Ecology of White-Tailed Deer on summer-fall range in Northcentral Idaho
by Thomas Robert Baumeister

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
Home range size, migration patterns, and habitat use were determined for white-tailed deer (Odocoileus virginianus) in a coniferous forest of northcentral Idaho. Sixty-nine deer of both sexes were radio-collared and monitored during daytime hours in summer-fall of 1990 and 1991. Summer-fall home range size for male deer (n = 14) averaged 76 ha (SD = 40). Sumner, fall, and summer-fall average activity radii for male deer averaged 0.33 km (SD = 0.08), 0.34 km (SD = 0.17), and 0.40 km (SD = 0.12), respectively. Distances between 1990 and 1991 summer-fall geographic activity centers averaged 0.31 km (SD = 0.25). On average, summer-fall home ranges in 1991 encompassed 44% (SD = 32) of 1990 home ranges. Fall migration distances averaged 38 km (SD = 8) in 1990 and 39 km (SD = 9) in 1991. Deer migrated, on average, in 4 days (SD = 2) and 7 days (SD = 4) to the winter range in 1990 and 1991, respectively. Two subpopulations of deer that differed in respect to date of departure from the summer-fall range and average migration distance were identified. Departure dates and migration distance were related to migration routes. Topography (slope, aspect, elevation, landform types) influenced habitat use to a lesser degree than vegetation structure and composition. Home ranges were composed of a mosaic of unlogged and logged areas. Deer preferred pole timber and avoided sapling stands, clearcuts, and the moistest habitat types. Relative to fall habitat, summer habitat was characterized by more open-canopied coniferous cover types associated with high forb and shrub cover. Male deer showed no differences in habitat use patterns between prehunt and hunt periods.

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APPROVAL

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Thomas Robert Baumeister

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date 8 Dec. 1992

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ABSTRACT

Home range size, migration patterns, and habitat use were determined for white-tailed deer (Odocoileus virginianus) in a coniferous forest of northcentral Idaho. Sixty-nine deer of both sexes were radio-collared and monitored during daytime hours in summer-fall of 1990 and 1991. Summer-fall home range size for male deer (n = 14) averaged 76 ha (SD = 40). Summer, fall, and summer-fall average activity radii for male deer averaged 0.33 km (SD = 0.08), 0.34 km (SD = 0.17), and 0.40 km (SD = 0.12), respectively. Distances between 1990 and 1991 summer-fall geographic activity centers averaged 0.31 km (SD = 0.25). On average, summer-fall home ranges in 1991 encompassed 44% (SD = 32) of 1990 home ranges. Fall migration distances averaged 38 km (SD = 8) in 1990 and 39 km (SD = 9) in 1991. Deer migrated, on average, in 4 days (SD = 2) and 7 days (SD = 4) to the winter range in 1990 and 1991, respectively. Two subpopulations of deer that differed in respect to date of departure from the summer-fall range and average migration distance were identified. Departure dates and migration distance were related to migration routes. Topography (slope, aspect, elevation, landform types) influenced habitat use to a lesser degree than vegetation structure and composition. Home ranges were composed of a mosaic of unlogged and logged areas. Deer preferred pole timber and avoided sapling stands, clearcuts, and the moistest habitat types. Relative to fall habitat, summer habitat was characterized by more open-canopied coniferous cover types associated with high forb and shrub cover. Male deer showed no differences in habitat use patterns between prehunt and hunt periods.

INTRODUCTION

The complexity of white-tailed deer (Odocoileus virginianus) ecology has long been recognized by biologists. Understanding white-tailed deer ecological relationships is increasingly important as human alteration of environments continues and public demands on natural resources increase. Deer habitat management guidelines developed for one geographical area may have limited value in another area. Consequently, habitat relations of deer can best be determined by investigating habitat selection and environmental factors at the local population level.

Habitat use by white-tailed deer in coniferous forests of the Northern Rocky Mountains has been intensively studied (Martinka 1968, Keay and Peek 1980, Mundinger 1980, Krahmer 1989, Hicks 1990). Yet, relatively little is known about habitat use patterns of white-tailed deer in Idaho. The Idaho Department of Fish and Game (IDFG) initiated a series of deer ecology studies in 1987 to fill this gap in knowledge. The first study investigated habitat use, food habits, home range characteristics, and seasonal migration patterns of white-tailed deer in the Priest River Drainage of northern Idaho (Pauley 1990). That area is characterized by a cool, moist climate with western red cedar (Thuja pilcata) and western hemlock (Tsuga heterophylla) dominating the landscape (Cooper et al. 1987). The Clearwater River Drainage in northcentral Idaho was selected for this second study primarily because of its drier and more open white-tailed deer habitat.

The habitat of white-tailed deer in the Northern Rocky Mountains is commonly viewed as being dominated by closed canopied coniferous forests associated with riparian areas and croplands (Leach 1982, Peek 1984, Krahmer 1989). Previous studies have suggested that summer habitat use by white-tailed deer was determined primarily by the availability of forage and cover (Shaw 1962, Kohn and Mootly 1971, Suring and Vohs 1979, Mundinger 1980, Owens 1981, Pauley 1990). Studies on summer food habits of white-tailed deer in Montana and Idaho have indicated that forbs and browse were dominant forage classes and that use of grass was insignificant (Allen 1968, Pauley 1990). Changes in forage availability, seasonal rhythms in activity, metabolism, forage intake, and the onset of the breeding season were factors causing changes in habitat use by deer during fall (Sparrow and Springer 1970, Moen 1978, Suring and Vohs 1979, Marchinton and Hirth 1984).

The onset of winter weather in northern environments is a particularly influential parameter for deer (Halls 1984). With the onset of cold weather, deer increase metabolic rate, reduce activity, and move to habitats providing thermal cover (Ozoga 1968). Verme and Ozoga (1971) found that a sharp drop in temperature was more important than snowfall in prompting deer to seek shelter.

Winter severity is recognized as an important regulatory factor for white-tailed deer populations, but little is known about the role summer habitat plays in regulating deer populations. This occurs even though productivity, recruitment, and growth rate of white-tailed deer are largely determined by summer range quality and quantity. Data describing and evaluating suitable summer habitat with respect to population dynamics are lacking.

Timber management may be the most important human influence on white-tailed deer in the Northern Rocky Mountains. Forest stand conditions influence amounts and quality of forage, and thermal and hiding cover available to deer. Although the white-tailed deer has been viewed as a species favored by early successional stages (Leach 1982, Krahmer 1989), Drolet (1976) found that early successional vegetation and edge areas were only used in small cutting units.

Hunting has the potential to be equally important, but little is known about the influence of hunting activity on white-tailed deer behavior and habitat selection in northcentral Idaho. Research in other areas of North America presents a mixed picture on the importance of hunting in habitat use. Some studies have indicated that hunting pressure and other disturbances affected daily movement patterns of deer (Downing et al. 1969, Dorrance et al. 1975) but did not result in movement to remote unhunted areas apart from the normal home range (Autry 1967, Marshall and Whittington 1969, Pauley 1990). In others, disturbance by hunters was at least partially responsible for annual home range shifts (Sparrow and Springer 1970, Kammermeyer and Marchinton 1976). The effects of human activity on movement, habitat selection, and home range size may largely depend on the quality of habitat occupied, amount of hunting pressure, and deer density. Sparrow and Springer (1970) found that movement of white-tailed deer was influenced by the availability of heavy cover in which they could escape disturbance by hunters. Due to the secretive nature of white-tailed deer and the dense cover they inhabit, animals tended to hide within their home range boundaries and decrease diurnal activity rather than utilize unfamiliar areas in response to disturbance by hunters (Autry 1967, Sweeney et al. 1971, Roseberry and Klimstra 1974, Pauley 1990).

Mild winters during the past several years are believed to have allowed white-tailed deer populations to increase throughout northern Idaho. Consequently, the IDFG management plan for 1986-1990 called for an increase in harvest by providing more hunting opportunities in some of the Game Management Units (GMU) in northcentral Idaho (Hanna 1985). Following this plan, a 19-day, late-season, buck-only, general hunt for white-tailed deer was added to the established 26-day general either-sex hunt in October and the archery seasons in September and December. This resulted in an increase in antlered deer harvest (Hanna et al. 1989) but also created some concern among sportsmen about the potential for overharvesting white-tailed deer in this region.

OBJECTIVES

1. To determine summer-fall distribution of male white-tailed deer in grand fir (Abies grandis) dominated forests of GMU 15.
2. To determine summer-fall habitat use by male white-tailed deer in grand fir dominated forests of GMU 15.
3. To determine which environmental factors are associated with summer-fall home range characteristics of male white-tailed deer in grand fir dominated forests of GMU 15.
4. To determine which environmental factors are associated with migration patterns of white-tailed deer in grand fir dominated forests of GMU 15.

STUDY AREA

The study area (Fig. 1) was within Game Management Unit 15 on the Nez Perce National Forest (NPNF) in northcentral Idaho. The South Fork of the Clearwater River formed the southern boundary and the Selway-Bitterroot Wilderness formed the eastern boundary of the roughly 1,000-km^2 study area. The majority of the area was under public ownership administered by the USDA Forest Service. Elevations ranged from 1,200 m at the western end of the winter range to 2,000 m at the peaks in the eastern portion of the summer-fall range.

The high elevation landscape on the eastern portion of the study area was characterized by diverse grand fir and subalpine fir (A. lasiocarpa) habitat types that graded into Douglas-fir (Pseudotsuga menziesii) and ponderosa pine (Pinus ponderosa) types on drier, warmer sites on the lower western portion (Cooper et al. 1987). The grand fir habitat types were the most common types on the study area and occurred on a wide array of landforms and elevations. Prominent climax and seral overstory tree species included grand fir, Douglas-fir and lodgepole pine (P. contorta). Common understory species included huckleberry (Vaccinium spp.), twinflower (Linnaea borealis), creeping Oregon grape (Berberis repens), fool's huckleberry (Menziesia ferruginea), Pacific yew (Taxus brevifolia), wild ginger (Asarum caudatum), queencup beadliliy (Clintonia uniflora), western goldthread (Coptis occidentalis), bunchberry dogwood (Cornus canadensis), and arnica (Arnica spp.). The floristically diverse and productive grand fir series on the NPNF offers great silvicultural opportunities.

The climate is heavily influenced by low-altitude storms from the Pacific Coast that create wet winters and springs. High-altitude storms from the Gulf of Mexico and California Coast provide moisture during May and June. The latter wet season often provides greater monthly precipitation than the former. Mean annual precipitation is 76 cm, with precipitation primarily between December and June.

Mean monthly minimum and maximum temperatures at the Elk City weather station range from -12 C to 1 C in January and from 4 C to 22 C in June, respectively. Average snowfall is 352 cm per year, with an average of 65 cm per month during December-March (NOAA 1989). Snow usually starts accumulating on the eastern portion of the study area by mid-November.

Cooper et al. (1987) determined that most stands sampled in forested habitat types of northcentral Idaho showed some evidence of past fire. The study area was within a zone in the Clearwater NF and NPNF which has more lighting-caused fires than any other area in Idaho or Montana (Steele et al. 1981). The average acreage burned per million acres for the NPNF is 2 to 10 times greater than on adjacent forest lands (Cooper et al. 1987). The thin soils in the study area are granite-derived and are considered highly erodible when subjected to runoff (Steele et al. 1981).

Logging has been intensive in northcentral Idaho since the late 1800s. Areas of heavy mining activity were the first sites harvested. Clearing for agriculture and timber needs of booming wartime and postwar economies have driven subsequent logging activities. The Clearwater, Red River, and Elk City ranger districts within the NPNF have extensive road systems because of intensive timber and mining activities and, consequently, have provided access for recreational activity. Livestock grazing was infrequent on the study area and generally limited to the valleys around Elk City and Red River and to portions of the winter range.

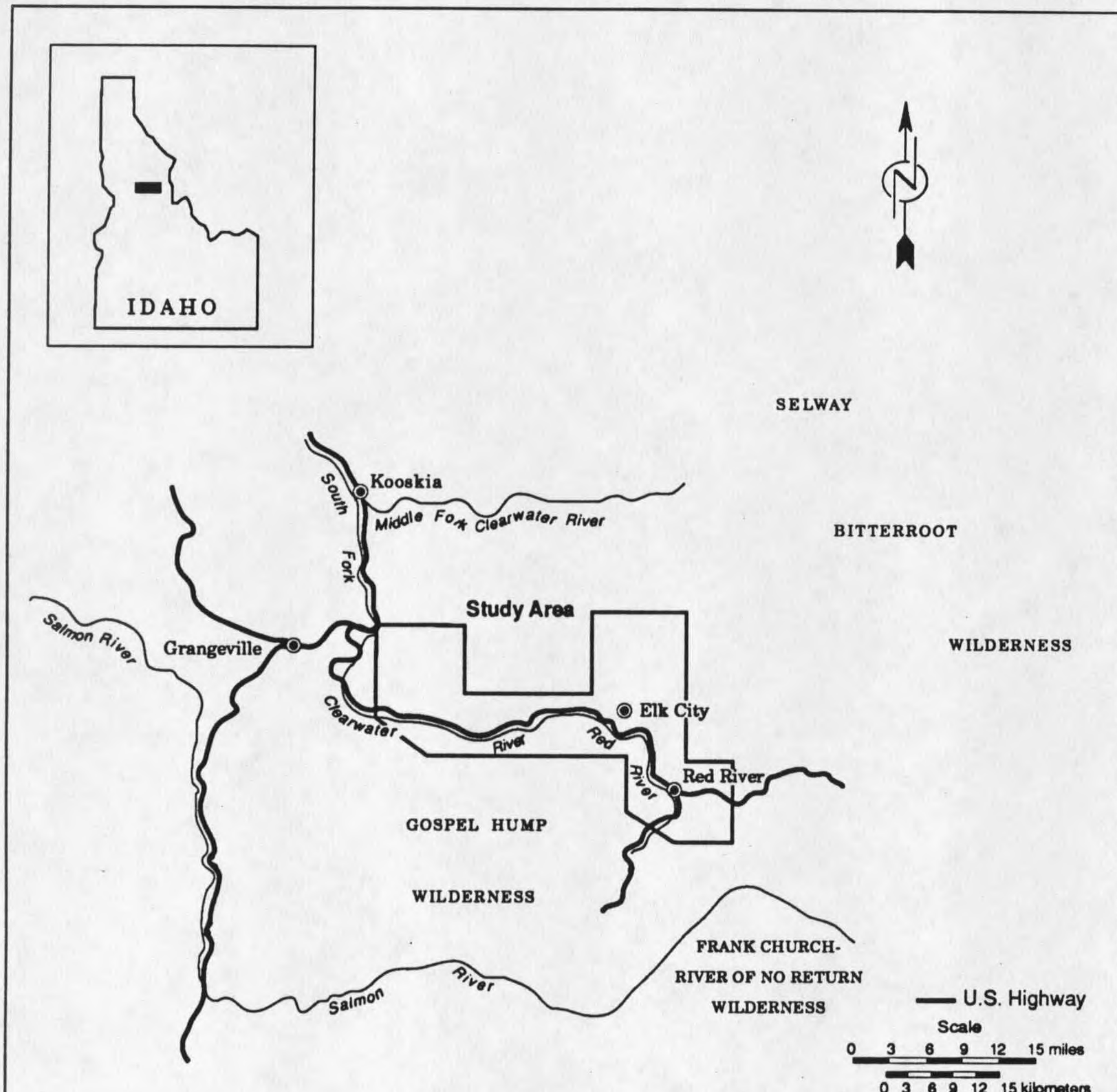

Fig. 1 Location of the study area in the South Fork of the Clearwater River Drainage, northcentral Idaho.

METHODS

Home range characteristics and habitat use for male white-tailed deer and migration patterns for white-tailed deer of both sexes were analyzed from telemetry data obtained from ground relocations of radio-collared deer during summer and fall of 1990 and 1991.

Capture and Relocation

Deer were trapped on the winter-spring range in 1990 and 1991 using single-gate Clover traps (Clover 1956) baited with alfalfa. In 1990, the trapping sites were 25 km east of Grangeville. Traps were placed on southwest facing slopes between Castle creek and Peasley creek along the South Fork of the Clearwater River. In 1991, additional trapping sites were established 10 km north of the 1990 trapping sites. Trapped deer were handled without drug immobilization. Deer were sexed, aged by tooth development and wear (Severinghaus 1949), equipped with "mortality-sensing" radio transmitters (Telonics Inc.; Mesa, AZ) and marked with plastic ear tags in both ears. Immature deer were fitted with expandable collars (Pauley 1990).

I radio-tracked deer during 15 August-15 December in 1990 and 15 June-15 December in 1991. Deer were relocated ≤2 times per week to maximize independence of consecutive ground relocations (Swihart and Slade 1985, Pauley 1990). An attempt was made to evenly sample during daylight hours. Deer relocations from the ground were obtained using a 2-element, directional H-antenna and a portable, hand-held receiver (Telonics Inc.; Mesa, AZ). Aerial relocations from a fixed-wing aircraft were used to obtain the status of animals not included in the habitat use or home range samples and to determine general summer range locations of deer at the beginning of each field season.

Errors in ground triangulation occur due to signal bounce, vegetational and topographical interference, and animal movement (Heezen and Tester 1967, Hupp and Ratti 1983, Lee et al. 1985, White and Garrott 1986). I estimated the accuracy of triangulations based on known transmitter locations. Results revealed that the triangulation procedure produced point estimate errors that were too large to meet the study objectives. Therefore, one of two different ground telemetry procedures was used depending on habitat diversity.

In homogeneous cover types, triangulation $\leq$150 m from the deer was considered sufficient to meet the study objectives. In heterogeneous cover types, either visual observation or 180 degree circling of the deer in proximity ($\leq$150 m) was used to obtain an accurate relocation (Pauley 1990). The error associated with the two relocation procedures was determined by disturbing bedded deer for which a point estimate of a relocation had been obtained prior to the disturbance. Mean radius of deviation from the actual deer relocation was approximately 40 m (n = 16). Relocations were classified into 1 of 4 categories according to the level of accuracy and proximity to the deer (Unsworth et al. 1989). Relocations in categories 2, 3, and 4 ($\geq$40-$\leq$150 m, <40 m, and visual, respectively) were used for home range analyses. Only relocations in categories 3 and 4 were evaluated for habitat use information. Relocations with the lowest rating in accuracy (1 = >150 m) were discarded. Relocations were plotted on U.S.

Geological Survey topographic maps (scale 1:24,000) and assigned to X, Y coordinates using Universal Transverse Mercator (UTM) meridians.

Home Range

Following Burt (1943), home range was defined as the area traversed by an individual in its normal daily activities. I estimated home range sizes for 3 periods: summer (15 June-31 August), fall (1 September-30 November), and summer-fall (15 June-30 November). Summer and fall were defined based on white-tailed deer distribution on the summer-fall range, white-tailed deer physiology, plant phenology, and weather conditions. Summer and fall contained similar numbers of weeks and relocations. Relocations obtained during migration and on winter range were excluded from estimates of home range size. Home range size for yearling males was not estimated separately because of the small sample size of this age class.

Seasonal home range boundaries were delineated using the minimum convex polygon method (Mohr 1947, Lonner and Burkhalter 1992). This method is sensitive to outlying relocations and may encompass areas within the polygon that deer did not use. Also, estimates of home range size are positively correlated with number of relocations used to generate estimates. Despite these disadvantages, this method is a commonly used technique which allows comparisons with many other studies; bias associated with this method is considered low when the sample size of relocations exceeds 20 (Jennrich and Turner 1969).

To minimize impacts of outliers on estimates, relocations were excluded if they were located beyond twice the average activity radius

(AAR) of the deer excluding the relocation in question (Burt 1943). The AAR is the mean distance of all relocation points of a home range to a computed geographic activity center (GAC) (Hayne 1949). To minimize biases due to small number of relocations, estimates of seasonal home range size were calculated only for deer with ≥1 relocation per week. Estimates of seasonal home range size for 1990 were not included in the average seasonal home range calculations due to inadequate number of relocations (≤1 relocation/week).

To determine if these conventions successfully reduced sample size biases, Spearman's rank correlation coefficients (Sachs 1984) were calculated between estimates of seasonal home range size and (1) number of relocations per season and (2) monitoring periods (weeks). Median estimates of summer and fall home range sizes were tested for differences using Wilcoxon's rank sum test (Sachs 1984).

Mobility of male white-tailed deer was evaluated by calculating mean seasonal AARs for deer. Patterns of mobility were evaluated for summer, fall, and summer-fall. Fidelity of male white-tailed deer to summer-fall ranges was determined by measuring straight-line distances between GACs for 1990 and 1991 (White and Garrott 1990).

Migration

I examined fall migration patterns of white-tailed deer by monitoring radio-collared deer of both sexes in 1990 and 1991. Deer were considered migratory if they moved between seasonal areas of use that showed no overlap (Brown 1992). Migration variables examined for deer included: (1) summer-fall to winter range straight-line distances,

(2) departure and arrival dates, (3) duration of migration, (4) daily distances migrated, and (5) migration routes. Distances between seasonal ranges for individual deer were calculated from distances between summer-fall GACs and the area used in the previous winter as indexed by the trapping site of the deer. Duration of migration was defined as the time it took deer, not occupying transitional ranges, to move between summer-fall home ranges and early winter range.

Wilcoxon's rank sum test (Sachs 1984) was used to test for differences between the sexes in departure dates from summer-fall range. Student's t-test was used to test for differences in duration of deer migration between early and late migrating deer in fall of 1991. November 29 was defined as the separation date between early and late migrating deer. To determine whether radio-collared deer migrated in the same order for consecutive years, a Spearman rank correlation coefficient was calculated between departure dates of deer in 1990 and 1991. The chi-square goodness-of-fit test was used to test for differences between migration patterns in 1990 and 1991 by testing number of deer leaving in 2-week intervals.

Simple correlation coefficients (Sachs 1984) were calculated between departure dates and migration routes. Routes were determined from relocations obtained for deer during migration. I used a 3-factor multiple regression analysis to test the hypothesis that deer initiated migration in response to a combination of weather severity, migration distance and route to winter range. Migration distance to winter range was a continuous variable indexed by the straight-line distance from individual summer-fall home ranges to the winter range. The mean elevation for summer-fall home ranges occupied by deer was selected as an index to weather severity. I assumed, based on my field observations, that an increase in elevation was positively correlated with an increase in snow depth and negatively correlated with temperature.

To examine whether departure dates of deer were related to specific weather conditions, Student's t-tests (Sachs 1984) were used to test for differences between the monthly snow depth average and the 48-h snow depth average prior to departure, and between the monthly minimum temperature average and the 48-h minimum temperature average prior to departure. A summary of summer-fall climatological data for the Elk City weather station (1238 m) was obtained from the NOAA (1991) to calculate mean snow depth and mean minimum temperature for November 1991.

My observations indicated that date of departure of deer varied considerably according to route of migration. Student's t-tests were used to test for differences in departure dates and distances to winter range for sets of deer using different routes of migration.

Habitat Use and Selection

Habitat use by male white-tailed deer was examined by sampling topographic and floristic variables at deer relocations. Topographic variables included: elevation (m), slope (%), aspect (azimuth), and landform (ridge, convex slope, straight slope, concave slope, and draw bottom). Distance measurements to the nearest paved or secondary road, trail, clearcut, and running water were taken from U.S. Geological

Survey topographic maps (scale 1:24,000).

I classified habitat types based upon plant species, topography, and elevation following Cooper et al. (1987). Overstory and understory plant species were identified using Patterson et. al (1985). Forested and non-forested cover types were sampled applying USDA Forest Service stand examination procedures. Overstory canopy height was estimated using a clinometer. Overstory canopy cover was measured with a spherical densiometer (Lemmon 1957, Strickler 1959) and averaged across readings taken from the 4 cardinal directions, 15 m from plot center. Basal area was measured with a 20 BAF prism. Overstory tree (≥12.7 cm diameter at breast height (dbh)) and sapling (<12.7 cm dbh) densities were determined using the point-centered-quarter method (Cottom and Curtis 1956). Height and crown ratio for saplings were estimated ocularly. Crown ratio was defined as the percentage of stem length that was covered by the tree crown.

Stem diameter for overstory trees was averaged from diameters of trees measured in the point-centered-quarter method. The stand density index, based upon density and basal area, was computed following McTague and Patton (1989). Percent ground coverage of understory plant categories (seedling (≤2.5 cm dbh), shrub, dwarf shrub, graminoid, forb, moss, total plant cover), deadfall (≥5 cm dia.) and non-plant-material was determined using a line-point transect (Levy and Madden 1933). The transect originated at plot center and extended 15 m to the north and south. Cover readings were taken every 30 cm along the transect.

Prominence values (Stringer and LaRoi 1970) were calculated for seedling, shrub, dwarf shrub, and forb species. Prominence value is a cover value that takes into account abundance and distribution of plants on all plots. The index is computed by multiplying the average percent cover of a plant on all plots by the square root of its percent frequency of occurrence on all plots. Plant species with prominence values ≤10 were excluded from further analysis.

Hiding cover was evaluated by averaging 4 readings of percent cover on a cover pole for 50 cm height intervals. Readings were taken for height intervals up to 1.5 m from the 4 cardinal directions at distances of 15 m from the pole positioned at plot center (Griffith and Youtie 1988).

Following Pauley (1990), forested cover types were defined using USDA Forest Service criteria and included old growth (≥ 30% canopy cover, ≥37 trees/ha ≥50 cm dbh); mature timber (≥30% canopy cover with the density of trees ≥23 cm dbh exceeding the density of trees 12 cm to 22 cm dbh); pole timber (≥30% canopy cover with the density of trees 12 cm to 22 cm exceeding the density of trees ≥ 23 cm dbh); or sapling (≥30% canopy cover and <10% of the trees ≥12 cm dbh). Non-forested cover types (≤30% canopy cover) were classified as either clearcuts, brushfields, or meadows.

Availability of habitat in the Clearwater study area was evaluated using data from 262 random plots sampled by Jones (1990). These plots provided the basis for my descriptions of differences among cover types, and they were used in comparisons of deer use with availability.

Habitat sampling methods used by Jones (1990) were identical to methods I employed in habitat use sampling at deer relocations except as follows: vegetation structure and plant species composition were sampled within 2 circular plots. In a 40.5 m^2 plot, trees (2.5-15.0 cm dbh) and shrubs were recorded by species and dbh. Live trees ≥15 cm dbh and shrubs were recorded by species and dbh in a 375 m^2 plot. Number of canopy levels was subjectively determined, and average height of each canopy level estimated using a clinometer. Ground coverage of shrubs and seedlings (≤1.8 m) was estimated by using four 10.9-m paced transects radiating out from plot center in the 4 cardinal directions. Ground cover was recorded at 15-18 points along each transect. The dominant plant species or, in the absence of vegetation, the most prominent non-plant ground cover at each point was recorded.

Small sample sizes in some of the habitat types recorded at deer relocations and random locations required pooling habitat types into ecologically similar habitat groups for analyses (Jones 1990). Ecological site (topography, elevation, and climate) and vegetation similarities were used to group habitat types into habitat groups following Cooper et al. (1987) (Table 22). For each habitat group, the name of the habitat type with the highest percent availability in the study area was used as a title.

Habitat use and selection by male white-tailed deer were determined for summer (15 June-31 August) and fall (1 September-30 November). Seasonal differences in habitat use for deer were examined based upon pooled relocations for all deer in each designated season. Seasonal comparisons of habitat use and selection were based only on deer with ≥15 relocations on the summer-fall range in order to minimize biases due to small samples. Student's t-test was used to test for differences in number of relocations per season in order to minimize the bias of unequal sample sizes in the analyses. Yearling male relocations were not analyzed for habitat use and selection because of the small sample size of this age class and the tendency of yearlings to behave differently than adult males (Marchinton and Hirth 1984).

Although habitat selection depends on the area delineated as available to animals under study (Johnson 1980), the impact of study area delineation on inferential analysis is considered unimportant when the dispersion patterns of habitat categories are regular or random (Church and Porter 1987). My field observations indicated that habitat variables in the Clearwater study area with respect to topography, plant communities, cover types, and access were evenly distributed. Therefore, habitat availability was defined as the area encompassed by the cumulative summer, fall, and early winter ground relocations of deer monitored throughout the duration of the study. Habitat within the study area was assumed equally available to all radio-collared deer throughout summer and fall. Analyses of habitat use included macrohabitat and microhabitat use and selection and the evaluation of hunting season security habitat for male white-tailed deer.

Macrohabitat Use and Selection

Habitat variables used in macrohabitat analyses included habitat groups, cover types, landform types, slope, aspect, elevation categories, and distances categories to the nearest road, trail, running water, and clearcut. Categorical variables were analyzed by use versus availability and tested for seasonal differences with the chi-square goodness-of-fit test (Neu et al. 1974, Byers et al. 1984). Use of categorical variables was compared between summer and fall. If no significant difference ($P > 0.05$) between seasonal use of a categorical variable occurred, then summer and fall relocations were pooled and compared to the availability of that variable in the study area. If significant differences ($P < 0.05$) between seasons or between use and availability of the variable occurred, then preference or avoidance was determined using 90% Bonferroni simultaneous confidence intervals (Marcum and Loftsgaarden 1980). Habitat components were considered preferred if they were used proportionally more than and avoided if used proportionally less than percent availability.

Chi-square analyses are appropriate for identifying habitat components that are used disproportionately relative to availability. However, this approach may not identify some habitat features essential to male white-tailed deer simply because they are commonly available. Because of this, I compared use data of summer-fall to early winter range in order to identify specific habitat characteristics that separated summer-fall range from early winter range. Comparison was based on habitat use data collected at deer relocations. Early winter range was defined as the area to which the radio-collared deer moved to during fall migration. Habitat characteristics of the ranges were not tested for differences due to small sample size of early winter relocations.

Spatial arrangements of habitat features within home ranges can be important in habitat selection by deer in the Clearwater study area. I determined availability of clearcuts ≥ 1 ha and forested cover types within 13 deer summer-fall ranges by overlaying a grid system ($0.09\ km^2$)

on home ranges and summing the proportions of non-forested and forested cover types for each cell. Use of forested cover types and clearcuts was compared to availability using the chi-square goodness-of-fit test. USDA Forest Service stand data base files were obtained to determine the age of clearcuts. Spearman's rank correlation (Sachs 1984) was used to determine whether home range size and proportion of home ranges that had been clearcut were related.

Spatial use patterns within home ranges were identified by superimposing a 0.09 km^2 grid over each home range and plotting the frequency of relocation points within each cell (Samuel et al. 1985, Samuel and Green 1988). The cell size was selected to encompass the telemetry error of ground relocations and to achieve an average of ≥ 1 relocation per grid point (Samuel et al. 1985). The use pattern was tested against a hypothesized uniform distribution of relocation points using the chi-square goodness-of-fit test (Sachs 1984). Core areas within home ranges were defined by the number of cells where the observed use distribution exceeded that expected in a uniform distribution ($P \leq 0.01$). To determine whether the occurrence of core areas was related to the number of relocations and estimates of home range size, Spearman's rank correlation coefficients were calculated between size of core areas and (1) number of relocations and (2) home range size. The question of why male white-tailed deer used core areas was addressed by comparing habitat composition of core and non-core areas. Relocations in core areas were used to evaluate habitat composition of core areas. Non-core relocations were used to describe habitat composition within the home ranges outside core areas.