TELEMETRY STUDIES OF DEER MOVEMENTS AND HABITAT UTILIZATION AT ACADIA NATIONAL PARK

BY Thomas J. Allen

An abstract of the Thesis Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science (in Wildlife Management). June, 1970.

Deer movements and habitat utilization were studied by telemetry at Acadia National Park, Mount Desert Island, Maine, from September, 1967 to June, 1970. The objectives of the project were to examine the home ranges of deer with emphasis on daily movement patterns and habitat utilization.

A total of 8 deer were radio-equipped during the winters 1967-68 and 1968-69. Of these animals, 4 were monitored for periods exceeding 6 months. Home ranges were oblong in shape and averaged 556 acres. Winter ranges averaged 171 acres, while the summer ranges averaged 310 acres. Mixed softwood stands of spruce and cedar were the primary type utilized by deer in winter, while hardwoods and meadows were used extensively during the summer. Movements from summer to winter ranges varied from 0.4 to 1.7 miles. Use of habitat types was influenced by meteorological conditions especially during winter months. Deer movements were greatly restricted on cold, windy days, and sheltered habitats were selected on leeward mountain slopes.

Daily movement patterns varied from a minimum of 0.4

miles during the winter to a maximum of 1.5 miles in the summer.

A browse survey of a heavily used wintering area along West Sargent Mountain indicated little available browse for deer resulting from continual overusage. The most abundant species present was balsam fir, a non-preferred food, composing 84.4 percent of the total. Blueberry, and sweetfern comprised 10.4 percent of the remaining species. Sweetfern showed the highest utilization followed by blueberry and balsam fir.

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INTRODUCTION

Deer, a major herbivore, have a profound influence on the composition and structure of vegetation. High populations of deer in Acadia National Park, Mount Desert Island, Maine, following the 1947 fire, have greatly influenced the structure of vegetation, especially in wintering areas. Heavy browsing has caused the deterioration of much habitat. As a result Park personnel initiated an annual herd control program in 1960 in an attempt to curtail the further destruction of winter habitat. The Park philosophy, as stated in their 1969 resource management plan, is to maintain a balance of forces in the natural environment through research findings and management.

The purpose of this project was to investigate the movement and behavior of white-tailed deer at Acadia Park. The need for studying deer movements at Acadia Park as a basis for regulation of future herd control programs was evident. Prior studies of deer on the Park had shown that many wintering areas were depleted of preferred food supplies through overuse by wintering populations. Deer were harvested from these areas with little background knowledge of home ranges, movements to and from winter yards, deer behavior, or degree of habitat destruction.

Recently the development of radio telemetric techniques has made it possible to obtain considerable

movement information about wild vertebrates. This technique was employed from September, 1967 to June, 1969, to study the shape, size and stability of deer home ranges during different seasons, and to determine the daily movement and habitat utilization patterns of deer. The study also included a winter browse survey of a heavily used wintering area to ascertain the amount of available food and its utilization.

REVIEW OF THE LITERATURE

Deer Movements of Marked Individuals

A considerable amount of research on white-tailed deer[1] has dealt with seasonal and annual movements. Until recently many investigators have relied upon direct observation of marked animals or hunter recovery for their movement information. Pioneer movement studies of a general nature were conducted by Newson (1926) who found that deer in the northeast were not inclined to roam except during the rutting season. Townsend and Smith (1933) found that deer in New York were inclined to stay in localized areas for several weeks before shifting to other nearby habitats. Seton (1937) stated that the home range of a white-tailed deer is probably smaller than that of any other cervid in America. Schoonmaker (1938) observed deer in the Hudson Valley region of New York and concluded that their home range was small and under normal conditions did not exceed one-half mile square. He concluded that males tended to travel beyond the limits of their normal home range during the rutting season.

Observations of 24 marked deer in the Adirondacks of New York indicated that some individuals wintered in restricted portions of their summer-fall range, while

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[1] Scientific names of plants and animals are presented in Appendix I.

others moved to areas distinct from the fall range (Behrend, 1966). Annual home range estimates of 4 deer varied from 445 to 595 acres, and summer-fall home range estimates of 11 deer varied from 105 to 595 acres.

From 1961 to 1969, 2,025 deer were tagged during the winter months in New York. Hunters recovered approximately 600 of these through the spring of 1969. Movements ranged from a few to more than 50 miles for different individuals. Many animals traveled long distances between their wintering areas and summer range. Yearling males were found to move the greatest distances. Approximately 100 deer were recovered in the same wintering area in subsequent years, indicating a homing tendency to return to the original yard (Hesselton, 1970). Additional movement studies of tagged deer in the Adirondack Mountains of New York indicated the majority of deer tagged remained in the vicinity of the tagging site (Wiley, 1969). Restrictions in deer activity were noted in this area by Dickinson (1969) due to winter weather conditions and snow depths.

Bartlett (1938) found that tagged deer in Michigan usually returned to the same swamp each winter regardless of the scarcity of available food. The average distance traveled from the tagging site to where the animal was shot was 6 to 9 miles. Bartlett (1950) also conducted deer movement studies in Michigan by means of hunter returns of marked animals.

Olson (1938) studied seasonal movements of deer in Minnesota by trapping and tagging animals. Male deer were recovered by hunters several miles further from the winter yard than were females. Most of the females were recovered within 1 mile of the yard location. There also appeared to be a strong tendency for both sexes to return to the same winter yard in successive years.

Hunt and Mangus (1954) also studied winter range utilization by deer in Minnesota. Tagging programs and related observations provided information on movement patterns during winter periods and spring dispersal. Records showed that 10 of the 34 tagged deer were recovered from 0.5 to 45 miles from the capture site while the remaining animals were either recaptured or observed near the trapping site.

A total of 781 deer were tagged in the northern coniferous forest of Minnesota between 1935 and 1942. Eighty-one percent of the 63 tagged deer recovered by hunters were within 7.5 miles of the tagging site. Males moved an average distance of 6.7 miles while females moved 3.7 miles. A study of the movements of 57 tagged deer in the prairie-deciduous region of Minnesota based on hunter returns showed an average movement of 9.7 miles. Males moved an average of 14 miles while females averaged only 6.8 miles (Carlsen and Farmes, 1957). In the deciduous-coniferous region of Minnesota, 104 marked deer recovered by hunters showed movements averaging 9.9 miles

from the trapping site (Moyle, 1965). Deer of both sexes were recovered at maximum distances varying from 20 to 85 miles from the tagging location. These data indicated that deer in the prairie-deciduous forest type were wider ranging than deer in the coniferous forest type. Some of these studies indicated large movements of deer from winter to fall habitat which may be due to distribution of habitat types, population densities, or a tendency to wander especially noted in young males.

Hamerstrom and Blake (1939) studied deer movement patterns in winter yards and spring dispersal in central Wisconsin. Movements from the yards showed a gradual expansion and contraction rather than continual progression in a single direction. During an unusually mild winter in Michigan, Bartlett and Wakemann (1929) noted movements to and from deer yards.

Progulske and Baskett (1958) studied deer movements in Missouri based upon observations of marked animals during all seasons. Average maximum distance moved by 17 male deer was 1.9 miles while the average distance for females was 1.4 miles. The average annual minimum home range was 400 acres for females and fawns and 940 acres for males.

In studies of deer movements in Texas (Thomas et al., 1964) only 3 of the 186 tagged deer recovered were from distances greater than 1.5 miles from the capture site. Again males showed a slightly greater mobility than females. Similar results were found by Michael (1965)

on the Welder Wildlife Refuge, in south Texas. In this study calculated areas utilized by deer varied from 60 to 340 acres for females and from 240 to 880 acres for males. Sixty-two white-tailed deer were trapped and tagged in south Texas between 1962 and 1967 by Ellisor (1969). Movements of 41 marked animals showed an average maximum distance of 1.4 miles. Of the 174 observations made, only 9 movements exceeded 2 miles. Recoveries by hunters or recaptures of 43 tagged deer in northeast Texas between 1957 and 1962 indicated average movements of 1.2 miles for females and 1.3 miles for males from the initial capture point (Alexander, 1968).

Additional deer movement studies involving direct observation or hunter returns of marked animals were conducted by Hahn (1945) and Hahn and Taylor (1950) in Texas, and Welch in Arizona (1960).

The above studies have consistently shown that most white-tailed deer occupy home ranges between 100 and 1,000 acres, many of which are elongated in shape. The home range of males have been larger than that of females and fawns. Seasonal differences in habitat use especially from summer to winter, were very pronounced. The winter home range was considerably less than the summer range. Although much variation exists in distances traveled by deer from capture locations, young males were found to travel the furthest. Habitat composition may account for many of the differences in movements in the various forest

formations, since deer in warmer climates seem to have smaller ranges than those in northern zones.

Daily Movement Patterns

Daily movement patterns of deer can be related to habitat composition, weather patterns, and seasons of the year.

Behrend (1966) found that daily summer activity of deer in the Adirondacks of New York was significantly correlated with hours of daylight. Some marked individuals appeared quite sedentary while others moved 1 to 2 miles in less than 24 hours.

Montgomery (1963) studied nocturnal movements and activity patterns of deer in hardwood areas of Pennsylvania by observing marked individuals. He found that deer used wooded areas during day and moved into the fields to feed about sunset. In the summer they were commonly found in fields at night, feeding and bedding; while in winter, they spent only a few hours in the fields before returning to wooded areas. In both seasons deer showed activity peaks during the hours of sunset and sunrise.

Studies in Minnesota showed deer activity peaks beginning just before sunrise and lasting for 2 to 3 hours. During the remainder of the day deer were inactive. Another activity peak was found to begin prior to sunset and extend to nearly midnight, at which time deer bedded. Daily activity varied with habitat. Movements were

confined to 40 acres where food and cover were abundant (Moyle, 1965).

Ruff (1938) and Schilling (1938) found that deer in North Carolina were active from late afternoon until almost midnight. This pattern varied slightly from season to season with deer becoming active later in the day during summer. Observations indicated that there were inactive periods during the day and night.

Telemetered Deer Movements

Because of the secretive and wary nature of deer, improved methods were needed to obtain accurate information about movement and behavior patterns. The recent development of radio telemetry methods has enabled the researcher to obtain continual information about animal activity, not obtainable through direct observational techniques. This method involves fastening a small radio transmitter to the animal which can be monitored with a receiving unit several miles away.

Tester et al. (1964) described a telemetry system used to monitor released, penned deer. Later this system was used by Tester and Heezen (1965) to determine deer responses to a drive census in Minnesota. Heezen and Tester (1967) listed some of the parameters obtained by telemetry useful in studying deer movements. These included total area, greatest linear dimension, mean activity radius and distribution of activity radius, and

appearance of the map. Comparisons of daily home range sizes were made between 6 deer from winter to early spring. Winter daily ranges varied from 6 to 145 acres while spring ranges varied from 71 to 345 acres.

Tester and Siniff (1965) described the following influences on interpretation of deer movement and home range data obtained by telemetry: (1) the effect of sampling interval on distance traveled and area used, (2) the center of activity including activity radius and, (3) the distribution of telemetry fixes within a home range.

Moulton (1967) studied winter deer activity in east-central Minnesota by telemetry. A 10-day sample period was examined in December, January, and February. The 3 deer studied indicated total areas used were 676 and 1,900 acres by 2 adult males, and 416 acres by a fawn doe. Individualistic patterns of behavior were observed by Moulton even though the 3 deer occupied the same area. Changes in monthly winter weather conditions did not appreciably affect daily activity patterns. Movements, however, were restricted in February when snow was deep and crusted.

Radio transmitters were placed on 14 deer in east-central Minnesota over a period of 2 winters (Rongstad and Tester, 1969). Winter home ranges varied between 400 and 1,200 acres. Monthly home ranges from January through March ranged between 83 and 576 acres. Dispersal from winter to summer range occurred in spring with the dis-

appearance of snow and onset of warmer weather.

Balding (1967) studied the movements by telemetry of a captive adult female white-tail released in west-central Illinois for 10 months beginning in March, 1963. Early movements and behavior appeared related to previous confinement while later movements were more normal. Total minimum home range for the 10-month period was 600 acres. The home range was elongated in shape measuring 0.5 miles by 2.0 miles. Twenty-four hour movement patterns seldom covered a distance of more than one-half mile.

Cross (1968) observed deer movements by telemetry and habitat usage in Rhode Island. In this study 1 deer was monitored for a period exceeding 5 months. There was an increased usage of bogs and swamps, characterized by shrubs, by the deer during winter months. Fields and hardwood types received greater use during fall and spring. Hurley (1968) examined movements and spatial use of deer in Rhode Island. He found that the mean area used by an adult female over a 22-day period was 416 acres, and for a male fawn was 300 acres. The adult female utilized a total area of 1,091 acres throughout the 5-month period from December, 1966 to May, 1967.

Marchinton (1968) studied the movement and behavior patterns of 38 deer by telemetry over a 5-year period in Florida and Alabama. Nine deer were studied for periods up to 2 months. Movement data from these animals indicated elongated home ranges varying from 147 to 243

acres and averaging 211 acres.

Lewis (1968) studied daily movements of white-tailed deer in Louisiana by telemetry. Minimum home ranges of the 3 deer studied for nearly 1-month periods were 406, 555, and 762 acres. Activity peaks were noted around sunset and from sunrise to mid-morning.

Additional references to deer movements and behavior in the southeastern United States include Marchinton (1964) and Marchinton and Jeter (1966, 1967).

Habitat Evaluation

A great variety of vegetation survey techniques are described in the literature. Several techniques have both advantages and disadvantages in various stand types, densities and sizes. Only those methods relevant to this study will be considered in this review.

Sampling Techniques

The primary considerations in making vegetation surveys are plot size, shape, and sampling design. The density and distribution of the vegetation to be sampled influence the size, shape and number of sample plots required. Information on size and shape of sample plots can be found in the following literature: Gates (1949); Greig-Smith (1957); Phillips (1959); Freese (1962); and Spurr (1964). Areas with the least variation require the least number and smallest plot sizes. In general, most

investigators have found that various vegetative types can be best sampled by the use of rectangular plots (Hasel, 1938; Schumacher and Chapman, 1948; Johnson and Hixon, 1952; Bormann, 1953; Passmore and Hepburn, 1955; Holscher, 1958; Ursic and McClurkin, 1958; Larson, 1959; and Shafer, 1963). Oosting (1956) stated that statistical studies show rectangular plots to be a more efficient sampling unit than squares or circles.

Belt transects, or segmented belt transects, of varying widths and lengths have been used to study low herbaceous vegetation (Larson, 1959; Bramble and Ashley, 1955; Johnson, 1956; Shaw and Stiteler, 1962; Stiteler and Shaw, 1966).

An advantageous sampling method is one which can be conducted rapidly in the field with accurate results, thus allowing a large number of samples to be taken in a short period of time. A series of sampling methods based on plant to plant or point to plant distance measurements has been developed by Cottam and Curtis (1949, 1956) and Catana (1963). The random pairs method outlined by Cottam and Curtis (1949) can be used to determine density, frequency, and dominance of trees in a stand. However, since the method examines only two trees on each plot there is a tendency to bias the data as a result of small sample size (Shanks, 1954; Rice and Penfound, 1955). The quarter method makes use of four individual trees at each location point, which doubles the sample size.

Cottam and Curtis (1956) concluded that this method was the most efficient of the distance measuring methods around sample points.

Much of the literature describing density sampling of vegetation assumes that populations are distributed at random. There is considerable evidence however, indicating that many populations of natural vegetation occur in a nonrandom fashion (Kershaw, 1963; Greig-Smith et.al., 1963; Laessle, 1965). The problems involved in the application of density-sampling methods to shrubs, forbs, and grasses have resulted in many problems and inconsistent findings (Fracker and Brischle, 1944; Hutchings and Morris, 1959; Dix, 1961; and Lycock, 1965). Lyon (1968) compared several density sampling techniques on shrub communities of known density. His results showed that some methods would not produce accurate estimates with any size sample, or that sample sizes required were so unreasonably large as to be prohibitive. The precision derived from these samples for statistical tests may fail to detect density differences that are probably obvious on visual inspection. Therefore, Lyon (1968) suggested that estimation methods of vegetation density may be as good or better than many measurement techniques. Estimation methods of sampling vegetation can also be conducted rapidly, minimizing mechanical measurements.

Browse Measurements

Deer browsing of vegetation can be measured by a number of methods or their combination; several of which are reviewed by Shafer (1965). The twig-count method which correlates twig-counts with pounds of browse per acre was concluded to be as accurate as other methods, and required less time to measure the available browse. The twig-count method has been used by several investigators in deer browse surveys (Jordan et al., 1965; Stiteler and Shaw, 1966; Stickney, 1966; and McLaughlin, 1968).

DESCRIPTION OF STUDY AREA

Mount Desert Island, located in southern Hancock County, 70 miles southwest of Canada in the Gulf of Maine (44° 15' N latitude and 68° 15' W longitude), is 16 miles long and 12 miles wide, and encompasses approximately 70,000 acres. Acadia National Park, approximately 30,000 acres in size, covers most of the southern half of the island with the greatest portion east of Somes Sound.

Topography and Climatology

The following description of Mount Desert Island is taken from the Acadia Park Master Plan, (National Park Service, 1966).

The terrain varies from granite mountains, 1,200 feet in elevation, to moderately steep hills and flat bogs. The island contains many lakes and ponds formed by glacial erosion. Cliff-like slopes of the mountains form the southeast aspect, while the northern slopes are more smoothly rounded.

The soils of the island are of 2 origins, glacial deposits and sedimentary. Many of the mountain slopes lack any soil except in isolated pockets. Soils are of 3 main types; glacial till, sand, and silt or clay. (Chapman, 1962).

The climate of the island is usually mild due to the effects of the sea, however, occasionally it is interrupted

by severe storms. The mean temperature in July is 57° F, and in January 20° F. Precipitation averages 42 inches annually. Prevailing winds are from the southwest in the summer and northwest in the winter.

Vegetation of Study Areas

Vegetation on the Park varies from the coniferous boreal forest type to the hardwood temperate forest type. In 1947, an intense fire burned over 17,000 acres of the eastern side of the island (Figure 1), leaving much of the area in what is now young hardwood-softwoods with birch predominating in the overstory and spruce in the understory. Vegetation on the burned granite hills is limited mainly to shrub species and herbs.

Gilmore Meadow Area (GM)

The Gilmore Meadow area, a tract of lowland varying in elevation from 180 to 500 feet above sea level, is situated in the eastern portion of the island between Eagle Lake and Somes Sound. This area lies almost entirely within the burn of 1947 (Figure 1). The topography ranges from well-drained at higher elevations to poorly drained bog areas. The area consists of 8 forest types, the most prevalent is softwood-hardwoods found in the winter yard. The remaining types are softwoods, mature hardwood-softwoods, young hardwood-softwoods, young beech, meadows, shrubs and bogs.

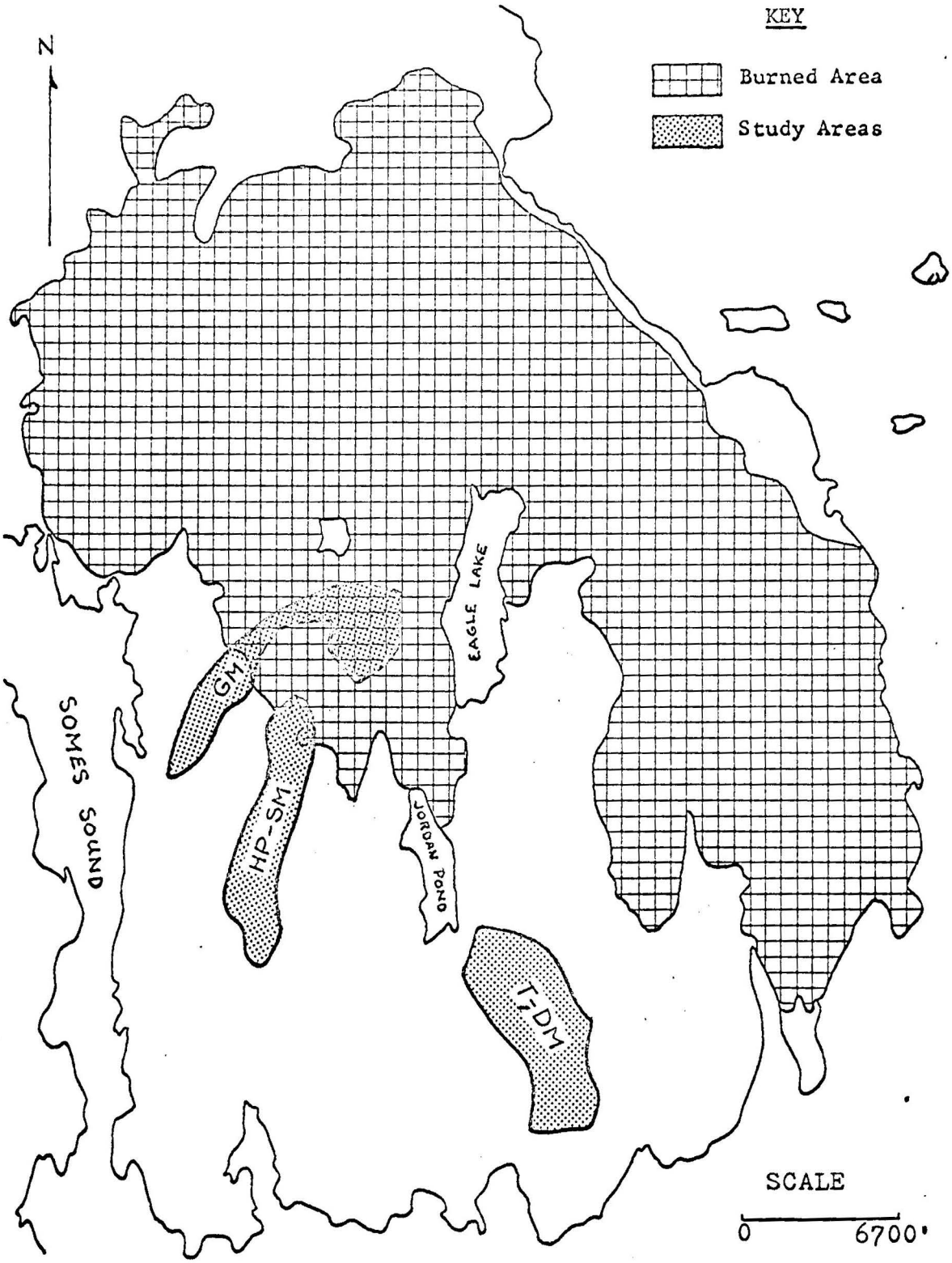


FIGURE 1. LOCATION OF THE THREE STUDY AREAS IN RELATION TO THE 1947 FOREST FIRE.

Hadlock Pond-Sargent Mountain Area (HP-SM)

The Hadlock Pond-Sargent Mountain area borders the Gilmore Meadow area on the south and has a mountainous topography ranging in elevation from 220 to 1,100 feet above sea level. A small portion of the study area lies within the burn while the remainder is in mature woodlands (Figure 1). The area is characterized by six major types, the most abundant of which is softwoods-hardwoods, found at high elevations. The other types are softwoods, hardwood-softwoods, meadows, and shrubs.

Triad-Day Mountain Area (T-DM)

The Triad-Day Mountain area is located along the coast just north of Seal Harbor in the southern portion of the island. The area lies entirely outside the burn of 1947 (Figure 1). It includes Day Mountain, elevation 580 feet, which has hardwood-softwood cover type, and Triad Mountain, 660 feet in elevation, composed mostly of softwood-hardwoods. The lowland between the mountains is mainly softwood-hardwoods with a small 8-acre grassy field. Hardwoods and shrubs are two other cover types found in the study area.

EQUIPMENT AND PROCEDURES

Capturing and Handling

Single-gate portable net traps (Clover, 1956) and double-doored wooden box traps baited with apples and cedar were used to capture deer. Deer were trapped during the fall and winter when they were most responsive to bait.

Apples baited with 2 grams of powdered Tranimul (diazepam)[2/], a tranquilizing drug, were also used to capture deer. The apples were placed where deer would readily find and eat them in the evening. Tranquilized animals were located and restrained the following morning.

Sex, age, weight, and physical condition of each deer captured were recorded. Age estimation was based on tooth replacement and wear as described by Severinghaus (1949). Deer captured in traps were fastened to a restraining bar (Klataske, 1968) and weighed on a balance scale (Figure 2). The weights of those animals captured by the drug had to be estimated because they were located in areas inaccessible with weighing equipment. Colored ear streamers (9x2 inches) made from plastic-coated nylon material as described by Harper and Lightfoot (1966) were attached in each ear of the animal with metal ear tags for future

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2/ Hoffmann-La Roche Inc. Nutley, New Jersey.



FIGURE 2. DEER (#MC8) BEING WEIGHED IN THE WEST SARGENT WINTERING YARD, JANUARY 26, 1968 (Photo courtesy of Robert Binneweis, Acadia National Park)

field identification (Figures 3 and 4). The transmitter was then attached and the animal released (Figure 7).

Telemetry Equipment

Transmitters

The transmitters used were of 2 types. One type produced a continuous signal and the other a pulsating signal. Both transmitted in the 151 mega-cycle (mc) band range and weighed from 12-25 grams each. The continuous signal transmitters were purchased from Markusen Electronics[3], while the pulsating transmitters were supplied by A.V.M. Electronics[4].

Transmitter life varied from less than 1 week to 6 months. Maximum distance of signal reception was approximately 4.5 miles, but averaged about 1 mile depending on the system, terrain, and weather conditions.

To increase transmitter life 2 pairs of 1.35 volt mercury batteries were connected in parallel (Cochran and Hagen, 1963). The increase in weight of the additional batteries was 74 grams. The transmitter life expectancy was increased from 3 to 6 months.

The first transmitters were constructed with a timing circuit, which gave 2 minute signals every 12 minutes.

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[3] Electronic Specialties, Esko. Minnesota.

[4] A.V.M. Instrument Co., Champaign, Illinois.



FIGURE 3. EAR-TAGGING DEER #MC2 AFTER IT WAS CAPTURED WITH TRANIMUL ON FEBRUARY 17, 1969, AT UPPER HADLOCK POND.



FIGURE 4. DEER #MC12M SHOWING COLORED EAR STREAMERS (TRIAD-DAY MOUNTAIN AREA, OCTOBER 23, 1968).

A self-winding watch was used as the timer. This was done in an attempt to increase the life of the transmitters. Because of the resistance imposed by the watch, the signal output was greatly reduced, and reception was less than 0.5 mile. Later, interference from local citizen radio band transmitters made reception difficult and use of the circuit was discontinued.

Collars

The transmitter and battery packages were imbedded in a silicone rubber compound and placed into a 2.75 x 2.0 x 1.5 inch aluminum box. The box was then attached to a 2 x 0.25 inch leather strap collar with screws and nuts. A 13-inch whip antenna made from 16-gauge stainless steel wire, for the transmitter, was attached to the collar at two points to prevent breakage (Figure 5). The collar was then padded with foam rubber, and covered with a colored vinyl coated nylon fabric[5/] secured with electrician's tape. The average weight of the completed unit (Figure 6) was 1.3 pounds. Collars used on adult male deer contained a 6-inch portion of 2 x 0.125 inch industrial rubber band[6/] to allow for expansion of the animal's neck during the mating season.

5/ Cooley, Inc., Pawtucket, Rhode Island.

6/ Firestone Industrial Products Co., Syracuse, New York.

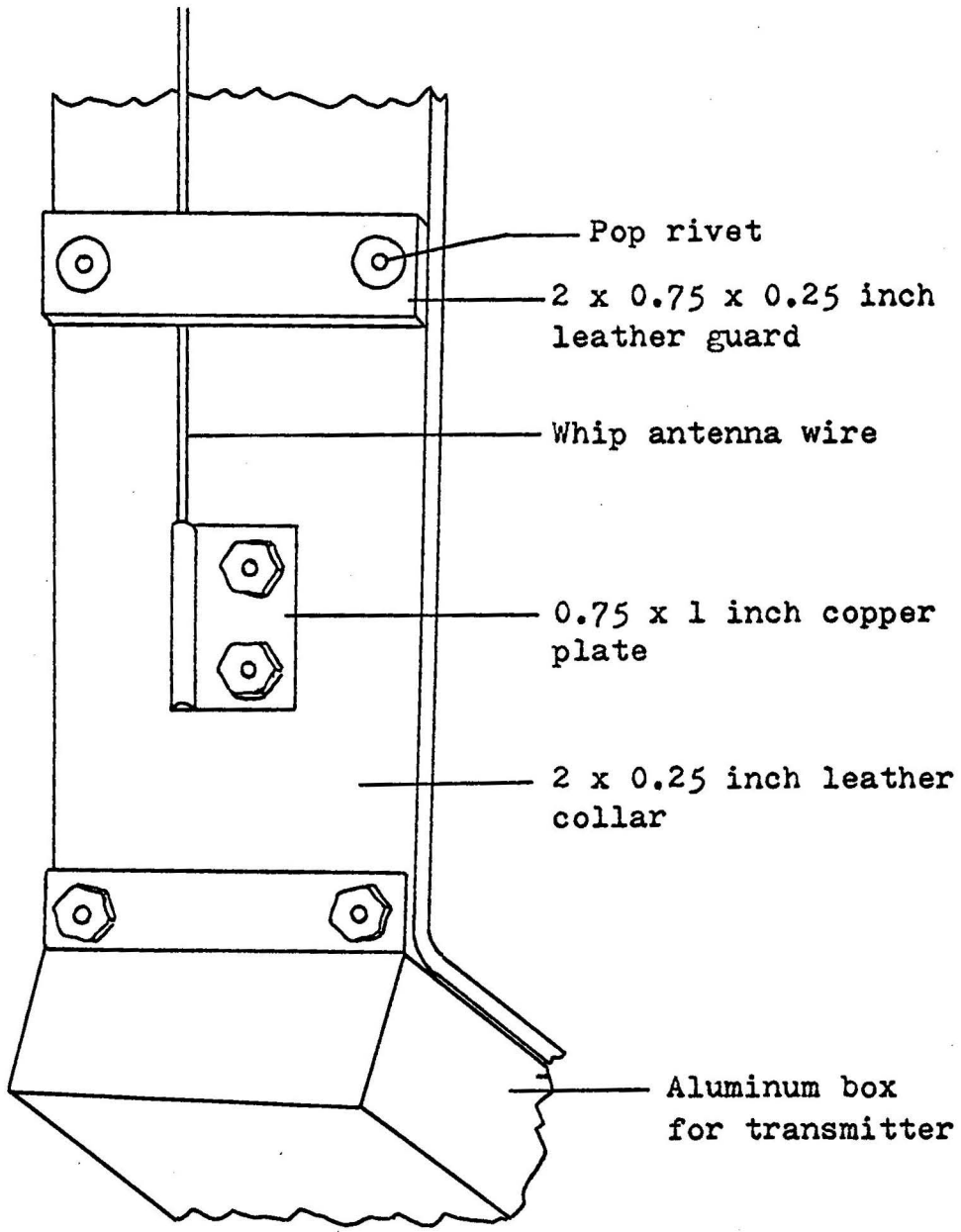


FIGURE 5. MOUNTING OF WHIP ANTENNA TO TRANSMITTER COLLAR.



FIGURE 6. CONTINUOUS SIGNAL TRANSMITTER AND COLLAR.



FIGURE 7. EQUIPPING DEER WITH TRANSMITTING UNIT.

Receivers

Two types of portable receivers were used in the study. The Markusen receiver (Figure 8), a 12-channel crystal-controlled superheterodyne type, measured 12 x 7 x 6 inches and weighed 5.9 pounds. The 11-channel A.V.M. receiver (Figure 9), measuring 9 x 4 x 3 inches and weighing 2.6 pounds, was a much smaller unit and therefore greatly facilitated field work. Headphones were used with both receivers.

Antennas

Yagi antennas were used exclusively to monitor the deer. Semi-permanent 8 and 10-element yagi antennas were erected on 20-foot masts (Figure 10) at high vantage points throughout the study areas. The antennas were erected after the animals had been tracked for 2 weeks, and were located so that animals could be monitored within 1 mile of a station. Tracking short distances prevented large errors in positioning the deer as described by Slade et al., (1965), Mech et al., (1966), and Heezen and Tester (1967).

Semi-permanent antenna stations were constructed using 8 and 10-element yagi antennas[2/] in the following manner. The yagi was mounted on a 20-foot, 1.25-inch

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2/ Cushcraft Antenna Co., Manchester, New Hampshire.

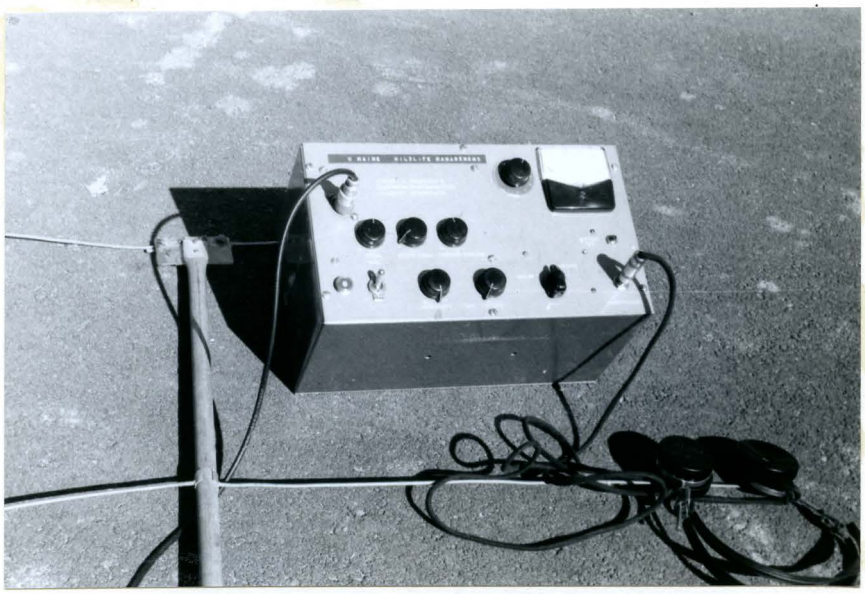


FIGURE 8. MARKUSEN PORTABLE RECEIVING EQUIPMENT.

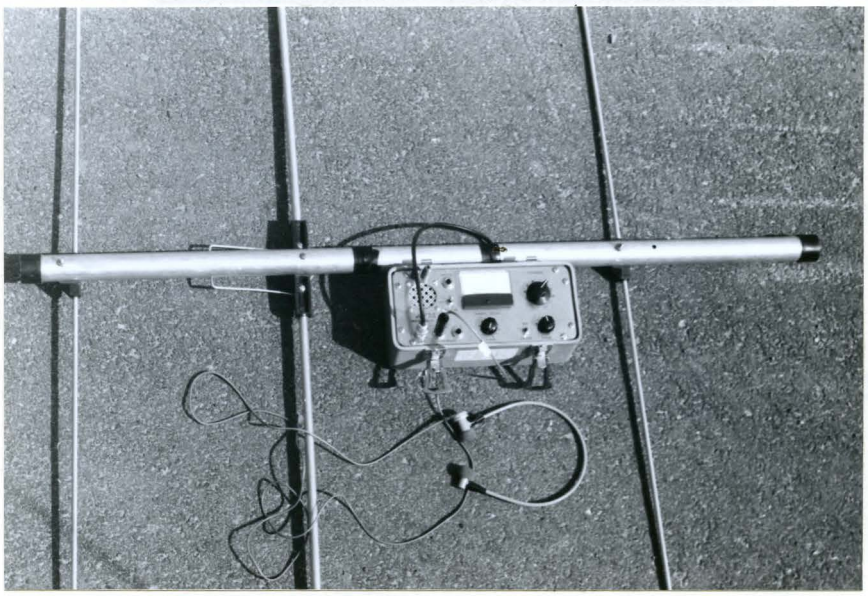


FIGURE 9. A.V.M. PORTABLE RECEIVING EQUIPMENT.



FIGURE 10. SEMI-PERMANENT MAST YAGI ANTENNA OVERLOOKING STUDY AREA.

thin-walled conduit pipe. A 5-foot piece of 1.5-inch galvanized iron pipe was driven into the ground and the antenna mast placed inside it. The antenna was stabilized by 4 guy wires to nearby trees. A compass rose was fastened to the stationary 1.5-inch galvanized iron pipe, and a pointer was fastened to the mast using standard hose clamps (Figure 11). These were used to indicate the yagi direction. The pointer was adjusted to the bearing of the yagi with a staff compass or transit.

Initial movements of the deer were obtained by a 5-element yagi antenna mounted on a pickup truck (Figure 12). A hand compass was mounted on the mast to indicate the change in orientation of the antenna when the truck was moved between stations. The compass rose had to be re-oriented each time the truck was stopped prior to recording a bearing to the animal. This operation required less than 1 minute.

Two and 3-element hand-held yagi antennas were used when a portable system was required. This allowed the observer to monitor deer at close range for visual observation (Figure 13).

Field Test of Equipment

The transmitting and receiving equipment was field tested prior to capturing and radio-equipping deer. Reception distances of the transmitters were directly dependent upon the topography of the land. Best reception

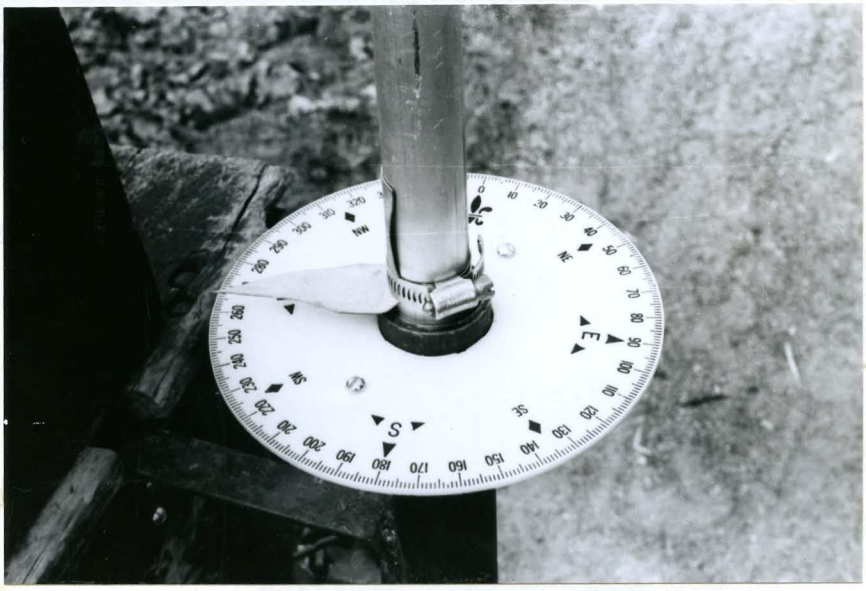


FIGURE 11. COMPASS ROSE AND POINTER OF THE SEMI-PERMANENT YAGI ANTENNA.



FIGURE 12. MOBILE TRACKING UNIT UTILIZING 5-ELEMENT YAGI ANTENNA.



FIGURE 13.

PORTABLE FIELD TRACKING UNIT.

was achieved when a direct and unobstructed line of sight existed from the receiver to the transmitter. Hills and other obstructions greatly reduced receiving efficiency. "Bounce" and "bending" of signals was a problem especially at close ranges due to vegetation and terrain; however, these were minimized by proper adjustment of the signal and sensitivity levels of the receiver.

Monitoring Deer and Recording Activity

The mobile unit consisting of a 5-element yagi antenna mounted on a pick-up truck was used to monitor the initial movements of the deer after release. One week was allowed for adjustment to the transmitters, and only periodic locations were made throughout this period.

Once the area in which the animal concentrated its activities had been determined, semi-permanent antenna stations were established. Numbers of stations per study area varied with topography and extent of deer movements.

The direction of the animal's location was determined by rotating the antenna to a maximum signal, both audio and metered. The bearing was read from the compass rose. Since the meter was more sensitive than the audio signal, it was used to determine bearings. The bearing to the deer was taken as the mean of the maximum peak limits (usually 5 to 10 degrees). To minimize this error, bearings to the animals were taken at distances less than 0.5 mile where possible. Animal locations were determined by

triangulation from 2 or more stations. Since simultaneous readings from 2 stations were not often possible, antennas were located within 2-3 minutes travel of each other to minimize error. In most cases, the distances moved by the animals between tracking intervals were so short that the error was found to be negligible.

During the winter period when the semi-permanent tracking stations were inaccessible or when visual observations were desired, portable equipment was used to monitor deer. When tracking with this equipment "fixes" were taken from pre-determined locations, usually a landmark, and the bearing to the animal recorded with a hand compass. The animal's activity was determined by fluctuations in the signal pitch and intensity. Repeated "fixes" were taken until the observer was sure of the animal's location. Bimonthly, after the location was determined, the deer were approached for identification and equipment check. Deer were usually found to be within 50 yards of the plotted location when seen or jumped.

Normally, deer were monitored every 1-3 hours throughout a 24-hour tracking period once each week until the transmitters failed. During storms or fawning periods deer were tracked for 48 hours or more each week. Periodic observations were made when possible on other days.

Meteorological information was also collected at the time deer were located. This information included temperature, wind (intensity and direction), cloud

conditions, and precipitation. Barometric pressure was recorded throughout the winter months.

Movement Parameters

Determination of Sample Adequacy

Locations and movement data were compiled for each deer along with other related information to determine adequacy of the sample for estimating minimum home range. The determination of minimum home range was influenced by the length of the period in which the animal was monitored after adjustment to the transmitter. If the area used by the animal was no longer increasing in size with additional locations, it was assumed that the home range was complete for that period of the year. This usually required 4 to 5 weeks of tracking.

Home Range

Minimum home range boundaries were determined by plotting all radio locations and observations of the animal throughout the duration of the study. Since most ranges were irregular in shape, an attempt was made to connect points that yielded the most accurate home range boundary. The animal's movement patterns, physical barriers, and vegetation composition were helpful in delineation of boundaries. This approach permitted a more accurate estimation of home range boundaries than a strict

mechanical one.

The home range major axis was considered the longest distance between boundaries of the home range at any period during the study. This line was not necessarily a straight line, but conformed to the shape of home range.

The home range minor axis was a line perpendicular to the major axis connecting the home range boundaries at the widest point.

The "core area" as described by Marchinton (1968), is that area which is the center of activity within an animal's home range. It is that area most frequently used for refuge, food, or home sites. Deer were found to have one or more "core areas" in this study. These were indicated by clusters of radio-locations in certain restricted areas.

Daily Locations

The DBE (distance between extreme) was the maximum distance between any two radio locations of a deer in a 24-hour period. The arithmetic mean of all DBE's for an individual deer was its average DBE.

The sum of the distances between each location of an individual deer during a 24-hour period was the MTD (maximum total distance). This value was subject to experimental error due to the varying time intervals between radio locations in a daily period. The arithmetic mean of all the MTD's for an individual deer was its average MTD.

Vegetation of Deer Ranges

A preliminary stand type map of the deer ranges was prepared from aerial photographs. Each stand was then examined in the field for more detailed vegetation measurements. Composition and density of the overstory, understory, and ground cover was determined along line transects. Cover type designations were based on the proportion of hardwood and softwood trees found in the overstory. Shrubs and herbaceous vegetation were used to classify types containing few or no overstory trees. Characteristics of each type are presented in Table 1.

The importance of all overstory trees in the stand type was calculated as the summation of the relative density, relative dominance, and relative frequency (Phillips, 1959).

A base line was established along a road through the study area. Parallel transect lines were located at 250-foot intervals perpendicular to the base line. Plot sampling points were located 100 feet apart along the transect lines.

Sampling Techniques

The random pairs (Cottam and Curtis, 1949) and quarter (Cottam and Curtis, 1956) methods were used to sample the overstory trees (4" or more in d.b.h.). These methods involved the use of spacing distances rather than fixed-area sample plots. The quarter method was used where

TABLE 1. CLASSIFICATION OF COVER TYPES ON STUDY AREAS, ACADIA NATIONAL PARK.

Types	
Softwoods (Softwood I) .....(S)	more than 80% softwood with spruce predominating
Softwood II .....(SII)	more than 80% softwood with cedar predominating
Hardwoods .....(H)	more than 80% hardwood
Softwood-Hardwoods (I) .....(SHI)	more than 50% softwoods with spruce predominating and 20% hardwood
Softwood-Hardwood II .....(SHII)	more than 50% softwood with cedar predominating and 20% hardwood
Hardwood-Softwood .....(HS)	more than 50% hardwood and 20% softwood
Young Hardwood-Softwood ....(YHS)	more than 50% hardwoods less than 4 inches d.b.h. and 20% softwood
Young Beech .....(YB)	more than 80% beech less than 4 inches d.b.h.
Meadow .....(M)	sparce overstory with more than 50% grass
Shrubs .....(Sh)	dry site with more than 80% of the trees less than 8 feet in height
Bog .....(Bog)	poorly drained area with ericaceous plants and shrubs
Field .....(F)	more than 80% grass
Height Classes	
1	1.0 to 7.9 feet
2	8.0 feet to 3.5 inches d.b.h.

possible to obtain a larger sample of overstory trees. However, when 4 trees did not exist within the 33-foot radius arbitrarily designated as the sample plot boundary, the random pairs method was used.

In the random pairs method, trees were chosen by means of an exclusion angle of 180 degrees. Once the sampling point was located, the transect line was used to divide the sample plot into 2 halves and the nearest tree "A" in 1 of the 180-degree sectors was recorded by species and diameter. The tree "B" nearest tree A, in the other 180-degree sector, was also recorded by species and diameter. The distance between trees A and B was measured to the nearest 0.5 foot (Figure 14). When using an angle of 180 degrees, the distance between trees was multiplied by a correction factor of 0.8 to give the correct distance (Phillips, 1959).

When using the quarter method, the sample plot was divided into 4 equal quadrants. The tree nearest the sampling point in each quadrant was recorded by species and diameter, and its distance from the sampling point was measured (Figure 15). The sum of the distances divided by 4 was equal to the average distance, and did not require a correction factor (Phillips, 1959).

All understory trees (1 foot in height to 3.5 inches in d.b.h.) were measured on a rectangular plot 33 x 3.3 feet. The trees were recorded by species as less than 8 feet tall or from 8 feet tall to 3.5 inches in d.b.h.

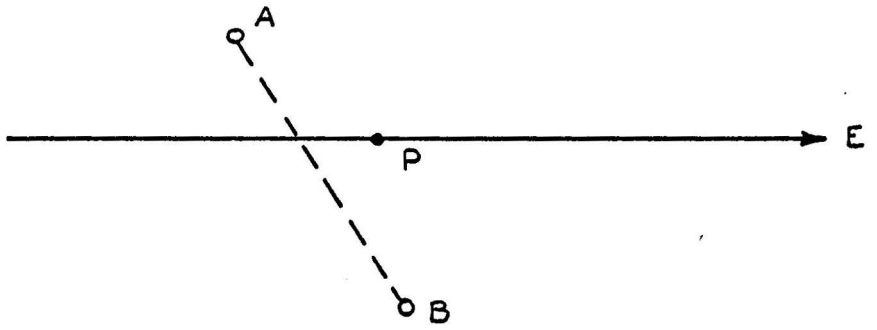


FIGURE 14. RANDOM PAIRS SAMPLING OF OVERSTORY TREES (imaginary line E separates 180-degree sectors containing trees A and B).

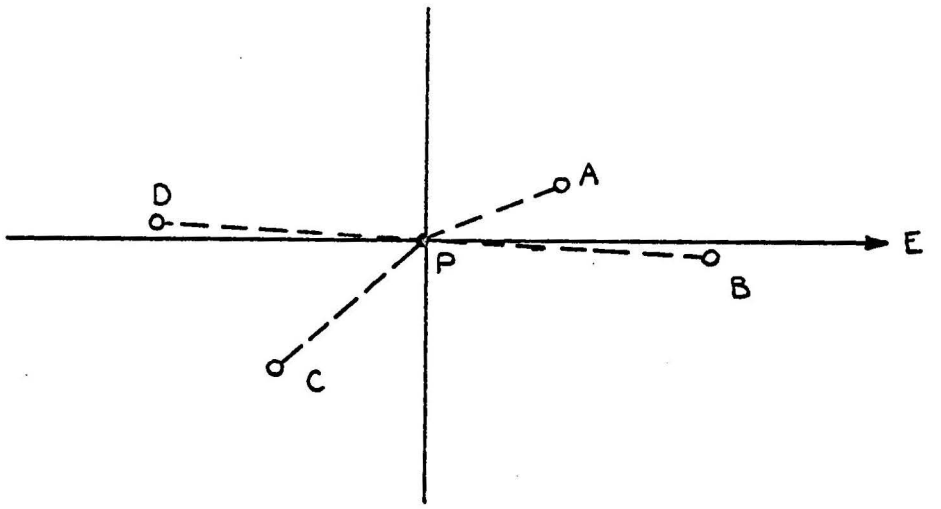


FIGURE 15. THE QUARTER METHOD OF SAMPLING OVERSTORY TREES (utilizes 4 quadrants).

A 3.3-foot square quadrat was used at the plot center point to measure the herbaceous ground cover and woody shrubs. All shrubs were recorded, but only the most abundant herbaceous species were noted. Species abundance (in percent) was recorded by ocular estimation.

Winter Browse Survey

Vegetation in the West Sargent Mountain winter deer range was examined for its extent of utilization by deer as well as species composition and density. McLaughlin (1968) recognized poor deer range conditions existing in many wintering areas at Acadia Park. As a result a browse survey was initiated in March of 1968, in the 320 acre deer yard along West Sargent Mountain prior to any current vegetative growth. This yard was chosen primarily because it was the trapping locale for the Gilmore Meadow study area deer, and because it had a past history of poor range conditions.

A modification of the browse survey method outlined by McLaughlin (1968) was used to sample vegetation. This method involved rectangular plots, 66 x 4 feet, randomly established along line transects. A road bisecting the winter yard was used as a base line. Twenty-four parallel transects were established at 5-chain intervals along the base line in a direction perpendicular to the slope of the land surface. A total of 145 sample plots were located and permanently marked. A 50-foot buffer strip

was left along the road to avoid its influence on vegetative types.

Twelve species of trees and 7 species of woody shrubs ranging from slightly palatable to highly preferred (Banasiak, 1961) were recognized as deer foods. White pine and spruce were the only tree species not tallied. All browsed and unbrowsed twigs occurring within the plot boundaries were recorded. Hare browsing was distinguished from that of deer.

RESULTS AND DISCUSSION

Individual Movements and Home Range

Eight animals were radio-equipped from 1968 to 1969, 4 of which were monitored long enough to adequately define their minimum home ranges. The minimum home range for these animals averaged 556 acres. Average summer range was 310 acres while winter range averaged 171 acres. The remaining 4 deer provided some valuable movement information for those periods when they were monitored, but no attempt was made to determine minimum home range.

Gilmore Meadow Area

Deer #MC8

An adult female deer 3.5 years old, was trapped in the West Sargent wintering area on January 26, 1968, and equipped with a radio transmitter containing a timing circuit device. She was in good physical condition and weighed 109 pounds. Because of poor reception of this transmitter, locating the animal was very difficult. On March 8, MC8 was observed on the highway in the vicinity of her prior capture. On March 11, she was recaptured in the yard 0.5 mile from the original trapping site and the transmitter was changed to a Markusen continous signal type. At the time of capture snow depth was 7 inches and was packed and crusted over much of the area, facilitating travel. When released the animal moved 1.7 miles, in a

TABLE 2. A SUMMARY OF MOVEMENT PARAMETERS FOR RADIO-EQUIPPED DEER, ACADIA NATIONAL PARK.

Deer Number	Sex	Age in Years	Telemetric Study Period	Total Number Days	Movement Parameters					
					Minimum Home Range (acres)	Major Axis (miles)	Minor Axis (miles)	Minimum Winter Range (acres)	Minimum Summer Range (acres)	Distance Traveled Between Ranges (miles)
MC8	F	3.5+	1-26-68* 9-15-68	231	498	2.7	0.8	180	185	1.7
MC12	F	3.5	10-29-68* 7-10-69	254	565	1.9	0.7	158	407	0.4
MC4	M	0.5	10-29-68* 4-19-69	172	585	1.9	0.7	158	427	0.4
MC2	M	3.5	2-17-69 6-22-69	125	576	2.4	0.6	186	220	1.5
MC3	F	0.5	11- 8-68* 1- 4-69	56	**	0.5	0.2	**	51	**
CC1	M	1.5	1-23-69 2-12-69	20	**	1.3	0.6	280	**	**
MC12M	M	1.5	10-23-68 11- 1-68	9	**	1.2	0.3	**	**	**
MC10	M	0.5	3- 9-68	7	**	**	**	**	**	**

* Additional visual observations were made either before or after telemetric period.
** Insufficient data to compute parameters.

north-easterly direction to Gilmore Meadow (Figure 16).

Movement and home range parameters based upon telemetered data are presented in Table 2.

MC8 was monitored in the Gilmore Meadow area for a total period of 187 days from March 12 to September 15, 1968. Total minimum home range was 498 acres, including that portion of the winter range in which the animal was captured and observed. Minimum spring and summer home range was 185 acres (Figure 17). The total home range was elongated with a major axis of 2.7 miles and a minor axis of 0.8 miles.

Restricted movement patterns were observed in the third week of June prior to fawning. A fawn was born between the 24th and 27th of June. During the first few weeks of the fawn's life, the doe spent much of the time in grassland meadows and dense young-growth hardwoods. During this period, core areas were established in the grassland meadows.

Hadlock Pond-Sargent Mountain Area

Deer #CC1

A 1.5 year old male deer was captured, using apples baited with Tranimul, in a wintering area bordering Upper Hadlock Pond, on January 23, 1969. This deer was equipped with an A.V.M. pulsating type transmitter. The deer was tracked for a 3-week period until reception of the

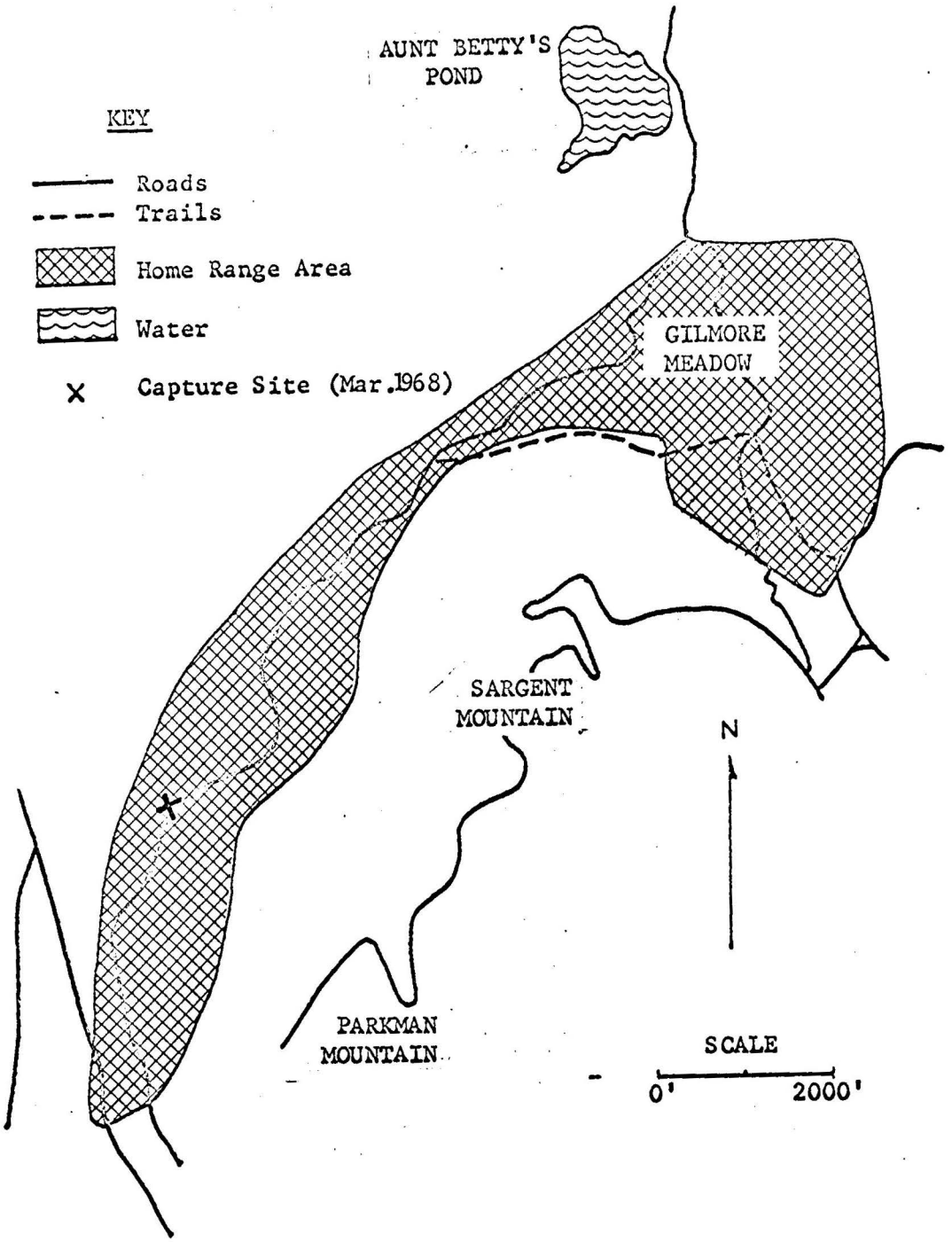


FIGURE 16. TOTAL MINIMUM HOME RANGE AREA OF DEER #MC8 FROM JANUARY TO SEPTEMBER, 1968.

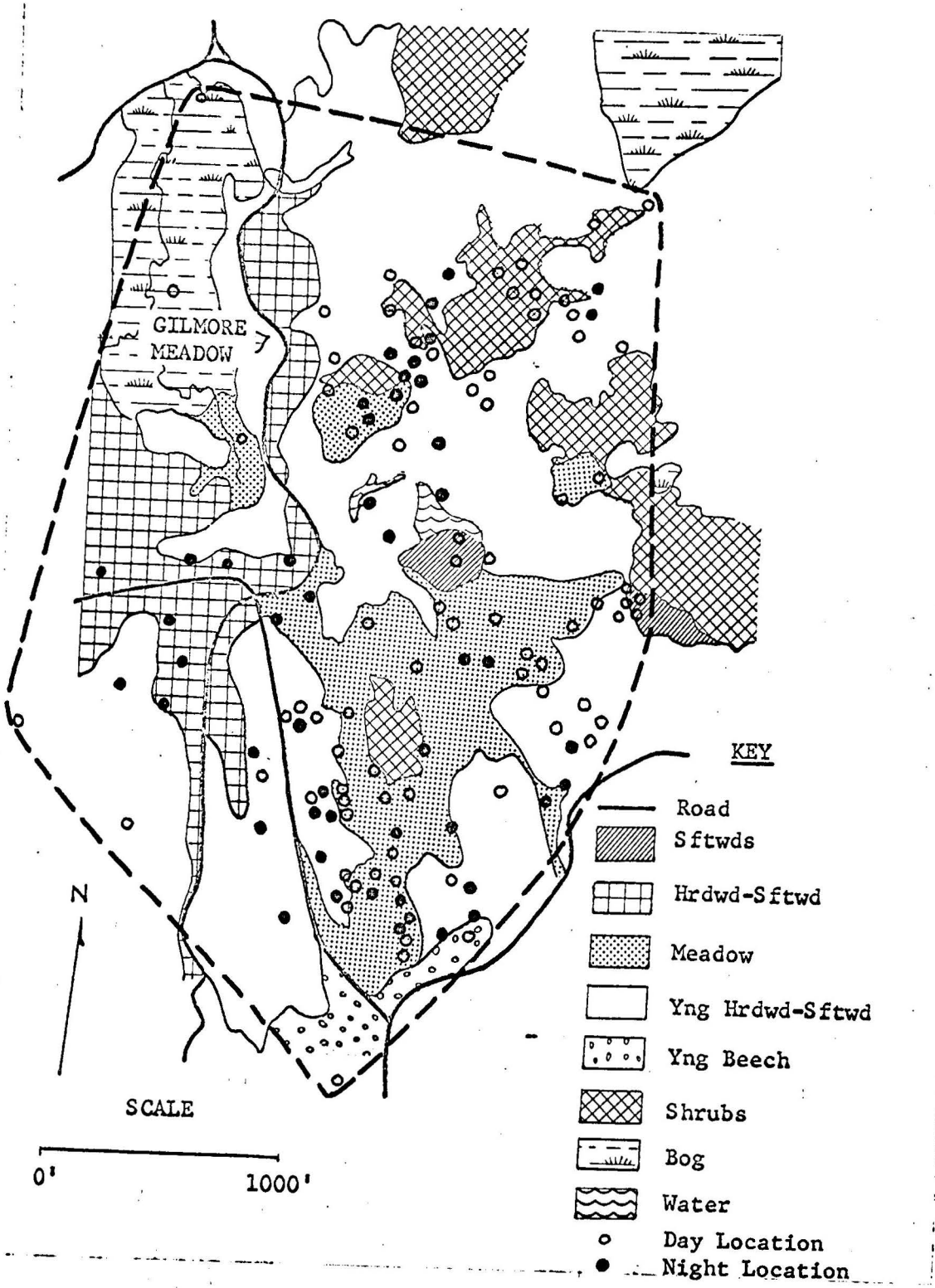


FIGURE 17. THE 185-ACRE MINIMUM SPRING AND SUMMER HOME RANGE OF DEER #MC8 (MARCH TO SEPTEMBER, 1968).

signal was lost. During the tracking period, he was observed crossing Route 198 between Sargent Mountain and Norumbego Mountain, a distance of 0.5 mile. The minimum winter range for CC1 was 280 acres during the 3-week monitoring period (Figure 18). Softwood covers were used throughout diurnal periods, while exposed mountain slopes were used to a large extent for nocturnal feeding.

Deer #MC2

A male deer, 3.5 years of age, was captured in the Hadlock Pond yard using Tranimul, on February 17, 1969. This deer was equipped with an expandable Markusen continuous signal-type transmitter. Movement information was collected on MC2 until June 22, a period of 125 days.

Total minimum home range was 576 acres, elongated from north to south (Figure 19). The major axis was 2.4 miles and the minor axis 0.6 miles. Winter range, which was confined to softwood covers, was 186 acres. A shift of 1.5 miles was noted between the winter and summer range. With the onset of warmer weather in late March, MC2 left the yarding area and moved to a point near the top of West Sargent Mountain where he remained in a softwood cover type for 2 weeks (Figures 29 and 30). He then moved 0.5 mile to the north-facing slope of the mountain, and established a summer range of 220 acres. This area consisted of high elevation meadows, shrubs, hardwood-softwood stands and softwood-hardwoods.

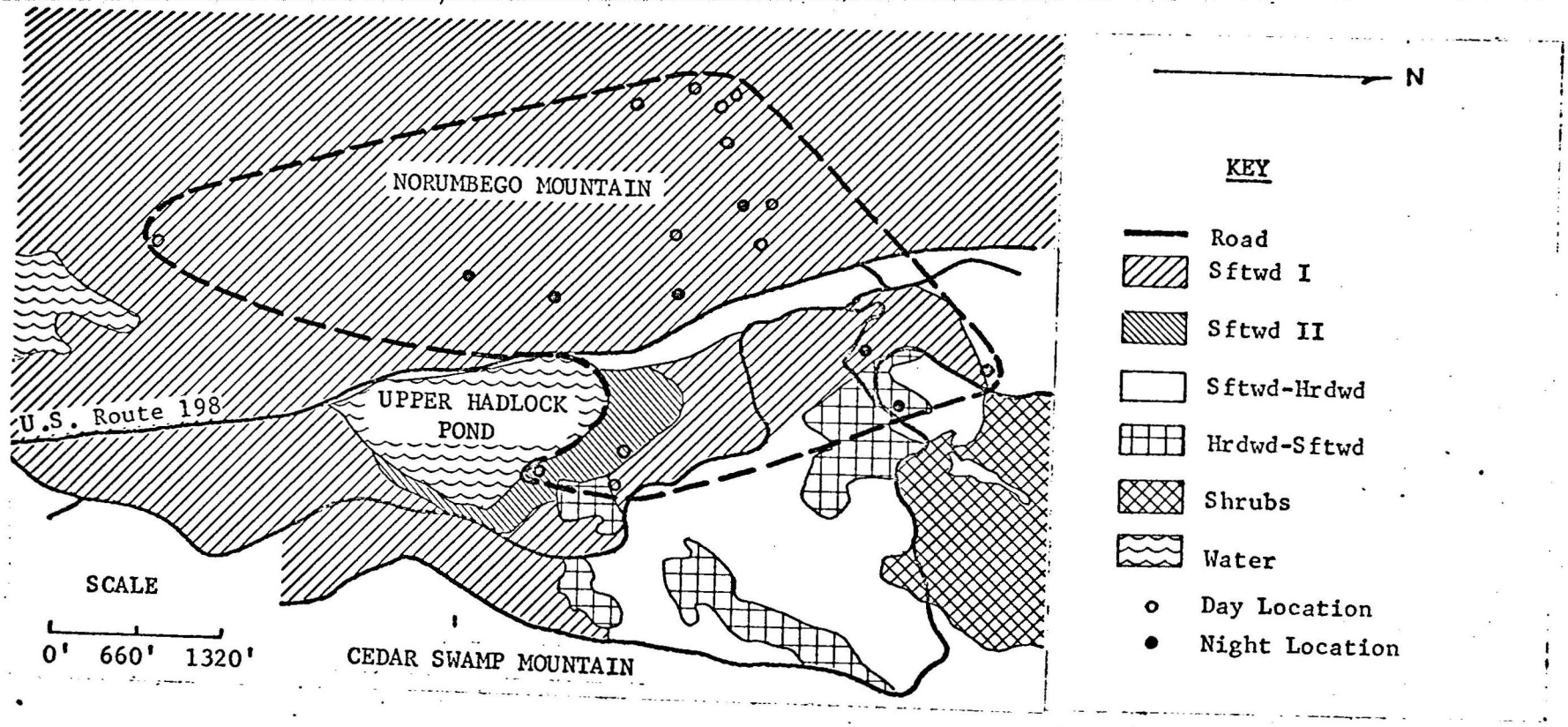


FIGURE 18. THE 280-ACRE MINIMUM WINTER RANGE OF DEER #CC1 (JANUARY TO FEBRUARY, 1969).

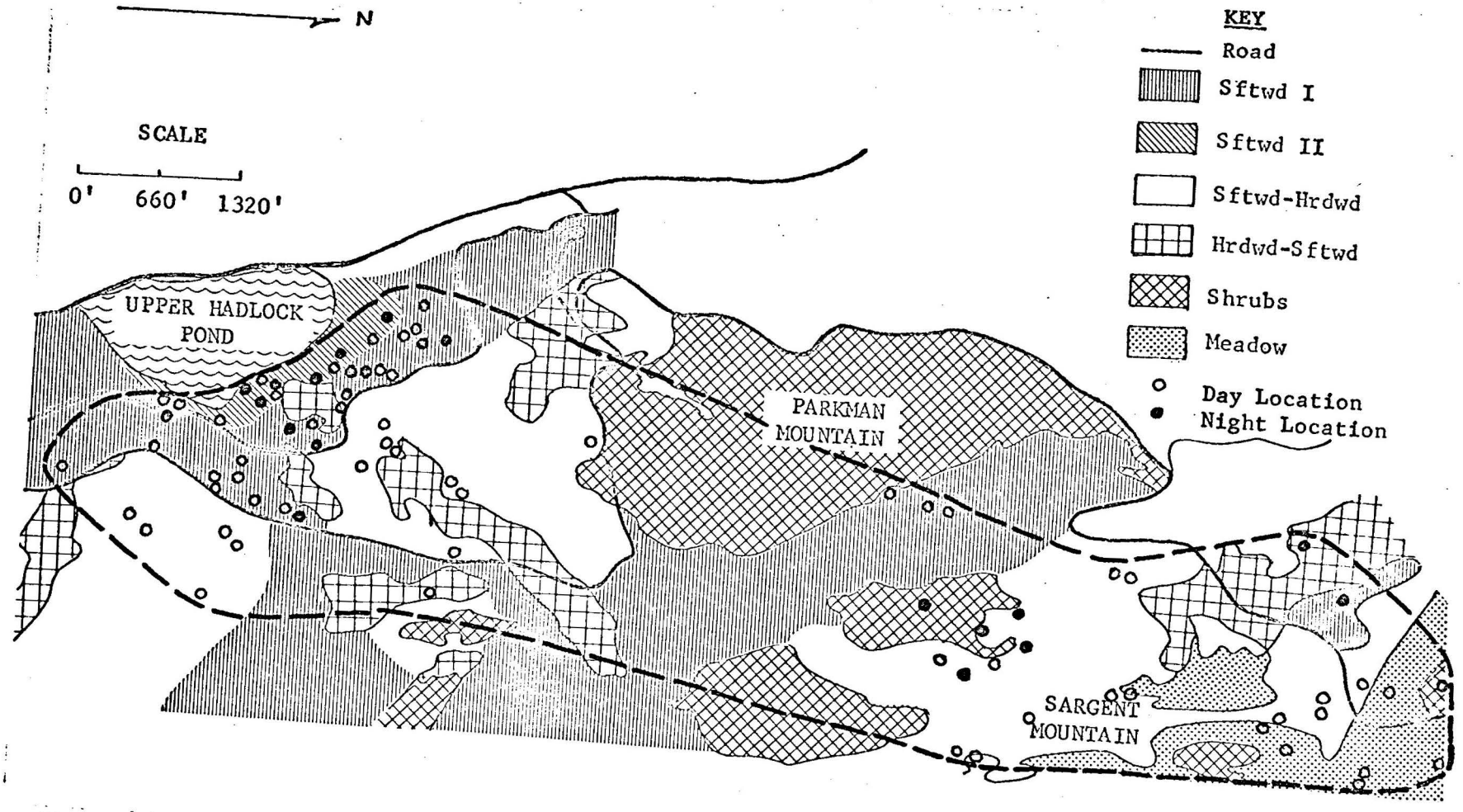


FIGURE 19. THE 576-ACRE MINIMUM HOME RANGE OF DEER #MC2 (FEBRUARY TO JUNE, 1969).

The deer was observed feeding and bedding most often in the meadows and shrub areas. The movement patterns of MC2 closely resembled those of MC4, MC12, and MC8.

Triad-Day Mountain Area

Deer #MC12M

A yearling male deer was trapped and radio-equipped on October 23, 1968. The animal had 3-inch spike antlers, weighed 90 pounds, and was in good physical condition. Since the deer was beginning to rut, it was equipped with a Markusen transmitter mounted on an expandable collar. MC12M was monitored until November 1st when the transmitter was recovered after being torn free from the animal.

Deer #MC4 and #MC12

On October 29, 1968, a 5-month old male (MC4) weighing 65 pounds, was trapped and equipped with a Markusen transmitter. The animal was monitored for 158 days until April 5, 1969, when the transmitter ceased to function. On April 19, the deer was killed by dogs near the southern border of its home range, but the carcass was not located until December 30, 1969.

A 3.5 year old adult female (MC12) weighing 112 pounds, was captured by baiting apples with Tranimul. She had two fawns, one of which was MC4. The female was located after drugging by radio tracking and plotting the

fawn's movements over a period of several hours. This doe was monitored for 191 days until mid-June, 1969, when the transmitter ceased functioning. Seldom were MC4, and MC12, its mother, found more than a few yards apart, and for that reason their movement patterns are considered together. This finding contrasts with the 39 telemetered observations made over a 16-day period of a 4-month old fawn and its mother in Alabama (Byford, 1969). At no time during Byford's study were the two animals located together. The fawn's home range was slightly smaller than the mother's, but both were within the same area and elongated in the same direction.

Minimum home range for MC12 was 565 acres and was oblong in shape, extending east to west (Figure 20). Movement data for MC4 indicated a minimum home range of 585 acres, 20 acres larger than that of MC12 (Figure 20). This difference was because MC4 used an extended area of hardwood-softwoods on the summer range in November before MC12 was radio equipped. It is suspected that both home ranges were similar in size. The major axis measured 1.9 miles and the minor axis 0.7 miles for both animals. There was a 0.4 mile shift in range between winter and summer, from softwood types to hardwoods. Minimum winter range was 158 acres while that of the spring, summer and fall range, collectively, was 427 acres.

During the winter months, the deer were confined to the softwood covers of Triad Mountain. The top of the

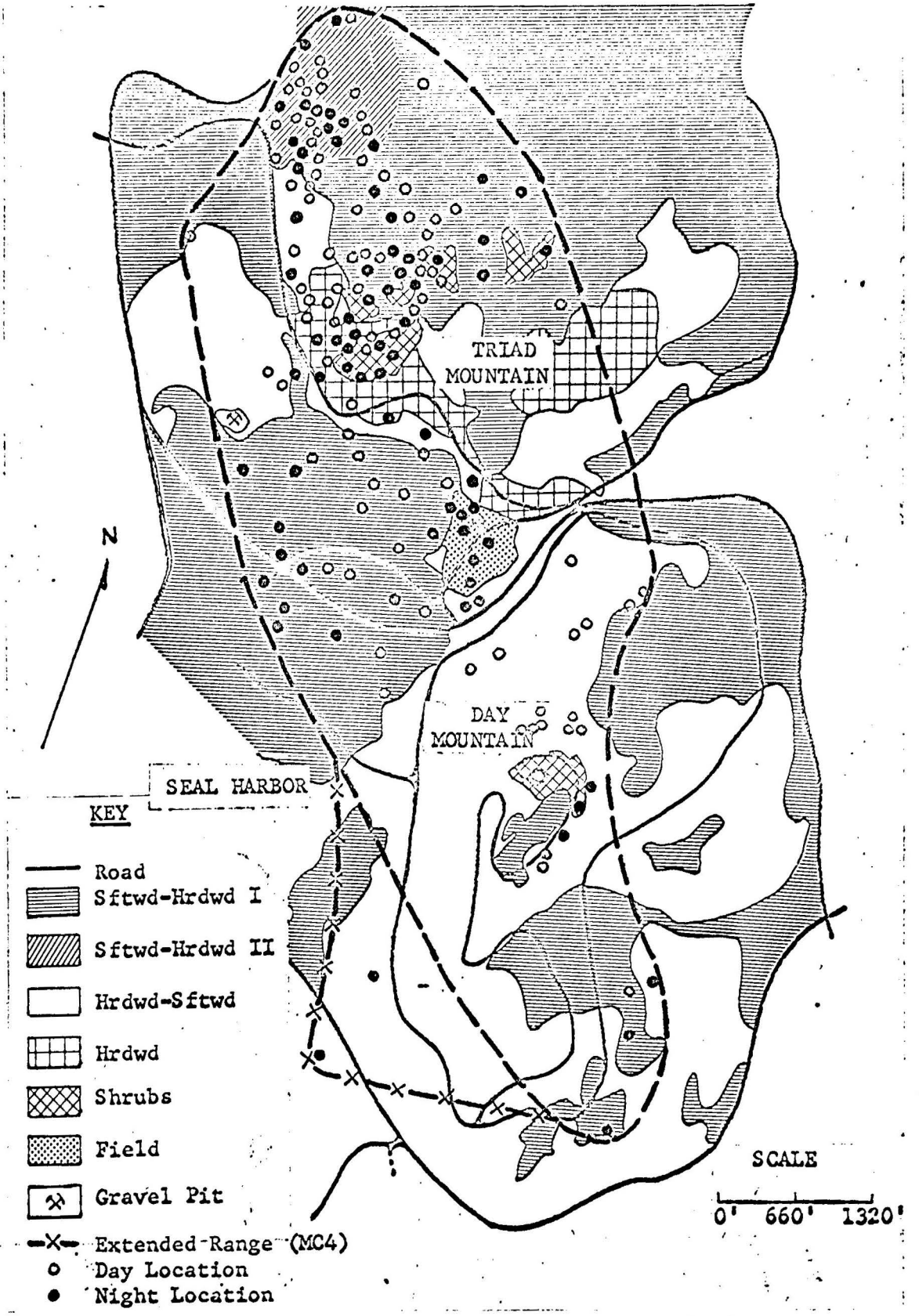


FIGURE 20. MINIMUM HOME RANGE AREAS OF DEER #MC4 AND #MC12 (OCTOBER, 1968 TO JUNE, 1969).

mountain was used for feeding during much of the winter. Shelter was found either in a gorge running east-west between two peaks of Triad Mountain or in the dense conifers on the western slope. During periods of deep snow, the animals remained on the western slope of the mountain.

In spring the pattern of movement coincided with that observed in the fall.

Deer #MC3

A small immature female weighing 54 pounds, was captured in a box trap and equipped with a light weight continuous signal transmitter on November 8, 1968. The animal was monitored for 32 days until December 10, 1968, when the signal was lost. On January 6, MC3 fell from an icy ledge on Triad Mountain into the road below after several snowmobiles had passed. Because of broken leg bones, the deer was killed and the transmitter recovered. Upon examination of the transmitter, a bullet hole was found through the battery pack. Gun shots were heard in the area during the last few days in which MC3 was monitored.

Movement patterns for this animal indicated a minimum home range of 51 acres (Figure 21). Cover type use was similar to that of MC4 and MC12 for the same time.

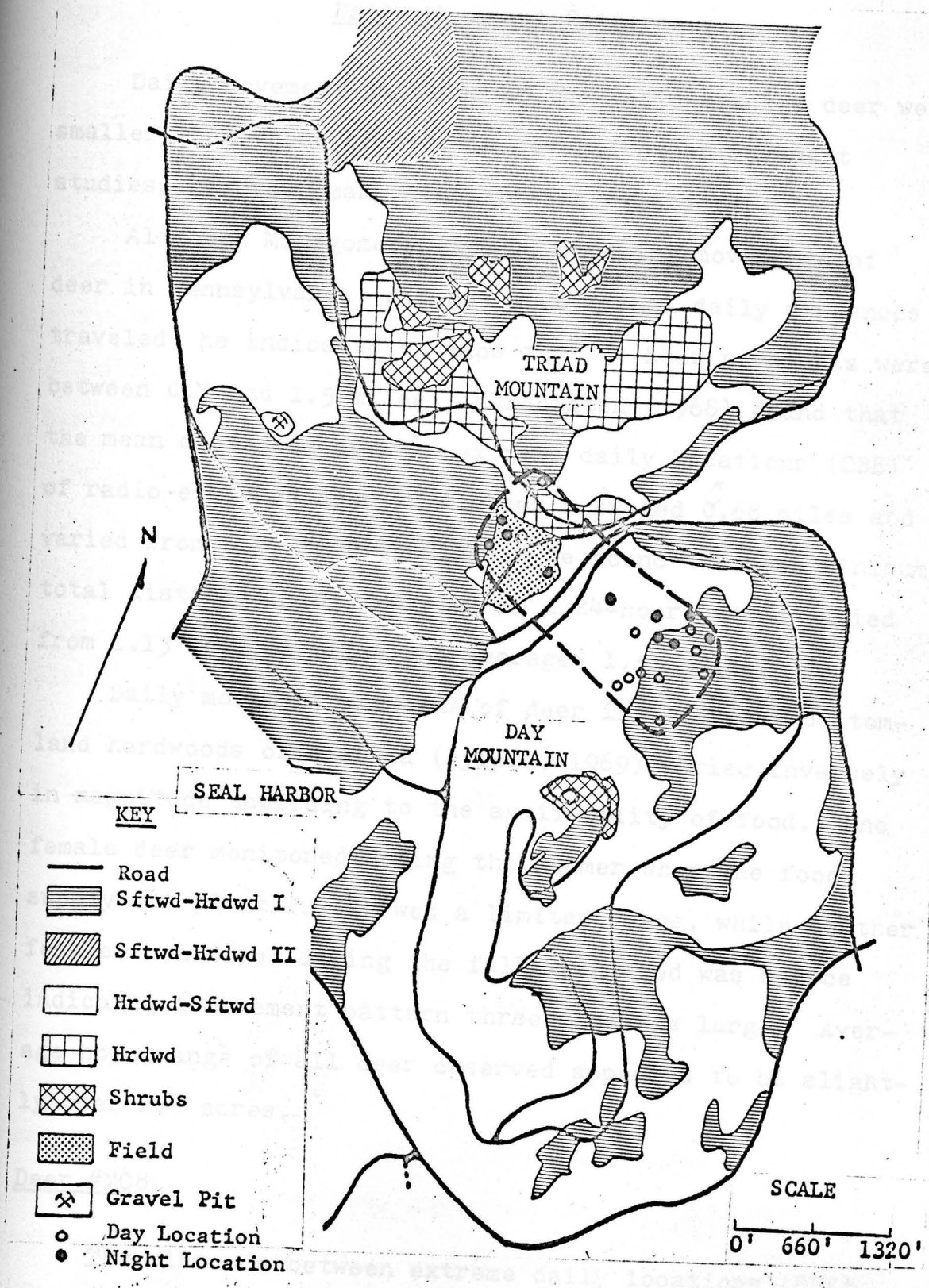


FIGURE 21. THE 51-ACRE MINIMUM FALL RANGE OF DEER #MC3 (NOVEMBER TO DECEMBER, 1968).

Daily Movement Patterns

Daily movement patterns of the radio-tracked deer were smaller than those of deer in several other movement studies, however, many similarities existed.

Although Montgomery (1963), studying movements of deer in Pennsylvania, did not give actual daily distances traveled, he indicated on maps that 24-hour movements were between 0.7 and 1.5 miles. Marchinton (1968) found that the mean distances between extreme daily locations (DBE)' of radio-equipped deer in Alabama averaged 0.68 miles and varied from 0.53 to 0.93 miles. He found the mean minimum total distance (MTD) traveled in a 24-hour period varied from 1.15 to 1.81 miles and averaged 1.51 miles.

Daily movement patterns of deer in clear-cut bottomland hardwoods of Alabama (Byford, 1969) varied inversely in magnitude according to the availability of food. One female deer monitored during the summer when the food supply was plentiful showed a limited range, while another female, monitored during the fall when food was scarce indicated a movement pattern three times as large. Average home range of all deer observed appeared to be slightly over 200 acres.

Deer #MC8

The distance between extreme daily locations (DBE)

for MC8 during a 24-hour period varied from 0.3 to 0.6 miles and average 0.5 miles. The average minimum total distance (MTD) moved in a 24-hour period was 1.1 miles, and varied from 0.7 to 1.5 miles.

Although the behavior of MC8 varied considerably, a repeated pattern of bedding during the early morning hours and mid-day emerged. The animal became active in late afternoon around 4 p.m. and gradually moved through upland hardwoods while feeding. MC8 bedded again shortly after midnight for short durations until about 4 a.m. From this time until 11 a.m., she slowly returned to the grassland meadows and bedded for the remainder of the day. A similar deer movement pattern was shown by Montgomery (1963) in Pennsylvania and by Marchinton (1968) in the southeastern United States. Tibbs and Lindzey (1967) in Pennsylvania observed a greater activity peak by deer in the evening than in the morning.

The nocturnal use of mature hardwood-softwoods for feeding was evident during the period from March to May, 1968 (Figures 22 and 23). Average minimum daily movements were 1.2 miles for the 3 months. Figure 24 shows an increased use of meadows in June. After fawning, movement patterns in July and August showed an increased daily occupancy of young hardwood-softwoods and shrubs (Figure 25 through 27).

Deer #MC2

The average DBE for MC2 was 0.4 miles and varied

from a minimum of 0.3 miles to a maximum of 0.5 miles. The average minimum total distance (MTD) traveled in any 24-hour period was 0.9 miles and varied from 0.5 to 1.3 miles.

Figures 28 and 29 show daily movement patterns restricted to the winter yard with 6 inches of snow in February and 23 inches of snow the 1st of March. As MC2 moved away from the yard in late March towards its summer range there was a continued use of softwoods. Shrub areas with little snow remaining were used primarily for feeding (Figures 29 and 30). Figures 30 and 31 show the daily use of meadows and hardwood types for both feeding and resting in the summer range during May and June.

Deer #MC4 and #MC12

The average observed DBE for MC4 and MC12 throughout the duration of the study period was 0.4 miles and varied from 0.1 to 0.7 miles. The average minimum total distance (MTD) traveled in a 24-hour period was 0.8 miles, with a minimum of 0.4 and a maximum of 1.4 miles.

Figure 32 shows the daily use of softwood-hardwoods and the field area in November, 1968. In December and January there was a gradual shift to increased usage of high elevation shrubs and softwood-hardwoods on Triad Mountain (Figure 32). Figure 33 shows the daily changes in the habitat occupied in February as climatic conditions changed. Hardwood-softwood types were used during the

winter months when the weather was mild and snow depths were not restrictive. With the heavy snows in March, daily movement patterns became restricted to the softwood area on the west slope of Triad Mountain (Figure 34). This 26-acre cedar area was used extensively for shelter and food until April, 1969. In the third week of April a shift away from the western slope of Triad Mountain to Day Mountain was noted, and daily movement patterns showed an increase in occupancy of hardwood types.

Behavior patterns of MC4 and MC12 were similar to those of MC8 in that the animals bedded during the mid-day hours and were active until shortly after midnight. They were inactive during the hours between 1 and 4 a.m. after which they began feeding again until mid-morning. This pattern was observed during the fall and spring. During the fall, MC4 and MC12 usually bedded in hardwood-softwoods or shrub areas on Day Mountain and moved 0.4 miles to an 8-acre open field between dusk and sunset. Several hours were spent feeding in the field area, and usually the deer spent the early morning hours bedded in the surrounding softwood cover. Movement back to the top of Day Mountain took place during the morning feeding period. Use of the field was noted during the fall when apples were available on the few trees present. At other periods during the fall and early winter the field was seldom visited by the deer. There was increased utilization of the field area again in spring as herbaceous vegetation emerged. Similar

findings were observed by Cross (1968) in Rhode Island.

In winter however, when movement was restricted to the yarding area due to weather conditions, the deer were active more frequently, bedding for short periods throughout the day and night.

Deer #MC3

Figure 35 shows the 24-hour movement pattern of MC3 on December 5-6, 1968. The DBE was 0.4 miles and the MTD was 0.9 miles for that period.

Deer #CC1

During the 3 weeks monitored, CC1 showed the largest daily movement pattern. Figure 36 presents the daily movement pattern on February 1-2, 1969. The DBE for the 24-hour period was 0.8 miles, and the MTD was 2.1 miles.

Use of Vegetative Types

Cover type use by all deer varied with season, time of day, and meteorological conditions. Figures 37 and 38 show the duration of use of each cover type during the study period for individual deer.

Deer #MC8

Young hardwood-softwoods and the meadow areas were the most important types used by MC8. These areas also occupied the largest acreage, 96 and 28, respectively

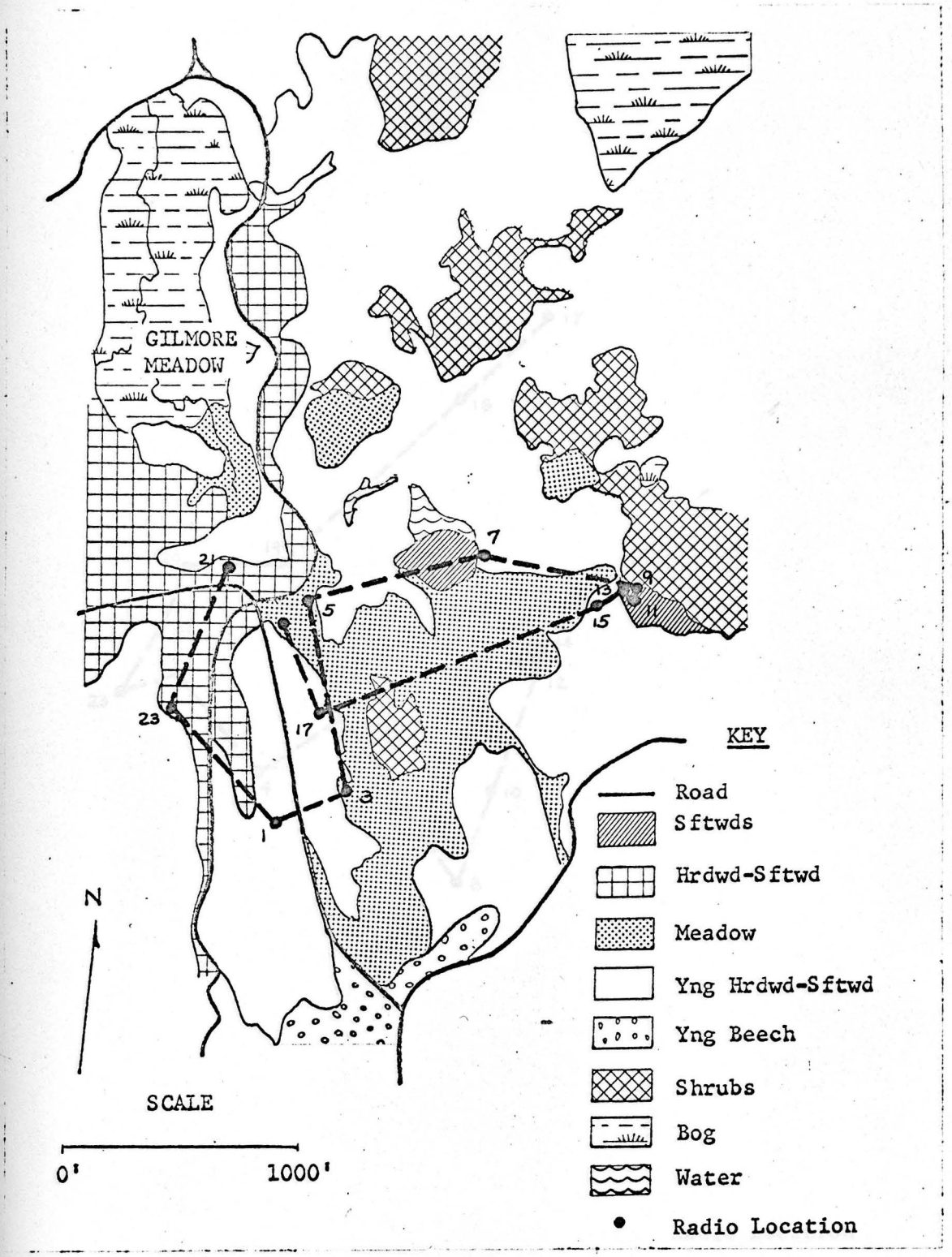
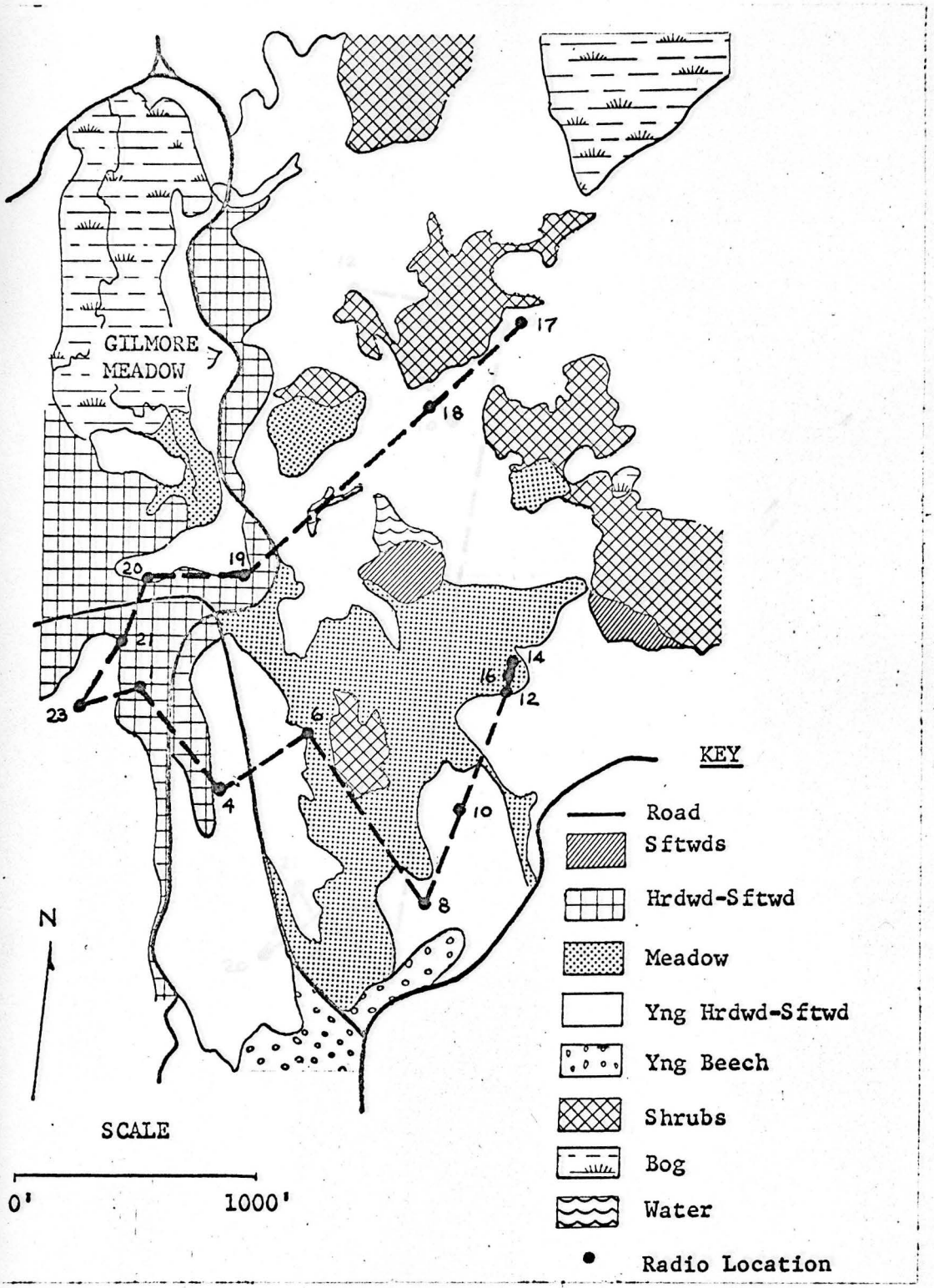


FIGURE 22. DAILY MOVEMENT PATTERN OF DEER #MC8 ON MARCH 29-30, 1968 (numerals are the hour of location based on a 24-hour clock).



IGURE 23. DAILY MOVEMENT PATTERN OF DEER #MC8 ON MAY 16-17, 1968 (numerals are the hour of location based on a 24-hour clock).

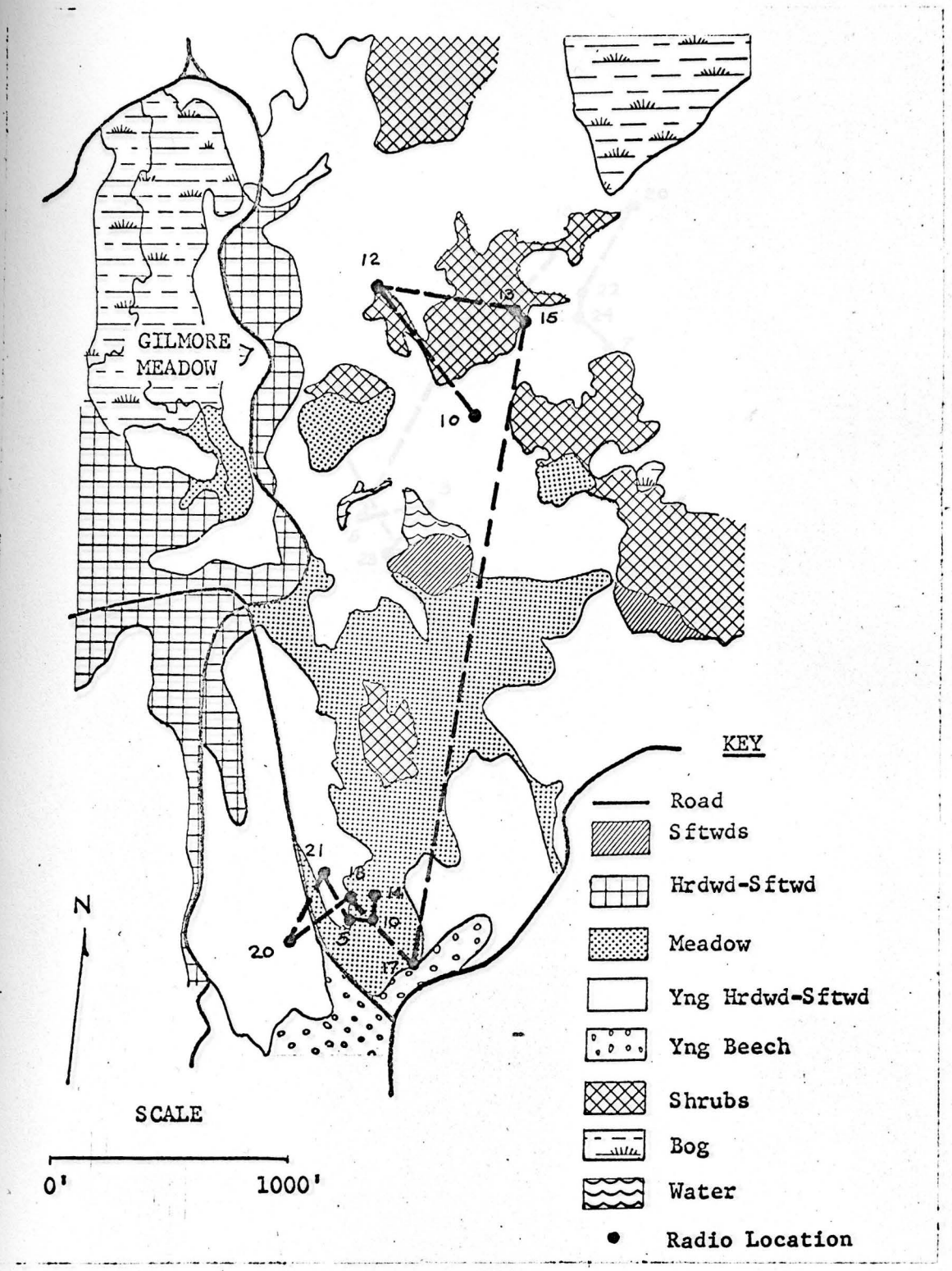


FIGURE 24. DAILY MOVEMENT PATTERN OF DEER #MC8 ON JUNE 20-21, 1968 (numerals are the hour of location based on a 24-hour clock).

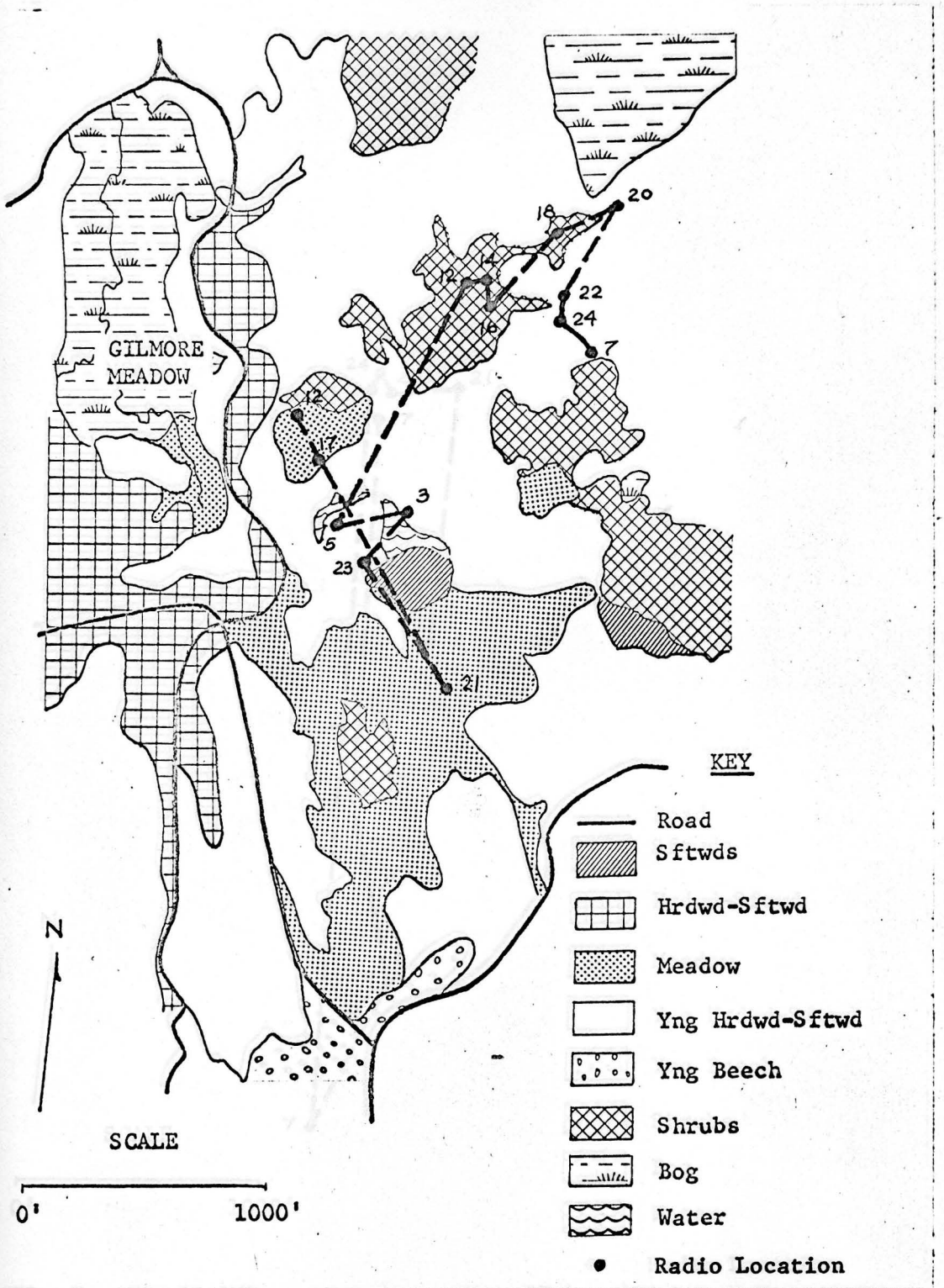


FIGURE 25. DAILY MOVEMENT PATTERN OF DEER #MC8 ON JULY 2-4, 1968 (numerals are the hour of location based on a 24-hour clock).

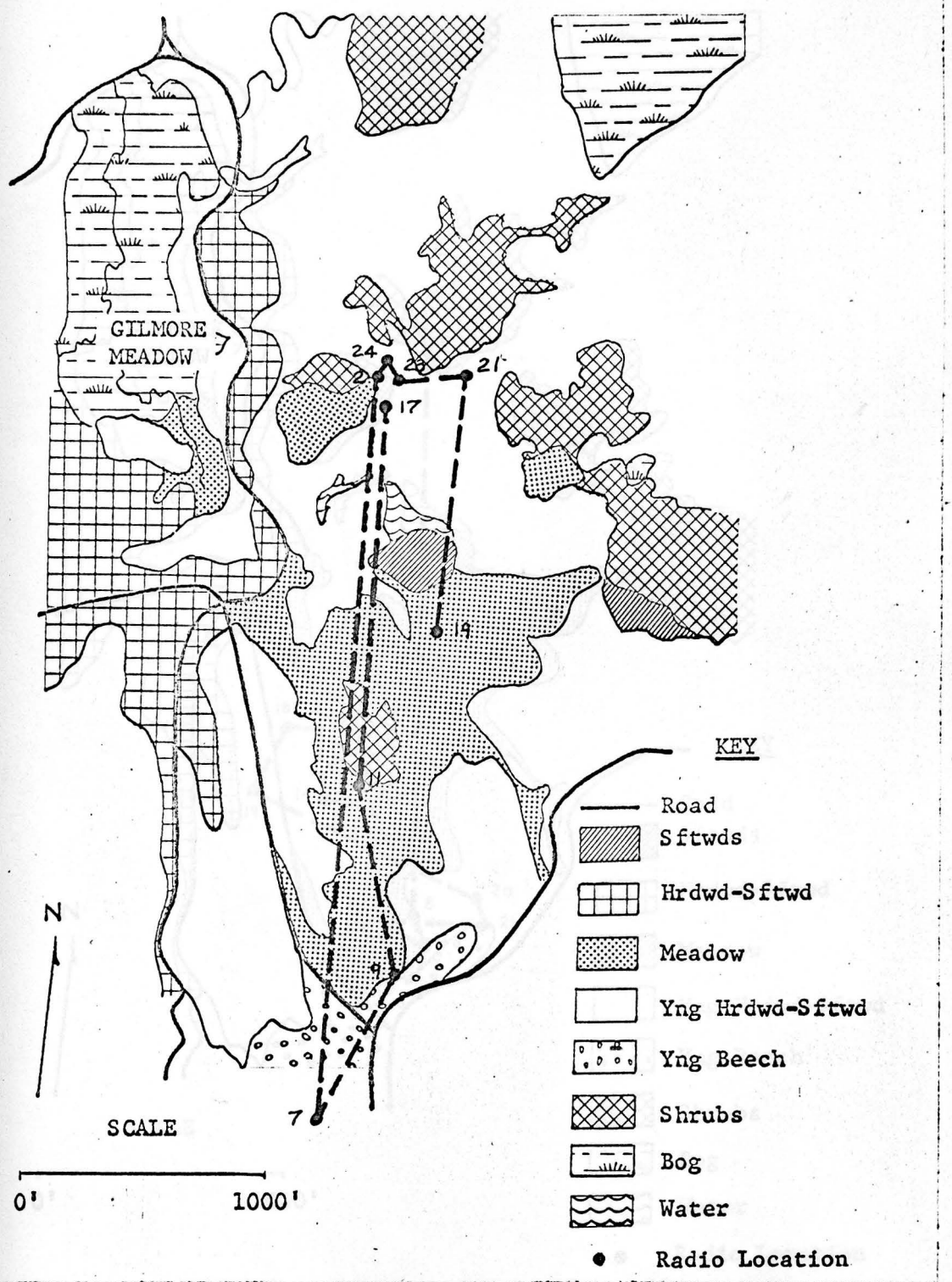


FIGURE 26. DAILY MOVEMENT PATTERN OF DEER #MC8 ON AUGUST 8-9, 1968 (numerals are the hour of location based on a 24-hour clock).

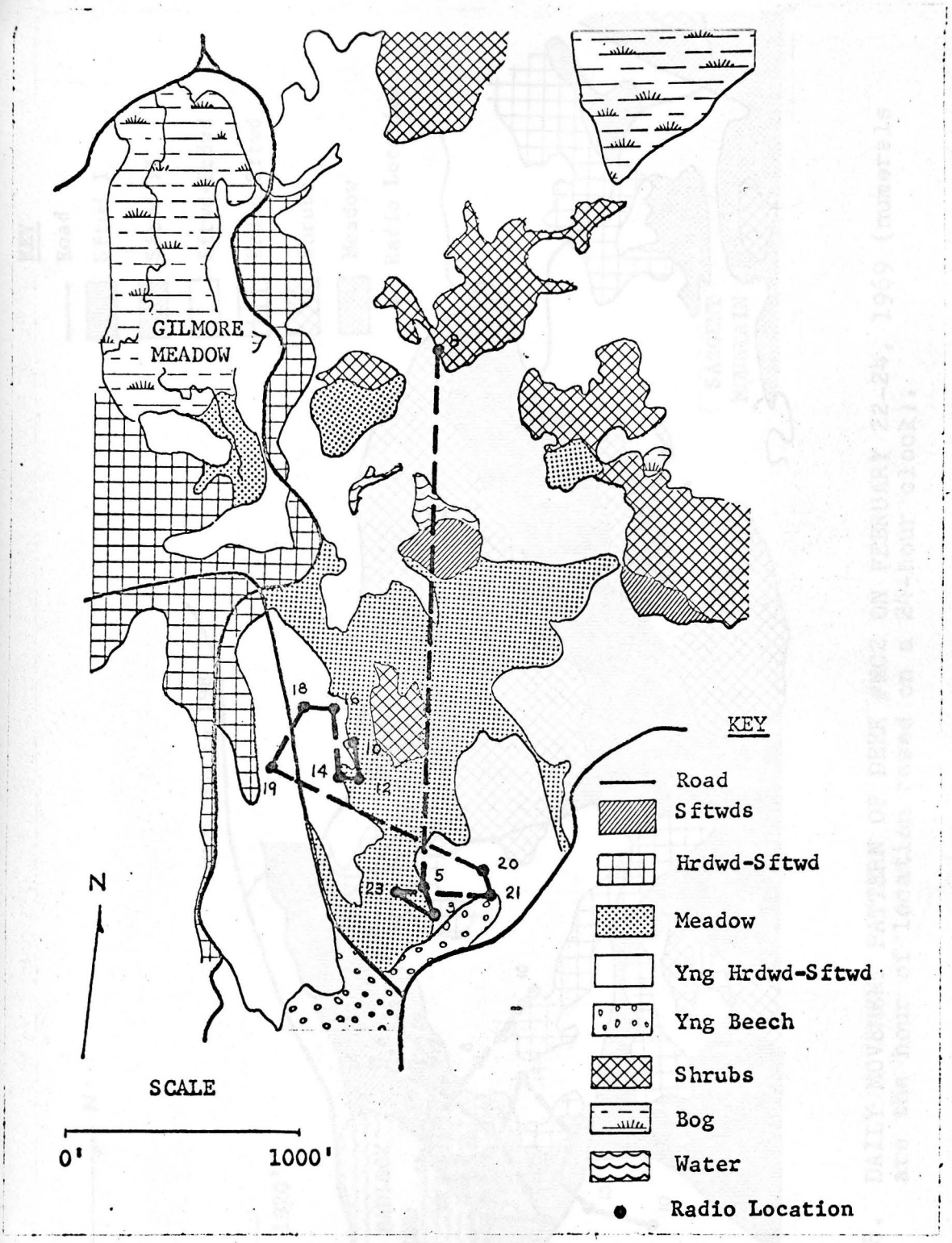


FIGURE 27. DAILY MOVEMENT PATTERN OF DEER #MC8 ON AUGUST 20-21, 1968 (numerals are the hour of location based on a 24-hour clock).

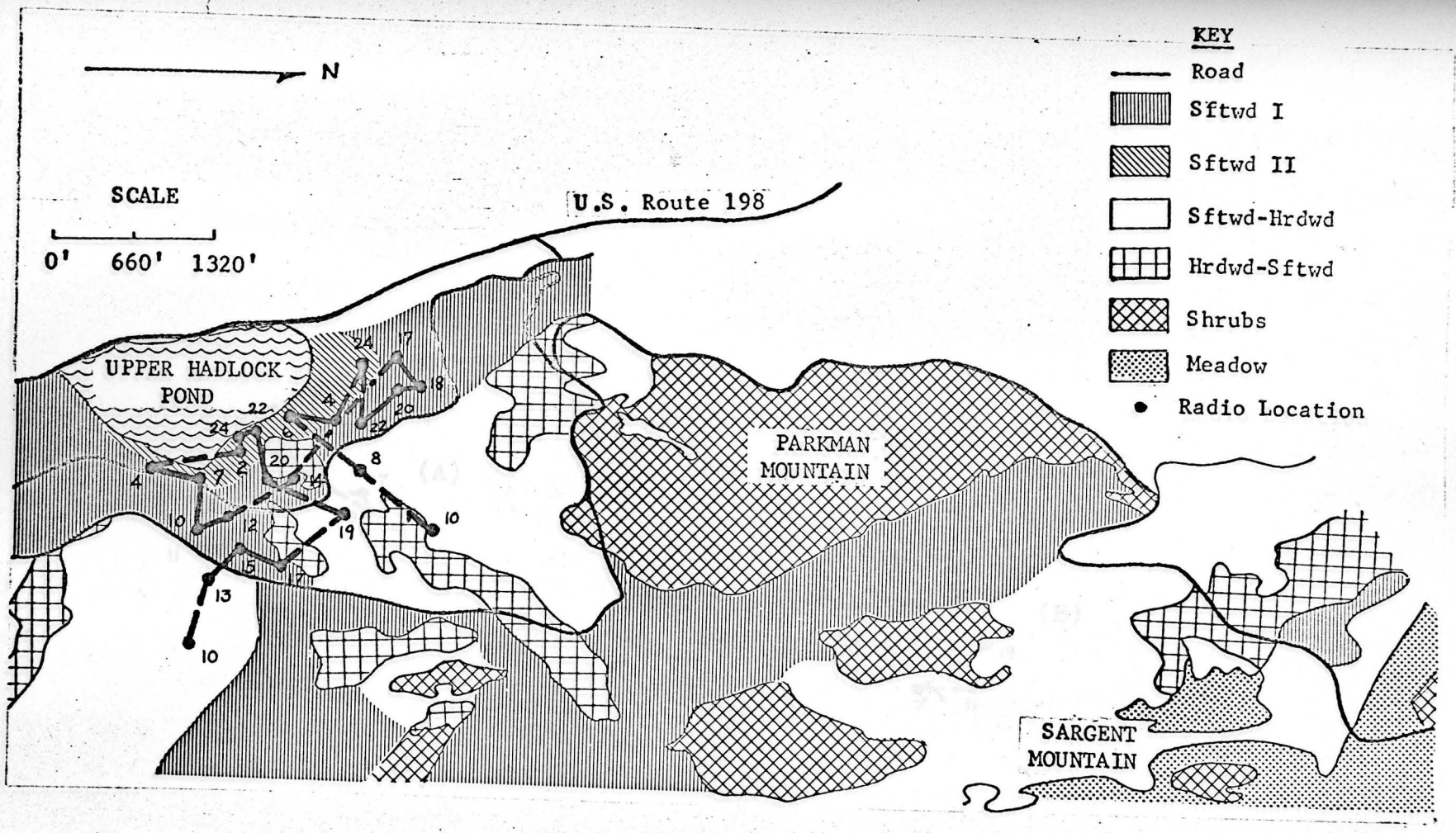


FIGURE 28. DAILY MOVEMENT PATTERN OF DEER #MC2 ON FEBRUARY 22-24, 1969 (numerals are the hour of location based on a 24-hour clock).

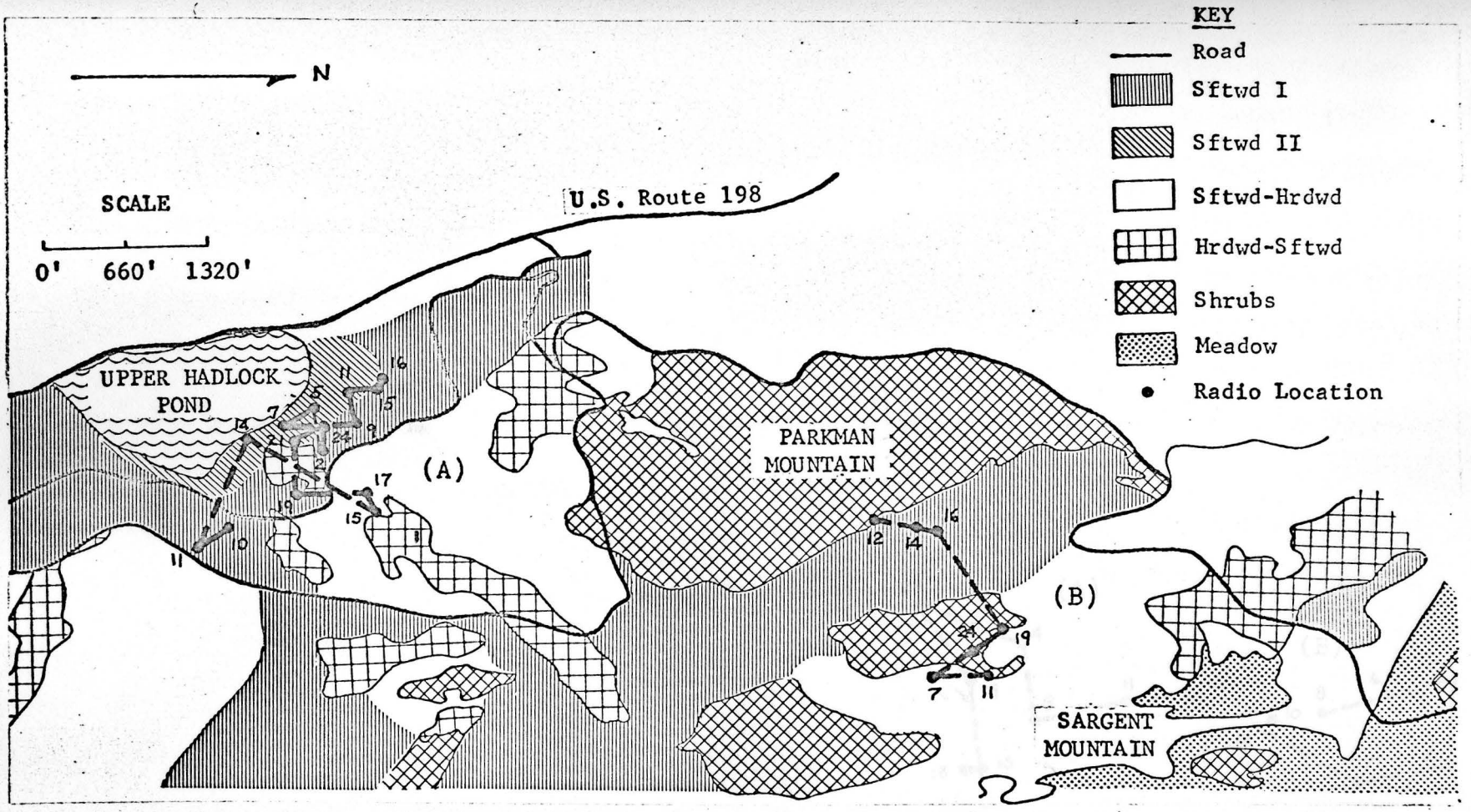


FIGURE 29. DAILY MOVEMENT PATTERNS OF DEER #MC2 ON MARCH (A) 1-3 AND (B) 29-30, 1969 (numerals are the hour of location based on a 24-hour clock).

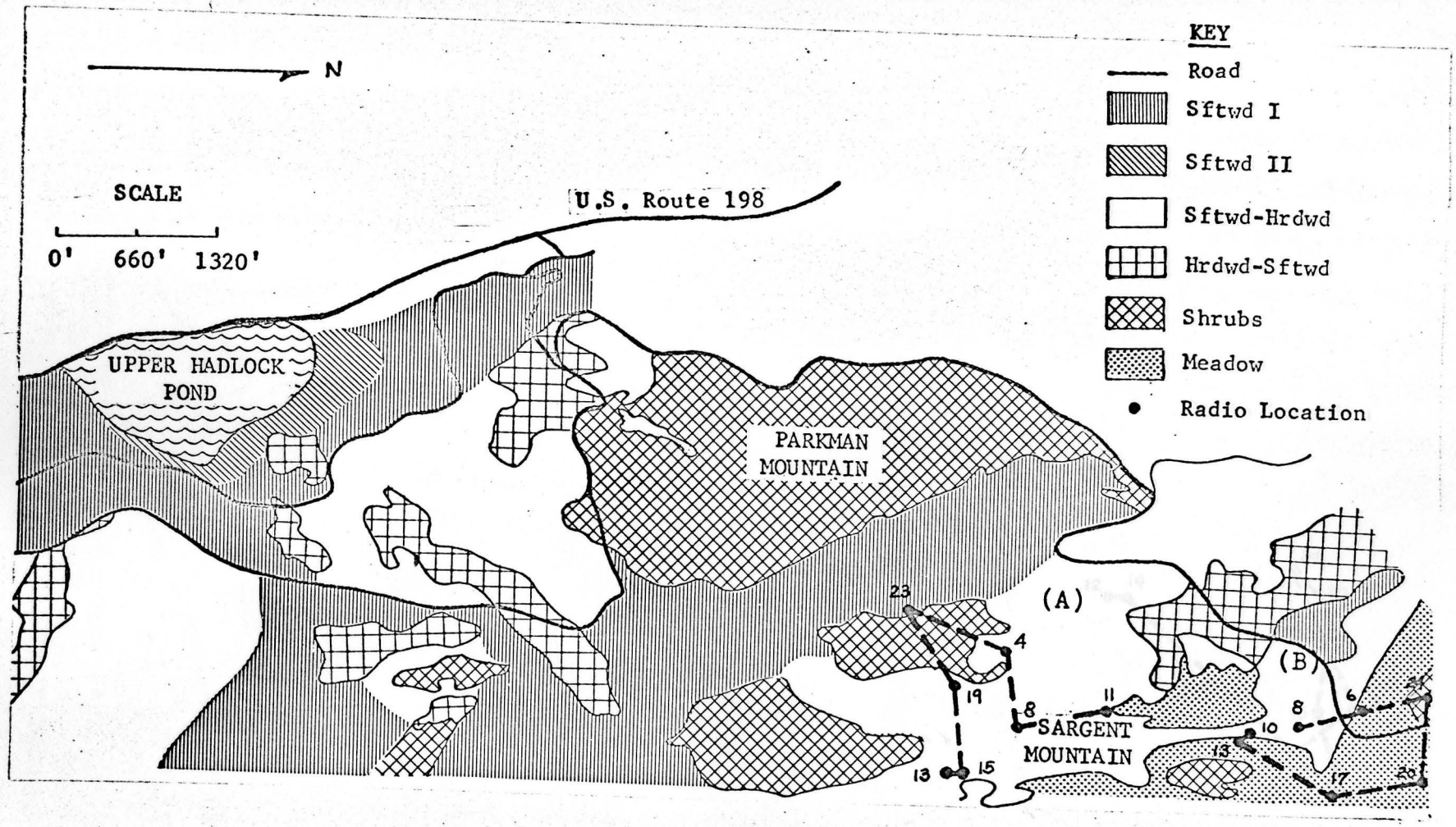


FIGURE 30. DAILY MOVEMENT PATTERNS OF DEER #MC2 ON (A) APRIL 4-5 AND (B) MAY 6-7, 1969 (numerals are the hour of location based on a 24-hour clock).

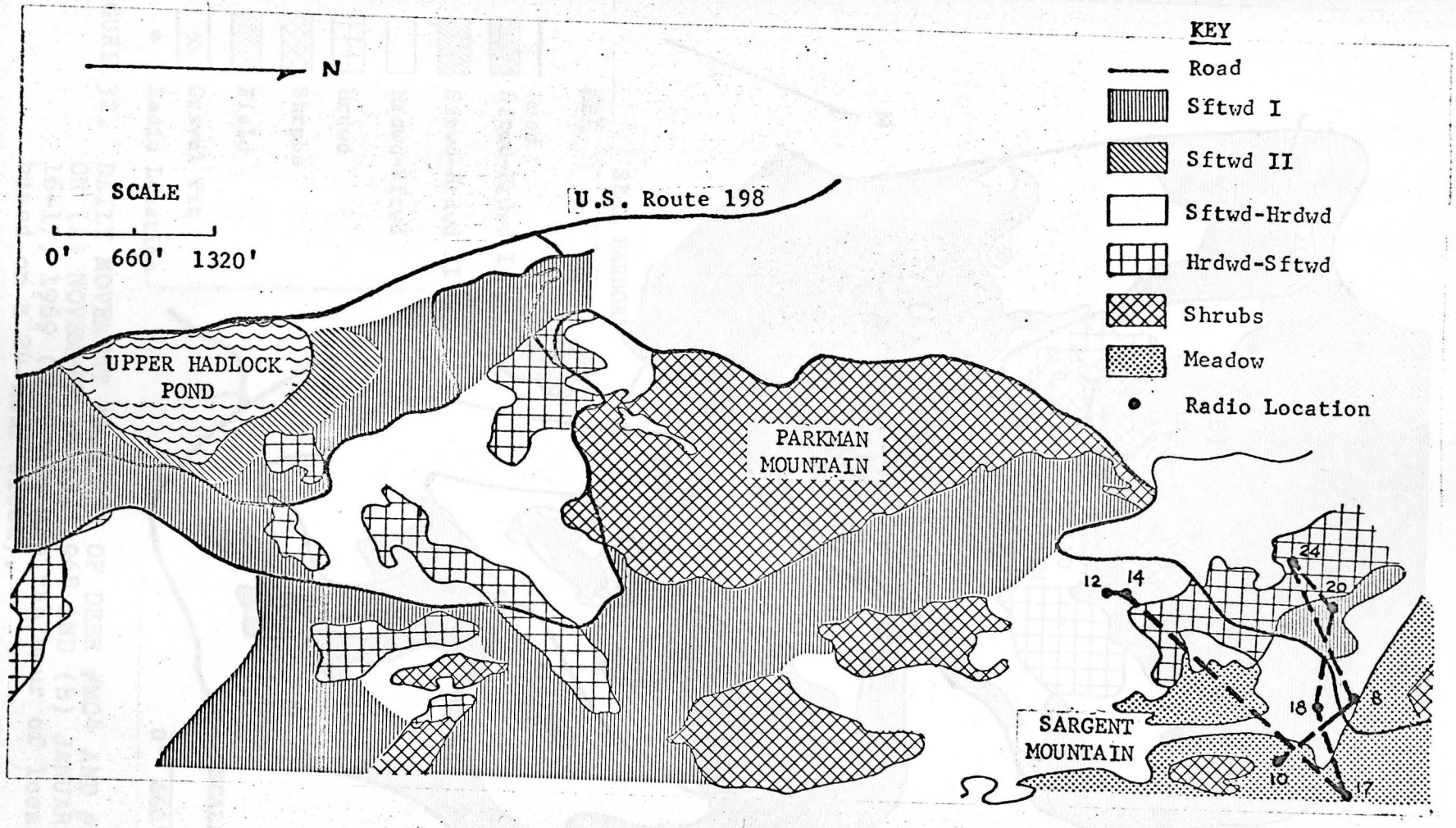


FIGURE 31. DAILY MOVEMENT PATTERN OF DEER #MC2 ON JUNE 20-21, 1969 (numerals are the hour of location based on a 24-hour clock).

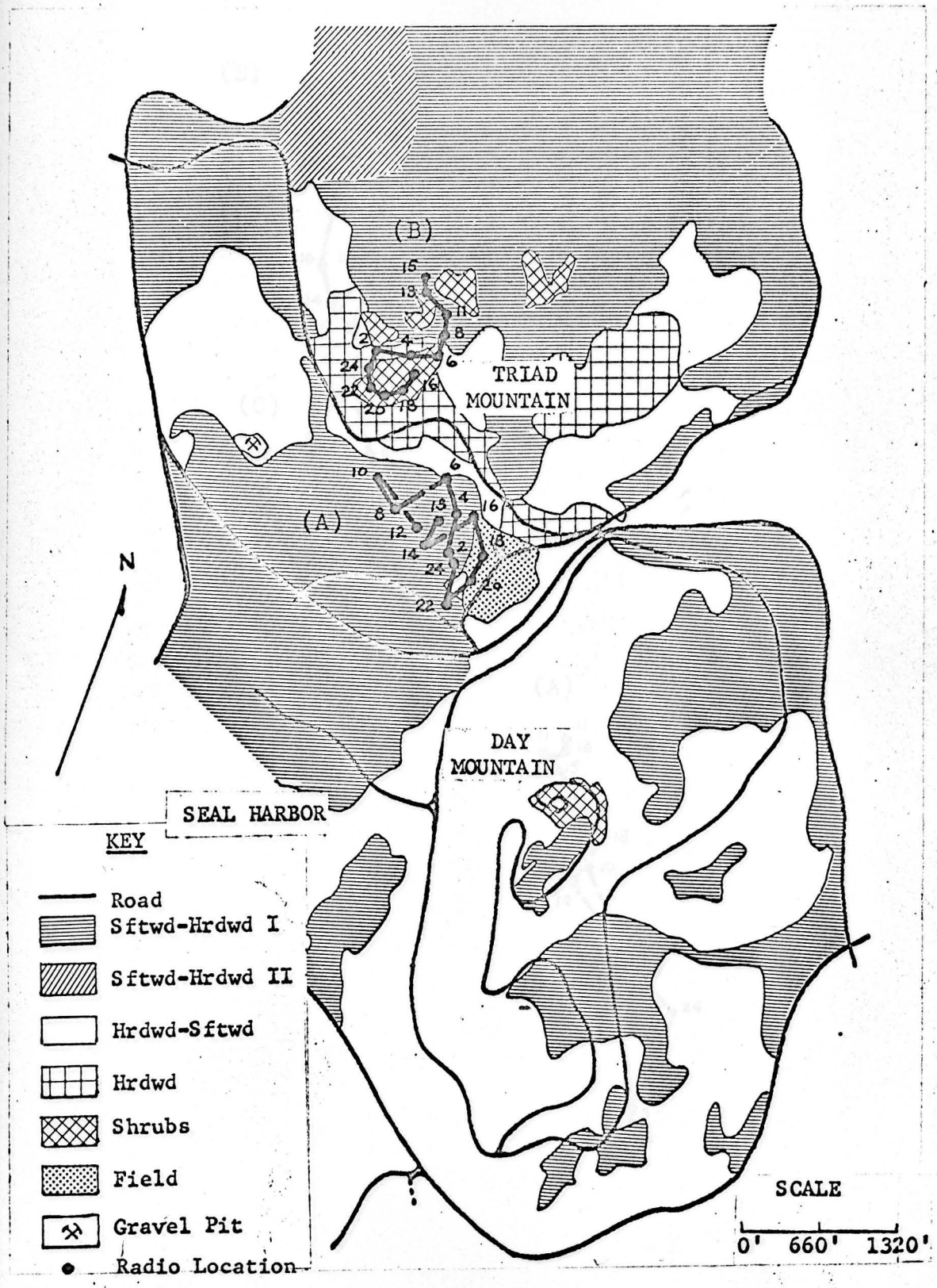


FIGURE 32. DAILY MOVEMENT PATTERNS OF DEER #MC4 AND #MC12 ON (A) NOVEMBER 12-13, 1968 AND (B) JANUARY 16-17, 1969 (numerals are the hour of location based on a 24-hour clock).

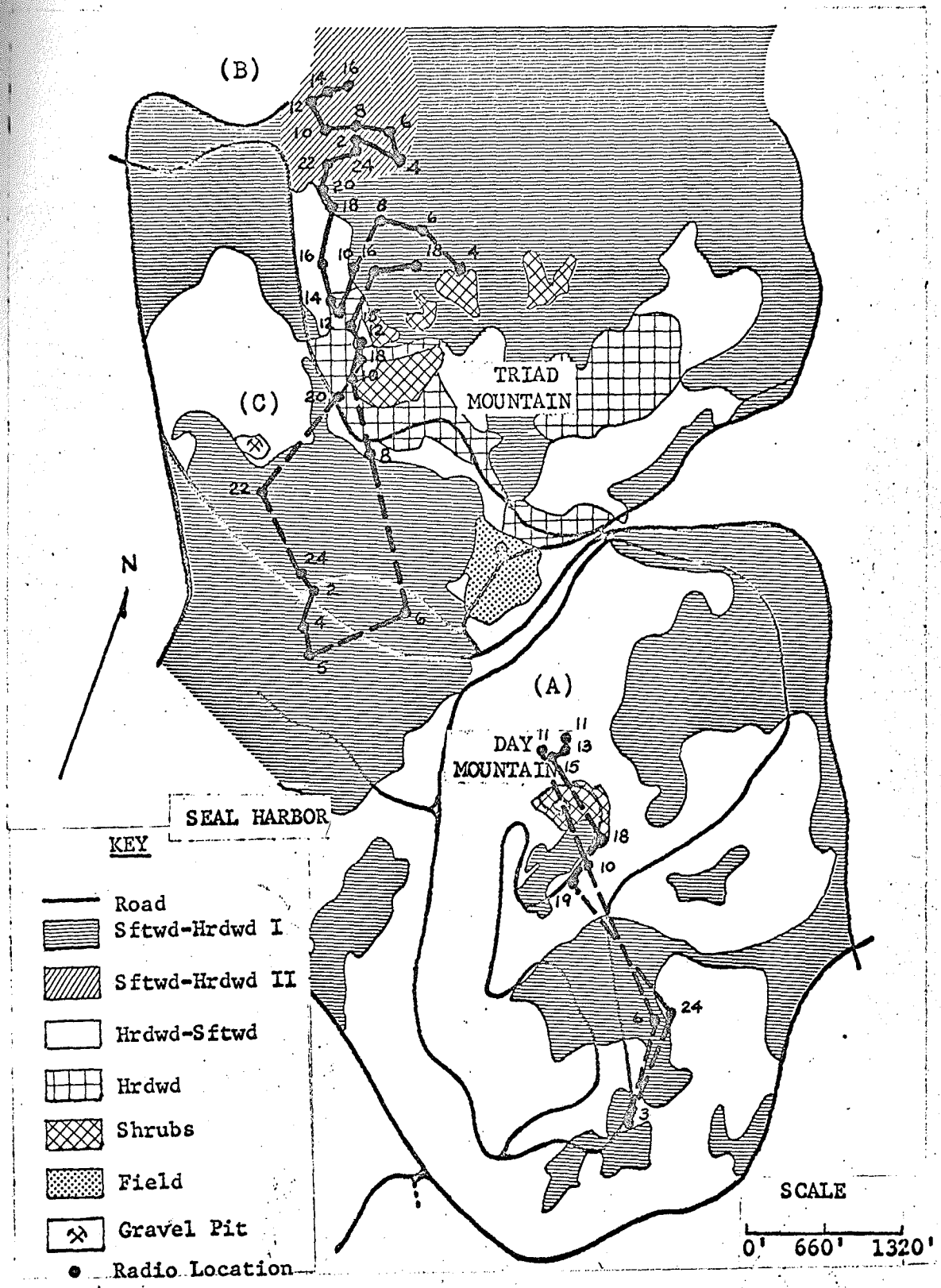


FIGURE 33. DAILY MOVEMENT PATTERNS OF DEER #MC4 AND #MC12 ON FEBRUARY (A) 1-2, (B) 10-12 AND (C) 22-23, 1969 (numerals are the hour of location based on a 24-hour clock).

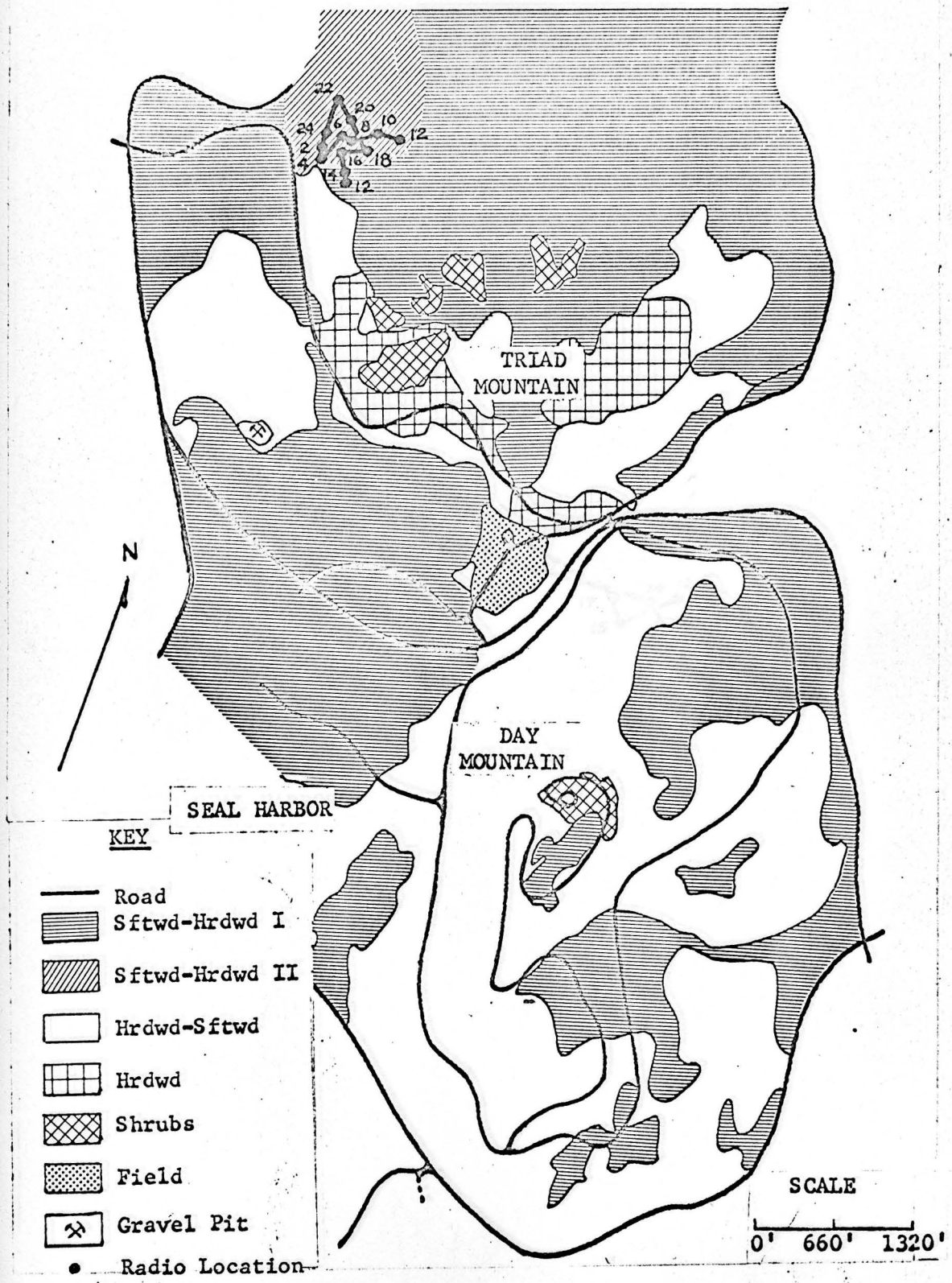


FIGURE 34. DAILY MOVEMENT PATTERN OF DEER #MC4 AND #MC12 ON MARCH 1-2, 1969 (numerals are the hour of location based on a 24-hour clock).

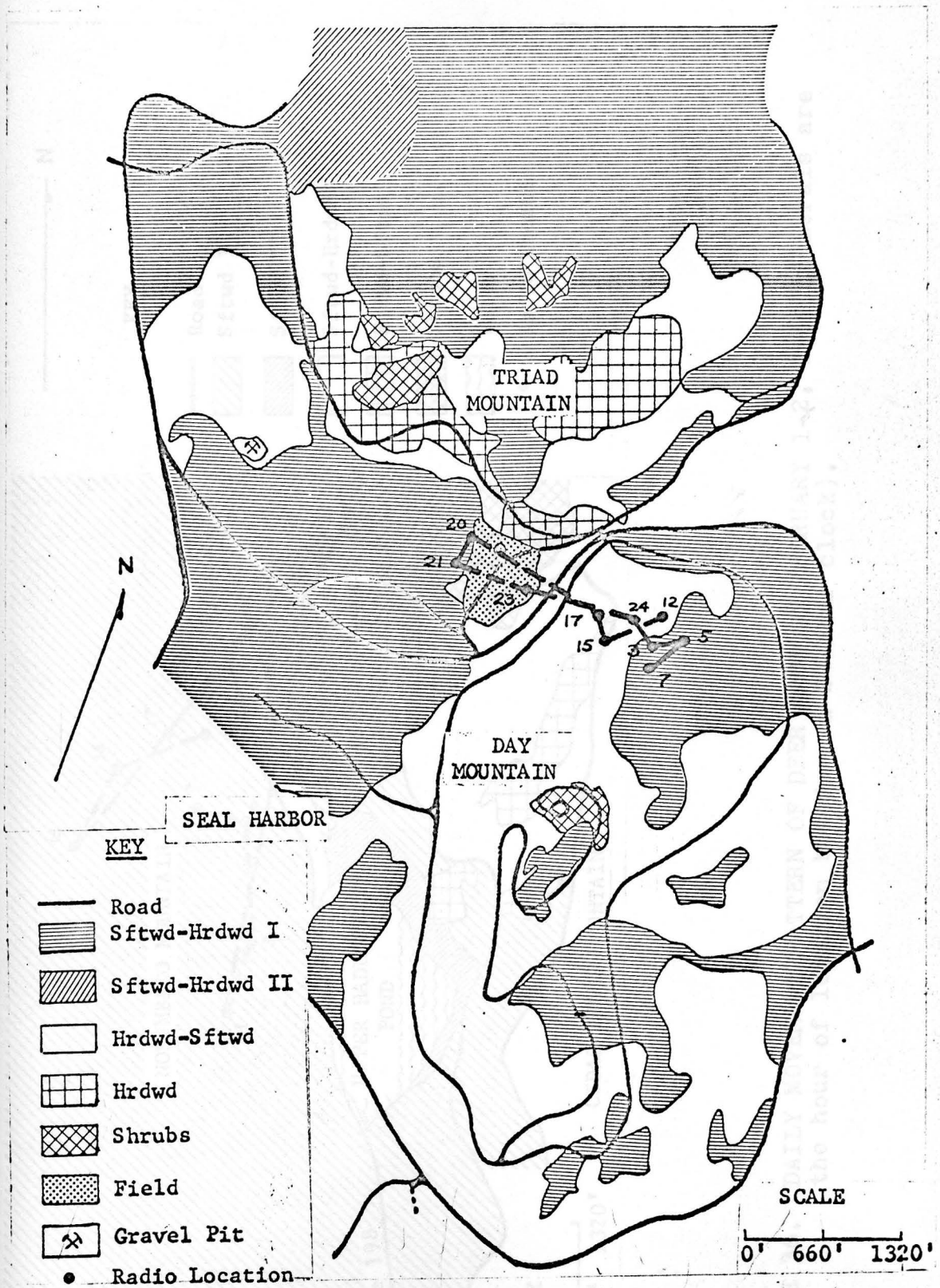


FIGURE 35. DAILY MOVEMENT PATTERN OF DEER #MC3 ON DECEMBER 5-6, 1968 (numerals are the hour of location based on a 24-hour clock).

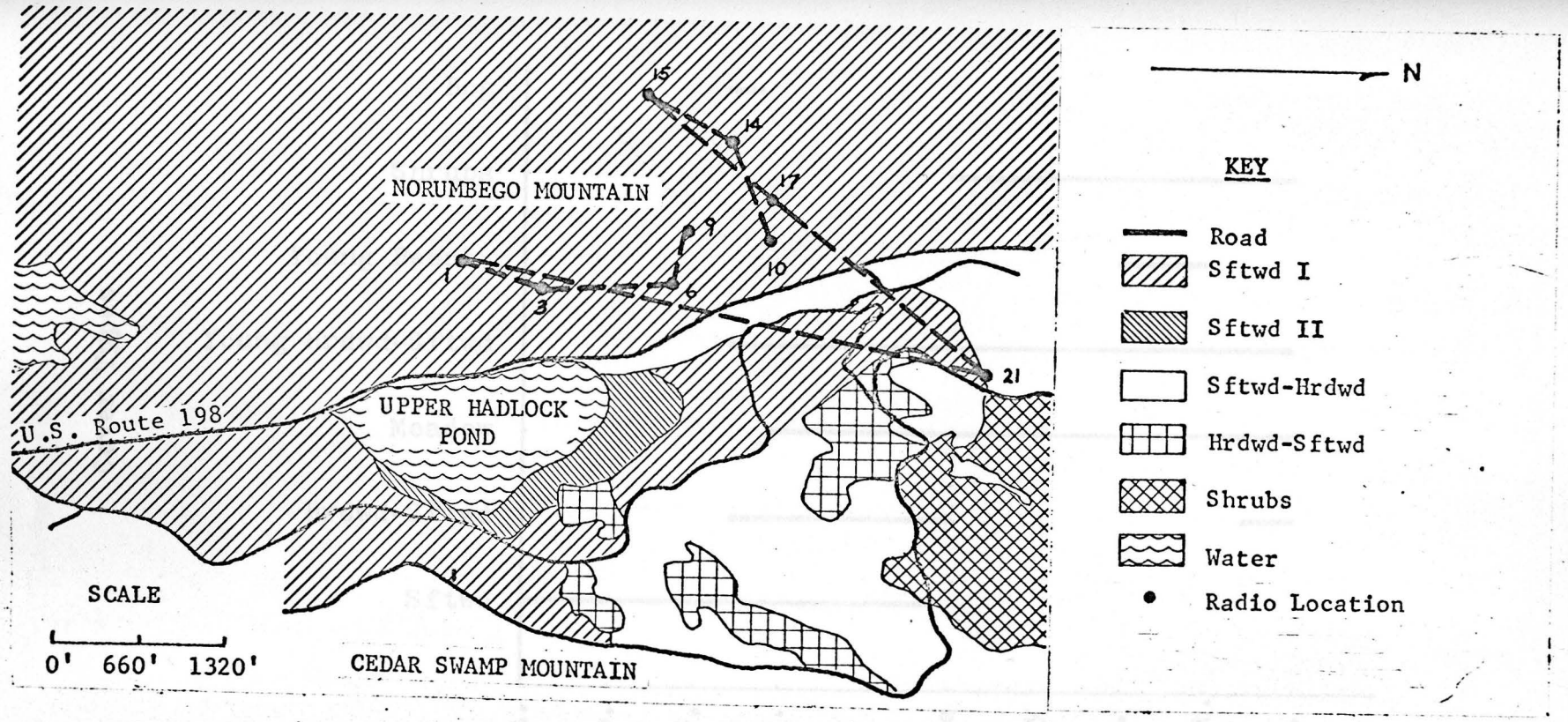


FIGURE 36. DAILY MOVEMENT PATTERN OF DEER #CC1 ON FEBRUARY 1-2, 1969 (numerals are the hour of location based on a 24-hour clock).

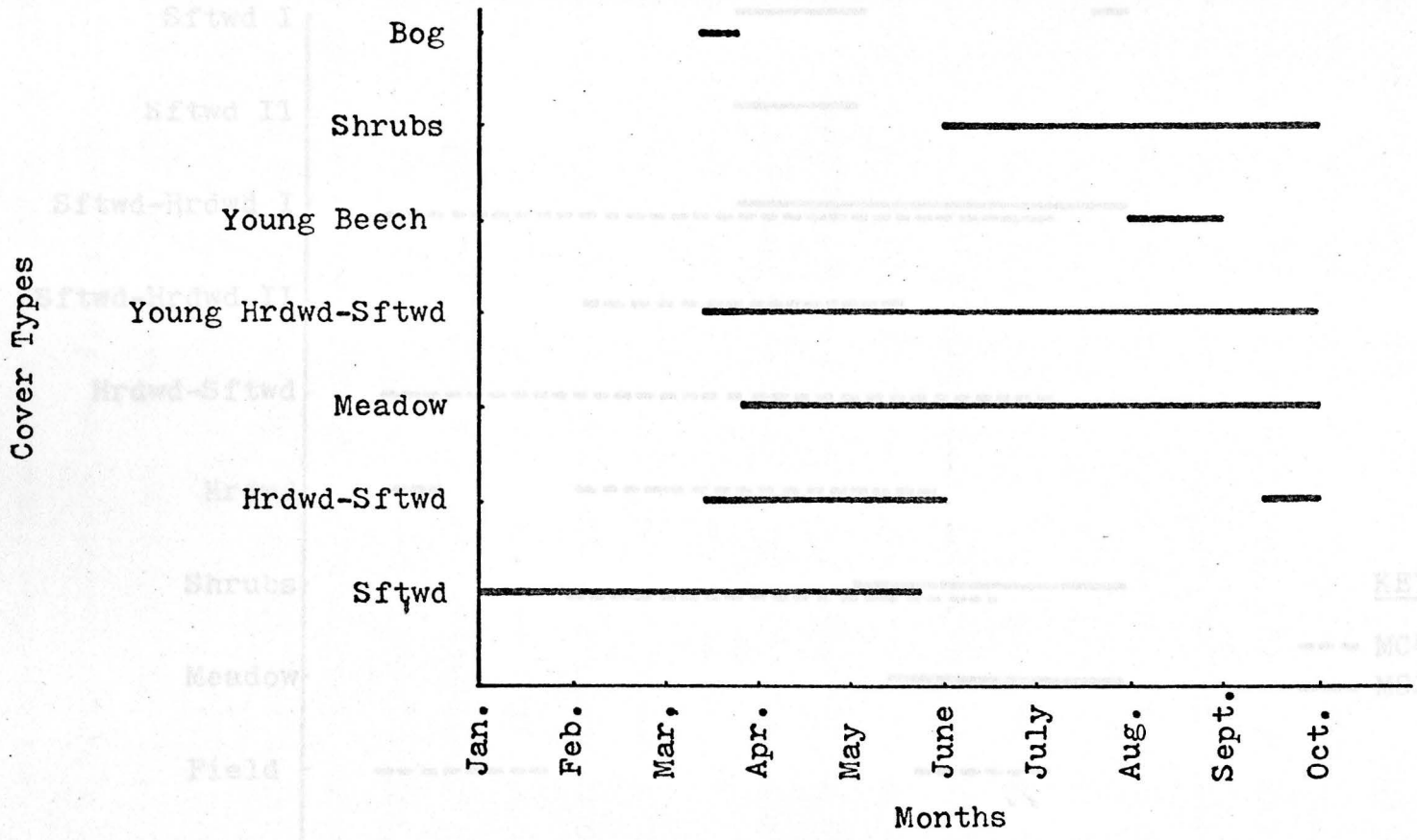


FIGURE 37. COVER TYPE USE BY DEER #MC8 DURING THE TRACKING PERIOD (indicated by solid lines) FROM JANUARY THROUGH SEPTEMBER, 1968.

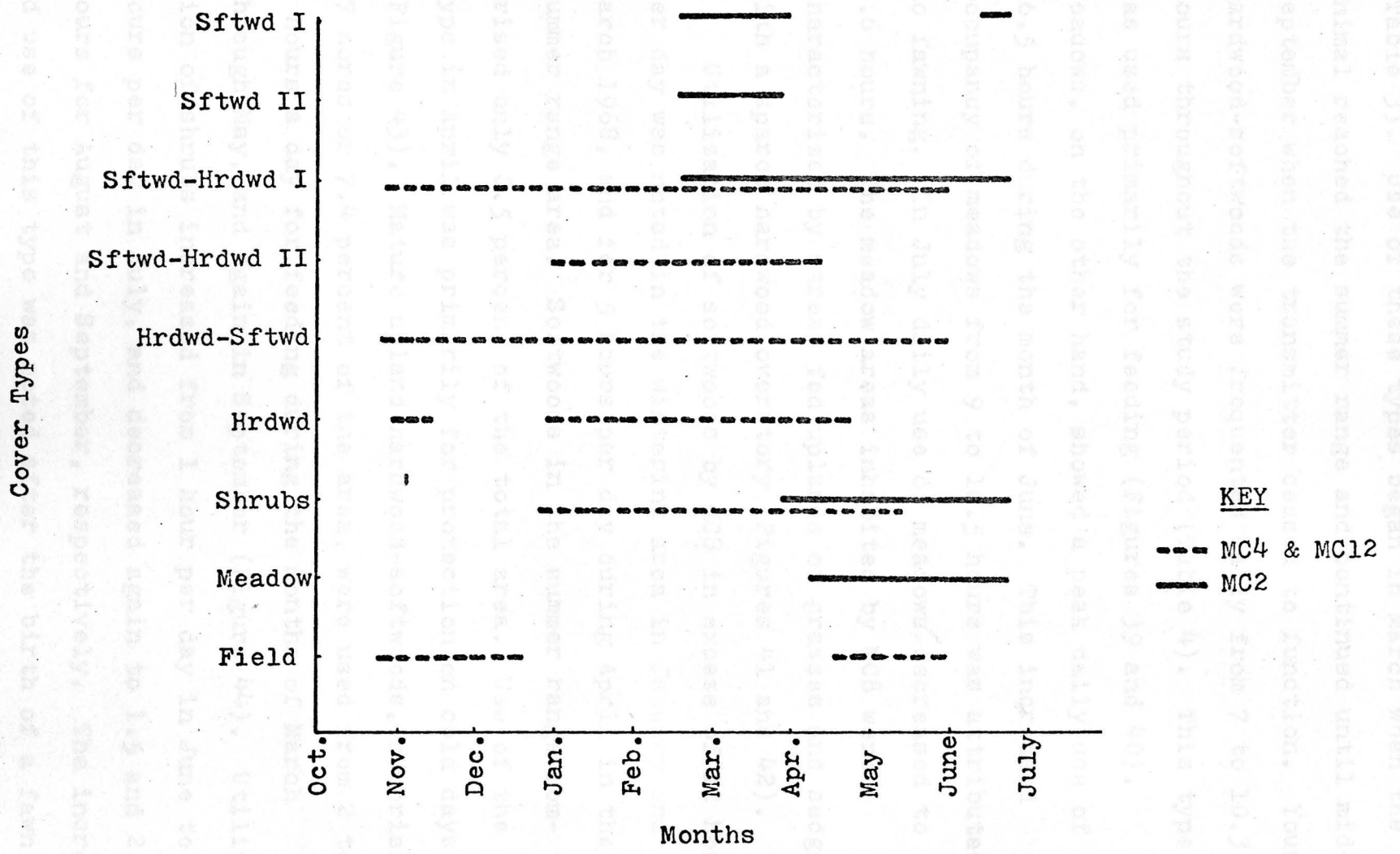


FIGURE 38. COVER TYPE USE BY DEER #MC4, #MC12 AND #MC2 DURING THE TRACKING PERIOD.

(Table 3). Use of these types began in March when the animal reached the summer range and continued until mid-September when the transmitter ceased to function. Young hardwood-softwoods were frequented daily from 7 to 10.3 hours throughout the study period (Table 4). This type was used primarily for feeding (Figures 39 and 40). Meadows, on the other hand, showed a peak daily use of 16.5 hours during the month of June. This increased occupancy of meadows from 9 to 16.5 hours was attributed to fawning. In July daily use of meadows decreased to 8.6 hours. The meadow areas inhabited by MC8 were characterized by stream fed uplands of grasses and sedges with a sparce hardwood overstory (Figures 41 and 42).

Utilization of softwoods by MC8 in excess of 12 hours per day was noted in the wintering area in January and March 1968, and for 5 hours per day during April in the summer range area. Softwoods in the summer range comprised only 0.5 percent of the total area. Use of the type in April was primarily for protection on cold days (Figure 43). Mature upland hardwood-softwoods, comprising 27 acres or 7.4 percent of the area, were used from 2 to 6 hours a day for feeding during the months of March through May, and again in September (Figure 44). Utilization of shrubs increased from 1 hour per day in June to 5 hours per day in July, and decreased again to 1.5 and 2 hours for August and September, respectively. The increased use of this type was noted after the birth of a fawn in

TABLE 3. ACREAGE OCCUPIED BY COVER TYPES IN EACH OF THE THREE STUDY AREAS

Cover Types	Area Occupied* (acres)					
	GM	(%)	HP-SM	(%)	T-DM	(%)
Softwood I (spruce predominating)	2	0.5	90	22.2		
Softwood II (cedar predominating)			15	3.7		
Softwood-Hardwood I (spruce predominating)	180	49.3	177	43.6	238	40.7
Softwood-Hardwood II (cedar predominating)					26	4.4
Hardwood-Softwood	27	7.4	54	13.3	262	44.8
Young Hardwood-Softwood	96	26.3				
Young Beech	5	1.3				
Hardwoods					34	5.8
Meadow	28	7.7	48	11.8		
Shrubs	13	3.6	19	4.7	15	2.6
Bog	13	3.6				
Field					8	1.4
Miscellaneous	1	0.3	3	0.7	2	0.3
	365	100	406	100	585	100

* GM = Gilmore Meadow Area
HP-SM = Hadlock Pond - Sargent Mountain Area
T-DM = Triad - Day Mountain Area

TABLE 4. AVERAGE NUMBER OF HOURS PER DAY SPENT IN EACH COVER TYPE BY RADIO-EQUIPPED DEER DURING THE TRACKING PERIOD. *

MC8 (Adult Female) Cover Types	Months						
	Mar.	Apr.	May	June	July	Aug.	Sept.
Softwoods I	12+	5.0	--	--	--	--	--
Hrdwd-Sftwd	4.0	2.0	6.0	--	--	--	4.0
Meadow	4.0	9.5	9.0	16.5	8.6	10.5	8.0
Young Hrdwd-Sftwd	7.3	7.0	9.0	7.0	10.3	9.5	10.0
Young Beech	--	--	--	--	--	2.5	--
Shrubs	--	--	--	1.0	5.0	1.5	2.0
Bog	4.0	--	--	--	--	--	--

MC2 (Adult Male)	Months				
	Feb.	Mar.	Apr.	May	June
Softwoods I	11.0	6.7	--	--	1.0
Softwoods II	8.5	9.5	--	--	--
Sftwd-Hrdwd I	4.5	4.7	14.0	6.5	4.0
Hrdwd-Sftwd	--	--	--	2.0	7.0
Shrubs	--	3.0	9.0	6.0	3.0
Meadows	--	--	1.0	9.5	9.0

MC4 (Fawn Male) & MC12 (Adult Female)	Months							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Sftwd-Hrdwd I	12.6	10.0	11.0	10.3	6.5	11.0	6.0	5.0
Sftwd-Hrdwd II	--	--	2.5	6.3	13.5	4.5	--	--
Hrdwd-Sftwd	6.0	9.0	3.5	8.0	1.0	5.0	14.0	15.0
Hardwoods	0.3	--	3.0	3.0	1.5	1.5	--	--
Shrubs	--	1.5	4.0	0.3	1.5	2.0	1.0	--
Field	5.0	3.5	--	--	--	--	3.0	4.0

* Based upon the total number of days monitored each month



FIGURE 39. DENSE STAND OF YOUNG HARDWOOD-SOFTWOODS IN GILMORE MEADOW AREA, SEPTEMBER, 1969.



FIGURE 40. HARDWOOD-SOFTWOODS (showing dense coniferous understory, Gilmore Meadow, September, 1969)



FIGURE 41. ONE ACRE GRASSLAND MEADOW (Gilmore Meadow, September, 1969)



FIGURE 42. DRAINAGE CHANNEL THROUGH BEAVER FLOODED GRASSLAND MEADOW (Gilmore Meadow, September, 1969)



FIGURE 43. SOFTWOOD STAND SHOWING DENSE SPRUCE OVERSTORY AND LACK OF GROUND COVER. (Gilmore Meadow, September, 1969)



FIGURE 44. HARDWOOD-SOFTWOOD STAND WITH A RELATIVELY DENSE UNDERSTORY OF FERNS (Gilmore Meadow, September, 1969)

late June. The dense shrub growth (7,000 trees and shrubs per acre) composed 3.6 percent of the home range habitat and provided excellent concealment of the fawn during the first few weeks of life (Figure 45). The use of bogs and beech stands was incidental and only occurred during a portion of 1 month of the study period (Figure 46). Daily use of cover types for all deer are summarized in Table 4. Vegetative composition and density occurring in the various stand types for all areas are presented in Tables 1 through 9 of Appendix II.

Deer #MC2

Softwood-hardwood stands, comprising 43.6 percent of the area, were the most important type used by MC2, (Table 3). This type was occupied from mid-February through June, 1969, until the transmitter signal was lost. Both softwood types, one with spruce predominating, and the other with cedar, were the major cover types selected during the winter period and showed a total daily use of 16 to 20 hours during February and March. These types together composed 25.9 percent of the total area. They were used primarily for shelter, although the cedar stand provided large quantities of food especially during the month of March when snow depths exceeded 20 inches. As MC2 traveled up Sargent Mountain in April, toward its summer range, cover type selection shifted from softwoods to softwood-hardwoods and shrubs. High elevation shrub areas,



FIGURE 45. SHRUB ZONE ON DRY ROCKY SITE. (average tree height less than six feet, Gilmore Meadow, September, 1969)



FIGURE 46. GILMORE MEADOW BOG SHOWING GRASSES, SEDGES AND BOG SHRUBS (September, 1969)

comprising 4.7 percent of MC2's home range, were used 9 hours per day during April, mainly for feeding. Their occupancy dropped to 6.0 and 3.0 hours per day during May and June, respectively, as the use of hardwood-softwood and meadow types increased. Meadows were used 9 hours per day during May and June for both feeding and resting. Daily utilization of hardwood-softwood types was highest in June at 7 hours.

Deer #MC4 and #MC12

Softwood-hardwood I stands and hardwood-softwood stands were the most important types used by MC4 and MC12. They composed 262 and 238 acres, respectively, of the total 585-acre home range. Their occupancy was observed throughout the duration of the study period from November, 1968, to June, 1969. Softwood-hardwoods, with spruce predominating, received the highest use, averaging 11 hours per day from November to March. Because of a 24-inch snowfall in March, selection of this type shifted to an increased occupancy of another softwood-hardwood stand with cedar predominating. Utilization of the cedar type reached 13.5 hours per day for that month. Together the two stands were occupied 20-hours per day during March. Hardwood-softwood stands reached their peak utilization of 14 and 15 hours per day during May and April. Hardwoods and high elevation shrub areas were used primarily for feeding. One to 4 hours per day were spent in these

types during the months between December and April when snow conditions permitted easy travel on the mountain slopes. These areas comprised 5.8 and 2.6 percent of the area (Table 3). The use of the field area was observed during the evening hours of November and December, 1968, and again in May and June, 1969. Field use ranked third in importance even though it composed only 8 acres (1.4 percent) of the total home range. Apple trees in the field provided fall food for the deer, while young succulent herbaceous vegetation provided spring food. Studies conducted in northern Wisconsin from 1959 to 1968 to determine the relationships between deer and forest openings showed that deer activity was significantly higher in stands of hardwoods containing grassy openings. Small openings less than 5 acres were used more extensively by deer than larger ones. Activity in these grassy openings was found to be highest during spring and fall and appeared related to seasonal forage preferences (McCaffery and Creed, 1969). Observations of deer in the Triad-Day Mountain area showed a similar preference for grassy openings.

Winter Browse Survey

Because of the poor deer range conditions recognized in many winter yards by McLaughlin (1968), an intensive investigation was considered necessary. Since West Sargent Mountain was chosen as the trapping locale of

radio-equipped animals during the winter 1967-68, and had a past history of overuse resulting in deer starvation, it was chosen as the site for the winter browse survey.

Results of the survey indicated a very low supply of several plant species available to deer. Balsam fir, a non-preferred food in this area, composed 84.4 percent of all available browse (Table 5). Blueberry and sweetfern together composed 10.4 percent of the remaining browse. A measure of total browse utilization by deer in the yard showed sweetfern to rank highest at 35.8 percent, followed by blueberry and balsam fir which ranked 26.7 percent and 21.3 percent, respectively.

Many highly preferred woody plants were scarce and relatively unavailable to deer. Of these species, mountain ash was the most preferred with 78.6 percent of the available browse consumed by deer. It was followed by sweetfern at 71.6 percent and honeysuckle at 57.7 percent. Other highly preferred species by deer were raspberry, blueberry, and mountain maple.

Seasonal Shifts in Home Range

Because of the severe winter climate characteristic of the northeast, deer are forced to move to the protective cover of softwoods during the winter months. Deer normally move to the vicinity of winter yarding areas with the onset of cold weather (Banasiak, 1961).

All four deer monitored through the winter season

TABLE 5. 1968 WINTER BROWSE SURVEY OF THE WEST SARGENT MOUNTAIN YARD

Species	Freq. of Occurrence (%)	Total Twigs Present		Total Twigs Browsed		Percent Composition of Browsed Twigs
		No.	%	No.	%	
Balsam Fir	58.6	17,881	84.4	394	2.2	21.3
Striped Maple	20.0	348	1.6	*123	35.3	6.7
Gray Birch	10.3	416	2.0	79	19.0	4.3
Blueberry	10.3	1,275	6.0	*493	43.6	26.7
Northern White Cedar	2.8	31	0.1	2	6.5	0.1
Witch-hazel	2.8	20	Tr.	-	-	-
Sweetfern	2.8	924	4.4	662	71.6	35.8
Bush Honeysuckle	2.1	26	0.1	15	57.7	0.8
Beech	2.8	118	0.6	33	28.0	1.8
Lambkill	1.4	20	Tr.	6	30.0	0.3
Serviceberry	2.8	17	Tr.	5	29.4	0.3
Mountain Maple	1.4	17	Tr.	7	41.2	0.4
Mountain Ash	1.4	14	Tr.	11	78.6	0.6
Meadow-Sweet	1.4	19	Tr.	3	15.8	0.2
Raspberry	1.4	28	0.1	13	46.4	0.7
Blackberry	Tr.	2	Tr.	-	-	-
Yellow Birch	Tr.	12	*Tr.	*-	-	-
White Birch	Tr.	7	Tr.	1	14.3	Tr.
Red Maple	Tr.	1	Tr.	-	-	-
Total		21,176	100	1,847		100

Trace Elements are less than 0.1 percent.

* Striped Maple - Plus 3 hare browsed
Blueberry - Plus 63 hare browsed
Yellow Birch - 7 hare browsed

were found to move to and from winter yards. The distance traveled varied for the individuals, ranging from 0.4 to 1.7 miles, and was dependent upon the distance from the summer range to the most accessible winter habitat affording the best cover and protection against the winter elements.

During periods of mild winter weather, the animals moved into areas adjacent to the yard. In spring there was a movement from the yards back to the summer range. The time of this movement varied for each area. None of the 4 deer returned to the yards again even during periodic spring cold spells. During these cold periods, small areas of softwood covers within the spring or summer range were used for protection.

Meteorological Influence

Effects of Snow Depth

Changes in cover type selection and mobility of the deer were noted with varying snow accumulations and physical conditions. This reaction has been observed by many investigators in the field; Marston (1942), Glasgow (1948), Robinson (1959), Banasiak (1961), and Day (1963), on white-tails in Maine, and Linsdale and Tomich (1953), Miller (1965), and Gilbert et.al. (1970), on mule deer in the West.

Air chill and snow accumulations interacted to affect

the type of habitat selected by deer during the winter months of 1967-68 and 1968-69. Use of softwood cover in the winter range area by MC4 and MC12 was evident with as little as 3 inches of snow accumulation (Figure 47). These deer sought the protection of softwood cover on the lower west slope of Triad Mountain during snow storms accumulating a total depth of more than 5 inches. Deer temporarily abandoned high elevation hardwoods when snow depth reached 24 inches, and movements were greatly restricted. Limited use of these areas was resumed when the snow crusted. Offshore winds created many snow-free areas on mountain tops by drifting and compacting snow. As a result travel and feeding by deer were facilitated at higher elevations, and many deer were observed traveling up the slopes to feed. They moved down only to seek shelter during storms or periods of cold.

Marston (1942) found that hardwoods in central Maine were used by deer extensively with snow accumulations of 5 inches, but were abandoned when snow depths reached 23 inches. He could find no correlation between the use of softwood types and snow depths alone. Day (1963) found deer movements in north-central Maine to be directly limited by the depth to which they sank in snow, crust conditions and availability and abundance of food. He found that sinking depths of 15 inches decreased deer activity in hardwood areas.

With a total of 5 inches of snow on the ground in

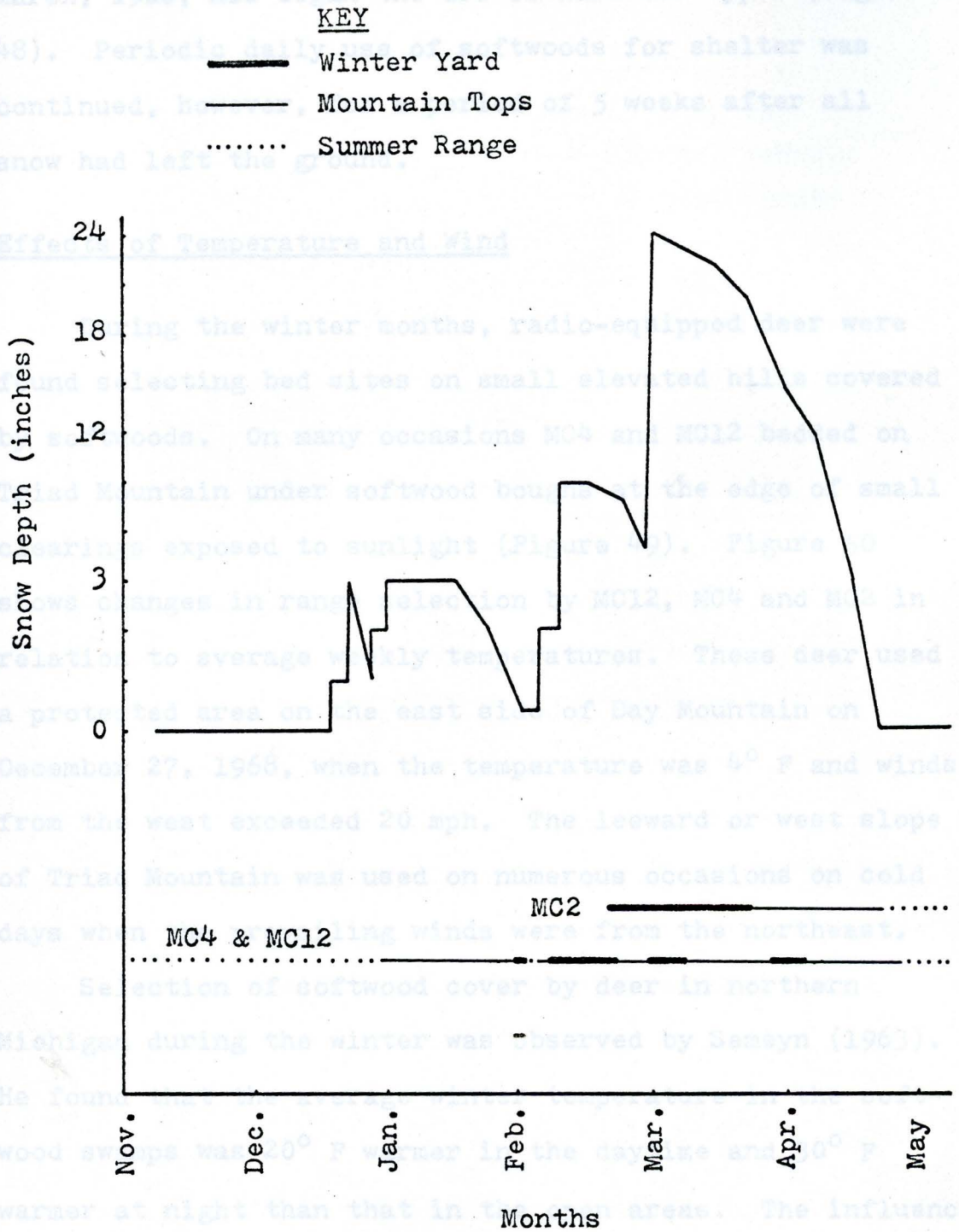


FIGURE 47. RANGE USE BY DEER #MC4, #MC12 AND #MC2 IN RELATION TO CHANGES IN SNOW ACCUMULATION DURING THE WINTER OF 1968-1969.

March, 1968, MC8 began the use of hardwood types (Figure 48). Periodic daily use of softwoods for shelter was continued, however, for a period of 5 weeks after all snow had left the ground.

Effects of Temperature and Wind

During the winter months, radio-equipped deer were found selecting bed sites on small elevated hills covered by softwoods. On many occasions MC4 and MC12 bedded on Triad Mountain under softwood boughs at the edge of small clearings exposed to sunlight (Figure 49). Figure 50 shows changes in range selection by MC12, MC4 and MC2 in relation to average weekly temperatures. These deer used a protected area on the east side of Day Mountain on December 27, 1968, when the temperature was 4° F and winds from the west exceeded 20 mph. The leeward or west slope of Triad Mountain was used on numerous occasions on cold days when the prevailing winds were from the northeast.

Selection of softwood cover by deer in northern Michigan during the winter was observed by Semeyn (1963). He found that the average winter temperature in the softwood swamps was 20° F warmer in the daytime and 30° F warmer at night than that in the open areas. The influence of wind on deer movements has also been reported by Darling (1937) for red deer; Taber and Dasmann (1958) and Linsdale and Tomich (1953) for mule deer in California, and Semeyn (1963) for white-tails of northern Michigan.

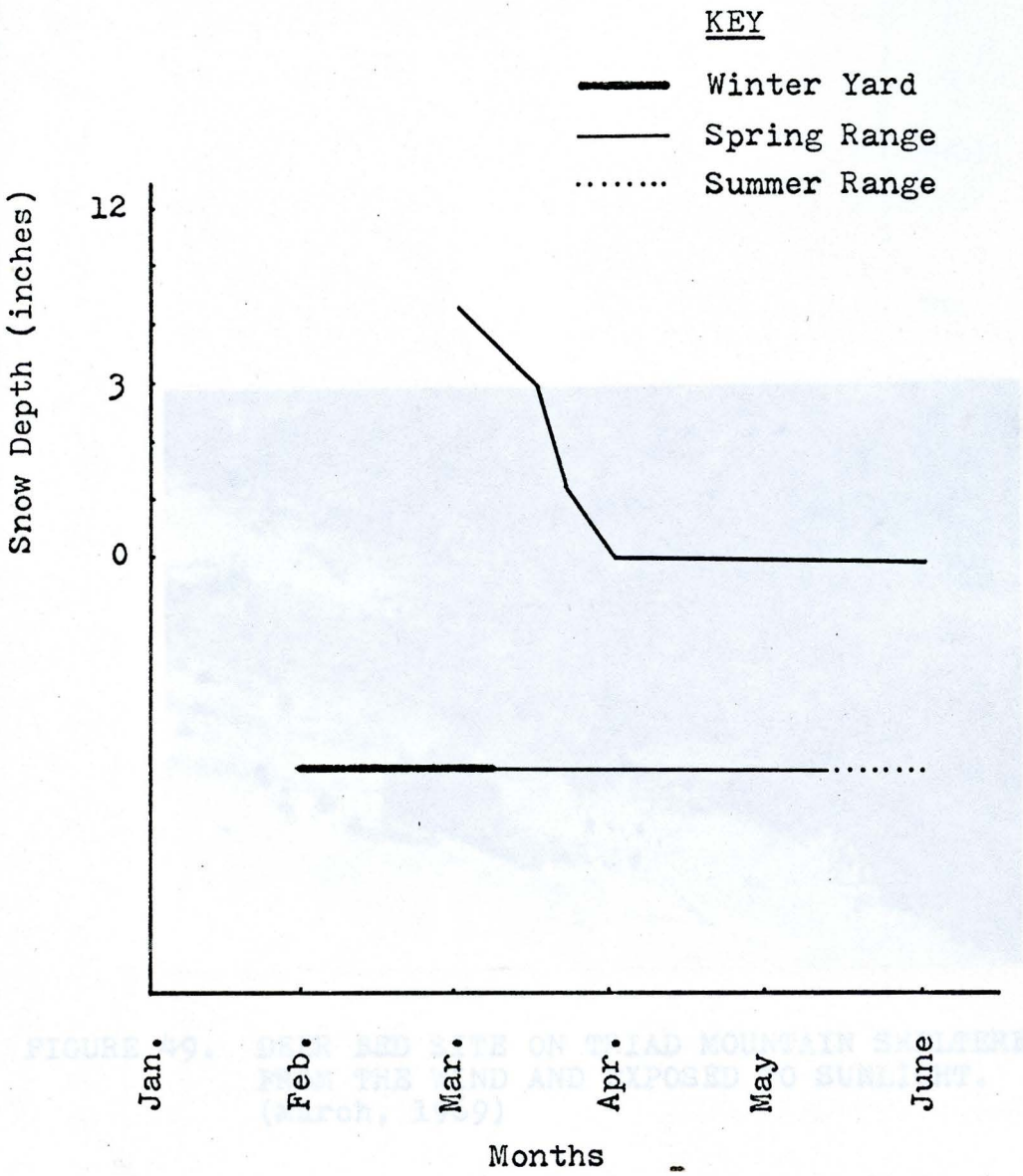


FIGURE 48. RANGE USE BY DEER #MC8 IN RELATION TO CHANGES IN SNOW ACCUMULATION DURING LATE WINTER, 1968.



FIGURE 49. DEER BED SITE ON TRIAD MOUNTAIN SHELTERED FROM THE WIND AND EXPOSED TO SUNLIGHT. (March, 1969)

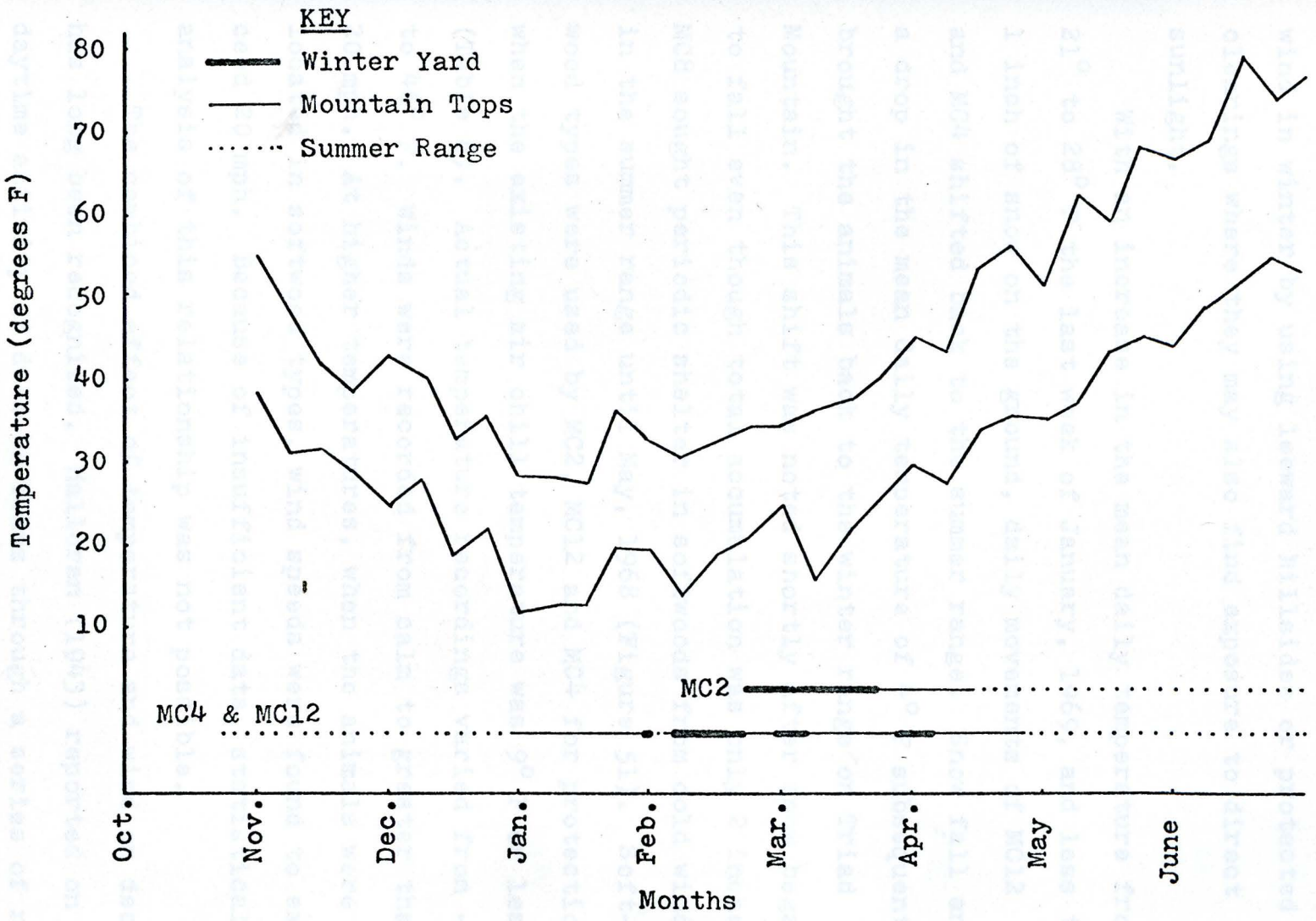


FIGURE 50. CHANGES IN RANGE USE BY DEER #MC4, #MC12 AND #MC2 IN RELATION TO AVERAGE WEEKLY TEMPERATURE (maximum and minimum).

In all cases, deer have been noted to seek shelter from the wind in winter by using leeward hillsides or protected clearings where they may also find exposure to direct sunlight.

With an increase in the mean daily temperature from 21° to 28° F the last week of January, 1969, and less than 1 inch of snow on the ground, daily movements of MC12 and MC4 shifted back to the summer range. Snow fall and a drop in the mean daily temperature of 4° F subsequently brought the animals back to the winter range on Triad Mountain. This shift was noted shortly after snow began to fall even though total accumulation was only 2 inches. MC8 sought periodic shelter in softwoods from cold winds in the summer range until May, 1968 (Figure 51). Softwood types were used by MC2, MC12 and MC4 for protection when the existing air chill temperature was 9° F or less (Table 6). Actual temperature recordings varied from -7° to 46° F. Winds were recorded from calm to greater than 20 mph. At higher temperatures, when the animals were located in softwood types, wind speeds were found to exceed 20 mph. Because of insufficient data, statistical analysis of this relationship was not possible.

The combined effect of temperature and wind on deer has long been recognized. Halloran (1943) reported on the daytime activity of deer in Texas through a series of road counts. He noted a decrease in the winter activity patterns due to cold morning temperatures and moderate

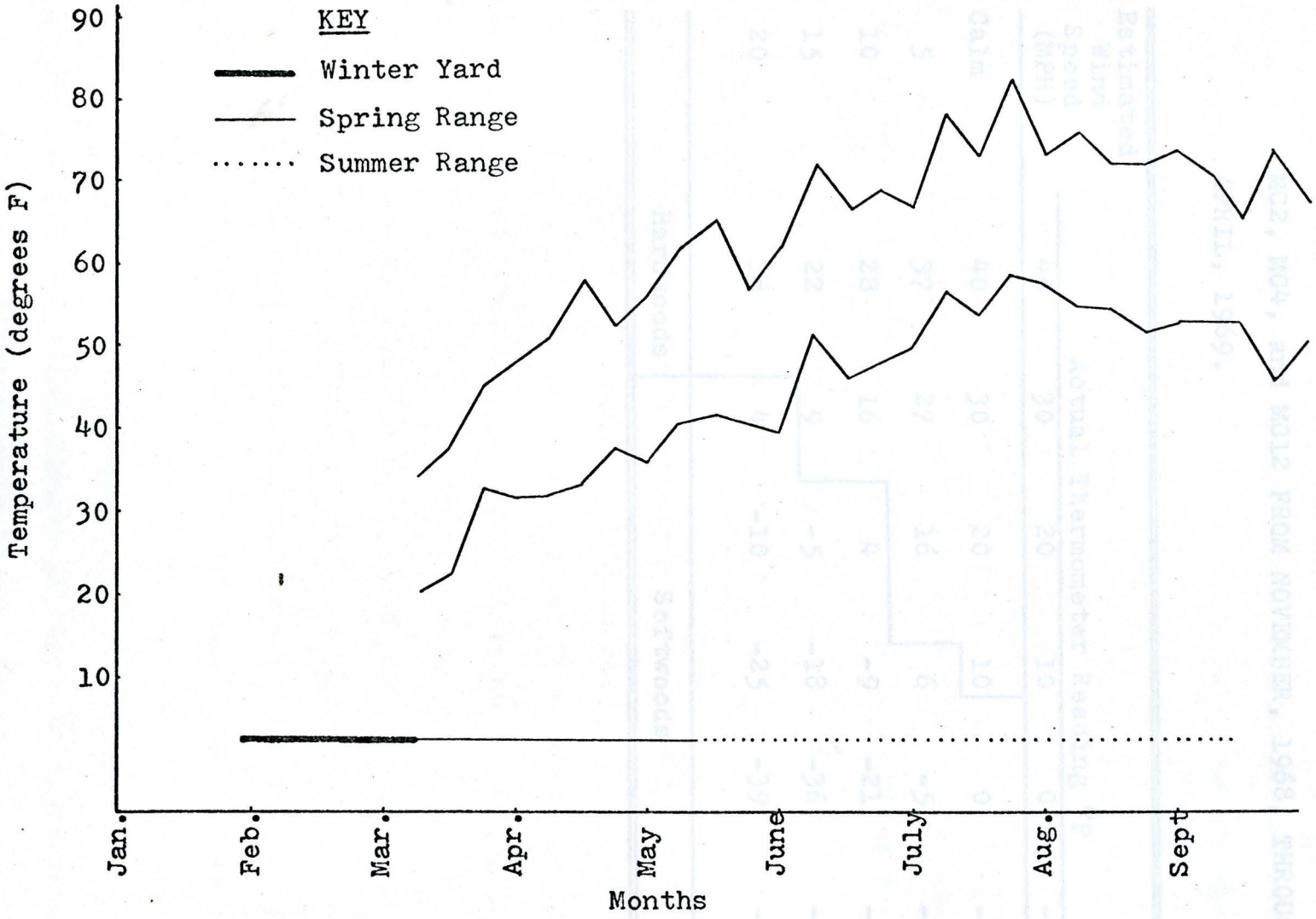


FIGURE 51. CHANGES IN RANGE USE BY DEER #MC8 IN RELATION TO AVERAGE WEEKLY TEMPERATURE (maximum and minimum).

TABLE 6. AIR CHILL EFFECTS ON COVER TYPE SELECTION OF MC2, MC4, and MC12 FROM NOVEMBER, 1968, THROUGH APRIL, 1969.

Estimated Wind Speed (MPH)	Actual Thermometer Reading °F					
	40	30	20	10	0	-10
Calm	40	30	20	10	0	-10
5	37	27	16	6	-5	-15
10	28	16	4	-9	-21	-33
15	22	9	-5	-18	-36	-45
20	18	4	-10	-25	-39	-53
	Hardwoods	Softwoods				

wind velocities. Taylor (1956) cited several examples of deer seeking shelter from cold winds. Linsdale and Tomich (1953) state that cold temperature increases the necessity of deer to find shelter from the wind. Semeyn (1963) found 3 times more daily movement observations in softwood swamps than in the open when "meaningful temperatures" were 5° F and -20° F respectively. Miller (1965) found that mule deer in Oregon remained in softwood cover when temperatures dropped below 20° F, and avoided those slopes exposed to high winds.

Barometric Pressure

No pattern or trend in deer movements could be directly related to barometric pressures. Changes in barometric pressures were indicative of weather changes and in that way may have an indirect effect. A drop in the barometric pressure was usually accompanied by increased temperature and snow, while a rise was usually accompanied by lower temperatures and fair weather. Deer were found to be inactive during heavy snowfalls. These findings agree with those of Semeyn (1963) in Michigan.

Changes in barometric pressures and cover type selection by MC4 and MC12 were examined during the winter months of 1969. Initial changes in barometric pressures showed no immediate changes in cover type selection. In all cases during February and March, however, deer moved to softwood covers during decreasing barometric pressure

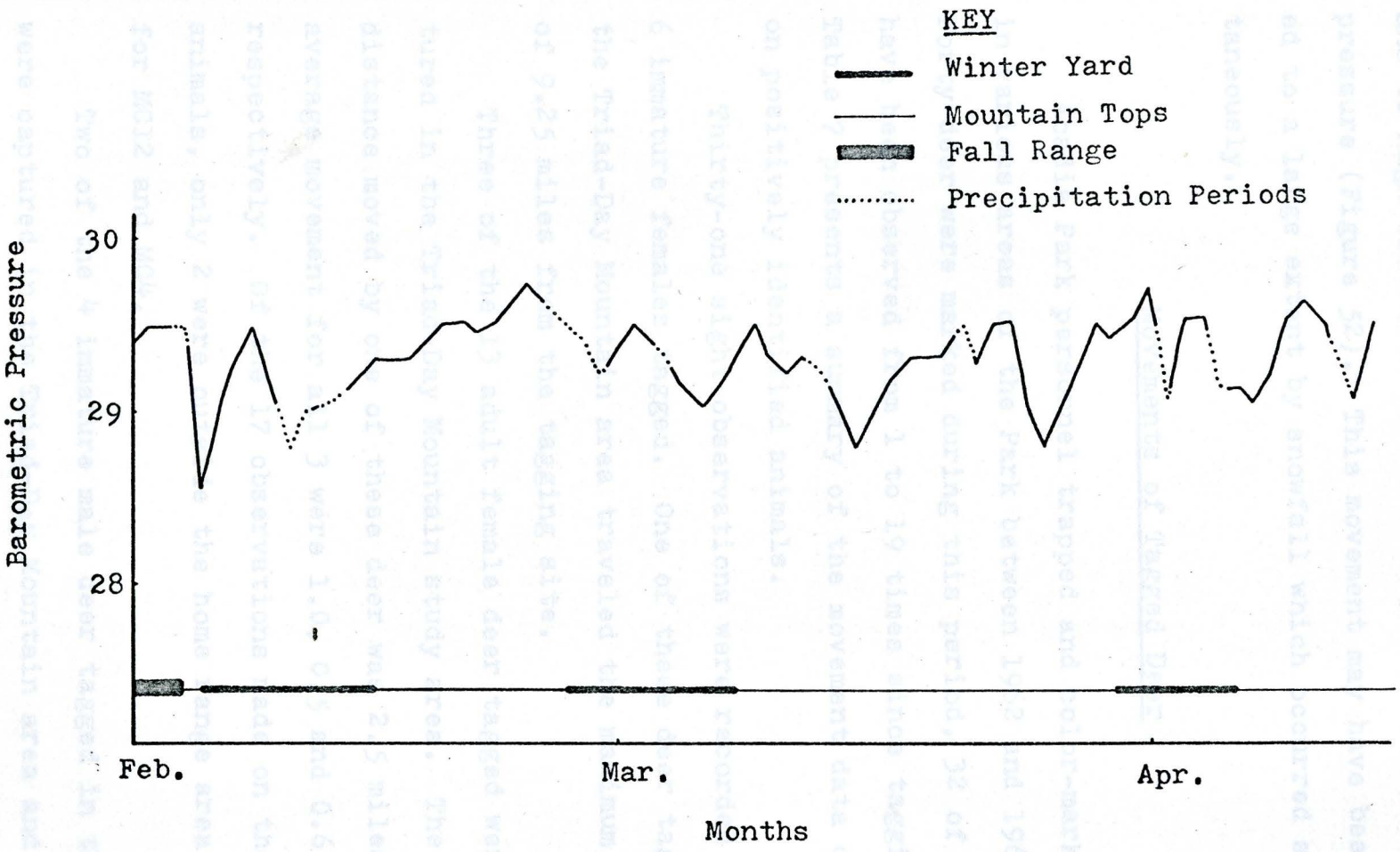


FIGURE 52. RANGE USE BY DEER #MC4 AND #MC12 IN RELATION TO CHANGES IN BAROMETRIC PRESSURE AND PRECIPITATION DURING THE MONTHS OF FEBRUARY THROUGH APRIL, 1969.

and to high elevation mountain slopes during increasing pressure (Figure 52). This movement may have been governed to a large extent by snowfall which occurred simultaneously.

Movements of Tagged Deer

Acadia Park personnel trapped and color-marked deer in various areas of the Park between 1962 and 1968. Forty deer were marked during this period, 32 of which have been observed from 1 to 19 times since tagging. Table 7 presents a summary of the movement data collected on positively identified animals.

Thirty-one sight observations were recorded for the 6 immature females tagged. One of these deer tagged in the Triad-Day Mountain area traveled the maximum distance of 9.25 miles from the tagging site.

Three of the 13 adult female deer tagged were captured in the Triad-Day Mountain study area. The maximum distance moved by one of these deer was 2.5 miles, and average movement for all 3 were 1.0, 0.5 and 0.6 miles, respectively. Of the 17 observations made on these animals, only 2 were outside the home range area defined for MC12 and MC4.

Two of the 4 immature male deer tagged in this study were captured in the Triad-Day Mountain area and moved less than 1 mile from 8 observations.

The 5 yearling males captured and tagged moved the

TABLE 7. SUMMARY OF TAGGED DEER OBSERVATIONS ON MOUNT DESERT ISLAND FROM 1962 TO 1969.

Sex and Age Class	Number of Animals Tagged	Total Number of Observations	Average Distance Traveled from Trap Site (miles)	Maximum Distance Traveled (miles)
Immature Females	6	31	1.6	9.3
Adult Females	13	53	0.9	6.3
Fawn Males	4	11	1.3	3.5
Yearling Males	5	39	2.9	9.3
Adult Males	4	12	--	3.5
Total	32	146		
Mean			1.7	6.3

greatest overall distances. The yearling male that traveled 9.25 miles was tagged at the same location as the immature female which also traveled that distance. These two animals were observed together on numerous occasions.

Four adult male deer were tagged during the study. Two of the animals were observed only at the trapping site and exhibited no movement. Average movements for the other two animals were 3.5 and 1.3 miles, respectively.

Movement distances of deer tagged in the telemetry study areas were similar to the radio-equipped animals. Many of the deer movement studies reviewed reported extended movements by some individuals. While none of the radio-equipped deer moved long distances, such movements were demonstrated by tagged individuals. Extreme distance movements were limited, however, by the size of the island.

Management Implications

Telemetry studies and observations of marked deer indicate that many animals inhabit localized areas of the Park. It is apparent that winter imposes the greatest stress and limitations on the deer populations in the Park. The amount of winter food available to deer varies in different areas, as well as from year to year, and is probably the most important limiting factor. The major winter habitat types in the yarding areas are spruce and

cedar, with cedar providing the bulk of the food supply for deer. Park policies attempt to maintain habitat in its most natural state with limited forest management in the form of cutting practices. Therefore, deer population levels must be controlled in order to maintain suitable winter habitat conditions.

Many wintering areas now lack necessary food for deer because of a long period of over-utilization. Most of these wintering areas surround the burn of 1947, and large numbers of deer have been forced to use a limited number of winter yards. This disproportion of winter habitat to summer range was a direct result of the fire.

Based on the use of wintering areas by local populations of deer, management in the form of intensive herd control should be practiced in these yards. A determination of winter deer population levels and habitat conditions should however, precede control. The program should stress taking a calculated number of animals from each major yard annually or periodically, based on observational and recorded data. Many of the major wintering areas have been recognized by Park personnel. Others can be located on type maps such as the one drawn up by McLaughlin (1968) and then field-checked.

Additional winter deer habitat will be provided in future years by the growth of softwoods in the burned area. However, at present it is felt that a yearly surplus of deer on Acadia Park must be harvested in localized areas

to prevent further destruction of winter habitat.

Management by this means will assist in preserving the natural environment stressed in the Acadia Park resource management plan of 1969.

RECOMMENDATIONS FOR FUTURE STUDIES

Future work should be centered on winter habitat because it is the most limiting factor on Acadia deer population levels. A survey of all major wintering areas, some of which were listed by McLaughlin (1968), should be conducted in an attempt to measure food availability and degree of utilization by deer. Many winter yards adjacent to the 1947 forest fire area are small, and yet, support relatively large numbers of deer. West Sargent Mountain, and Otter Point are two examples of areas that are felt to contain winter food supplies at a critical level due to a long period of overuse. Deer population levels which can be supported under the existing conditions should be determined and maintained in these areas to avoid further destruction of this habitat.

SUMMARY

A telemetry study was conducted at Acadia National Park, Mount Desert Island, Maine, from September, 1967, to June, 1970, to determine the movement patterns, home range, and habitat utilization of deer. Eight deer were radio-equipped during the study, 4 of which were monitored for a period of 6 months each.

1. Deer were captured during the fall and winter in box or net traps, or by using apples baited with Tranimul, a tranquilizing drug.

2. The minimum home ranges of the 4 deer studied most intensively were elongated in shape and averaged 556 acres, varying from 498 to 585 acres.

3. Average winter ranges were found to be approximately 0.5 the size of the summer range, 171 and 310 acres, respectively. Minimum home range major axis averaged 2.2 miles and varied from 1.9 to 2.7 miles. The minor axis varied from 0.6 to 0.8 miles and averaged 0.7 miles.

4. Daily movement patterns indicated an average distance between extreme daily locations (DBE) of 0.4 miles varying from 0.1 to 0.6 miles. The minimum total distance (MTD) moved in a 24-hour period averaged 0.9 miles and varied from 0.4 to 1.5 miles for the 4 deer studied most intensively.

5. Daily movements during the summer involved a

feeding period from late afternoon to approximately midnight. The animals rested from midnight to just before dawn, moving only occasionally. Another feeding period began at this time and lasted until mid-morning or 11 a.m. On many occasions this morning feeding period duplicated the prior evening's feeding pattern, and the deer bedded again in the same area for the remainder of the day. In winter, deer were active more often, bedding for short periods throughout the day and night. This behavior pattern was not consistent from day to day and varied with meteorological influence.

6. A winter browse survey in a heavily used deer yard indicated very few preferred food plants available to deer. Balsam fir, a non-preferred food, comprised 84.4 percent of all available browse.

7. Seasonal shifts were noted in late fall and spring between summer and winter ranges. These shifts varied from 0.4 to 1.7 miles, but depended largely on the distance from the summer range to the nearest suitable softwood stand affording protection and cover from the winter elements.

8. Temperature and wind were important factors in determining the movement and behavior patterns of the deer. On cold, windy days the animals sought shelter in dense softwoods or leeward slopes protected from the wind and exposed to sunlight.

9. Snow depths greater than 5 inches altered movements patterns of deer in winter. Cold and wind were also important factors in restricting deer movements. Deer were inactive during snow storms.

10. Deer showed a high preference for hardwoods and meadows in the summer months, and for softwoods in winter.

11. Supplemental observations of 32 marked deer on the Park showed that yearling males move the greatest distances averaging 2.9 miles. Adult female deer exhibited the shortest movements averaging only 0.9 miles.

12. Management of heavily used wintering areas in the form of an annual or periodic harvest of surplus deer was recommended.

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BIOGRAPHY OF THE WRITER

Thomas John Allen was born in Boston, Massachusetts on November 21, 1940 as a twin. He attended public schools in Belmont, Massachusetts, through grade 6. He then moved to Barrington, Rhode Island where he attended junior high and high school. Moving again to Amherst, Massachusetts, in 1959, he graduated from Amherst High School in 1960.

Mr. Allen joined the U.S. Air Force in June, 1960, where he served as an electronics technician until 1964. During his tour of duty he was stationed in Texas, Colorado, Montana, and Labrador.

Mr. Allen entered the University of Maine in September, 1964, and received his Bachelor of Science degree in Entomology in August, 1967.

During his undergraduate years Mr. Allen worked summers for the Moosehorn National Wildlife Refuge, Calais, Maine, banding woodcock; also for the University Agricultural Experiment Station in Monmouth, Maine.

He married the former Jane McCorrison of Orono, Maine, in 1968.

He entered the University of Maine as a Graduate Assistant of the Maine Cooperative Wildlife Research Unit in September, 1967. Mr. Allen is a candidate for the Master of Science degree in Wildlife Management from the University of Maine in June, 1970. He holds membership in the Wildlife Society and Xi Sigma Pi, honorary forestry fraternity.

APPENDIX I

List of Scientific Names

Common Name	Scientific Name
Mammals (from Miller and Kellogg, 1955)	
Beaver	*Castor canadensis* Kuhl
Deer, mule	*Odocoileus hemionus* (Rafinesque)
Deer, red*	*Cervus elaphus* L.
Deer, white-tailed	*Odocoileus virginianus* (Zimmermann)
Woody Plants (from Fernald, 1950)	
Alder, green	*Alnus crispa* (Act.) Pursh
Alder, speckled	*Alnus rugosa* (Du Roi) Spreng.
Ash	*Fraxinus* spp. L.
Ash, mountain	*Pyrus americana* (Marsh)
Ash, white	*Fraxinus americana* L.
Aspen, big-toothed	*Populus grandidentata* Michx.
Aspen, quaking	*Populus tremuloides* Michx.
Bayberry	*Myrica pensylvanica* Loisel.
Beech	*Fagus grandifolia* L.
Birch, gray	*Betula populifolia* Marsh.
Birch, white	*Betula papyrifera* Marsh.

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* from Walker, 1964

Common Name	Scientific Name
Birch, yellow	Betula lutea Michx. f.
Blackberry	Rubus spp. L.
Blueberry, highbush	Vaccinium corymbosum L.
Blueberry, lowbush	Vaccinium angustifolium Ait.
Cedar, northern white	Thuja occidentalis L.
Cherry, black	Prunus serotina Ehrh.
Cherry, pin	Prunus pensylvanica L. f.
Chokeberry, black	Pyrus melanocarpa (Michx)
Chokeberry, purple	Pyrus floribunda Lindl.
Cranberry, highland	Vaccinium Vitis-Idaea L.
Fir, balsam	Abies balsamea (L.) Mill.
Gale, sweet	Myrica Gale L.
Hazel, beaked	Corylus cornuta Marsh.
Hazel, with-	Hamamelis virginiana L.
Hemlock, eastern	Tsuga canadensis (L.) Carr.
Huneysuckle, bush	Diervilla spp. Duham.
Hop-hornbeam, American	Ostrya virginiana (Mill) K. Koch
Huckleberry	Gaylussacia baccata (Wang.) K. Koch
Lambkill	Kalmia angustifolia L.
Leatherleaf	Chamaedaphne calyculata (L.) Moench
Maple, mountain	Acer spicatum Lam.
Maple, red	Acer rubrum L.
Maple, striped	Acer pensylvanicum L.
Maple, sugar	Acer saccharum Marsh.

Common Name	Scientific Name
Meadow-sweet	Spiraea spp. L.
Oak, northern red	Quercus rubra L.
Pine, red	Pinus resinosa Ait.
Pine, white	Pinus Strobus L.
Raspberry	Rubus spp. L.
Serviceberry	Amelanchier, spp. Medic.
Spruce, red	Picea rubens Sarg.
Spruce, white	Picea glauca (Moench) Voss
Sweetfern	Comptonia peregrina (L) Coult.
Tamarack	Larix laricina (Du Roi) K. Koch
Witherod	Viburnum cassinoides L.
Willow	Salix spp. L.
Winterberry	Ilex spp. L.

Herbaceous Plants (from Fernald, 1950)

Aster	Aster spp. L.
Bunchberry	Cornus canadensis L.
Cattail	Typha spp. L.
Cinquefoil	Potentilla spp. L.
Dewberry	Rubus spp. L.
Fern, bracken	Pteridium aquilinum (L.) Kuhn
Ferns	
Christmas	Polystichum spp. Roth
Crested wood	Dryopteris cristata (L.) Gray
Interrupted	Osmunda spp. L.

Common Name	Scientific Name
Ferns	
Lady	*Athyrium* spp. Roth
Marsh	*Dryopteris Thelypteris* (L.) Gray
Sensitive	*Onoclea sensibilis* L.
Goldenrod	*Solidago* spp. L.
Grasses	
Blue joint	*Calamagrostis* spp. Adams.
Fescue	*Festuca* spp. L.
Wood reedgrass	*Cinna* spp. L.
Iris	*Iris versicolor* L.
Sedges	Cyperaceae

A P P E N D I X I I

Tables 1 to 9

TABLE 1. COMPOSITION OF HARDWOOD-SOFTWOOD STANDS (HS)

Species	No. Trees Per Acre			Importance Value		
	Location*					
	GM	HP-SM	T-DM	GM	HP-SM	T-DM
Overstory						
Red Maple	21	63	5	19	22	4
Sugar Maple	16	--	--	18	--	--
Striped Maple	--	--	32	--	--	12
White Birch	16	--	43	15	--	29
Yellow Birch	--	95	11	--	22	8
Red Spruce	11	16	22	9	5	11
E. Hemlock	5	32	--	7	20	--
Balsam Fir	--	16	27	--	5	9
N.W. Cedar	--	--	11	--	--	7
White Ash	5	32	5	8	11	4
Quaking Aspen	21	--	--	16	--	--
B.T. Aspen	11	--	11	8	--	6
Beech	--	32	16	--	7	10
Am. Hop-hornbeam	--	32	--	--	8	--
	107	318	183	100	100	100

	No. Stems Per Acre					
	Height Class**					
	GM		HP-SM		T-DM	
	1	2	1	2	1	2
Understory						
Red Maple	240	--	--	640	--	89
Striped Maple	160	--	--	--	311	311
Mtn. Maple	--	--	--	--	44	--
White Birch	80	--	--	--	--	--
Gray Birch	320	160	--	--	--	--
Red Spruce	640	160	560	--	533	--
Balsam Fir	240	--	80	160	222	--
White Pine	--	--	--	--	267	--
White Ash	480	--	--	--	--	--
Beech	80	--	--	240	400	356
Green Alder	--	--	--	80	178	--
Willow	80	--	--	--	--	--
Bayberry	--	--	--	--	--	89
	2320	320	640	1120	2044	756

TABLE 1. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover		
	GM	HP-SM	T-DM
Bayberry	--	--	0.6
Blueberry	--	--	5.4
Meadow-sweet	1.7	--	0.6
Sweetfern	2.5	--	--
Aster	5.0	--	1.3
Goldenrod	1.7	--	--
Bracken Fern	2.5	--	1.7
Other Ferns	18.3	--	0.6
Grasses	5.0	--	3.6
Sedges	11.7	--	--
Bunchberry	5.0	--	1.1
Mosses	--	--	12.2
Lichens	--	--	3.3
Total	53.4	--	30.1

* GM = Gilmore Meadow
HP-SM = Hadlock Pond-Sargent Mountain
T-DM = Triad-Day Mountains

** Height Class 1= 1.0 to 7.9 feet
Height Class 2= 8.0 feet to 3.5 inches d.b.h.

TABLE 2. COMPOSITION OF SOFTWOOD STANDS (S)

Species	No. Trees Per Acre			Importance Value		
	Location*					
	GM	HP-SM I	HP-SM II	GM	HP-SM I	HP-SM II
Overstory						
Red Spruce	309	--	240	55	--	63
Balsam Fir	24	--	46	8	--	12
N.W. Cedar	--	411	46	--	100	9
E. Hemlock	--	--	23	--	--	11
White Pine	24	--	--	8	--	--
Red Pine	71	--	--	12	--	--
B.T. Aspen	47	--	--	17	--	--
Yellow Birch	--	--	11	--	--	5
Total	475	411	366	100	100	100

	No. Stems Per Acre					
	Height Class**					
	GM		HP-SM I		HP-SM II	
	1	2	1	2	1	2
Understory						
N.W. Cedar	--	--	--	--	--	200
Red Maple	--	--	--	133	--	--
Red Spruce	80	560	200	200	--	--
Balsam Fir	--	80	--	600	200	400
White Birch	--	80	--	--	--	--
Gray Birch	160	80	--	--	--	--
Green Alder	--	--	67	--	--	--
Total	240	800	267	933	200	600

TABLE 2. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover		
	GM	HP-SM I	HP-SM II
Blueberry	--	8.3	--
Huckleberry	1.7	--	--
Sweetfern	0.3	--	--
Goldenrod	--	3.3	--
Ferns	6.7	--	--
Grasses	6.7	5.0	15.0
Sedges	--	--	15.0
Mosses	--	--	35.0
Total	15.4	16.6	65.0

* GM = Gilmore Meadow
HP-SM = Hadlock Pond-Sargent Mountain

** Height Class = 1.0 to 7.9 feet
Height Class = 8.0 feet to 3.5 inches d.b.h.

TABLE 3. COMPOSITION OF SOFTWOOD-HARDWOOD STANDS (SH)

Species	No. Trees Per Acre				Importance Value			
	Location*							
	GM	HP-SM	T-DM I	T-DM II	GM	HP-SM	T-DM I	T-DM II
Overstory								
Red Spruce	119	80	193	73	24	27	50	16
N.W. Cedar	146	106	13	254	27	28	3	43
Red Maple	49	27	40	54	12	12	13	15
White Pine	33	--	47	--	10	--	17	--
Balsam Fir	16	27	13	18	4	8	3	4
White Birch	22	--	40	54	10	--	14	11
Gray Birch	--	27	--	--	--	8	--	--
White Spruce	--	27	--	--	--	9	--	--
Serviceberry	--	27	--	--	--	8	--	--
B.T. Aspen	22	--	--	--	4	--	--	--
Red Oak	11	--	--	--	4	--	--	--
White Ash	11	--	--	--	3	--	--	--
Am. Hop-hornbeam	5	--	--	--	2	--	--	--
Yellow Birch	--	--	--	54	--	--	--	11
Total	434	321	346	507	100	100	100	100

	No. Stems Per Acre							
	Height Class**							
	GM		HP-SM		T-DM I		T-DM II	
	1	2	1	2	1	2	1	2
Understory								
Balsam Fir	180	40	--	--	1200	246	1257	400
Red Spruce	300	--	667	400	431	--	171	57
Witherod	--	--	1066	--	--	--	--	--
Red Maple	20	20	--	--	--	31	--	--
Striped Maple	20	--	--	--	--	--	--	57
Green Alder	--	--	--	--	92	--	--	--
White Pine	160	--	--	--	--	--	--	--
Witch-Hazel	20	60	--	--	--	--	--	--
N.W. Cedar	--	40	--	--	--	--	--	--
Huckleberry	--	--	--	--	462	--	--	--
Total	700	160	1733	400	2185	277	1428	514

TABLE 3. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover			
	GM	HP-SM	T-DM	
			I	II
Blueberry	--	8.3	3.1	--
Highland Cranberry	--	--	0.9	--
Lambkill	--	1.7	0.4	--
Aster	--	3.3	--	--
Bracken Fern	--	--	4.0	--
Grasses	--	6.7	--	--
Bunchberry	--	5.0	0.2	--
Mosses	--	15.0	9.2	11.4
Lichens	--	8.3	--	--
Total	--	48.3	17.8	11.4

* GM = Gilmore Meadow
HP-SM = Hadlock Pond-Sargent Mountain
T-DM = Triad-Day Mountains

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 4. COMPOSITION OF HARDWOOD STANDS (H)

Species	No. Trees Per Acre	Importance Value
	Location*	
	T-DM	T-DM
Overstory		
Beech	176	36
Yellow Birch	78	21
White Birch	78	18
Red Maple	39	13
E. Hemlock	20	12
Total	391	100

	No. Stems Per Acre	
	Height Class **	
	T-DM	
	1	2
Understory		
Striped Maple	560	160
Beech	1120	160
Red Maple	--	80
Balsam Fir	80	--
Total	1760	400

* T-DM = Triad-Day Mountains

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 5. COMPOSITION OF MEADOW AREAS (M)

Species	No. Trees Per Acre		Importance Value	
	Location*			
	GM	HP-SM	GM	HP-SM
Overstory				
Red Maple	19	24	39	27
Sugar Maple	3	--	8	--
Striped Maple	--	3	--	4
White Birch	--	6	--	8
Yellow Birch	3	--	7	--
Gray Birch	--	15	--	12
Red Spruce	--	3	--	5
White Spruce	--	6	--	8
E. Hemlock	3	--	9	--
Balsam Fir	--	9	--	12
N.W. Cedar	--	3	--	4
White Ash	9	3	26	5
Quaking Aspen	6	3	11	4
B.T. Aspen	--	3	--	4
Serviceberry	--	6	--	7
Total	43	84	100	100

	No. Stems Per Acre			
	Height Class**			
	GM		HP-SM	
	1	2	1	2
Understory				
Red Maple	31	--	100	--
Striped Maple	63	--	50	--
Gray Birch	250	--	500	150
Red Spruce	156	31	550	--
White Spruce	--	--	100	--
White Ash	31	--	--	--
Beech	344	63	--	--
Speckled Alder	125	31	--	--
Green Alder	--	--	350	--
Willow	125	--	--	--
Witherod	--	--	800	--
Total	1125	125	2400	150

TABLE 5. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover	
	GM	HP-SM
Blueberry	--	19.4
Chokeberry, Purple	--	1.3
Lambkill	--	3.8
Meadow-sweet	1.5	--
Sweetfern	--	0.6
Aster	6.5	5.6
Goldenrod	--	1.3
Cattail	0.8	--
Iris	0.4	--
Raspberry	0.4	--
Bracken Fern	--	5.6
Other Ferns	11.9	--
Grasses	56.5	52.5
Sedges	21.2	--
Bunchberry	--	0.6
Total	99.2	91.7

* GM = Gilmore Meadow
HP-SM = Hadlock Pond-Sargent Mountain

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 6. COMPOSITION OF YOUNG HARDWOOD-SOFTWOOD STANDS (YHS)

Species	No. Trees Per Acre	Importance Value
	Location*	
	GM	GM
Overstory		
B. T. Aspen	13	23
Red Maple	6	12
Red Pine	6	12
Am. Beech	6	11
White Birch	4	9
Red Oak	4	9
E. Hemlock	1	6
White Pine	3	4
N.W. Cedar	1	4
White Ash	1	4
Am. Hop-hornbeam	1	3
Balsam Fir	1	3
Total	47	100

	No. Stems Per Acre	
	Height Class**	
	GM	
	1	2
Understory		
Gray Birch	2385	615
White Birch	1094	1761
Red Spruce	1855	34
Red Pine	17	--
White Pine	26	26
Witherod	128	--
Tamarack	17	--
Balsam Fir	402	43
Beaked Hazel	9	--
Red Maple	256	17
Striped Maple	128	34
Willow	--	17
Quaking Aspen	9	145
Yellow Birch	9	--
Speckled Alder	9	26
B.T. Aspen	--	137
Red Oak	9	--
White Ash	9	--
Pin Cherry	--	9
Beech	9	111
Total	6371	2975

TABLE 6. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover GM
Blueberry	10.0
Huckleberry	0.2
Lambkill	1.7
Meadow-sweet	0.6
Sweetfern	5.5
Aster	3.3
Goldenrod	0.3
Bracken Fern	3.8
Other Ferns	0.9
Raspberry	0.1
Grasses	5.7
Sedges	2.2
Bunchberry	1.1
Total	35.4

* GM = Gilmore Meadow

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 7. COMPOSITION OF YOUNG BEECH STANDS (YB)

Species	No. Stems Per Acre	
	GM *	
	1**	2
Understory		
Beech	1600	6600
White Birch		400
Totals	1600	7000

* GM = Gilmore Meadow

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 8. COMPOSITION OF SHRUB AREAS

Species	No. Trees Per Acre	Importance Value
	Location*	
	T-DM	T-DM
Overstory		
Red Maple	12	28
Balsam Fir	59	72
Total	71	100

	No. Stems Per Acre					
	Height Class**					
	GM		HP-SM		T-DM	
	1	2	1	2	1	2
Understory						
Gray Birch	5147	347	880	--	167	--
Witherod	400	--	2400	--	1666	--
Green Alder	53	--	2320	--	1166	--
Red Spruce	533	--	400	--	83	--
Mtn. Ash	--	--	480	--	500	--
Balsam Fir	587	--	80	--	--	--
Black Cherry	--	--	--	--	833	--
Red Maple	27	--	--	--	167	--
Willow	107	--	--	--	--	--
White Pine	--	--	80	--	--	--
Serviceberry	--	--	80	--	--	--
Red Oak	53	--	--	--	--	--
Quaking Aspen	27	--	--	--	--	--
Red Pine	--	27	--	--	--	--
Total	6934	374	6720	--	4582	--

TABLE 8. CONTINUED

Shrub Layer and Ground Cover

Species	Percent Cover		
	GM	HP-SM	T-DM
Blueberry	28.3	24.0	16.0
Chokeberry, Black	--	2.0	--
Highland Cranberry	--	--	0.4
Huckleberry	2.3	--	--
Lambkill	2.3	2.0	10.0
Sweetfern	12.7	--	--
Blackberry	--	2.4	4.0
Bracken Fern	7.7	2.0	13.0
Aster	4.7	2.0	1.4
Grasses	9.5	31.0	22.0
Cinquefoil	--	--	1.4
Dewberry	0.3	--	--
Winterberry	--	--	0.4
Bunchberry	--	0.4	--
Mosses	5.3	--	0.4
Lichens	--	10.0	4.4
Total	72.5	75.8	73.8

* GM = Gilmore Meadow
HP-SM = Hadlock Pond-Sargent Mountain
T-DM = Triad-Day Mountains

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.

TABLE 9. COMPOSITION OF BOG AREAS

Species	No. Stems Per Acre	
	GM*	
	1**	2
Understory		
Speckled Alder	200	0
Total	200	

Shrub Layer and Ground Cover

Species	Percent Cover
	GM
Leatherleaf	2.5
Meadow-sweet	2.5
Sweet Gale	55.0
Grasses	40.0
Total	100.0

* GM = Gilmore Meadow

** Height Class 1 = 1.0 to 7.9 feet
Height Class 2 = 8.0 feet to 3.5 inches d.b.h.