

# DYNAMICS OF HOME RANGE AND MOVEMENTS OF ADULT BLACK BEARS IN NORTHEASTERN PENNSYLVANIA<sup>1</sup>

GARY L. ALT, Pennsylvania Cooperative Wildlife Research Unit, The Pennsylvania State University, University Park 16802

GEORGE J. MATULA, JR., Pennsylvania Cooperative Wildlife Research Unit, The Pennsylvania State University, University Park 16802

FLOYD W. ALT, Star Route, Moscow, Pennsylvania 16802

JAMES S. LINDZEY, Pennsylvania Cooperative Wildlife Research Unit, The Pennsylvania State University, University Park 16802

**Abstract:** Home range and movement patterns of 17 radiocollared adult black bears (*Ursus americanus*) were determined from approximately 2,000 radio-locations obtained between January 1973 and December 1976 in northeastern Pennsylvania. Total home range size averaged 173 km<sup>2</sup> for males and 41 km<sup>2</sup> for females. Females traveling with offspring used larger areas than solitary females. Seasonal variations in home range and movement patterns were extensive. Maximum home range size and maximum daily movements of adult males and breeding females occurred during the June and July breeding season, whereas home range size and movements of females with cubs increased from spring through summer, peaking in September. Monthly home range size and distance between daily sequential locations were directly related ( $R^2=0.74$ ), indicating that as bears increase their home range size they also become more mobile. Home ranges for both sexes appeared to be geographically stable both on an annual and seasonal basis.

Published home range estimates for black bears refer primarily to the total areas the bears used while they were observed, with little consideration for the length of time or season they were observed or how the animals used the areas dynamically (Erickson and Petrides 1964, Sauer et al. 1969, Jonkel and Cowan 1971, Rieffenberger 1973, Matula 1976, Amstrup and Beecham 1976). This study examined the relationship of home range and movement patterns of adult black bears to sex and season, and related the results to the ecology and management of the black bear in northeastern Pennsylvania.

Field work was conducted throughout most of Pike, southeastern Lackawanna, southern Wayne, and northern Monroe counties in northeastern Pennsylvania. A vegetative characteristic of the study area that appears important to this productive bear population is the occurrence of swamps — with interspersions of spruce (*Picea rubra*), rhododendron (*Rhododendron maximum*), and blueberries (*Vaccinium* spp.) — throughout the mixed hardwood forests.

The study area has no major industrial development; however, numerous lakes, large tracks of state game lands and state forest lands, and private hunting and fishing clubs provide the base for a large recreational economy. The recent completion of Interstate Highway 84, connecting this area with New Jersey, Connecticut, and New York City, has greatly stimulated extensive

housing developments. These large developments, used primarily for recreational purposes, retirement, or permanent homesites, have resulted in marked changes in available bear habitat. Physiography, geography, climate, vegetation, land use, human population, and the economy of the study area have been described by Eveland (1973) and Kordek (1973).

We gratefully acknowledge funding, field assistance, and cooperation provided by the Pennsylvania Game Commission V. Alt, L. Biesecker, F. Stettler, L. Stettler, and T. Eveland provided valuable field assistance in capturing and instrumenting bears and recording data.

## METHODS

Captured bears were instrumented with radiocollars manufactured by AVM Instrument Company, Champaign, Illinois, and EMF Systems Inc., State College, Pennsylvania. Detailed descriptions of capture and telemetry techniques were presented by Alt et al. (1976) and Matula (1976).

Locations of each animal, as determined by radio signal or direct observation, were recorded on U.S. Geological Survey 7½-minute quadrangles and coded as *X* and *Y* coordinates of the Universal Transverse Mercator grid system (Kordek 1973). The coded locations were recorded on computer cards, and home range estimates were calculated by a computer program, according to methods described by Jennrich and Turner (1969). The covariance matrix (95 percent confidence region) estimate was used to compare home range data because it does not assume circular home range, it provides a confidence region, and it is statistically unbiased. Repeated locations at den sites were

<sup>1</sup>Paper No. 212 of the Pennsylvania Cooperative Wildlife Research Unit, School of Forest Resources, The Pennsylvania State University. The Pennsylvania Cooperative Wildlife Research Unit is jointly sponsored by the U.S. Fish and Wildlife Service, the Pennsylvania Game Commission, and the Wildlife Management Institute.

excluded because they would have given undue weighting to these positions.

## RESULTS AND DISCUSSION

Seventeen adult black bears (5 males and 12 females), radio-instrumented during this study, provided usable home range data. Home range and movement activities are based on roughly 2,000 radio-locations taken between January 1973 and December 1976.

### Home Range as Related to Sex of the Bear

The average total home range was 173 km<sup>2</sup> for males and 72 km<sup>2</sup> for females. Examination of the distribution of individual home range estimates revealed that 2

(Rogers 1977). Burt (1943) stated that occasional forays outside the ordinarily occupied areas should not be interpreted as expansion of the home range. A reanalysis of home range, excluding excursions by these 2 females, reduced their respective home ranges from 295 km<sup>2</sup> to 27 km<sup>2</sup> and from 206 km<sup>2</sup> to 50 km<sup>2</sup> and also reduced the average home range for all females from 76 km<sup>2</sup> to 41 km<sup>2</sup> (range, 14-84 km<sup>2</sup>) (Fig. 1B). These reduced estimates are comparable to home range estimates for the other females and, we believe, they are also more representative of the actual area utilized. In contrast, the movements of the male bear appeared to occur homogeneously throughout his home range, with no irregular excursions. The larger home range

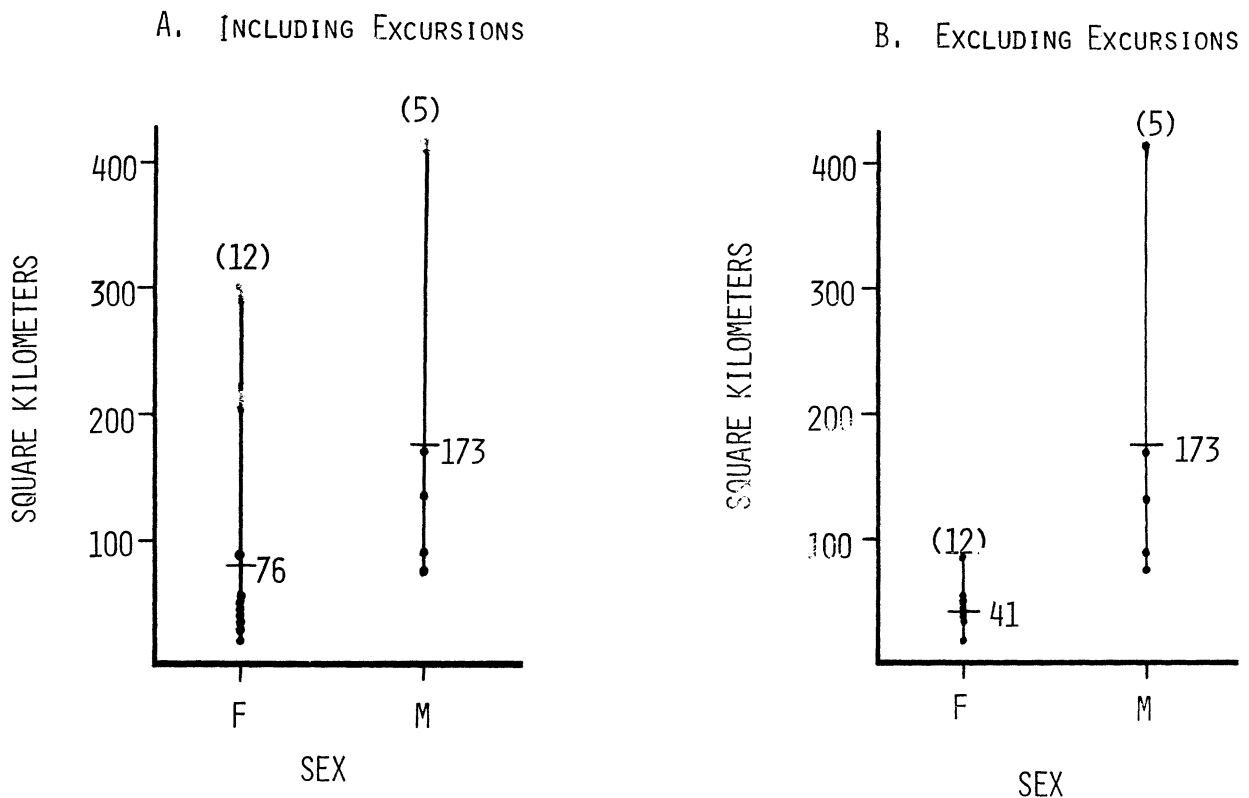


Fig. 1. Home ranges of adult male and female black bears in northeastern Pennsylvania, 1973-76.

females and 1 male occupied areas much larger than those occupied by other bears of the same sex (Fig. 1A). Closer examination showed that both adult females made long excursions while traveling with their cubs during September and October. Similar findings have also been reported for black bears in Minnesota

estimate for the male may reflect such factors as bear population density, social status of individual bears, or some other ecological or behavioral factors (Jewell 1966, Maza et al. 1973). Thus, average home range size for males remained at 173 km<sup>2</sup> (range, 72-413 km<sup>2</sup>).

Another parameter occasionally used for home range comparisons is the greatest linear distance across the home range. In this study, adult males averaged 18.0 km (range, 12.3-25.1 km) whereas adult females averaged only 8.3 km (range, 5.1-12.2 km) when excursions were excluded. Consideration of both area and greatest linear distance across home range indicates that adult male black bears, in general, occupied much larger areas than adult females, which is comparable to findings reported for other states (Erickson and Petrides 1964, Sauer et al. 1969, Jonkel and Cowan 1971, Rieffenberger 1973, Amstrup and Beecham 1976).

#### Home Range Differences Within the Female Population

Adult female bears in Pennsylvania appear to have a biennial reproductive cycle. They give birth to cubs in their winter dens during January, remain with their offspring for approximately 18 months, breed during June or July (after separating from their yearlings), then remain solitary for about 6 months until cubs are born

and the cycle begins again. Females unsuccessful at breeding every other year, or that lose their cubs before the next breeding season, are assumed to repeat the solitary phase of the cycle. Therefore, part of the female population each year is solitary while another part is traveling with offspring.

During this study, 5 adult female bears radiotracked while solitary and also when traveling with offspring, maintained larger home ranges while accompanied by offspring (Fig. 2). If reproductive synchrony (high and low cub-producing years) exists, as suggested by Lindzey et al. (1976), the greater spatial requirements of females with offspring may cause increased competition for available space in densely populated breeding areas during high cub years.

Closer examination of only the females traveling with offspring revealed that during the spring of any given year there are those accompanied by small cubs (less than 4.5 kg) and those traveling with yearlings. Radiotracking confirmed that movements of females traveling with small cubs may be restricted because of the lack of mobility of their offspring.

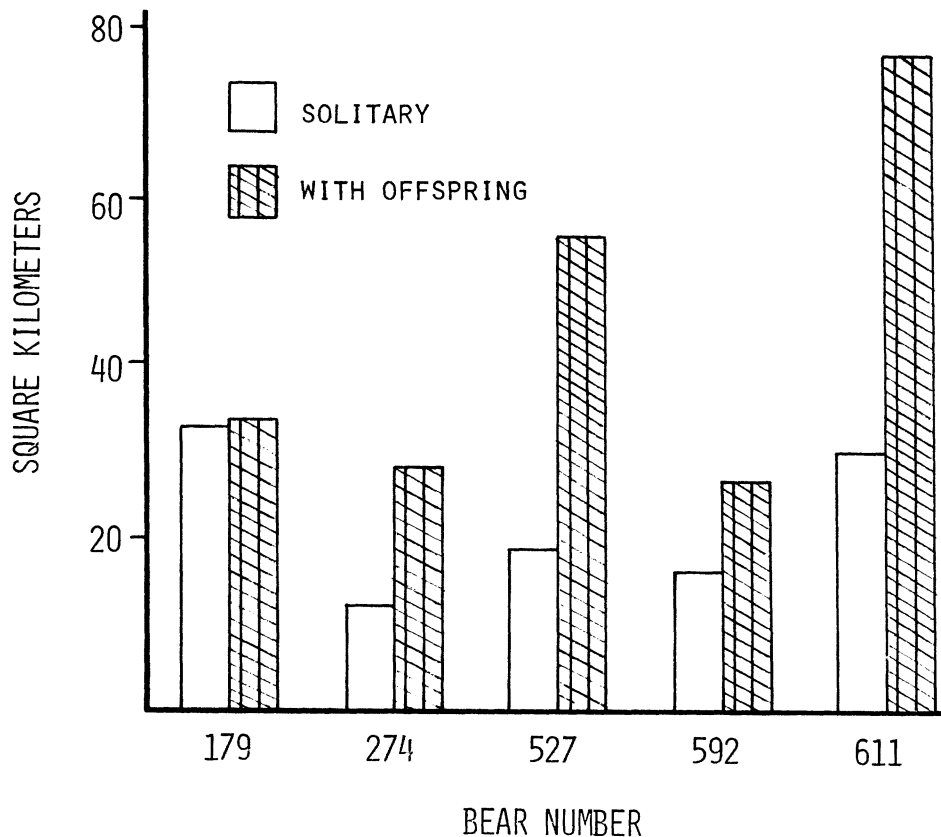


Fig. 2. Home ranges of individual adult female black bears in northeastern Pennsylvania, 1973-76.

**Seasonal Variation in Home Range and in Movements**

Adult bears were classified into 3 groups: (1) males, (2) breeding females (solitary or with yearlings), and (3) females with cubs. Monthly home range estimates for each group were pooled and averaged, as were average distances between sequential locations taken 1 day apart, to characterize seasonal trends (Figs. 3, 4).

Monthly home range size and movements of all 3 classes of bears demonstrated substantial seasonal variation (Figs. 3, 4), and 2 basic trends were apparent: (1) Adult males and breeding females (the breeding segments of the population) were synchronized to the extent that both segments occupied the greatest area and were most mobile during the June and July breeding season. (2) Females with cubs increased home range size and mobility from spring through summer and reached a peak in the fall as the cubs matured. The greater mobility and home range size of adult males and breeding females during the breeding season may increase the chances of reproduction, particularly when the density of the bear population is low.

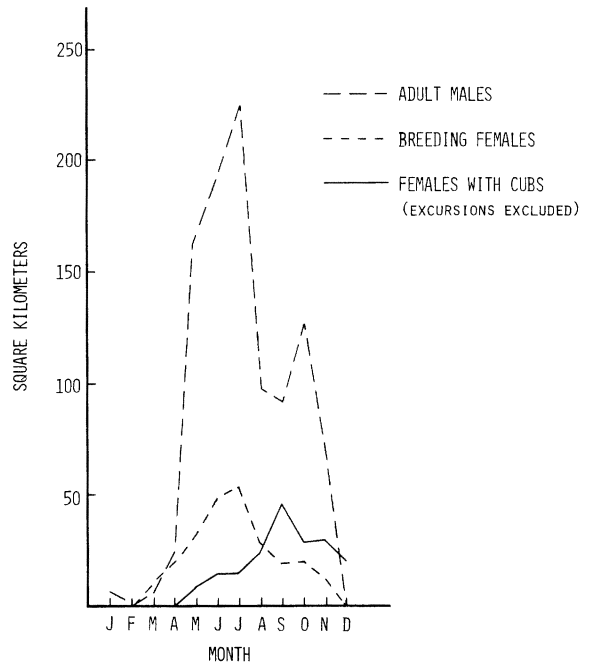


Fig. 3. Seasonal variation in home range size of adult black bears in northeastern Pennsylvania, 1973-76.

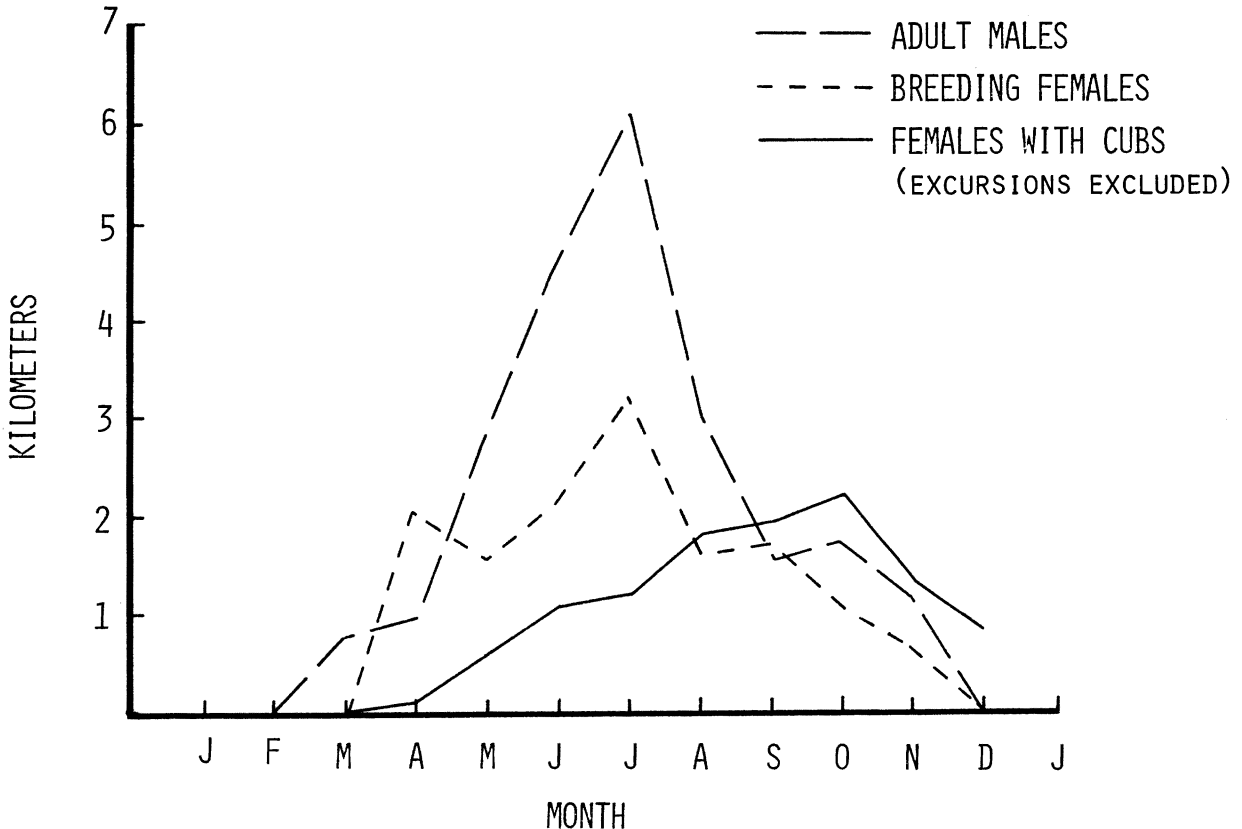


Fig. 4. Distance moved by adult black bears between sequential locations 1 day apart in northeastern Pennsylvania, 1973-76.

The average distance between daily sequential locations for each month and the monthly home range size were directly related ( $R^2=0.74$ ). In other words, as bears used larger areas they also traveled greater distances per day. This strategy should help bears locate foods and mates and perhaps enables them to defend a larger area more effectively.

#### Percentage of Annual Home Range Used Per Month

Annual home ranges were evaluated for 9 bears: 4 adult males, 3 breeding females, and 2 females with cubs. Bears were radiotracked a minimum of 6 active months during any given year before estimates of their annual home ranges were made. These estimates remained quite stable from year to year, based on data for 5 bears that were radiotracked 2 or more consecutive years. Monthly home range estimates were pooled, averaged, and expressed as percentages of the annual home ranges (Fig. 5). During the breeding season (June and July), breeding bears (adult males and breeding females) utilized areas larger than their annual home ranges, as determined by the method of Jennrich and Turner (1969), but used areas smaller than their

annual home ranges during all other months. In contrast, females with cubs used areas smaller than their annual home ranges from January through August but used areas greater than their annual home ranges from September through December.

#### Geographic Stability of Home Range

Although home range size and mobility of adult bears vary considerably throughout the year, geographic stability of home ranges on an annual basis seems to be maintained. The activity centers (Hayne 1949) of annual home ranges were calculated and the distance between them for consecutive years determined. The average distance between annual home range activity centers was 1.59 km (range, 1.24-1.92 km,  $N=2$ ) for adult males and 0.99 km (range, 0.90-1.78 km,  $N=5$ ) for adult females. These shifts were relatively small when compared with home ranges that averaged 18.0 km across for males and 8.3 km for females.

A similar analysis undertaken to determine the distance between monthly activity centers and the activity centers of annual home ranges indicated that the average distance for males was 2.02 km (range, 0.30-5.48

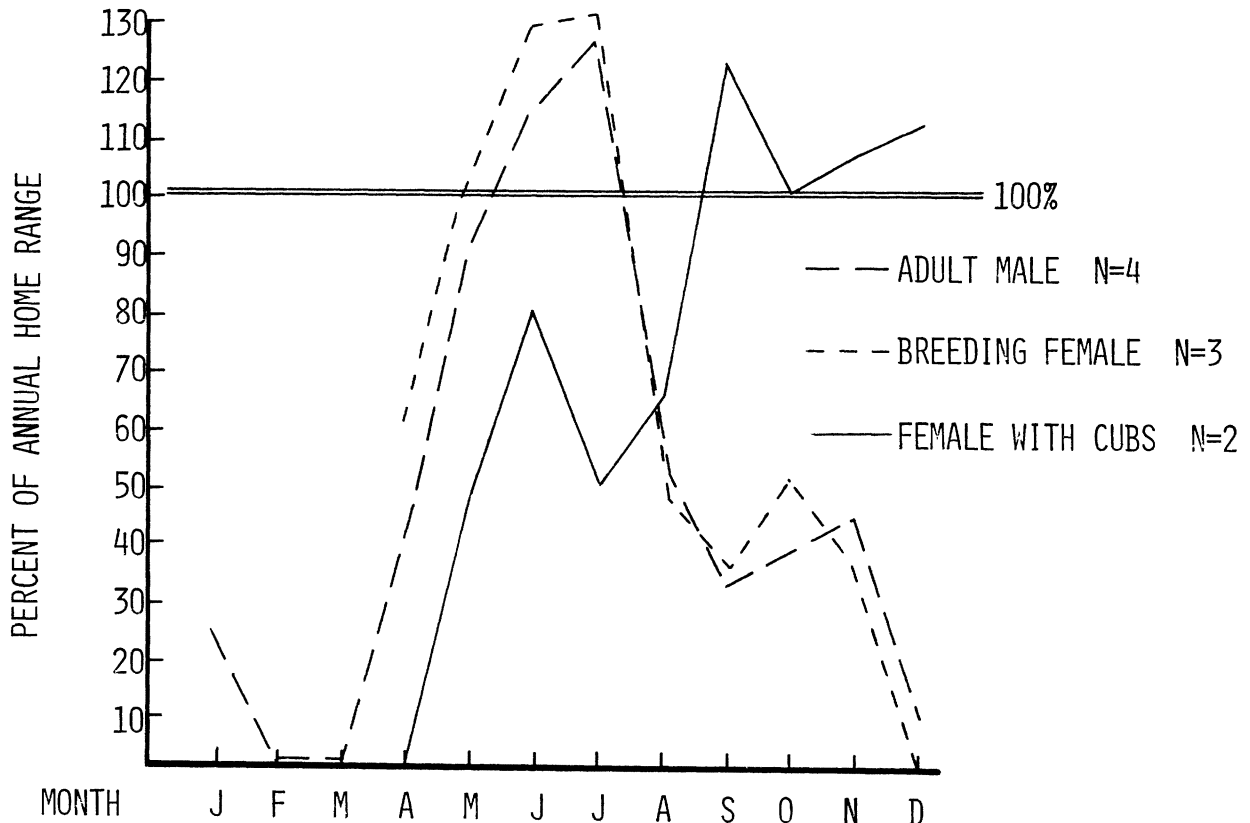


Fig. 5. Percentage of annual home range used per month by adult black bears in northeastern Pennsylvania, 1973-76.

km,  $N=31$ ) and the average for females was 0.93 km (range, 0.11-2.28 km,  $N=41$ ). These averages suggest only slight shifting of seasonal home ranges within the annual home ranges. Both annual and seasonal home ranges appear geographically stable in northeastern Pennsylvania.

## CONCLUSIONS

Male black bears, in general, maintained home

ranges about 4 times larger than those occupied by females. Females traveling with offspring tended to use larger areas than females that were solitary. Seasonal variation in home range size and in mobility of black bears was substantial. When home ranges increased in size, bears tended to travel greater distances per day. Geographic stability of home ranges appears to be maintained despite the seasonal changes in home range size and in the mobility of bears.

## LITERATURE CITED

- ALT, G. A., F. W. ALT, AND J. S. LINDZEY. 1976. Home range and activity patterns of black bears in northeastern Pennsylvania. *Proc. Northeast Sec. of The Wildl. Soc.* 33:45-56.
- AMSTRUP, S. C., AND J. BEECHAM. 1976. Activity patterns of radio-collared black bears in Idaho. *J. Wildl. Manage.* 40(2):340-348.
- BURT, W. H. 1943. Territoriality and home range concept as applied to mammals. *J. Mammal.* 24 (4):346-352.
- ERICKSON, A. W., AND G. A. PETRIDES. 1964. Population structure, movements, and mortality of tagged black bears in Michigan. *Michigan State Univ. Agric. Ex. Stn. Res. Bull.* 4:46-67.
- EVELAND, J. F. 1973. Population dynamics, movements, morphology, and habitat characteristics of black bears in Pennsylvania. M. S. Thesis. The Pennsylvania State Univ., University Park. 157pp.
- HAYNE, D. W. 1949. Calculation of size of home range. *J. Mammal.* 30(1):1-18.
- JENNRICH, R. I., AND F. B. TURNER. 1969. Measurement of non-circular home range. *J. Theoret. Biol.* 22(1):227-237.
- JEWELL, P. A. 1966. The concept of home range in mammals. *Symp. Zool. Soc. London* 18:85-109.
- JONKEL, C. J., AND I. MCT. COWAN. 1971. The black bear in the spruce-fir forest. *Wildl. Monogr.* 27. 57pp.
- KORDEK, W. S. 1973. An investigation of the structure, stability, and movements of Pennsylvania black bear with particular emphasis on Pike County. M.S. Thesis. The Pennsylvania State Univ., University Park. 77pp.
- LINDZEY, J. S., W. S. KORDEK, G. J. MATULA, JR., AND W. P. PIEKIELEK. 1976. The black bear in Pennsylvania — status, movements, values, and management. Pages 215-224 in M. R. Pelton, J. R. Lentfer, and G. E. Folk, Jr., eds. *Bears — their biology and management*. IUCN Publ. New Ser. 40.
- MATULA, G. J. 1976. Behavioral and physiological characteristics of black bears in northeastern Pennsylvania. M.S. Thesis. The Pennsylvania State Univ., University Park. 187pp.
- MAZA, B. G., N. R. FRENCH, AND A. P. ASCHWANDEN. 1973. Home range dynamics in a population of heteromyid rodents. *J. Mammal.* 54(2):405-425.
- RIEFFENBERGER, J. C. 1973. Range and movements of West Virginia black bears during summer and autumn, 1973. *Proc. Eastern Workshop on Black Bear Manage. and Res.* 2:139-142.
- ROGERS, L. L. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Thesis. Univ. of Minnesota, Minneapolis. 194pp.
- SAUER, P. R., S. L. FREE, AND S. D. BROWNE. 1969. Movements of tagged black bear in the Adirondacks. *N. Y. Fish Game J.* 16(2): 205-223.