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Daily Summer Movements, Activity Patterns, and Home Range of Pronghorn

Abstract

Daily movements, activity patterns, and spatial and behavioral use of summer home ranges of pronghorn (*Antilocapra americana*) were examined by radiotelemetry in southeastern Idaho from June through August 1980. Five pronghorn were located every 30 minutes over 16 24-hour sampling periods. Daily movements for bucks and does averaged ($\bar{x} \pm$ SD) 15.9 ± 4.4 and 20.4 ± 8.1 km, respectively. The size and shape of summer home ranges were estimated by the minimum area method and two grid-size analyses. Some areas within each home range were used exclusively for resting or loafing, while others were used only for feeding. Two major (0430 - 0630 and 1930 - 2230 MST) and 2 minor (0930 - 1130 and 1330 - 1630 MST) peaks of feeding activity occurred daily. Pronghorns spent approximately 30 percent of each day feeding and 65 percent resting or loafing. Rapid directional movements accounted for about 5 percent of the daily activity. With the possible exception of one, none of the study animals moved to and used open water during any of the 24-hour sampling periods.

Introduction

The advantages and shortcomings of radiotelemetry systems and methodologies in monitoring wildlife by remote sensing have been well documented (Slater 1963, Heezen and Tester 1967, Biggins and Pitcher 1978, Amlaner and Macdonald 1980, and others). With some notable exceptions (Mech 1967, Knowlton *et al.* 1968, Woodruff 1977, Laundré and Keller 1981), wildlife studies involving radiotelemetry were generally designed to determine an animal's area of use (home range: Burt 1943) and/or document migration routes and distances traveled. Although these studies provided reliable data on the spatial use of the environment, they had only limited ecological application (Sanderson 1966, Laundré and Keller 1981). They failed to provide much useful information on how habitat was being used, *viz.* the animal's activity or behavioral use. This was an acute problem if the study animals could not be observed visually, or, as in the case of pronghorns, the animals were often alert to the observer and hence modified their activity. Recently biologists have increased the amount of information gained via telemetry by locating the animals more frequently (Rongstad and Tester 1969, Woodruff 1977, Laundré and Keller 1981). When telemetric locations of an animal were determined at hourly intervals or less, behavioral use could then be estimated by analyzing the movement and velocity patterns. Using this approach, the objective was to study the daily activity patterns and area of use of selected pronghorns on the Idaho National Engineering Laboratory (INEL) in southeastern Idaho.

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Methods

The INEL occupies 2,315 km² of semiarid, cold-desert rangeland on the Snake River Plain approximately 48 km west of Idaho Falls, Bonneville County, Idaho. Atwood (1970), Nace *et al.* (1972, 1975), Harniss and West (1973), McBride *et al.* (1978), and Anderson and Holte (1981) provide detailed descriptions of the climate, geology, and vegetation of the INEL. In general, the topography is flat to gently rolling, with frequent lava outcroppings characteristic of the Columbia Plateau Province. The vegetation of the site is dominated by big sagebrush (*Artemisia tridentata*). During the study, ambient temperatures ranged from 1.7 to 31.1°C. Average daily minimum and maximum temperatures were $6.1 \pm 2.7^\circ$ and $26.8 \pm 3.7^\circ$ C, respectively. Total precipitation from June-August 1980 was 4.9 cm. For the period two days prior to and including each 24-hour sampling regime, rainfall in excess of 0.2 cm was recorded only four times. Trace amounts of rainfall for the same interval preceding and including the the remaining sampling dates occurred five times.

During late April 1979, Idaho Department of Fish and Game personnel and researchers from the INEL Environmental Sciences Branch placed solar-powered radio-transmitters (Wildlife Materials, Carbondale, IL) on 15 pronghorn (Autenrieth *et al.* 1981). Five of these animals (two bucks, three does) were the subject of this study from June through August 1980. All animals, except a two-year old male, were adults at least three years of age. Neither of the bucks was territorial.

Initial plans were to locate each animal every 30 minutes during five separate 24-hour sampling periods spaced at 2-3 week intervals during the summer. Animals were monitored from a four-wheel drive vehicle with a portable, programmable receiver (Cedar Creek, Bethel, MN) equipped with a null-peak junction box. Twin five-element yagi antennas were mounted on a rotating mast that extended into the cab of the vehicle.

For each location two compass readings were taken and the animal's position was estimated by triangulation. The general procedure was to take a compass bearing from a known point, quickly drive to a second point (generally 0.8 km away) and take another reading. This process was repeated every 30 minutes until 49 pairs of readings were recorded. Heezen and Tester (1967) reported that the position of an animal obtained by triangulation rarely represented its actual location. They stated that the degree of error depended upon the accuracy of each compass reading, the angle of the intersection of the bearing lines for each pair of fixes, and the distance from the animal to the monitoring device. During this study, the distance from the vehicle to the animal rarely exceeded 1 km, and generally was from 0.5 to 1.0 km. Efforts were made to take compass readings from points at which the bearing lines would intersect at the optimum 90° to reduce the error polygon.

Triangulation error was determined by taking 10 pairs of compass readings on a stationary transmitter from distances ranging from 0.5 to 1.5 km. In no trial was the calculated position greater than 100 m from the actual location of the transmitter. Because a time lapse of 2-6 minutes occurred between the first and second compass readings for each pair of fixes, the distance between the true and calculated location of an animal increased if the animal was moving. This displacement error was estimated by taking compass readings on a transmitter carried in a vehicle on a known path at speeds up to 15 km/hour. Only at the greatest velocities was the location error more than 250 m, with most calculated locations being less than 150 m from the actual

locations. The above tests for triangulation error indicated that the calculated location of the animal was most likely within 200 m of its true position.

Patterns of spatial use (home range) during the summer were determined by computer analysis using the grid method described by Rongstad and Tester (1969), Fossey (1974), and Caro (1976). When using this technique, the reliability of the estimate of the home range size depends on the number of new grids entered by an animal during each successive sampling period. The number of new grids entered is, in turn, a function of the grid size. Theoretically, when large grids are used, the number of new grids entered during each additional sampling period rapidly approaches zero. But, this results in the inclusion of areas within the grids that are not actually used by the animal. When extremely small grids are used, the probability of including non-use areas is minimized, but new grid use does not decline significantly with each successive sample. Grid sizes of 1.0 (1 x 1 km) and 0.25 km² (0.5 x 0.5 km) were examined for suitability of estimating pronghorn home ranges. Results based on these grid sizes were compared with the more conventional minimum area method of estimating home range size described by Mohr (1947), Strickel (1954) and Mohr and Stumpf (1966).

Distances between successive locations were determined by computer analysis (Laundré 1979) and the rate of travel (velocity) was calculated and recorded as distance (km) per hour. All distances between successive locations were assumed to result from straight line movement at a constant rate of travel. A frequency distribution, augmented by field observations, was used to classify velocities into behavioral categories and to study 24-hour activity patterns.

Velocities of different behaviors, to be used as standards for determining the behavioral use of home ranges, were ascertained by observing free-ranging pronghorn. An animal's position was marked on a detailed map of the area and its activity subjectively classified as resting (recumbent)/loafing (upright and stationary), feeding, or rapid directional movement. When the activity obviously changed to another behavioral category, the time expired was noted and the new position (if any) was recorded. Using these data, calculating velocities for each behavioral category was possible.

Velocities for each 30-minute interval for the 24-hour sampling periods were calculated by dividing the distances between successive locations by the time between fixes (30 min). These data were grouped into 0.2 km/hr intervals and a frequency distribution was generated. This distribution was examined and compared with data from field observations to assess the usefulness of the velocities assigned to each category of behavior. When the velocity for each activity was thus identified, the frequency of occurrence of each type of activity was plotted against time of day to illustrate daily activity patterns.

Once the appropriate grid size for estimating home range size was selected and the velocities of each movement type were determined, the behavioral use of each home range was examined. To do this, the velocity at which an animal moved during each 30-minute interval was recorded for each grid the subject animal entered during that particular time period. These velocities were compared to the previously determined rate of travel for each activity class, and each grid in every home range was then classified according to behavioral use. Unless stated otherwise, all mean values are $\bar{x} \pm SD$.

Results

Because of transmitter failures and other difficulties, only 18 of 25 planned 24-hour studies were completed. Data from two of these were excluded from analysis because monitoring activities disturbed the subject animals and obviously influenced their movements and behavior. The results are therefore based on 16 successful 24-hour samples. The 2-year-old buck was monitored during two complete 24-hour cycles. Two does were each tracked for three complete cycles, and the remaining buck and doe were each followed for four 24-hour periods.

Home Range: Spatial and Temporal Use

As expected, the number of new 1.0 km²-grids entered by each pronghorn during successive 24-hour sampling periods quickly declined (Fig. 1A). Initially, the number of

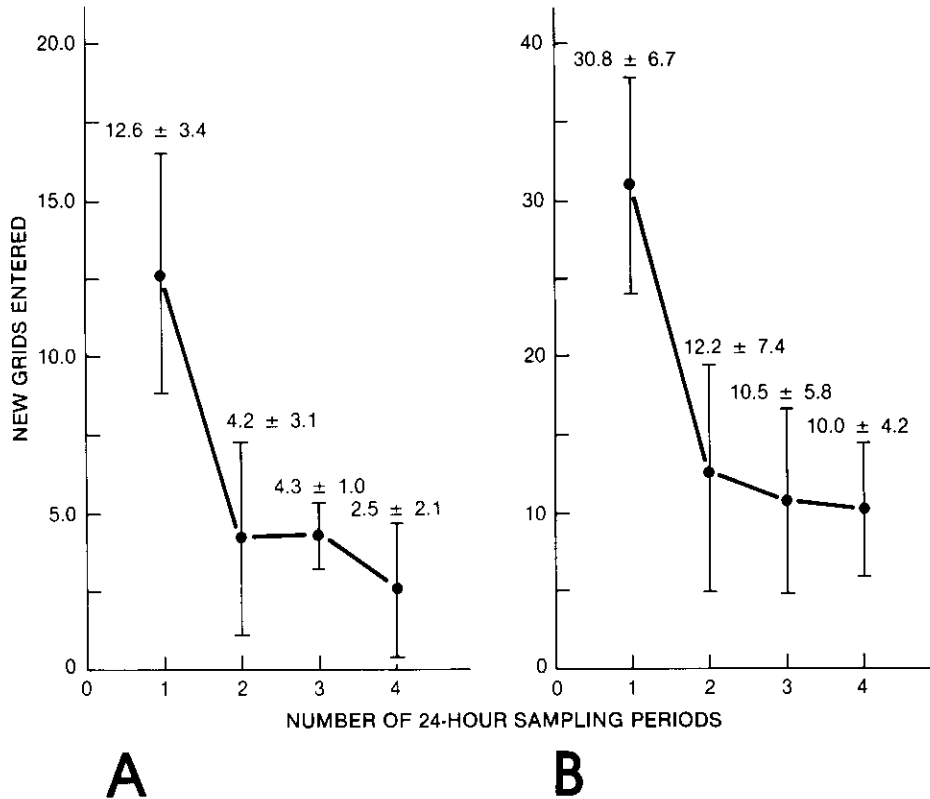


Figure 1. Number of new 1.0 km² (A) and 0.25 km² (B) grids ($\bar{x} \pm SD$) entered by pronghorn in successive sampling periods on the INEL Site, June-August 1980. Note: ordinate scale values differ.

new 0.25 km²-grids entered also sharply declined, but after the second sampling period (Fig. 1B), this leveled off to about 10 new grids entered during each successive sampling period. Home range size estimates did not differ significantly ($P > 0.20$; t -test) between the 0.25 km²-grid analysis and the minimum area method (Table 1.). Estimates of home range size were significantly larger ($P < 0.05$) when calculated using the

TABLE 1. Estimates of 1980 summer home ranges (km²) of pronghorn on the Idaho National Engineering Laboratory Site determined by 1.0 and .025 km²-grid analyses and the minimum area method.

Sex	Animal	N	Estimated home range (km ²)		
			Grid Method		Minimum Area Method
			1.0 km ²	0.25 km ²	
Female	527	3	26	17.75	14.87
Female	509	4	22	15.52	12.82
Female	616	3	17	11.00	9.52
Male	704	2	24	14.00	12.24
Male	738	4	17	11.00	10.20
All Females ^a	10		21.67 ± 4.51	14.76 ± 3.44	12.40 ± 2.70
All Males ^a	6		20.50 ± 4.95	12.50 ± 2.12	11.22 ± 1.44
All animals ^a	16		21.20 ± 4.09	13.85 ± 2.93	11.93 ± 2.14

^aTotal home range estimates reported as $\bar{x} \pm SD$.

larger grid size. Although the results varied among methods by as much as 95 percent, the average home range for males and females did not differ ($P > 0.40$; *t*-test) regardless of which method of measurement was used.

Data from Female 527 were used to illustrate the size and shape of the home range

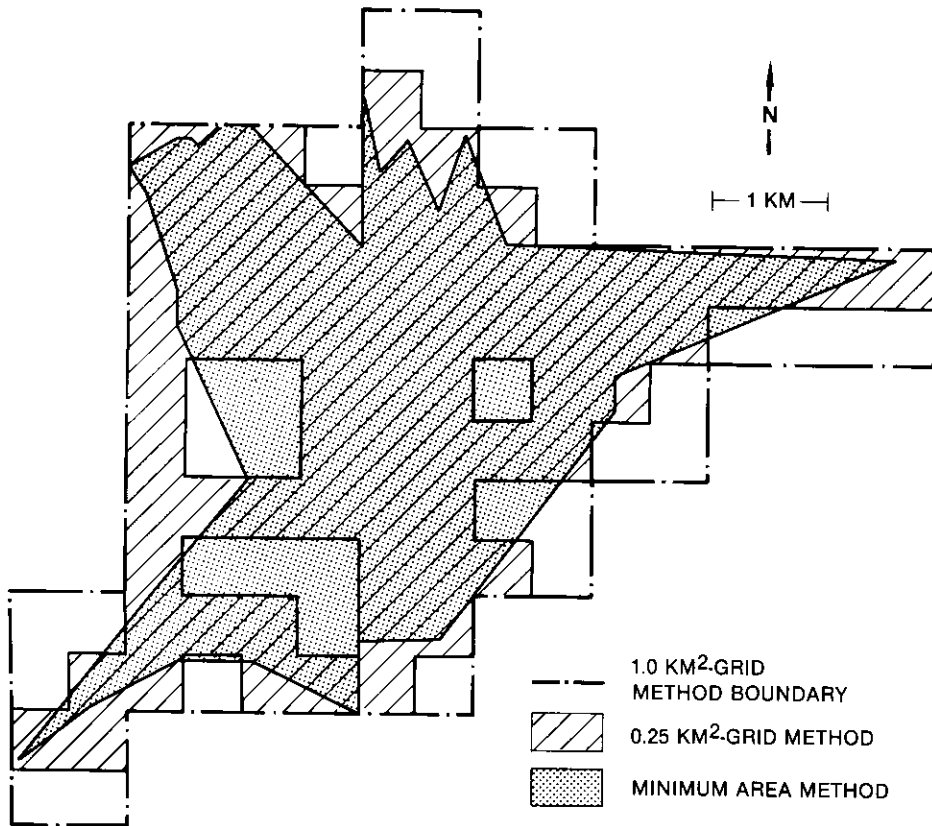


Figure 2. Home range determined by 3 methods for Female 527 on the INEL Site, June-August 1980.

as measured by the different grid size analyses and the minimum area method (Fig. 2). The latter method and the 1.0 km²-grid analysis both included areas within the home range boundaries that were not recorded as areas of use when the 0.25²-grid system was employed.

For consistency, data from Female 527 were used again to illustrate the time spent in each 0.25 km²-home range grid cell (Fig. 3). Home range use was not uniform. An

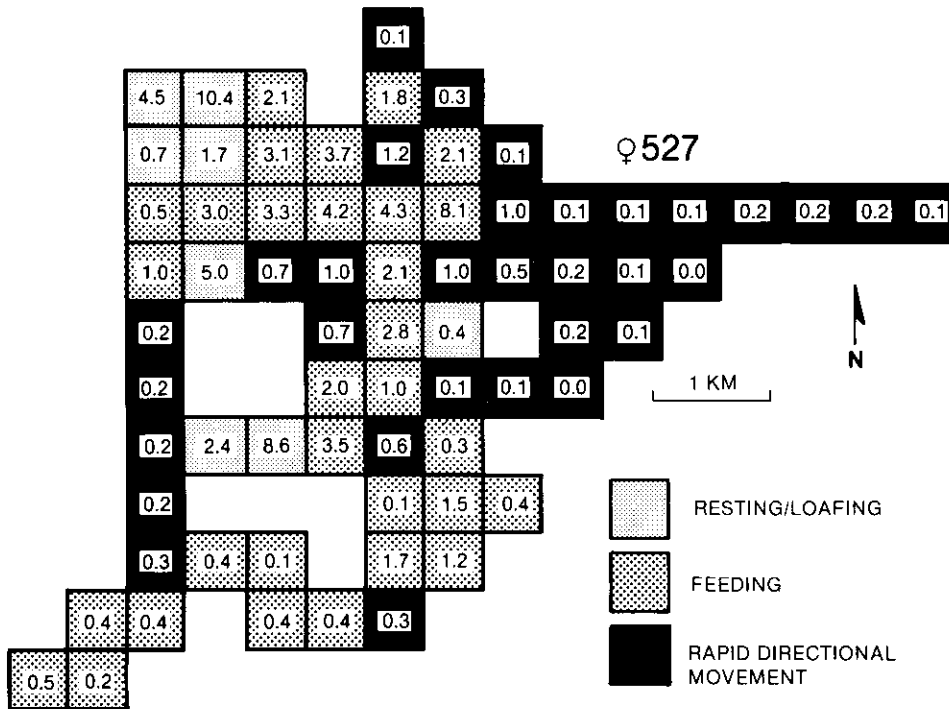


Figure 3. Activity and percent of the total time spent by Female 527 in each 0.25 km²-grid cell of her home range on the INEL Site, June-August 1980. Values rounded to the nearest 0.1 percent.

area of intensive use occurred roughly in the northwest portion of her home range. Following Craighead *et al.* (1973), this area was called the center of activity and included all grid cells occupied by the doe at least 2 percent of the total monitoring time. Thus, while the center of activity comprised only 25 percent of the total home range area, the doe occupied the activity center more than 75 percent of the time. For all five study animals, the centers of activity composed 17-29 percent of each home range and averaged about 3.5 km². Animals were within their centers of activity 65-80 percent of the time.

Home Range: Behavioral Use

Data from Female 527 indicated that the behavioral use of each estimated home range was not uniform (Fig. 3). That is, some grid cells within the home range were used only for resting/loafing, while others were used exclusively for feeding or rapid directional movement. With few exceptions, cells that were used during more than one sampling period or more than once during a single sampling period, were used for the

same purpose. While rapid directional movement tended to occur at the outer edges of the home range, this behavior was also occasionally recorded within the center of activity. Conversely, although resting/loafing and feeding behavior were the predominant behavioral classes recorded in the activity centers, these behaviors were not restricted to those areas and were recorded throughout the home range.

Behavioral Categories and Daily Activity Pattern

A priori, three main categories of pronghorn behavior were selected: resting/loafing, feeding, and rapid directional movement. Field observations indicated that during resting, pronghorn would occasionally rise from recumbency, move a short distance, and again lie down. The distance of these movements was generally less than 100 m at a velocity of less than 0.6 km/hr. Similarly, loafing animals periodically changed their location.

Feeding behavior was observed and defined as a prolonged slow walk associated with browsing activity. Feeding velocities ranged from 0.8 to 1.8 km/hour. Rapid directional movement ranged from a fast walk to a full run and velocities of 2.0 to 51.4 km/hour were calculated from field observation data. Maximum velocities were usually a short burst of speed associated with disturbance (predators, vehicles, intraspecific interaction). Only rarely did pronghorn cover more than 0.5 km at the maximum velocity.

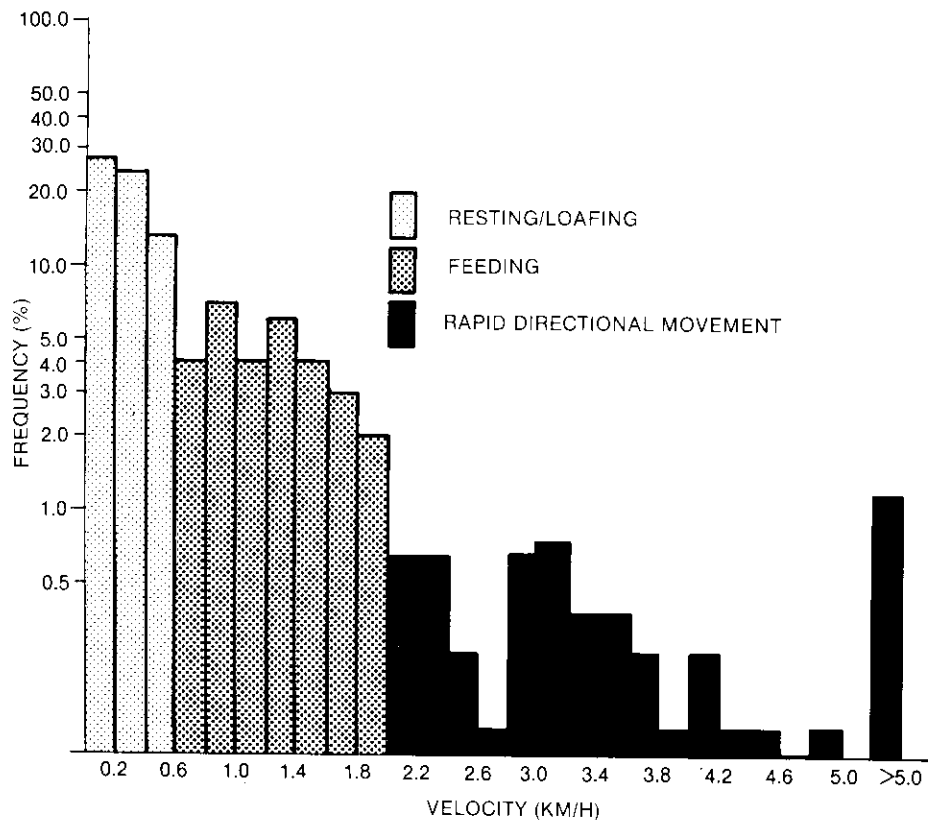


Figure 4. Frequency distribution of velocities recorded via radiotelemetry for pronghorn on the INEL Site, June-August 1980. Data for each 0.2 km/hour interval are presented as a percent of the total number of 30 minute intervals (768) between radio-fixes.

When velocities recorded from the 24-hour samples were grouped into 0.2 km/hour intervals, the resultant percent frequency distribution (Fig. 4) indicated that the frequency of the rates of movement for each behavioral class were different. This suggested that the velocity groupings (< 0.6, 0.6-1.8, and > 1.8 km/hour) from field observations could be identified via radiotelemetry and would provide a reliable classification of velocities into behavioral categories.

A frequency distribution of the time of occurrence for each type of behavior indicated the daily pattern of pronghorn activity (Fig. 5). Daily movements for bucks and

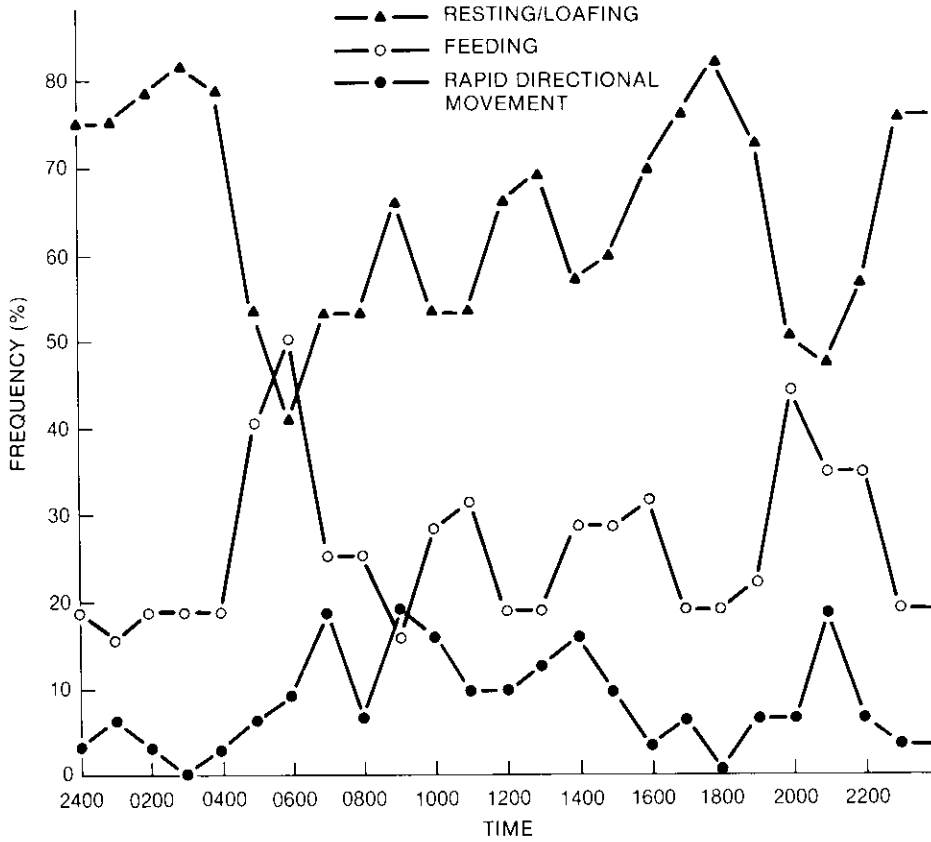


Figure 5. Daily activity patterns of pronghorn on the INEL Site, June-August 1980. Data points for each behavioral use are presented as a percent of the total possible number of movements (32) recorded on the hour and the following half-hour telemetry readings. does average 15.9 ± 4.4 and 20.4 ± 8.1 km, respectively. These were not significantly different ($P > 0.20$) and the average daily movement for all pronghorn sampled was 18.5 ± 7.1 km per day.

Discussion

During this study, all three does with transmitters were in summering groups consisting mostly of does and fawns, an occasional yearling buck, and usually a territorial male. The radio-collared 2-year-old buck was a member of a bachelor band of 6-8 males. Animals within each group tended to move as a unit, and although the precise loca-

tions of each animal varied, the movement and habitat use by each radiomarked animal was considered to be representative of the group. The one mature buck in this study was a solitary, non-territorial animal, blind in one eye and perhaps beyond reproductive age.

Home range estimates based on the 1.0 km²-grid analysis ranged from 67 to 96 percent (\bar{x} = 78 percent) larger than those calculated by the minimum area method (Table 1). Estimates based on this grid size included areas within the home range that were not delimited by either of the other methods (Fig. 2). Use of a 1.0 km²-grid size was thus considered inappropriate for accurately estimating size of pronghorn home ranges. When a 0.25 km²-grid size was used to estimate home range, the results averaged 16 percent (range: 8-21 percent) larger, but not significantly different from those calculated by the minimum area method (Table 1). The 0.25²-grid analysis also delineated travel corridors between successive locations that were not shown by the minimum area method (Fig. 2), and defined some non-use areas within the boundary of each home range. Thus, the 0.25²-grid analysis was considered a sensitive and accurate method of estimating pronghorn home range size and was used for subsequent temporal, spatial and behavioral analyses of home range use.

The average summer home range from the 0.25 km²-grid analysis was 13.85 ± 2.95 km². This was 17 percent larger than the average 11.5 km² winter home range for adult does determined (minimum area method) by Bayless (1969) in Montana, and considerably smaller than the 20.33 ± 3.22 km² ($N = 34$) average summer home range (minimum area method) reported by Hoskinson and Tester (1980) in southeastern Idaho. The latter study included home range estimates for yearlings which the investigators reported as having summer ranges 2-5 larger than adults. Eliminating their yearling home ranges resulted in an average summer home range for adult pronghorn of 13.65 km² ($N = 25$), similar to the findings of this study.

Pronghorn used specific areas within their home range for different behavioral activities (Fig. 3). The majority of the behaviors recorded within the centers of activity were resting/loafing and feeding. This was consistent with the findings of Craighead *et al.* (1973) for elk (*Cervus elaphus*) in Yellowstone National Park, where nearly 85 percent of all feeding and bedding occurred within the centers of activity.

Pronghorn exhibited two major and two minor peaks of feeding activity daily. Major peaks occurred early in the morning (0430-0630 MST) and in the late evening (1930-2230 MST) (Fig. 5). Kitchen (1974) and Amstrup (1978) also reported morning and evening peaks in feeding activity. I additionally recorded minor periods of feeding activity during mid-mornings and mid-afternoons. Overall, feeding accounted for nearly 30 percent of the daily activity. This is below the 50-60 percent frequency of feeding recorded by Amstrup (1978) during dawn, daylight, and dusk hours. These differences are probably the result of differences in monitoring techniques and/or habitat quality. Bouts of feeding were generally separated by periods of resting/loafing, although rapid directional movement increased following the major morning and during the major evening feeding periods. Apparently the marked pronghorn, and presumably others, began each day by feeding near their overnight resting areas. They then moved away to ruminate, and spent the daylight hours alternately feeding and resting/loafing. About 65 percent of each day was spent resting/loafing (Fig. 4). This percentage is considerably higher than that reported by Beuchner (1950) and

Amstrup (1978) who found pronghorn inactive less than 30 percent of the time. Differences in periods of inactivity reflect the differences in foraging activity given above. During or after a major late-evening feeding bout, pronghorn moved to an area for overnight resting. These areas changed little from night to night, and without exception were within the center of activity of the home range. Pronghorn generally rested during the night when coyotes (*Canis latrans*), the main predator of pronghorn resident on the INEL, were most active (Lanudre' and Keller 1981). Nightly selection of the same resting areas may afford pronghorns increased security resulting either from familiarity with the area or from the presence of some undetermined topographic or physiogomic feature of the area.

Total daily summer movements in excess of 15 km were not uncommon for pronghorns. Yoakum (1978) reported that summer movements ranged from 0.1 to 0.8 km. His data probably represents the linear distance between the two most distant points that animals moved during the course of a day, rather than the total distance actually traveled. The minimum and maximum linear distances pronghorn moved in a day in this study were 2.3 and 8.0 km ($\bar{x} = 4.5$ km). These data correspond more closely with the daily range from fall and winter movements of 3.2-9.7 km reported by Yoakum (1978). Differences in daily movements between his summer data and those from this study are most likely the result of different sampling procedures and study areas.

Open water was known to be within the boundary of only one of the five home ranges defined in this study. Thus, while one radio-collared animal and her band had access to free water and possibly drank daily, no evidence indicated that the other four study animals and their bands did so. Published reports of water use and requirements for pronghorn are conflicting. In reviewing this topic, Prenzlou (1965) cited references indicating water use by pronghorn varied from drinking each morning and evening (Kautz 1942) to water demands being met by the production of metabolic water (Davis 1960). Yoakum (1978) and Amstrup (1978) suggested that pronghorn go to water daily and imply that pronghorn avoid areas where free water is not available. Einarsen (1948) reported that pronghorn drink water if it is available, and if it is not, the moisture content in the vegetation consumed meets daily water needs. Phelps (1978) maintained that in Arizona, Sonoran pronghorn (*A. a. sonoriensis*) may go from May to August without drinking water. Directional movements to a water source were not recorded during this study. This tentatively implies that the study animals and the bands they were with relied on the moisture in the vegetation to provide sufficient water for metabolic maintenance during the study period.

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