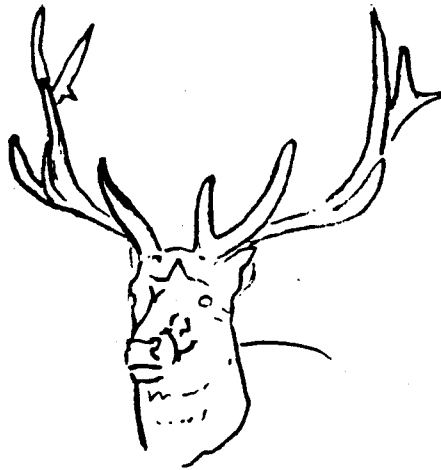


EVALUATION OF MOVEMENTS AND HABITAT USE
OF ELK IN THE SOUTHERN BLACK HILLS,
SOUTH DAKOTA, 1980-1986

Completion Report
by
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ABSTRACT

EVALUATION OF MOVEMENTS AND HABITAT USE OF ELK IN THE SOUTHERN BLACK HILLS, SOUTH DAKOTA, 1980-1986

Transplanted elk (Cervus elaphus) from Wind Cave National Park were used to determine movements and habitat use of native elk populations in the Black Hills, South Dakota. Total elk transplanted was 89 head. All were ear tagged and adults neck collared. Additionally, six adult cows were equipped with radioed neck collars. Transplanted elk joined native herds which allowed study objective determination.

All elk herds in this study were nonmigratory. Home range for seven hunted populations ranged from 23 to 77 square kilometers. Home range for one nonhunted population was 16 square kilometers. Daily movement for hunted populations was twice that of the nonhunted herd. Greater home range and daily movements was due to hunting, interspecific competition with domestic livestock, and disturbance created by logging, firewood cutters, and other miscellaneous human activity.

Elk habitat use was divided into four activities: 1) feeding, 2) loafing/resting, 3) escape from disturbance, and 4) calving. Feeding habitats utilized were meadows and small areas where deciduous trees were dominant canopy. Meadows where prescribed fire and natural wildfire had occurred were heavily utilized. When disturbance factors occurred feeding areas shifted to small openings less than 2 hectares in size. Agricultural cropland was utilized as feeding areas primarily in early spring and late summer. With onset of grazing on the Black Hills National Forest in late spring, space competition between elk and cattle caused radical change in elk habitats used. Elk sought areas with little or no cattle occurrence.

Loafing/resting habitats used varied from zero to complete ponderosa pine (Pinus ponderosa) canopy closure. Disturbance factors determined areas utilized. Due to lack of weather related stress, thermal cover needs were not considered to be of importance.

Elk utilized vegetative and topographic escape cover to avoid human disturbance. Flight response was generally at least 1.6 kilometers during daylight and 0.4 kilometers at night with line-of-sight barriers between elk and disturbance in both cases. If disturbance was repetitive or long in duration, greater flight distance occurred and topographic barriers no longer sufficed for escape cover needs. Under these conditions only ponderosa pine with virtually 100 percent crown closure provided needed escape cover.

Calving areas were small forest openings less than 0.4 hectares in size. Overstory was less than 5 feet tall but ground cover was present in the form of shrub or downed timbers. Dense escape cover was always adjacent to openings utilized for calving.

Two external factors greatly influenced elk movements and habitat use: 1) human activity and 2) domestic livestock. No matter what form of human activity occurred, elk behavior was adversely affected. Vehicle access to elk populations compounded the problem. Feeding areas, loafing/resting habitats, and escape cover security needs all were influenced by degree of human activity. Presence of domestic livestock (cattle) created "space competition" and altered elk feeding and loafing/resting habitats utilized. Recommendations to minimize these conflicts were presented.

PREFACE

Data gathered by South Dakota Department of Game, Fish and Parks personnel during fiscal periods, 1980-81, 1981-82, 1982-83, 1983-84, 1984-85, 1985-86, on Evaluation of Movements and Habitat Use of Elk in the southern Black Hills, South Dakota, under Pittman-Robertson Projects W-75-R-23-28, Jobs I and II, are analyzed and presented in this completion report.

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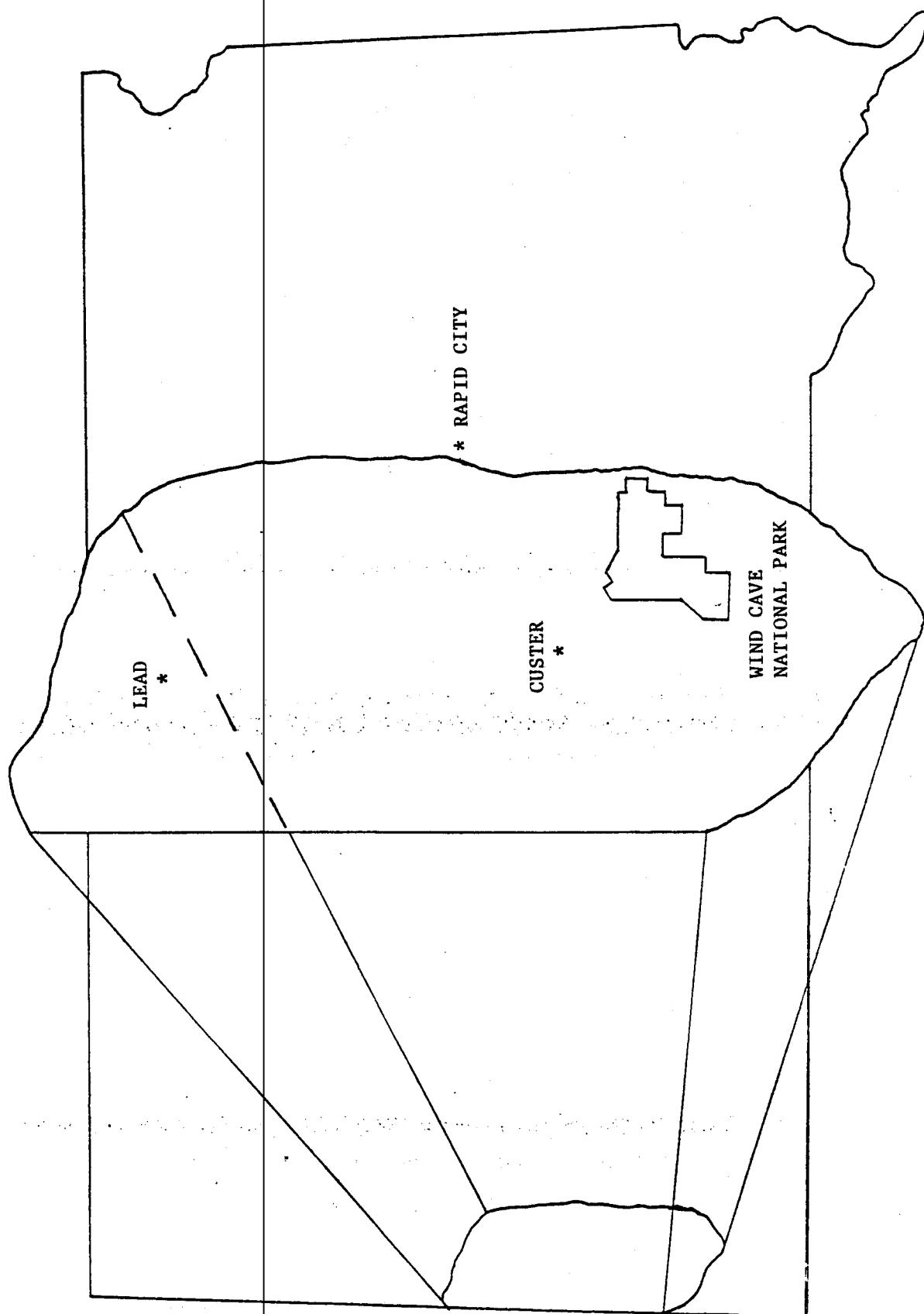


Fig. 1. Study area, Evaluation of Movements and Habitat Use of Elk in the Southern Black Hills, South Dakota, 1980 - 1986.

Land ownership patterns, therefore, make management of individual elk herds complicated. Management goals are further complicated by increased demands both by consumptive and nonconsumptive general public.

Approximately 480 head of elk can be found on the South Dakota portion of the Black Hills National Forest and on intermingled private lands. There are an additional 460 animals which can be seasonally found on National Forest lands administered by the United States Forest Service. These 460 elk represent transient populations which spend a portion of the year in Custer State Park, Wind Cave National Park or Wyoming. Elk management goals of the South Dakota Department of Game, Fish and Parks call for increasing the 900 to 1,000 elk presently managed to 2,300 by year 2000. Of the 2,300, 1,360 would be found year round on the Black Hills National Forest and private lands. The remaining 940 animals would be seasonally found on the Black Hills National Forest. In order to meet this goal, more intensive management of both elk herds and the land resource will be needed.

Elk populations within the Black Hills are located in five management units (Fig. 2) plus remnant herds outside unit boundaries. Population estimates are based on prehunt 1986 levels.

1. Unit 1 -

Elk in this management unit total 400 animals. The population is slightly increasing. A portion of this herd can seasonally be found in Wyoming. Degree of movement between South Dakota and Wyoming is in part correlated with South Dakota snow depth. Snow depths over 0.5 meters (20 inches) increase the likelihood of elk movement into Wyoming. Another portion of this population serves as a reservoir for emigrating elk into Management Unit 2. Additionally, seasonal movement of a segment of the elk population is believed to occur between Units 1 and 2. At present, both South Dakota and Wyoming allow limited hunter harvest of both sexes to control herd numbers. Population goal by year 2000 is 800 elk to be found seasonally in this unit.

2. Unit 2 -

Elk in this unit, estimated at 120 animals, are believed to be seasonally a portion of populations from Management Units 1 and 3 plus the State of Wyoming. Of the five management units, herds found here are most variable due to low population numbers. Management is limited hunter harvest of both sexes. Goal by year 2000 is 500 animals to be seasonally found in the unit.

3. Unit 3 -

An estimated population of 330 elk are found in this unit. Portions of the herds in this unit immigrate from and emigrate into Custer State Park and Wind Cave National Park. Also, seasonal movement is believed to occur with Management Unit 2. Populations are stable-to-decreasing due to landowner tolerance. Potential emigration from both park systems can be seriously affected by management within those parks. Management effort is directed toward controlling numbers through limited either sex hunter harvest. Potential growth may be accomplished in the western portion of this unit but not in the eastern area due to landowner tolerance. This unit may have to be divided into smaller management areas in order to accomplish goal of 600 elk by year 2000.

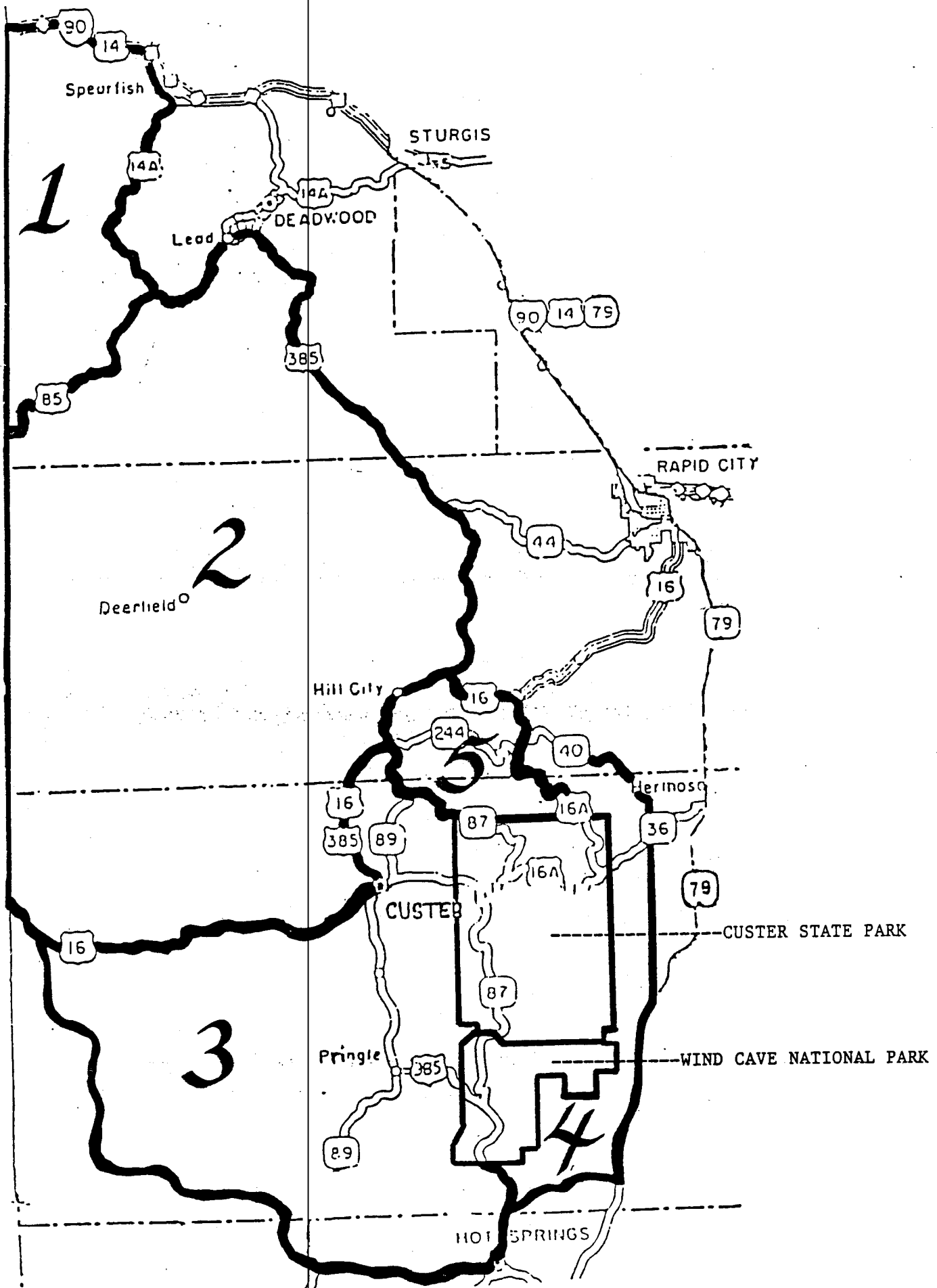


Fig. 2. Elk management units, Black Hills, South Dakota, 1986.

4. Unit 4 -
Prehunt 1986 population was approximately 80 animals. Due to landowner tolerance, numbers were reduced from 1985 levels (100 head) through hunter harvest. As with Unit 3, elk are believed to move into and out of both park systems. Management direction in both park systems could potentially influence elk numbers as with Unit 3. Under present depredation complaint policy, goal by year 2000 is to hold this herd at a maximum of 100 elk. Expansion of goal numbers will only be possible with a change in attitude by landowners experiencing depredation losses.
5. Unit 5 -
Herd estimate is approximately 40 animals. This unit contains the only designated wilderness area found in the Black Hills. Elk found in this unit can seasonally be found in Custer State Park.

As in Unit 3 and 4, management direction for Custer State Park will influence elk numbers in Unit 5. Management goals in part depend on Black Hills National Forest management of the Black Elk Wilderness Area and Norbeck Wildlife Preserve. At this time natural fire is controlled in the wilderness area and habitat conditions are poor due to pine encroachment. Goal by year 2000 is for expansion of the herd to approximately 150 head assuming improved habitat conditions. As with all other units herds are managed with limited harvest of both sexes.
6. Miscellaneous Herds -
There are small, remnant elk herds found outside the five management units which number less than 75 animals. These herds hold potential for increased numbers, and elk management units in these areas are year 2000 goals.

RESOURCE NEEDS AND CONFLICTS

Resource Demands

Black Hills elk herds have historically presented unique challenges for managers. For no other big game species does demand so far exceed supply. Both consumptive and nonconsumptive user demand numbers have grown drastically. Under present elk populations, demand for consumptive use cannot be satisfied. For the 1986 fall elk hunting seasons, 3,061 hunters applied for 475 total permits including: 1,017 applications for 105 permits in Unit 1; 199 applications for 50 permits in Unit 2; 1,456 applications for 220 permits in Unit 3; 329 applications for 60 permits in Unit 4; and 60 applications for 40 permits in Unit 5. This was over two times as many applications as were received in 1980 even though permits issued increased almost three fold (1,321 applications for 180 permits, 1980). Obviously consumptive demand cannot presently be met.

Nonconsumptive uses include listening to bulls bugle during the rut and visual sightings of elk or evidence of them. As outdoor recreation has gained popularity, more and more nonconsumptive demand is placed on the resource. While not a serious problem at this time, conflicts between consumptive and nonconsumptive uses are probably inevitable with the limited elk resource.

While both consumptive and nonconsumptive user groups obviously want a considerable increase in elk numbers, limits must be placed on degree of expansion due to forage availability on National Forest lands and private landowner tolerance of elk numbers. Depredation potential by elk exceeds other big game species in the Black Hills. Damage to standing agricultural crops, haystacks, and fences can reach intolerable levels if herd expansion is not limited. Therefore, landowners experiencing depredation will demand elk populations lower than that wanted by consumptive and nonconsumptive users. Regardless of elk numbers, home range, food habits, and behavior dictates that elk will spend a portion of the year on private land. Therefore, overall herd levels will have to be maintained at numbers below potential.

Resource Needs

While data have been collected in conjunction with hunter harvest, incidental observations, and winter distribution, other factors vital to proper elk management in the Black Hills National Forest were virtually unknown. Home range, seasonal movements, habitat use and preference, effects of disturbance and conflicts with other resource uses needed to be ascertained. These unknowns created problems with habitat management for elk herds. Until these elements were documented, changes in National Forest management for the betterment of the elk resource could not be accomplished. Elk use of certain habitat types in the Rocky Mountains has been ascertained through multitudes of studies. However, the Black Hills present situations unique to the area. Number of plant communities, ponderosa pine (Pinus ponderosa) regeneration, and other complex factors dictated baseline data requirements on elk habitat use within the Black Hills National Forest. Since no true secluded areas occur on National Forest lands due to human access, potential for human disturbance effects on elk populations was unique.

Conflicts between elk and other resource users have been documented in numerous studies throughout North America. Logging industry, cattle grazers, recreational enthusiasts, and many other multiple use factions all place demands on the public resource which are often in conflict with habitat needs of elk populations.

Timber Resource Conflicts

The land management activity that most directly influences elk habitat is silvicultural practices. Ponderosa pine is the major tree species being managed in the Black Hills. Wildfire control and current silviculture practices have caused much of the Black Hills to reach a climax plant community dominated by ponderosa pine which is detrimental to elk habitat needs. Smith (1962) pointed out that silviculture restricts stand composition to those species most suited to an area from both economic and biological standpoints. He felt this dictated that total number of species in a managed forest was less than what occurred under purely natural conditions. Pine encroachment into grassland vegetation is in direct conflict with elk habitat preferences. Geist (1982) gave detailed description on importance of grassland vegetation to elk.

Nelson and Leege (1982) also point out that elk are nutritionally better suited for herbaceous vegetation rather than browse at least when snow depths are not limiting. Silvicultural practices within the Black Hills are based largely on selective cutting of ponderosa pine. This necessitates several thinning entries

with resultant disturbance that is detrimental to elk populations. Lyon and Ward (1982) state most investigators have shown favorable forage increases after thinning has been accomplished but few investigators have reported increased elk use. Reynolds (1964b) felt conservative selective thinning produced more forage and still provided needed elk escape cover but Lyon and Ward (1982) stated the same results could have been obtained with clear cuts which required less roads and less area disturbance. Because of disturbance factors Lyon and Ward (1982) determined intermediate cuts (thinnings) were detrimental to elk populations. Reynolds (1969a) and Smith (1962) pointed out that if thinning occurs late in a rotation system, resultant slash may cause elk use to be negligible. Current forestry practices require slash to be no higher than 18 inches on the Black Hills National Forest but Lonner (1976) found elk pellet groups declined 50% when slash was over 0.5 meters (15 inches) deep. Black et al. (1976) also found elk tended to avoid areas covered by logging slash.

Pearson (1968) found greatest elk use occurred in ponderosa pine thinned to zero - a clear cut. Lyon and Ward (1982:453) stated "... despite the probability that forage production can be increased by intermediate cuttings, we conclude that there are few situations in which the practice is likely to be largely beneficial to elk." This is in direct conflict with present silvicultural practices in the Black Hills National Forest which allow for selective thinning and few if any, clear cuts. Thomas et al. (1976:452) carried this point even further by stating "... has become increasingly obvious that such cliches as 'good timber management is good wildlife management' will no longer suffice." In the future if selected areas are identified where elk habitat management should take precedence over traditional timber management, it is vital that silvicultural practices beneficial to elk be determined for the Black Hills.

Cattle Resource Conflicts

Conflicts between the elk resource and cattle grazing on public lands has been well documented. Degree of conflict depends on area where investigation took place. Nelson (1982) felt that diet similarities caused elk to compete with cattle more than any other large herbivore. Even in the absence of cattle, elk appear to have a built in deferred-rotation system so one seldom finds areas where all preferred food was eaten prior to elk movement (Lyon and Ward 1982). However, overstocking by either species could create problems for both (Nelson 1982). Skovlin et al. (1968) found elk use significantly decreased as cattle grazing level increased. Several authors found presence of cattle discouraged elk use (Jeffrey 1963, Blood 1966, Mackie 1970, Lonner 1974, Knowles 1975b, Yorgason et al. 1975, Burbridge and Neff 1976, and Neff 1980). In some areas elk habitat preference helps to limit competition (Nelson 1982). Migrant herds appear to have less forage competition on summer range but winter range competition can be serious (Nelson and Burnell 1975). Another study on migrant herds found the summer diet of cattle was mostly grass (64%) while elk use was 75% forbs (Mackie 1970). However, where conditions caused decrease in forb or grass production more conflicts occurred (Mackie 1970). Nelson (1982) also reports that elk on the Pacific Coast and Canada used browse extensively in summer thus reducing competition. Nelson and Burnell (1975) found that distribution helped limit conflicts. Elk used steeper slopes than cattle even though gentler slopes were preferred. Roads also helped separate the species. Julander and Jeffrey (1964) found cattle used lower slopes and ridges while elk used mid to upper slopes. The same authors noted elk used only edges of large meadows while cattle used the entire area. However, this difference was not significant. Gordon (1968b) pointed out that even seasonal use differences

could influence competition. Summer cattle grazing on south facing slopes and ridge tops removed grass needed by elk during winter. Salting of ridge tops to improve cattle distribution compounded the problem. On the other hand, cattle could be used to improve elk winter range by grazing in early summer to stimulate vegetative regrowth to the early seed stalk stage by the end of the growing season (Anderson and Scherzinger 1975). Nelson and Legee (1982) point out that if early summer cattle grazing is used for this purpose a rotation grazing system and extremely close monitoring was required.

Most elk in the Black Hills are not migratory. This places both cattle and elk on Forest Service allotments at the same time from early summer to late fall. Nelson (1982) pointed out that elk have a subordinate role in relationship with cattle. As cattle use increased, elk use decreased. Nelson and Burnell (1976) further state that cattle impact on elk appears as a form of social interaction. Elk left vicinity when cattle were introduced. Elk may even move from the management unit. Even with cattle removal they report elk use in the management unit was limited to areas ungrazed by cattle. Stevens (1966) and Mackie (1970) also reported elk returned in limited numbers after cattle were removed but tended to utilize areas of little cattle use. Both authors found elk movements were directly influenced by presence of cattle. This may explain differences in slope habitats used by elk when compared to cattle slope use. Slope used by elk may in fact be determined by this social interaction rather than preference to a given area. That elk are subordinate to cattle for this space competition was documented by Lonner (1975b and 1976) who reported cattle distribution was not influenced by presence of elk. Lonner (1976) further reported a strong negative interaction of elk and cattle determined by both visual observation and elk pellet group counts. Elk were displaced by what appeared to have been an initial social intolerance toward cattle. Skovlin et al. (1968) determined elk use was significantly lower on ranges where cattle were present than on ranges where cattle use was restricted. Stocking rate and grazing system used also determine degree of cattle-elk conflicts. Skovlin and Harris (1970) found moderate stocking rate of 3.0 hectares (7.5 acres) per animal unit month (AUM) inhibited elk use nearly as much as a heavy stocking of 2 hectares (5 acres) per AUM. Under light stocking rate of 4 hectares (10 acres) per AUM elk use was higher with season long grazing than with deferred-rotation systems. However, under heavy stocking rates the opposite was true. Most of these investigations were with migrant elk. Nelson (1982) reported space competition was not as evident on migrant elk winter range. Other authors have found space competition between elk and cattle did not exist at any time on their areas of investigation. Ward et al. (1973) and Ward (1973a) found elk were socially compatible with cattle and exhibited similar grazing area preference. In these studies elk did not select pastures where cattle were absent in a rotation grazing system even though such pastures were less than 0.8 kilometers (0.5 miles) away. Documentation of cattle-elk conflicts, if any, in the Black Hills National Forest had never been attempted.

Miscellaneous Herbivore Resource Conflicts

Elk-domestic sheep conflicts have been documented by Stevens (1966) where sheep forb consumption during July increased competition and thus forced elk to less preferred feeding areas. Nelson (1982) felt elk-deer conflicts were not serious unless overpopulation of either species occurred. When elk were forced to utilize browse plants forage competition increased. Generally such competition is at the expense of deer. Increased emphasis on herbaceous vegetation

importance to deer herds year round may alter the belief that elk-deer conflicts are not serious in the Black Hills. However, elk numbers and long term management goals are so limited that elk-deer competition is not anticipated.

Human Disturbance Conflicts

Another potential conflict that can be extremely detrimental to elk populations occurs between elk and human resource users. Elk require fairly large areas of solitude. Hunters, loggers, miners, and miscellaneous recreational users all have potential adverse effects on elk use of a given area when human access is not restricted. Human disturbance, especially when repeated, changes elk behavioral patterns drastically (Geist 1982).

Interference or barriers imposed by people, and not habitat availability, caused elk habitat preference alteration and diurnal activity to be replaced by nocturnal (Geist 1982). It was not until the 1970's that research confirmed forest roads created serious elk management problems due to human access (Lyon and Ward 1982). Since the 1970's, road standards in the Black Hills have substantially increased to facilitate timber harvest. This has increased human access to areas previously accessible only to foot traffic or 4-wheel-drive vehicles. The Wyoming Forest Study Team (1971:48) states "... as road densities increase elk retreat from this disturbance until, eventually, there is no escape left." Lyon and Ward (1982) cite numerous studies where roads with unlimited vehicle access caused elk to vacate the area. Roads improve hunter access which increase elk harvest, reduces man-days needed to harvest elk, but forces elk into areas of reduced habitat quality. The same result may occur with increased recreational use such as sightseers, berry pickers, and fire wood haulers. Several authors have documented decline in elk use adjacent to roads. Width of elk avoidance ranged from 0.4 to 2.9 kilometers (0.25 - 1.8 miles) depending on kind of traffic, quality of roads and screening density adjacent to road (Rost and Bailey 1974, 1979 and Pedersen 1979). Most studies have shown the greater the traffic flow on high quality roads the greater elk avoid the area (Lyon and Ward 1982). Elk numbers were reduced 10 to 70 percent within 0.4 kilometers (0.25 mile) of open roads (Idaho Interagency Study Team 1977b). Exceptions have been found with these investigations. Burbidge and Neff (1976) found slower moving traffic on primitive roads had a greater effect than fast moving traffic on improved roads. Ward (1976) felt out-of-vehicle human activity had significantly more affect on elk than fast moving traffic on Interstate 80 in Wyoming. When people were out of their vehicles, elk required at least 0.8 kilometer (0.5 mile) distance from disturbance even with line-of-sight barriers in between (Ward 1976).

Road density also influenced elk use of an area. Lyon (1979a) reported when road densities reached 1.9 kilometers per 100 hectares (3 miles per section) elk habitat effectiveness was zero. Thomas et al. (1979b) found densities of 3.8 kilometers per 100 hectares (6 miles per section) caused elk to vacate areas regardless of habitat quality provided.

Human activity in conjunction with timber harvest adversely affected elk use of areas around the disturbance (Pedersen and Adams 1976, Ward 1976, and Lyon 1979b). No matter what time of year, logging operations have a disturbing effect. Lyon and Ward (1982) report that it has been generally documented that elk reaction is to move from logging activity to areas free from disturbance on both summer and winter ranges. Beall (1974) and Lyon (1975) state displacement

distance ranges from 3.2 to 6.4 kilometers (2 to 4 miles). The further elk move from the disturbance, the less likely they are to return (Marcum 1975). Lyon (1979b) found several consecutive years of disturbance may imprint avoidance for entire drainages after logging completion. However, elk generally move only as far as necessary to escape line-of-sight connection with the logging activity. Lyon (1975 and 1979a) reported line-of-sight barrier could be topographic and Ward (1976) determined vegetative barrier would suffice. Beall (1974) and Ward (1976) further reported displacement was temporary with some elk returning at night or on weekends. McLellan (1978) found some elk even returned during daylight hours once disturbance had ceased. Distance from logging operation also influences elk activity. Hershey and Legee (1976) found no elk response at 1.6 kilometers (1 mile) from logging activity. Ward (1976) again determined reaction to disturbance ceased 0.8 kilometers (0.5 miles) from the disturbance source if vegetative barriers were present.

Elk reaction to snowmobile traffic in winter is generally the same as with other disturbances. Anderson and Scherzinger (1975) found elk numbers decreased 50% where snowmobile disturbance occurred. Numbers recovered after closure of the area to snowmobiles.

OBJECTIVES

The objectives of this study were to determine seasonal/daily movements and habitat use of elk in the southern Black Hills, South Dakota.

METHODS

Ability to determine elk movement and habitat use would have been greatly facilitated if elk from resident populations could have been captured, marked and radio equipped. However, ability to capture sufficient numbers of elk within management units was cost prohibitive. Through correspondence and meetings with personnel from Wind Cave National Park, it was determined that a portion of elk surplus to the park's needs were available to the South Dakota Department of Game, Fish and Parks. To maintain proper carrying capacity, excess elk numbers in Wind Cave National Park were periodically live-trapped and removed. Elk were available in sufficient numbers to meet study needs. Through a long, complicated procedure which included preparing an environmental assessment report, permission to transplant approximately 50 elk on to National Forest Lands was obtained. It was assumed that transplanted elk would join with resident herds. Therefore, release sites were located in areas where elk existed. Elk movements and habitat use within management units could thus be determined from those released animals. Use of transplanted elk created several unknown factors which could prevent accomplishment of study objectives. Would elk combine with existing herds? Would elk remain in area of release? Would elk return to Wind Cave National Park where they were captured? It was hoped that at least a portion of the transplanted elk would approximate behavior of existing herds. Release sites were all located in the Black Hills in western South Dakota (Fig. 3).

Wind Cave National Park personnel began elk capture on December 15, 1980. Elk were herded in corrals with aid of two helicopters and 4-wheel-drive pickups. Forty-three elk were captured on December 15. Each trapped animal was brucellosis tested and positive reactors destroyed (1 of 88 tested). In

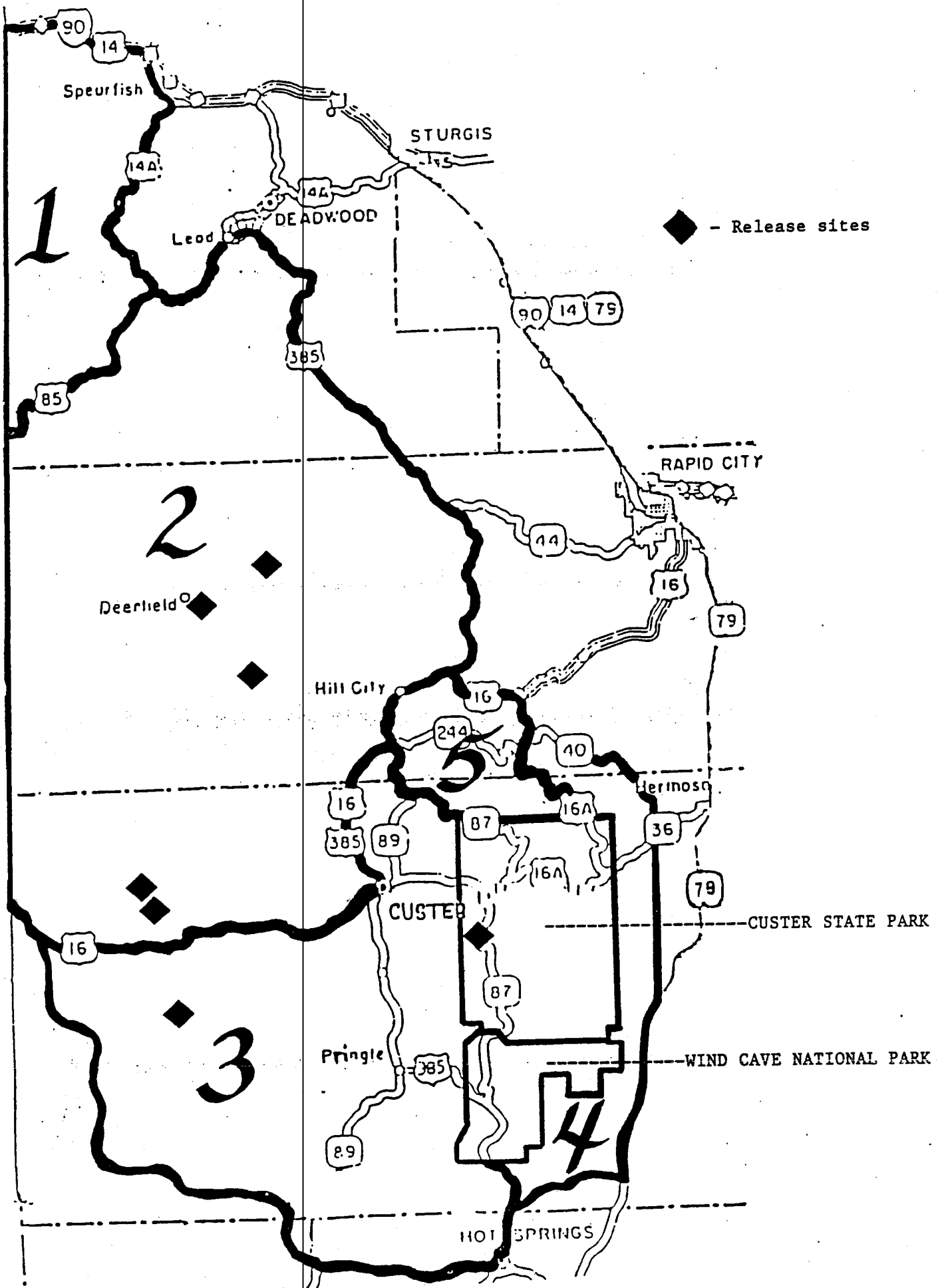


Fig. 3. Black Hills elk release sites, 1980, 1985, 1986.

addition, blood samples were taken by personnel at South Dakota State University for ongoing research projects. Twenty elk were trapped on December 18, 1980. Further trapping effort proved unsuccessful and trapping operations were discontinued.

Elk were marked for future identification. Calves and adults were marked with plastic, cattle ear tags. Each ear tag was colored and numbered. Adult bulls were fitted with expandable neck collars. Nonexpandable neck collars were put on all adult cows. Neck collars were also colored and numbered. Additionally, six adult cow elk were equipped with radio transmitters attached to white neck collars. All elk were transported to release sites in canvas covered stock trucks.

Study design originally called for three release sites (20 elk at one site, and 15 at two other sites). However, vehicle used in initial transplant of 20 elk was involved in a traffic accident in Custer State Park. All 20 escaped unharmed approximately 9 miles north of capture site. It had been theorized that release of elk so close to Wind Cave National Park would prove unsuccessful due to elk returning to original home range. Accidental release, while not in original study design, was used to determine if elk would return to home ranges within Wind Cave National Park.

Custer State Park release site was approximately 7 miles southeast of Custer, South Dakota (Fig. 3). A total of 20 elk were released; 12 adult cows, 2 adult bulls, and 6 cow calves (Table 1). Two adult cows were radio equipped.

Second release site was on Castle Creek drainage, 7 miles east, northeast of Deerfield, South Dakota (Fig. 3). Eleven elk were released; 7 adult cows, 1 adult bull, 2 cow calves, and 1 bull calf (Table 2). One adult cow was radio equipped.

Third release site was near Medicine Mountain, 9 miles west, southwest of Hill City, South Dakota (Fig. 3). Ten elk were released; 6 adult cows, 3 cow calves, and 1 bull calf (Table 3). One adult cow was radio equipped.

Fourth transplant site was located near Mud Springs, 12 miles west of Custer, South Dakota (Fig. 3). Ten elk were released; 7 adult cows, 1 adult bull, a cow calf, and 1 bull calf (Table 4). Two adult cows were radio equipped.

It was originally planned to release at least one adult bull at each transplant site, but due to trapped sample and accidental release in Custer State Park, this was not accomplished.

All release sites were in fairly rugged country with limited human activity with exception of accidental release in Custer State Park. While no areas in the Black Hills are free from human disturbance due to road systems and trails, elk release sites were located in areas where human disturbance would be primarily limited to loggers or hunters.

A form was prepared and distributed to participating department personnel to record elk movement and habitat preference (Fig. 4). Personnel were instructed to use one sheet for each elk herd observed and for each activity documented. Both daylight and spotlight sampling were used to locate marked animals. Aircraft, vehicular, and foot monitoring of transmitter-equipped elk was conducted. Hunter-returned information was also used to determine movements.

Table 1. Custer State Park elk transplant 1980, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar	Transmitter	
			Color/Number	Frequency	Number
White/Black 500	Adult	Cow	Black/White/0	--	--
White/Black 501	Adult	Cow	--	51.775	7257
White/Black 502	Adult*	Cow	Black/White/1	--	--
White/Black 503	Adult	Cow	--	51.826	7258
White/Black 504	Adult	Cow	Black/White/2	--	--
White/Black 505	Adult	Cow	Black/White/3	--	--
White/Black 506	Adult	Cow	Black/White/4	--	--
White/Black 507	Adult	Cow	Black/White/5	--	--
White/Black 508	Adult	Cow	Black/Yellow/0	--	--
White/Black 509	Adult	Cow	Black/Yellow/1	--	--
White/Black 510	Calf	Cow	--	--	--
White/Black 511	Adult*	Bull	White/Black/0	--	--
White/Black/512	Calf	Cow	--	--	--
White/Black 513	Calf	Cow	--	--	--
White/Black 514	Adult*	Cow	Black/Yellow/2	--	--
White/Black 515	Calf	Cow	--	--	--
White/Black 516	Adult*	Cow	Black/Yellow/3	--	--
White/Black 517	Calf	Cow	--	--	--
White/Black 518	Calf	Cow	--	--	--
White/Black 519	Adult*	Bull	White/Black/1	--	--

* - Adult Yearling

Date Released: 12/15/80 -- Temp: 50's -- Cloud Cover: Clear -- Wind: NW 15-20
Release Site: SW 1/4 Sec. 2, T4S, R5E

Table 2. Castle Creek drainage elk transplant 1980, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar	Transmitter	
			Color/Number	Frequency	Number
White/Black 523	Adult	Cow	--	51.214	7254
White/Black 525	Adult	Cow	Green/Yellow/1	--	--
White/Black 527	Adult*	Cow	Green/Yellow/3	--	--
White/Black 528	Adult	Cow	Green/Yellow/4	--	--
White/Black 530	Adult*	Bull	White/Black/2	--	--
White/Black 531	Adult	Cow	Green/Yellow/5	--	--
White/Black 532	Adult*	Cow	Green/White/0	--	--
White/Black 533	Calf	Cow	--	--	--
White/Black 534	Adult	Cow	Green/White/1	--	--
White/Black 536	Calf	Bull	--	--	--
White/Black 537	Calf	Cow	--	--	--

* - Adult Yearling

Date Released: 12/15/80 -- Temp: 50's -- Cloud Cover: Clear
Wind: NW 15-20 -- Release Site: SW 1/4 Sec. 1, T1N, R3E

Table 3. Medicine Mountain elk transplant 1980, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar	Transmitter	
			Color/Number	Frequency	Number
White/Black 520	Calf	Cow	--	--	--
White/Black 521	Calf	Cow	--	--	--
White/Black 522	Adult	Cow	--	51.476	7253
White/Black 524	Adult	Cow	Green/Yellow/0	--	--
White/Black 526	Adult	Cow	Green/Yellow/2	--	--
White/Black 529	Calf	Bull	--	--	--
White/Black 535	Adult*	Cow	Green/White/2	--	--
White/Black 538	Adult	Cow	Green/White/3	--	--
White/Black 539	Adult	Cow	Green/White/4	--	--
Orange/Black 500	Calf	Cow	--	--	--

* - Adult Yearling

Date Released: 12/15/80 -- Temp: 50's -- Cloud Cover: clear -- Wind: NW 15-20

Release Site: SW 1/4 Sec. 34, T1S, R3E

Table 4. Mud Springs elk transplant 1980, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar	Transmitter	
			Color/Number	Frequency	Number
Orange/Black 501	Calf	Bull	--	--	--
Orange/Black 502	Adult*	Cow	Yellow/Black/0	--	--
Orange/Black 503	Adult	Cow	Yellow/Black/1	--	--
Orange/Black 504	Adult	Cow	--	51.726	7256
Orange/Black 505	Adult	Cow	--	51.676	7255
Orange/Black 506	Adult	Cow	Yellow/Black/3	--	--
Orange/Black 507	Adult	Cow	Yellow/Black 2	--	--
Orange/Black 508	Calf	Cow	--	--	--
Orange/Black 509	Adult*	Bull	White/Black/3	--	--
White/Black 507	Adult	Cow	Black/White/5	--	--

* - Adult Yearling

Date Released: 12/19/80 -- Temp: 15° -- Cloud Cover: mostly cloudy --

Wind: NW 10 -- Release Site: NE 1/4 Sec. 24, T3S, R2E

Observer _____ Date _____ Time _____

ELK MOVEMENT-HABITAT USE DATA FORM

Elk transmitter number: 1 2 3 4 5 6

Elk collar color _____ Number _____

General Location _____

Weather: Cloud cover _____%; Wind _____, _____; Rain _____; Snow _____; Temp _____°F

Animal Data: Vectored and seen _____; Vectored only _____; Seen only _____.

Location: _____ 1/4; _____ 1/4; Section _____; Township _____; Range _____;

Elevation _____; Aspect _____; Slope _____%.

Activity: Feeding _____; Resting _____; Ruminating _____; Hiding _____;

Walking _____; Running _____; Fighting _____; Playing _____;

Breeding _____; Calving _____; Nursing _____; Unknown _____.

Total Animals: _____; Cows _____; Fawns _____; Spikes _____; Bulls _____; Unk _____

Other Animal Use:

Deer: Absent 1 mi _____; Present within 1 mi _____; 100 yds _____; Unknown _____.

Cattle: Absent 1 mi _____; Present w/in 1 mi _____; 100 yds _____; Unknown _____.

Roads: Type _____ Location _____

Timber Harvest: Logging within - 1 mi. _____; 1/2 mi. _____; 1/4 mi. _____

Recreation: Absent 1 mi. _____; Within 1 mi. _____;

Type: _____

Other telemetered elk found this date: 1 2 3 4 5 6

Other collared elk seen _____

Habitat: Ponderosa _____; Aspen _____; Aspen-Ponderosa _____; Spruce _____;
Spruce-Aspen _____; Clear-cut _____; Meadow _____; Ponderosa-Mtn. Mahogany _____;
Riparian _____; Ponderosa-Savanna _____; Other _____

HU-1 _____; HU-2 _____; HU-3 _____; HU-4 _____; HU-5 _____; HU-6 _____; HU-7 _____;
HU-8 _____; HU-9 _____; HU-10 _____; HU-11 _____; HU-12 _____; HU-13 _____.

Remarks _____

Fig. 4. Elk observation form for movement-habitat use study.

Locations of marked elk were plotted on topographic maps. Daily and seasonal movements were used to determine home range, migration patterns, if present, and other baseline data. Of primary importance was determining elk movements, if any, caused by or related to other resource uses such as logging, domestic livestock grazing, recreation, etc.

Observation of marked and unmarked elk was used to determine habitat use. Habitat classification was based on previous work done by Thilenius (1972) where applicable, plus author classification where needed.

In January, 1985, Wind Cave National Park again had surplus elk available. Since some of the elk transplanted in 1980 did return to Wind Cave National Park, permission was obtained from the Forest Service to release up to 35 elk onto Forest Service lands. Capture technique and disease testing procedures were identical to 1980. No positive reactors were found. A sample of adult elk were additionally marked with florescent orange neck collars. Collars were not numbered and no radio collars were used due to insufficient lead time involved. A total of 34 animals were marked and released in two locations.

First release site was located within two miles of the Mud Springs site used in 1980 (Fig. 3). Seventeen elk were released; 8 adult cows, 2 adult bulls, 3 cow calves, and 4 bull calves (Table 5).

Second release site was in Pass Creek area, 7 miles west and 6 miles south of Custer, South Dakota (Fig. 3). Seventeen elk were also released at this site; 6 adult cows, 1 adult bull, 4 cow calves and 6 bull calves (Table 6).

Release sites were chosen because both resident elk and elk transplanted in 1980 utilized the area. It was hoped elk released in 1985 would have less tendency to return to Wind Cave National Park and would have less random movements than those elk released in 1980 due to release site selection.

In January, 1986, Wind Cave National Park furnished surplus elk to several Indian Reservations in South Dakota. It was agreed that any elk captured during this round-up that were marked from previous transplant operations would again be made available to the South Dakota Department of Game, Fish and Parks. Initial capture efforts yielded four marked elk which were retransplanted. All disease tested negative.

Table 5. Mud Springs elk transplant 1985, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar
Red/White 18	Adult	Cow	--
Red/White 19	Adult*	Bull	Orange
Red/White 20	Adult*	Bull	Orange
Red/White 21	Calf	Bull	--
Red/White 22	Calf	Cow	--
Red/White 23	Calf	Cow	--
Red/White 24	Adult	Cow	Orange
Red/White 25	Adult	Cow	Orange
Red/White 26	Calf	Bull	--
Red/White 27	Adult*	Cow	Orange
Red/White 28	Adult	Cow	Orange
Red/White 29	Calf	Cow	--
Red/White 30	Calf	Bull	--
Red/White 31	Adult	Cow	Orange
Red/White 32	Adult	Cow	Orange
Red/White 33	Adult	Cow	Orange
Red/White 34	Calf	Bull	--

*Adult Yearling

Date released: 1/9/85 -- Temp: 15° -- Cloud cover: 100% -- Wind: Calm

Release site: NE1/4 Sec. 24, T3S, R2E

Table 6. Pass Creek elk transplant 1985, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar
Red/White 1	Calf	Cow	--
Red/White 2	Calf	Cow	--
Red/White 3	Calf	Bull	--
Red/White 4	Adult*	Cow	--
Red/White 5	Adult	Cow	--
Red/White 6	Adult	Cow	Orange
Red/White 7	Adult*	Bull	Orange
Red/White 8	Adult	Cow	Orange
Red/White 9	Calf	Cow	--
Red/White 10	Adult*	Cow	Orange
Red/White 11	Calf	Cow	--
Red/White 12	Calf	Bull	--
Red/White 13	Calf	Bull	--
Red/White 14	Calf	Bull	--
Red/White 15	Calf	Bull	--
Red/White 16	Adult*	Cow	Orange
Red/White 17	Calf	Bull	--

*Adult Yearling

Date released: 1/9/85 -- Temp: 15° -- Cloud cover: 100% -- Wind: calm

Release site: NE1/2 Sec. 6, T5S, R3E

Release site chosen was one mile south of Deerfield Lake due to resident elk presence and distance from Wind Cave National Park (Fig. 3). Three of the four elk released had ear tags from previous transplants (Table 7). One elk had lost original colored ear tag but did retain metal ear tag initially attached for Wind Cave Park identification purposes. All transplanted elk were adults (4 adult cows, and 1 yearling bull). Radio transmitters were not utilized due to time frame involved.

Table 7. Deerfield elk transplant 1986, Black Hills, South Dakota.

Ear Tag Number	Age	Sex	Neck Collar Color/Number	Wind Cave Number
Red, White 13	Adult*	Bull	--	TNT-8065
White, Black 500	Adult	Cow	Black/White/0	IJA-8832
--	Adult	Cow	--	IJA-8835
White, Black 504	Adult	Cow	Black/White/2	IHT-3602

*Adult Yearling

Date released: 1/29/86 -- Temp: 40° -- Cloud cover: clear -- Wind: calm

Release site: Center Sec. 31, T1N, R3E

FINDINGS

Data from radio-collared and marked elk indicated that transplanted animals suffered no capture myopathy. All released animals appeared to be healthy and no loss was observed.

Due to environmental conditions and partly due to boundary fence, elk within Wind Cave National Park are nonmigratory. Winters are mild and snow depth is insufficient to cause migratory behavior. Nonmigratory behavior resembles that determined by Moran (1973) for elk released in restricted portions of original eastern range. Madson (1966) determined Tule elk (*C. e. nannodes*) was also nonmigratory and there was no evidence to indicate these elk ever were. This nonmigratory behavior probably created behavioral patterns for Wind Cave elk as described by Franklin and Lieb (1979) in that individuals were closely bonded to paternal cow groups. Capture and transplanting operations would, however, unavoidably separate individual cow groups. Elk released at any one site would, therefore, have consisted of portions of several cow groups. It was anticipated that if this had in fact occurred, released elk would separate into smaller groups rather than remain in one unit. This did occur with six animals being the largest marked group that remained together after release.

Accomplishment of study objectives required transplanted elk to join with native herds. Approximately 83% of all elk transplanted joined with existing elk populations. In some cases, joining occurred almost immediately. In other cases, small groups wandered extensively for up to nine months before joining was accomplished and new home range established. The remaining 17% returned to Wind Cave National Park and historic home range. Data were collected from all released elk including those which returned to Wind Cave National Park.

Joining of transplanted elk with native populations near release site met with mixed results. Generally speaking, those elk released furthest north moved more extensively than those released at more southern sites. Direction of this extensive movement was almost universally southward. Portions of cow groups from all release sites joined native herds with home ranges encompassing the same geographic township as Wind Cave National Park. Undoubtedly vegetative similarities of open savanna habitat types influenced the southward movement and home range establishment.

Once home range was established, neither transplanted elk nor native elk exhibited migrational movements. Skovlin (1982) cites several authors who determined 16 inches of snow caused elk to exhibit migrational behavior. Environmental conditions were never severe enough to force elk to migrate, thus, portions of home ranges were utilized year round.

ELK MOVEMENTS

Custer State Park Elk Transplant

Based on radio telemetry data, observations of marked elk and kill data, five distinct home ranges were determined from the Custer State Park elk transplant (Fig. 5). All were south or southwest of release site except for a single cow which moved approximately 32 kilometers northwest.

Of the 20 elk released, only one established home range within Custer State Park (Fig. 6). This elk was released as a yearling cow and was harvested at Cow Camp on September 30, 1981, nine months after release. This cow joined seven native elk in Custer State Park and was observed four times before harvest. Home range was approximately 23 square kilometers. All other elk moved west out of Custer State Park within three weeks of release. This movement was not enmasse but rather in staggered herds probably associated with paternal cow groups.

For some of the released elk, return to Wind Cave National Park was almost immediate. Mature cow elk number 507 was recaptured during trapping operations in Wind Cave National Park on December 18, 1980, only three days after release. This elk was rereleased at the Mud Springs transplant.

Radio-collared elk number 3 plus five other elk moved west out of Custer State Park by December 29, 1980. Based on observations and radio telemetry, this entire paternal cow group moved back into Wind Cave National Park by January 8, 1981, less than one month after release. This group rejoined existing herds within Wind Cave National Park and presumably reestablished home range utilized before trapping operations were conducted. From December 15, 1980, through June 30, 1984, elk number 3 was monitored 141 times for home range estimation. Home range encompassed approximately 16 square kilometers (Fig. 6). During four years of observation the radio-collared elk was observed with both marked and unmarked elk. Herds totaled over 100 head during winter. During

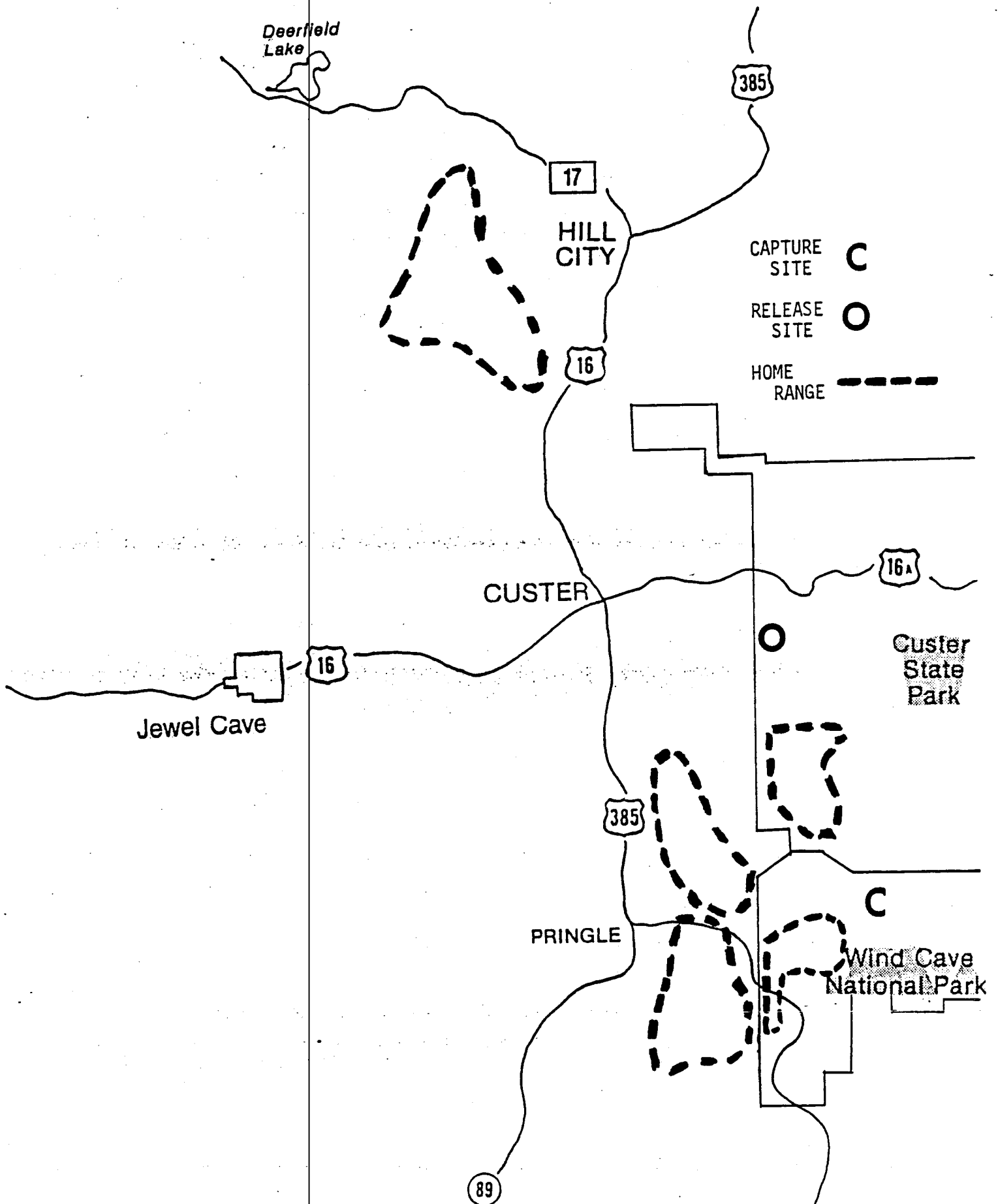


Fig. 5. Home ranges determined for elk from Custer State Park transplant.

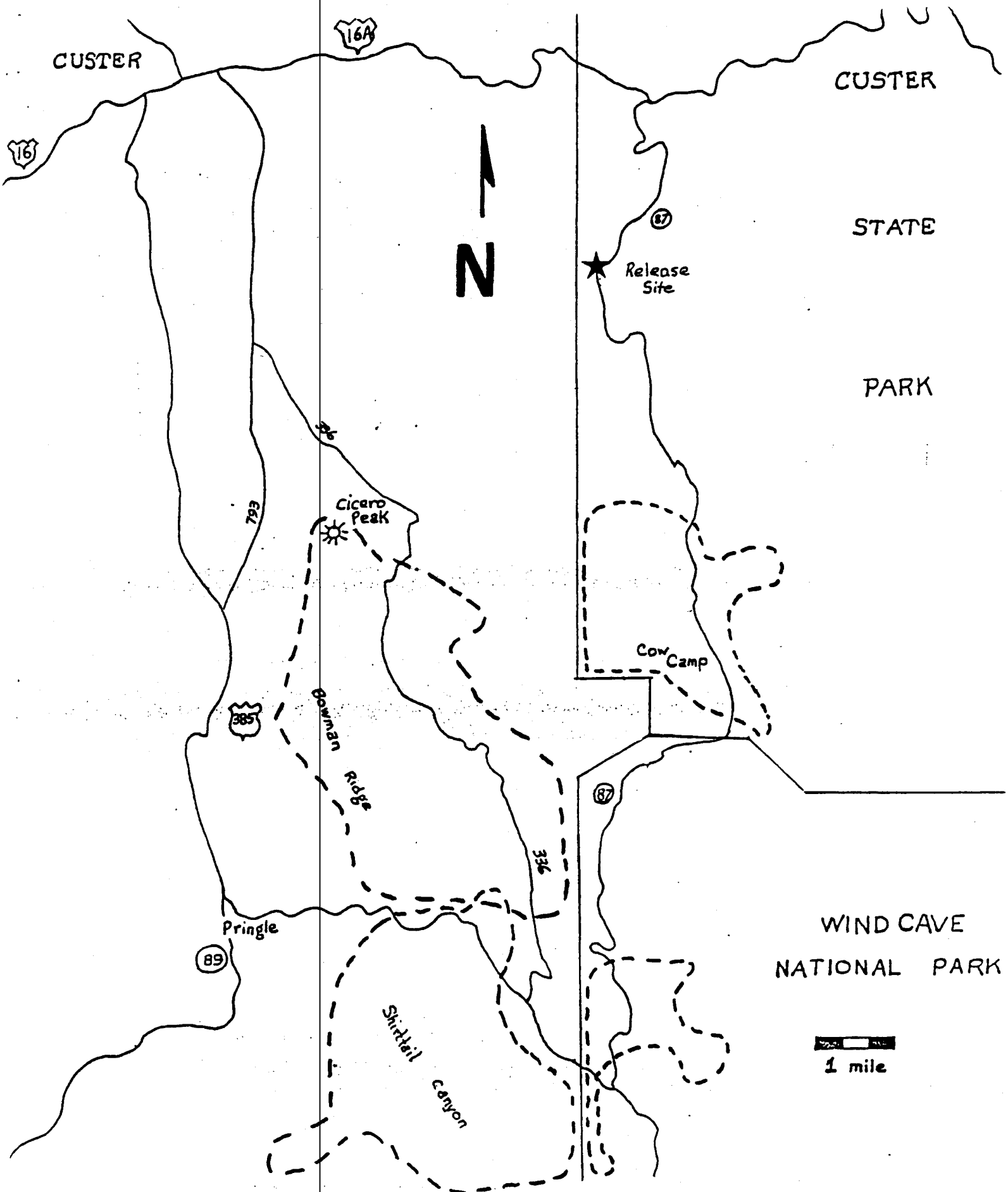


Fig. 6. Custer State Park, Wind Cave National Park, Bowman Ridge and Shirrtail Canyon elk home ranges.

calving period in May, the cow was generally alone. The rest of the year herd groups averaged close to 20 animals. Seasonal movements were not documented. Daily movements were dependent upon travel from feeding to resting sites within home range and averaged less than 1 kilometer per 24 hour period. Radio-collared cow number 3 produced a single, healthy calf each year monitored (1981 through 1984).

A minimum of seven cows (35%) released in Custer State Park returned to Wind Cave National Park. No bulls were observed to return.

Radio-collared elk number 4 moved west of Custer State Park by January 8, 1981. This elk was observed with up to five unmarked elk on numerous occasions. Home range was probably dependent upon joining existing elk on Bowman Ridge (Fig. 6). Home range was approximately 30 square kilometers. Seasonal movements were not documented. Daily movements averaged less than 2 kilometers for any 24 hour period. No calf was observed during the single calving season the radio-collared elk was monitored.

On September 11, 1981, a rancher found elk number 4 dead in a hay field. Poachers had shot the elk, drove into the meadow and then left. Radio collar may have caused poacher abandonment as it was still functioning when removed from the carcass. Elk number 4 was followed 271 days from release to time of death. Movements were documented by monitoring radio signal 48 times during this time period.

Observation of marked elk indicated home range was established in two other areas. Several marked animals were observed again with native elk in Shirttail Canyon West of Wind Cave National Park (Fig. 6). Home range was approximately 34 square kilometers. One cow elk was observed three times with native elk in or near Newton Fork drainage West of Hill City (Fig. 7). Home range was approximately 39 square kilometers based on limited observations.

Harvest data from fall 1981 through fall 1986 show that 7 of the 20 elk released were legally taken and one was poached (Fig. 8). Since at least 7 of the 20 elk released returned to Wind Cave National Park, harvest rate was 61.5% of the remaining 13 elk over a five year period. Both bulls released in Custer State Park were legally harvested in 1981 on or near Bowman Ridge West of Custer State Park. Two cows were killed in 1981, one in Custer State Park and one poached near Bowman Ridge. In 1985, another cow was killed northwest of Bowman Ridge. Additional harvest all occurred near Shirttail Canyon: 1 in 1983, 1 in 1984 and 1 in 1985.

Mud Springs Number 1 Transplant

Radio telemetry monitoring and sightings of marked elk indicated considerable movement occurred with this first group of elk transplanted near Mud Springs. Generally home ranges were not established until calving period in May. Even then, home range size was considerably larger than that established by Custer State Park transplanted elk.

Three distinct home ranges were identified from Mud Springs number 1 transplant (Fig. 9). None of the released elk were observed to return to Wind Cave National Park until December 1985, when one radio-collared cow returned to

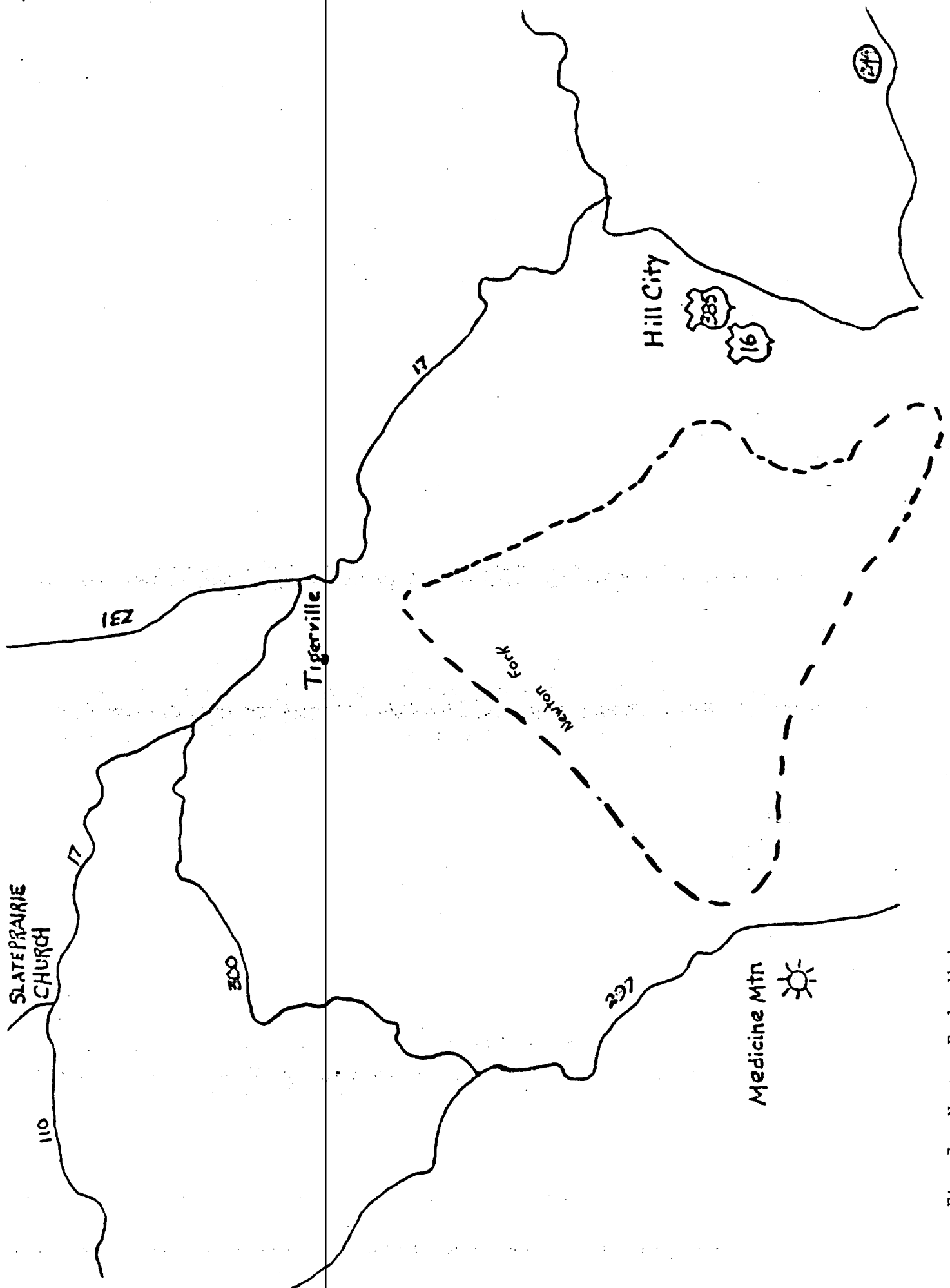


Fig. 7. Newton Fork elk home range.

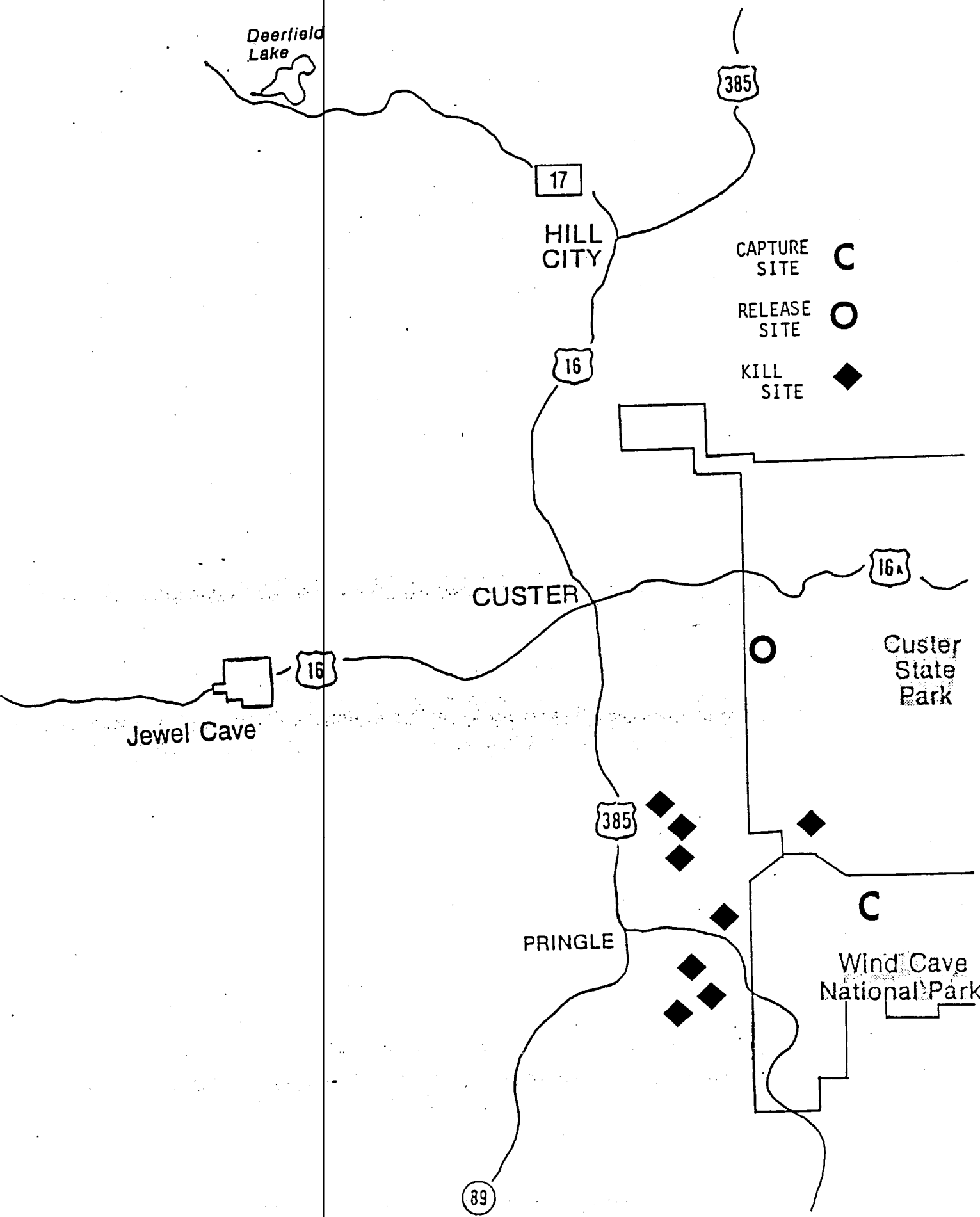


Fig. 8. Known elk kill from Custer State Park transplant fall 1981 through fall 1986.

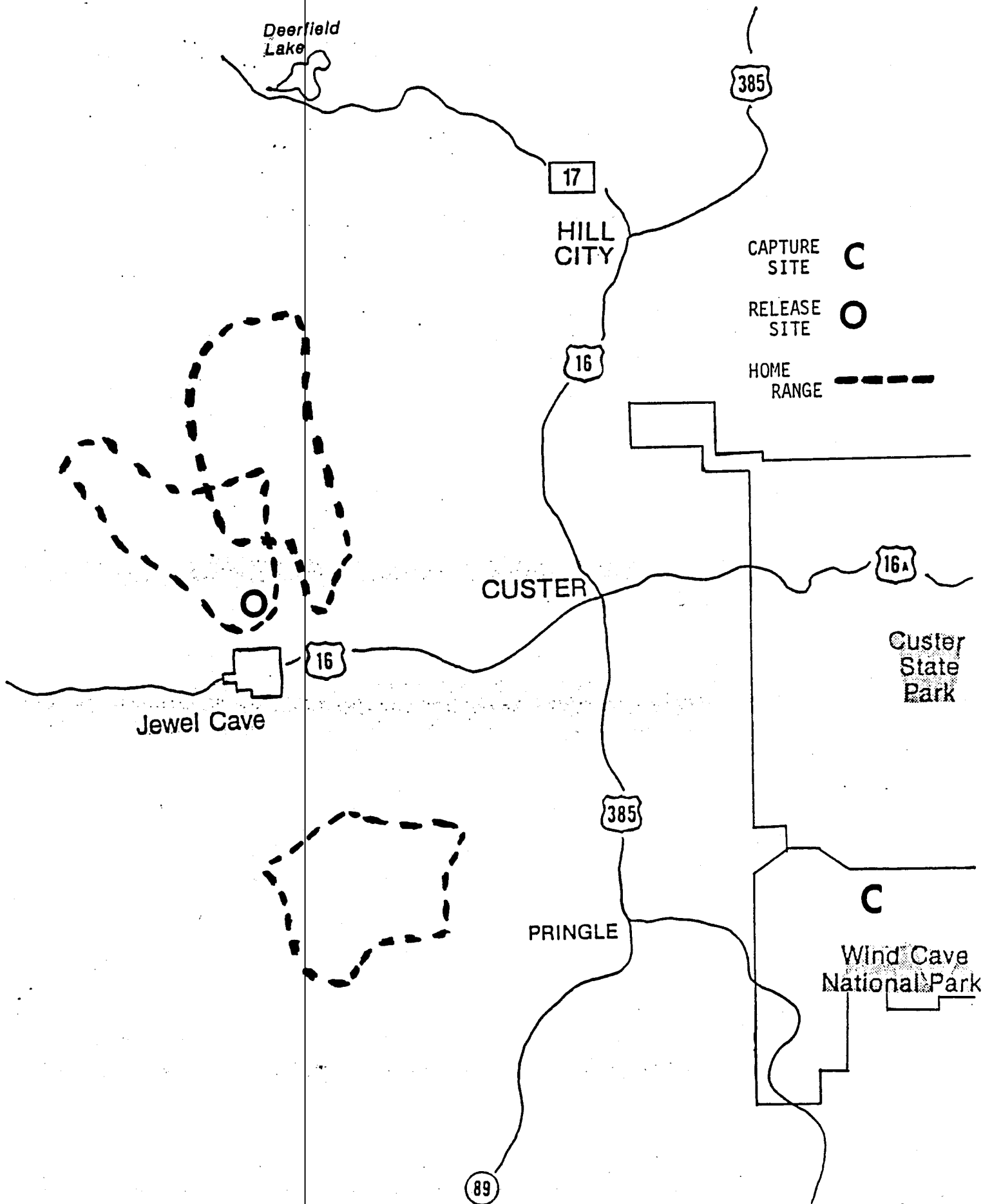


Fig. 9. Home ranges determined for elk from Mud Springs Number 1 transplant.

original home range after five years in the Martin Draw area. It was believed this cow accompanied elk from 1985 transplant when return to Wind Cave National Park occurred.

Of the three home ranges established by the Mud Springs number 1 transplant, six of 10 elk released established home ranges in Martin Draw area (Fig. 10). Two were radio-collared. Radio telemetry locations totaled 167 for elk number 5 and 162 for elk number 6 (December 1980 through June 1984). Both radios were still functioning at cessation of monitoring. Home range for this group was approximately 65 square kilometers.

First observation of grouping with unmarked, native elk occurred in July 1981, when elk number 6 was observed with three unmarked and one marked adult cows. Largest herd numbers observed were 22 animals during winter of 1984. Five of the 22 elk were marked but all did not come from the Mud Springs number 1 release (see later transplant discussions). Both radio-collared cows were observed with calves four years (1981 through 1984). Seasonal movements were not observed and daily movements averaged less than 2 kilometers.

Home range boundaries for the other two areas utilized by elk from Mud Creek Transplant number 1 were determined from five observations of marked animals and kill data. Since sample size was small home range boundaries and configuration are approximations. Observations of unmarked elk were also used in boundary determination. Signal Hill home range was approximately 47 square kilometers (Fig. 11). Lemming Draw home range was approximately 77 square kilometers (Fig. 11). In all cases marked elk were observed with native, unmarked elk.

Harvest data from 1981 through 1986 showed 3 of the 10 elk released were taken by legal hunters (Fig. 12). Harvest was 33 percent for the five year period. All bulls released were harvested; one in 1981 released as a calf and one in 1983 released as a yearling. In 1986 a cow released as a yearling was taken.

Castle Creek Transplant

Of 11 elk released on Castle Creek drainage, one adult cow was radio-equipped. From December 15, 1980 through January 26, 1981 this cow was monitored 23 times. Extensive movements were documented. During one, 12-hour period over 21 linear kilometers were covered. Radio failure occurred on January 26, 1981. Home range was not established during monitoring. During these extensive movements, the radio-equipped cow was accompanied by another cow and calf from the release. Average movement was over 5 kilometers per day.

Due to radio failure and limited observations of marked animals, home range establishment from this transplant was difficult to determine. Movements were extensive. It was assumed that where observations and kill data from marked animals occurred within home range estimated for elk from other transplants that home range establishment corresponded for Castle Creek transplanted elk.

Four separate home ranges were believed utilized by elk from this transplant (Fig. 13). At least 3 of the 11 released returned to original home range in Wind Cave National Park (Fig. 6). All were adult cows. An adult bull and adult cow were observed within Martin Draw home range established by some of the Mud Springs number 1 transplant (Fig. 10). Two adult cows utilized Shirttail Canyon home range used by a portion of the Custer State Park transplanted elk (Fig. 6).

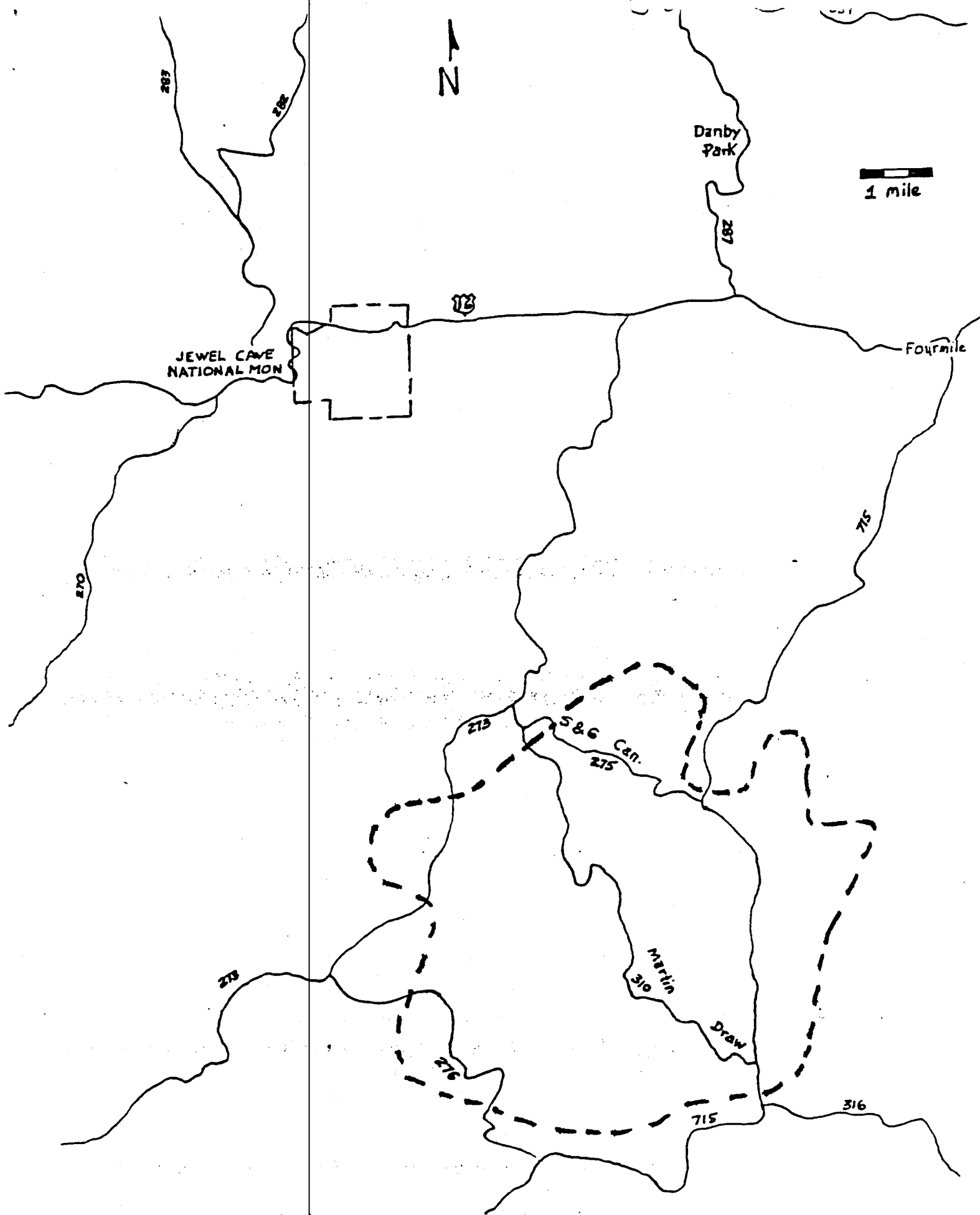


Fig. 10. Martin Draw elk home range.

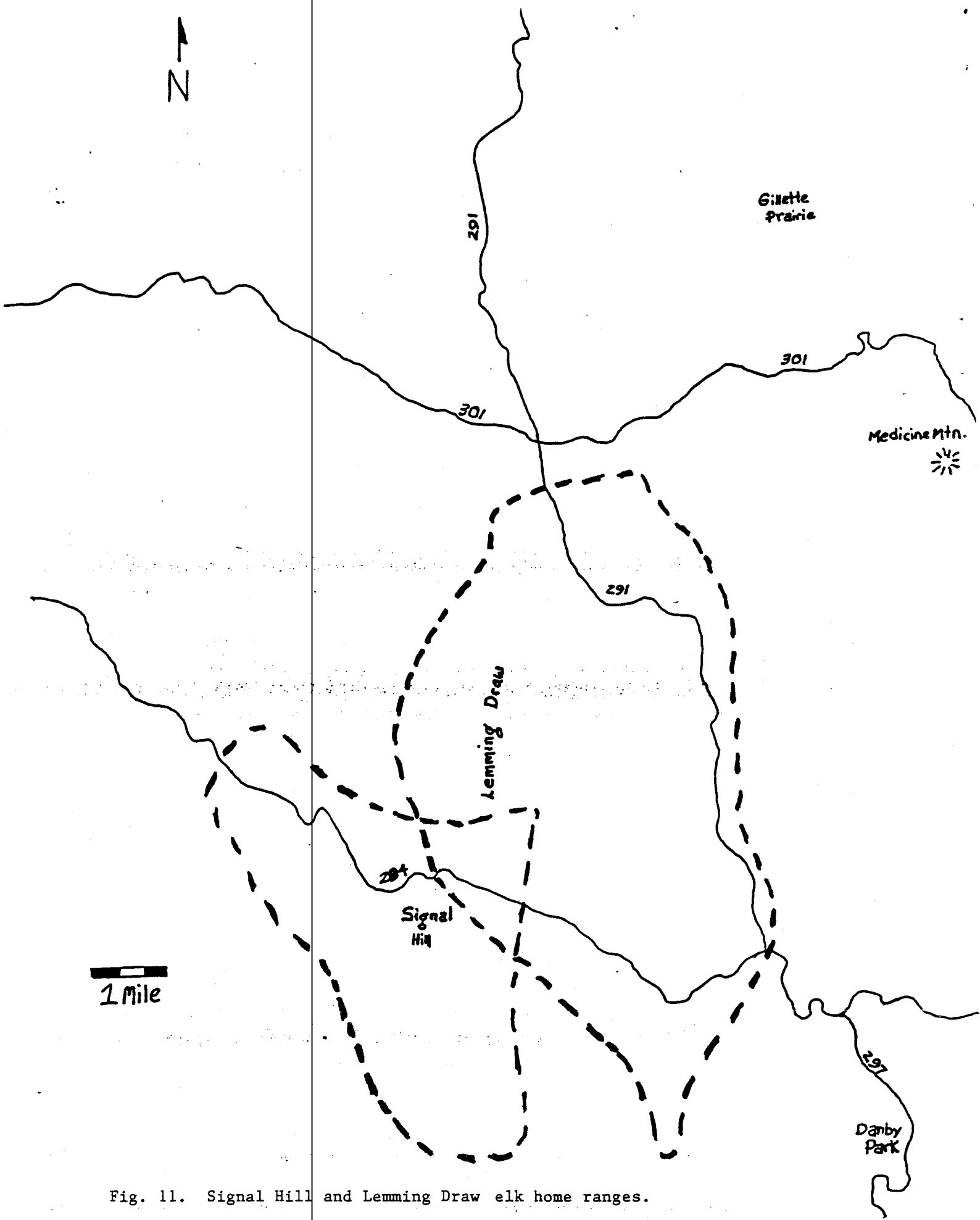


Fig. 11. Signal Hill and Lemming Draw elk home ranges.

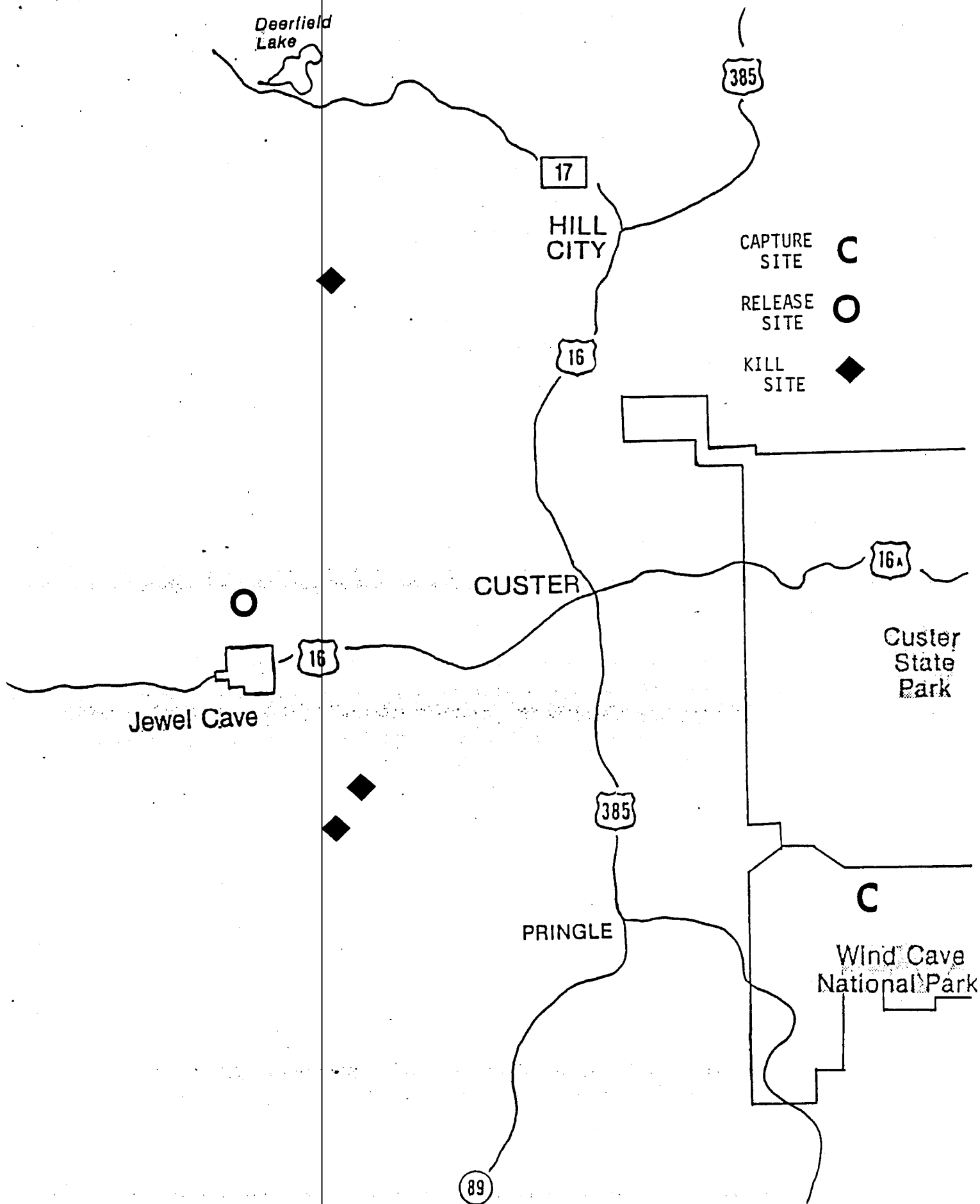


Fig. 12. Known elk kill from Mud Springs Number 1 transplant, fall 1981 through fall 1986.

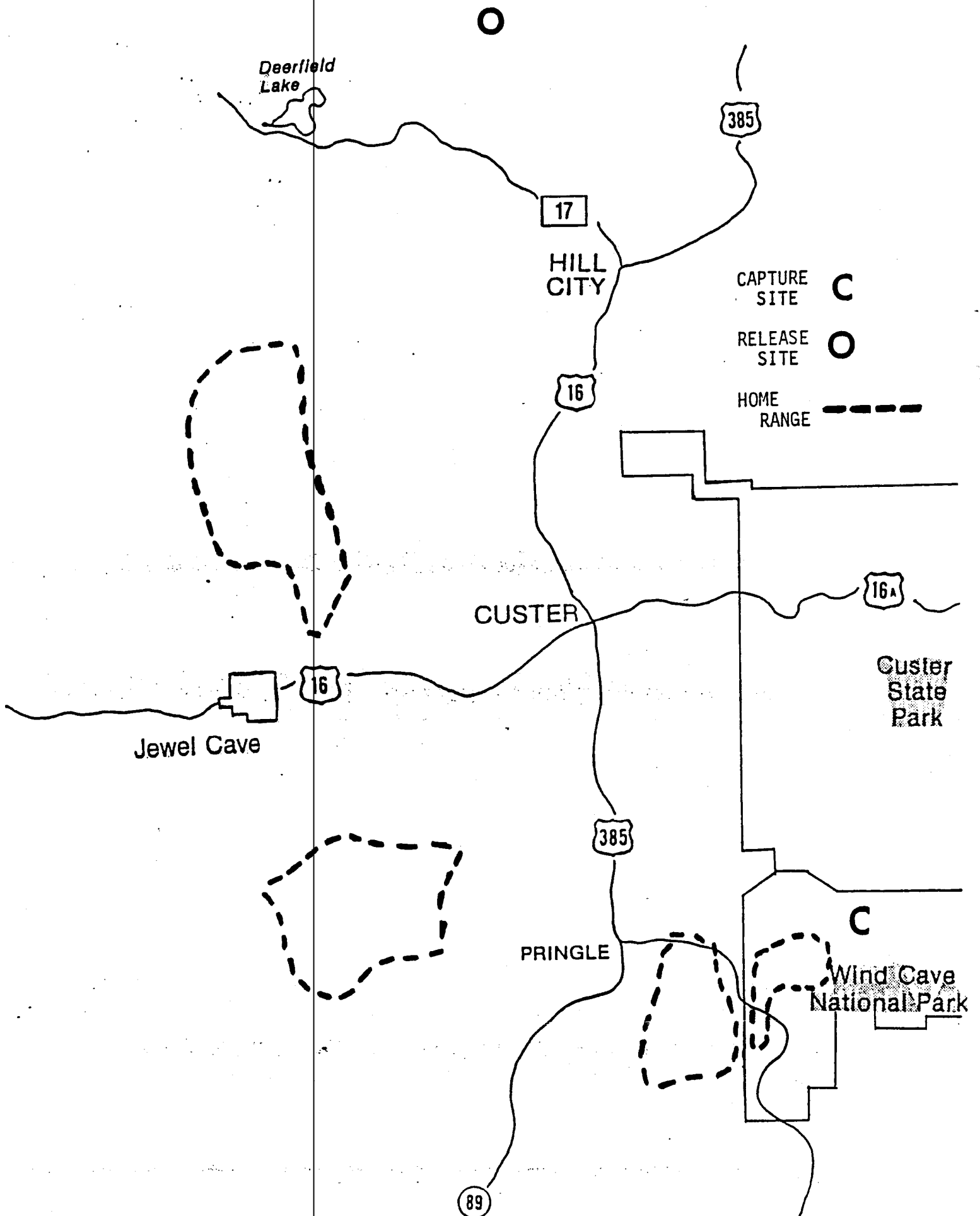


Fig. 13. Home ranges determined for elk from Castle Creek transplant.

A single cow was observed five times in three years within Lemming Draw home range of Mud Springs number 1 transplanted elk (Fig. 11).

Of the 11 elk originally released at the Castle Creek transplant site, four were legally harvested from 1981 through 1986 (Fig. 14). As at least three elk from this transplant returned to Wind Cave National Park, kill was 50 percent of the remaining eight elk available. In 1984, the only adult bull released was taken. Only one bull released as a calf had not been reported harvested. Two cows released as adults were killed, one in 1982 and 1986. A cow released as a yearling was harvested in 1981.

Medicine Mountain Transplant

One adult cow was radio equipped from this transplant. Again extensive movement occurred until August of 1981 when home range was established. This cow was not observed with calf in spring of 1981 which may explain why home range establishment occurred so late. Cow was monitored 57 times until she was believed poached near Bowman Ridge in fall of 1981. Radio signal was weak at that time and it was originally assumed radio failure occurred. Lack of observation or known legal harvest in subsequent years led to poaching supposition. From release to home range establishment movements were extensive. Cow remained in generally small areas (less than 5 kilometers) for up to two weeks then moved up to 24 kilometers where another small area was utilized. A total of six such areas were used with movements between each averaging 14 linear kilometers. As with Castle Creek transplant observation of marked elk from this transplant were limited and spread over a wide area for the first six months following release. A total of three home ranges were established (Fig. 15), and all corresponded with those utilized by elk from other transplants. Four cow elk utilized the Lemming Draw home range (Fig. 11). At least two elk established home range in Martin Draw Area (Fig. 10) and until poached, the radio collared cow utilized area around Bowman Ridge (Fig. 6). None were observed to return to Wind Cave National Park.

Harvest of elk from Medicine Mountain transplant totaled four animals (Fig. 16). One was believed poached during fall 1981 elk seasons. The remaining three were legally taken and were all harvested as adult cows. Two were shot in 1983 and one in 1986. For the five years of study kill was at least 40% of released elk.

Mud Springs Number 2 Transplant

Home range determination from observations and kill data of 17 marked elk were limited by study conclusion in 1986. Establishment of two home ranges were determined (Fig. 17). Again estimated home ranges corresponded to areas established by other transplanted elk (Fig. 10 and Fig. 11). While no documentation of return to Wind Cave National Park was made, length of observation time was short.

From fall 1985 through fall 1986 a total of six elk were legally harvested (Fig. 18). Three elk were taken in 1985 all in the Martin Draw area. Two were released as bull calves and one as an adult cow. The remaining three harvested were taken in 1986. Two adult cows released were killed in Martin Draw area. One elk released as a bull calf was taken in the Signal Hill area. Harvest for two hunting seasons was 35 percent (6 of 17 released), considerably higher than rates for previously transplanted elk.

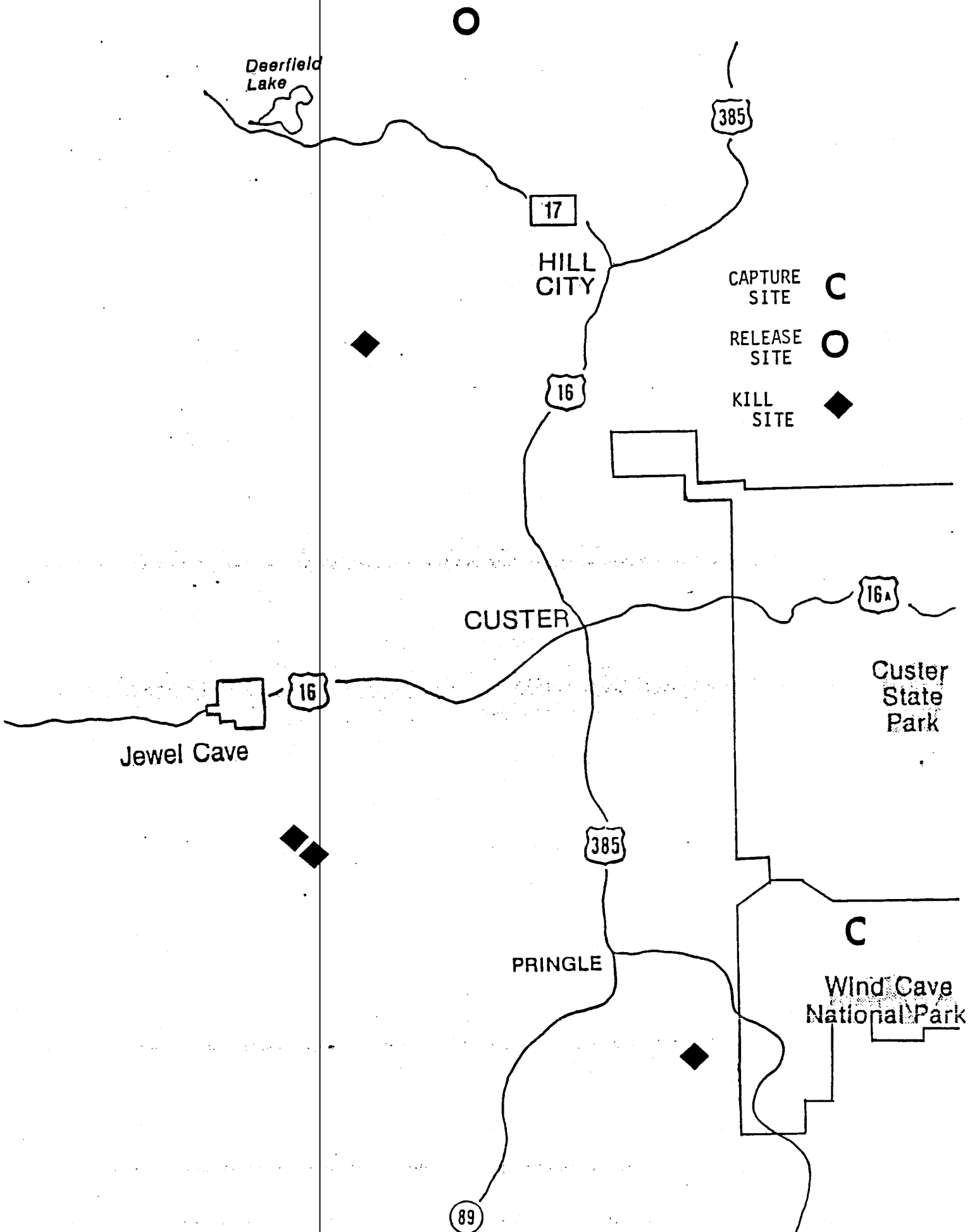


Fig. 14. Known elk kill from Castle Creek transplant, fall 1981 through fall 1986.

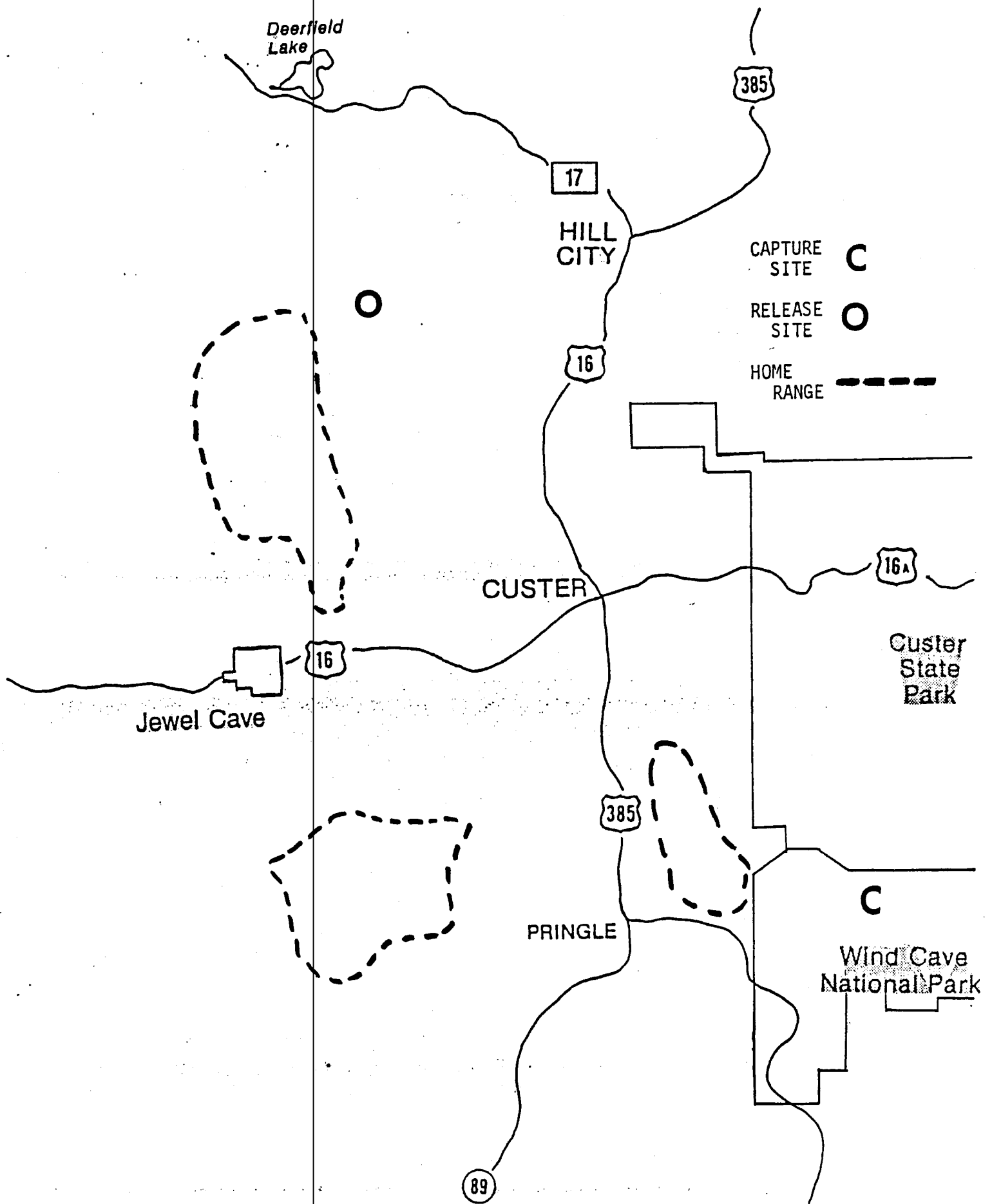


Fig. 15. Home ranges determined for elk from Medicine Mountain transplant.

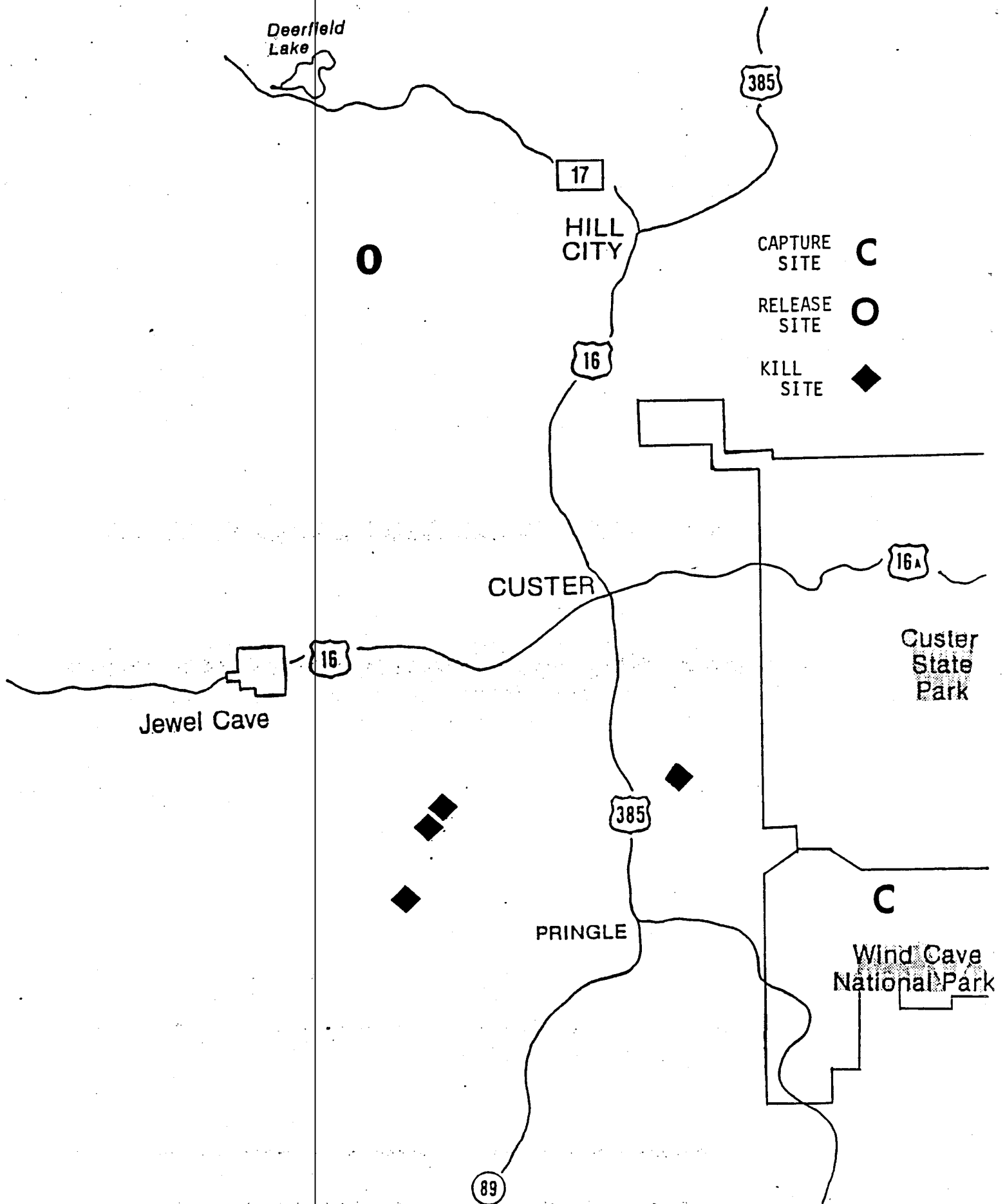


Fig. 16. Known elk kill from Medicine Mountain transplant, fall 1981 through fall 1986.

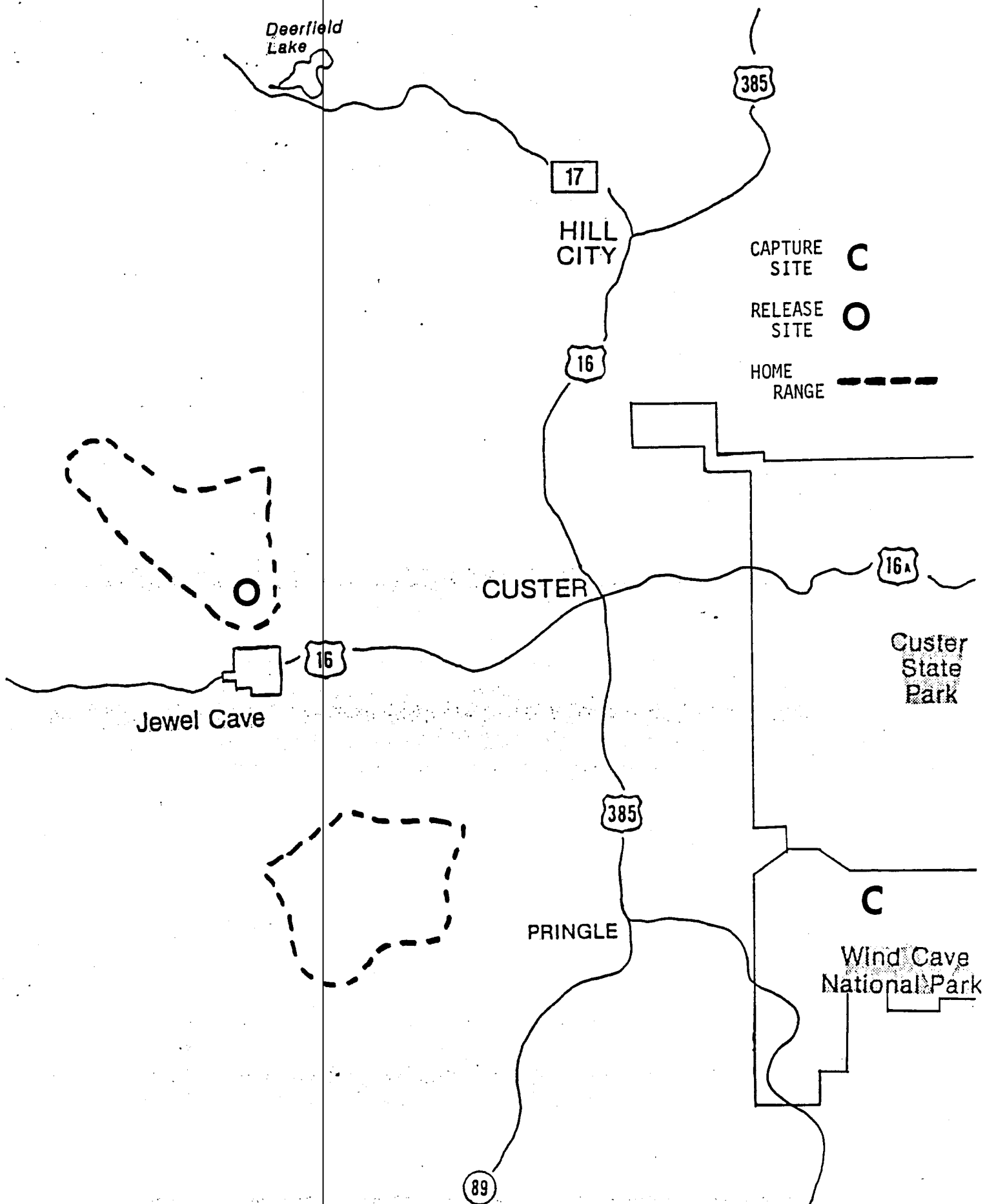


Fig. 17. Home ranges determined for elk from Mud Springs Number 2 transplant.

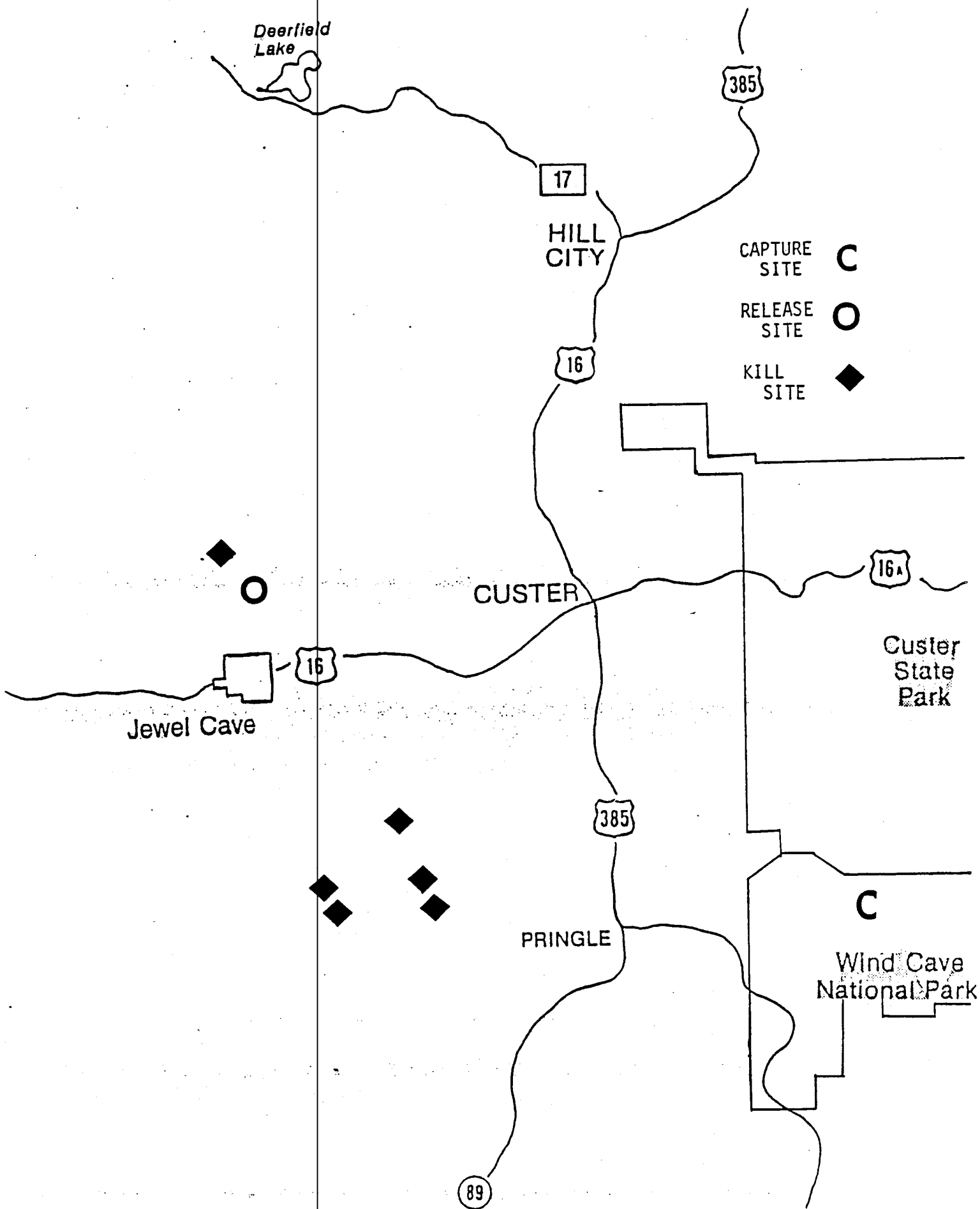


Fig. 18. Known elk kill from Mud Springs Number 2 transplant, fall 1985 through fall 1986.

Martin Draw Transplant

As with Mud Springs number 2 transplant, time for data collection was only two years. Nevertheless, home range estimation comprised of three locations (Fig. 19). Two individual elk returned to Wind Cave National Park (Fig. 6). One was released as a yearling cow and the other as a bull calf. Additionally at least two more elk were identified in the same home range but due to similar markings it could not be determined if these two elk were from the Martin Draw or the Mud Springs number 2 transplant sites. Individually marked elk were observed in both Shirttail Canyon (Fig. 6) and Martin Draw (Fig. 10) areas during winters of 1985 and 1986.

Of the 17 elk released, 7 were legally harvested from 1985 through 1986 (Fig. 20). If one assumes all similarly marked elk observed in Wind Cave National Park (total of four) were from this transplant then harvest totaled 54 percent of the elk released. Again harvest was considerably higher than that for earlier transplants.

Of the seven elk harvested, four were bulls. Three released as a yearling bull and two bull calves were taken in 1985. The bull taken in 1986 was released as a calf. Cows harvested in 1985 totaled two and were released as an adult and a calf. The remaining cow was taken in 1986 and was released as a calf.

Deerfield Lake Transplant

The four elk released at the Deerfield Lake Site were all marked elk from previous transplants that returned to Wind Cave National Park. Two were originally released as adult cows in Custer State Park, one was originally released as an adult cow at Castle Creek and one was originally released as a bull calf in Martin Draw. No observations from this transplant were made.

Sample size and time factor undoubtedly influenced lack of observations. The bull rereleased as a yearling was harvested in Martin Draw in fall 1986 (Fig. 21). This was the area of original release in 1985.

ELK HABITAT USE

Habitat use determination was primarily based on data collected from radio collared, adult cow elk. A total of 598 general locations were estimated. Exact locations were determined 298 times. Elk habitat use was primarily dependent upon four activities: 1) feeding, 2) loafing/resting, 3) escape from disturbance, and 4) calving.

Feeding Habitat Use

Habitat used for feeding was almost exclusively devoid of ponderosa pine overstory. Most feeding sites were openings with no forest canopy or else limited canopy of bur oak (Quercus macrocarpa) or quaking aspen (Populus tremuloides). Geist (1982) reported elk habitat preference was toward open terrain probably due to grass-like forage when compared to the ancestral form, the Red Deer (C. e. lynnaeus). Skovlin (1982) cites several studies where elk feeding occurred in forest openings. These studies pointed out importance of edge due to wide variety of succulent forage and availability of escape cover. These studies further reported elk use was directly related to quality and

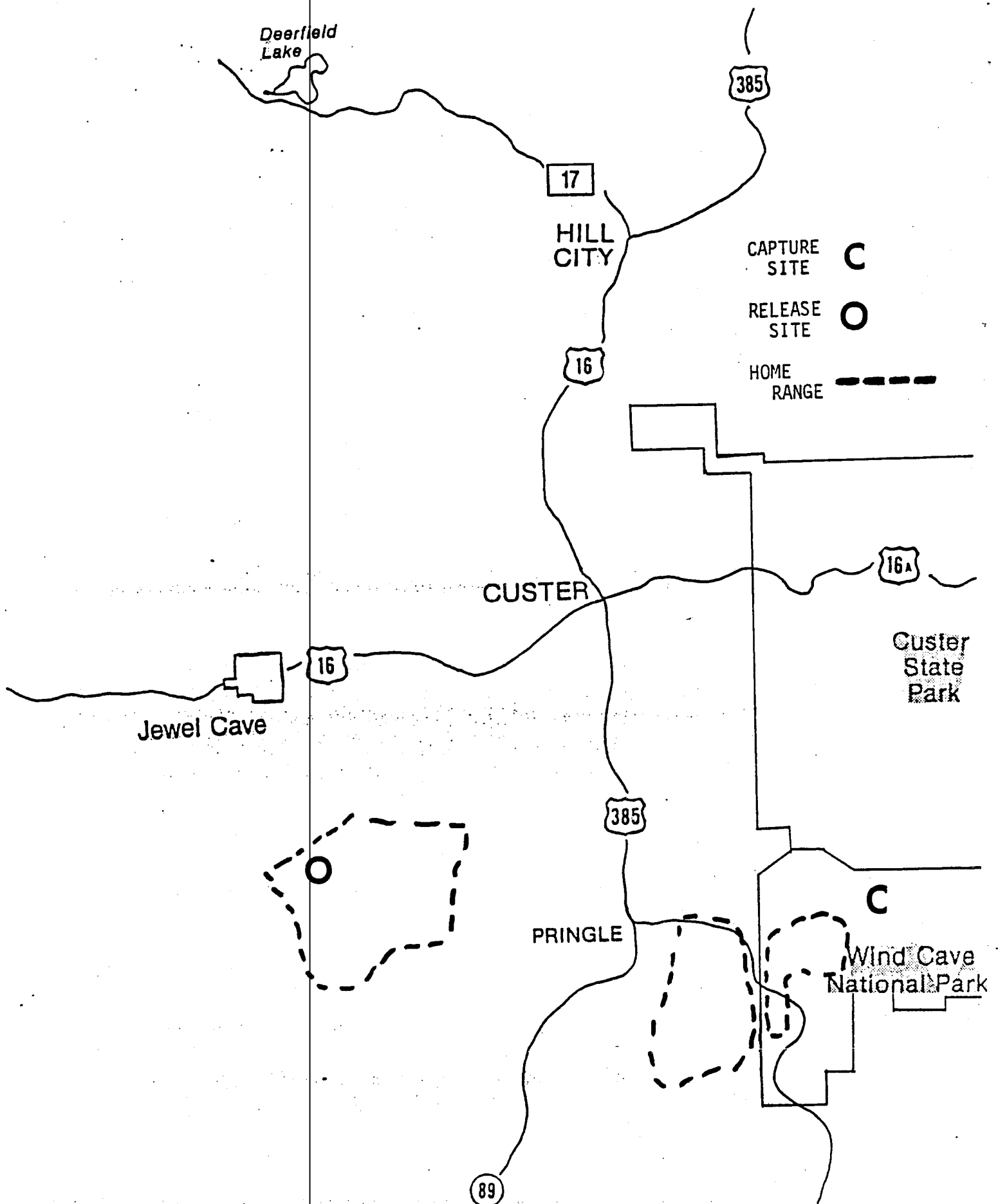


Fig. 19. Home range determined for elk from Martin Draw transplant.

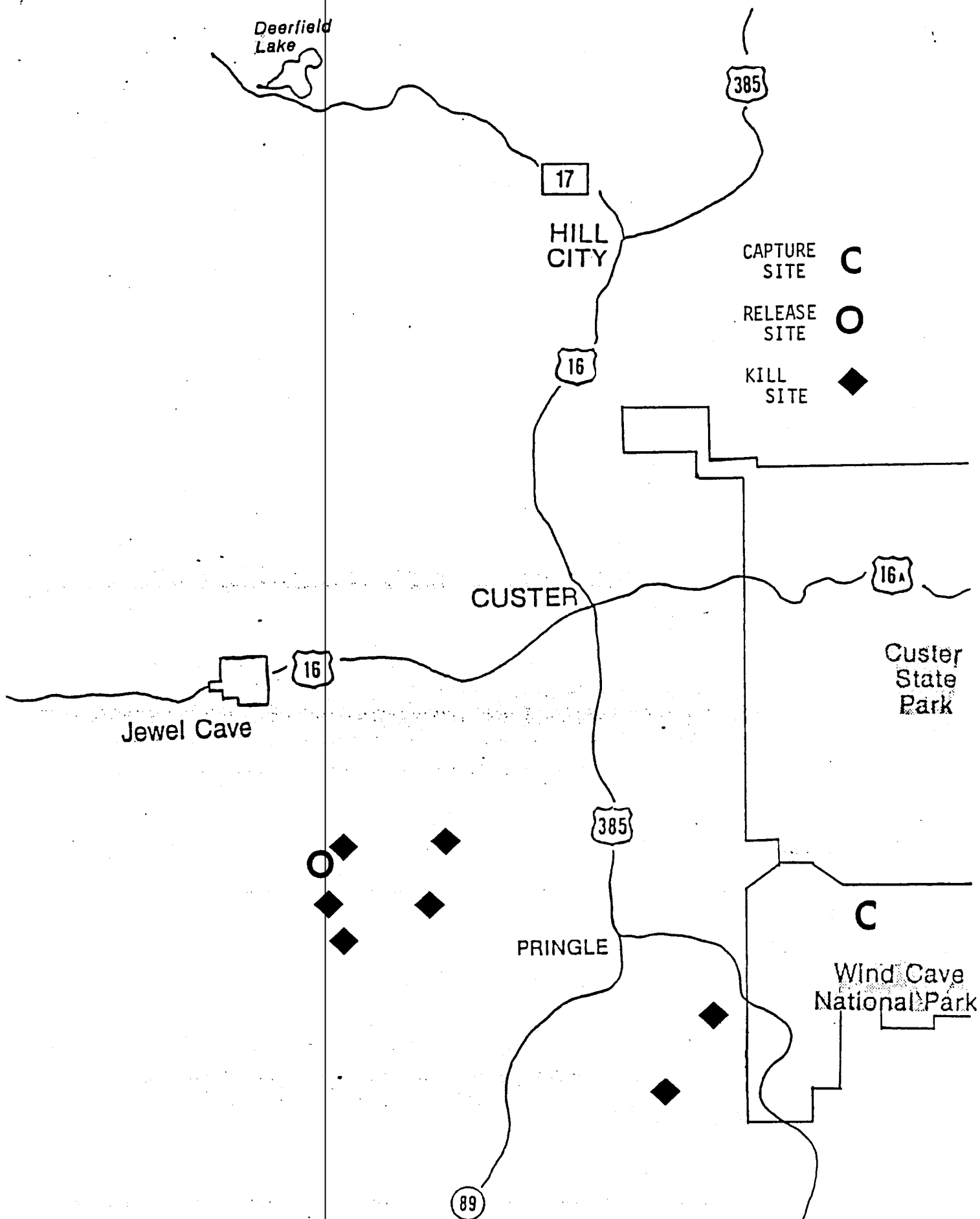


Fig. 20. Known elk kill from Martin Draw transplant, fall 1985 through fall 1986.

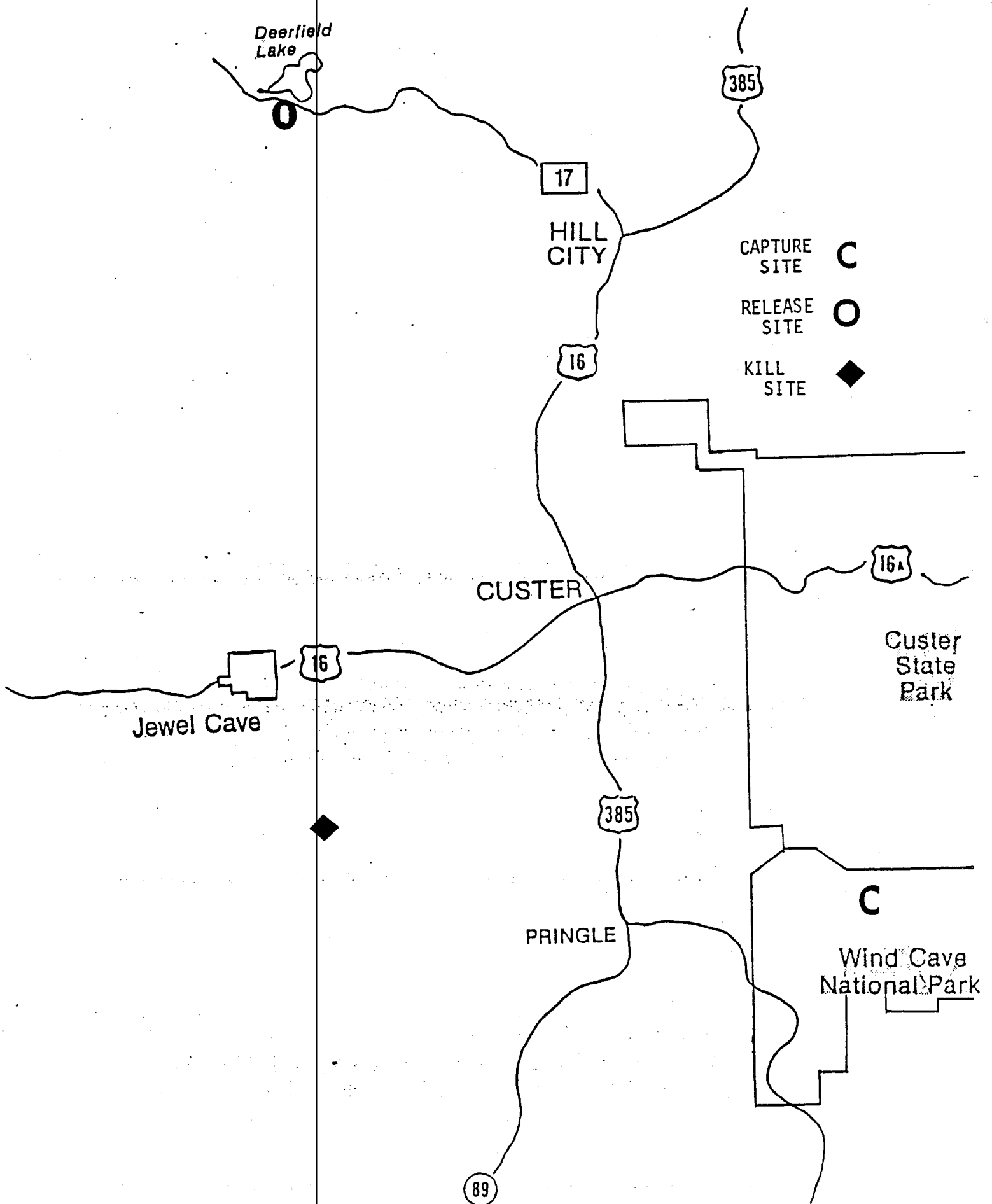


Fig. 21. Known elk kill from Deerfield transplant, fall 1986.

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GAME REPORT

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EVALUATION OF MOVEMENTS AND HABITAT USE OF ELK IN THE SOUTHERN BLACK HILLS, SOUTH DAKOTA, 1980-1986

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quantity of forage available at edge of openings. Level of elk use decreased with increasing distance from forest interface. Use of opening edge was well documented in this study during spring, summer and fall. Elk seldom ventured more than 90 meters (100 yards) from forest edge during these time periods. However, use of openings in winter greatly expanded with edge effect having less influence. Elk were often observed in middle of openings over 0.4 kilometers (1/4 mile) from forested areas. Nelson and Legee (1982) pointed out elk made maximum use of open country during winter months.

Skovlin (1982) cited studies which showed exposure preference by elk depending upon time of year. This was not observed in this study probably due to limited snowfall in winter. Summer exposure preference was more related to forage availability rather than slope exposure. Degree of slope use also conflicted with findings in other studies. Slopes of 15-30 percent were reported to be preferred while slopes of 0 to 15 percent received less use and slopes over 40 percent received little use (Skovlin 1982). Slopes of openings used in this study were predominately less than 15 percent with corresponding less use as slope increased. Skovlin (1982) did not indicate if competition with domestic livestock or other large herbivores influenced results of studies cited.

Type of opening used for feeding depended upon several factors. Openings created or maintained by both wildfire and prescribed burns were extensively used year round unless disturbance prevented such use. Nelson and Legee (1982) felt prescribed burns on winter range were beneficial to elk due to nitrogen fixation. Production of high energy herbaceous vegetation was enhanced through such fires. Geist (1982) also reported all ages and sexes utilized forage found after fire. He felt cows would utilize larger burn areas than bulls.

Openings with limited canopy of quaking aspen or bur oak were heavily utilized especially when such habitats comprised less than 1% of home range. Areas used were often less than 0.2 hectare (1/2 acre) in size. Use was undoubtedly dependent upon food habits and/or preference.

Alfalfa (Medicago sativa) and other agricultural crops planted in valley meadows on private land were utilized in late spring, early fall, and somewhat during winter months.

During early fall use of openings underwent a radical change. This was undoubtedly influenced by onset of rut and disturbance by hunters. Use of large opening edges ceased during daylight hours. Use of openings less than 2.0 hectares (5 acres) increased substantially. Feeding under ponderosa pine canopy was documented but was limited in nature and occurred in stands less than 60 basal area. Coop (1971) reported elk glade use was less in autumn and McLean (1972) felt rut and hunting seasons caused more fall timber use. Use of smaller openings in fall occurred in Wind Cave National Park where no hunting seasons were held indicating such use a natural occurrence.

Use of forest openings and meadows undoubtedly was related to food habits and/or preference. Nelson and Legee (1982) reported perennial grasses were most important in early spring. Late spring and summer forage use was dominated by forbs and sedges (Nelson and Legee 1982, Knight 1970, and Stevens 1966). By late summer and fall diet again switched back to grasses (Nelson and Legee 1982). Elk observed during spring, summer and fall generally followed the above feeding pattern except for utilization of private agricultural crops described

previously. For all sexes and ages summer forage was reported to be critical for storage of fat for winter months (Geist 1982). In addition bull summer forage was fall-rut related and maximum digestible summer forage was utilized both for rut onset and the fact bull teeth wear greater than cows on comparable forage (Geist 1982). Winter elk forage was determined to be related to availability (Nelson and Legee 1982). They reported grass ranges in Montana were primarily utilized while areas in Idaho had more browse consumption. In areas where both browse and grass were available, grass was preferred. Geist (1982) related browse consumption to body size with calves able to digest less fibrous forage, then cows and last bulls. During course of this study browse utilization was not observed. Feeding within Wind Cave National Park was concentrated Pinus ponderosa/Andropogon scoparius/Boulevard gracilis on habitat type (HU-13). This ecotype was a true savanna. Only scattered pine occurred in meadows and major shrubs, graminoids, and forbs resembled true prairie ecotypes. Late spring, summer and early fall feeding use of Pinus ponderosa/Prunus virginiana/Andropogon scoparius (HC-12) occurred where small stands of bur oak occurred.

Primary feeding sites for elk in Martin Draw home range was Pinus ponderosa/Andropogon scoparius (HU-11). This ecotype was primarily dry prairies with ponderosa pine interspersed in more mesic sites. Extensive use of this ecotype occurred year round where both wildfire and prescribed burns had taken place. During fall and winter months elk also fed in ecotype HU-10: Pinus ponderosa/Juniperus scopulorum/Cercocarpus montanus/Symphoricarpos albus/Andropogon scoparius. The presence of heavy stands of mountain mahogany Cercocarpus montanus made this ecotype unique although elk were not observed foraging on it.

Remaining feeding ecotypes used were determined from radio-collared elk where transmitters worked less than one year and from observations of marked elk. Five major ecotypes were utilized: 1) Pinus ponderosa/Juniperus communis/Symphoricarpos albus/Berberis repens (HU-1); 2) Pinus ponderosa/Shepherdia canadensis/Symphoricarpos albus/Arclostaphylos uva-ursi (HU-2); 3) Pinus ponderosa/Symphoricarpos occidentalis/Rosa fendleri/Poa pratensis (HU-4); 4) Pinus ponderosa/Poa pratensis/Danthonia intermedia (HU-9), and 5) HU-12. In almost all cases feeding areas were found in old wildfire burns, open meadows, openings, aspen or oak overstory and "blow down" clearings within these ecotypes.

Loafing/Resting Habitat Use

Greatest habitat use diversity for any activity type was for loafing/resting. Habitats used ranged from open meadows to complete canopy closure. Overstories included shrubs, coniferous forest, and deciduous trees. As a general rule milder weather conditions caused more open canopy habitats to be used. Conversely, severe weather conditions, either hot or cold temperatures or strong winds, cause increased use of habitats with more canopy closure. Numerous studies have indicated this is a function of thermal cover requirements either vegetative or topographic which offer protection against adverse weather (Skovlin 1982). However, these studies were conducted where weather conditions can be severe. Adverse weather during this study was short in duration and it is questionable if such conditions created any real stress on elk herds. Geist (1982) speculated that good quality thermal cover was incidental to the fact that cover supplied security needs. He points out that an elk is a big bodied

animal with low surface to mass ratio and that the light colored coat has great insulative value. Further, elk have excellent mechanisms to shed heat and show great insensitivity to heat or cold. Thermal cover requirements for elk herds in this study were felt to be negligible and habitat management efforts with that objective in mind are not recommended.

Ecotypes utilized for loafing/resting cover included all those listed for feeding ecotypes above. For very short periods of severe weather complete canopy closure found in Pinus ponderosa/Symphoricarpos albus/Arctostaphylos uva-ursi (HU-5) were utilized by some herds.

Escape Cover Habitat Use

As with loafing/resting habitat use, escape cover utilized was variable and depended mainly on type, duration, and repetitiveness of disturbance. Numerous studies have shown escape cover can be vegetative or topographic so long as screening provides security (Skovlin 1982). Escape cover is related to sight distance and has been defined as the "average distance into cover type beyond which a simulated elk or 'cover density board' cannot be seen by the human eye" (Skovlin 1982:384). Flight distance results as a response to those factors which trigger behavioral pattern of seeking escape cover. Altmann (1958) describes flight distance as a measure of closeness that a potential enemy can approach before an elk takes flight and can be triggered by sight, sound or smell. Primary factor which caused elk to seek escape cover was human activity. Ward et al (1973) felt human disturbance occurring less than 0.8 kilometer (1/2 mile) from elk would cause flight from area until the 0.8 kilometer buffer was once again established. Activities such as camping, fishing or hiking caused this response. Flight distance varies by season, habitat and conditioning (Altmann 1958). He pointed out that greatest flight sensitivity occurred in fall and while hunted populations were more apt to respond to disturbance the increase in fall flight response also occurred in unhunted herds. Coop (1973) pointed out elk had reduced alertness and flight response at night and Altmann (1958) found single animals had longer flight distance than groups. All of the above findings were generally supported by results of this study. While elk in Wind Cave National Park exhibited flight response and sought escape cover there was marked differences from elk found outside of the National Park. Flight distance was shorter (often less than 0.4 kilometers or 1/4 mile) and escape cover utilized was generally topographic rather than vegetative. This was undoubtedly due to less human activity within park home range.

Flight distance and escape cover utilization was far different for elk found on the Black Hills National Forest. During daylight hours human activity caused flight response which was generally at least 1.6 kilometers (1 mile) from disturbance. Flight response at night more resembled elk movements in Wind Cave National Park (0.4 kilometers). If disturbance was localized in specific areas and ceased with elk movement, then escape cover sought was generally topographic and vegetative cover utilized at end of flight response varied. However, if human activity caused disturbance that was longer in duration and repetitive then flight distance was greater and topographic escape cover alone failed to meet security needs. Under these conditions elk sought dense stands of ponderosa pine in relatively rugged terrain. Nelson and Burnell (1975) reported escape cover utilized had 75 to 100 percent crown cover. Under repetitive disturbance this was true for elk on the Black Hills National Forest.

Ecotypes used for escape cover by elk varied considerably and included most listed for feeding and loafing/resting habitats. Specific ponderosa pine ecotype was not critical so long as escape cover provided security needs.

Calving Habitat Use

Calving behavioral patterns for elk in this study followed those described by Graf (1943) where cow elk leave the family group a few days before calving and rejoin the group after a month or more. Five calving sites were determined. Aspect varied from year to year and with individual elk between years. Sweeney and Steinhoff (1976) reported utilization of south facing slopes while Phillips (1974) reported use of north facing slopes. Skovlin (1982) cited studies where 20 to 30 percent slopes were utilized. Results of this study showed north facing slopes were selected twice, south facing once and flat terrain twice. All were in areas of less than 20 percent slope. Three factors were found in common for all five calving sites: 1) All were located in openings less than 0.4 hectares (1 acre) in size, no overstory over 5 feet was present. 2) Ground cover consisted of herbaceous vegetation, shrubs and from one to three large, downed timbers. 3) At least one side of opening was adjacent to dense ponderosa pine forest with virtually 100 percent canopy closure. This corresponds to studies cited by Skovlin (1982) where areas of ground cover and adjacent hiding cover were selected calving sites. Free water near calving sites was less than 800 meters (0.5 mile) distance at one site but was less than 200 meters (0.13 mile) from the other four. Skovlin (1982) reported sites with free water within 400 meters (1,312 feet) were selected. Other authors (Miller 1974 and Thomas et al. 1976) reported lactating cows had a high seasonal dependency on water. However, during calving period in late spring water availability was not considered to be a limiting factor in this study due to numerous water sites present.

As with most other uses of habitat ecotypes, calving site selection was site specific rather than dependant on a specific ecotype. Within one week of calving, habitat use followed feeding and loafing/resting patterns described earlier.

Water in Relation to Habitat Use

In addition to water needs of lactating cows, summer habitat use was found to be dependent on water supply within 800 meters (0.5 mile) even if domestic livestock were present by Nelson and Burnell (1975) and Mackie (1970). Skovlin (1982) speculated even greater dependence or use of habitat near water would exist if cattle were not present. He felt dependence was more on water than on forage availability. Findings of this study were in agreement in some of the findings cited above but not with others. Water dependency was noted in summer months of July and August. Feeding and loafing/resting areas were selected with water sources within the 800 meters described above. However, while exceptions occurred, areas selected had little or no domestic livestock use at either water sources or feeding areas. Once hunting seasons began even greater distances were covered from escape cover to water and feeding areas. Elk often moved more than 3 kilometers (1.8 miles) at night between the two habitat sites.

DISCUSSION

For the most part external forces determined elk movements and habitat use. Absence of those external forces would have undoubtedly altered findings.

Hunting Seasons

The greatest affect on elk movements and habitat use was hunter disturbance. Feeding areas used just prior to hunting season initiation were either abandoned or use was greatly curtailed to brief periods during nighttime hours. Greater feeding dependence on small openings next to escape cover occurred. Loafing/resting areas were also radically altered. No longer would areas of limited canopy closure be utilized. Instead, thick stands of ponderosa pine with virtually 100 percent canopy closure were used as loafing/resting areas undoubtedly due to escape cover quality. Topographic features no longer sufficed as escape cover due to repeated disturbance by hunter vehicle access on road systems. The only habitat that prevented repetitive flight response was the dense stands of ponderosa pine. Skovlin (1982) documented that adequate escape cover was vital to prevent continual flight response from hunting pressure. He pointed out that such repetitive flight response caused elk to use too much energy and subsequent weight loss could not be replaced before or during winter due to low forage nutrient value. Such forage provided maintenance diet at best. Thus escape cover provided by dense stands of ponderosa pine was critical for elk in this study. Black et al. (1976) reported size of such stands of hiding cover needed to range from 2.6 to 10.5 hectares (6.5 - 26 acres). In this study location of escape cover was as critical as size. Elk feeding use of small openings with essentially no ponderosa pine overstory greatly increased during and immediately after hunting seasons. These feeding areas were generally less than 2 hectares (5 acres) in size. Adequate escape cover needed to be either immediately adjacent to such feeding areas or at least within 0.2 kilometers (1/8 mile).

Harvest rates of transplanted elk showed importance of escape cover during hunting seasons. Of 34 elk released in 1985, 15 were harvested in just two seasons. As at least four of the released elk returned to Wind Cave National Park and were thus unavailable to hunters, harvest rate was 25% annually for the 30 elk available. All yearling and older bulls transplanted in this study were harvested within two years of release. Undoubtedly, native elk were not as vulnerable to hunting as transplanted elk. Nevertheless, harvest rates were high and escape cover importance cannot be overemphasized. Above described elk response to hunting seasons was not limited to elk seasons but also occurred during the Black Hills deer season (November 1 - 30, annually) and to a lesser degree, during Black Hills turkey seasons both spring and fall.

Domestic Livestock

Next to hunting season disturbance, presence of cattle caused the greatest alteration in movements and habitat use. Affect was primarily change in elk feeding area use. This change occurred immediately upon cattle introduction into pasture system used by elk. Elk either vacated pastures where cattle were present or used areas within those pastures not frequented by cattle. As grazing season progressed and cattle began utilizing more inaccessible areas, elk vacated pastures entirely. It must be emphasized that there were exceptions to the above stated elk response to cattle presence. By and large, however, elk

and cattle use of same feeding areas was incompatible. Elk alteration of feeding use areas appeared to be the result of space competition rather than forage competition. Since response was generally immediate, forage availability was not considered to be a factor causing elk behavioral change.

Space competition response was not observed between elk and deer. Elk aggressive behavior toward deer was observed but was limited in duration and deer flight response was short. Both species were often observed feeding within 46 meters (50 yds.) of each other. Under present elk management goals, elk numbers will not be sufficient to affect deer population numbers.

Timber Harvest

Considerable variation in elk habitat use in response to logging occurred. Portions of herds vacated areas of logging disturbance entirely and continued to do so even at cessation of timber harvest activity. Other elk returned to area of disturbance either on weekends when disturbance ceased or immediately after logging activity was completed. Elk flight response to active logging disturbance always occurred, however. Generally, flight response ceased within 1.6 kilometers (1 mile) and topographic barriers provided main form of escape cover. It must be emphasized that timber harvest occurring within home range of elk during this study was limited. Disturbance occurred only in small areas within a single drainage at any one time so disturbance was limited to that area and along roads used by logging trucks. Had timber harvest covered larger area and several drainages, elk response undoubtedly would have been greater. Lyon and Ward (1982) found at least a portion of an elk herd most commonly returned to logged areas within a few days or weeks at end of disturbance if area of disturbance was not large.

Timber harvest has two main effects on elk populations: 1) disturbance and short term habitat use change and 2) long term habitat modification (Lyon and Ward 1982). For these reasons, Lyon and Ward (1982) recommended timber sales be designed and scheduled in such a way that elk escape cover and alternate feeding areas would be available. They further felt timber sales should be small and disturbance limited to short periods of time. In any case, both Lyon and Ward (1982) and Thomas et al. (1976) recommended that timber management plans should be designed around a 40:60 ratio of hiding cover to feeding areas.

In addition to short term disturbance habitat modification influenced elk use. As stated previously, elk utilized small openings in forested areas with little or no pine canopy extensively for feeding areas during part of the year. Also, areas of limited aspen and bur oak overstory were utilized. Clary (1972) reported ponderosa pine stands of less than 9.2 square meters basal area per hectare (40 sq. ft./acre) was insufficient for escape cover while stands greater than 18.4 square meters basal area per hectare (80 sq. ft./acre) did not provide sufficient forage for feeding. He, therefore, recommended stands for feeding be 9.2 to 18.4 square meters per hectare (40-80 sq. ft./acre) and that sufficient unthinned thickets for escape cover be included in timber sales. During course of this study, however, elk preference for small areas of little or no canopy closure in forested areas tended to form the belief that clear cuts would be preferred to thinned areas for feeding sites. Lyon and Ward (1982) felt timber harvest must be limited in size and felt scale of cut for either clear cut or selective thinning of 243 hectares (600 acres) was unacceptable. They recommended that combinations of openings, forest feeding areas and escape cover

should be 12-32 hectares (30-79 acres) in size but felt it was best to be conservative since size was speculative and if error occurred such error should be in favor of smaller forest feeding areas and larger areas of escape cover.

As found in many studies, elk used timbered travel lanes between meadow or forest feeding areas and loafing/resting or escape cover sites. Timber management design should take into account these travel corridors. Pedersen and Adams (1976) and Winn (1976) found forested travel lanes between open meadows, grasslands or riparian areas were preferred by elk and allowed most efficient use of feeding complexes. Skovlin (1982) recommended wooded travel lanes just below ridge tops and north facing slopes in mountainous terrain.

Miscellaneous Human Activity

Other forms of human disturbance within elk home range illicit flight response and subsequent alteration in elk behavior. Activities such as berry-picking, sightseeing, and firewood gathering caused elk to move from area of disturbance again approximately 1.6 kilometers (1 mile). If disturbance was limited in area and short in duration disturbance was only temporary with elk returning within days or even hours of disturbance cessation. Flight response was generally greater when vehicles stopped or foot traffic occurred. Moving vehicle traffic caused flight response but only as far as screening cover availability. If disturbance occurred in multiple drainages and if such disturbance was repetitive, then elk response was more radical and area was vacated entirely.

Vehicle Access

To one degree or another, most of the above disturbance and habitat alteration factors which caused changes in elk movements and habitat use were a result of vehicle access within elk home range. This can be seen by differences in home range and average daily movements between elk found in the Black Hills National Forest and those found in Wind Cave National Park. Undoubtedly lack of hunting season was the primary factor causing differences but restricted human disturbance from other users undoubtedly influenced results. Within Wind Cave National Park two paved roads with unlimited vehicle access were found within elk home range. All other roads had vehicle restrictions placed on them. Thus human access was limited except next to major highways. Elk home range within Wind Cave was approximately 16 square kilometers (6 sq. miles). Lack of human disturbance undoubtedly contributed to this small home range. Conversely, home ranges within the Black Hills National Forest ranged from 31 square kilometers (12 sq. mi.) to 78 square kilometers (30 sq. mi.). Unlimited vehicle access was possible within approximately 0.4 kilometers (1/4 mile) of all area within home ranges found on the Black Hills National Forest. Human access and thus greater possibility of disturbance undoubtedly caused those home ranges to be far greater than that for Wind Cave National Park.

Lyon and Ward (1982) felt solution to vehicular traffic was to combine low standard roads with road closures. Black et al. (1976), Lyon (1976), Perry and Overly (1976) and Marcum (1976) all recommended fewest possible roads of smallest possible width be located in dense timber away from openings. They further recommended these roads should avoid escape cover areas or moist areas used by elk. Gardner (1971) and the Wyoming Forest Study Team (1971) felt small scale roads capable of doing the job would be least damaging to the environment. Line of sight barriers should also be used in road construction planning

(Skovlin 1982). Ward (1976) reported elk would cross roads adjacent to feeding areas in meadows or clear cuts but over three-fourths of such crossings occurred where timbered areas existed on both sides of the road.

Area road closure would undoubtedly cause adverse reaction by elk hunters due to limited access and retrieval effort required. However, Lyon and Ward (1982) reported hunters generally favored road closure even though retrieval was hindered. Basil and Lonner (1979) evaluated hunting effects on elk herds in two areas with road closures: 1) where escape cover was limited elk vacated areas when roads were used. When the roads were closed, the same hunting pressure caused no enmasse elk movements, and 2) where adequate security cover was present no elk movement from the area occurred even with road use. While effects of vehicle access and subsequent human disturbance were complicated, management efforts should be directed at limiting vehicle access thus minimizing adverse influence on elk populations.

RECOMMENDATIONS

FEEDING AREAS

Management systems should be designed to provide maximum herbaceous vegetation for elk year round. Efforts should be concentrated on natural meadows and openings less than 2 hectares (5 acres) within forested areas. Aspen and oak habitats should be enhanced and expanded. Use of natural fire where possible and prescribed burns on these feeding habitats should be emphasized in management plans. Maximum feeding to minimal escape cover ratio should be 60:40.

LOAFING/RESTING AREAS

Special management efforts to provide loafing/resting areas and thermal cover are not recommended.

ESCAPE COVER

Dense stands of ponderosa pine from 3 to 10 hectares (5 to 25 acres) either immediately adjacent to or within 0.2 kilometers (1/8 mile) of feeding areas are recommended. Minimal escape cover to maximum feeding area ratio should be 40/60.

TIMBER MANAGEMENT

Timber management efforts where elk benefits are an objective should concentrate on clear cuts from 2 to 5 hectares (3 to 13 acres) in size. Selective thinning while producing increased forage has little effect in increasing elk use. Escape cover requirements should be included with such clear cuts. Maximum road density should be one per square mile. All other roads including chicken track trails should be revegetated and closed to vehicular traffic. Road standards should be the lowest possible allowed to accomplish management goals. Line of sight barriers next to roads should be provided. Travel lanes from feeding areas to escape cover should be included in timber management plans.

Tree covered travel corridors next to ridge tops and north facing slopes should be provided.

DOMESTIC LIVESTOCK

Due to space competition with domestic livestock and alteration in elk habitat use, plus need to provide maximum herbaceous cover available for elk in at least one pasture of an allotment, it is recommended rest-rotation grazing systems be implemented within all areas where elk populations occur. Due to elk avoidance of areas utilized by cattle even for long periods after cattle are removed, those grazing systems that utilize all pastures within an allotment during a single grazing season even under a rotational system are not recommended. Water developments under a rest-rotation grazing system hold potential to benefit elk populations. Water development under grazing systems which utilize all pastures within a single season, including rotational systems, is not recommended due to improved cattle distribution. Increased space competition would result.

ELK RESOURCE

Because of elk movements after release, habitat utilization occurred in the southern Black Hills. Due to different moisture regimes, habitat types and terrain, study results may or may not apply to elk populations in the northern Black Hills. Use of transplanted elk to determine native elk movements and habitat use should be investigated.

More detailed population dynamics for all elk populations in the Black Hills need to be determined. Potential hunter harvest dictates more intensive management surveys be initiated.

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