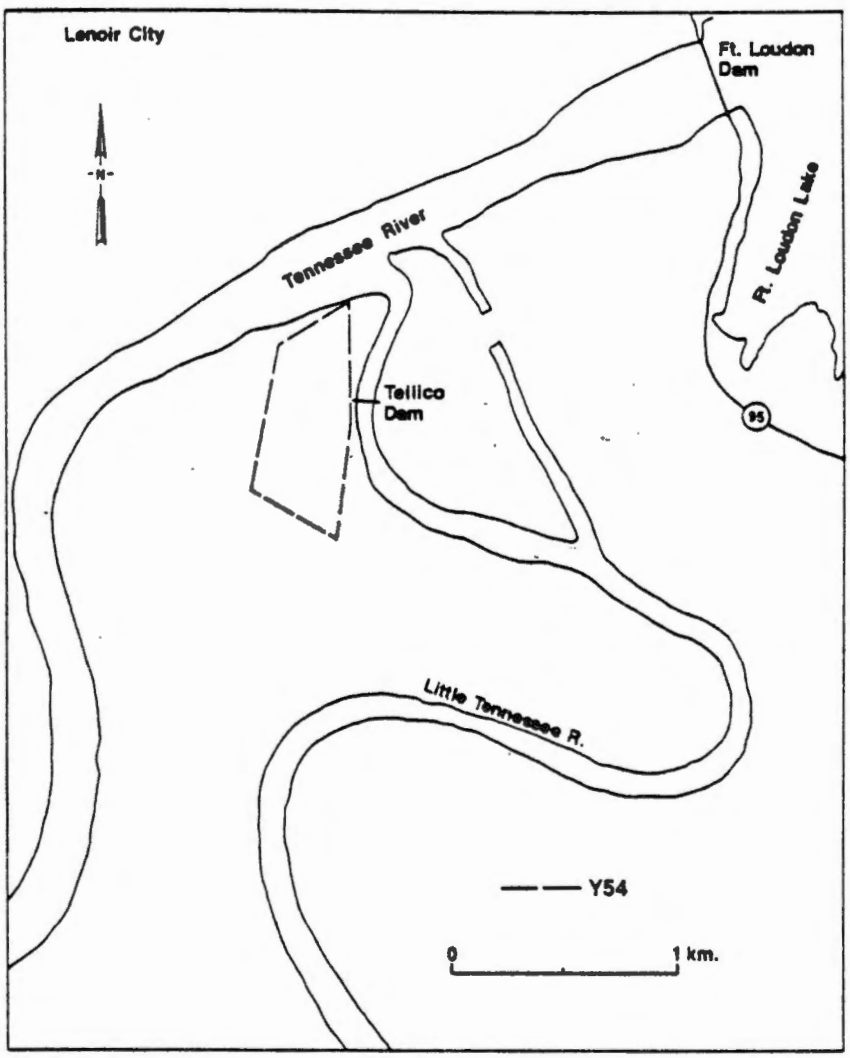


Figure 24. Convex polygon home range of raccoon number Y54 (adult female) released in Loudon County, Tennessee and radio-monitored for 108 days.

remained here until tracking was discontinued (Figure 25). Y55 and Y52 were often located in close proximity to each other, and utilized the same food sources throughout the summer and early fall. When tracking was discontinued 11 November 1978, the transmitter was still functional. A total of 150 locations were recorded for Y55 over a 200 day period.

Raccoon Number Y57 and Y58

Y57 (male) and Y58 (female) weighed 3.3 and 2.1 kg, respectively when released 5 May 1978 at the Glendale-Little Tennessee River site. They were both killed during dog training activities within 2 days following release.

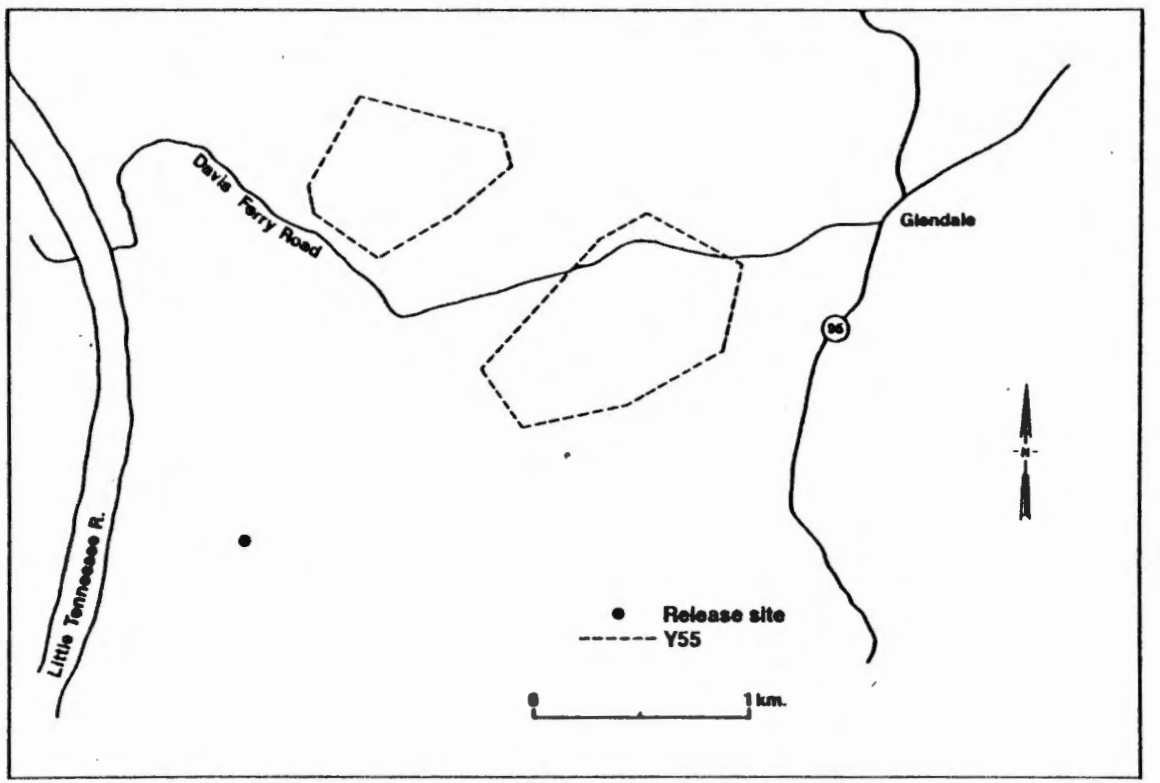


Figure 25. Convex polygon home ranges of raccoon number Y55 (adult female) released in Loudon County, Tennessee and radio-monitored for 200 days.

TABLE 13. West Tennessee raccoons ear-tagged and released in Blount and Loudon Counties, 16 July 1975 through 5 May 1978.

Release date	Release county	Adult males	Juvenile males	Total males	Adult females	Juvenile females	Total females	Total raccoons
7-16-75	Blount	4	7	11	11	8	19	30
7-25-75	Loudon	4	6	10	4	6	10	20
8-1-75	Loudon	4	10	14	6	2	8	22
8-7-75	Blount	8	6	14	11	5	16	30
8-7-75	Loudon	2	1	3	2	2	4	7
8-13-75	Blount	9	4	13	14	3	17	30
3-10-77[a]	Loudon	1	0	1	2	0	2	3
4-9-77[a]	Loudon	2	0	2	1	0	1	3
6-14-77	Blount	4	4	8	2	0	2	10
6-25-77[a]	Blount	5	1	6	5	4	9	15
7-7-77	Blount	5	3	8	11	1	12	20
7-13-77	Blount	0	2	2	2	5	7	9
7-13-77	Loudon	3	3	6	1	6	7	13

TABLE 13. Continued

Release date	Release county	Adult males	Juvenile males	Total males	Adult females	Juvenile females	Total females	Total raccoons
7-23-77	Loudon	10	5	15	10	9	19	34
8-4-77	Loudon	6	4	10	6	2	8	18
8-23-77	Loudon	6	1	7	5	3	8	15
12-3-77[a]	Loudon	0	0	0	4	0	4	4
5-5-78	Loudon	1	0	1	2	0	2	3
Blount County Total		35	27	62	56	26	82	144
Loudon County Total		39	30	69	43	30	73	142
	Total	74	57	131	99	56	155	286

[a]Denotes release dates of ear-tagged raccoons equipped with radio transmitter collars.

TABLE 14. Tag returns of 29 West Tennessee raccoons released 16 July 1975 through 5 May 1978 in Blount and Loudon Counties, East Tennessee.

Tag number Metal	Tag number Plastic	Sex and age[a]	Days to recovery	Reproductive status	Dispersal distance (km)	Dispersal direction	Recovery method[b]
--	B58	M A	187	--	1.92	SW	FD (Auto)
T3939	Y28	F A	18	--	7.29	S	FD (Auto)
T4054	Y53	F A	80	Had not bred	0.12	SE	FD
T4055	Y54	F A	108	Had not bred	6.01	N	FD
T3106	--	F A	20	--	2.40	W	FD
T3113	--	M A	365	--	0.24	W	R
T3166	R20	F A	339	Bred	4.57	NW	R
T2945	--	F J	147	Had not bred	1.92	SE	R
T2933	--	F A	727	Had not bred	4.80	E	R
229	R73	M A	72	--	1.27	NE	R
556	Y001	M A	109	--	2.04	NE	R
T3145	--	F A	704	Had not bred	12.25	SW	R
T3169	--	M A	152	--	13.22	NW	IL
T3658	--	M J	873	--	3.61	SW	IL

TABLE 14. Continued.

Tag number Metal	Tag number Plastic	Sex and age[a]	Days to recovery	Reproductive status	Dispersal distance (km)	Dispersal direction	Recovery method[b]
T2773	--	F A	1084	Bred	2.16	W	IL
T3105	--	F A	1091	Bred	0.50	NW	IL
254	R57	M A	358	--	6.20	N	IL
233	R68	M A	213	--	13.60	E	IL
555	RY100	M A	4	--	4.81	N	IL
222	B82	M A	119	--	37.13	W	IL
T3941	Y36	F A	33	--	1.11	S	IL
T2263	Y42	M A	179	--	3.48	N	IL
T4056	Y57	F A	1	--	0.05	E	IL
T4057	Y58	F A	2	--	0.07	W	IL
T3132	--	F A	1207	Bred	2.10	S	H
--	B57	M A	505	--	1.00	W	H
257	R54	F J	477	Bred	2.00	W	H
T4051	Y51	F A	337	Bred	0.50	E	H

TABLE 14. Continued.

Tag number Metal	Plastic	Sex and age[a]	Days to recovery	Reproductive status	Dispersal Distance (km)	Dispersal direction	Recovery method[b]
268	RY83	F A	458	Bred	7.50	E	H
		$\bar{X}$	343.8		4.96		

[a]Adult or juvenile.

[b]FD = found dead, R = recapture, IL = illegal kill, H = legal kill during experimental hunt.

TABLE 15. Sex, age, and weight of 17 West Tennessee raccoons radio-collared and released in Blount and Loudon Counties from 10 March 1977 to 5 May 1978.

Tag number Metal	Tag number Plastic	Transmitter frequency (MHz)	Sex	Age class[a]	Weight (kg)	Release date	Release location
T3939	Y28	150.905	F	II	4.50	3-11-77	Lotterdale Knob
T3942	Y29	151.010	M	I	3.30	3-10-77	Lotterdale Knob
T3941	Y36	151.157	F	II	4.10	3-10-77	Lotterdale Knob
T2258	Y37	151.085	M	II	4.10	4-9-77	Lotterdale Knob
T2259	Y38	150.932	F	I	3.20	4-9-77	Lotterdale Knob
--	Y40	151.110	M	II	3.70	4-9-77	Lotterdale Knob
T2263	Y42	151.130	M	III	4.20	6-25-77	Alexander Knob
T2275	Y45	151.690	F	V	3.90	6-25-77	Alexander Knob
T2274	Y48	150.905	F	II	4.60	6-25-77	Alexander Knob
T2273	Y49	150.960	M	II	5.00	6-25-77	Alexander Knob
T4051	Y51	151.360	F	II	3.85	12-3-77	Glendale-Little Tennessee River
T4053	Y52	151.258	F	IV	3.40	12-3-77	Glendale-Little Tennessee River

TABLE 15. Continued

Tag number Metal	Tag number Plastic	Transmitter frequency (MHz)	Sex	Age class[a]	Weight (kg)	Release date	Release location
T4054	Y53	151.315	F	IV	3.00	12-3-77	Glendale-Little Tennessee River
T4055	Y54	151.420	F	II	4.60	12-3-77	Glendale-Little Tennessee River
T4060	Y55	151.346	F	I	2.90	5-5-78	Glendale-Little Tennessee River
T4056	Y57	151.395	M	III	3.30	5-5-78	Glendale-Little Tennessee River
T4057	Y58	151.236	F	I	2.10	5-5-78	Glendale-Little Tennessee River

[a]After Grau et al. (1970).

TABLE 16. Home range estimates for 14 West Tennessee raccoons fitted with radio transmitters and released in Blount and Loudon Counties, East Tennessee.

Raccoon number	Sex	Age class[a]	Number of locations	Confidence interval ellipse (ha)				Convex polygon (ha)	Minimal polygon (ha)
				95%	90%	75%	50%		
Y29	M	I	155	99.59	76.35	46.14	23.00	161.16	50.34
Y36	F	II	19	202.29	148.76	85.09	40.68	69.06	31.54
Y37	M	II	62	1385.48	1051.51	624.80	308.53	765.65	398.74
Y38	F	I	122	160.93	123.19	73.39	36.54	215.57	55.22
Y40	M	II	96	910.98	694.23	413.33	205.02	670.08	361.77
Y42	M	III	12	685.79	495.39	275.02	129.58	140.28	46.56
Y42	M	III	43	586.82	443.58	262.05	128.45	367.49	217.59
Y45	F	V	69	770.81	585.60	348.07	172.04	436.23	180.51
Y48	F	II	120	538.90	412.52	245.75	122.35	454.68	186.37
Y49	M	II	98	661.56	507.19	306.52	152.82	302.71	113.94
Y49	M	II	39	260.78	196.85	116.02	56.79	143.17	61.86
Y51	F	II	38	271.57	204.85	120.57	59.01	70.50	42.37
Y52	F	IV	176	81.89	62.78	37.94	18.92	67.73	47.08

TABLE 16. Continued

Raccoon number	Sex	Age class[a]	Number of locations	Confidence interval ellipse (ha) 95%	90%	75%	50%	Convex polygon (ha)	Minimal polygon (ha)
Y52	F	IV	66	40.77	30.95	18.39	9.08	18.92	12.48
Y53	F	IV	58	46.07	34.94	20.74	10.23	53.26	32.12
Y54	F	II	44	26.04	19.68	11.62	5.69	29.29	8.06
Y55	F	I	39	100.65	75.98	44.78	21.92	38.04	24.98
Y55	F	I	96	76.63	58.44	34.78	17.25	65.39	43.87
		$\bar{X}$	75.11	383.75	290.16	171.39	84.33	226.05	106.41

[a]As described by Grau et al. (1970).

TABLE 17. Average minimum 24-hour movements of 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee (based on approximately 1000 movements).

Raccoon number	Sex	Age class[a]	Release site	Release season	Average 24-hour movements (m)	
					Adjustment period	Post-adjustment period
Y29	M	I	Lotterdale Knob	Winter	284.56	315.33
Y36	F	II	Lotterdale Knob	Winter	383.82	392.96
Y37	M	II	Lotterdale Knob	Spring	1628.06	1480.98
Y38	F	I	Lotterdale Knob	Spring	422.52	403.77
Y40	M	II	Lotterdale Knob	Spring	1140.89	1187.04
Y42	M	III	Alexander Knob	Summer	840.23	639.54
Y45	F	V	Alexander Knob	Summer	689.54	440.30
Y48	F	II	Alexander Knob	Summer	543.41	461.93
Y49	M	II	Alexander Knob	Summer	610.94	980.83
Y51	F	II	Glendale-Little Tennessee River	Fall	670.79	429.25
Y52	F	IV	Glendale-Little Tennessee River	Fall	277.11	230.01

TABLE 17. Continued.

Raccoon number	Sex	Age class[a]	Release site	Release season	Average 24-hour movements (m) Adjustment period[b]	Post-adjustment period[c]
Y53	F	IV	Glendale-Little Tennessee River	Fall	211.98	249.71
Y54	F	II	Glendale-Little Tennessee River	Fall	681.12	278.31
Y55	F	I	Glendale-Little	Spring	463.38	276.39
				$\bar{X}$	632.09	554.71

[a]As described by Grau et al. (1970).

[b]Adjustment period includes 30 days following release.

[c]Post-adjustment = total days monitored - adjustment period.

TABLE 18. Dispersal characteristics of 17 West Tennessee raccoons equipped with radio-transmitters and released in Blount and Loudon Counties, Tennessee.

Tag number		Sex	Days monitored	Number of locations	Minimum dispersal (km)	Dispersal direction	Maximum dispersal (km)
Metal	Plastic						
T3939	Y28	F	18	11	6.63	SE	--
T3942	Y29	M	183	155	0.00	--	1.44
T3941	Y36	F	33	30	1.11	S	1.95
T2258	Y37	M	91	67	0.46	SE	3.61
T2259	Y38	F	150	122	0.00	--	2.45
--	Y40	M	144	96	0.00	--	2.57
T2263	Y42	M	179	60	1.42 3.48	NE N	7.74
T2275	Y45	F	96	75	0.22	NW	1.68
T2274	Y48	F	180	126	0.65	NE	3.87
T2273	Y49	M	178	141	0.00 1.06	-- NE	2.81
T4051	Y51	F	84	48	0.48	E	1.37
T4053	Y52	F	257	261	1.13 1.92	NE NE	2.14
T4054	Y53	F	80	58	0.00	--	1.03

TABLE 18. Continued

Tag number Metal	Tag number Plastic	Sex	Days monitored	Number of locations	Minimum dispersal (km)	Dispersal direction	Maximum dispersal (km)
T4055	Y54	F	108	75	6.15	NW	11.15
T4060	Y55	F	200	150	1.59	NE	2.72
T4056[a]	Y57	M	1	2	--	--	--
T4057[a]	Y58	F	2	3	--	--	--
		$\bar{X}$	87.12	116.76	1.46		3.32

[a]Raccoons number Y57 and Y58 were illegally killed immediately after release and were not included in dispersal calculations.

TABLE 19. Physical parameters of 60 den sites recorded for 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee.

Den site	dbh (cm)	Height (m)	Distance from den location (m)			
			Water	Agricultural Land	Type	Human inhabitance
Quercus alba	61	18	144	15	Pasture	20
Q. alba	60	9	15	360	Pasture	600
Q. alba	71	17	20	50	Corn	340
Q. alba	45	10	240	360	Pasture	720
Q. alba	55	14	336	480	Corn	600
Q. alba	30	10	140	576	Corn	960
Q. alba	40	15	24	59	Corn	840
Q. alba	71	17	72	20	Corn	240
Q. alba	66	10	192	50	Pasture	480
Q. alba	45	10	240	250	Pasture	696
Q. alba	61	8	360	120	Pasture	355
Q. alba	61	15	72	408	Pasture	480
Q. alba	76	11	216	475	Pasture	528
Q. alba	127	14	96	5	Pasture	360
Q. alba	51	14	10	600	Corn	2160
Q. velutina	56	21	72	240	Pasture	312
Q. velutina	84	14	75	816	Corn	600
Q. velutina	58	14	96	360	Pasture	552
Q. velutina	51	14	48	384	Corn	840
Q. velutina	66	14	72	15	Corn	720
Q. velutina	66	15	75	40	Corn	745
Q. velutina	61	12	70	35	Corn	732
Q. velutina	81	17	72	80	Pasture	192

TABLE 19. Continued.

Den site	dbh (cm)	Height (m)	Distance from den location (m)			Human inhabitance
			Water	Agricultural Land	Type	
Quercus velutina	81	21	48	168	Soybeans	432
Q. velutina	46	13	24	365	Pasture	720
Q. velutina	40	7	96	380	Pasture	709
Q. velutina	76	15	96	70	Pasture	456
Q. velutina	51	13	10	325	Corn	892
Q. rubra	51	18	183	720	Pasture	960
Q. rubra	53	20	120	192	Soybeans	576
Q. rubra	81	20	124	200	Soybeans	590
Q. rubra	66	14	360	480	Corn	984
Q. rubra	81	20	20	72	Corn	361
Q. rubra	66	14	70	50	Pasture	216
Carya tomentosa	48	11	18	242	Pasture	432
C. tomentosa	41	9	144	260	Pasture	450
C. tomentosa	53	20	72	480	Pasture	412
C. tomentosa	46	15	10	50	Corn	241
C. ovata	30	14	30	60	Corn	605
C. ovata	30	9	21	62	Corn	584
C. ovata	51	17	130	105	Soybeans	291
Lirodendron tulipifera	76	23	120	97	Corn	484
L. tulipifera	61	20	192	122	Pasture	238
L. tulipifera	43	11	95	60	Corn	320
Fagus grandifolia	56	12	25	620	Pasture	1080
Liquidambar styraciflua	46	14	50	108	Corn	410
Nyssa sylvatica	51	14	144	239	Pasture	585
Paulowina tomentosa	40	12	50	558	Corn	1105

TABLE 19. Continued

Den site	dbh (cm)	Height (m)	Distance from den location (m) Water	Agricultural Land	Type	Human inhabitance
Fraxinus americana	51	12	5	220	Pasture	250
Juniperus virginiana	21	8	182	96	Pasture	420
	$\bar{X}$ 57.6	14.2				
Ground den			5	20	Pasture	220
Ground den			96	576	Corn	1060
Ground den			144	50	Corn	360
Ground den			240	550	Corn	1100
Ground den			85	675	Corn	1015
Ground den			120	240	Pasture	474
Ground den			168	220	Pasture	205
Ground den			255	50	Pasture	175
Ground den			10	175	Corn	251
Ground den			2	860	Corn	1115
		$\bar{X}$	105	260		603

TABLE 20. Physical characteristics of 19 raccoons killed during an experimental hunt held in portions of Blount and Loudon Counties, Tennessee.

Hunt date	Sex	Age class[a]	Weight (kg)	Standard mammal measurements (cm)					Area killed
				Head-body	Tail	Hind foot	Front foot	Ear	
11-3-78	F	II	5.2	64.8	26.7	9.5	6.4	4.5	Alexander Knob
11-3-78	M	I	2.5	49.0	22.0	10.5	7.0	4.5	Alexander Knob
11-3-78	F	I	1.9	41.0	21.0	9.0	6.0	3.9	Lotterdale Knob
11-3-78	M	II	3.3	50.0	22.0	10.0	6.0	5.0	Lotterdale Knob
11-3-78	F[b]	II	3.2	48.0	22.9	9.5	6.4	5.7	Alexander Knob
11-3-78	M[b]	II	3.5	49.0	23.0	9.0	6.0	4.0	Lotterdale Knob
11-4-78	F	II	2.4	45.7	25.4	7.1	6.2	5.1	Alexander Knob
11-4-78	F	I	3.1	48.3	25.4	10.8	7.6	4.5	Lotterdale Knob
11-4-78	F[b]	III	4.8	53.3	25.4	10.8	7.6	5.1	Alexander Knob
11-4-78	F[b]	II	4.3	53.3	25.4	10.2	6.9	5.1	Glendale-Little Tennessee River
11-10-78	F	I	3.5	48.3	20.3	10.2	6.9	5.1	Lotterdale Knob
11-10-78	M	II	5.5	58.4	25.4	11.4	7.0	5.1	Lotterdale Knob

TABLE 20. Continued

Hunt date	Sex	Age class[a]	Weight (kg)	Standard mammal measurements (cm)					Area killed
				Head-body	Tail	Hind foot	Front foot	Ear	
11-10-78	F	I	4.1	52.0	25.4	10.8	6.9	5.1	Lotterdale Knob
11-11-78	M	I	3.5	48.3	21.6	10.1	7.6	5.1	Alexander Knob
11-11-78	M	II	6.1	58.4	20.3	11.4	7.6	6.4	Glendale-Little Tennessee River
11-11-78	M	II	5.7	59.7	24.1	10.2	7.6	5.1	Alexander Knob
11-11-78	M	I	1.8	40.6	16.5	8.9	6.4	3.8	Alexander Knob
11-11-78	F[b]	II	3.6	50.8	24.1	10.2	7.6	5.1	Alexander Knob
11-11-78	M[b]	III	6.1	66.1	21.6	10.2	7.6	5.1	Alexander Knob
		$\bar{X}$	3.9	51.8	23.0	9.9	6.9	4.9	

[a]As described by Grau et al. (1970).

[b]Indicates an ear-tagged West Tennessee raccoon released in the study area.

TABLE 21. Habitat utilization recorded from approximately 1500 radio locations of 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee.

Raccoon number	Sex	Release site	Release season	Number of Locations				
				Forest	Edge	Old-field	Pasture	Crop land
Y29	M	Lotterdale Knob	Winter	137	12	5	0	0
Y36	F	Lotterdale Knob	Winter	9	7	4	0	0
Y37	M	Lotterdale Knob	Spring	36	7	10	0	2 Corn
Y38	F	Lotterdale Knob	Spring	108	19	0	0	3 Corn
Y40	M	Lotterdale Knob	Spring	59	20	7	0	4 2 Soybeans 2 Corn
Y42	M	Alexander Knob	Summer	37	5	0	0	2 Corn
Y45	F	Alexander Knob	Summer	21	7	26	0	20 Corn
Y48	F	Alexander Knob	Summer	120	12	0	0	4 Corn
Y49	M	Alexander Knob	Summer	131	11	6	2	5 Corn
Y51	F	Glendale-Little Tennessee River	Fall	19	2	0	0	12 Corn
Y52	F	Glendale-Little Tennessee River	Fall	133	78	29	0	3 Corn
Y53	F	Glendale-Little Tennessee River	Fall	54	3	1	0	1 Corn

TABLE 21. Continued

Raccoon number	Sex	Release site	Release season	Number of Locations					
				Forest	Edge	Old-field	Pasture	Crop land	
Y54	F	Glendale-Little Tennessee River	Fall	41	7	6	0	0	
Y55	F	Glendale-Little Tennessee River	Spring	93	30	5	11	12	10 Corn 2 Soybeans
			Total	998	220	99	13	68	64 Corn 4 Soybeans
		Percent of all locations		71.4	15.7	7.1	0.9	4.9	94.1 Corn 6.2 Soybeans

TABLE 22. Stream utilization by 14 West Tennessee raccoons released in Blount and Loudon Counties, East Tennessee.

Raccoon number	Sex	Release site	Release season	Number of locations by stream cover type					Total
				Forest	Edge	Old-field	Pasture	Crop land	
Y29	M	Lotterdale Knob	Winter	39	0	2	0	0	41
Y36	F	Lotterdale Knob	Winter	4	2	2	0	0	8
Y37	M	Lotterdale Knob	Spring	1	2	8	0	0	11
Y38	F	Lotterdale Knob	Spring	43	1	0	0	0	43
Y40	M	Lotterdale Knob	Spring	14	3	4	0	0	21
Y42	M	Alexander Knob	Summer	19	2	0	0	0	21
Y45	F	Alexander Knob	Summer	0	2	20	0	2 Corn	24
Y48	F	Alexander Knob	Summer	11	9	0	0	0	20
Y49	M	Alexander Knob	Summer	21	3	4	2	2 Corn	32
Y51	F	Glendale-Little Tennessee River	Fall	2	0	0	0	0	2
Y52	F	Glendale-Little Tennessee River	Fall	4	2	3	0	0	9
Y53	F	Glendale-Little Tennessee River	Fall	7	2	1	0	0	10

TABLE 22. Continued

Raccoon number	Sex	Release site	Release season	Number of locations by stream cover type					Total
				Forest	Edge	Old-field	Pasture	Crop land	
Y54	F	Glendale-Little Tennessee River	Fall	2	0	0	0	0	2
Y55	F	Glendale-Little Tennessee River	Fall	7	4	0	2	0	13
			Total	173	32	45	4	4	258
		Percent of total		67.0	12.4	17.4	1.6	1.6	

TABLE 23. Analysis of elliptical home range estimates based on normality in the distribution of locational points.

Raccoon number	Skewness X-Axis	Skewness Y-Axis	Kurtosis X-Axis	Kurtosis Y-Axis	Accuracy of home range estimates	95% ellipse (ha)
Y29	NS[a]	-[b]	L[c]	L	Overestimate	99.59
Y36	NS	+[d]	NS	NS	Good estimate	202.29
Y37	+	NS	NS	NS	Good estimate	1385.48
Y38	-	-	L	L	Overestimate	160.93
Y40	+	NS	L	NS	Fair estimate	910.98
Y42	NS	NS	NS	NS	Good estimate	685.79
Y42	-	NS	L	NS	Fair estimate	586.82
Y45	-	-	NS	NS	Fair estimate	770.81
Y48	+	+	NS	NS	Fair estimate	538.90
Y49	+	+	L	L	Overestimate	661.56
Y49	NS	NS	NS	NS	Good estimate	260.78
Y51	+	+	L	L	Overestimate	271.57
Y52	-	NS	L	NS	Fair estimate	81.89
Y52	NS	-	NS	L	Fair estimate	40.77
Y53	+	+	L	L	Overestimate	46.07
Y54	NS	+	NS	L	Fair estimate	26.04
Y55	-	NS	NS	NS	Good estimate	100.65
Y55	NS	-	NS	L	Fair estimate	76.63

TABLE 23. Continued

[a]Significant level set at P > .05.

[b]Negatively skewed.

[c]Leptokurtic.

[d]Postively skewed.

VITA

Curtis Irwin Taylor was born in Welch, West Virginia, on October 12, 1954. He is the son of Mrs. Maxine S. Taylor and the late Mr. Charles I. Taylor.

Mr. Taylor attended elementary school in Welch, West Virginia and graduated from Welch High School in 1972. He entered West Virginia University in August 1972 and received the degree of Bachelor of Science in Wildlife Management in December 1976. While attending West Virginia University, he worked as a Research Assistant for the Division of Forestry, West Virginia University. He entered the University of Tennessee, Knoxville, in January 1977 and accepted a research assistantship with the Department of Forestry, Wildlife, and Fisheries. He received a Master of Science Degree in Wildlife and Fisheries Science in June of 1979.

Mr. Taylor is a member of Xi Sigma Pi, the honor society of forestry, Gamma Sigma Delta, the honor society of agriculture, and The Wildlife Society.