Description and evaluation of the seasonal ranging and movement behavior of white-tailed deer, 1979

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PROJECT TITLE: Wildlife Ecology, Behavior and Habitat Improvement in New York

STUDY NO. AND TITLE: VI - Description and evaluation of the ranging and movement behavior of white-tailed deer

STUDY OBJECTIVE: To describe the location, configuration, and movements within and between seasonal home ranges; and to account for the development, maintenance, and variability of seasonal ranging and movement patterns of a representative sample of white-tailed deer.

JOB NO. AND TITLE: VI-5 The relationship of deer movement and activity patterns to timber management activities.

JOB OBJECTIVE: To evaluate the effects of timber management on patterns of habitat utilization exhibited by daily movements of a sample of white-tailed deer on their spring-summer-fall home range.

PERIOD COVERED: April 1, 1977 to March 31, 1978
Abstract:

The ranging behavior and activity patterns of eight white-tailed deer, *Odocoileus virginianus* were monitored by means of radio-telemetry during three tracking sessions in May, August and October of 1977. Use of logged and unlogged areas and several forest types were compared. Minor shifts in range locations as well as significant changes in time of activity were documented between tracking sessions.
Background:

The central Adirondack region of northern New York is commonly held to be comprised primarily of three general forest types. Northern hardwood stands occupy about 40 percent of the land area. Conifer forests and mixed hardwood-conifer forests occupy approximately 39 percent and 13 percent of the land area respectively. Open land and water (Huntington Forest unpublished data) occupy the remaining 8 percent of the area.

Beginning in the 1940's and increasing until the present time, timber management in this region has emphasized the northern hardwood type. Production of hardwood pulpwood and sawtimber far exceeds softwood utilization in the area.

Approximately 60 percent of the land within the Adirondack Park is in private ownership. Large parcels, held by paper companies or individuals, are typical. Wood fiber for both pulpwood and sawtimber products are produced on most of these lands. Northern hardwood and mixed hardwood-conifer forest types have been shown to constitute 66 percent of the average spring-summer-fall range of white-tailed deer on a study area within this region (unpublished data, Huntington Forest). Thus, private land timber management on these ownerships has the potential for significant regional impact on white-tailed deer summer range.

Previous Study VI Jobs at the Huntington Wildlife Forest, 1968-77 (P-R W-105-R, Jobs VI-1 and 2) had documented that individual deer in the Adirondack region of New York State had well established spring-summer-fall ranges which they occupied year after year throughout their adult life. These ranges averaged about 184 hectares in size. It appeared that individual adult deer did not alter the basic location of their spring-summer-fall range even when major habitat modifications such as timber harvesting occurred within and around these established ranges. However, ranges had been delineated by intermittent telemetry triangulation with the periods between successful locations ranging from hours to weeks. Therefore, use of the ranges in response to harvesting could only be marginally evaluated.

Timber harvesting has long been looked upon as having a beneficial effect on the quality of summer deer range. In extensively forested areas, harvesting has often been considered the major form of deer habitat modification. Certain types of timber harvesting, particularly successful regeneration cuts and heavy intermediate cutting, typically result in an abundance of both woody and non-woody plant development and diversity on or near the ground and available to deer. Past studies at the Huntington Forest have documented the tremendous impact of deer on this newly established vegetation suggesting its importance as forage (Farnsworth and Barrett, 1966; Wiersma, 1968; Tierson et al. 1966; Tierson, 1969).

Other researchers (T.W. Hoekstra, personal communication) have documented the "ever-changing" selective feeding behavior exhibited by white-tailed deer. Such selectivity is probably related to such factors as availability, palatability and nutrient status of vegetation. The specificity of selection suggests the importance of plant diversity within deer habitat. These relationships, findings and inferences served as a basis for this study. Differential seasonal use of the habitat in response to timber management effects was the reasonable expectation.

By employing nearly continuous radio monitoring of several individual deer during selected periods of the spring-summer-fall season, an attempt was made to document shifts in range utilization and activity and relate these changes to habitat conditions associated with timber harvesting.
Procedures:

Methods: Eight deer were outfitted with radio transmitter collars in the spring of 1976 in related jobs. Six deer were adult females, one was an adult male and one was a yearling male. The "Deer Trapping, Marking, and Telemetry Techniques" manual, prepared in conjunction with P.R. Project W-105-R Jobs VI-1 and 2, provides further information on trapping, handling and radio telemetry techniques employed in the sequence of jobs.

The overall location and configuration of the summer and winter ranges of these subjects had been documented by the related Jobs. In order to determine to what extent the location and configuration of their overall spring-summer-fall ranges might have been influenced by past timber harvesting and presumed changes in forage use, these deer were intensively monitored during three separate periods within the spring-summer-fall season.

At least four of these deer were followed by means of radio telemetry techniques during one or more of the following sessions: May 23-27, 1977; August 8-12, 1977; and October 18-21, 1977. Unfortunately, none of these animals could be monitored during all three of the sessions. The time periods are known to be well within the limits of the summer season and precede the initiation of range expansion apparently associated with fall breeding activity (Huntington Forest, unpublished data).

During each tracking session, each subject was located by means of triangulation at approximately 30 minute intervals during four periods, twelve hours in length. Two periods from midnight until noon and two from noon to midnight were conducted in each session.

During the May tracking session, all locations were triangulated from two fixed tracking stations. In August and October, however, animal locations were determined by triangulation using one fixed station and one mobile tracking unit. Transmitters failed on two deer monitored in May, necessitating monitoring different animals in August and October. The new subjects could not be located from the two fixed stations used originally.

The distance between the tracking station or mobile unit and the deer, with few exceptions, did not exceed two kilometers and most commonly, the distance was less than one kilometer. All deer locations were plotted immediately on a base map showing forest type classification, management unit and stand number. The coordinates of each location were read on the basis of the Universal Transverse Mercator Grid System and recorded with other data collected. Two-way radio communication between tracking stations permitted nearly simultaneous triangulation. For each successful triangulation: deer number, date, time (EST), method of encounter, direction to deer from each tracking station, activity status, management unit, forest type classification and stand number were recorded.

Activity status was an appraisal of whether or not the deer was active or inactive. The determination was based upon the strength and variability of the transmitted signal. The technique involves a subjective judgment by the researcher and may be subject to criticism. However, all personnel involved in this study had been monitoring deer using this same equipment for a least five years and had had the opportunity to observe penned and free ranging transmittered animals while monitoring telemetry signals received from those deer. Staff experience and the option to classify the activity status as unknown produced a high degree of confidence in the simple activity classification.
Management unit, forest type classification and stand number were defined as follows:

1.) Management Units - There were 14 management units within the study area. Their distribution is shown in Figure 2. These units varied in size from 20 hectares to over 400 hectares. Logged units were distinct areas harvested under a similar cutting plan during a one or two year period. The uncut areas in and around the cut units were also assigned a management unit number for purposes of identification.

2.) Forest Type Classification - In all, 21 different forest type classifications were used as shown in Figure 3. Areas in a single forest type ranged in size from 20 to 485 hectares. Classification was done using aerial photo interpretation. Three criteria were used to classify units with similar vegetative characteristics as follows:

(A) Height of trees
   (1) Less than 15 meters in height
   (2) 15 meters or greater in height

(B) Proportion of hardwood and softwood species
   (1) Softwood - more than 85% conifers
   (2) Softwood-hardwood - 61 to 84% conifers
   (3) Mixedwood - more than 40% hardwood or softwood but less than 60% hardwood or softwood
   (4) Hardwood-softwood - 61 to 84% hardwoods
   (5) Hardwood - more than 85% hardwoods

(C) Logging History
   (1) Cut stands - at least 50% or more of the basal area per hectare removed through cutting during the past 25 years.
   (2) Uncut stands - no cutting or less than 50% removal of basal area per hectare in the past 25 years.

3.) Stand Number - A Huntington Forest stand inventory number. These stands range in size from 1/2 to 80 hectares. Each stand had been inventoried through a system of point samples. Data were available to document total stand basal area, basal area by species by size class (large sawtimber, small sawtimber and pole-timber), percent stocking of saplings by species, density of high ground cover (0.6 - 2.4 m) and low ground cover (0 - 0.6 m) and a ranking of species abundance in these two ground cover classes. Together this information results in a quantitative or qualitative description of all major vegetation components in the stand.

All data were coded for computer storage, retrieval and manipulation. An I.B.M., Model 1130 computer and a CalComp, Model 563 plotter were used in the data summary process. Data analysis was restricted to basic graphic and statistical procedures. An alpha level of 0.05 was used in all statistical tests of significance.

Deer range size and shape was determined by drawing a line around the plotted distribution of point locations producing an "ameboid" shape. The area of the ranges was determined using a compensating polar planimeter. The "ameboid" shape drawn around the distribution of point locations seemed to be the "best" subjective representation of the actual area used by the study animals.
Study Area Description:

The study area was located within a 6070 hectare property known as The Archer and Anna Huntington Wildlife Forest Station (Newcomb Campus of the State University of New York College of Environmental Science and Forestry). This property is located near the geographic center of New York's Adirondack Mountains.

The flora and fauna of the area are typical of the Adirondack region and the transition zone between the Deciduous and the Taiga or Coniferous Biomes (Dice, 1952; Allee et al., 1949).

Although portions of the region were farmed until the early 1900's, at present the area is essentially completely forested. The limited amount of open land is primarily associated with scattered centers of human habitation and the activities of beaver, Castor canadensis.

The topography of the study area can be characterized as mountainous, with elevations ranging from 470 meters in valley areas to over 820 meters for some of the higher peaks. Mount Marcy, the highest point in New York State lies only 27 kilometers east of the northeast corner of the study area.

Soils on the study area are predominately glacial tills. They have been formed from fine grained metamorphic and igneous rocks. The profile found beneath softwood and mixedwood stands are those of mature podzol soils. The profiles associated with hardwood stands represent the Brown Podzolic Soils. Humus layers vary beneath the different forest types; there being a greasy mor under spruce-fir stands, a granular mor under mixedwood stands, and a fine mull associated with hardwood stands. A recent (1973) soil survey conducted by the Soil Conservation Service on the Huntington Wildlife Forest described four predominate soil series; Becket, Peru, Canaan and Cathro. Becket soils are found on midslopes and are associated with hardwood stands. Peru soils are associated with drainages and lake shores and generally support softwood or mixedwood stands. Canaan soils are located on steep slopes at the higher elevations. Canaan soils are shallow usually less than 76 cm to bedrock and support softwood forest stands. Cathro soils are muck soils high in organic matter and usually very wet. They are located in small basins which were formerly lakes or ponds.

Climate: As a result of the northern latitude and elevations, growing seasons are short, typically 90-120 days (Smith, 1955). Winters are cold and long with an average snowfall of 286 cm. The average number of days with snow on the ground is 134 days. The mean monthly temperature for January is -8.1°C and for July, 18.6°C. The combination of snowfall and cold temperatures generally results in a snowpack of 35 to 130 cm from mid-January through the end of March. (These data were recorded at the Huntington Wildlife Forest at National Weather Service Cooperative Weather Station, Newcomb 4WNW, and represent averages for the 26 year period 1950-1976).

At snow depths of 38 cm or greater, deer move to winter concentration areas. As the snowpack falls below this level in spring, deer begin to move from winter range toward spring-summer-fall range. The number of days deer are confined on winter range varies considerably from one year to the next. However, snow depth records collected during the period 1962-1977 suggest confinement periods ranging from a minimum of 50 days in 1967 to a maximum of 131 days in 1970-71 with a mean of 84 days. The survival of white-tailed deer in winter is believed to be highly correlated with the length of confinement to winter range (Mattfeld et al. 1975).
Vegetation: Most of the area was logged in the late 1800's for white pine, Pinus strobus, red spruce, Picea rubens and hemlock, Tsuga canadensis. Current logging operations have been concentrated on hardwood species including sugar maple, Acer saccharum, yellow birch, Betula alleghaniensis, beech, Fagus grandifolia, red maple, Acer rubrum, white ash, Fraxinus americana, and black cherry, Prunus serotina. Primary products from these species include sawtimber, veneer and pulpwood. Commercially important softwood species include white pine, hemlock, red spruce, and balsam fir, Abies balsamea, used for both sawtimber and pulpwood products.

The forest types of the area are complex. They include northern hardwoods (beech-brich-maple, type 25), coniferous types (red spruce-balsam fir, type 33) and mixedwood types (type 24 and 30) (SAF, 1964). However, individual stands may vary from nearly pure sugar maple to nearly pure red spruce. Less common merchantable species include paper birch, Betula papyrifera, aspen, Populus spp. and northern white cedar, Thuja occidentalis. Noncommercial tree species such as pin cherry, Prunus pensylvanica, mountain ash, Sorbus americana, hop hornbeam, Ostrya virginiana and striped maple, Acer pensylvanicum are common.

Although Adirondack forests have often been characterized as a spruce-fir or coniferous biome island, northern hardwood forest types predominate in the study area. Stands on the Huntington Forest have been classified as 50 percent northern hardwood stands, 30 percent mixedwood stands and 20 percent softwood stands. Timber volumes for the same area are estimated as 70 percent hardwood and 30 percent softwood.

The forests of the specific study area can be characterized as Behrend (1966) described for the entire Huntington Forest.

Upper elevations - largely coniferous; mostly red spruce
Middle elevations - mostly hardwood; beech and sugar maple predominately, with some yellow birch and conifers.
Lower slopes and drier bottoms - predominately mixed-growth; with hemlock, red spruce and yellow birch comprising the bulk of the stands.
Bottoms, swamps, lakeshores - mostly coniferous; varying with site from spruce-fir to white cedar.

Deer Densities: As evidenced by hemlock age composition (Behrend et al., 1970), deer populations on the area increased sharply approximately 70 years ago after widespread softwood logging operations and fire. Since then, the author suggests that population densities have fluctuated between two and twelve deer/km², depending on the intensity of logging, severity of winters and access for hunting. In a previous study, the deer population on a 20 km² portion of the study area was reduced from an estimated density of 10 to 5 deer/km². (Behrend et al. 1970). These estimates were based on deer drives, track counts and roadside observations. During recent years, these same indices closely parallel annual regional buck harvests. Severe winters during 1969, 1970 and 1971 reduced deer densities throughout the region. Based on observation records and harvest data, the author estimates that during the 14 year period (1962-1976) preceding this study, deer densities have ranged from 3 to 10 deer/km². The population density was estimated to be approximately 4-5 deer/km² during the year (1977) of this study.

The limits of the specific study area were defined by the location and configuration of the overall summer range of the eight individual deer monitored. An area of approximately 1,500 hectares located in the northeast corner of the Huntington Forest includes these eight summer deer ranges (Figures la and lb).
Figure 1a. Location and Configuration of the Overall Summer Ranges of Four Deer. Determined by Periodic Telemetry; Newcomb, NY 1977.
Figure 1b. Location of and Configuration of the Overall Summer Ranges of Four Deer. Determined by Periodic Telemetry; Newcomb, NY 1977.
The description of the entire Huntington Forest area applies to the portion of the property involved in this study. Figures 2 and 3 present in detail the distribution of management units and forest type classifications referred to in methods.

The following definitions are important to the discussion:

1.) There were three sessions during which deer were monitored; May, August, and October. Each session was comprised of four, 12-hour, tracking periods.

2.) A period range represents all the locations of an individual deer determined during any one of the four, 12-hour periods within a session.

3.) A composite or session range represents all the locations for an individual animal determined during an entire session (four, 12-hour periods combined).

Findings:

Range size. No shifts in habitat use were expressed as changes in range size. The size of the range delineated for each deer during each 12-hour tracking period was compared to range size exhibited by that same deer in other periods of the session as well as other deer monitored during the same session. There were no statistical differences in the size of any one deer's 12-hour range when compared to any other 12-hour period range for that same deer. No differences were found when any one deer's range size was compared to any other deer's 12-hour period range size for any of the three tracking sessions.

The mean size of the forty nine, 12-hour, period ranges documented for all deer, during all sessions, was 33 hectares. The smallest was 10 hectares and the largest was 69 hectares. There were no significant differences between the ranges of the two male deer monitored during this study and those of the six female deer. The mean size of all the 12-hour period ranges determined in October was significantly smaller than the corresponding means for August and May. As illustrated in Figure 4, no difference in mean period range between the May and August sessions was detected.

Based upon visual inspection of the plotted points and the "drawn" range, no important difference could be detected in the location or configuration of the 12-hour period ranges for any one deer. A statistical test using the mean distance from each point location to the calculated geometric center of the range (plus or minus two standard errors) was also not significant. It was unlikely, however, that this technique would identify the subtle shifts in range which occurred in this study. The locations from all four periods for each deer during each tracking session were grouped together to form composite ranges for the May, August or October session. Examples of how the four period ranges relate to one another and form the composite range for an individual deer for a particular session are shown in Figure 5.

The mean size of the fourteen session ranges observed was 85 hectares. The smallest composite range was 45 hectares and the largest was 161 hectares. An analysis of these composite ranges revealed no difference in size of any single deer's composite range when compared to the composite range of other deer monitored during that same session. No difference in range size was detected when any
Figure 2. Distribution of Forest Management Units Within the Archer and Anna Huntington Wildlife Forest Station Portion of the Study Area.
Figure 3. Distribution of Forest Types Classified Within the Archer and Anna Huntington Wildlife Forest Station Portion of the Study Area.
Figure 4. A comparison of mean smooth polygon deer range size for 12-hour periods, by month. From telemetry locations; Newcomb, NY 1977.

Composite Session Range Sizes

12-Hour Period Range Sizes

= Mean ± 2 SE
( ) = n

Range Size (Hectares)

May    August    October

Session

(16)    (16)    (16)
Figure 5. An example of the development of session composite deer ranges from four individual 12-hour telemetry observation periods on four deer. Newcomb, NY 1977.
composite range for a deer in a single session was compared to the composite range of the same deer in any other tracking session.

The mean size for all composite ranges were compared between May, August and October. As shown in Figure 4, no significant differences were found.

Range Location and Configuration. The location and configuration of composite ranges for individual deer were compared between sessions. Differences were not indicated by the statistical procedures used to describe a variation about a geometric center (bivariate mean). However, visual inspection indicated a recognizable shift in range location between May, August or October for all eight deer involved in the study. Examples of the relationship between the locations of composite ranges for several of the deer studied are presented in Figures 6a and 6b. Additional support for the validity of the observed shifts in range was found in a comparison of the amount of overlap which existed between 12-hour period ranges as opposed to overlap between session composite ranges. Overlap between 12-hour period ranges within sessions averaged 68 percent and ranged from 26 to 100 percent. In contrast, overlap between composite session ranges (May, August, or October) averaged only 24 percent and ranged from 0 to 48 percent.

Further support for the differences in location of composite session ranges is seen in the significant differences in the vegetative characteristics of the habitat in which these ranges were located. These differences will be discussed later in this report under a separate section.

The differences in the location and configuration of an individual deer's May, August or October range, were relatively small when compared to the separation of summer and winter range of deer in this region which often exceeds 4-5 kilometers (Mattfeld et al. 1975). The distance between the geometric center of any individual deer's May, August or October composite range did not exceed 1 kilometer. The mean distance for all deer session combinations was 439 meters.

Each of the composite ranges of an individual deer were compared to the overall spring-summer-fall range for that deer (determined previously under Job VI, 1 and 2, P.R. Project W-105-R). Composite ranges for each session generally fell within the overall range previously described by intermittent telemetry and observation. Seventy-four to 96 percent (mean 89 percent) of the composite range areas were within the bounds of the overall range described for respective deer. The total area encompassed by the combined session ranges determined in this study for each deer with two sessions of data was compared to the size of the overall range previously delineated for the deer. Differences were apparent. The mean size of the overall summer range of the eight deer involved in this study was 324 hectares. The smallest was 129 hectares and the largest 683 hectares. Depending on the individual deer, the combined session ranges included from 30 to 92 percent of the total area of the overall range, with a mean of 51 percent for all deer. As shown in Figures 6a and 6b, single session composite ranges only included from 15 to 77 percent of the overall range area, with a mean of 34 percent.

In summary, the following relationships regarding ranging behavior within the spring-summer-fall season have been documented in this study:

1.) The size of the average 12-hour period ranges of the deer monitored in October are significantly smaller than those of the deer monitored in May or August.
Figure No. 6a. A comparison of the overall spring-summer-fall range of an individual deer (from periodic telemetry locations) and the composite session ranges defined for the same deer (from 3 sets of four 12-hour telemetry periods). Newcomb, NY 1976 and 1977.

Legend

- Overall Range
- Session 2 - August Range
- Session 3 - October Range

Scale: 4.2 cm = 1 kilometer
Figure No. 6b. A comparison of the overall spring-summer-fall range of an individual deer (from periodic telemetry locations) and the composite session ranges defined for the same deer (from 3 sets of four 12-hour telemetry periods). Newcomb, NY 1976 and 1977.

Legend
- Overall Range
- Session 1 - May Range
- Session 2 - August Range
- Lake

Scale 4.2 cm = 1 kilometer
2.) There appears to be no difference in the location or configuration of the 12-hour period ranges for any single deer within any one tracking session.

3.) There appears to be a minor shift in location between an individual deer's composite session ranges. This was observed for all eight deer monitored.

4.) The location and configuration of the session composite ranges of an individual deer are enclosed by the overall range previously defined for that deer to a very large extent.

5.) The combined area of the composite session ranges for any individual deer represents only a portion (51 percent mean for all deer) of the overall range for the deer.

Habitat Characteristics. After documenting shifts in the location of an individual deer's range between tracking sessions, selected habitat characteristics associated with the forest stands within each session range were analyzed. These analyses included management unit, forest type, presence or absence of prior logging activity, distribution of size classes of trees, basal area, and high and low ground cover abundance.

Significant changes in use of management units were documented for only two of the eight deer studied. Deer #59 showed a significant increase in the use of uncut oldgrowth stands (state land - Santanoni Preserve) and a corresponding reduction in use of heavily logged (60% removal of overstory) hardwood stands between the May and August tracking sessions. Deer #407 significantly increased use of heavily cut stands (70% removal of overstory) during October as compared to May at which time this animal used moderately logged (40-50% overstory removed), and uncut areas nearly equally. Three deer appeared to shift their habitat use similar to deer #407 (increased use of logged stands in August and/or October). However, the differences were not statistically significant.

It is quite probable that the large size of the management units (averaging over 200 hectares in size) was such that the subtle shifts in range locations documented for individual animals within the summer season would not be reflected by changes in management units. In total, management units which were classed as logged (light to heavy) were associated with 58% of the deer locations collected in all tracking sessions and uncut units accounted for 42 percent.

Changes in deer use of various forest types were documented for several of the study animals between tracking sessions. However, these changes were not statistically significant. However, when the data for all deer in any one session were pooled, several significant relationships were defined.

Deer use of hardwood forest types did not change between the May, August, and October sessions. The amount of use expressed as a percent of the total number of locations was 62 percent in May, 66 percent in August and 58 percent in October with a mean for all sessions of 62 percent. However, a significant decrease in use of mixed forest types between May and August and August and October was documented. A corresponding significant increase in use of softwood types during these same periods was also observed. A significant increase in the number of locations in logged stands was noted between the May and October tracking sessions. There was no significant difference in the use of logged stands when May-August or August-October data were compared.
This same relationship was documented using the basal area of the stands in which the deer locations occurred as a means of comparison. The mean basal area of stands used by deer in May (weighted by number of locations) was 16.3 square meters/hectare; in August 15.4 square meters/hectare and in October 13.5 square meters/hectare. Again, only the difference between May and October was significant.

A comparison of the distribution of tree size classes of the forest stands used by deer during the different tracking sessions revealed no significant relationships. No relationship between high and low ground cover abundance could be discerned in the analyses of these data. However, it is quite probable that the inventory data used in these analyses no longer reflected the conditions on the ground to which the deer may have been responding. It is known that dramatic changes have occurred in the ground cover vegetation as a result of recent logging activity. These changes have not been incorporated in the inventory data.

Activity. Deer activity, as interpreted from the radio transmitter signal strength and variability, was evaluated in relation to deer locations by management unit, forest type, time of day, and duration of activity. The following relationships were documented in these analyses.

Management Unit and Forest Type: There were no significant differences between those locations classified as active and those classified as inactive when compared on the basis of management unit or forest type in any of the tracking sessions for any of the deer studied.

Season: No significant differences in overall (all hours of the day taken together) levels of activity (as expressed by percent of total locations classed as active) were detected for any individual deer, or for all deer as a group, between tracking sessions. The mean percent of telemetry classed as active locations was 69 percent over all three tracking sessions. Activity appeared highest during the May tracking session (77 percent) but this figure was not statistically significant when compared with the August (64 percent) and October (65 percent) figures. The range in percent of active location for a single deer varied from a low of 53 percent to a high of 89 percent during any single tracking session. Overall activity levels for any individual deer, when compared on the basis of the four 12-hour periods within any of the three tracking sessions, varied over a similar range (44 to 91 percent active locations).

Daylight: When activity levels were compared on the basis of daylight hours alone for the three tracking sessions, a significant difference was detected between May and October with August levels intermediate (not significant) between these two periods. The mean daylight hours activity level for May was 46 percent, August-59 percent, and October-70 percent. As might be expected, May darkness hours activity levels were significantly higher (mean of 73 percent) than the August (48 percent) and October (49 percent) levels (Figure 7).

Duration: The duration of activity periods appeared to follow a bimodal distribution. This same relationship was documented by Lamoy (R.E. Lamoy, unpublished data Huntington Forest). Analyses of the distribution of lengths of activity periods showed a high number of short activity periods (less than 30 minutes duration) averaging 12 minutes in length and a large number of longer activity periods (greater than 30 minutes duration) averaging 127 minutes in length. Inactive periods followed a similar trend with short periods averaging 11 minutes and long periods averaging 90 minutes in duration.
Figure 7. - A comparison of deer activity levels during daylight and darkness hours in three intensive telemetry tracking sessions. Newcomb, NY 1977.

\[ \overline{x} = \text{Mean} \pm 2 \text{ standard errors} \]

\( (\_\_\_) = n \)
It should be noted that although these data follow a distribution similar to that described by Lamoy, the actual length of the short periods (both active and inactive) are questionable. This is due to the fact that all singly occurring active or non-active locations were assigned an assumed time period of 10 minutes duration.

Comparisons of the mean duration of both short and long activity periods for individual deer between tracking sessions revealed no significant differences. Also, no significant changes in duration of activity periods were detected when the data for all deer in any one session were pooled and compared to the pooled data from another session.

Daily Pattern: The time of day when activity occurred was compared between the May, August and October tracking sessions (Figures 8, 9 and 10). A chi-square test of independence supports the visual impression derived from examination of these figures which show that significant shifts in time of activity occurred between May and October. August appears to be a transition stage between these two periods; the data for August are not significantly different from that of May or October. In May, activity follows a typical crepuscular pattern. August data indicate the beginning of a breakdown in this pattern and by October despite the lack of data in the midnight through 5 a.m. period, it is clear that this pattern of activity has been replaced by consistently high activity levels during the daylight hours and reduced activity in evening and early morning.

When the data for all sessions, May, August and October are combined, the picture is one of relatively consistent activity levels throughout the 24 hours of the day (Figure 11). The finding is consistent with visual observations of white-tailed deer along forest roads during the summer months, gathered over a 16 year period in conjunction with another study (P-R Project W-105-R, Jobs VIII 1 and 2). In that study, there were no significant differences in the total number of deer observed by one hour periods, during the hours between 7:00 a.m. and 4:00 p.m. (EST) over the entire summer period.

Analysis:

The documentation of the subtle shifts in the location of an individual deer's range between tracking sessions represents the most significant contribution from this study. It strongly suggests that the overall summer range of an individual deer may be the result of the sum of several smaller distinct ranges. Although this study fell short of explaining the factors responsible for these shifts, some evidence in support of the theory of availability of certain forms of vegetation was collected.

It has long been hypothesized by Huntington Forest forestry personnel and supported by other research efforts (Wiersma, 1968) undertaken at the Forest, that the impact of deer on woody vegetation, particularly tree reproduction, occurred primarily in late summer and fall. The significant increase in use of logged hardwood stands between May and October, with August data intermediate between these periods, supports this theory. It is known that this logging has successfully established a varied species composition of commercially important tree species at densities (3 to 15 ft. in height) in excess of 30,000 stems per acre throughout most of these management units. This same logging has produced an increased abundance and diversity of herbaceous and shrub species as well. Both types of vegetative response constitute an enhanced forage base. Deer utilization (as evidenced by percent of total locations) averaged 58 percent over all tracking sessions in logged management units. These stands are probably providing a significant portion of the requirements of the animals studied. It is also of interest
Figure 8. An hourly summary of the percent of telemetry locations indicating an active deer for the intensive tracking session in May. Newcomb, NY 1977.

Time of Day (one hour periods)
Figure a. An hourly summary of the percent of telemetry locations indicating an active deer for the intensive tracking session in August. Newcomb, NY 1977.
Figure 10. An hourly summary of the percent of telemetry locations indicating an active deer for the intensive tracking session in October.
Newcomb, NY 1977.
Figure 11. An hourly summary of the percent of telemetry locations indicating deer activity for the 3 intensive telemetry sessions, combined; May, August, October. Newcomb, NY 1977.
that these logged stands appeared to be used both during active and inactive periods throughout all three tracking sessions. This would suggest that logged areas, even heavily logged stands with as much as 70 percent of the overstory trees removed, continued to provide adequate resting as well as feeding habitat during the summer season.

Logging, per se, does not necessarily guarantee deer use of an area. Units within the study area which were logged removing less than 30 percent of the total basal area of the overstory trees accounted for less than one percent of the deer locations determined in this study. There was virtually no response in the establishment and growth of desirable vegetation following such light cutting in these management units.

In spite of the apparent importance of logged areas, 42 percent of the locations of the deer monitored in this study occurred in uncut management units. All deer used at least two management units with four being the most common number of units used. One deer used five different management units. All deer used at least one logged unit and one uncut unit. Thus, it would appear that the total summer requirements of the deer studied were met through the use of some combination of logged and unlogged stands.

The documentation of subtle shifts in the location of "sub-ranges" within the overall spring-summer-fall range of an individual deer has important implications for interpreting past (and planning future) radio-telemetry studies. It appears that, if only the general location of the summer range of a deer is needed, a relatively brief (24 hour) continuous monitoring session would be sufficient to identify this area. However, if a more complete description of the full extent of the summer range of an individual is required, it is quite probable that the most economical means of gathering this information would be to conduct several (perhaps one a month) 24 hour long tracking sessions distributed throughout the entire spring-summer-fall season.

The presence of "sub-ranges" within the overall summer season range would explain some of the discrepancies between the sizes of home ranges of white-tailed deer reported by different researchers. Several studies have monitored only a few deer under a very intensive, if not continuous, monitoring set up. Usually these studies follow the animals for only a relatively short period of time (generally less than 10 weeks). It is likely, based on the information gathered in this study, that the size of the deer ranges determined using this approach would be smaller than if the deer were monitored periodically or continuously throughout the entire spring-summer-fall season. Several of these short term studies have been directed at identifying habitat use, activity patterns, and feeding behavior. It should be recognized that this information may only be representative for a portion of the overall summer season.

The documented significant shifts in time of activity between tracking sessions are most probably related to factors other than logging. No differences within session activity were apparent for deer while using logged areas versus unlogged areas.

The consistent high use of the northern hardwood forest type by all deer involved in this study during all sessions of the spring-summer-fall season, further emphasizes the importance of this forest type to deer in the region during a substantial portion of the year. Because they have another seasonal preference, this is not proof of welfare dependence. It is the author's opinion that the
contribution of the spring-summer-fall range to overall survival and health of deer in the Adirondack region is equal in importance to that of the winter range. Further, a managed northern hardwood forest may provide an enhanced spring-summer-fall range complex for deer.

Recommendations:

The relationships of timber harvesting to deer ranging and behavior have only been touched upon in this study. The results indicate that timber harvesting as practiced on the study area results in increased diversity and abundance of plants in a zone available to deer. These logged areas appear to provide both suitable feeding and cover habitat for deer during the spring-summer-fall season. However, a longer term study involving more animals, including deer whose summer range lies entirely outside of logged areas, should be undertaken. Hopefully, it will define further the relationships between timber harvesting, summer deer range, and deer survival capacity/density limits in the northern climate zones.

As stated previously, certain findings resulting from this study have direct application to the interpretation of deer ranging information gathered by means of radio-telemetry and planning future telemetry studies.

The data gathered concerning summer deer activity was secondary to the main objective of this study. However, the significant shifts in time of activity during the summer season which were observed, are important to recognize and should definitely be considered by other researchers interested in seasonal deer activity patterns. This information could be very useful in gaining a better understanding of the recreational opportunities associated with white-tailed deer, such as viewing, photography and hunting.

The information gathered in this study on summer season ranging of white-tailed deer had direct implications to the work done under P-R Project W-105-R, Jobs VI-1 and 2 and were incorporated in associated manuscripts for publication.