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Date 6 January 1989

CHARACTERISTICS OF A MANAGED RACCOON POPULATION
IN EAST TENNESSEE WITH AN EMPHASIS ON
SUMMER DOG TRAINING AND FALL HARVEST

A THESIS
PRESENTED FOR THE
MASTER OF SCIENCE
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ABSTRACT

The impacts of summer dog training on reproductive success and movement ecology of adult female raccoons were studied through radio telemetry on 2 portions of a study area (5133 ha) on Chuck Swan Wildlife Management Area, Tennessee. Telemetry data from 24 radio-collared female raccoons were collected from 3 March 1987 to 15 August 1988. From 8 June 1987 to 12 October 1987 and from 5 March 1988 to 10 August 1988, 83 experimental dog training sessions were conducted in the vicinity of 12 radio-collared female raccoons on the experimental portion of the study area. The 246 animals treed were classified as one of the radio-collared raccoons 78 times (31%), young-of-year 18 times (7%), eartagged 14 times (6%), untagged 24 times (10%), eye reflection 26 times (11%), and unseen 76 times (31%). One radio-collared female raccoon never returned to her offspring following an experimental dog training session during which she was chased and treed. A nursing, radio-collared female was caught and killed by a dog and an untagged male raccoon jumped from a tree and was killed by the dogs during experimental dog training sessions. All raccoons seen (69%) could have been illegally harvested with or without the aid of a firearm. Night refugia included 220 trees and 26 burrows or caves. Large and/or leafy trees and underground refugia tended to offer the most protection to treed raccoons. Oaks comprised 40% of the night refugia.

Home range size prior to and during experimental dog training sessions did not differ between chased and unchased females, nor did distance between consecutive activity centers or nocturnal movement rates. Mean probability of nocturnal activity was significantly less for experimental animals ($\bar{x}=0.74$) than for control animals ($\bar{x}=0.82$), suggesting a shift by chased females to more diurnal activity in response to dog training exercises.

Bivariate ellipse home range estimates averaged 143.8 ha at the 95% confidence level; convex polygon model estimates averaged 93.2 ha. Home range estimates compared favorably to previous reports for female raccoons during summer in Tennessee. Estimated home range size was significantly reduced during nursing, but was similar during pregnancy and weaning. Litter sizes of radio-collared females ranged from 1 to 5, with a mean of 2.4 offspring per litter. Litters of 4 chased and 3 unchased study animals were abandoned and orphaned due to researcher disturbance (n=3), experimental dog training activities (n=1), haybaling operations (n=1), and mortality (n=2).

The location of 268 individual day rest sites 444 times indicated that trees were chosen more frequently (86.5%) than ground dens (13.5%). Maternity sites were restricted to cavities in large trees ($\bar{x}=188.4$ cm), and occupied for a mean of 50 days. Leaf nests were utilized as day rest sites 19.8% of the time, which was more frequent than previously

reported from Tennessee. Ground dens were observed as day rest sites for 13.5% of the day locations, and included ground burrows, rock crevices, and caves.

During 1920 trapnights, 227 raccoons were captured 327 times as part of population estimation efforts. Density estimates of 1 raccoon/13.8 ha for late summer 1986 and 1 raccoon/13.4 for late summer 1987 were obtained from Jolly-Seber population estimates for the study area.

During a three night managed hunt in 1986, 77 raccoons were harvested by 109 parties for a success rate of 70.6% or 1 raccoon/94.6 ha. A 4-night managed hunt in 1987 yielded 117 raccoons to 161 parties for a success rate of 72.7% or 1 raccoon/62.3 ha. On the experimental portion of the study area, 25% and 35% of the estimated late summer population was legally harvested in 1986 and 1987, respectively. Reproductive tracts from females harvested in 1986 and 1987 indicated a pregnancy rate of 65% and 46%, with a mean of 1.9 and 2.6 young per litter, respectively. The 44 parties/night quota system resulted in an apparent sustained yield with high hunter success.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
II. STUDY AREA	4
Study Area Description	4
Study Area Choice	8
III. MATERIALS AND METHODS	11
Radio Telemetry	11
Data Collection	11
Selection of individuals	11
Equipment	11
Sampling	12
Data Analysis	14
Experimental Dog Training	16
Data Collection	16
Experimental dog training sessions	16
Data Analysis	18
Population Characteristics	18
Data Collection	18
Trapping	18
Hunting	20
Data Analysis	23
Study statistics	23
Open model estimator	23
Closed model estimators	25
IV. RESULTS AND DISCUSSION	27
Radio Telemetry	27
Radio-collared Individuals	27
Reproduction	27
Mortality	32
Home Range	33
Periodic home range	37
Shift in activity center	46
Rate of movement	47
Daily activity	48
Day rest sites	50
Trees	52
Ground sites	56
Experimental Dog Training	57
Experimental Dog Training Sessions	57
Night Refugia	63
Dog training summary	66
Population Characteristics	67
Trapping	67
Hunting	67

CHAPTER	PAGE
Open Model Estimates	73
Closed Model Estimates	76
Density Estimates	80
Harvest Impacts	81
V. SUMMARY AND CONCLUSIONS	85
LITERATURE CITED	94
APPENDICES	101
APPENDIX A. Data From Radio-collared Female Raccoons, 1987 and 1988, CSWMA	102
APPENDIX B. Experimental Dog Training Session Summaries, 8 June 1987 to 10 August 1988, CSWMA	108
APPENDIX C. Capture Data From Raccoons Trapped On 2 Portions Of Study Area, CSWMA	121
APPENDIX D. Total Captures of Non-target Species on 2 Portions of Study Area, CSWMA	135
APPENDIX E. Data From Raccoons Harvested on CSWMA, November - December 1986, and November 1987	136
VITA	140

LIST OF TABLES

TABLE	PAGE
1. Capture dates, weights, parturition dates, and observed litter sizes of radio-collared female raccoons, CSWMA, 1987 and 1988	28
2. Mean bivariate estimated home range sizes of chased and unchased adult female raccoons, CSWMA, Tennessee, 1987-1988	34
3. Estimated home range sizes of adult female raccoons reported from different regions of Tennessee and other states	36
4. Mean circumference of tree species used as day rest sites and night refugia by radio-collared female raccoons on CSWMA, 1987-1988	53
5. Mean circumference (cm) of trees by type used as day rest sites by radio-collared female raccoons on CSWMA, 1987-1988	55
6. Classification of animals treed during 83 experimental dog training sessions on the experimental portion of study area, CSWMA, 1987-1988	61
7. Harvest data from quota raccoon hunting on experimental portion of study area and rest of hunted area of CSWMA, November 1986, and November 1987	69
8. Litter sizes and pregnancy rates as determined by placental scar counts for 5 age classes of raccoons harvested on CSWMA, November 1986, and November 1987	71
9. Population estimates of raccoons on 2 portions of the study area, CSWMA, 1985-1987	75
10. Population densities of raccoons from different areas of the United States	82
11. Background histories of radio-collared female raccoons on CSWMA, 1987-1988	102

TABLE

PAGE

12.	Apparent causes for abandonment of litters by radio-collared female raccoons on 2 portions of study area, CSWMA, 1987-1988	.103
13.	Annual and periodic home range sizes (ha) estimated by bivariate 95% ellipse model for adult female raccoons on 2 portions of study area, CSWMA, 1987-1988	.104
14.	Annual and periodic home range sizes (ha) estimated by convex polygon model for adult female raccoons on 2 portions of study area, CSWMA, 1987-1988	.106
15.	Summaries of 83 experimental dog training sessions conducted on experimental portion of study area, CSWMA, 1987-1988	.108
16.	Outcome of experimental dog training chases on CSWMA, 1987-1988	.112
17.	Estimated birth dates and ages of preweaned raccoons captured on 2 portions of study area, CSWMA, 1986-1987	.121
18.	Capture records of raccoons trapped on study area, CSWMA, 1 September 1986 to 14 September 1987	.122
19.	Total captures of non-target species trapped during late summer sample periods on 2 portions of study area, CSWMA, 1986-1987	.135
20.	Data from raccoons harvested on CSWMA, November 1986 and November 1987	.136

LIST OF FIGURES

FIGURE	PAGE
1. Map of the study area on CSWMA, Tennessee	9
2. Mean estimated convex polygon home range size of adult female raccoons during pregnancy, nursing, and weaning of adult female raccoons on 2 portions of study area, CSWMA, 1987-1988	41
3. Convex polygon home range size and overlap of radio-collared female raccoons on the experimental portion of the study area, CSWMA, 1987	43
4. Convex polygon home range size and overlap of radio-collared female raccoons on the experimental portion of the study area, CSWMA, 1988	44
5. Activity patterns of female raccoons on 2 portions of study area, CSWMA, 1987-1988	49
6. Percent occurrence of day rest site types of radio-collared female raccoons on 2 portions of study area, CSWMA, 1987-1988	51
7. Comparison of late summer Jolly-Seber population estimates of raccoons on 2 portions of study area, CSWMA, 1982-1987	83

CHAPTER I

INTRODUCTION

The raccoon (Procyon lotor) is the state animal of Tennessee, and has been a popular subject of hunters since pioneer days. There has been an increase in the popularity of raccoon hunting in the eastern portion of the state. Since the 1950's, the total number of raccoon hunters in Tennessee has declined slightly, while the percentage of raccoon hunters in east Tennessee has more than tripled from 7% in 1951 to an estimated 25% of the total raccoon hunters in the state in 1986 (Kocka 1988). Statewide, over 23,800 raccoon hunters sold over 26,000 pelts in 1985 valued at \$302,258 (TWRA 1988). Raccoons are one of the many furbearers which historically have been considered abundant by State agencies in the southeastern U.S. (Sumner and Hill 1980). However, raccoons were considered scarce in many areas of east Tennessee as early as 1940 (Wing 1940, Minser and Pelton 1982).

Increasing popularity, despite low fur prices, is evidence that the American tradition of 'coon hunting is practiced primarily for recreation. Recognizing that hunting with dogs may occur without harvest of the treed raccoon, hunters have argued successfully for extended dog training seasons and frequent field trials. In some east Tennessee counties, political pressure has encouraged legislators to lengthen the dog training season to include

the period of breeding, pregnancy, and nursing of raccoons. The potential for illegal harvest is great during dog training activities (Wright 1977, Hardy 1978, Taylor 1979). Club-sanctioned field trials also may be staged legally during these critical reproductive periods. The objectives of field trials and dog training exercises are essentially the same, varying only in the activity of their human participants. The ability of dogs to kill a raccoon during either of these activities must not be underestimated (Whitney and Underwood 1952). Johnson (1970) felt that females traveling with their young were especially susceptible to hunting dogs.

Dog training during summer has been suspected of causing abortion, abandonment of offspring, poor condition of young raccoons, increased juvenile mortality, and illegal harvest (Johnson 1970, Hardy 1978, Warr 1978, Taylor 1979, Minser and Pelton 1982). However, no previous work has focused on accurately measuring the effects of summer dog training on raccoons.

The objectives of this study were to (1) describe behavioral aspects of pregnancy, parturition, and post-parturition for female raccoons, (2) assess the impacts of dog training on population dynamics and movement ecology of female raccoons before, during, and after experimental dog training exercises, (3) describe characteristics of maternity dens, day rest sites, and night refugia of

radio-collared raccoons, and (4) monitor impacts of varied raccoon harvest rates under a quota hunt system.

CHAPTER II

STUDY AREA

Study Area Description

Chuck Swan Wildlife Management Area (CSWMA) is located approximately 40 km north of Knoxville, Tennessee in Campbell and Union Counties. The 9872-ha area lies on the peninsula formed by the Powell and Clinch River arms of Norris Reservoir. The study area includes approximately 5133 ha of the total management area.

CSWMA lies within the Great Valley of east Tennessee, a part of the Ridge and Valley Province of the Appalachians (Fenneman 1938). This area is characterized by numerous elongated ridges and intervening valleys. The study area is bisected by a main central ridge, reaching from the northeast towards the southwest and having secondary ridges extending at right angles. Elevations range from 305 m at Norris Reservoir to 512 m at Weaver's Knob. CSWMA is underlain by cherty and sandy dolomitic limestone of the Knox formation (U.S. Dept. Agriculture 1953). The soils are generally low in organic matter and strongly acidic. Dolomitic limestone outcrops, sinkholes, and caves are common on lower elevation hillsides, especially on the Clinch River side of the area (Safley 1974). Eight major caves exist on CSWMA. Three perennial surface streams and 4

springs are located on the area; most surface streams are temporary.

Climate of the area is temperate and continental. Data collected from White Hollow, CSWMA over a 15-year period indicated a mean annual precipitation of 117.4 cm (Summers 1968). The greatest precipitation occurs during winter (December-March) and mid-summer (July), and the driest period is from late summer to early fall (August-October). Weather data collected in Union County over 28 years indicated an average growing season of 174 days (Minckler 1946). Mean temperature is 3.3° C in winter and 23.8° C in summer (Rothacher 1953). Ground-covering snowfalls are infrequent and remain only a few days.

Differences in forest cover on CSWMA are a result of human and biological influences. Some of these differences are a result of slope, exposure, and steepness of topography (Minckler 1946). Oak (Quercus spp.) and oak-pine (Pinus spp.) occur on southerly slopes; yellow-poplar (Liriodendron tulipifera) and yellow-poplar-shortleaf pine (P. echinata) associations occur on northerly slopes. A greater diversity of hardwoods is found in bottomlands, with American beech (Fagus grandifolia), maple (Acer spp.), sycamore (Platanus occidentalis), and yellow-poplar being the most frequent. During the mid-1970's a large portion of the southern pine forest at CSWMA was devastated by an infestation of the southern pine beetle (Dendroctonus frontalis). This

occurrence changed the forest composition considerably, and favored hardwood regeneration. Presently, approximately 93% of the study area is forested, of which 85% is hardwoods (Nottingham 1985).

Human development has occurred for over 200 years. The earliest permanent development occurred in the Clinch River basin in the late 1770's or early 1780's (Safley 1974). Early settlers derived sustenance from farming. Numerous cemeteries, remnants of buildings, cisterns, fences, and roads exist throughout the area. In 1935 and 1936, the Tennessee Valley Authority (TVA) purchased most of the land making up the area to complement its development of Norris Reservoir. Approximately 2400 persons resided on 531 tracts at the time of purchase (Lewis and Safley 1967). In 1981, 164 ha of inholdings were condemned and purchased by Tennessee Wildlife Resources Agency (TWRA) and Tennessee Department of Conservation, Division of Forestry (Kocka 1988).

The Division of Forestry is responsible for the management of the forest resource on CSWMA. Early management of the forest lacked continuity. Recent management objectives include long-term planning with even-aged management for hardwoods and pine (Nottingham 1985). The CSWMA is managed by compartment. There are presently 18 compartments. The Division of Forestry is

charged with maintenance of approximately 144 km of developed roads on the area.

TWRA administers and manages the wildlife resources on CSWMA. The area is managed primarily for white-tailed deer (Odocoileus virginianus) and wild turkey (Meleagris gallopavo), with controlled hunting playing an important role. Some small game species such as cottontail rabbits (Sylvilagus floridanus), mourning doves (Zenaida macroura), and raccoons may benefit from practices intended for other species (Safley 1974). Fields comprise approximately 7% of the area and are leased to local farmers for corn or orchardgrass and clover production. The lease agreement normally includes a provision for 20% of the crop to remain unharvested. Most fields are rotated into the production of row crops every 2-3 years to reduce spread of undesirable fescue (P. Bledsoe, TWRA, pers. comm.).

Raccoon populations on CSWMA were probably limited and did not increase until protection was provided by TVA's acquisition of the land in the 1930's (Safley 1974). Managed hunts began in the 1950's and continued annually until closure in 1965. Annual harvests ranged from 66 to 158 raccoons until a significant decrease in harvest success occurred in the early 1960's. Following a 6-year closure, hunting was permitted from 1971-78 until another apparent over-harvest warranted closure (Nottingham et al. 1982). The raccoon season remained closed until 1984, when a quota

hunt was initiated (Kocka 1988). Trapping of furbearers was not allowed until a limited season was initiated in January 1986, at which time all furbearers except raccoons could be legally trapped. A single entrance road and a resident TWRA area manager reduce the likelihood of illegal hunting.

Study Area Choice

Two areas of comparable size (control = 2588 ha; experimental = 2545 ha), adjacent to one another for logistical considerations, were established on CSWMA (Figure 1). Live-trapping of raccoons was conducted in both areas from 1983-1987. Quota raccoon hunts were conducted throughout CSWMA, except in the control area, from 1984-1987. Butterfield (1944) found that raccoons are usually confined to a single watershed and that ridges may constitute a physical barrier. It was assumed that the dividing ridge between the 2 areas restricted raccoon movement to the extent that individuals could be classified to area of residence.

Within each of the 2 portions of the study area an area was selected for radio-telemetry study of female raccoons. In the experimental portion of the study area the Rice Erwin Road/Lost Creek Cemetery area was chosen, while the Henegar Bend area of the control area was selected (Figure 1). These portions of each area were chosen on their merits of

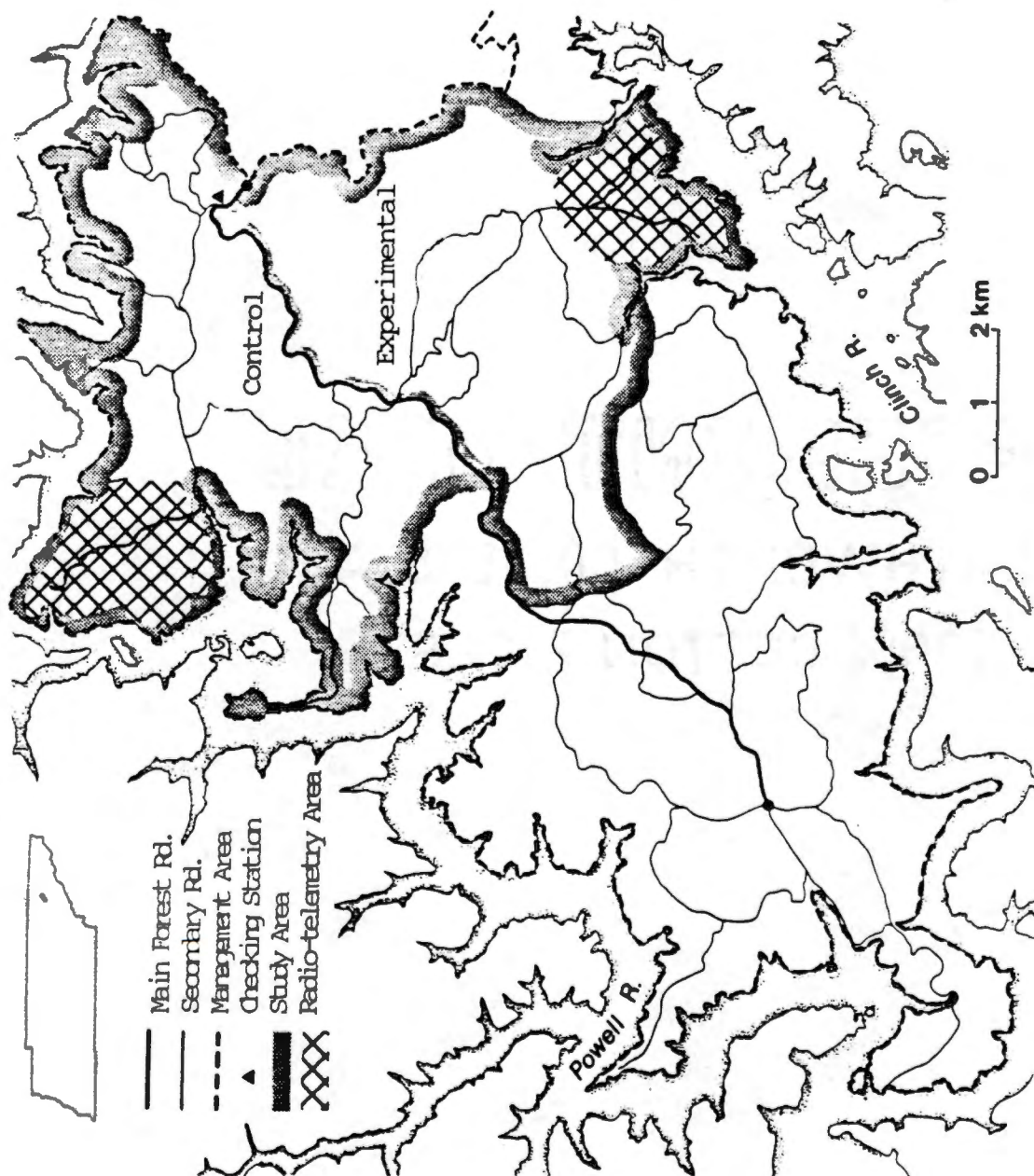


Figure 1. Map of the study area on CSWMA, Tennessee.

isolation from one another, accessibility and relative evenness of topography for minimal radio-telemetry error, and long boundary with Norris Reservoir.

CHAPTER III

MATERIALS AND METHODS

Radio Telemetry

Data Collection

Selection of individuals. Trapping was conducted from 24 February to 26 April 1987 and from 1 March to 26 April 1988 for the purpose of attaching radiotransmitters to adult, female raccoons. Females were selected which appeared to be parous and in good condition. Teat size and pigmentation were used to determine reproductive condition (Sanderson and Nalbandov 1973). Trapping procedures are described in 'Trapping'. Between 15 and 30 traps were placed in the selected portions of each area. However, since raccoons are usually inactive during cold and/or wet weather in winter (Moore and Kennedy 1985), traps were not opened during foul and predicted foul weather to increase efficiency. Trapping continued until all transmitters were placed on selected raccoons, or until nursing females were captured.

Equipment. All of the radio transmitters used during the study operated in the 150-152 MHz range. The transmitter packages used during 1987 weighed approximately 200 g (Wildlife Materials, Inc., Carbondale, IL). Antenna

breakage drastically reduced the range of signal detection and premature failure of one of these transmitters prompted trial of a heavier antenna design and another brand of transmitter for 1988. The new transmitter package (Telonics, Mesa, AZ) tried was approximately 1/3 the size of the WMI transmitter, weighed approximately 100 g, possessed an efficient attachment design, and performed satisfactorily.

The receiving equipment consisted of a TR-2 receiver and a hand-held 2-element "H" antenna (Telonics, Inc.). Directional readings were measured to the nearest degree with a hand-held baseplate compass (Silva, Inc).

Sampling. Raccoons were located by triangulation of azimuths from known map points. Data recorded for each reading were tracking station number, time, transmitter frequency, azimuth, animal activity, relative signal strength and integrity. Azimuths were obtained using the loudest signal method of Springer (1979). Known map points were established at strategic locations throughout each portion of the study area. Individuals with motion sensitive transmitters were judged to be active if the signal pulse and strength changed, while individuals without a motion-sensitive transmitter were classified as active solely on the basis of noticeable changes in signal strength. Relative signal strength was recorded on a scale of 1 to 5, for the purpose of choosing the best pair of

azimuths for triangulation. Time between bearings was minimized to reduce error introduced by animal movement between readings. Azimuths were plotted in the field on 1:24,000 topographic maps and readings were taken until a pair produced a reasonable interior angle. Radio-telemetry sampling was accomplished on alternate nights from that of experimental dog training exercises; sampling was initiated on alternate portions of the study area, beginning at dark and lasting for approximately 4 hours on one portion of the study area, and then continuing for 4 hours on the remaining portion of the study area. Attempts were made to locate each animal on the particular portion at 1-hour intervals during the 4-hour sample.

Day rest sites of radio-collared raccoons were located by homing. Characteristics of day rest sites recorded were Universal Transverse Mercator (UTM) location, forest cover type, understory vegetation, distance to water, aspect, and exposure. Distance to water was recorded as distance to nearest blue-line water, or permanent water, on 1:24,000 topographic maps. Characteristics recorded for trees used as day rest sites include type of use, tree species, circumference, height of tree, height and position of raccoon in tree, and direction and dimensions of cavity opening. Type of use of trees was classified to one of 4 major categories: leaf nest, tree roost, limb roost, den. Dens were further divided into those used as maternity

sites, as litter trees, and those as dens used prior to parturition. Characteristics recorded for subterranean rest sites were direction and dimensions of opening.

Subterranean rest sites were classified as caves, rock crevices, or animal burrows (groundhog or fox den).

Data Analysis

Data were transferred from telemetry field data sheets to files containing time, activity, tracking station, and azimuth data on floppy diskette. Triangulation of azimuths was accomplished using SAS (Hill and Fendley 1982) on the UT Computing Center (UTCC) Vax Cluster Computer System (VAX). Analyses were accomplished with the PC version of SAS and SAS on the UTCC Vax. Since telemetry stations were recorded on a 10x10 m grid, intersection of azimuths were rounded to the same resolution.

Locational data for each radio-collared individual were grouped into subsets for home range and movement analysis according to the chronology of estimated date of parturition and by chronology of experimental dog training sessions. The 3 subsets determined by the date of parturition included all locations obtained: (1) up to the time of parturition, (2) during the 45-day period following the date of estimated parturition in which the young are restricted primarily to the den tree, and (3) during the period of weaning, measured here as beginning 46 days after

parturition to the end of monitoring. Females for whom an estimated date of parturition was not available were assigned the mean date of parturition for other females for that year and portion of the study area. Home ranges were constructed for each female for periods prior to and during dog training, and for pregnancy, nursing, and weaning periods. Bivariate home ranges, (BV) (Koepl et al. 1975) were calculated using program MCPAAL. The minimum convex polygon home range model, (CV) (Jennrich and Turner 1969) was determined with program MCPAAL and SAS, area calculated by the trapezoidal method, and boundaries were plotted using SAS and SASGRAPH.

Analysis of variance techniques were used to test for variation due to area, year, reproductive period, and experimental period. Rate of movement between consecutive locations was calculated for data collected between 2000 and 0500 hours. Movement rates were calculated only from pairs of readings taken within a 2-hour time span and readings which indicated activity. Activity data were analyzed by hourly and 4-hour intervals between 0000 to 0700 hours and 1600 to 2400 hours. Since day rest sites were located by homing, telemetry activity data obtained between 0700 and 1600 hours were not included. Geometric activity centers were calculated from day rest site and night telemetry locations, and are merely the means of the easting (X) and northing (Y) UTM coordinates.

Experimental Dog Training

Data Collection

Experimental dog training sessions. Experimental dog training sessions were scheduled 3 times weekly.

Experienced local raccoon hunters were enlisted to utilize their trained raccoon dogs.

Experimental sessions began shortly after dark in the vicinity of one or more radio-collared raccoons. Targeted individual females were selected on their merits of nearness, apparent activity, and interval since last chase. Homing techniques were employed to position the dogs within close proximity of the targeted female. When the signal of the transmitter was detected without the aid of the receiving antenna, the distance to the radio-collared female was estimated to be within 100 meters. Differences in topography, animal activity, and individual transmitter strength were considered in this estimation. When she was judged within range of the dogs, the direction of the female from the research party was determined with the directional antenna. The dogs were then released in the corresponding direction, and the time recorded. The time of first strike, or when the first dog barked on the trail, was recorded, as well as time the dogs reached the tree and changed from trailing to treeing barks. During the chase, the transmitter signal was monitored periodically to judge

the success of the strike. The frequencies of other nearby individual females were scanned to evaluate their general reactions.

The dog handlers and researcher then proceeded to the location of the treeing hounds. The dogs were leashed at the tree, but allowed to continue barking. A red or amber lens was placed over the lights and shined into the crown of the tree. Colored or dim lights are more readily looked at by raccoons, and light reflected by the tapetum of the raccoons eye is easily seen. Squalling sounds were made by the hunters to induce the raccoon to look into the light. It was often necessary to shake a bush or to rap the tree trunk with a rock to persuade the raccoon to look. Once located, or if not located within a reasonable period, a bright light was shined into the tree. Binoculars were used to observe the animal and determine the presence of a radiocollar or eartags. Treed raccoons were classified by either the frequency of their transmitter, or as having red eartags, yellow eartags, no eartags, as eyes only, young-of-the-year, or as being unseen. Several bearings were taken from around the tree to verify the presence of a radio-collared individual.

Species, circumference, and UTM location of the tree were recorded on the data sheet. Fluorescent ribbon, marked with the date, session number, and transmitter frequency was tied to the tree. The presence of fluorescent ribbon from

previous training sessions or day rest site locations was noted, along with the date, frequency, and use recorded on the ribbon. Notes were made as to the behavior of the treed raccoon, the relative ease of finding it in the tree, and relative cover afforded by the leafiness and height of the tree.

Data Analysis

Data were transferred from field data sheets to floppy diskette. Analyses were accomplished with the PC version of SAS and SAS on the UTCC Vax.

Mean circumference of refugia trees was summarized according to animal classification. Radio-collared animals were pooled for comparison with other groups of treed animals, and considered individually in least squares ANOVA for within group comparisons.

Population Characteristics

Data Collection

Trapping. Between 1 September 1986 and 14 September 1987, 2 12-night trapping periods were conducted on both portions of the study area. Forty wire live-traps (Tomahawk Live Trap Co., Tomahawk, WI) were baited with sardines at established trap sites during each trapping period. Each trapping period consisted of 12 consecutive nights of trapping in the experimental area, followed by 12

consecutive nights of trapping on the control area.

Trapsites were located at the center of evenly spaced circular plots having a radius of 0.8 km. Trap spacing was based on estimated home range size of adult raccoons from east Tennessee (Hardy 1978). The distance between centers of adjacent circular plots (1.6 km) was less than the average distance travelled from original capture sites by raccoons on CSWMA in 1976 (Woods 1978). Trap sites were the same as used by Kocka (1988) and 74 of the 80 were the same as used by Nottingham (1985). Traps were baited with 1/2 can of fresh sardines daily, which was pinned to the back of the trap with a slender stick to maximize the chance of triggering the trap. The previous days' bait and cans were placed in front of the trap as additional attractant. A dense covering of leaves and sticks was placed over the back of the traps to prevent bait theft.

Live traps were checked and re-baited daily. Raccoons were sedated with an injection of Ketaset (Bristol-Meyers Co., Syracuse, NY), at a dosage of 0.2 cc/kg of estimated body weight (Bigler and Hoff 1974). Ketaset was administered with a hand-held or jabstick-mounted syringe and needle. Immobilized raccoons were sexed, weighed and standard morphological measurements taken. Raccoons were aged according to tooth wear (Grau et al. 1970), which assigns individuals to one of 5 age classes: class I, 0-14 months; class II, 15-38 months; class III, 39-57 months;

class IV, 58-86 months; and class V, more than 86 months. Ages of preweaned raccoons were estimated by patterns of deciduous and permanent tooth eruption (Montgomery 1964); this allowed for accurate age estimation up to 111 days old. Animals were examined for general body condition, reproductive condition, ectoparasites, and trap injury. Raccoons were tagged with consecutively numbered plastic Rototags (Nasco, Ft. Atkinson, WI) in each ear. Eartags were color coded according to the sex of the raccoon; red tags were applied to males and yellow tags were applied to females. Ear-tag numbers of recaptured raccoons were recorded prior to release without handling the animal. Damaged or missing ear tags were replaced. All captured animals were released at the capture site.

Computer-format data sheets were completed at the capture site for each raccoon capture or recapture. Use of these data sheets insured the collection of all relevant data, while eliminating the need for transcription prior to keypunch. Daily trap activity, minimum nightly and maximum daily temperatures, precipitation, and cloud cover were also recorded.

Hunting. Controlled raccoon hunts were conducted on 17 November, 19 November, and 28 November 1986, and 16 November, 18 November, 23 November, and 27 November 1987. Each year's quota hunt dates were announced in area newspapers and hunters were required to submit an

application with party members' names, addresses, and hunting license numbers to the Region IV TWRA office by 29 August. Regulations specified a maximum party size of 3 persons, each party assigned to an area compartment, 0200 hour maximum check out time, 1 dog per party member, and a bag limit of 1 raccoon per party. Forty-four party permits were issued for each hunt on a first come basis by TWRA.

CSWMA is divided into 18 management compartments, of which 5 lie within the control area and were not hunted. Five compartments lie within the experimental area, while the remaining 8 compartments comprise an additional area of 4739 ha. These 8 compartments were designated the remaining hunted area (RHA). On the night of each hunt, drawn party members with the proper area permit were required to wait at the CSWMA checking station until approximately 1800 hours. At 1800 hours, the rules and regulations of the hunt were read aloud to the hunters by the area manager, the assignment process was explained, and a role call of party leaders was made. Each party received a compartment map with the non-hunted control area outlined. The first 20 parties were assigned on a volunteer basis to a compartment of their choice in the experimental area, at a density of 4 parties per compartment. If fewer than 20 parties volunteered to hunt in the experimental area, the required number of parties were drawn from a hat and assigned to the remaining compartments in the experimental area. The

remaining parties were drawn at random and given their choice of the vacant compartments in the RHA. The RHA was assigned parties at a maximum density of 3 parties per compartment.

Each party received a card with their compartment and assignment number on it to place in the windshield of their vehicle. This allowed TWRA personnel to verify that parties hunted in the correct management compartment. After receiving a windshield card, the party was allowed to enter the area.

Harvested raccoons were brought whole to the checking station. Morphological data and harvest compartment were recorded on the computer-format data sheets for each individual. Following examination of the whole carcass, the hunters were allowed to skin the animal. Reproductive tracts of females were collected from the skinned carcass and examined for the presence of placental scars (Sanderson 1950). Entire gastro-intestinal tracts of animals harvested in 1987 were collected, labeled, and preserved in formalin for future food habits and parasitology studies. Time of kill, number of other raccoons seen with the harvested animal, species and size of tree taken from, and total raccoons seen during the hunt were recorded as reported by the hunters.

Data Analysis

Study statistics. Data files containing capture, trap activity, and harvest of raccoons were created and edited on IBM-PC, stored on diskette and UTCC Vax files. The SAS System was invoked to edit, compile, subset, summarize, and statistically analyze all data. Chi-square tests were conducted on sex ratio data to determine goodness-of-fit to a 1:1 ratio.

The rates of recapture of tagged raccoons were examined through a 3x2 chi-square contingency table. The recapture rates were examined to evaluate age as a source of heterogeneity of capture between the 2 fall sample periods, and as such a possible bias of population estimates. Age I, Ages II and III combined, and Ages IV and V combined were the 3 age categories considered.

Open model estimator. Open and closed model estimators were derived from mark-recapture data in this study. Open model estimators assume geographic closure only (White et al. 1982). Open population estimates were derived through the use of the POPAN computer program (Arnason and Baniuk 1980). This program uses a range of variations of the J-S model (Jolly 1965, Seber 1965) to calculate population estimates. The full J-S model allows for immigration, emigration, recruitment, and mortality over a sample period, and was used to calculate population estimates and

variances. The J-S model assumes that capture probabilities vary by night only.

Within each sample period, data were pooled so that any individual captured was considered once, no matter how many times recaptured during that sample (Arnason and Baniuk 1980, Pollock 1982, Nottingham 1985, Kocka 1988). This approach allows the reasonable assumption of closure over the 12-night sample period and increases precision among all J-S estimates (Nottingham 1985).

Individuals having capture histories indicative of frequent movement between the 2 portions of the study area were excluded from the population analysis. Previously excluded individuals (Nottingham 1985, Kocka 1988) with consistent recaptures within either portion of the study area were reinstated for population estimates in this study.

Estimates are not produced for the first and last sampling periods under constraints of the J-S model, however as part of an on-going study data were available from ten previous 20-night sample periods between 1981 and 1985, (Nottingham 1985, Kocka 1988) and a 12-night follow-up sample in 1988 (S. Glass, Univ. of TN., unpubl. data), and estimates were calculated for 1985, 1986, and 1987. Inclusion of capture histories of all previously captured individuals increased the precision of the estimates. Data from quota harvests in 1984, 1985, 1986, and 1987 were

included as separate samples. Pre-harvest estimates and harvest estimates were produced for each of these years.

Closed model estimators. Population estimates were calculated from 2 closed model estimators, program CAPTURE (Otis et al. 1978) and Chapman's modification of the Petersen estimator (Seber 1982). Trapping data from fall 1985, 1986, and 1987 were analyzed by the program CAPTURE. Fall trapping was conducted within a relatively short interval during which recruitment and mortality are negligible (Johnson 1970), thereby meeting the requirements for assumption of closure. The 8 models used by CAPTURE are based upon variation in animal capture probabilities by time, behavior, individual, and combinations thereof. CAPTURE tests for closure, selects the appropriate model, and derives population estimates. CAPTURE utilizes only individual capture histories obtained during the sample period, so that previous captures of an individual are inconsequential to the program.

The Chapman modification of the Petersen estimator was utilized to derive population estimates from trapping and harvest data (Petersen-I) and solely from trapping data (Petersen-II). Petersen-I estimates were obtained by treating the 12-night trapping period as the marking period, while the resampling period was the Fall harvest. Petersen-II estimates followed Nottingham's (1985) approach and treated the first 6 nights of the trapping period as the

sample period, while the last 6 nights were considered the resampling period. All Petersen estimates were calculated with the formula:

$$N = \frac{(M + 1)(n + 1)}{(m + 1)} - 1, \text{ where}$$

N is the estimated population; M is the number of animals marked during the sampling period; n is the number of marked and unmarked animals captured in the resampling period; and m is the number of marked animals captured in the resampling period. The variance for the estimator is obtained by the formula:

$$\text{Var } (n) = \frac{(M + 1)(n + 1)(M - m)(n - m)}{(m + 1)^2 (m + 2)} .$$

Coefficients of variation (CV) were obtained for all population estimates by dividing the standard error of the estimate by the estimate itself. Coefficients of variation allow comparisons of relative precision between open and closed model estimates (Lefebvre et al. 1982).

CHAPTER IV

RESULTS AND DISCUSSION

Radio Telemetry

Radio-collared Individuals

Twenty-six adult female raccoons were fitted with radio collars from 5 March 1987 to 26 April 1988 (Table 1). All individuals were judged to be in good condition, and pregnant or in estrus at the time of capture. Mean body weight was 3.5 kg for radio-collared females captured on the control area and 3.3 kg for radio-collared females on the experimental area. Body weight at capture did not vary significantly between the 2 areas ($F=0.35$, $P=0.5597$).

Reproduction. Observed litter sizes for radio-collared females ranged from 1 to 5, with a mean of 2.4 kittens per litter (Table 1). This estimate of litter size is conservative; 4 females were observed with at least 1 young, and may have had more than 1 (Appendix A, Table 11). Observed litter sizes did not vary significantly between areas ($F=0.32$, $P=0.5794$). However, mean observed litter size on the experimental area was 3.0 kittens/litter in 1987 and 1.7 kittens/litter in 1988. The litter size for 2 individuals monitored both years of the study on the experimental area was 4 and 3, respectively, in 1987, and 2 and 1, respectively, in 1988; the 1988 litters did not

Table 1. Capture dates, weights, parturition dates, and observed litter sizes of radio-collared female raccoons, CSMMA, 1987 and 1988.

Portion of Study Area	Range of Capture Dates	Mean Weight	Range of Parturition Dates	Observed Litter sizes Range Mean
<u>1987</u>				
Control	20 April - 26 April	3.5	9 May - 16 May	2 2
Experimental	3 March - 31 March	3.6	9 May - 22 May	1 - 5 3.2
<u>1988</u>				
Control	3 March - 25 April	3.3	25 April - 15 May	2 - 3 2.3
Experimental	3 March - 22 April	3.3	5 May - 24 May	1 - 2 1.8
Total/Mean	3 March 1987 - 25 April 1988	3.3	25 April - 24 May	1 - 5 2.4

survive to weaning.

Bissonette and Csech (1937) noted that although there was considerable variation among individuals, litter size was relatively constant for individual female raccoons. Although the number of individual females observed both years of this study was low, decreased litter sizes despite a trend toward larger litters on CSWMA during this time (Hunting, p.67) suggests that reproduction was affected by experimental dog training sessions.

Estimated dates of parturition of radio-collared females ranged from prior to 25 April to 27 May (Table 1). There was no apparent difference in chronology of parturition between the 2 portions of the study area. Estimated date of parturition of 34 preweaned raccoons captured between mid-August and late September ranged from 15 May to 4 July (Appendix C, Table 17). Nottingham (1985) reported a range of parturition from 25 April to 27 June by backdating estimated ages of 12 preweaned raccoons captured on CSWMA during 1982. Kocka (1988) estimated births of 22 preweaned raccoons captured on CSWMA in 1983 and 1984 occurred during the period 13 April to 3 July. In Cades Cove, estimated births of 22 preweaned raccoons occurred from 12 May to 2 August; 4 radio-collared females gave birth between 21 May and 4 June (Rabinowitz 1981). Estimating birth dates by eruption of deciduous and permanent teeth yields a narrow view of overall chronology of parturition,

accounting only for raccoons which have emerged from their den but are 112 days old or younger. Trapping may bias this sample unless capture efforts span the entire range of den emergence.

Movement of offspring to litter trees was recorded 12 times for 8 females. Distances between maternity sites and consecutive litter trees averaged 268 m (range = 106-682 m). Disturbance at the maternity tree or disturbance in general may trigger the female to move the litter. Possible causes also include crowding in cavity; litter trees were larger than maternity trees (Day Rest Sites, p.50). Distances between litter trees tended to increase with age of litter; mobility of offspring likely influenced distances between consecutive sites during weaning. Schneider et al. (1971) reported distances of 210 and 630 m between consecutive maternity and litter trees of a female raccoon disturbed by researchers.

Radio-collared females abandoned offspring for a variety of reasons. Experimental dog training probably caused 1 female to abandon her offspring; denning behavior characteristic of parturition was observed for 26 days, at which time, the female was chased to the maternity tree by the dogs during an experimental dog training session. Subsequent non-maternal day rest site selections and movement patterns indicated that ID 314 abandoned her litter. Offspring were probably abandoned due to

disturbance by the researcher in 3 other instances. ID 690 (control animal) was captured in a live-trap and fitted with a radio-collar on 26 April 1988. At this time she was obviously nursing, and the ordeal of being trapped apparently was sufficient to trigger abandonment. ID 970 abandoned her litter of 2 offspring at (approximately 30 days old) after each was handled and marked with a small radio transmitter and/or eartag. ID 550 abandoned her 25-day old litter of 1 after it was eartagged. ID 174 had 2 young on 16 May 1987, in a honeysuckle-draped apple tree (Prunus malus), approximately 10 m from Henegar Bend Road at the edge of a hayfield. On 17 June 1987, 3 days after a shift in day rest sites, the apple tree was inspected for internal cavity measurements; at this time, 2 young were located dead in the apple tree. Hay-baling operations at about the time of abandonment may have been the cause.

The effects of researcher disturbance are both unavoidable and difficult to discern from those of the experimental treatments. Transmitters were felt to impose no real burden upon females, comprising only 3-8% of an individual female's body weight. Observations of radio-collared individuals did not indicate any annoyance after an initial 5-30 minute preoccupation with removal during recovery from immobilization.

Individual raccoons responded differently to disturbances, demonstrating no apparent response, moving

their litter, or abandoning their offspring. Differing responses may arise from differing ages of females, previous experiences, degree of danger perceived, and age of offspring. From observations in this study, it appears that female raccoons are particularly sensitive to disturbance 20-30 days after parturition. Schneider et al. (1971) attributed abandonment by 1 female raccoon to human disturbance at the maternity site, while other females only moved their offspring after capture and handling, human disturbance at the maternity site, and handling of young. Stuewer (1943b) reported that all wild females he studied moved their young following disturbances. Whitney and Underwood (1952) observed captive females carrying their young about after they were disturbed.

Mortality. Two radio-collared females were found dead during the study. One individual, ID 121 was fatally injured during an experimental dog training session. After seeking refuge in a shallow burrow, the raccoon flushed from the hole and was caught by the dog at the entrance to a second burrow within 60 m. Injuries sustained before the researcher and hunter could separate the animals resulted in death within 24 hours. ID 021 was located dead on 7 July 1988 under the branches of a fallen treetop. Estimated date of death of ID 021 was 3 July 1988; exact cause of death was not determined due to decomposition of the carcass, but was probably due to the treetop falling on the female, or the

female falling with the treetop. Nottingham (1985) captured a raccoon paralyzed from a broken spine, and attributed the injury to a large limb falling at the trap site just prior to capture (B. Nottingham, pers. comm.). Holzman et al. (1988) reported finding a radio-collared coyote (Canis latrans) pinned beneath a fallen tree. Such cases of accidental natural mortality are probably not uncommon in a semi-arboreal species such as the raccoon.

Home Range

Sufficient data were collected to calculate home ranges for 24 adult, female raccoons (Table 2). Based on the bivariate home range model calculated at the 95% confidence level, mean home range for all raccoons in this study was 143.8 ha (Table 2), with a range of 47.1 to 543.0 ha (Appendix A, Table 13). The convex polygon model yielded a mean home range estimate of 93.2 ha with individual estimates ranging from 32.6 to 247.4 ha (Appendix A, Table 14). Individual home range size was not related to experimental treatment (bivariate model $F=0.85$, $P=0.49$; convex polygon model $F=1.20$, $P=0.34$), and no significant difference in home range size was detected due to year of the study (bivariate model $F=0.04$, $P=0.85$; convex polygon model $F=0.14$, $P=0.71$). Home range size did not differ significantly among age classes (bivariate $F=0.28$ $P=0.88$; convex polygon model $F=0.48$, $P=0.75$).

Table 2. Mean bivariate home range sizes of chased and unchased adult female raccoons on CSWMA, Tennessee, 1987 and 1988.

	Pretreatment	Treatment	Pregnancy	Nursing	Weaning	Annual
	<u>1987</u>					
chased	150.3 (7) ^a	140.3 (7)	197.2 (7)	130.9 (7)	180.0 (6)	174.9 (7)
unchased	152.0 (5)	142.0 (5)	337.3 (3)	103.9 (5)	152.6 (5)	146.0 (5)
	<u>1988</u>					
chased	62.1 (6)	84.6 (6)	88.3 (6)	87.3 (6)	96.6 (5)	85.0 (6)
unchased	186.9 (6)	144.9 (6)	111.3 (3)	94.6 (5)	176.4 (5)	164.4 (6)
Total $\bar{x}$	137.8 (24)	127.9 (24)	166.3 (19)	105.8 (23)	152.8 (21)	143.8 (24)

^a Sample size in parenthesis.

Home ranges are dynamic and subject to many environmental factors (Hayne 1949). Techniques for locating raccoons and calculating home range sizes have varied and include location by mark-recapture (Stuewer 1943a, Hoffman and Gottschang 1977) and radio telemetry (Ellis 1964, Schneider et al. 1970, Fritzell 1978, Taylor 1979, Hardy 1979, Allsbrooks 1981, Rabinowitz 1981), with calculation techniques including minimum area, convex polygon, concave polygon, and bivariate ellipse models (Table 3). Estimates of bivariate home range size of female raccoons in Tennessee range from 118 ha in west Tennessee (Allsbrooks 1981) to 210.6 ha for 9 west Tennessee raccoons translocated to east Tennessee (Taylor 1979) (Table 3). Convex polygon home range sizes of resident east Tennessee female raccoons averaged 133.8 ha (Hardy 1979). Rabinowitz (1981) estimated that bivariate annual home ranges of female raccoons in a protected, relatively high density population in east Tennessee averaged 300 ha, with summer home ranges averaging 170 ha. Ellis (1964) showed that in areas of high population density and high quality habitat, raccoons occupied smaller home ranges than in areas of low density and low quality habitat. Taylor (1979) and Hardy (1979) reported that illegal dog training activities influenced raccoon movements and home range size.

Home range sizes of female raccoons on CSWMA fell within the range of those previously reported from east

Table 3. Estimated home range sizes of adult female raccoons reported from different regions of Tennessee and other states.

State	Size (ha)	Sample Size	Methods		Source
			Location/Model ^a		
Tennessee	93.2	24	R/CV	This study	
	118	6	R/BV	Allsbrooks (1981)	
	133.8	5	R/CV	Hardy (1979)	
	138.0	11	R/CV	Taylor (1979)	
	143.8	24	R/BV	This study	
	210.6	11	R/BV	Taylor (1979)	
	300	7	R/BV	Rabinowitz (1981)	
Illinois	13.9-41.0	3	R/CV	Ellis (1964)	
Ohio	14.6	10	T/CV	Hoffman and Gottschang (1977)	
	88.2	3	R/CV	Urban (1970)	
Michigan	108.5	17	T/MA	Stuewer (1943a)	
Minnesota	120-350	4	R/CC	Schneider, Mech, and Tester (1971)	
N. Dakota	227-2160	7	R/CV	Fritzell (1978)	

^a R, radiotracking; T, trapping; BV, 95% bivariate ellipse; CC, concave polygon model; CV, convex polygon model; MA, circular minimum area.

Tennessee. Although the estimates of BV and CV home range size are lower than those reported from the Tri-county area, estimates in this study are probably more precise; roads on CSWMA offer better opportunities for radio-tracking than those in the Tri-county area and telemetry sampling was accomplished over shorter time spans and distances, reducing overall error. The difference in estimated home range size may be due to differences in population densities. Raccoon density in the Tri-county area was too low to estimate (Hardy 1979), while that on CSWMA is high for upland deciduous forest. Mean BV home range for females was larger in Cades Cove than in CSWMA. The Cades Cove mean however, included 4 females which did not rear young; individual BV estimates for females with young were comparable for CSWMA and Cades Cove.

Periodic home range. Home range estimates were calculated for each of 24 individuals from locations obtained prior to and following initiation of experimental dog training sessions. Sufficient data were collected to calculate home ranges for 19 animals for the period of pregnancy, 23 animals for the period of nursing, and 21 animals for the period of weaning. The bivariate model and convex polygon model of home range are presented and discussed separately for the 2 experimental periods and the 3 reproductive stages.

Bivariate model. The average bivariate estimate of home range prior to parturition was 166.3 ha (range = 41.9-650.8 ha), during nursing 105.7 ha (range = 6.9-242.8 ha), and during weaning was 152.8 ha (range = 38.6-543.0) (Appendix A, Table 13). There was a significant difference among bivariate home ranges by developmental stage of offspring ($F=3.87$, $P=0.0003$), with home range size during nursing significantly smaller than home range size during pregnancy and weaning (Duncan's Multiple Range Test, $P < 0.05$). However, pregnancy and weaning home ranges were different (Duncan's Multiple Range Test, $P > 0.05$). Other studies also have shown that female raccoons exhibit restricted movements and have smaller home ranges while nursing young (Schneider et al. 1971, Hardy 1979, Rabinowitz 1981).

Estimated home range size (BV) during pregnancy on the experimental portion of the study area was significantly lower during 1988 than 1987 ($F=15.98$, $P=0.0021$); but not on the control portion ($F=1.98$, $P=0.2323$). Size of home range during pregnancy (BV) on the experimental portion for 1987 ($\bar{x}=197.19$ ha) was higher than the 1988 mean ($\bar{x}=88.33$ ha) ($t=3.997$, $P=0.0021$). Experimental dog training sessions were initiated during the time radio-collared females were pregnant in 1988, and may have caused this reduction in home range size.

Home range size (BV) during nursing in 1988 was lower than 1987 on the experimental area ($F=5.61$, $P=0.0372$), while there was no significant difference between 1987 and 1988 on the control area ($F=0.04$, $P=0.8524$). However, there was no difference in home range size during nursing (BV) between the two portions of the study area during 1987 ($F=0.94$, $P=0.3548$) or 1988 ($F=0.04$, $P=0.8546$).

Home range during weaning (BV) was not different between the 2 portions of the study area during 1987 ($F=0.23$, $P=0.6438$) or during 1988 ($F=0.11$, $P=0.7455$). Weaning home range size (BV) was not different between 1987 and 1988 on the control portion ($F=0.05$, $P=0.8272$) or the experimental portion ($F=4.82$, $P=0.0557$) of the study area.

One individual had a significantly larger home range than 20 others (BV) (Duncan's Multiple Range Test, $P < 0.05$). The convex polygon annual home range estimate for this individual was significantly larger than that of 8 other females (Duncan's Multiple Range Test, $P < 0.05$).

Since the bivariate model estimates are an index of size only and are not intended to define specific areas of use (Smith 1983), the estimates were used in this study for comparisons of size only. A low correlation between home range size (BV) and number of locations per animal ($r = -0.273$) indicates that the number of locations used for calculating the bivariate home ranges did not influence these estimates.

Convex polygon model. The convex polygon model produced estimates and boundaries which probably best describe areas of actual use and familiarity of CSWMA raccoons. The average of the home range estimates as calculated from the convex polygon method was 42.8 ha during pregnancy, 36.4 ha during the period of nursing, and 67.6 ha for the period of weaning (Appendix A, Table 14). There was a significant difference in size of convex polygon home range due to reproductive period ($F=3.38$, $P=0.0096$). There was no difference in home range size between the 2 experimental periods (CV) ($F=0.29$, $P=0.5951$).

Home range size (CV) during pregnancy was greater in 1987 ($\bar{x}=56.65$) than 1988 ($\bar{x}=27.49$) ($t=3.2452$, $P=0.0065$). Home range size during pregnancy (CV) was larger on the experimental portion of the study area than that on the control portion during 1987 ($F=5.44$, $P=0.0481$), but was not different between the 2 areas during 1988 ($F=0.30$, $P=0.5995$). This variation was evident in the analysis of variance of size of home range during pregnancy (CV) for year on the experimental portion ($F=18.53$, $P=0.0012$), but not on the control portion ($F=0.25$, $P=0.6463$). Home range size during pregnancy (CV) on the control portion was relatively constant (1987, $\bar{x}=32.99$; 1988, $\bar{x}=24.35$), while that of the raccoons subjected to the experimental treatment was not (1987, $\bar{x}=66.79$; 1988, $\bar{x}=37.76$) (Figure 2).

Variation in home range size during nursing (CV) was

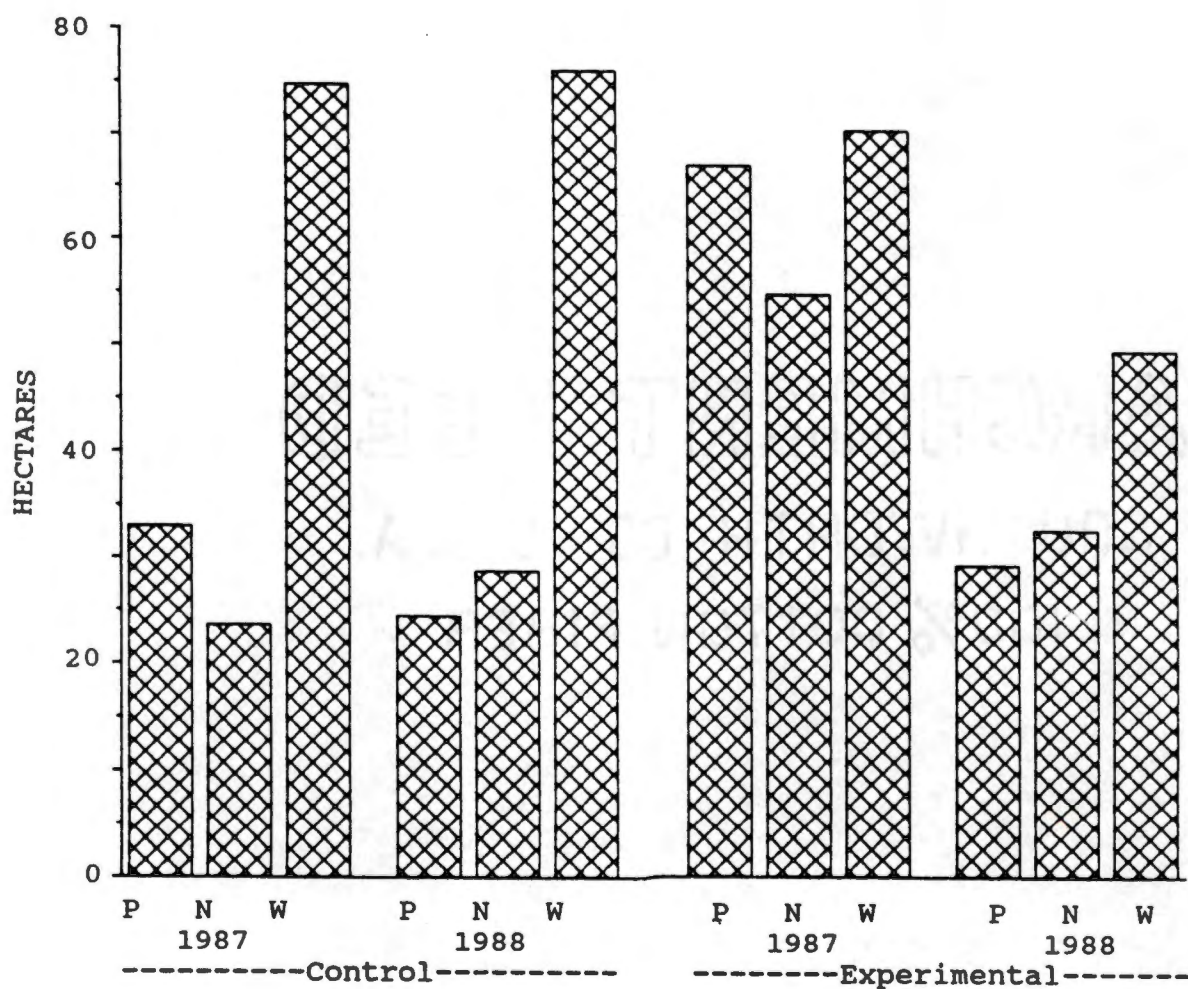


Figure 2. Mean estimated convex polygon home range size of adult female raccoons during pregnancy (P), nursing (N), and weaning (W) on 2 portions of study area, CSWMA, 1987-1988.

not different between years ($F=1.815$, $P=0.1923$). Home range size during nursing (CV) of females exposed to experimental dog training was larger ($\bar{x}=44.32$ ha) than that of the control females ($\bar{x}=26.10$) ($t=2.4099$, $P=0.0252$). In 1987, home range size during nursing (CV) for females subjected to experimental dog training ($\bar{x}=54.54$) was greater than that of the unharassed females ($\bar{x}=23.6$) ($t=4.3036$, $P=0.0028$); while during 1988 home range size (CV) for the experimental animals ($\bar{x}=32.40$ ha) was not different from than that of the control animals ($\bar{x}=28.63$ ha) ($t=0.3347$, $P=0.7455$).

The reduction in home range size during nursing (CV) in 1988 from that of 1987 on the experimental portion of the study area may be a result of the experimental dog training sessions held during this time. Although the mean number of times experimental females were treed was not different between years ($t=0.360$, $P=0.7223$), all experimental chases in 1988 were within hearing distance of each female. Home ranges of experimental females in 1987 were more disjunct (Figure 3) than those in 1988 (Figure 4). Females often sought refuge up trees soon after the dogs "opened", even when not the subject of the chase. Typical nightly movements of raccoons include a foraging route in the area of the prior day's feeding, followed by a brief exploratory trip to locate new food resources (Mech et al. 1966). Experimental training sessions probably disrupted the normal

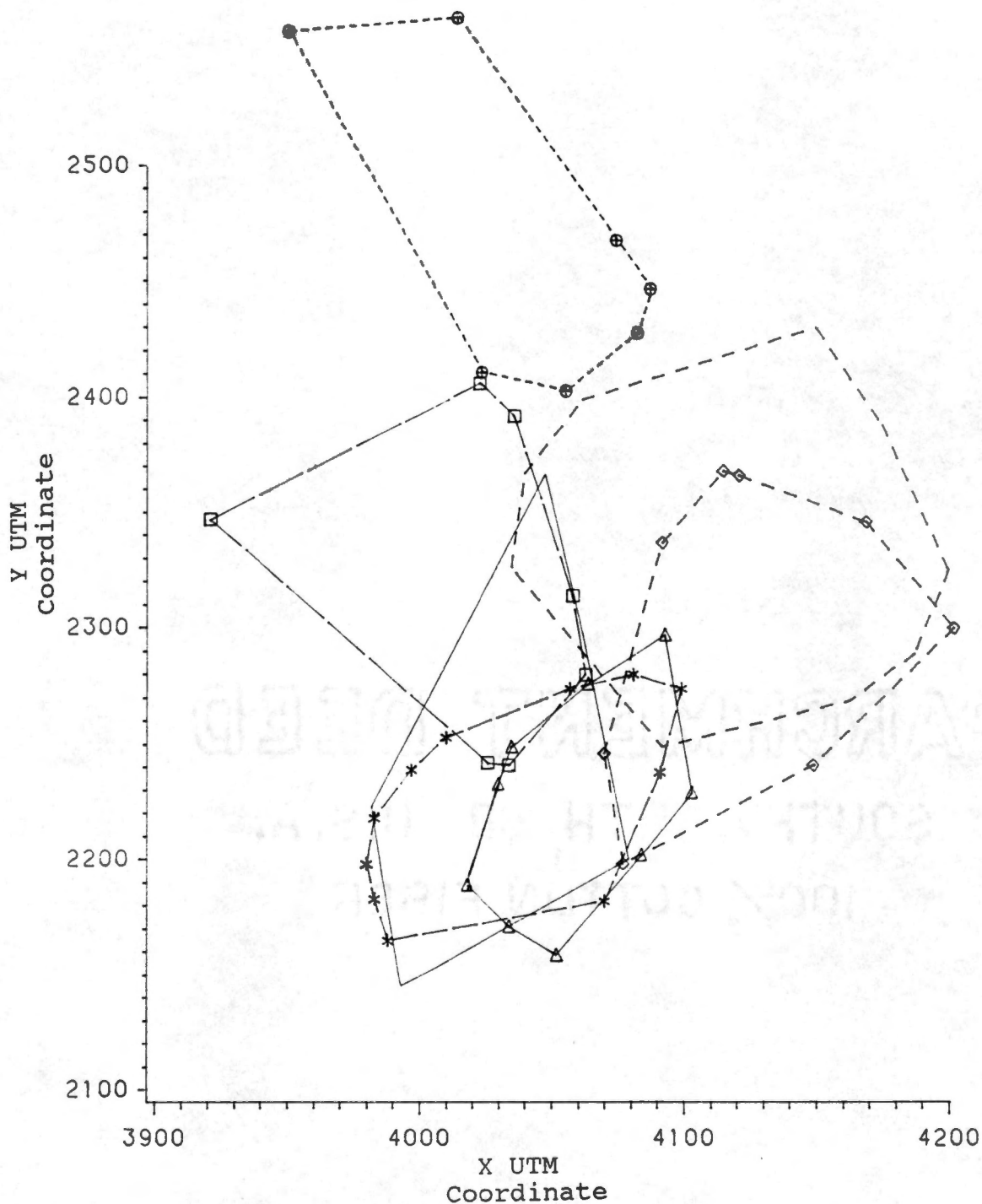


Figure 3. Convex polygon home range size and overlap of radio-collared female raccoons on the experimental portion of the study area, CSWMA, 1987.

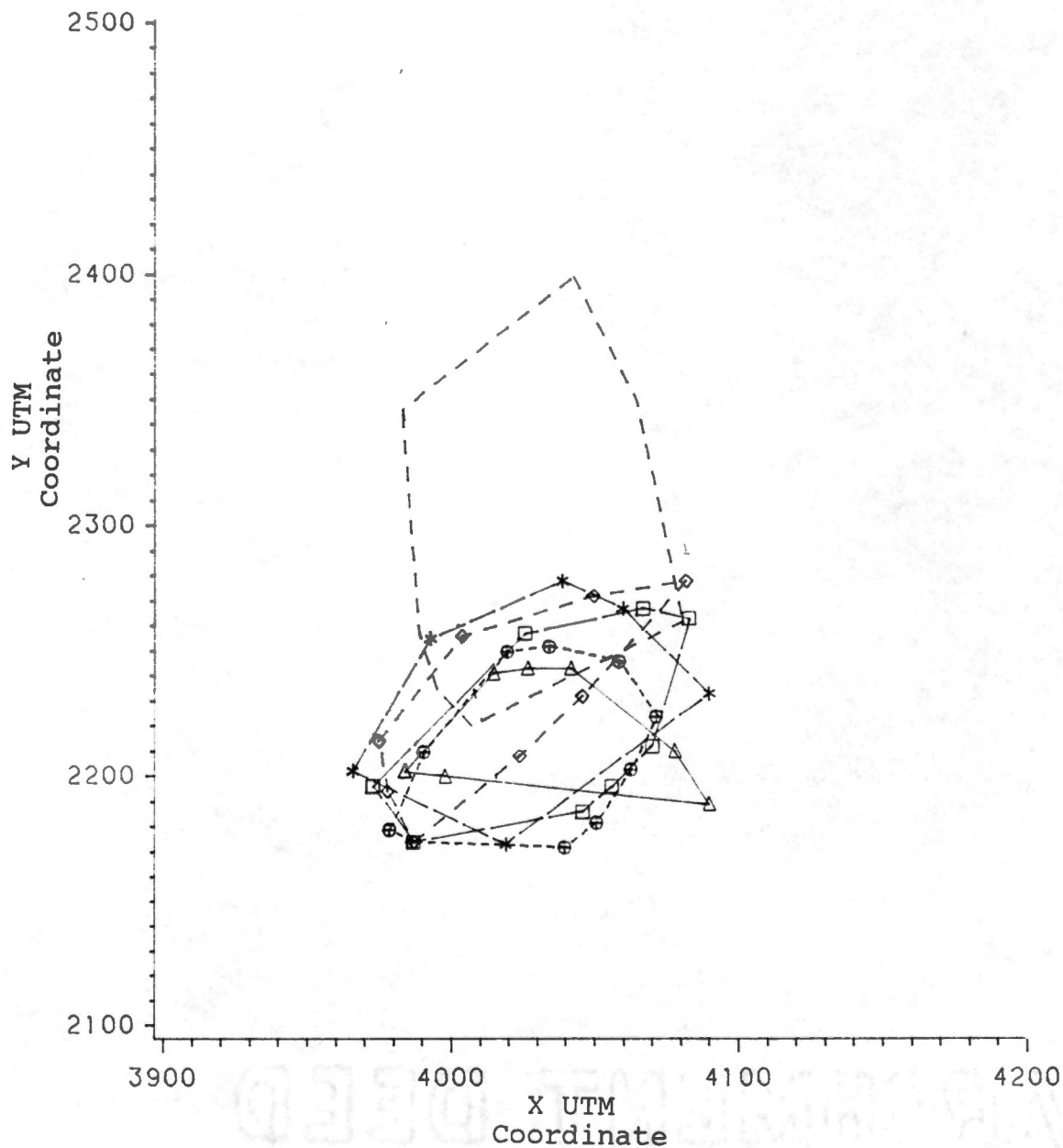


Figure 4. Convex polygon home range size and overlap of radio-collared female raccoons on the experimental portion of the study area, CSWMA, 1988.

feeding and movement patterns of females such that exploratory forays after feeding were short and/or rare.

Home range size during weaning (CV) was not dissimilar between the 2 years ($F=0.177$, $P=0.6786$), or the 2 portions of the study area ($F=0.42$, $P=0.5256$). As with the bivariate model, the average convex polygon estimate of home range size during weaning ($\bar{x}=67.6$ ha) was similar to home range size during pregnancy ($\bar{x}=42.8$ ha), but was significantly larger than home range size during nursing ($\bar{x}=36.4$ ha) (Duncan's Multiple Range Test, $P < 0.05$). As their offspring became increasingly mobile at weaning, radio-collared female raccoons utilized home ranges estimated to be similar in size to those used prior to parturition. Schneider et al. (1971) found that female raccoons resume normal movements as they wean their young.

There was no difference in mean size of pre-treatment home range (CV) between years of the study ($t=0.6605$, $P=0.5158$), or between portions of the study area ($t=0.1622$, $P=0.8726$). Mean home range size during experimental dog training was similar for both years of the study ($t=1.7702$, $P=0.0933$). Mean home range size (CV) during experimental training sessions did not differ between chased and unchased female raccoons ($t=0.2873$, $P=0.7766$).

The size of home range of adult female raccoons during spring and summer is influenced most by behaviors associated with parturition and nursing. Although nutritive

requirements are highest during nursing, raccoons may expend less energy searching for new food resources, and instead rely upon resources within close proximity of the maternity site. The reduced average home range size during 1988 of radio-collared females which were chased was probably due to the impact of the experimental dog training exercises on normal foraging and the influence of the abandonment of offspring. The difference in average home range size between portions of the study area was insignificant during the first year of the study, yet average home range size during 1988 was significantly different between chased and unchased raccoons, suggesting that dog training exercises restrict normal behavior of females when the efforts are frequent and/or concentrated.

Shift in activity center. Although geometric centers of activity do not possess any biological meaning and may even lie outside of the home range boundary, they are a function of locations visited (Hayne 1949), and as such provide an index to periodic shifts in home range. Due to high frequency of reuse of day rest sites recorded, the location of activity centers is probably representative of the areas of greatest familiarity of raccoons in this study.

Distance between pre-treatment and intra-treatment activity centers averaged 221 m. There was no difference between the control and the experimental portions of the study area in mean distance of activity center shift

($t=0.341$, $P=0.736$). Mean shift in activity center from pregnancy to nursing and from nursing to weaning did not differ between areas ($t=0.723$; $P=0.478$, $t=0.424$; $P=0.676$, respectively). Mean distance from center of activity during pregnancy to maternity site did not differ between portions of the study area ($t=1.665$, $P=0.117$). Distances between consecutive geometric centers of activity reflect changes in location of food resources and day rest sites within the familiar area of an individual raccoon. The similarity of distances between consecutive activity centers of individuals on the 2 portions of the study area suggests that individuals subjected to experimental dog training did not shift their activities significantly in response to harassment.

Rate of movement. Mean rate of movement between consecutive telemetry locations was 325 m/hr (range = 17-3300 m/hr). Mean rate of movement of females subjected to experimental dog training was 340 m/hr, and was not significantly different from that of unharassed females ($\bar{x}=282$ m/hr) ($t=0.4939$, $P=0.5640$). Variation in mean rate of movement was not related to area ($F=0.47$, $P=0.5177$). Lack of significant differences between experimental and control animals suggests that overall foraging and travel activities were not affected by experimental dog training exercises, and were probably a function of distance and topography between denning and primary food resources.

Rate of movement during experimental chases was not measured. However, raccoons move faster while chased and slower while treed than while foraging, and this would probably influence mean movement rates.

Mean rate of movement for all radio-collared CSWMA female raccoons (325 m/hr) was similar to that of female raccoons in Cades Cove during summer (280 m/hr) (Rabinowitz 1981). Urban (1970) reported a mean movement rate of 150 m/hr, while Ellis (1964) reported movement rate for a single female raccoon to be 107 yards/hr (98 m/hr) prior to parturition, and 9.6 yards/hr (8.9 m/hr) for a 3-day period at parturition. Minimum distance between consecutive day rest sites was 557 meters for female raccoons in the Tri-county area of east Tennessee (Hardy 1979). Taylor (1979) reported a mean of 351 meters for minimum 24-hour distance moved after home range establishment by 9 female raccoons translocated from west to east Tennessee.

Daily activity. A total of 956 activity readings taken between 1600 and 0700 hours was used to calculate probability of activity by hour. Probability of activity varied significantly by hour recorded ($F=5.36$, $P=0.0001$) (Figure 5), as did probability of activity by 4 hour periods ($F=4.11$, $P=0.0327$). There was a significant difference in mean probability of activity between the 2 portions of the study area ($t=2.959$, $P=0.0032$), with mean

activity level of chased females ($\bar{x}=0.74$) less than that of unchased females ($\bar{x}=0.82$). Probability that chased female raccoons would be active was 76% and 71%, respectively, for 1987 and 1988; for unchased females it was 94% and 79% for 1987 and 1988, respectively. The lower probability for raccoons being activity at night during the experimental dog training season may reflect a shift in activity to more diurnal feeding. Since activity data were not collected between 0700 hrs and 1600 hrs, probability of activity during daylight hours can not be compared between chased and unchased animals.

Probability of activity between 1600 hrs and 0800 hrs was 41% for resident raccoons in the Tri-county area of east Tennessee (Hardy 1979); probability of activity between 1800 hrs and 0600 hrs was 50% for translocated female raccoons in the same area (Taylor 1979). Schneider et al. (1971) reported variable starting times of activity of female raccoons during summer months, and Ellis (1964) reported activity of 5 raccoons during 74% of the daylight periods monitored.

Day Rest Sites

Raccoons were located 444 times at 268 day rest sites, including 219 trees and 49 caves, rock crevices, or ground burrows. Tree rest sites were recorded 86.5 % of the time and ground dens were recorded 13.5 % of the time (Figure 6).

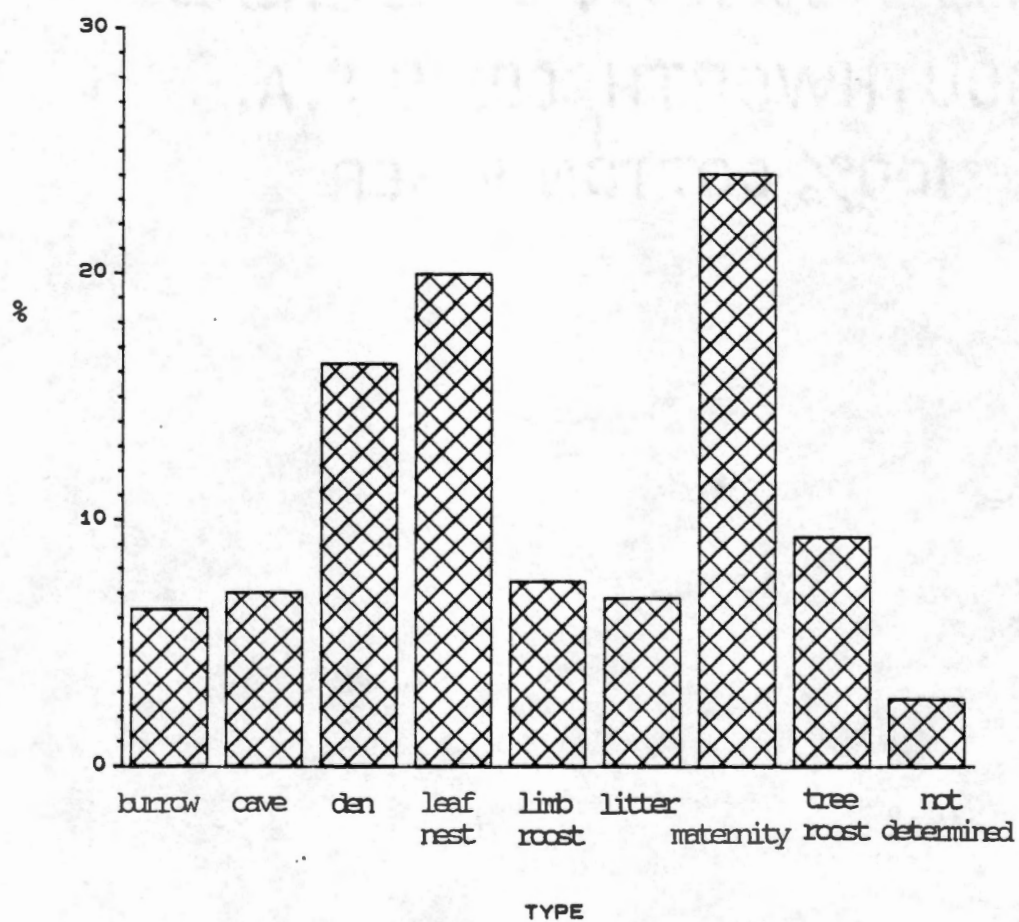


Figure 6. Percent occurrence of day rest site types of radio-collared female raccoons on 2 portions of study area, CSWMA, 1987-1988.

Percent utilization of day rest site may differ from the percent recorded due to sharp attenuation of radio signals from subterranean dens. Individual day rest sites were not determined 13 times during 1988 owing to no detectable radio signal.

Distance from rest sites to water varied significantly due to portion of the study area ($F=33.05$, $P=0.0001$) and by type of tree rest site (Duncan's Multiple Range Test, $P < 0.05$). These differences between areas and among tree-use types are probably a function of the individual's home range shape and proximity of food resources to water. Distance to water varied according to the level of Norris Reservoir and the state of temporary streams and ponds throughout the area. The arbitrary nature of the method of measuring distance to water was accentuated by the observation of one radio-collared female drinking from tree knotholes on the side of an otherwise dry ridge. On CSWMA, location of day rest sites is probably not related to water availability since drinking water is readily available from knotholes, ponds, and puddles.

Trees. Mean circumference of all trees recorded as day rest sites was 128.0 cm. There was a significant difference in mean circumference due to species of tree ($F=23.06$, $P=0.0001$), with chestnut oak (Quercus prinus) having the largest mean circumference ($\bar{x}=214.65$ cm) (Duncan's Multiple Range Test $P < 0.05$) (Table 4). Circumference of trees used

Table 4. Mean circumference of tree species used as day rest sites and night refugia by radio-collared female raccoons on CSWMA, 1987-1988.

Tree Species	Mean Circumference (cm)	
	Day Rest Sites	Night Refugia
<u>Acer negundo</u>	33.5 (1)	
<u>A. rubrum</u>	163.2 (2)	198.7 (1)
<u>Carya ovata</u>	145.6 (2)	
<u>C. tomentosa</u>		115.2 (5)
<u>Cornus florida</u>	38.3 (1)	
<u>Diospyros virginiana</u>	70.2 (1)	
<u>Fagus grandifolia</u>		144.0 (1)
<u>Fraxinus americana</u>	80.6 (1)	227.4 (1)
<u>Juglans nigra</u>	97.8 (5)	
<u>Juniperus virginiana</u>	76.3 (67)	98.9 (6)
<u>Liriodendron tulipifera</u>	188.7 (46)	162.0 (9)
<u>Morus rubra</u>	127.7 (4)	
<u>Ostrya virginiana</u>	169.2 (2)	
<u>Oxydendrum arboreum</u>	70.2 (1)	
<u>Nyssa sylvatica</u>		192.0 (1)
<u>Prunus malus</u>	138.0 (5)	
<u>Prunus serotina</u>	67.6 (3)	
<u>Pinus virginiana</u>	141.8 (11)	109.4 (6)
<u>Pinus spp.</u>	199.5 (1)	
<u>Robinia psuedoacacia</u>	255.4 (1)	
<u>Quercus alba</u>	212.4 (26)	119.1 (1)
<u>Q. falcata</u>	209.4 (26)	158.3 (9) *
<u>Q. michauxii</u>	88.0 (8)	189.9 (1)
<u>Q. prinus</u>	214.7 (7)	
<u>Q. rubra</u>	173.7 (82)	205.7 (13)
<u>Q. stellata</u>	163.2 (12)	143.4 (4)
<u>Q. velutina</u>	212.8 (42)	203.9 (6)
<u>Quercus spp.</u>	210.6 (18)	
<u>Ulmus americana</u>		247.0 (2)
<u>U. alata</u>	63.0 (1)	51.1 (1)
Total	163.0 (381)	161.1 (67)

* Significant difference between means ($P < 0.05$).

as rest sites varied according to type ($F=28.09$, $P=0.0001$) (Table 5).

Mean circumference of trees recorded as day rest sites with the raccoon lying in a leaf nest was 99 cm, and was significantly less than all other rest site means (Duncan's Multiple Range Test, $P < 0.05$). Leaf nests were used as day rest sites 19.8% of the time. Leaf nests were most often found in eastern red cedars (Juniperus virginiana) (69.3%). The frequency of use of leaf nests on CSWMA is higher than previously reported from east Tennessee, with a 10% use in the Tri-county study (Taylor 1979), and 4-5% use by females in Cades Cove during spring and summer (Rabinowitz 1981). However, raccoons in Taylor's study (1979) were translocated from west Tennessee, where Allsbrooks (1981) observed no use of leaf nests by raccoons. Leaf nests are probably cooler and have fewer insect pests than tree dens in summer (Rabinowitz 1981), and may be more comfortable than a bare limb.

Maternity sites of radio-collared females were in large trees ($\bar{x}=188.4$ cm circumference), even though smaller trees and ground dens were used as day rest sites. Recorded length of use of maternity trees ranged from 27 to 84 days ($\bar{x}=50$ days), comparable to a 60 days use in Cades Cove (Rabinowitz 1981). The use of tree dens as maternity sites is consistent throughout the raccoon's range (Berner and Gysel 1967, Schneider et al. 1971, Schnell 1970,

Table 5. Mean circumference (cm) of trees by type used as day rest sites by radio-collared female raccoons on CSWMA, 1987-1988.

Type	Portion of Study Area	
	Control	Experimental
Den	185.3 (32) ^a	175.4 (40)
Leaf Nest	105.7 (32)	94.2 (56)
Litter	213.1 (19)	212.9 (11)
Limb Roost	186.5 (16)	158.2 (16)
Maternity	187.3 (50)	189.4 (56)
Tree Roost	185.8 (19)	155.0 (22)
Undetermined	154.4 (2)	160.2 (8)
Total Mean	173.0 (171)	154.8 (210)

a Sample size

Stuewer 1943), although Sanderson (1987) mentions infrequent use of subterranean maternity sites.

Cavity heights on the control portion averaged 7.4 m, compared to 9.4 m on the experimental. Maternity sites were on south facing ($\bar{x}=191^\circ$) on the control area and southeast facing ($\bar{x}=148^\circ$) on the experimental area, again reflecting general topography of the 2 portions of the study area.

Den trees used as day rest sites by females with their litters, were classified as litter trees. They had a mean circumference ($\bar{x}=213.0$ cm) slightly greater than maternity trees ($\bar{x}=188.4$ cm). It is possible that the larger circumference of the sites classified as litter trees correspond to larger internal cavity measurements needed by growing offspring. Stuewer (1943b) felt that crowding in the maternity cavity prompted females to move to a larger tree.

Ground sites. Use of ground dens as day rest sites was recorded on 49 occasions, accounting for 13.5% of the sites located. The majority of ground dens were groundhog burrows (40.7%) or rock crevices (35.6%) (Figure 6). Entrance measurements averaged 24.1 cm wide by 32.3 cm high. Mean opening width and height were significantly different between the 2 portions of the study area (width, $t=2.0881$, $P=0.0567$; height, $t=2.3104$, $P=0.0390$), with openings on the control portion smaller than those on the experimental

portion. This difference may be a function of availability rather than preference.

Extensive use of rock and ground dens has been well documented in the literature (Berner and Gysel 1967, Giles 1940, 1942, Mech et al. 1966, Stuewer 1943, Shirer and Fitch 1970). In Iowa, more than 50% of the den sites for a raccoon population were in rock outcroppings (Shirer and Fitch 1970), and raccoons in a hunted area showed a preference for rock dens (Giles 1942). In East Tennessee, Taylor (1979) found rock dens used in preference to trees where they were available, particularly during simulated dog training exercises. Rabinowitz and Pelton (1986) found that ground dens were optimal as day-beds due to stable annual temperatures. West Tennessee raccoons used ground dens 25.6% of the time (Allsbrooks 1981). Day rest sites were ground or rock dens 52% of the time in West Virginia (Holman 1983).

Experimental Dog Training

Experimental Dog Training Sessions

From 8 June to 12 October 1987 and from 5 March to 10 August 1988, 83 experimental dog training sessions were conducted in the vicinity of 12 adult, female raccoons on the experimental portion of the study area. The dog training sessions began from 2030 hours to 2345 hours and lasted until 0000 hours to 0545 hours. Duration of dog

training sessions was from 2.0 to 8.0 hours, with a mean of 4 hours and 36 minutes (Appendix A, Table 15). Training sessions were generally scheduled 3 times per week. This intensity of dog training activity was felt to fall within the range of that experienced by raccoons throughout east Tennessee. Experimental training sessions imitated the club-sponsored field trials as well as typical dog training activities. Dogs behave similarly in field trial and training activities, and the only differences might be that quality and experience of dog differs between those entered in field trials and those being "trained". Field trials are scheduled on CSWMA 4 times annually, twice in March and twice in September. Data were recorded from 1 cast of hunters for each of these field trials and included in the analyses.

The frequency of field trials in east Tennessee is limited to 1 trial per club per month when dog training season is closed (10 April, sunrise to 1 September, sunset). There are 23 recognized raccoon hunting clubs in east Tennessee (J. Heath, E. TN. Houndsmen, Assoc., pers. comm.). This potential of 23 legal field trials per month is rarely realized. Field trial participants disperse in groups, often into several surrounding counties. However, particular areas known to harbor a few individual raccoons are usually the destination of these groups, or "casts", of hunters several times per week. Each cast commonly consists

of 3 or 4 field trial participants and the same number of dogs. Field trials begin shortly after dark and have deadlines ranging from 0200 to 0400 hours, with a total time of 2 or 3 hours allowed for the dogs to be unleashed and hunting.

Dogs were released 212 times during the 83 dog training sessions (Appendix A, Table 16). These releases resulted in 225 chases, which ranged in duration from less than 1 minute to 112 minutes ($\bar{x}=11.0$ min). Mean time from release of the dogs to initial location of a raccoon track was 6.5 minutes (range = <1-135 min).

Escape behavior of chased raccoons was grouped in 3 categories: 1) outdistance dogs and seek refuge in a particular tree or rock crevice, 2) seek refuge in nearest tree, 3) climb a tree, jump from opposite side of trunk and continue (called "tapping" by hunters). Depending upon the nearness of the dogs and the proximity of a favorite refuge site, female raccoons employed each of these escape methods while chased. Evidence of these escape methods and their learned basis is presented in Night Refugia (p.63).

Whitney (1931) noted that the raccoon is not particularly swift when pursued, but uses judgement based upon past experiences to elude dogs. The theory of learned or "planned" escape behavior by raccoons is common among hunters and those who have used dogs to study raccoons (Whitney and Underwood 1952, Cunningham 1962, Johnson 1970).

Whitney (1930) described an example of a particular raccoon which learned to elude the trailing dogs by swimming following a successful escape.

The 246 treed raccoons included radio-collared animals 78 times (31%), and uncollared animals 168 times (69%) (Table 6). Uncollared animals were further classified to the highest degree possible. Raccoons with red eartags (males) made up 5% (n=12) of the treed raccoons, those with yellow eartags (uncollared females) made up 0.8% (n=2) of the total sample. Raccoons without eartags (other than young-of-year) comprised 10% (n=24) of the treed animals, and raccoons classified as young-of-year 7% (n=18). The percentage of young-of-year raccoons underestimates the number treed as I did not distinguish between solitary kittens and litters, nor between solitary radio-collared females and those with kittens. Raccoons were seen only by the reflection of their eyes 11% of the time; no animal was seen in 31% of the trees. Other species treed included Virginia opossum (Didelphis virginiana) (n=2) and long-tailed weasel (Mustela frenata) (n=1). White-tailed deer were the quarry in 2% of the experimental chases.

The number of raccoons treed with radio-collared raccoon ranged from 0 to 5, ($\bar{x}$ =1.19 raccoons/tree). The majority of trees contained only the radio-collared female (n=64) (82%). Raccoon ID 013 and her 5 offspring were treed together on 1 occasion. On 6 occasions, radio-collared

Table 6. Classification of animals treed during 83 experimental dog training sessions on the experimental portion of study area, CSWMA, 1987-1988.

Classification	Year		Total
	1987	1988	
radio-collared	39	39	78
eyes only	24	2	26
kitten	16	2	18
red tag	6	6	12
yellow tag	1	1	2
untagged	17	7	24
unseen	44	31	75
other species	5	6	11
Total treed	152	94	246

females sought refuge underground; the presence of offspring or other raccoons accompanying these females was not determined.

Mean number of raccoons observed in a single tree differed between experimental dog training sessions held in 1987 ($\bar{x}=0.9868$) and experimental dog training sessions held in 1988 ($\bar{x}=0.568$) ($t=4.2929$, $P=0.0001$). Raccoons were not treed in family groups during the 1988 dog training sessions. Other raccoons or offspring may have been in the tree undetected. However, the difference in number of raccoons treed together probably reflects the difference in reproductive success of radio-collared females during 1988. Only 2 young-of-year raccoons were treed during the 1988 experimental training sessions; neither of these 2 raccoons were within the boundaries of any of the 6 radio-collared raccoon's home ranges.

Reactions of treed animals varied by group and by individual. Young-of-year raccoons tended to look at lights more readily than older animals, and may have been illegally harvested easily. An uncollared male raccoon was killed by the dogs during an experimental dog training session on 26 June 1987 when it jumped from the tree. Individual animals react differently to squalling by the hunters. Mouth-blown calls are manufactured by several firms to make the squalling noise of a fighting raccoon; advertisements

proclaim the treed raccoon will be convinced to jump to escape while the dogs are occupied with another raccoon.

Night Refugia

Refuge sites during experimental dog training sessions included trees 220 times (89%) and burrows or caves 26 times (11%).

Burrows and caves tended to offer the most protection from dogs and hunters. In most instances dogs would return to the hunters, or continue hunting when a chase ended in a hole. Field trial dogs are conditioned against baying at a hole because points are not awarded for unseen raccoons. A raccoon was visible in only 1 case in a subterranean refuge site, and as such offered enough incentive for 1 dog to dig at the site (Mortality, p.32). Raccoon ID 981 (ID 550 during 1988) seemed to develop a preference for rock crevices after being shaken from a tree and chased into a burrow. Taylor (1979) found that raccoons preferred underground refugia during simulated dog training exercises. A similar preference was observed in a hunted population of raccoons in Iowa (Giles 1942).

Circumference of trees used as refugia varied significantly by species ($F=5.32$, $P=0.0001$) (Table 4, p.53). Mean circumference by tree species was greater for day rest sites for 10 tree species ($P < 0.05$), and greater for trees used as night refugia for 4 tree species ($P < 0.05$)

(Table 4, p.53). There was no difference in selection of tree species between radio-collared females and uncollared animals ($X^2=30.909$, $P=0.471$), and there was no difference in tree species selection among radio-collared females during 1987 ($X^2=67.908$, $P=0.549$). However, there was a difference in frequency of tree species recorded among radio-collared females during 1988 ($X^2=64.82$, $P=0.028$). Raccoon ID 530 was recorded in Virginia pines (*Pinus virginiana*), eastern red cedars, southern red oaks (*Quercus falcata*), and northern red oaks (*Q. rubra*) more often than the other radio-collared females. Raccoon ID 670 was treed more often in yellow-poplars (*Liriodendron tulipifera*) than the other radio-collared females. These apparent preferences corresponded to species which tend to be larger or more densely foliated than other species.

Mean circumference of trees used as night refugia by radio-collared females ($\bar{x}=161$ cm) was not significantly different from the mean circumference of those used as day rest sites ($\bar{x}=163$ cm) ($t=0.2149$, $P=0.83$). This suggests that selection of night refugia and day rest sites was based upon similar requirements of security. Mean circumference of trees used by all raccoons as night refugia ($\bar{x}=135$ cm) was significantly different from mean circumference of trees used as day rest sites by radio-collared females ($t=4.8861$, $P=0.0001$). This difference again probably reflects a learned selectivity of the radio-collared females for secure

sites, along with a random selection by young-of-year and adult males. Raccoons with small home ranges, such as adult females, are probably more familiar with choice refugia within it.

Johnson (1970) noted that refuge trees tended to be the largest and most densely foliated, with yellow-poplars accounting for 40% of the refuge sites in his study. Yellow-poplar trees accounted for only 9% of the refuge sites in this study. The most frequently recorded tree species used as night refugia were northern red oaks, which accounted for 12% and black oaks (Q. velutina), which comprised an additional 10% (Table 4, p.53). All oak species (Quercus spp.) comprised 40% of the night refugia. Eastern red cedar and mockernut hickory (Carya tomentosa) were recorded as refuge sites 9% and 8%, respectively. The oak species were large ($\bar{x}$ =170 cm circumference) and fairly leafy, and as such afforded good cover for treed raccoons. Eastern red cedars are densely foliated and offer excellent cover, but tended to be smaller ($\bar{x}$ =84 cm circumference). The hickories (mockernut hickory and shagbark hickory, C. ovata) were very leafy, fairly large ($\bar{x}$ =107 cm circumference), and probably provided the most cover for treed raccoons. It is apparent that large trees are important for safe refuge, as well as for maternity sites, day-rest sites, and water-holding knotholes.

Potential for illegal harvest of treed raccoons was high. With varying effort, all raccoons seen in trees (69%) could have been harvested, with or without the aid of a firearm. Depending upon the type of refugia chosen by the raccoon, a number of methods are available to "get some fur in the dog's mouth", including use of a mouth-blown squaller, shaking or cutting the tree, climbing the tree and knocking the raccoon out, throwing rocks, use of a slingshot, use of a firearm with soft-report ammunition, or a combination of any of these. The efficiency of raccoon harvest without firearms has been demonstrated previously (Atkeson and Hulse 1953), and should not be underestimated. Raccoon hunters checked during dog-training season in eastern Kentucky were in violation of game laws 36% of the time; 28% of violators were in possession of firearms (Wright 1977). Taylor (1979) attributed 52% of known mortality of translocated raccoons to illegal harvest; in the same area, 24% of radio-collared raccoons were killed illegally (Hardy 1978).

Dog training summary. Behaviors associated with parturition and nursing most influence movement of female raccoons during summer. There was no difference in home range size, movement rates, distance between consecutive activity centers, litter size, and mortality rate between radio-collared female raccoons subjected to experimental dog training and those monitored as controls. However, chased

radio-collared females apparently adapted to dog training activities by a shift to less nocturnal activity. With varying effort, each raccoon seen during experimental dog training sessions (69%) could have been harvested illegally, with or without the aid of a firearm.

Population Characteristics

Trapping

From 1 September to 25 September 1986 and from 15 August to 14 September 1987, four 12-night trapping periods yielded 1920 trapnights. Each trapping period utilized 40 traps per night. The 2 portions of the study area produced 327 raccoon captures of 227 individuals. A complete capture history for each raccoon is included in Appendix C. Six non-target species were captured (Appendix D).

Of the 327 raccoon captures, 191 were males (140 males:100 females). The control area yielded 101 males from a total of 191 raccoon captures (112 males:100 females), while the experimental area yielded 90 males from a total of 136 raccoon captures (195 males:100 females). The capture frequencies by age and sex group indicated heterogeneity of capture ($\chi^2=26.964$, $P=0.0001$).

Hunting

During November and December 1986 and November 1987, a total of 270 hunting parties participated in 7 nights of raccoon hunting on CSWMA. In 1986, 77 raccoons were

harvested by 109 parties from the hunted portion of CSWMA, a party success rate of 70.6% or 1 raccoon/94.6 ha (1 raccoon/283.8 ha/night). In 1987, 117 raccoons were harvested by 161 hunting parties in 4 nights of hunting for a party success rate of 72.7% or 1 raccoon/62.3 ha (1 raccoon/249 ha/night).

The party success rate was not different among the past 4 years ($X^2=1.74$, $P=0.63$) (Table 7), despite an increase from 3 to 4 nights of hunting in 1987. During the 9-night 1976 season, 638 parties harvested 136 raccoons from CSWMA (Woods 1978) (including present control portion of the study area), resulting in a party success rate of 21.3% or 1 raccoon/72.6 ha (1 raccoon/653 ha/night). Annual harvest success rates have remained relatively constant ($X^2=1.74$, $P=0.63$) over the past 4 harvest seasons and are probably a function of the 44 parties/night quota. Kocka (1988) reported a negative relationship between nightly hunting-party density and harvest success under the present raccoon hunting party quota system at CSWMA. The nightly quota and dispersion by compartment assignment reduces the affect of this negative relationship and produces a high harvest success rate.

In 1986, 36 raccoons were harvested from the experimental portion of the study area at a party success rate of 60% for the 3 nights (Table 7). In 1987, with 4 nights of hunting, 59 raccoons were harvested from the

Table 7. Harvest data from quota raccoon hunting on experimental portion of study area and rest of hunted area of CSMWA, November 1986, and November 1987.

Date	<u>Experimental Portion^a</u>			<u>Rest of Hunted Area^b</u>		
	Hunting Parties	Raccoons Harvested	Success Rate (%)	Hunting Parties	Raccoons Harvested	Success Rate (%)
<u>1986</u>						
17 Nov	20	16	80.0	17	12	70.6
19 Nov	20	12	60.0	16	12	75.0
28 Nov	20	13	65.0	16	12	75.0
<u>total</u>	<u>60</u>	<u>41</u>	<u>68.3</u>	<u>49</u>	<u>36</u>	<u>73.5</u>
<u>1987</u>						
16 Nov	20	18	90.0	19	17	89.5
18 Nov	20	14	70.0	20	10	50.0
23 Nov	20	14	70.0	21	17	81.0
27 Nov	20	12	60.0	21	15	71.4
<u>total</u>	<u>80</u>	<u>58</u>	<u>72.5</u>	<u>81</u>	<u>59</u>	<u>72.8</u>

a 2545 ha.

b 4739 ha.

experimental portion for a party success rate of 74% (range=50 to 80% per night).

Reproductive tracts from 90 female raccoons harvested in 1986 and 1987 were examined for the presence and number of placental scars. Forty-two individuals had not bred, while 48 (53%) had distinguishable scars (Table 8). Pregnancy rate of harvested females was 65% and 46%, respectively, for 1986 and 1987. Kocka (1988) reported 66% and 32% pregnancy rates for female raccoons harvested from CSWMA in 1984 and 1985, respectively. Pregnancy rates for age class I and II (5% and 36%, respectively) were lower than those of age class III, IV, and V raccoons (80%, 100%, and 100%, respectively). Since age class II includes animals age 15-38 months, yearling pregnancy rates are confounded within this group, and likely are lower than that of 2 to 3 year old raccoons.

Mean litter sizes of females harvested in 1986, 1.9 young per breeding female, was less than that of 1987, 2.6 young per breeding female ($t=46.0$, $P=0.0026$) (Table 8). Mean litter size of animals harvested in 1986 and 1987, 2.3 young per breeding female, within the range of 2.8 young/litter reported by Woods (1978) and 2.0 young/litter reported by Kocka (1988). Mech et al. (1968) felt that larger litter sizes of raccoons at more northerly latitudes was a mechanism to compensate for higher winter mortality. Changes in CSWMA raccoon litter sizes among years is likely

Table 8. Litter sizes and pregnancy rates as determined by placental scar counts for 5 age classes of raccoons harvested on CSWMA, November 1986, and November 1987.

Number of Placental Scars	Number of Individuals					Total
	Age I	Age II	Age III	Age IV	Age V	
<u>1986</u>						
0	8	1	2	0	1	12
1	1	4	0	2	1	8
2	0	2	4	0	2	8
3	0	0	3	1	2	6
Mean # Scars ^a	1	1.3	2.4	1.7	2.2	1.9
<u>1987</u>						
0	12	17	1	0	0	30
1	0	2	0	0	0	2
2	0	0	2	3	2	7
3	0	2	3	9	3	17
Mean # Scars ^a	0	1.8	2.6	2.8	2.8	2.6
1986 Total	9	7	9	3	6	34
1987 Total	12	21	6	12	5	56
Grand Total	21	28	15	15	11	90
1986 % Parous	11	86	78	78	100	65
1987 % Parous	0	9	83	100	100	46
Total % Parous	5	36	80	100	100	53
Mean # Scars ^a	1.0	1.5	2.5	2.3	2.4	2.3

^a Mean number of scars per parous female.

a response to decreased density and improved physical condition following the 1979-1983 harvest closure. Estimates from 1982 suggested that raccoons had recovered from an apparent overharvest in 1978 (Nottingham 1985). Litter sizes apparently responded inversely to increasing density during the harvest closure 1978 to 1984. An inverse relationship between density and fecundity has been established for many species (Errington 1956, Keith 1962). Bissonette and Csech (1938) have demonstrated that raccoon reproduction is affected by protein intake. Since the control portion of the study area has been unharvested, placental scar samples are not available for comparison. However, observed litter sizes of radio-collared female raccoons are available (Appendix A, Table 11), and fall within the range of placental scar estimates.

Mean litter size of harvested raccoons did not differ between the experimental portion of the study area and the non-study portion of CSWMA ($t=0.1804$, $P=0.8577$). Factors affecting litter size on the experimental portion of the study area are likely similar to those on the RHA of CSWMA.

Hunters were asked to report the number of raccoons treed along with the harvested raccoon to determine if young raccoons had become self sufficient. Mean number of raccoons reported treed with the harvested raccoons in November 1987 was 0.2 (range = 0-2). Raccoons were alone when harvested 88% of the time. Adult females, kittens, and

adult males were taken from a tree with other raccoons present 13%, 12%, 11% of the time, respectively. The similarity in these frequencies suggests that family groups have disbanded by the time young-of-year raccoons are from 5 1/2 to 7 months old. This does not conflict with Johnson (1970), who felt that family groups remained intact for at least 3 months following parturition. However, young raccoons may still travel and feed with their mother, yet seek refuge in a nearby tree undetected by the hunters. Members of an intact family group may be in the same tree as a harvested individual, yet remain unseen.

Mean reported time of harvest was 2126 hrs (range = 1800-0145 hrs). Mean number of raccoons seen per successful party during 1987 was 1.8 (range = 1-7). Mean number of trees treed upon was 2.1 (range = 0-9), similar to experimental dog training sessions (Appendix B, Table 15). Mean estimated circumference was 62.7 cm and ranged from 9.4 cm to 157.1 cm. There was no significant difference among adult females, adult males, and kittens in circumference of trees used as refugia ($F=1.23$, $P=0.2972$).

Open Model Estimates

Open model estimators assume geographic closure, but relax assumptions of demographic closure, permitting the analysis of complete mark-recapture histories of individual raccoons from 1981 to present. Jolly-Seber estimates and corresponding confidence intervals were produced for each

late summer and fall harvest sample for the experimental portion of the study area, and for each late summer sample for the control portion from 1985 to 1987 (Table 9).

The population increased 43% from late summer 1985 to late summer 1986 on the control portion, and decreased 7% from late summer 1986 to late summer 1987. Estimates for the experimental portion of the study area however, indicated the population decreased 35% from late summer 1985 to late summer 1986, increased 20% from late summer 1986 to late summer 1987. The differences in the population estimates likely reflected the impact of the managed harvest on the experimental portion of the study area (Harvest Impacts, p.81).

The J-S estimates for the experimental portion of the study area indicate a 42% decrease from late summer 1985 to the 1985 fall harvest, a 55% increase from late summer to fall harvest 1986, and a 51% increase from late summer to fall harvest 1987. The increase in estimated population size during fall 1986 and fall 1987 likely reflected differences in sampling methods; capture probabilities vary by sex and age (Trapping, p.67), while harvest with dogs probably provides a more representative sample.

Closed Model Estimates

Closed model estimates were calculated using capture data from each 12-night trapping period in program CAPTURE. Data from the fall trapping periods met the hypothesis for

Table 9. Population estimates of raccoons on 2 portions of the study area, CSWMA, 1985-1987a.

Estimator	Fall 1985	Fall 1985 Harvest	Fall 1986	Fall 1986 Harvest	Fall 1987	Fall 1987 Harvest
<u>Control</u>						
Jolly-Seber	160+37 (12%)	N/A	229+89 (20%)	N/A	212+98 (24%)	N/A
Petersen-I ^b		N/A	266+78 (15%)	N/A	281+77 (14%)	N/A
Petersen-II ^b		N/A	184+84 (23%)	N/A	240+120 (25%)	N/A
Jackknife ^c	210+54 (13%)	N/A	255+68 (13%)	N/A	356+77 (11%)	N/A

Table 9. Continued.

Estimator	Fall 1985	Fall 1985 Harvest	Fall 1986	Fall 1986 Harvest	Fall 1987	Fall 1987 Harvest
	<u>Experimental</u>					
Jolly-Seber	218±84 (19%)	127 ^d	142±44 (15%)	220 ^d	171±52 (16%)	259 ^d
Petersen-I ^b		230±55 (24%)	156±53 (17%)	226±119 (26%)	228±82 (18%)	466±248 (27%)
Petersen-II ^b			111±58 (26%)	N/A	155±69 (22%)	N/A
Jackknife ^c	163±54 (17%)	N/A	125±36 (14%)	N/A	247±67 (14%)	N/A

^a Ninety-five percent confidence intervals and coefficients of variation (in parenthesis) accompany each estimate.

^b Chapman's modification of the Petersen Model (Seber 1982).
 Petersen-I = marking period is previous late summer sample period.
 Petersen-II = marking period is first 6 nights of sample period.

^c Model M(h) of program CAPTURE (Otis et al. 1978).

^d Standard error estimate not available.

demographic closure (range of $z = 0.175-1.960$, range of $P = 0.43072-0.97500$). The test for closure is computed by program CAPTURE for Model M_h as the null hypothesis. These estimates were probably robust to the assumption of closure since mortality is low during late summer (Johnson 1970) and recruitment is complete by this time (Reproduction, p.27).

CAPTURE selected model M_0 (constant capture probability) as the most appropriate model for fall 1986 for the experimental portion of the study area, and fall 1985 and fall 1987 for the control portion. The population estimate by Model M_0 for the experimental portion for fall 1986 was 146 (C.I. 64 to 228). The fall 1985 and fall 1987 control portion estimates by the Model M_0 were 201 (C.I. 122 to 280) and 308 (C.I. 165 to 451), respectively. Model M_b (behavior) was selected as the most appropriate model for the experimental portion of the study area for Fall 1985, and produced an estimate of 57 (C.I. 42 to 72). The lower confidence bound falls below the actual number captured, so the number captured should be used as the lower bound. Model M_{bh} (behavioral response and heterogeneity) was selected as the most appropriate model for the experimental portion for fall 1987, and produced an estimate of 102 (C.I. 58 to 146). Since the lower confidence bound falls below the actual number of animals captured (69), the number captured should be regarded as the lower bound. Model M_{th}

(time effects and heterogeneity) was selected as most appropriate for the control portion for fall 1986, however there is no associated estimator available for this model (Otis et al. 1978).

Each trapping period experienced heterogeneity of capture due to age and sex (Trapping p.67). Previous research on CSWMA documented age (Nottingham 1985, Kocka 1988) and sex (Woods 1978, Nottingham 1985, Kocka 1988) as sources of heterogeneity in raccoon trapping. Model M(h), the Jackknife estimator, assumes unequal catchability of individuals due to sex, age, home range size and shape, or activity level (Otis et al.1978), making it the most robust of CAPTURE's models. Model M(h) was reported as CAPTURE's most robust estimator for raccoon populations in west Tennessee (Leberg 1985, Moore and Kennedy 1985). Kocka (1988) reported the Jackknife estimator to be the most robust and consistent closed model estimator of the CSWMA raccoon population. For comparisons with CAPTURE estimates from previous work on CSWMA and in Tennessee, the Jackknife estimates are included in Table 9.

Closed model estimates were calculated with Chapman's Modification of the Petersen Model from trapping data for the control and experimental portions of the study area and from trapping and harvest data for the experimental portion of the study area utilizing the previous late summer trapping sample as the marking period (Petersen-I).

Petersen estimates were also derived by using the first 6 days of a trapping sample as the marking period, and the last 6 days as the recapture sample (Petersen-II).

The Petersen-I estimates of raccoons in the control portion of the study area in late summer were 184 (C.I., 100-267) and 239 (C.I., 119-359), for 1986 and 1987, respectively (Table 9). Petersen-I estimates of raccoons in late summer for the experimental portion of the study area were 111 (C.I., 53-169) and 155 (C.I., 87-224), for 1986 and 1987 respectively. This represents an increase of 30% from 1986 to 1987 for the control portion of the study area, and an increase of 40% for the experimental portion.

The Petersen-II produced population estimates for Fall 1986 of 170 (C.I., 99-244) for the control portion of the study area; and the Petersen estimate for the experimental portion was 103 (C.I., 50-156) (Table 9). The Petersen II produced population estimates for Fall 1987 for the control portion of the study area of 281 (C.I., 202-358) and 241 (C.I., 148-333) for the experimental portion.

Petersen-I estimates were calculated for the experimental portion of the study area utilizing the late summer trapping data as the marking sample and the quota hunt data as a recapture sample. Ear-tagged raccoons were harvested each year from the experimental portion of the study area ($n=12$, 1986; $n=14$, 1987). In 1987, 2 ear-tagged individuals were harvested from the non-study portion of

CSWMA. However, only raccoons captured on the experimental area during the previous late summer trapping period and harvested within the experimental area were considered as recaptures. Petersen-I estimates for the experimental portion of the study area were 227 (C.I., 107-347) for late fall 1986, and 467 (C.I., 218-716) for late fall 1987. This represents an increase in estimated population of 106% from 1986 to 1987, despite a harvest of 36 raccoons from the experimental portion in 1986.

Assumptions of the Petersen Model include that of equal catchability of individuals in a population. However, the assumption of equal catchability was found to be invalid in this study (Trapping, p.67). Moore and Kennedy (1985) reported that Lincoln (Petersen) estimates were slightly larger than the actual number of tagged animals when heterogeneity of capture was present. The Petersen-II estimates probably underestimate the actual population size.

Density Estimates

Density estimates, pooled across the study area, were derived for comparing CSWMA raccoon populations with those in other areas of the United States. J-S population estimates yielded late summer densities for 1985, 1986, and 1987 of 1 raccoon/13.6 ha, 1 raccoon/13.8, and 1 raccoon/13.4 ha, respectively. Jackknife population estimates provided densities of 1 raccoon/13.8 ha, 1

raccoon/13.5 ha, and 1 raccoon/8.5 ha for late Summer 1985, 1986, and 1987, respectively.

Density estimates were compared to estimates from other areas and previous work on CSWMA (Table 10). Differences in sampling techniques and seasons obviously affect comparisons, but highest densities were documented in swamp and marsh areas, while lowest densities were recorded from upland forests. The J-S density estimates are some of the highest reported for upland hardwood habitat in east Tennessee, only exceeded by that of Kocka (1988) for fall 1984 (1 raccoon/11.6 ha).

Harvest Impacts

In 1985, 1986, and 1987, percentage of the estimated late summer population harvested from the experimental portion of the study area was 13, 25, and 35, respectively. These removal rates were calculated from late summer J-S estimates. Nottingham et al. (1982) reported that hunters harvested 31.2-37.2% of the estimated CSWMA population in 1976, too high to permit sustained yields.

In a harvest system aimed at sustained yield, natural mortality is replaced by harvest of surplus animals. While the unharvested control portion of the study area demonstrated fluctuations in numbers typical of density-dependent natural mortality, the harvested, experimental portion showed a decrease in numbers following the initiation of a quota harvest system in 1984 (Figure 7).

Table 10. Population densities of raccoons from different areas of the United States.

State	Density (raccoons/ha)	Habitat Type	Source
Alabama	1/8.5	Bottomland hardwood	Johnson (1970)
Ohio	1/10.9-1/42.9	Upland hardwood	Butterfield (1944)
Florida	1/8.7	Bottomland hardwood, pine-oak	Conner et al. (1983)
Illinois	1/5.7	Marshland	Urban (1970)
South Carolina	1/4.0	Swampland	Cunningham (1962)
Tennessee			
CSWMA			
1976	1/27.5 ^a	Upland hardwood	Woods (1978)
1982	1/14.7 ^a	Upland hardwood	Nottingham (1985)
1983	1/19.4 ^a	Upland hardwood	Kocka (1988)
1984	1/11.6 ^a	Upland hardwood	Kocka (1988)
1986	1/13.8 ^a	Upland hardwood	This study
1987	1/13.4 ^a	Upland hardwood	This study
Cades Cove	1/17	Upland hardwood	Rabinowitz (1981)
Shelby Forest	1/7.2	Bottomland hardwood	Moore (1983)
Virginia	1/5.7	Upland hardwood	Sonenshine and Winslow (1972)

^a Mean estimate of both portions of study area for late summer.

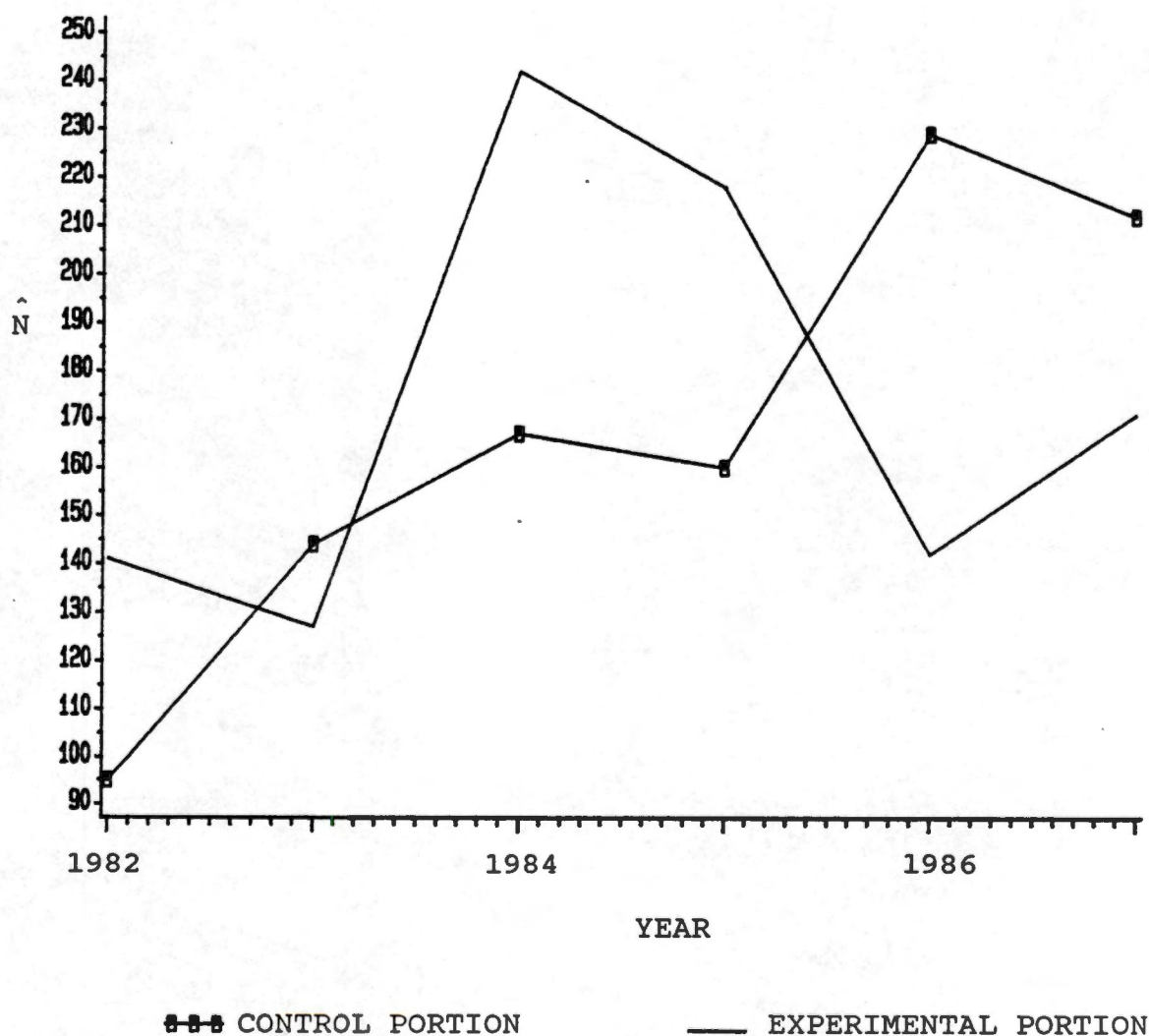


Figure 7. Comparison of late summer Jolly-Seber population estimates of raccoons on 2 portions of study area, CSWMA, 1982-1987.

McCullough (1984) demonstrated that harvest rates below the level of maximum sustained yield (MSY) will tend to stabilize the population somewhere between carrying capacity and the MSY residual population size. The experimental portion of the study area appeared to have reached this equilibrium. The balancing effect in the experimental portion of the study area is probably the reduction of late-winter intraspecific competition by the harvest. In response to reduced breeding density, there was an increase in fecundity on the experimental area (Hunting, p.67), which appeared to have stabilized experimental area raccoon numbers by 1987. The experimental area apparently adjusted to the 3-night harvest in 3 years. Combined with a 1-year lag in J-S population estimates, harvest rates could be adjusted only after 4 years at a constant rate.

The addition of 1 night of hunting in 1987 resulted in a larger total harvest with no change in hunting success rate. Under the present quota system, harvest rates could be adjusted through the manipulation of nights of hunting allowed. Since harvest success rate is influenced directly by nightly hunting party density (Kocka 1988), additional nights of hunting would be relatively insensitive to a diminishing harvestable surplus. Harvests rates could be adjusted cautiously to prevent overharvest.

CHAPTER V

SUMMARY AND CONCLUSIONS

1. Behavioral aspects of pregnancy, parturition, and post-parturition for female raccoons were determined through telemetry. Average home range size calculated by the bivariate model was 143.8 ha, while average home range size calculated by the convex polygon model was 93.2 ha. These home range estimates compared favorably to previous reports for east Tennessee. Home range sizes (bivariate and convex polygon model) were significantly smaller during the period of nursing than the period of pregnancy and weaning. This reduction in movements is typical of female raccoons while nursing young. Litter sizes of radio-collared, adult females ranged from 1 to 5, with a mean of 2.4 offspring per litter. Probability of activity varied significantly by hour recorded ($F=5.36$, $P=0.0001$), with highest probabilities between 2100 and 2300 hrs and again between 0300 and 0400 hrs.

2. An investigation of the effects of summer dog training on radio-collared female raccoons was conducted from 3 March 1986 to 15 August 1988 on 2 portions of a study area on the Chuck Swan Wildlife Management Area, Tennessee. From 8 June 1987 to 12 October 1987 and from 5 March 1988 to 10 August 1988, 83 experimental dog training sessions were conducted in the vicinity of 12 radio-collared female

raccoons. Experimental training sessions were scheduled 3 times per week. Trained raccoon dogs were released 212 times during the eighty-three experimental dog training sessions, resulting in 225 chases. The treed raccoons were classified as one of the radio-collared study animals 78 times (31%), young-of-year 18 times (7%), eartagged 14 times (6%), untagged 24 times (10%), and unseen 76 times (31%). No young-of-year raccoons were treed during 1988 experimental dog training sessions within the home range boundaries of radio-collared females. Although treeing success of radio-collared raccoons was relatively low, females reacted to the chases within hearing distance.

Offspring of 4 experimental females (33%) and of 3 control females (25%) were abandoned or orphaned. A single radio-collared female was caught and killed by a dog on the ground, leaving a dependent litter orphaned; 1 female abandoned her young after being treed during an experimental dog training session, 1 female was apparently killed by a falling limb, 3 females apparently abandoned offspring due to researcher activity, and 1 female evidently deserted her offspring following hay baling operations in a nearby field. The losses of these litters emphasizes the sensitivity of the female during early stages of offspring's lives, whether the disturbance is dog training or other human activities.

Mean home range size prior to and during experimental training sessions (bivariate and convex polygon) was not

significantly different between females subjected to experimental dog training and females used as controls. Mean litter size was not significantly different between chased and unchased radio-collared females ($F=0.32$, $P=0.5597$). The observed litter sizes of radio-collared females concurred with estimates from placental scar counts of raccoons harvested from CSWMA, exclusive of the control portion of the study area, in 1986 and 1987 ($\bar{x}=2.3$ young per breeding female). Distance between consecutive geometric centers of activity were not significantly different between experimental and control animals; this suggests that radio-collared females did not abandon their normal home range to avoid dog training activities. The distances between consecutive geometric centers of activity likely reflect changing food resources and day rest site locations.

Mean rate of movement between consecutive telemetry locations was not significantly different between experimental ($\bar{x}=340$ m/hr) and control raccoons ($\bar{x}=282$ m/hr) ($t=0.4939$, $P=0.564$), suggesting that overall foraging and travel activities were not affected by experimental dog training exercises. Movement rates were not recorded during experimental chases, however, raccoons probably moved faster while chased and slower while treed than while foraging. Movement rates of all study animals were similar to those reported previously from east Tennessee.

Mean probability of nocturnal activity of experimental females ($\bar{x}=0.74$) was significantly less than that of control females ($\bar{x}=0.82$) ($t=2.959$, $P=0.0032$). The lower probability of activity for raccoons subjected to experimental dog training exercises may reflect a shift to more diurnal movement in response to night harassment. The results of experimental dog training exercises indicated a high potential (69%) for illegal harvest during summer dog training, with or without the aid of firearms.

Home range, shifts of geometric centers of activity, and movement rates were not affected by the level of dog training realized in this study, whereas litter survival, altered activity patterns of chased raccoons, and high potential for illegal harvest indicated the likelihood of the population to decline when subjected to frequent harassment.

3. Maternity dens, day rest sites, and night refugia of radio-collared female raccoons were described. Day rest sites of radio-collared raccoons were located 444 times in 219 trees and 49 caves, burrows, or crevices. Leaf nests were recorded as day rest site type more frequently (19.8% of the time) than previously reported from east Tennessee. Mean circumference of all trees recorded as day rest sites was 128.0 cm. Maternity sites were in cavities of large trees ($\bar{x}=188.4$ cm). Recorded length of use ranged from 27 to 84 days. Height of cavity openings of maternity trees

differed between the experimental ($\bar{x}=7.43$ m) and control ($\bar{x}=9.41$ m) portions of the study area ($t=3.0373$, $P=0.0030$). Mean direction of aspect of maternity tree sites differed between the experimental ($\bar{x}=148^\circ$) and control ($\bar{x}=191^\circ$) portions of the study area ($t=2.4214$, $P=0.0179$), but likely reflects topography differences of the two areas. Litter trees used subsequent to the maternity site had a slightly larger mean circumference ($\bar{x}=213.0$ cm) than maternity trees. Large trees are important as maternity sites, as well as secure refuge and for hard and soft mast production. Forest management should recognize the importance of long rotation and conservation of trees of poor form for the benefit of forest wildlife, including raccoons.

Ground dens comprised 13.5% of the day rest sites located; ground dens were classified most frequently as groundhog burrows (40.7%) and rock crevices (35.6%). Ground dens have been demonstrated to be optimal day rest sites, presumably due to stable annual temperatures.

Refuge sites recorded during experimental training sessions included 220 trees (89%) and 26 burrows or caves (11%). Radio-collared females sought refuge 6 times underground. Underground refugia tended to offer the most protection from dogs and hunters. Mean circumference of trees used as night refugia by radio-collared females ($\bar{x}=161$ cm) was not significantly different from mean circumference of those used as day rest sites ($\bar{x}=163$ cm) ($t=0.2149$,

$P=0.0001$). Radio-collared females used significantly larger circumference trees ($\bar{x}=161$ cm) as refugia than other raccoons ($\bar{x}=135$ cm) ($t=4.8861$, $P=0.0001$), indicating a selection for secure refuge sites. Large and/or leafy trees offered the most protection to treed raccoons. Tree species recorded most frequently as night refugia were northern red oaks (12%) and black oaks (10%), with all oak species comprising 40% of night refugia.

4. Impacts of a quota raccoon harvest system were evaluated through mark-recapture population estimates and mandatory check station. Raccoons were live trapped to provide mark-recapture data from which population estimates were derived for both portions of the study area. Open (Jolly-Seber Model) and closed (Jackknife and Petersen Models) population estimators were utilized to make model comparisons. During 1920 trapnights, 327 raccoon captures (1 raccoon/5.87 trapnights) were comprised of 227 individuals. Jolly-Seber population estimates for the unharvested portion of the study area indicated a 43% increase from late summer 1985 to late summer 1986, and a 7% decrease from late summer 1986 to 1987. J-S estimates for the harvested portion of the study area indicate a 35% increase from late summer 1985 to 1986, and a 20% increase from late summer 1986 to 1987. Jackknife population estimates of the harvested portion of the study area for late summer 1985, 1986, and 1987 were 163, 125, and 247

raccoons, respectively. Jackknife population estimates of the unharvested portion of the study area for late summer 1985, 1986, and 1987 were 210, 255, and 356, respectively. Petersen-I population estimates of the harvested portion of the study area were 111 and 155 raccoon for late summer 1986 and 1987. Petersen-I population estimates of the unharvested portion of the study area were 184 and 239 raccoons for 1986 and 1987. Petersen-II estimates for late summer 1986 and late summer 1987 were 103 and 241 raccoons for the harvested portion of the study area, and 170 and 281 raccoons for the unharvested portion of the study area. Petersen-II estimates for the harvested portion of the study area employing the annual harvest as a recapture period were 227 and 467 for Fall 1986 and Fall 1987, respectively. Density estimates of 1 raccoon/13.6 ha, 1 raccoon/13.8 ha, and 1 raccoon/13.4 ha for late summer 1985, 1986, and 1987, respectively, were derived from population estimates pooled across the study area.

Seven nights of managed raccoon hunting were conducted on CSWMA, excluding the control portion of the study area. Three nights of hunting were held on 17, 19, and 28 November 1986; four nights of hunting were conducted on 16, 18, 23, and 28 November 1987. During all 7 nights of hunting, 4 parties were assigned to each of 5 management compartments within the experimental portion of the study area, while up to 3 parties were assigned to each of 8 management

compartments in the non-study area portion of CSWMA. A total of 270 hunting parties participated in 7 nights of raccoon hunting on CSWMA. In 1986, 77 raccoons were harvested by 109 parties for a party success rate of 70.6% or 1 raccoon/94.6 ha (1 raccoon/284 ha/night). In 1987, 117 raccoons were harvested by 161 hunting parties for a party success rate of 72.7%, or 1 raccoon/62.3 ha (1 raccoon/249 ha/night). Annual harvest success rates remained relatively constant over the past 4 harvest seasons (range = 61-74%) ($X^2=1.74$, $P=0.63$) and were probably a function of the 44 parties/night quota. In 1985, 1986, and 1987, 13%, 25%, and 35%, respectively, of the estimated late summer population on the experimental portion of the study area was harvested. The harvest rate in 1987 approached that of 1976 (38%), which resulted closure the following year due to apparent overharvest. Reproductive tracts were collected from 90 females harvested in 1986 and 1987. Distinguishable scars were present in 53% of the uteri examined, while 47% appeared not to have bred. Pregnancy rates were lowest for age class I (5%) and age class II (36%), and highest for age class III, IV, and V females (80%, 100%, 100%, respectively). Mean litter sizes of females harvested in 1986 and 1987 was 1.9 and 2.6 young per breeding female, respectively (range = 1-3 young per litter). The 1987 litter size is similar to that of 1976 (2.8) when the CSWMA population was over harvested.

The results of the managed raccoon harvest indicated an apparent sustained yield at the present harvest rate. The CSWMA raccoon population evidently requires 3 years to reach equilibrium at a particular harvest rate. Following the 3-year population adjustment period, harvest rates could be adjusted judiciously with respect to population estimates, reproduction, and age structure to prevent over-harvest.

LITERATURE CITED

LITERATURE CITED

- Arnason, A. N., and L. Baniuk. 1980. A computer system for mark-recapture analysis of open populations. *J. Wildl. Manage.* 44:325-332.
- Atkeson, T. Z., and D. C. Hulse. 1953. Trapping versus night hunting for controlling raccoons and opossums within sanctuaries. *J. Wildl. Manage.* 17:159-162.
- Berner, A., and L. W. Gysel. 1967. Raccoon use of large tree cavities and ground burrows. *J. Wildl. Manage.* 31:706-714.
- Bigler, W. J., and G. L. Hoff. 1974. Anesthesia of raccoons with ketamine hydrochloride. *J. Wildl. Manage.* 38:364-367.
- Bissonette, T. H., and A. G. Csech. 1937. Modification of mammalian sexual cycles, VII - fertile matings of raccoons in December instead of February induced by increasing daily periods of light. *Proc. Roy. Soc. London. Ser. B.* 122:246-254.
- _____ and _____. 1938. Sexual photoperiodicity of raccoons on low protein diet and second litters in the same breeding season. *J. Mammal.* 19:342-348.
- Butterfield, R. T. 1944. Populations, hunting pressure, and movements of Ohio raccoons. *Trans. N. Am. Wildl. Conf.* 9:337-344.
- Conner, M. C., R. F. Labisky, and D. R. Progulske, Jr. 1983. Scent-stations indices as measures of population abundance for bobcats, raccoons, gray foxes, and opossums. *Wildl. Soc. Bull.* 11:146-152.
- Cunningham, E. R. 1962. A study of the eastern raccoon Procyon lotor L. on the Atomic Energy Commission, Savannah River Plant. M.S. Thesis, Univ. of Georgia, Athens. 55pp.
- Dixon, K. R., and J. A. Chapman. 1980. Harmonic mean measure of animal activity areas. *Ecology.* 61:1040-1044.
- Ellis, R. J. 1964. Tracking raccoons by radio. *J. Wildl. Manage.* 28:363-368.
- Errington, P. L. 1956. Factors limiting higher vertebrate populations. *Science* 124:304-307.

- Fenneman, N. M. 1938. Physiography of the eastern United States. McGraw-Hill Book Co., New York. 714pp.
- Fritzell, E. K. 1978. Habitat use by prairie raccoons during the waterfowl breeding season. J. Wildl. Manage. 42:118-127.
- Giles, L. W. 1942. Utilization of rock exposures for dens and escape cover by raccoons. Amer. Midl. Nat. 27:171-176.
- Grau, G. A., G. C. Sanderson, and J. P. Rogers. 1970. Age determination of raccoons. J. Wildl. Manage. 34:364-372.
- Hardy, G. H. 1979. Movement ecology of resident raccoons in east Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 82pp.
- Hayne, D. W. 1949. Calculation of size of home range. J. Mammal. 30:1-18.
- Hoffman, C. O., and J. L. Gottschang. 1977. Numbers, distribution, and movements of a raccoon population in a suburban residential community. J. Mammal. 58:623-636.
- Holman, M. E. 1983. Sociological and ecological relationships of the raccoon (Procyon lotor) on the Fork Creek Public Hunting Area, West Virginia. M.S. Thesis, West Virginia Univ., Morgantown. 147pp.
- Holzman, S., M. J. Conroy, and J. Pickering. 1988. Home ranges, habitat use and survival rate of coyotes in South-Central Georgia. Abstract. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 42:In Press.
- Hill, H. S., and T. T. Fendley. 1982. Animal movement analysis and home range determination package. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 36:656-663.
- 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.
- Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigration-stochastic model. Biometrika 52:225-247.

- Keith, L. B. 1962. Wildlife's ten-year cycle. Univ. Wisconsin Press, Madison. 201pp.
- Kocka, D. M. 1987. An evaluation of population estimators, densities, and scent-station indices of a raccoon population in East Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 153pp.
- Koeppel, 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.
- Leberg, P. L. 1985. Density and habitat relationships of the raccoon. Procyon lotor, in western Tennessee. M.S. Thesis, Memphis State Univ., Memphis. 78pp.
- Lefebvre, L. W., D. L. Otis, and N. R. Holler. 1982. Comparison of open and closed models for cotton rat population estimates. J. Wildl. Manage. 46:156-163.
- Lewis, J. C., and L. E. Safley. 1967. The Central Peninsula Deer Herd, 1950-1956. Tenn. Game and Fish Comm. Nashville. 19pp.
- McCullough, D. R. 1984. Lessons from the George Reserve, Michigan. Pages 211-242 in L. K. Halls, ed. White-tailed deer. Stackpole Books, Harrisburg, Pa.
- Mech, L. D., J. R. Tester, and D. W. Warner. 1966. Fall daytime resting habits of raccoons as determined by telemetry. J. Mammal. 74:450-466.
- Mech, L. D., D. M. Barnes, and J. R. Tester. 1968. Seasonal weight changes, mortality, and population structure of raccoons in Minnesota. J. Mammal. 49:63-73.
- Minckler, L. S. 1946. Old field reforestation in the Great Appalachian Valley as related to some ecological factors. Ecol. Monogr. 16:87-108.
- Minser, W. G., and M. R. Pelton. 1982. Impact of hunting on raccoon populations and the management implications. Agric. Exp. Sta. Univ. of Tennessee Bull. No. 612. 32pp.
- Montgomery, G. G. 1964. Tooth eruption in preweaned raccoons. J. Wildl. Manage. 28:582-584.
- Moore, D. W., and M. L. Kennedy. 1985. Factors affecting response of raccoons to traps and population size estimation. Amer. Midl. Nat. 114:192-197.

- Nottingham, B. G., Jr. 1985. Raccoon population parameters on the Chuck Swan Wildlife Management Area with an evaluation of scent-stations for monitoring raccoon populations in East Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 127pp.
- _____, K. G. Johnson, J. W. Woods, and M. R. Pelton. 1982. Population characteristics and harvest relationships of a raccoon population in East Tennessee. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 36:691-700.
- Rabinowitz, A. R. 1981. The ecology of the raccoon (Procyon lotor) in Cades Cove, The Great Smoky Mountains National Park. Ph.D. Diss., Univ. Tennessee, Knoxville. 133pp.
- Rothacher, R. D. 1953. White Hollow watershed management: 15 years of progress in character of forest, runoff, and stream flow. J. For. 51:731-738.
- Safley, L. E. 1974. Wildlife management guide for the Chuck Swan Wildlife Management Area. M.S. Thesis, Univ. of Tennessee, Knoxville, 111pp.
- Sanderson, G. C. 1950. Methods of measuring productivity in raccoons. J. Wildl. Manage. 14:389-402.
- _____. 1987. Raccoon. Pages 486-499 in M. Novak, J.A. Baker, M.E. Obbard, and B Malloch, eds. Wild Furbearer management and conservation in North America. Ontario Trappers Assoc., North Bay.
- _____, and A. V. Nalbandov. 1973. The reproductive cycle of the raccoon in Illinois. Ill. Nat. Hist. Surv. Bull. 31:29-85.
- SAS. 1985. SAS User's Guide: Basics. Sas Institute, Inc., Cary, NC. 1290pp.
- Schneider, D. G., L. D. Mech, and J. R. Tester. 1971. Movements of female raccoons and their young as determined by radio-tracking. Anim. Behav. Monogr. 4:1-43.
- Seber, G. A. F. 1965. A note on the multiple-recapture census. Biometrika 52:249-259.
- _____. 1982. The estimation of animal abundance and related parameters. 2nd ed., Macmillan Pub. Co., New York, NY. 654pp.

- 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, W. P. 1983. A bivariate normal test for elliptical home-range models: biological implications and recommendations. *J. Wildl. Manage.* 47:613-619.
- Sonenshine, D. E., and E. L. Winslow. 1972. Contrasts in distribution of raccoons in two Virginia localities. *J. Wildl. Manage.* 36:838-847.
- Stuewer, F. W. 1943a. Raccoons: their habits and mangement in Michigan. *Ecol. Monogr.* 13:203-257.
- _____. 1943b. Reproduction of raccoons in Michigan. *J. Wildl. Manage.* 7:60-79.
- Summers, D. D. 1968. Relationships of soil, site, and time on the changes in forest composition on Big Ridge Natural Study Area, Union County, Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 133pp.
- Sumner, P. W., and E. P. Hill. 1980. Scent-stations as indices of abundance in some furbearers of Alabama. *Proc. S.E. Assoc. Fish and Wildl. Agencies* 34:572-583.
- Taylor, C. I. 1979. Movements, activities, and survival of translocated raccoons in east Tennessee. M.S. Thesis, Univ. of Tennessee, Knoxville. 178pp.
- TWRA. 1988. Furbearer status report: 1983/84 - 1985/86 seasons. TWRA Technical Report No. 88-7.
- U.S. Dept. Agriculture. 1953. Soil survey-Norris area. Series 1939, No. 19, Soil Consv. Serv., Washington D.C. 173pp.
- Urban, D. 1970. Raccoon populations, movement patterns, and predation in a managed waterfowl marsh. *J. Wildl. Manage.* 34:372-382.
- White, G. C., D. R. Anderson, K. P. Burnham, and D. L. Otis. 1982. Capture-recapture and removal methods for sampling closed populations. Los Alamos Natl. Lab., New Mexico. 235pp.
- Whitehead, C. J. 1975. 1975-1976 Wildlife research program. Tennessee Wildlife Resources Agency, Nashville, Tenn. 113pp.

- Whitney, L. F. 1931. The raccoon and its hunting.
J. Mammal. 12:29-38.
- _____. 1933. The raccoon-some mental attributes.
J. Mammal. 14:108-114.
- _____.and A. N. Underwood. 1952. The raccoon. Practical
Science Publ. Co., Orange, Connecticut. 177pp.
- 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.
- Wing, L. 1940. A game survey in northeastern Tennessee.
J. Tenn. Acad. Sci. 15:309-320.
- Wright, G. A. 1977. Dispersal and survival of translocated
raccoons in Kentucky. Proc. Ann. Conf. S.E. Assoc. Fish
and Wildl. Agencies. 31:285-294.

APPENDICES

100% COTTON FIBER

2016/2017 CO. D. 2. A

ENVIRONMENTAL DEED

APPENDIX A.

Table 11. Background histories of radio-collared female raccoons on CSWMA, 1987-1988.

ID No.	Age	Capture Weight (Kg)	Capture Date	Date of Parturition	Observed Litter Size
<u>Control</u>					
012	2	3.0	03-23-88	dropped collar	
021	4	2.8	03-24-88	05-22-88	. ^b
174	3	2.9	04-23-87	05-16-87	2 ^a
313	4	3.5	03-25-88	dropped collar	
650	4	3.6	04-10-88	04-26-88	2
690	4	2.7	04-25-88	04-26-88	. ^a
740	5	3.4	04-13-88	05-13-88	2
800	5	3.8	04-14-88	05-10-88	3
946	4	3.3	04-23-87	05-11-87	2
963	5	3.8	04-23-87	05-09-87	.
986	5	4.0	04-26-87	05-10-87	.
987	5	.	.	05-15-88	.
995	3	3.7	04-20-87	05-11-87	.
<u>Experimental</u>					
013	2	3.8	03-31-87	05-16-87	5
022	3	3.5	03-31-87	05-09-87	3
120	4	4.1	03-20-87	05-22-87	4
121	4	3.7	03-03-88	05-27-88	2 ^b
234	2	3.0	03-06-87	05-15-87	at least 1
314	2	2.7	03-24-87	05-14-87	. ^a
530	3	3.3	04-22-88	.	0
550	3	3.7	03-19-88	05-24-88	1 ^a
630	2	2.9	04-09-88	05-05-88	0
670	2	2.9	03-20-88	05-14-88	0
914	3	3.9	03-28-87	05-14-88	2
970	3	3.3	04-23-88	05-23-88	2 ^a
981	2	4.4	03-21-87	05-09-88	3

^a Offspring abandoned.^b Female died before weaning young.

APPENDIX A

Table 12. Apparent causes for abandonment of litters by radio-collared female raccoons on 2 portions of study area, CSNWA, 1987-1988.

Raccoon ID	Portion of Area	Litter Size	Litter Age (days)	Apparent Cause of Abandonment
690	Control	unknown	unknown	trapping of female
174	Control	2	30	hay mowing at maternity site
021	Control	unknown	unknown	female killed by falling tree
314	Experimental	unknown	26	female treed during dog training session
550	Experimental	1	25	handling by researcher
121	Experimental	2	32	female killed during dog training session
970	Experimental	2	30	handling by researcher

APPENDIX A

Table 13. Annual and periodic home range sizes (ha) estimated by bivariate 95% ellipse model for adult female raccoons on 2 portions of study area, CSWMA, 1987-1988.

Raccoon No.	Annual ^a area	Prehunt area	Hunt area	Pregnancy area	Nursing area	Weaning area
<u>Control Portion</u>						
021	543.0	649.7	344.9			543.0
174	67.2	83.6	46.6	125.5	76.2	38.6
650	63.5	59.3	61.2		49.4	56.9
690	79.4	71.8	75.8		66.8	83.7
740	63.8	71.6	56.8	129.7	6.9	113.2
800	101.8	159.3	83.7	82.9	106.8	85.3
946	110.0	94.6	100.4	235.4	75.9	107.3
963	65.9	72.7	68.2		71.1	66.2
987	222.9	89.6	264.0		85.6	292.9
987	134.9	109.6	246.4	121.4	242.8	
995	264.1	419.4	230.9	650.8	210.6	257.9
mean	156.0	171.0	143.6	224.3	99.2	164.5
std. dev.	145.1	188.9	106.1	215.1	72.4	157.9

Table 13. Continued.

Raccoon No.	Annual ^a area	Prehunt area	Hunt area	Pregnancy area	Nursing area	Weaning area
<u>Experimental Portion</u>						
013	119.4	140.0	103.3	119.6	163.9	96.6
022	176.0	148.2	191.7	242.0	145.7	173.0
120	145.8	116.9	113.9	157.8	96.9	203.1
121	74.3	44.4	55.5	157.8	83.5	
234	158.9	198.6	22.8	261.4	82.8	
314	166.2	141.1	128.6	185.1	172.3	104.5
530	84.3	94.7	74.8	101.1	99.9	76.2
550	98.9	77.5	101.6	68.7	118.5	121.9
630	71.7	82.5	67.9	104.5	68.8	70.6
670	47.1	34.9	51.0	56.8	44.8	51.4
914	306.5	165.9	274.2	248.7	157.5	295.1
981	151.6	141.7	147.5	165.8	97.5	207.7
mean	133.4	109.6	114.6	146.9	110.8	142.1
std. dev.	66.2	51.9	67.4	73.4	38.9	73.7

^a All locations during this study.

APPENDIX A

Table 14. Annual and periodic home range sizes (ha) estimated by convex polygon model for adult female raccoons on 2 portions of study area, CSWMA, 1987-1988.

Raccoon No.	Annual ^a area	Prehunt area	Hunt area	Pregnancy area	Nursing area	Weaning area
<u>Control Portion</u>						
021	247.4	247.0	68.6			247.4
174	54.1	28.1	42.6	14.1	24.9	30.2
650	43.4	17.5	39.7		17.3	33.8
690	46.6	24.2	37.0		28.4	35.5
740	33.0	24.1	25.0	23.3	2.1	24.2
800	81.8	52.0	45.1	10.8	51.7	38.7
946	91.6	30.3	80.0	21.4	18.3	80.0
963	42.2	19.1	26.5		25.1	23.7
986	144.5	17.9	133.3		17.5	133.3
987	63.4	39.0	34.3	39.0	43.6	
995	79.3	111.6	106.1	63.6	32.1	106.1
mean	93.4	55.5	58.0	28.7	26.1	75.3
std. dev.	68.7	69.0	35.2	19.7	14.1	71.4

Table 14. Continued.

Raccoon No.	Annual ^a area	Prehunt area	Hunt area	Pregnancy area	Nursing area	Weaning area
<u>Experimental Portion</u>						
013	65.7	53.5	50.4	29.2	55.6	41.3
022	124.3	66.1	115.4	82.9	59.7	97.5
120	89.1	64.6	51.9	75.2	40.1	51.6
121	32.6	14.2	11.5	23.0	9.2	
234	110.1	106.8	3.1	74.2	38.1	
314	127.8	67.0	69.0	55.0	88.6	56.6
530	59.2	36.8	47.5	39.5	36.2	45.4
550	73.0	42.8	62.3	42.8	38.9	50.7
630	50.4	30.0	46.5	32.3	22.2	44.3
670	44.4	15.7	40.6	13.2	27.2	37.9
914	203.1	81.8	134.1	72.7	59.0	112.3
981	114.9	79.6	63.8	78.3	40.6	61.3
mean	93.1	52.1	62.4	49.4	44.3	60.6
std. dev.	46.3	28.7	38.9	24.7	20.4	23.8

^a All locations during this study.

APPENDIX B

Table 15. Summaries of 83 experimental dog training sessions conducted on experimental portion of study area, CSWA, 1987-1988.

#	Date	Time		Temperature	% Cloud		Rain		Number				Radio Collared
		Start	End		Start	End	Prior	During	Hunters	Dogs	Trees	Ground	
1987													
1	06/08	2220	0110	3:10	62	0	0	n	2	3	2	1	
2	06/10	2212	0405	6:07	60	75		n	3	4	4	1	
3	06/12	2209	0445	6:36		100	20	y	4	6	3	1	
4	06/15	2230	0345	5:15		100		y	7	7	3	0	
5	06/19	2135	0345	6:10	64	50		y	2	4	3	0	
6	06/23	2230	0220	4:10	64	50	0	n	3	5	4	0	
7	06/24	2250	0245	4:05	63	10		y	3	4	4	1	
8	06/26	2120	0330	6:10	58	0		n	4	7	4	1	
9	06/27	2225	0130	3:05	57	0		n	3	3	3	0	
10	06/29	2250	0230	4:20	63	0	0	n	1	3	5	0	
11	07/01	2300	0345	4:45	63	100	0	n	3	4	2	0	
12	07/03	2320	0245	3:25	68	100		y	2	2	4	0	
13	07/06	2345	0300	4:45	65	90	50	y	4	3	3	0	
14	07/08	2245	0545	7:00	66	20	0	y	6	8	2	0	
15	07/09	2130	0210	5:20	67	90	50	n	2	2	2	2	
16	07/10	2130	0530	8:00	67	90	0	y	4	4	5	3	
17	07/13	2130	0300	6:30		100	90	n	6	7	4	0	
18	07/15	2200	0345	5:45	59	10	90	n	4	6	6	1	
19	07/17	2130	0300	6:30	61	0	0	n	4	4	4	0	
20	07/20	2200	0440	6:40	69	5	0	n	9	10	2	0	
21	07/22	2200	0415	6:15		5	5	n	7	7	5	0	
22	07/24	2130	0415	7:15	77	5		n	5	7	5	1	
23	07/27	2305	0510	6:05	67	90	0	y	4	7	1	0	

Table 15. Continued.

#	Date	Time		Temperature Start	End	% Cloud Cover		Rain Prior	During 24 hrs Session	Number				
		Start	End			Start	End			Hunters	Dogs	Trees	Ground	Radio Collared
24	07/29	2150	0440	74	65	5	10	n	n	4	5	2	0	0
25	07/31	2200	0330			5	5	n	n	3	6	1	1	0
26	08/03	2200	0030	76	65	10	100	n	y	3	3	3	0	0
27	08/05	2200	0240	69		90	5	y	n	6	6	1	0	2
28	08/12	2130	0130	74	67	05	30	n	n	2	3	3	0	1
29	08/16	2230	0145	70	68	0	5	n	n	4	3	3	1	1
30	08/17	2230	0010	66	64	100	100	y	n	2	4	1	0	0
31	08/19	2230	0300			25	0	n	n	3	2	3	1	0
32	08/26	2200	0400	78		05	0	n	n	4	6	7	0	1
33	08/28	2110	0310	70	65	100	25	y	n	3	4	6	1	1
34	09/02	2230	0245	62	54	0	0	n	n	2	3	2	1	0
35	09/11	2100	0130	67	65	100	100	y	y	3	4	2	0	0
36	09/14	2220	0215	72	55	0	5	n	n	3	2	1	1	0
37	09/16	2115	0100	65	65	40	10	y	n	1	2	2	1	1
38	09/18	2240	0300					n	n	3	3	4	0	0
39	09/19	2300	0100	62		10		y	n	4	4	4	0	0
40	09/21	2100	0130	56	52	0	0	n	n	5	5	3	0	1
41	09/25	2320	0230	58		0	0	n	n	5	6	3	0	1
42	09/30	2140	0030	53	48	0	0	n	n	3	4	2	0	0
43	10/04	2200	0130	48	40	0		n	n	1	3	1	0	1
44	10/05	2100	0200	54	58	20	90	n	n	4	5	1	0	1
45	10/12	2130	0035	44	37	0	0	n	n	3	4	2	0	1
1988														
46	03/05	2030	0100			0	10	n	n	3	3	3	0	1
47	03/25													

Table 15. Continued.

#	Date	Time		Temperature	End	Start	Duration	% Cloud		Rain		Number					Radio Collared
		Start	End					Cover	End	Prior	During	Hunters	Dogs	Trees	Ground		
48	05/16	2140	0010	62	58	10	0	Y	n	n	3	4	2	0	0	1	
49	05/18	2200	0220		48	5	0	n	n	n	1	2	1	0	0	1	
50	05/20	2210	0030	64	56	0	0	n	n	n	2	4	1	0	0	1	
51	05/23	2220	0115	60	59	10	85	Y	n	n	2	2	3	0	0	3	
52	05/25	2245	0300	57	45	0	0	Y	n	n	4	6	4	0	0	0	
53	05/27	2255	0035	63	55	0	0	n	n	n	1	2	2	1	2	2	
54	05/30	2245	0040	70	67	0	0	n	n	n	4	4	4	0	0	1	
55	06/02	2250	0100	74	66	0	10	n	n	n	4	4	2	0	0	0	
56	06/04	2300	0330	54	48	0	0	n	n	n	2	2	1	1	2	2	
57	06/06	2210	0040	69	66	0	0	n	n	n	3	4	3	0	0	2	
58	06/08	2155	0105	69	65	0	0	n	n	n	2	2	1	0	0	1	
59	06/13	2140	0115	70	63	0	0	n	n	n	3	3	1	0	0	1	
60	06/15	2220	0030	73	70	0	0	n	n	n	2	3	3	0	0	2	
61	06/17	2220	0100	68	64	0	0	n	n	n	1	2	0	1	0	0	
62	06/20	2230	0200	70	66	0	0	n	n	n	4	4	4	0	0	2	
63	06/22	2220	0140	78		0	0	n	n	n	3	4	2	0	0	1	
64	06/24	2230	0000	78	72	0	0	n	n	n	4	4	1	0	0	0	
65	06/27	2230	0130	65	60	0	0	n	n	n	1	3	2	1	2	2	
66	06/29	2230	0130		64	95	100	n	Y	Y	2	4	2	0	0	1	
67	07/01	2210	0145	61	56	65	20	n	n	n	2	3	1	1	0	0	
68	07/08	2230	0230	83	75	0	0	n	n	n	4	4	2	0	0	0	
69	07/11	2145	0030	78	71	100	100	n	Y	Y	1	4	2	0	0	1	
70	07/13	2215	0230	67	68	100	100	Y	Y	Y	1	2	2	0	0	1	
71	07/15	2250	0430	79	72	0	0	n	n	n	3	5	3	0	0	1	
72	07/18	2210	0145	72	67	0	0	n	n	n	2	4	1	1	0	0	
73	07/20	2215	0120	74	74	60	100	n	n	n	2	4	2	1	1	1	
74	07/22	2205	0010	70	66	10	100	n	n	n	3	4	1	0	0	0	
75	07/23	2315	0245	66	62	0	0	Y	n	n	4	4	2	0	0	1	

Table 15. Continued.

#	Date	<u>Time</u>		<u>Temperature</u>		<u>% Cloud Cover</u>		<u>Rain</u>		<u>Number</u>				
		Start	End	Start	End	Start	End	Prior	During	Hunters	Dogs	Trees	Ground	Radio Collared
76	07/25	2210	0130	69	66	0	5	n	n	1	3	3	0	1
77	07/27	2215	0345	69	64	20	0	n	n	4	4	4	1	1
78	07/29	2235	0140	72	68	0	0	n	n	1	3	2	0	1
79	08/01	2225	0110	78	76	0	0	n	n	3	5	3	0	2
80	08/03	2215	0026	71	69	5	20	y	n	4	4	2	0	1
81	08/05	2220	0220	68	66	0	0	y	n	4	5	3	0	1
82	08/08	2230	0130	72	65	0	0	n	n	2	3	1	1	2
83	08/10	2135	0010	72		0		n	n	1	2	1	0	0

APPENDIX B

Table 16. Outcome of experimental dog training chases, CSWMA, 1987-1988.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual	Visible Number
03	2047	2055	112	Carya tomentosa	Female_981	yes 4
04	2235	2240	80	Carya tomentosa	Female_013	no 0
05	0038				Female_022	no 0
05	2230	2250	160	Juglans nigra	red_tag	no 0
05	0117		128	L. tulipifera	untagged	yes 2
06	2250	2251	128	Quercus alba	kitten	yes 2
06	2312	2322	287	Quercus alba	unseen	no 0
06	2340	2342	80	J. virginiana	unseen	no 0
06	2346	0015	40	Cornus florid	unseen	no 0
07	2305	2306	138	Quercus rubra	unseen	no 0
07	2305	2306	71	Quercus stellata	unseen	no 0
07	2335	2340	107	Quercus falcata	Female_022	yes 1
07	0012	0013		ground	Female_981	yes 1
07	0012	0016	136	J. virginiana	Female_120	yes 1
07	0130	0154	214	Quercus velutina	unseen	no 0
07	0130	0154	219	L. tulipifera	unseen	no 0
08	2126	2135		ground	unseen	no 0
08	2249	2300	80	Acer rubrum	unseen	no 0
08	2345	0255		Quercus velutina	Female_022	yes 4
08	2400	0142		Juglans nigra	untagged	yes 1
08	0231	0306	168	Quercus rubra	Female_914	yes 1
09	2246	2253	60	J. virginiana	unseen	no 0
09	2314	0006	117	Q. palustris	untagged	yes 1
09	0053	0104	106	Carya tomentosa	eyes_only	yes 1
10	2318	2328	16	Acer rubrum	unseen	no 0
10	0003	0003	112	Quercus coccinea	unseen	no 0

Table 16. Continued.

Session	Time		Tree		Animal		
	Release	Strike	Treed	Circumference Species	Individual Visible Number		
10	0100	0102	155	L. tulipifera	Female_013	yes	1
10	0214	0216	40	Acer rubrum	unseen	no	0
10	0214	0216	156	Quercus velutina	untagged	yes	1
11	2327	2330	184	Quercus alba	unseen	no	0
11	2355		80	J. virginiana	Female_120	yes	1
12	0000	0001	167	Quercus rubra	untagged	yes	1
12	0043	0050	80	J. virginiana	unseen	no	0
12	0025		96	Pinus virginiana	Female_981	yes	1
12	0205	0207	154	Quercus stellata	Female_013	yes	6
13	0007	0022	207	Quercus alba	unseen	no	0
13	0103	0106	32	D. virginiana	untagged	yes	1
13	0111	0114	140	L. tulipifera	untagged	yes	1
14	2324	2355	207	Quercus rubra	red_tag	yes	1
14	0302	0327	212	Quercus falcata	unseen	no	0
15	2201	2201	151	Quercus rubra	eyes only	yes	1
15	2228	2241	129	J. virginiana	Female_981	yes	1
15	0053	0057		ground	Female_314	yes	1
16	2236	2237	139	J. virginiana	unseen	no	0
16	2255	2257		ground	Female_914	yes	1
16	2255		144	Quercus alba	eyes only	yes	1
16	0134		180	Quercus stellata	Female_120	yes	1
16	0239	0241		ground	unseen	yes	1
16	0248		110	Pinus virginiana	Female_981	yes	1
16	0333	0338	154	L. tulipifera	Female_981	yes	1
17	2208	2210	118	Quercus alba	Female_022	yes	3
17	2311	2313	180	Quercus velutina	Female_981	yes	1
17	0021	0024	51	Ulmus alata	Female_120	yes	1
17	0021	0022	48	Pinus virginiana	kitten	yes	2
17	0149	0150	168	Prunus serotina	unseen	no	0
18	2217	2224	422	Quercus velutina	unseen	no	0

Table 16. Continued.

Session	Time		Tree circumference	Species	Animal	
	Release	Strike			Treed	Individual Visible Number
18		2246	2255	ground	unseen	no 0
18	2305	2326		Carya tomentosa	untagged	yes 1
18		0054	0056	Pinus virginiana	unseen	no 0
18		0118	0134	Pinus virginiana	untagged	yes 1
18		0202	0240	Quercus velutina	untagged	yes 1
18			0240	Quercus velutina	eyes_only	yes 1
19		2152	2225	Quercus velutina	eyes_only	yes 1
19		2339		Quercus velutina	red_tag	yes 1
19		0221	0223	Quercus rubra	untagged	yes 2
19		0221	0223	J. virginiana	Female_013	yes 1
20	2215	2241	2237	Pinus virginiana	unseen	no 0
20	2347	0003	0023	Quercus velutina	Female_314	yes 1
21	2212	2216	2233	Pinus virginiana	red_tag	yes 1
21	2312	2339	0015	F. americana	Female_022	yes 3
21		0202	0205	Carya tomentosa	yellow_tag	yes 1
21		0230	0242	Q. michauxii	Female_314	yes 1
21	0336	0338	0343	Quercus stellata	Female_314	yes 1
22	2148	2148	2210	Quercus falcata	Female_314	yes 1
22	2148	2148	2210	J. virginiana	unseen	yes 1
22	2148	2148	2210	Quercus spp.	unseen	no 0
22	2327	2335	0007	Carya tomentosa	unseen	no 0
22	2327	2335	0007	L. tulipifera	eyes_only	yes 1
22		0323	0324	ground	unseen	no 0
23	2316	2317			deer	no 0
23	2335	2337			deer	no 0
23	0118	0121			deer	no 0
23	0342	0356	0409	L. tulipifera	eyes_only	yes 1
24	2230	2237	2239	P. occidentalis	unseen	no 0
24	0213	0214	0252	Quercus falcata	eyes_only	yes 1
25	2223	2224	2235	ground	unseen	no 0

Table 16. Continued.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual Visible Number	
25	0123	0125	0134	48 Sassafras albidum	untagged	yes 1
26	2213	2213	2253	114 Quercus rubra	unseen	no 0
26	2213	2213	2255	75 Nyssa sylvatica	unseen	no 0
26	2213	2213	2340	36 D. virginiana	kitten	yes 1
27	2224	2235	2255	187 Quercus falcata	eyes_only	yes 1
28	2135	2135	2240	88 L. tulipifera	untagged	yes 1
28	2349	2350	2359	189 Quercus velutina	Female_981	yes 1
28	0057	0059	0121	165 Quercus velutina	untagged	yes 1
29	2300	2305	2325	225 Carya tomentosa	kitten	yes 3
29	2300	2305	2335	199 Carya tomentosa	Female_981	yes 1
29	0010	0010	0010	68 L. tulipifera	Female_981	yes 1
29	0025	0025	0037	ground	Female_981	no 0
30	2258	2259	140	L. tulipifera	kitten	yes 2
31	2337	2341	2348	182 Quercus stellata	kitten	yes 1
31		0108	72	D. virginiana	untagged	yes 1
31		0211		ground	unseen	no 0
31		0229	0232	133 Quercus falcata	untagged	yes 1
31		0108	96	Carya tomentosa	kitten	yes 3
31		0108	80	Juglans nigra	kitten	yes 3
32	2224	2226	2230	98 L. tulipifera	eyes_only	yes 1
32	2224	2226	2230	164 L. tulipifera	eyes_only	yes 1
32	2310	2311	2315	192 Nyssa sylvatica	Female_314	yes 1
32	0010	0012	0012	24 A. altissima	kitten	yes 2
32	0010	0012	0012	112 L. tulipifera	eyes_only	yes 2
32	0153	0154	0200	55 J. virginiana	unseen	no 0
32	0153	0216	0218	188 Ulmus thomasii	unseen	no 0
33			96	Quercus falcata	eyes_only	yes 1
33	0039	0039	0040	130 Juglans nigra	kitten	yes 3
33	0048	0048	0049	144 Quercus spp.	eyes_only	yes 2
33	0106	0106	0108	ground	unseen	no 0

Table 16. Continued.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual Visible Number	Number
33	0023	0025	0026	124 Quercus stellata	Female_022	yes 4
33	0209	0210	0210	ground	unseen	no 0
33	0209	0210	0212	Quercus stellata	kitten	yes 2
34	2246	2247	2250	Carya tomentosa	eyes_only	yes 2
34	2316	2317		ground	unseen	no 0
34	0047	0056		ground	unseen	no 0
34	0106	0107	0111	A. altissima	red_tag	yes 1
35	2110	2120	2127	Acer rubrum	untagged	yes 1
35	2218		0012	Pinus virginiana	kitten	yes 3
35			0115	Carya tomentosa	weasel	yes 1
36	2239	2247	2346	ground	unseen	no 0
36					kitten	yes 3
37	2133	2134	2134	Quercus velutina	eyes_only	yes 2
37		2206	2222	ground	unseen	no 0
37			2238	F. grandifolia	Female_022	yes 3
38		2251	2254	Carya tomentosa	eyes_only	yes 1
38	2325	2326	2330	Quercus falcata	eyes_only	yes 1
38	0025	0110	0125	Juglans nigra	eyes_only	yes 1
38	0225	0235		Morus rubra	eyes_only	yes 1
39	2308	2309	2311	Carya ovata	red_tag	yes 1
39	2324	2325	2328	Quercus velutina	kitten	yes 1
39	2340	2350	2354	Quercus rubra	eyes_only	yes 1
39	2340	2351		Quercus rubra	unseen	no 0
40	2134	2136	2136	D. virginiana	kitten	yes 2
40	2134	2136	2136	Quercus rubra	kitten	yes 1
40	2134	2136	2136	J. virginiana	kitten	yes 1
41	2337	2341	2355	Quercus rubra	Female_013	yes 1
41	0030	0031	0032	Quercus falcata	unseen	no 0
41			0054	Quercus falcata	unseen	no 0
42	2215	2217	2218	Quercus velutina	Female_981	yes 1
				Quercus rubra	eyes_only	yes 2

Table 16. Continued.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual	Visible Number
42	2332	2336	2337	120 Quercus alba	eyes_only	yes 3
43	2244	2245	2245	358 Quercus rubra	Female_314	yes 1
44	2118		2121	124 L. tulipifera	Female_314	yes 2
45	2213	2232		202 Quercus falcata	eyes_only	yes 1
45	2305			181 L. tulipifera	Female_981	yes 1
46	2041	2049	2112	91 O. arboreum	unseen	no 0
46	2041	2049		258 Quercus velutina	untagged	yes 1
46		2359	0006	199 Quercus rubra	Female_981	yes 1
48	2154	2155	2157	69 Pinus virginiana	unseen	no 0
48	2236	2240	2317	199 Acer rubrum	Female_120	yes 1
49	2216	2224	2231	95 Quercus falcata	Female_630	yes 1
50	2227	2228			bobcat	no 0
50	2327	2334	2344	135 Quercus velutina	Female_630	yes 1
51	2236	2236	2237	226 Quercus rubra	Female_670	yes 1
51	2304	2307	2313	199 Quercus rubra	Female_530	yes 1
51	2333	2334	2340	ground	Female_550	no 0
51		0007		168 Quercus falcata	red_tag	yes 1
52	2202	2207	2207	144 Quercus velutina	untagged	yes 1
52	2240	2253	2254	152 Quercus velutina	unseen	no 0
52	2329	2329	2331	158 Quercus rubra	yellow_tag	yes 1
52	0006	0008	0200	94 Carya tomentosa	unseen	no 0
53	2227	2228	2229	140 Pinus virginiana	Female_530	yes 1
53	2353	2355	2358	ground	Female_550	yes 1
54	2205	2206	2207	92 J. virginiana	Female_530	yes 1
54	2205	2206	2210	179 Quercus spp.	untagged	yes 1
54	2259	2300	2319	148 Quercus velutina	red_tag	yes 1
54	2259	2300		160 Quercus rubra	unseen	no 0
55	2207	2208	2239	197 Quercus falcata	untagged	yes 1
55	2342	2356	2359	148 Ostrya virginiana	untagged	yes 1
56	2319	2323	2335	235 L. tulipifera	Female_530	yes 1

Table 16. Continued.

Session	Release	Time		Treeed	Tree		Animal	
		Strike	Tree		Circumference	Species	Individual	Visible Number
56	0007	0010	0023	ground			Female_970	yes 1
56	0057	0101					unseen	no 0
57	2223	2224	2225	Pinus virginiana			unseen	no 0
57	2223	2224	2225	J. virginiana	126		Female_530	no 0
57	2347	2348	0008	L. tulipifera	130		Female_670	yes 1
58	0019	0020	0021	Pinus virginiana	90		Female_970	yes 1
59	2351		0010	Quercus falcata	150		Female_670	yes 1
60	2240	2243	2245	L. tulipifera	175		Female_670	yes 1
60	2240	2218	2220	J. virginiana	71		unseen	no 0
60			2230	Quercus rubra	120		Female_530	yes 1
61	2233	2237						no 0
61	0008	0019	0046	ground			unseen	no 0
62	2239	2240	2253	Carya tomentosa	78		Female_970	yes 1
62			2341	J. virginiana	118		unseen	no 0
62	0055	0058	0105	Quercus velutina	205		unseen	no 0
62	0055	0058	0105	Quercus rubra	211		Female_530	yes 1
63	2242	2243	2244	Quercus velutina	174		eyes only	yes 1
63	2307	2312	2318	Quercus falcata	220		Female_630	yes 1
64	2345	2245	2246	J. virginiana	70		unseen	no 0
65	2245	2245	2246	L. tulipifera	235		Female_670	yes 1
65	2324	2326	2332				unseen	no 0
65	2324	2348	0014	ground			Female_120	yes 1
66	2301	2302	2303	Quercus rubra	237		Female_550	yes 1
66	2341	2345	0015	Acer saccharum	24		kitten	yes 1
67	2225	2228	2230	ground			unseen	no 0
67	2225	2228	2234	Quercus rubra	106		unseen	no 0
67	2329	2334						no 0
68	2300	2300	2308	Quercus rubra	247		untagged	yes 1
68	0017	0020					deer	no 0
68	0058	0115	0117	Carya tomentosa	106		unseen	no 0

Table 16. Continued.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual	Visible Number
69	2152	2159	2159	115 Pinus virginiana	Female_530	yes 1
69	2152			74 Carya tomentosa	unseen	no 0
70	2229	2230	2238	174 Quercus falcata	Female_530	yes 1
70	0106	0106	0122	20 Cornus florida	opossum	no 0
71	2314	2316	2337	64 J. virginiana	opossum	no 0
71	2314	2316	2337	150 Quercus falcata	Female_670	yes 1
71	0008	0012		65 Quercus alba	red_tag	yes 1
72	2219	2227	2235	ground	unseen	no 0
72	2250	2258	2258	108 Ulmus alata	red_tag	yes 1
73	2234	2238	2250	83 D. virginiana	unseen	no 0
73	2346	0002	0022	124 Quercus falcata	Female_530	yes 1
73	2346			ground	unseen	no 0
74	2216	2217	2235	72 J. virginiana	Female_970	yes 1
74	2317	2317	2332	50 J. virginiana	unseen	no 0
75	2315	0130	0140	258 Quercus falcata	Female_530	yes 1
75	2315	0105	0215	188 Quercus falcata	eyes_only	yes 1
76	2230	2230	2232	70 Quercus velutina	red_tag	yes 1
76	2314	2317	2331	141 Prunus serotina	unseen	no 0
76	0003	0007	0007	128 Quercus rubra	Female_670	yes 1
77	2244	2258	2259	196 Quercus rubra	Female_670	yes 1
77	2244	2300	2308	162 Quercus rubra	unseen	no 0
77	2244	2300	2308	136 L. tulipifera	unseen	no 0
77	0116	0124	0135	ground	unseen	no 0
77	0116	0124		64 Carya tomentosa	kitten	yes 1
78	2247	2254	2305	75 Quercus velutina	red_tag	yes 1
78	2247	2300	2303	247 Ulmus americana	Female_670	yes 1
78	0024	0027			unseen	no 0
79	2242	2247	2252	99 J. virginiana	unseen	no 0
79	2242	2247	2252	247 Ulmus americana	Female_670	yes 1
79	2344	0014	0030	254 Quercus rubra	Female_630	yes 1

Table 16. Continued.

Session	Time		Tree		Animal	
	Release	Strike	Treed	Circumference Species	Individual	Visible Number
80	2248	2248	2254	106 Pinus virginiana	Female_530	no 0
80	2346	2350	2351	32 D. virginiana	unseen	no 0
81	2243	2233	2243	40 J. virginiana	unseen	no 0
81	0006	0028			swam lake	no 0
81	0006		0059	188 Quercus rubra	Female_550	yes 1
81	0006		0145	139 Quercus stellata	unseen	no 0
82	2233	2243	2243	107 Carya tomentosa	Female_670	yes 1
82	0054	0054	0057	ground	Female_670	yes 1
83	2140	2141	2146	77 Carya tomentosa	untagged	yes 1
83	2218	2220			unseen	no 0

APPENDIX C.

Table 17. Estimated birth dates and ages of preweaned raccoons captured on 2 portions of study area, CSWMA, 1986-1987.

ID #	Sex	Capture Date	Age (days)	Birth Date
<u>Control Portion</u>				
603	F	4 Sept 1986	58	24 June 1986
605	M	4 Sept 1986	58	24 June 1986
610	M	5 Sept 1986	65	1 July 1986
615	F	7 Sept 1986	65	3 July 1986
618	M	8 Sept 1986	65	4 July 1986
670	F	16 Aug 1987	85	24 May 1987
677	M	19 Aug 1987	82	30 May 1987
679	M	19 Aug 1987	65	16 June 1987
680	M	19 Aug 1987	65	16 June 1987
686	M	23 Aug 1987	65-72	20-27 June 1987
690	F	24 Aug 1987	81	5 June 1987
693	M	24 Aug 1987	102	15 May 1987
694	M	24 Aug 1987	102	15 May 1987
697	F	25 Aug 1987	81-85	6-10 June 1987
696	F	25 Aug 1987	81-85	6-10 June 1987
699	M	27 Aug 1987	82	7 June 1987
703	M	28 Aug 1987	82	8 June 1987
705	M	28 Aug 1987	87	3 June 1987
709	F	30 Aug 1987	96	27 May 1987
<u>Experimental Portion</u>				
631	F	18 Sept 1986	111	7 June 1986
637	F	20 Sept 1986	111	9 June 1986
640	F	22 Sept 1986	105	17 June 1986
719	M	4 Sept 1987	98	29 May 1987
720	M	4 Sept 1987	97	30 May 1987
723	F	5 Sept 1987	98	30 May 1987
725	M	5 Sept 1987	98	30 May 1987
726	F	5 Sept 1987	90	7 June 1987
727	F	5 Sept 1987	102	27 May 1987
728	F	6 Sept 1987	86	13 June 1987
732	M	8 Sept 1987	97	4 June 1987
733	M	8 Sept 1987	88	13 June 1987
735	F	8 Sept 1987	106	26 May 1987
738	F	10 Sept 1987	112	22 May 1987
749	M	14 Sept 1987	100-112	7-19 June 1987
n = 34		range of birth dates: 15 May - 4 July		

APPENDIX C

Table 18. Capture records of raccoons trapped on study area, CSMMA, 1 September 1986 to 14 September 1987.

ID No.	Capture No.	Area ^a	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
109	20	1	16	208	644	645	R	08	09	86	M	5	
117	06	1	09	210	340	341	Y	10	09	86	F	5	
117	07	1	09	220	340	341	Y	24	08	87	F	5	
120	14	1	35	205	564	565	R	05	09	86	F	4	
120	16	1	35	222	564	565	R	29	08	87	M	5	
120	15	1	35	217	564	565	R	23	08	87	M	5	
125	03	1	22	216	015	016	Y	19	08	87	F	5	
129	11	1	31	218	236	237	Y	22	08	87	F	5	
132	09	1	13	204	023	024	Y	04	09	86	F	3	3.0
132	08	1	12	202	023	024	Y	02	09	86	F	3	
132	10	1	13	219	023	024	Y	23	08	87	F	4	
134	07	1	36	216	215	028	Y	24	08	87	F	5	
138	06	1	33	205	031	032	Y	05	09	86	F	5	3.2
138	05	1	34	202	031	032	Y	02	09	86	F	5	
142	17	2	74	205	442	443	R	20	09	86	M	4	
142	18	2	74	214	442	443	R	04	09	87	M	5	
144	06	1	32	219	046	047	R	23	08	87	M	5	
157	08	2	65	211	792	793	R	27	09	86	M	5	5.1
167	07	2	73	211	543	544	R	27	09	86	M	4	
177	08	1	25	207	745	481	R	07	09	86	M	4	3.6
183	05	1	27	211	051	052	Y	11	09	86	F	4	
183	07	1	27	219	051	052	Y	23	08	87	F	5	

Table 18. Continued

ID No.	Capture Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
183	06	1	27	214	051	052	Y	17	08	87	F	5
197	05	1	24	203	343	342	Y	03	09	86	F	4
198	46	2	47	224	689	690	R	14	09	87	M	5
198	45	2	45	217	689	690	R	07	09	87	M	5
199	08	2	70	221	551	552	R	11	09	87	M	5
210	13	1	14	218	466	467	Y	22	08	87	F	5
230	05	1	30	217	364	365	Y	21	08	87	F	4
231	12	1	32	223	220	221	Y	27	08	87	F	4
231	11	1	32	214	220	221	Y	17	08	87	F	4
235	06	1	38	216	144	143	Y	24	08	87	F	5
240	04	1	34	221	151	152	Y	29	08	87	F	4
249	08	2	67	209	161	162	Y	25	09	86	F	4
263	08	2	56	224	179	180	Y	14	09	87	F	4
267	05	2	60	223	447	448	R	13	09	87	M	4
273	05	1	38	221	408	409	R	29	08	87	M	4
274	03	1	36	212	191	192	Y	12	09	86	F	4
274	04	1	36	215	191	192	Y	23	08	86	F	4
281	02	2	64	217	215	216	R	07	09	87	M	5
286	07	2	49	208	623	624	R	24	09	86	M	4
286	08	2	44	220	623	624	R	10	09	87	M	4
288	05	1	26	212	197	198	Y	12	09	86	F	3
296	16	2	49	220	235	236	R	10	09	87	M	4
303	05	1	30	209	211	212	Y	09	09	86	F	3
303	04	1	30	203	211	212	Y	03	09	86	F	3
303	03	1	30	202	211	212	Y	02	09	86	F	3
303	06	1	30	222	211	212	Y	26	08	87	F	4
304	08	1	31	211	213	214	Y	11	09	86	F	3

4.7

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
304	10	1	21	223	213	214	Y	27	08	87	F	3	
311	04	1	16	203	218	219	Y	03	09	86	F	3	
316	04	1	38	210	222	223	Y	10	09	86	F	3	
318	02	1	09	218	226	227	Y	22	08	87	F	4	
320	04	1	33	213	232	233	Y	21	08	87	F	3	
322	06	1	26	220	269	270	R	24	08	87	M	3	
330	04	2	70	207	784	785	R	23	09	86	M	3	5.0
334	06	2	80	207	246	247	Y	23	09	86	F	4	
334	08	2	80	216	246	247	Y	06	09	87	F	4	3.6
338	06	2	68	215	254	255	Y	05	09	87	F	3	
343	06	2	60	219	263	264	Y	09	09	87	F	4	
353	10	1	03	208	574	575	R	08	09	86	M	3	
353	11	1	03	220	574	575	R	24	08	87	M	3	
356	03	1	34	221	260	261	Y	25	08	87	F	5	
360	06	1	21	207	330	743	R	07	09	86	M	3	4.5
372	04	2	45	211	347	348	R	27	09	86	M	3	
374	04	2	65	224	277	278	Y	14	09	87	F	4	
374	03	2	67	214	277	278	Y	04	09	87	F	4	
379	12	1	35	223	858	859	R	27	08	87	M	4	4.3
383	03	1	19	207	285	286	Y	07	09	86	F	3	
384	05	1	30	211	368	369	R	11	09	86	M	3	
388	05	1	14	212	289	290	Y	12	09	86	F	4	
388	06	1	14	215	289	290	Y	18	08	87	F	4	
392	04	1	12	216	378	379	R	19	08	87	M	3	
399	05	1	36	209	390	392	R	09	09	86	M	3	
402	06	2	47	218	303	304	Y	08	09	87	F	4	
410	03	1	38	205	309	310	Y	05	09	86	F	3	

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
416	04	1	40	209	424	425	R	09	09	86	M	3	
424	03	1	07	209	464	729	R	09	09	86	M	3	
424	02	1	05	205	464	729	R	05	09	86	M	3	5.3
428	04	1	20	202	330	331	Y	02	09	86	F	2	
430	04	1	27	207	742	475	R	07	09	86	M	3	4.9
434	02	1	32	209	338	339	Y	09	09	86	F	2	
436	02	1	28	202	346	347	Y	02	09	86	F	4	
436	03	1	28	218	346	347	Y	22	08	87	F	4	
444	02	1	19	208	358	359	Y	08	09	86	F	5	
451	06	2	72	210	506	507	R	26	09	86	M	3	
451	05	2	70	202	506	507	R	17	09	86	M	3	
453	02	2	48	217	376	377	Y	07	09	87	F	4	
470	03	1	20	209	527	528	R	09	09	86	M	2	
473	04	2	66	205	533	534	R	20	09	86	M	4	
473	05	2	65	213	533	534	R	03	09	87	M	4	
479	06	2	66	209	394	395	Y	25	09	86	F	3	3.6
479	08	2	66	219	394	395	Y	09	09	87	F	3	
479	07	2	66	214	394	395	Y	04	09	87	F	3	
484	05	2	62	218	507	508	Y	08	09	87	F	3	
488	03	2	61	222	406	407	Y	12	09	87	F	3	
490	03	2	68	212	555	556	R	28	09	86	M	4	
490	02	2	73	204	555	556	R	19	09	86	M	4	
495	03	2	43	206	412	413	Y	22	09	86	F	2	
495	04	2	43	213	412	413	Y	03	09	87	F	3	
497	03	1	07	202	414	415	Y	02	09	86	F	2	
499	03	1	03	201	570	711	R	01	09	86	M	2	5.2
511	03	1	20	208	590	591	R	08	09	86	M	2	

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
511	02	1	14	202	590	591	R	02	09	86	M	2	
511	04	1	20	214	590	591	R	17	08	87	M	3	
512	03	1	16	215	418	589	Y	18	08	87	F	4	3.4
517	02	1	31	224	598	599	R	28	08	87	M	3	
518	02	1	28	211	600	601	R	11	09	86	M	2	
526	02	2	49	223	442	443	Y	13	09	87	F	3	
528	04	2	67	211	613	614	R	27	09	86	M	3	
528	03	2	64	204	613	614	R	19	09	86	M	3	
528	05	2	65	215	613	614	R	05	09	87	M	4	
531	02	2	77	205	617	618	R	20	09	86	M	2	
532	03	2	75	207	619	620	R	24	09	86	M	2	
532	05	2	75	223	619	620	R	13	09	87	M	3	
532	04	2	72	213	619	620	R	03	09	87	M	3	
536	02	1	19	205	626	627	R	05	09	86	M	2	
536	03	1	20	222	626	627	R	26	08	87	M	2	
537	02	2	70	215	448	449	Y	05	09	87	F	4	3.0
540	03	2	65	203	454	455	Y	18	09	86	F	2	
541	02	2	66	206	781	629	R	22	09	86	M	2	3.8
545	02	2	57	202	634	635	R	17	09	86	M	2	
548	02	1	04	220	462	463	Y	24	08	87	F	3	
549	02	1	08	203	531	465	Y	03	09	86	F	2	4.4
549	03	1	08	216	465	531	Y	19	08	87	F	2	
551	03	2	62	220	640	885	R	10	09	87	M	4	
552	05	1	27	210	642	643	R	10	09	86	M	2	
552	04	1	27	208	642	643	R	08	09	86	M	2	
552	03	1	27	205	642	643	R	05	09	86	M	2	
552	12	1	23	222	642	643	R	20	08	87	M	2	

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
552	11	1	21	220	642	643	R	24	08	87	M	2	
552	10	1	23	217	642	643	R	21	08	87	M	2	
552	09	1	23	216	642	643	R	19	08	87	M	2	
552	08	1	23	214	642	643	R	17	08	87	M	2	
556	03	1	22	211	650	744	R	11	09	86	M	2	
556	02	1	22	207	650	744	R	07	09	86	M	2	3.4
561	02	1	23	202	658	659	R	02	09	86	M	1	
562	02	1	35	203	660	716	R	03	09	86	M	3	3.4
563	02	1	19	203	479	480	Y	03	09	86	F	1	
563	03	1	19	219	479	480	Y	23	08	87	F	2	
567	02	1	01	206	665	670	R	06	09	86	M	1	
569	03	2	78	600	671	672	R	04	10	86	M	2	3.4
569	02	2	77	208	671	672	R	24	09	86	M	2	
573	03	2	71	207	678	679	R	23	09	86	M	1	
573	02	2	75	201	678	679	R	16	09	86	M	1	
573	04	2	75	216	678	679	R	07	09	87	M	2	
579	02	2	62	600	495	496	Y	04	10	86	F	2	
581	02	2	75	204	497	498	Y	19	09	86	F	2	
585	02	2	60	210	503	504	Y	26	09	86	F	2	
589	02	2	57	204	509	510	Y	19	09	86	F	1	
589	03	2	57	219	509	510	Y	09	09	87	F	2	
592	03	2	61	207	699	700	R	23	09	86	M	2	
592	02	2	60	203	699	700	R	18	09	86	M	2	
593	03	2	57	212	701	702	R	28	09	86	M	3	
593	02	2	74	203	701	702	R	18	09	86	M	3	
594	01	1	06	202	526	527	Y	02	09	86	F	1	2.9
595	01	1	11	202	713	712	R	02	09	86	M	1	2.4

Table 18. Continued

ID No.	Capture Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
596	01	17	202	714	715	R	02	09	86	M	2	3.3
596	02	17	217	714	715	R	21	08	87	M	2	
597	02	18	209	511	512	Y	09	09	86	F	2	
597	01	18	202	511	512	Y	02	09	86	F	2	2.7
598	01	36	203	717	718	R	03	09	86	M	1	3.2
598	04	36	224	717	718	R	01	09	87	M	2	
598	03	36	219	717	718	R	27	08	87	M	2	
598	02	36	214	717	718	R	22	08	87	M	2	
599	02	37	212	721	762	R	12	09	86	M	2	2.9
599	01	37	203	721	720	R	03	09	86	M	2	2.9
599	03	67	600	721	762	R	04	10	86	M	2	
600	01	31	203	529	528	Y	03	09	86	F	1	2.7
601	01	32	203	525	530	Y	03	09	86	F	2	2.8
602	01	24	203	722	724	R	03	09	86	M	1	0.9
603	01	13	204	532	533	Y	04	09	86	F	1	0.8
604	02	24	208	725	726	R	08	09	86	M	2	
604	01	25	204	725	726	R	04	09	86	M	2	3.0
605	01	32	204	727	728	R	04	09	86	M	1	1.0
606	01	40	204	534	535	Y	04	09	86	F	4	3.1
607	01	09	205	730	731	R	05	09	86	M	1	2.2
608	01	24	205	732	733	R	05	09	86	M	2	2.3
609	01	33	205	536	537	Y	05	09	86	F	1	1.1
610	02	34	209	734	735	R	09	09	86	M	1	
610	01	39	205	734	735	R	05	09	86	M	1	2.1
611	01	03	206	538	539	Y	06	09	86	F	2	3.6
611	02	03	213	538	539	Y	16	08	87	F	2	
612	02	04	208	736	737	R	08	09	86	M	3	

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
612	01	1	04	206	736	737	R	06	09	86	M	3	3.1
612	03	2	77	600	736	737	R	04	10	86	M	3	
613	01	1	30	206	738	739	R	06	09	86	M	1	2.9
613	02	1	30	223	738	739	R	27	08	87	M	2	
614	01	1	26	207	740	741	R	07	09	86	M	3	2.9
615	01	1	39	207	540	541	Y	07	09	86	F	1	1.9
616	01	1	14	208	746	747	R	08	09	86	M	2	3.0
616	07	1	28	221	746	747	R	25	08	87	M	2	
616	06	1	23	219	746	747	R	23	08	87	M	2	
616	05	1	28	213	746	747	R	16	08	87	M	2	
617	01	1	36	208	748	749	R	08	09	86	M	3	4.0
618	01	1	39	208	750	751	R	08	09	86	M	1	2.0
618	02	2	69	224	750	751	R	14	09	87	M	1	
619	01	1	06	209	542	543	Y	09	09	86	F	2	3.4
620	01	1	24	209	752	753	R	09	09	86	M	2	4.3
620	03	1	24	216	752	753	R	19	08	87	M	2	
621	01	1	25	209	754	755	R	09	09	86	M	3	3.6
621	04	1	24	223	754	755	R	27	08	87	M	3	
622	01	1	03	210	756	757	R	10	09	86	M	2	3.3
623	01	1	25	210	544	545	Y	10	09	86	F	1	3.2
623	02	1	25	216	544	545	Y	19	08	87	F	2	
624	01	1	37	210	546	547	Y	10	09	86	F	2	3.2
625	01	1	40	211	758	759	R	11	09	86	M	2	3.6
625	02	2	62	207	758	759	R	23	09	86	M	2	
626	01	1	16	212	548	549	Y	12	09	86	F	1	3.1
627	01	1	24	212	760	761	R	12	09	86	M	2	3.8
628	02	2	78	203	763	764	R	18	09	86	M	2	

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
628	01	2	79	201	763	764	R	16	09	86	M	2	3.3
629	01	2	66	202	765	766	R	17	09	86	M	2	3.6
630	01	2	52	203	767	768	R	18	09	86	M	2	3.0
631	01	2	67	203	550	551	Y	18	09	86	F	1	1.7
632	01	2	65	204	769	770	R	19	09	86	M	2	3.4
633	02	2	61	600	771	772	R	04	10	86	M	2	2
633	01	2	59	204	771	772	R	19	09	86	M	2	3.7
633	03	2	60	215	771	772	R	05	09	87	M	2	2
634	01	2	45	205	774	773	R	20	09	86	M	3	3.6
634	02	2	46	214	774	882	R	04	09	87	M	4	3.7
635	01	2	48	205	775	776	R	20	09	86	M	1	1.6
636	01	2	48	205	777	778	R	20	09	86	M	1	1.3
637	01	2	80	205	552	553	Y	20	09	86	F	1	1.4
638	01	2	59	205	554	555	Y	20	09	86	F	1	3.1
639	01	2	48	206	779	780	R	22	09	86	M	3	4.0
640	01	2	44	206	556	557	Y	22	09	86	F	1	1.7
640	02	2	44	216	556	557	Y	06	09	87	F	1	1
641	02	2	56	209	782	783	R	25	09	86	M	2	2
641	01	2	56	207	782	783	R	23	09	86	M	2	3.2
642	02	2	73	212	786	787	R	28	09	86	M	2	2
642	01	2	73	207	786	787	R	23	09	86	M	2	3.8
642	05	2	68	222	786	787	R	12	09	87	M	2	2
642	04	2	73	218	786	787	R	08	09	87	M	2	2
642	03	2	73	215	786	787	R	05	09	87	M	2	2
643	01	2	59	207	788	789	R	23	09	86	M	2	3.2
644	01	2	80	209	790	791	R	25	09	86	M	2	4.6
645	01	2	62	210	558	559	Y	26	09	86	F	2	2.8

Table 18. Continued

ID No.	Capture No.	Area	Site	Capture	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
646	01	2	45	212	794	795	R	28	09	86	M	3	3.4	
646	02	1	39	217	794	795	R	21	08	87	M	3		
647	01	2	80	212	796	797	R	28	09	86	M	2	5.0	
648	01	2	74	212	798	799	R	28	09	86	M	2	2.1	
649	01	2	41	600	800	801	R	04	10	86	M	2	3.8	
650	01	2	54	600	802	803	R	04	10	86	M	1	1.4	
658	03	2	53	224	566	567	Y	14	09	87	F	3	3.3	
660	02	2	79	221	817	818	R	11	09	87	M	2		
660	03	2	56	214	817	818	R	04	09	87	M	2		
668	02	1	21	222	822	823	R	26	08	87	M	4		
669	01	1	15	213	583	584	Y	16	08	87	F	3	2.5	
670	01	1	21	213	585	586	Y	16	08	87	F	1	1.6	
671	01	1	03	214	587	588	Y	17	08	87	F	2	3.5	
672	02	1	07	220	824	825	R	24	08	87	M	3		
672	01	1	10	214	824	825	R	17	08	87	M	3	3.6	
673	02	1	11	216	826	827	R	19	08	87	M	2		
673	01	1	11	214	826	827	R	17	08	87	M	2	3.8	
674	01	1	30	214	828	829	R	17	08	87	M	2	2.9	
675	01	1	26	215	830	831	R	18	08	87	M	2	2.8	
676	01	1	01	216	832	833	R	19	08	87	M	2	3.4	
677	01	1	08	216	834	835	R	19	08	87	M	1	1.5	
678	01	1	21	216	836	837	R	19	08	87	M	3	3.4	
679	01	1	35	216	838	839	R	19	08	87	M	1	0.8	
680	01	1	35	216	840	841	R	19	08	87	M	1	0.8	
681	01	1	35	216	590	591	Y	19	08	87	F	4	2.8	
682	01	1	18	217	592	593	Y	21	08	87	F	4	3.0	
683	01	1	38	213	594	595	Y	21	08	87	F	3	2.8	

Table 18. Continued

ID No.	Capture Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
684	01	1	01	218	844	845	22	08	87	M	2	3.8
685	01	1	25	219	596	597	23	08	87	F	2	2.5
686	01	1	36	215	846	847	23	08	87	M	1	1.2
687	01	1	38	215	598	599	23	08	87	F	2	2.4
688	01	1	40	219	848	849	23	08	87	M		4.3
689	01	1	14	220	850	851	24	08	87	M	3	3.3
690	01	1	13	220	600	601	24	08	87	F	1	1.3
691	01	1	28	220	602	603	24	08	87	F	4	3.4
692	01	1	22	220	604	605	24	08	87	F	4	2.6
693	01	1	22	220	852	853	24	08	87	M	1	1.2
694	01	1	22	220	854	855	24	08	87	M	1	1.2
695	02	1	37	220	608	609	28	08	87	F	2	
695	01	1	37	217	608	609	25	08	87	F	2	2.2
696	01	1	08	221	610	611	25	08	87	F	1	1.4
697	01	1	08	221	612	613	25	08	87	F	1	1.4
698	01	1	01	221	856	857	25	08	87	M	2	2.8
699	01	1	29	223	614	615	27	08	87	F	1	1.0
700	01	1	22	223	616	617	27	08	87	F	4	2.6
701	01	1	02	224	861	862	28	08	87	M	3	4.3
702	01	1	27	224	860	863	28	08	87	M	2	4.1
703	01	1	29	224	864	865	28	08	87	M	1	1.0
704	01	1	32	224	618	619	28	08	87	F	1	3.1
705	01	1	19	224	866	867	28	08	87	M	1	1.3
706	01	1	33	221	620	621	29	08	87	F	1	2.5
707	01	1	35	221	606	607	25	08	87	F	4	2.9
708	01	1	36	223	622	623	30	08	87	F	4	3.0
709	01	1	36	222	624	625	30	08	87	F	1	1.5

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
710	01	1	37	222	868	869	R	30	08	87	M	2	3.8
711	01	1	38	223	870	871	R	31	08	87	M	2	2.6
712	01	1	33	224	626	627	Y	01	09	87	F	1	2.7
713	01	2	47	213	872	873	R	03	09	87	M	1	3.3
714	01	2	76	213	628	629	Y	03	09	87	F	2	3.3
715	01	2	75	213	874	875	R	03	09	87	M		2.7
716	02	2	64	221	630	631	Y	11	09	87	F	1	
716	01	2	73	213	630	631	Y	03	09	87	F	1	2.6
717	01	2	68	214	632	633	Y	04	09	87	F	1	2.2
718	01	2	62	214	876	877	R	04	09	87	M	2	4.3
719	01	2	63	214	878	879	R	04	09	87	M	1	1.9
720	01	2	56	214	886	887	R	04	09	87	M	1	1.4
721	01	2	78	214	880	881	R	04	09	87	M	1	3.7
722	01	2	64	215	883	884	R	05	09	87	M	2	3.8
723	01	2	68	215	634	635	Y	05	09	87	F	1	1.8
724	01	2	71	215	888	889	R	05	09	87	M	2	3.3
725	02	2	76	221	890	891	R	11	09	87	M	1	
725	01	2	76	215	890	891	R	05	09	87	M	1	1.3
726	01	2	56	215	636	637	Y	05	09	87	F	1	1.2
727	01	2	63	215	638	639	Y	05	09	87	F	1	1.7
728	01	2	66	216	640	641	Y	06	09	87	F	1	1.2
729	01	2	69	216	892	893	R	06	09	87	M	4	4.4
730	02	2	62	223	642	643	Y	13	09	87	F	1	
730	01	2	62	216	642	643	Y	06	09	87	F	1	2.7
731	01	2	65	217	894	895	R	07	09	87	M	3	4.7
732	01	2	56	218	896	897	R	08	09	87	M	1	1.2
733	01	2	55	218	898	899	R	08	09	87	M	1	1.4

Table 18. Continued

ID No.	Capture No.	Area	Capture Site	Sample Period	Left Tag	Right Tag	Tag Color	Day	Month	Year	Sex	Age	Weight (Kg)
734	01	2	51	218	644	645	Y	08	09	87	F	1	2.9
735	01	2	61	218	646	647	Y	08	09	87	F	1	1.7
736	01	2	43	218	900	901	R	08	09	87	M	2	3.2
737	01	2	59	219	648	649	Y	09	09	87	F	2	3.1
738	01	2	54	220	650	751	Y	10	09	87	F	1	1.5
739	01	2	69	221	902	903	R	11	09	87	M	4	5.2
740	01	2	76	221	904	905	R	11	09	87	M	1	1.5
741	01	2	78	221	906	907	R	11	09	87	M	2	3.5
742	01	2	45	221	908	909	R	11	09	87	M	2	3.6
743	01	2	76	222	752	753	Y	12	09	87	F	3	2.7
744	01	2	74	222	910	911	R	12	09	87	M	2	3.7
746	01	2	55	223	912	913	R	13	09	87	M	2	4.1
747	01	2	78	223	914	915	R	13	09	87	M	2	3.2
748	01	2	54	224	916	917	R	14	09	87	M	2	3.7
749	01	2	47	224	918	919	R	14	09	87	M	1	1.9

a 1=Control 2=Experimental

APPENDIX D

Table 19. Total captures of non-target species trapped during late summer sample periods on 2 portions of study area, CSWMA, 1986 and 1987.

Year	Species					
	Opossum	Groundhog	Gray Fox	Dog	House cat	Terrapin
Control						
1986	33	3	0	1	0	1
1987	74	4	2	0	0	1
Experimental						
1986	31	1	0	1	4	2
1987	48	2	0	0	1	3
Total	186	10	2	2	5	7

APPENDIX E

Table 20. Data from raccoons harvested on CSWMA, November 1986 and November 1987.

ID No.	Management Compartment	Date	Sex	Age Class	Weight (Kg)
425	11	11/17/86	M	1	3.4
	11	11/17/86	M	3	5.1
	12	11/17/86	F	5	5.0
	10	11/17/86	M	3	5.5
541	10	11/17/86	M	3	4.6
	13	11/17/86	M	3	5.4
	12	11/17/86	F	2	4.1
585	13	11/17/86	F	3	4.0
599	11	11/17/86	M	1	3.4
	15	11/17/86	M	3	4.1
	18	11/17/86	M	1	2.3
	15	11/17/86	F	1	2.5
	12	11/17/86	M	2	5.5
	08	11/17/86	M	4	5.8
	07	11/17/86	F	3	3.8
	15	11/17/86	M	1	3.0
	12	11/17/86	F	4	3.9
	09	11/17/86	M	2	4.9
	08	11/17/86	F	3	4.8
	14	11/17/86	M	5	5.1
	07	11/17/86	M	2	3.6
	17	11/17/86	M	1	3.1
	18	11/17/86	M	1	2.7
	09	11/17/86	M	2	4.6
	16	11/17/86	F	1	2.6
	15	11/17/86	F	1	2.6
645	13	11/17/86	F	3	4.0
	07	11/17/86	M	3	5.6
297	15	11/19/86	M	1	3.1
632	13	11/19/86	F	5	5.2
159	15	11/19/86	M	4	4.7
	13	11/19/86	M	5	5.9
	11	11/19/86	F	2	3.8
	06	11/19/86	M	2	5.2
	10	11/19/86	M	3	5.0
	16	11/19/86	M	3	5.2
	11	11/19/86	F	3	4.8
	08	11/19/86	F	1	2.2
	16	11/19/86	F	3	5.3
	11	11/19/86	F	5	5.2
	18	11/19/86	M	4	4.6

Table 20. Continued.

ID No.	Management Compartment	Date	Sex	Age Class	Weight (Kg)
	07	11/19/86	F	3	4.4
	15	11/19/86	M	2	2.6
	07	11/19/86	M	4	5.3
	08	11/19/86	F	2	5.1
	18	11/19/86	F	3	5.0
	10	11/19/86	F	5	5.0
	16	11/19/86	F	2	4.5
	10	11/19/86	F	5	5.7
	09	11/19/86	M	3	4.7
	12	11/19/86	M	1	2.8
	09	11/19/86	F	1	2.8
	15	11/28/86	F	1	2.8
	15	11/28/86	F	4	4.5
	09	11/28/86	M	1	2.2
	10	11/28/86	M	1	2.6
	12	11/28/86	M	1	3.0
	10	11/28/86	F	3	5.2
	18	11/28/86	F	5	6.0
	17	11/28/86	F	3	5.4
	08	11/28/86	M	1	2.7
	09	11/28/86	F	1	3.1
	11	11/28/86	F	1	2.7
	17	11/28/86	F	4	4.6
	15	11/28/86	F	2	4.5
592	13	11/28/86	M	4	6.2
	09	11/28/86	F	2	4.8
	16	11/28/86	F	2	4.6
	11	11/28/86	M	1	3.2
	14	11/28/86	M	1	2.7
648	13	11/28/86	M	4	4.0
	13	11/28/86	F	1	2.4
513	15	11/28/86	M	4	6.6
	07	11/28/86	F	1	2.7
451	15	11/28/86	M	5	6.1
	08	11/28/86	M	5	5.8
	18	11/28/86	M	1	3.3
	15	11/16/87	M	2	5.0
	12	11/16/87	M	2	3.3
	15	11/16/87	F	4	4.0
	17	11/16/87	F	4	5.2
	10	11/16/87	M	1	2.2
	18	11/16/87	F	4	4.7
263	12	11/16/87	F	4	4.0
488	13	11/16/87	F	4	4.5
	11	11/16/87	M	2	5.1

Table 20. Continued.

ID No.	Management Compartment	Date	Sex	Age Class	Weight (Kg)
634	10	11/16/87	M	2	5.4
	11	11/16/87	M	5	6.0
	06	11/16/87	F	2	4.5
	16	11/16/87	M	2	5.4
	10	11/16/87	F	2	4.0
	07	11/16/87	M	3	4.2
	06	11/16/87	F	3	4.1
	12	11/16/87	F	2	3.7
	13	11/16/87	F	2	2.5
	13	11/16/87	F	2	2.4
	12	11/16/87	F	2	2.9
	18	11/16/87	F	3	3.0
	13	11/16/87	M	2	2.5
427	15	11/16/87	F	4	4.7
	18	11/16/87	F	3	5.3
	09	11/16/87	F	2	3.8
	09	11/16/87	M	1	2.2
	08	11/16/87	M	3	5.3
	11	11/16/87	F	2	3.7
	07	11/16/87	F	4	4.2
	09	11/16/87	F	2	2.7
	10	11/16/87	M	1	2.6
	17	11/16/87	F	2	4.5
	14	11/16/87	F	2	2.3
	17	11/16/87	F	4	5.2
	10	11/18/87	F	3	5.1
749	13	11/18/87	M	1	2.5
	09	11/18/87	F	2	4.0
	11	11/18/87	M	4	5.0
286	11	11/18/87	M	3	6.3
	09	11/18/87	M	3	5.4
519	06	11/18/87	F	2	5.1
	13	11/18/87	M	1	2.8
	10	11/18/87	F	1	3.0
	16	11/18/87	M	3	4.8
	11	11/18/87	M	1	3.0
	18	11/18/87	F	1	2.4
	09	11/18/87	M	3	5.9
	15	11/18/87	.	.	.
	18	11/18/87	F	5	4.2
	17	11/18/87	M	3	6.1
747	12	11/18/87	M	2	4.6
653	12	11/18/87	M	4	4.9
	12	11/18/87	M	2	5.1
	10	11/18/87	F	2	4.7

Table 20. Continued.

ID No.	Management Compartment	Date	Sex	Age Class	Weight (Kg)
	07	11/18/87	M	3	4.6
	08	11/18/87	F	1	2.7
	13	11/18/87	M	1	2.5
	15	11/18/87	F	4	4.2
	11	11/23/87	M	2	4.6
	13	11/23/87	M	1	2.5
	08	11/23/87	M	4	4.7
347	10	11/23/87	M	5	7.0
	11	11/23/87	M	1	3.1
622	12	11/23/87	F	1	2.9
728	15	11/23/87	F	1	2.5
	11	11/23/87	F	1	2.9
	08	11/23/87	M	1	3.4
	15	11/23/87	M	3	5.3
	14	11/23/87	F	2	4.2
	15	11/23/87	F	2	3.1
292	08	11/23/87	M	4	4.9
	12	11/23/87	F	1	2.5
	06	11/23/87	F	3	4.3
	07	11/23/87	M	4	6.4
	09	11/23/87	F	1	2.5
	09	11/23/87	F	1	2.6
	14	11/23/87	F	1	2.7
	14	11/23/87	M	1	1.4
	11	11/23/87	F	1	2.9
	09	11/23/87	F	3	4.8
338	15	11/23/87	F	4	5.3

VITA

Mark Alan Cantrell was born in Maryville, Tennessee on 26 November 1963. He attended elementary schools in Haywood and Jackson Counties in North Carolina, Catoosa County, Georgia, and graduated from Sylva-Webster High School in Jackson County NC, in June 1982. The following September he entered The University of Tennessee, Knoxville, and in June 1986 received a Bachelor of Science in Wildlife and Fisheries. After working for the North Carolina Wildlife Resources Commission for 2 months, he accepted a graduate research assistantship at The University of Tennessee, Knoxville and began study toward a Master's degree in Wildlife and Fisheries.