Ecology of white-tailed deer and mule deer in agricultural lands in the Gallatin Valley, Montana
by Kathryn Susan OConner

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
Home range patterns, habitat use and social organization of Rocky Mountain mule deer (Odocoileus hemionus hemionus) and white-tailed deer (O. virginianus) in the Gallatin Valley, Montana, were studied during 1983-1984 via aerial surveys and telemetry relocation sessions on radio-collared and color-collared does. Relocations of deer made during an earlier, 1981-1982 study were also used in home range and association analyses. Six radio-collared white-tailed does were followed for 3-1/2 years and six radio-collared white-tailed does and four radio-collared mule deer does were followed for 2-1/2 years during the two studies. With one exception, all color-collared does seen in the second and third years after trapping were related to radio-collared does. Related adult does were seen together in fall, winter, and spring, but not in summer.

One doe, 1 doe-1 fawn, 1 doe-2 fawns, and 2 does were the most common social groups seen in all seasons for both species. Buck-doe groups were seen only in late summer and fall. Mean group size increased from summer to late -winter. Agricultural practices appeared to affect habitat use of mule deer and white-tailed deer. Fields not rotated/plowed yearly (alfalfa and pasture) were used most frequently in summer. Grainfields were used more often in fall and winter. Fields not plowed in spring (alfalfa, pasture and winter wheat) were used most frequently in spring. Summer fallow was avoided in all seasons.

Mule deer preferred mixed brush in summer and fall, but used it and tree cover with brush equally in winter and spring. White-tailed deer habitat selection varied with location in the valley, but tree cover with brush was preferred over mixed brush overall. Deer bedded in brush patches near preferred crops and not near crops they avoided. Mule deer summer ranges were significantly smaller than other seasonal ranges. White-tailed deer spring and fall ranges were significantly larger. All individuals showed high fidelity to a general area, but many moved short distances (0.8 - 1.6 km) to new seasonal ranges between years. Thirty percent of the summer home ranges were altered, while changes of other seasonal ranges were < 10%. Deer may have established new summer ranges in response to changing habitat availability, caused by rotation of fields.

ECOLOGY OF WHITE-TAILED DEER AND MULE DEER IN AGRICULTURAL LANDS IN THE GALLATIN VALLEY, MONTANA

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Kathryn Susan O'Connor

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Fish and Wildlife Management

MONTANA STATE UNIVERSITY
Bozeman, Montana

December 1987

APPROVAL

of a thesis submitted by

Kathryn Susan O'Connor

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, citations, bibliographic style, and consistency and is ready for submission to the College of Graduate Studies.

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ACKNOWLEDGEMENTS

I wish to express my gratitude to the people who contributed to the completion of this study: H. D. Picton, for his advice, guidance and faith; Roger Stradley and James Stradley, for their expertise as "wildlife pilots"; W. O. Vogel for use of his 1981-1982 data; R. J. Mackie and R. E. Moore for review of the manuscript; and local landowners for their cooperation and assistance. I also wish to thank many individuals of the Biology Department of Montana State University, the Montana Agricultural Experiment Station, and the Montana Department of Fish, Wildlife and Parks for the financial support of my study and my degree. And finally, special thanks to A. K. Wood, J. D. Herriges, and B. B. Compton for sharing ideas; J. J. Scanlon for untiring moral support; and "E.T." Trimble for preserving my insanity when I needed it most.

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ABSTRACT

Home range patterns, habitat use and social organization of Rocky Mountain mule deer (Odocoileus hemionus hemionus) and white-tailed deer (O. virginianus) in the Gallatin Valley, Montana, were studied during 1983-1984 via aerial surveys and telemetry relocation sessions on radio-collared and color-collared does. Relocations of deer made during an earlier, 1981-1982 study were also used in home range and association analyses. Six radio-collared white-tailed does were followed for 3-1/2 years and six radio-collared white-tailed does and four radio-collared mule deer does were followed for 2-1/2 years during the two studies. With one exception, all color-collared does seen in the second and third years after trapping were related to radio-collared does. Related adult does were seen together in fall, winter, and spring, but not in summer. One doe, 1 doe-1 fawn, 1 doe-2 fawns, and 2 does were the most common social groups seen in all seasons for both species. Buck-doe groups were seen only in late summer and fall. Mean group size increased from summer to late winter. Agricultural practices appeared to affect habitat use of mule deer and white-tailed deer. Fields not rotated/plowed yearly (alfalfa and pasture) were used most frequently in summer. Grainfields were used more often in fall and winter. Fields not plowed in spring (alfalfa, pasture and winter wheat) were used most frequently in spring. Summer fallow was avoided in all seasons. Mule deer preferred mixed brush in summer and fall, but used it and tree cover with brush equally in winter and spring. White-tailed deer habitat selection varied with location in the valley, but tree cover with brush was preferred over mixed brush overall. Deer bedded in brush patches near preferred crops and not near crops they avoided. Mule deer summer ranges were significantly smaller than other seasonal ranges. White-tailed deer spring and fall ranges were significantly larger. All individuals showed high fidelity to a general area, but many moved short distances (0.8 - 1.6 km) to new seasonal ranges between years. Thirty percent of the summer home ranges were altered, while changes of other seasonal ranges were < 10%. Deer may have established new summer ranges in response to changing habitat availability, caused by rotation of fields.

INTRODUCTION

Sympatry between Rocky Mountain mule deer (Odocoileus hemionus hemionus) and white-tailed deer (O. virginianus) has been reported in prairie (Dusek 1975, Severson and Carter 1978, Swenson et. al. 1983, and Wood 1987) and forest (Allen 1968, Kamps 1969, Kramer 1973, and Hudson et. al. 1976) habitats. Most studies found white-tailed deer distributions to be concentrated on floodplain agricultural lands within these habitats, which received only limited use by mule deer. Actual range overlap was limited as a result of differing habitat preferences (Swenson et. al. 1983). Few observers have documented year-round use by mule deer of agricultural lands and developed areas (Happe 1983, Ball, pers. comm.), while use of these areas by white-tailed deer is common (Martinka 1968).

A study in the Gallatin Valley, Montana, during 1981-1982 (Vogel 1983) located a small mule deer herd resident to agricultural land. This herd was surrounded by a white-tailed deer population, and separated from other mule deer populations in adjacent mountain-foothill habitat. Observations were made on distribution, population dynamics, activity and food habits of valley white-tailed deer and mule deer.

My study continued observations on these two species

in the Gallatin Valley during 1983-1984. Objectives were to assess possible differences between mule deer and white-tailed deer in seasonal and yearly home range patterns, habitat use, and social organization, to complement the previous study. The analysis incorporated applicable data from the 1981-1982 study.

Funding was provided by the Montana Agricultural Experiment Station and the Montana Department of Fish, Wildlife and Parks. Substantial assistance was provided by the Biology Department of Montana State University.

DESCRIPTION OF STUDY AREA

Geography

The Gallatin Valley (Fig. 1) is an intermontane basin covering over 1,000 square kilometers in southwest Montana (DeYoung and Smith 1931, Hackett et. al. 1960, Vogel 1983). It is bounded on the south by the Gallatin Range and its foothills, on the northeast by the Bridger Range and foothills, and on the north and west by the Horseshoe Hills and Camp Creek Hills, respectively. The valley slopes from an elevation of 2,000 m in the southern and eastern foothills to under 1,300 m near the northwest outlet for the Gallatin River, the major drainage stream. The western branch of the river flows north from its canyon outlet along the western portion of the valley, while the eastern branch and its tributaries drain the central and eastern majority. Soils are mostly brown and light-brown sandy loams, of alluvial and eolian nature.

Five portions of the valley were selected for the study:

Reese Creek: rolling benchlands between the Bridger Range and Horseshoe Hills, which are drained by North Cottonwood, Bear and Reese Creeks.

Pine Butte: the Camp Creek Hills in the vicinity of Pine Butte, west of Bozeman.

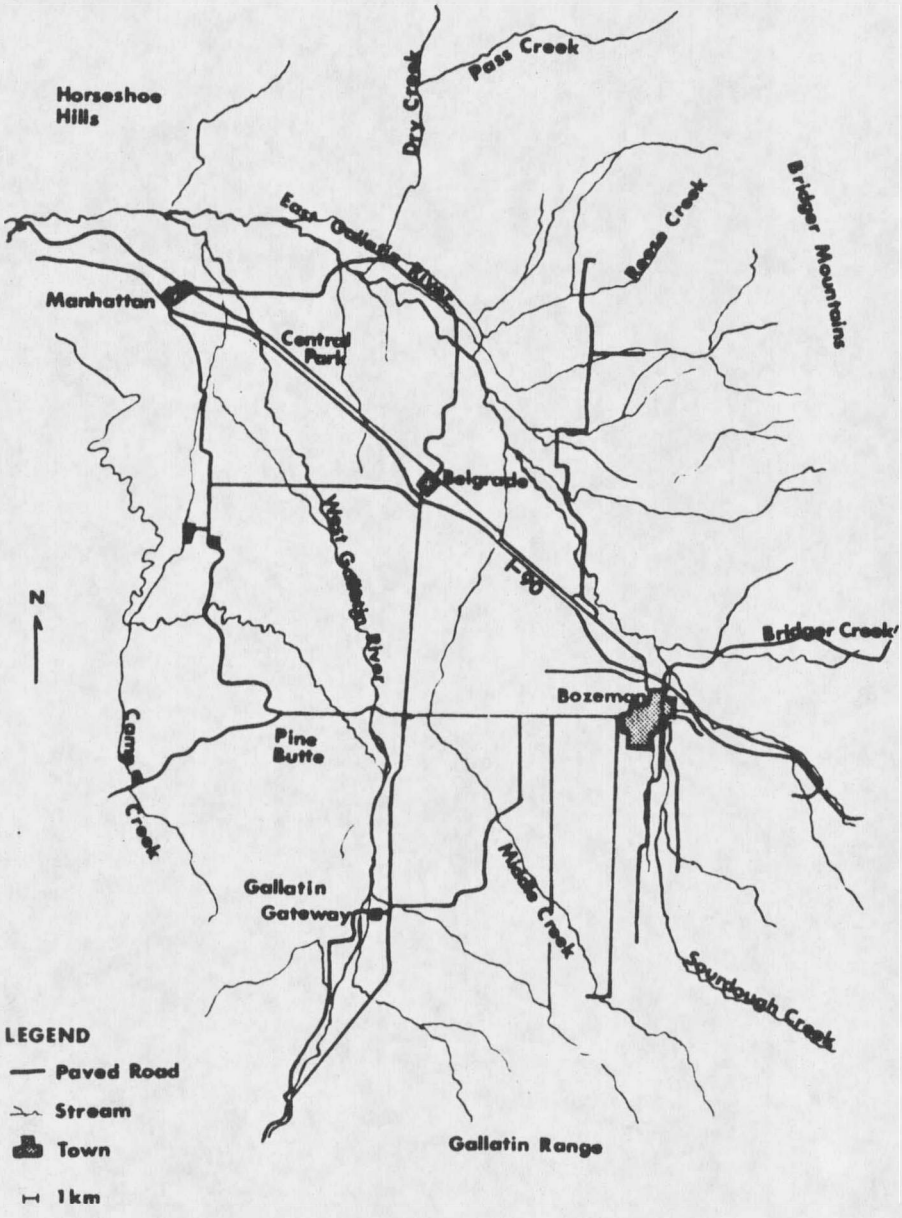

Figure 1. A map of the Gallatin Valley, Montana (Vogel 1983).

Sourdough: agricultural lands and foothills adjacent to Sourdough Creek, south of Bozeman.

Valley Center: flat agricultural lands around Hyalite Creek southeast of Belgrade.

Penwell Bridge: flat agricultural lands surrounding the East Gallatin River northeast of Belgrade.

Climate

The Gallatin Valley climate is montane-continental; temperatures during the short summers rarely reach 32 C, while winter temperatures commonly drop below -18 C. Killing frosts occur in any month. The average frost-free period in Bozeman is 114 days. Pacific fronts bring warm "chinook" winds, with resulting snowmelt, during all winter months, but typically in January and February. Proximity of the mountains results in greater precipitation in the eastern and southern portions of the valley than elsewhere. The average annual precipitation at Bozeman is 46.6 cm; the 11 year (1971-1982) mean winter snowfall was 223 cm (Pac et. al. 1982).

Winter 1980-1981 was characterized by low snowfall and above average temperatures; only one winter since 1971-1972 was milder (Pac et. al. 1984). Winter 1981-1982 had normal temperatures and above average snowfall, while the converse was true of winter 1982-1983. Winter 1983-1984 was the third most severe since 1971-1972, due to a 3-week period in December of -40 C temperatures. This was followed by

mild temperatures in late January through late February, and above average snowfall in March through May. However, only winter 1980-1981 fell outside the biometeorological normal.

Vegetation and Agricultural Practices

Vegetation in the valley is an interspersion of agricultural fields and pasture, with woody vegetation along stream courses. Ranches, farms and dairies are common. Roughly half of the fields are irrigated. Plant nomenclature is according to Hitchcock and Cronquist (1981). Habitat classes were adapted from Vogel (1983).

Lands undisturbed by agricultural practices were placed in the following habitat classes:

Cottonwood: A canopy of cottonwood (Populus trichocarpa) with little or no brushy understory occurred along banks of major rivers and streams.

Mixed brush: A layer of brush without overstory trees, bordering streams and ditches, contained shrubs such as willow (Salix spp.), serviceberry (Amelanchier sp.), dogwood (Cornus sp.), hawthorn (Crataegus sp.), chokecherry (Prunus sp.), current (Ribes spp.), and snowberry (Symphoricarpos sp.). It sometimes had grasses such as basin wildrye (Elymus cinereus) and reed canary grass (Phalaris arundinacea) associated with it.

Deciduous forest: A structural and vegetative combination of the Cottonwood, Aspen, and Mixed brush types occurred along rivers and larger streams, and on slopes immediately below the Conifer forest type.

Willow: Pure stands of willow (Salix spp.) grew in low-lying wet areas, and along rivers and streams.

Marsh: Plants such as cattails (Typha spp.), rushes (Juncus spp.) and sedges (Carex spp.) occupied low-lying wet areas.

Aspen: Aspen (Populus tremuloides) was found along some smaller streams and wet areas, and in the mountains.

Linear herbaceous: The uncut herbaceous vegetation along fences, irrigation ditches and railroad rights-of-way had a variable composition of species from the Pasture, Grass hay, Alfalfa and Small grain types.

Riparian: Riparian areas were bodies of water and adjacent areas such as gravel bars.

Most of the valley acreage was devoted to agricultural uses. Farmers and ranchers' activities were nearly synchronous over 2- to 3-week periods. The following agricultural habitat classes were identified:

Small grain: Winter wheat and spring wheat (Triticum aestivum) and barley (Hordeum vulgare) were common; oats (Avena sativa) and rye (Secale cereale) were uncommon. Spring planting occurred in late April to early May, spring wheat preceding barley. Winter wheat was planted in September. Grains were cut in September; a field might be plowed at this time rather than the spring, but winter fallow was the common practice. Occasionally winter wheat was cut for hay. Cattle were observed grazing in harvested fields in the fall.

Alfalfa: Alfalfa (Medicago sativa or M. falcata) with orchard grass (Dactylis glomerata) and brome grass (Bromus spp.) was usually irrigated or subirrigated. Hay was cut in June and August; a third cutting might be made in the fall. The first cutting contained a mixture of alfalfa and grasses, but the second crop was exclusively alfalfa.

Grass hay: Orchard grass and brome grass, without an accompanying legume, was often used as cattle pasture for part of the season and cut only once.

Pasture: Pasture contained introduced grasses such as Poa spp. and Phleum spp. with native species Festuca idahoensis, Agropyron spicatum, A. smithii and Koelaria cristata. Weeds such as thistle (Cirsium spp.) were common. Pastures in the central valley also contained orchard grass and brome grass in high amounts. Livestock were rotated between pastures during the growing season, but were confined to one field and fed hay throughout the winter.

Potato: Potato fields were common on the western edge of the valley.

Lawn: Sod-forming grasses such as Kentucky bluegrass (Poa pratensis) were kept short by frequent mowing.

Some vegetative types rarely occurred within the valley but were common to adjacent foothills and mountains:

Conifer forest: Douglas fir (Pseudotsuga menziesii) and lodgepole pine (Pinus contorta) grew at higher elevations around the rim of the valley.

Juniper: Juniper (Juniperus scopulorum), skunkbush sumac (Rhus trilobata), antelope bitterbrush (Purshia tridentata), big sagebrush (Artemisia tridentata) and limber pine (Pinus flexilis) grew on rocky slopes of intermediate to high elevations, such as in the northeast and western hills.

Mixed forest: A mixture of the Conifer and Deciduous forest types.

METHODS

Field Methods

Four mule deer does and twelve white-tailed does were radio-collared in a previous study (Vogel 1983). White-tailed deer at Pine Butte and Reese Creek were trapped in 1981 in two helicopter drive net operations. In 1982, rocket nets and Clover traps were used to capture white-tailed deer at Sourdough and Penwell Bridge and mule deer at Valley Center. Radio beacons (AVM Instrument Co.) were placed on adult does in March and April 1981, while transmitter motion-sensing collars (Telonics, Inc.) were fixed to does trapped from January through March 1982. Individually recognizable collars were placed on fawns and bucks in both years (Vogel 1983).

All instrumented deer were relocated during 25 flights, made at two- to three-week intervals from March 1983 to June 1984, from a Piper Supercub with a belly-mounted three-element Yagi antenna and a Telonics receiver. The following information was recorded for all deer observed: weather, date and time, location (in Universal Transverse Mercator coordinates), habitat, activity, species, sex, age class, social group and aggregation size, and animal identification number (when verified). A social group was two or more individuals within 3 m (2 doe-

lengths) of each other, and further than 4.6 m from other deer groups. I also recorded individuals as one social group if they moved together. Aggregations were any deer feeding within the same field, in sight of each other. In winter when deer formed large groups, some aggregations were recorded only as total deer and not broken into social groups.

Fawn:doe and buck:doe ratios by species were obtained in an aerial survey of the valley, made in three flights on September 23-24, 1983. Social group and aggregation size and approximate location were recorded.

Radio-collared deer at Valley Center and Penwell Bridge were relocated from the ground 15 times a month on a varying day and time (between dawn and midnight) schedule from June 1983 to June 1984. Equipment and procedures followed Hallberg et. al. (1974) with the following modifications: antenna height was 3 m; reference bearings on the antenna and truck were taken from the road; and a Telonics TAC-5 null-peak system with two-element Yagi antennas were used. Procedures for determining locations followed Pac (1978). Whenever possible, three bearings were taken at 0.8 km intervals within one half hour. Information recorded in the field included: weather, date and time, animal identification number, compass bearing, signal quality, null quality and signal speed (fast, slow, or changing). For deer seen, all information was recorded

as for aerial observations.

Accuracy of the ground antenna system was determined by locating a beacon from three stations. Twenty-three trials were conducted, with actual location and movement between trials of the beacon being unknown to the observer. No consistent biases between the true bearings and the measured ones were found. The mean distance of the plotted locations from the actual location was 63m ± S.E. 35m. At a distance of 0.8 km from station to beacon, this was roughly a ± 2-1/2 degree error, or a total error arc of 5 degrees (100m). All bearings were straight and true (no bounce) due to the flat terrain.

Analytical Methods

Compass bearings from ground telemetry sessions were plotted on USGS 15 minute topographic quads. When bearings intersected in an error triangle rather than a precise point, the midpoint of the triangle was used as the location of the deer (after Pac 1978). When 4 or 5 bearings were available from a ground session, all were used to define the error polygon unless noted as poor signals or nulls. Locations were classified as "good "or "poor" by the size of the error triangles: triangles larger than 100 m on a side (the expected average error of the system) were designated "poor", and triangles 100 m or less on a side were "good". Locations from only two

bearings were designated "good" if within 0.8 km of the stations or "poor" if at a greater distance.

All deer home ranges were plotted and calculated using the computer program TELDAY (Lonner and Burkhalter 1986). I made no assumptions on the duration or dates of seasons, instead defining them by deer movements. Changes in areas of use over time were identified by inspection, and geographic activity centers (GACs) were calculated for each subyearly range. Seasons were then identified by average dates of movement, for all does, to new ranges. Three indices of home range size were calculated for each seasonal period: convex polygon (CP) (Mohr 1947), average activity radius (AAR) (Hayne 1949), and standard diameter (SD) (Harrison 1958). Seasonal values by year were weighted with the number of locations and averaged.

Social organization parameters, home range indices, and habitat use were compared using the MSUSTAT statistical software package (Lund 1983). Random points for assessing habitat availability in the Valley Center and Penwell Bridge areas were generated by subroutines of the computer program GEOSCAN (Software Designs 1984).

Detailed vegetation maps were constructed for the Valley Center and Penwell Bridge areas. Information on agricultural crops and pasturage for June 1983 to June 1984 was collected from Agricultural Stabilization and Conservation Service files, landowner interviews and

personal observations. These data and woody cover, stream courses, fence lines, roads, houses, irrigation ditches, and former railroad right-of-ways were recorded on overlays for USGS 7.5 minute orthophotoquads.

Habitat use patterns of Valley Center mule deer and Penwell Bridge white-tailed deer were analyzed from pooled locations from triangulations, flights, and ground observations for which the occupied habitat was determined. Habitat use was recorded by two methods, the habitat class at the point location, and the habitat classes in an error/scanning circle of 100 m diameter centered around each point. The circle was divided into four quadrants, and the dominant habitat class in each was recorded. Because the linear herbaceous, mixed brush, and deciduous forest types were usually too narrow to dominate a quadrant, they were recorded as a special fifth observation when present. The habitat class at the point location was assigned to the fifth score when these classes weren't present.

Deer movements at Valley Center and Penwell Bridge were used to define the perimeter of the areas mapped for habitat availability. Percentages of each habitat class in these areas, by season, were determined by two methods, dot-grid counts and random points. The dot-grid counts were used as the most accurate measure of habitat availability; random points were "controls" to compare with

deer locations, with habitat classes at point locations and quadrants recorded as for the latter.

Habitat classes that were rare in the two areas were combined with others with similar vegetation and agricultural practices, for statistical tests: grass hay with pasture, oats with barley, willow with mixed brush, and cottonwood with deciduous forest.

Habitat use by mule deer and white-tailed deer was compared to habitat availability in the study areas by chi-square tests of the distributions (Marcum and Loftsgaarden 1980, Byers et. al. 1984). Z-tests were used to determine which habitat classes were used differently from availability. Deer point locations were compared to the dot-grid percentages, while deer quadrant scores were compared to random point quadrant scores. If deer use matched availability, it was said to be "expected" use, otherwise the habitat class was "preferred" or "avoided".

RESULTS

Movements and Home Ranges

Three mule deer does and ten white-tailed does were radio-tracked from March 1983 to June 1984. Twenty-five flights yielded 297 locations usable in determining home ranges. Ground triangulations produced another 301 locations on three mule deer does at Valley Center and 289 locations on three white-tailed does at Penwell Bridge. I also used 479 locations made during the previous study, from March 1981 through January 1983, on all 13 radio-collared does and 3 additional (1 mule deer and 2 white-tailed) does (Vogel 1983).

Three radio-collared does died during this study. One white-tailed doe died of unknown causes at age 5-1/2 in November 1983; a 4-1/2 year old mule deer doe was poached in January 1984; and a second mule deer doe died of malnutrition (as judged by bone marrow appearance) in April 1984, at age 10-1/2.

Average dates (for all does combined) of changes in location of home range GACs were used to define six seasons: spring (4/1 - 5/31), fawning (6/1 - 7/31), postfawning (8/1 - 9/15), early fall (9/16 - 11/15), late fall (11/16 - 12/31), and winter (1/1 - 3/31). "Summer" was fawning/postfawning combined, and "fall" was early

fall/late fall combined.

General Movements

Reese Creek: Three radio-collared white-tailed does had home ranges centered on Bear, Hays, and North Cottonwood Creeks, with occasional use of Reese Creek in spring and fall. Two does used North Cottonwood as summer ranges, the third used Hays Creek. Winter ranges tended to be north of the summer ranges, and fall and spring ranges were expanded to include all three drainages (Fig. 2).

Pine Butte: All three radio-collared white-tailed does spent winter and spring on the agricultural flats north of Pine Butte. Two does had summer/fall ranges on the W. Gallatin River, and one used Elk Grove Slough and areas further east (Fig. 3).

Sourdough: All three white-tailed does radio-collared in 1982 wintered near the mouth of Sourdough Canyon. One summered on the winter range, another moved further north on Sourdough Creek, and the third moved to the eastern outskirts of Bozeman, 3 km north. In subsequent years, the one surviving doe wintered at Pine Butte and spent spring at Elk Grove Slough (Fig. 4).

Penwell Bridge: Two white-tailed does had home ranges

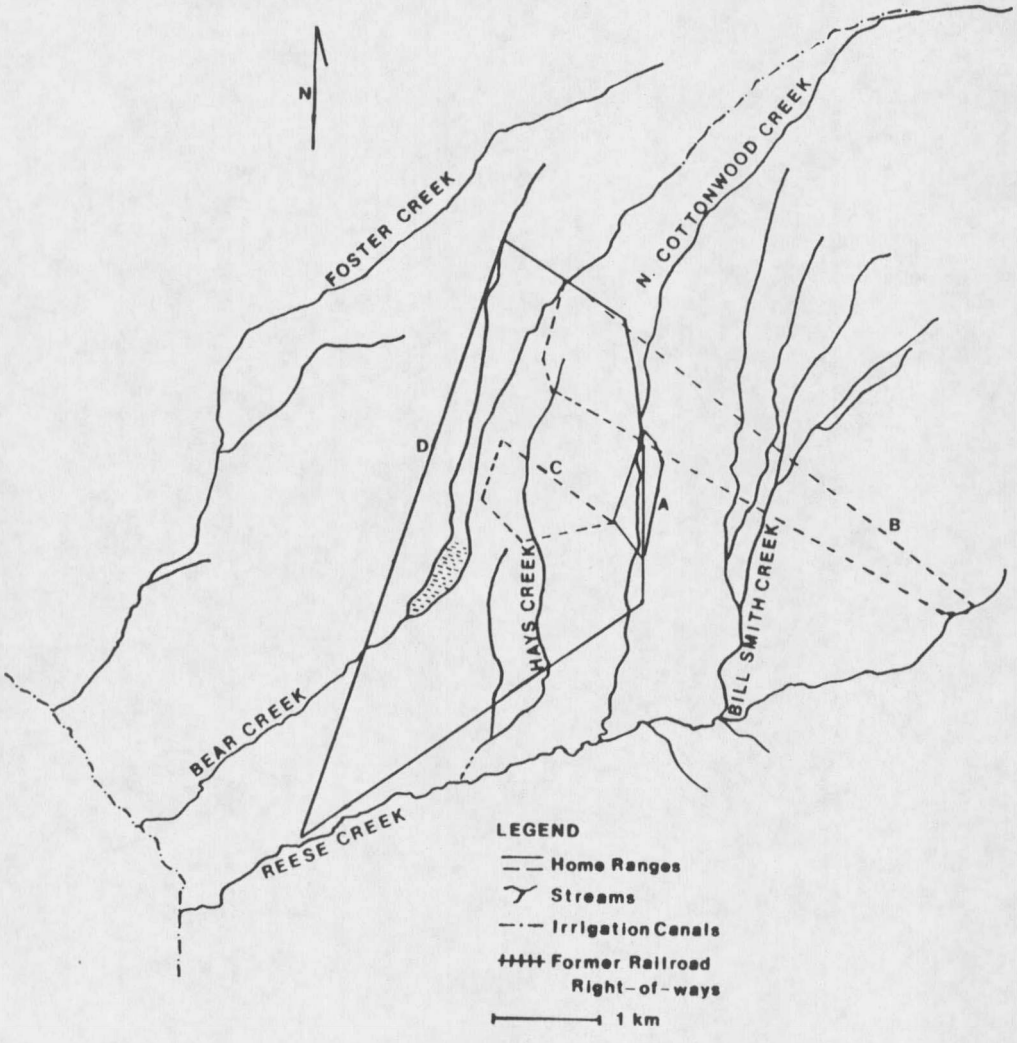

Figure 2. A map of the Reese Creek study unit, and seasonal home ranges for white-tailed doe #1 from March 1981 to November 1983. (A = summer range, B = fall range, C = winter range, and D = spring range)

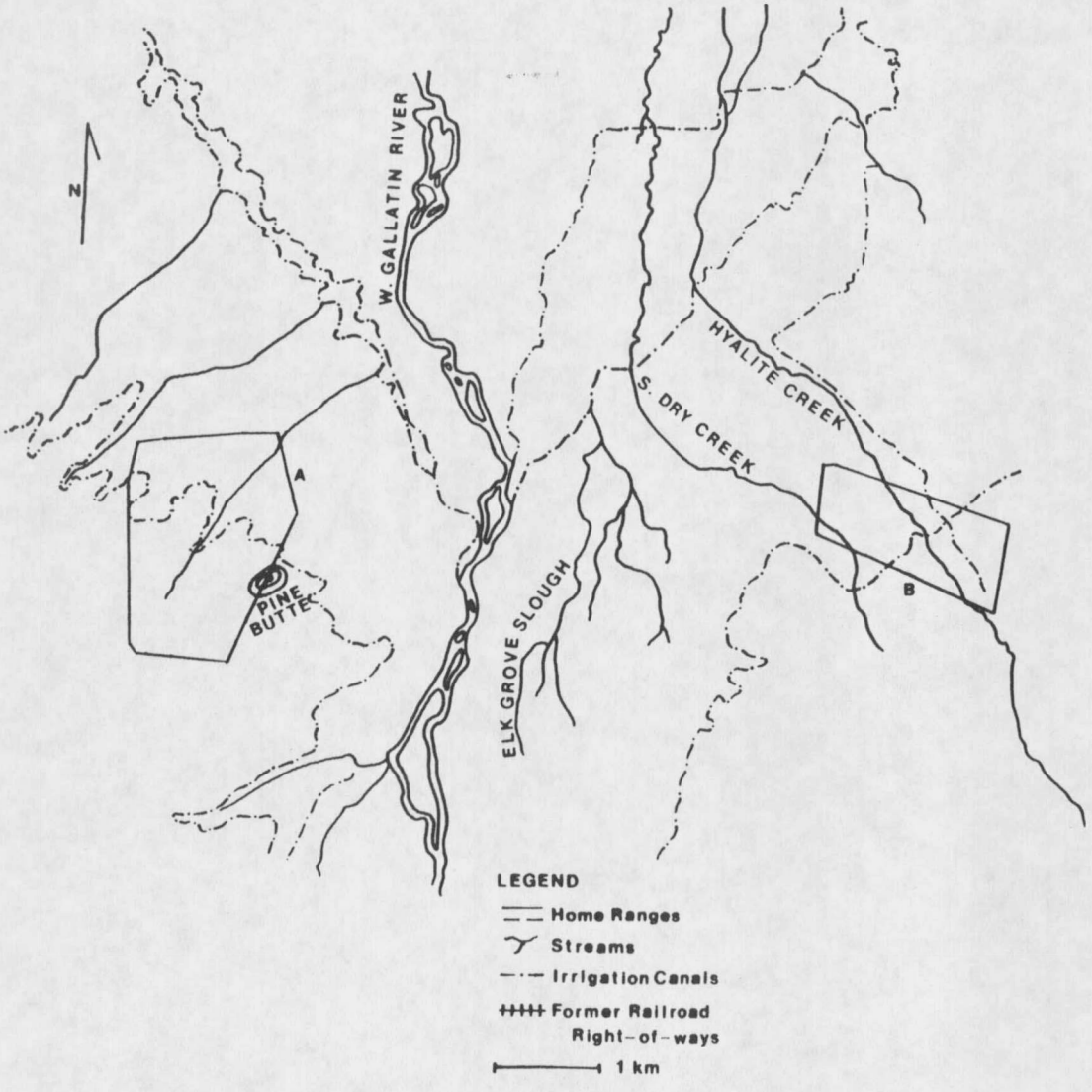

Figure 3. A map of the Pine Butte study unit, and seasonal home ranges for white-tailed doe #8 from April 1981 to June 1984. (A = winter/spring range and B = summer/fall range)

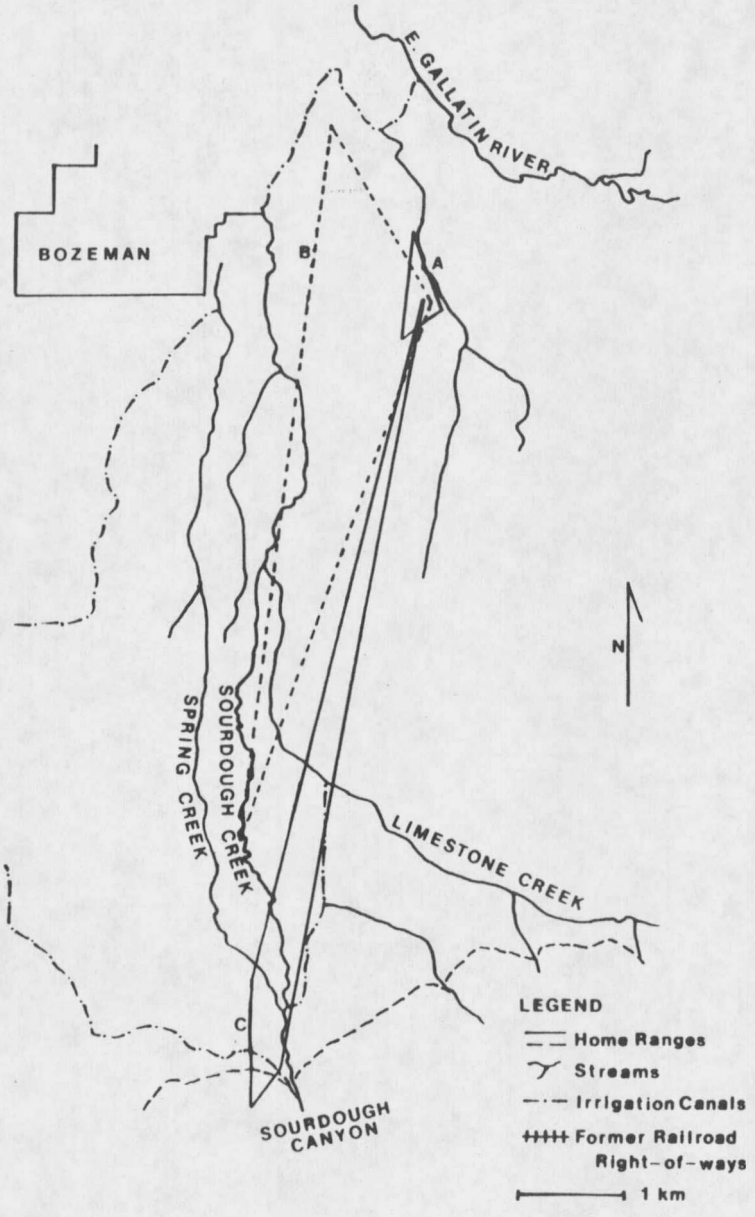

Figure 4. A map of the Sourdough study unit, and seasonal home ranges for white-tailed doe #46 from March 1982 to December 1982. (A = summer range, B = fall range, and C = winter/spring range)

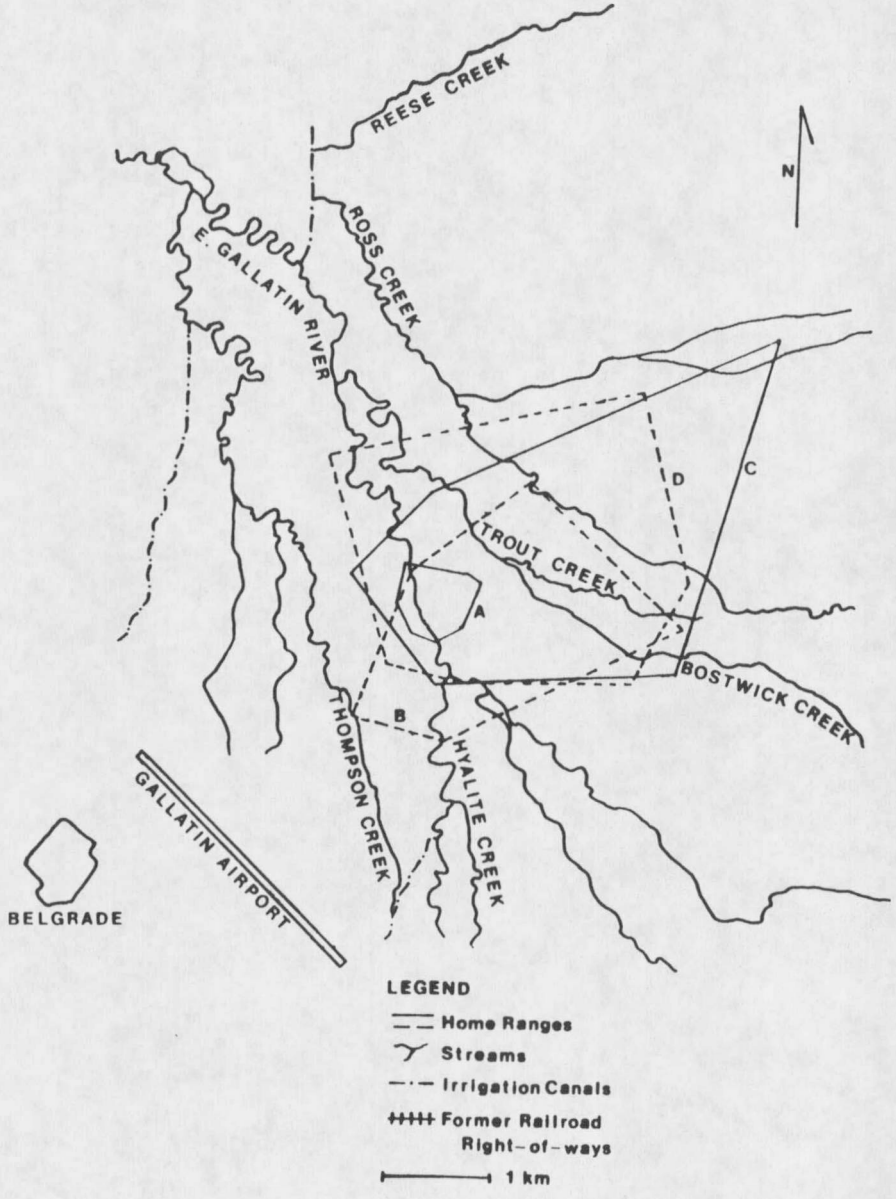

Figure 5. A map of the Penwell Bridge study unit, and seasonal home ranges for white-tailed doe #26 from February 1982 to June 1984. (A = summer range, B = fall range, C = winter range, and D = spring range)

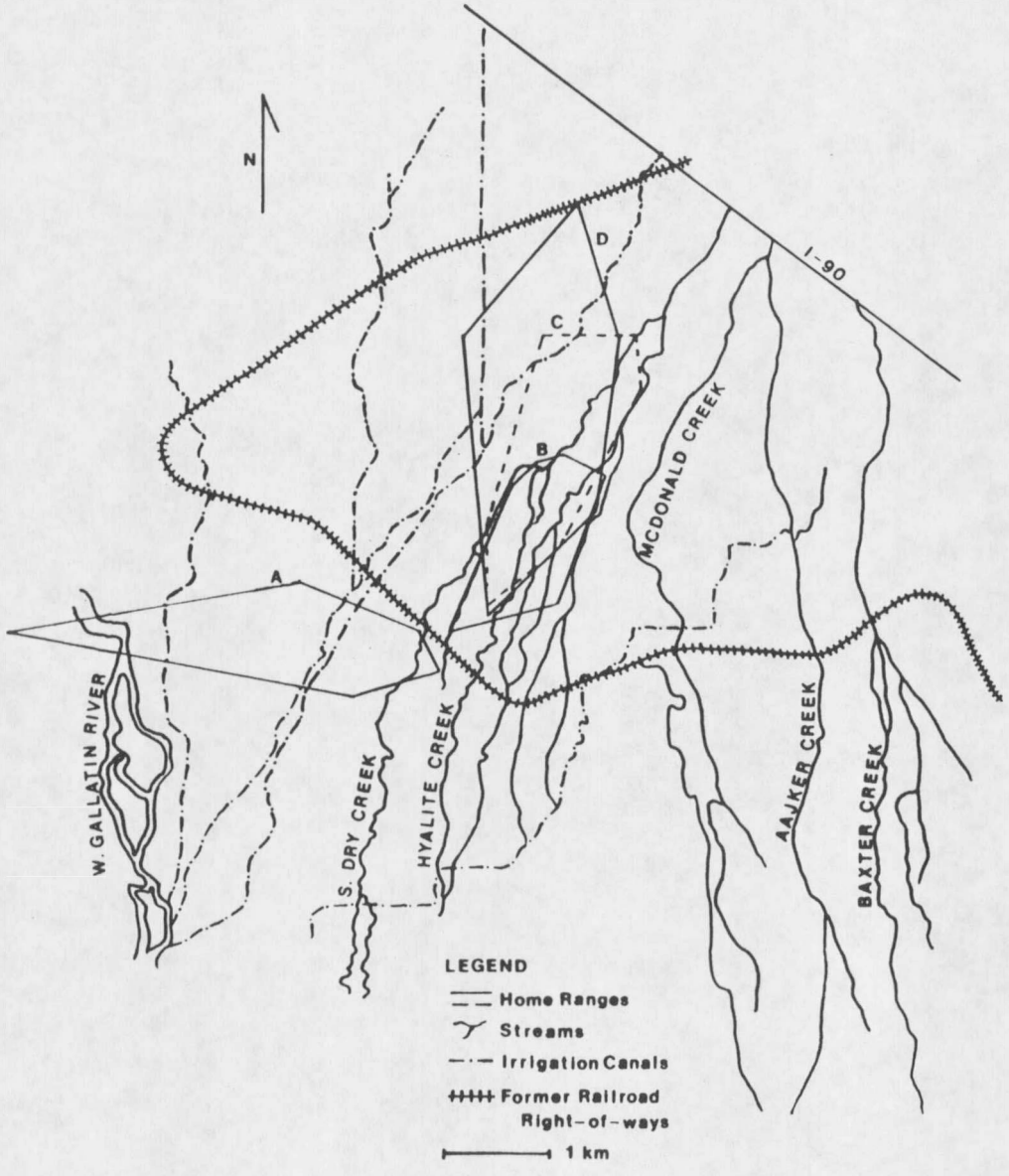

Figure 6. A map of the Valley Center study unit, and seasonal home ranges for mule deer doe #22 from February 1982 to April 1984. (A = 1983 fawning range, B = 1983 postfawning range, C = fall range, and D = winter/spring range)

centered year-round on the E. Gallatin River; the third summered in Bridger Canyon, and wintered on Trout and Bostwick Creeks east of the river (Fig. 5).

Valley Center: All mule deer wintered on Hyalite Creek. Two radio-collared does had summer/fall home ranges on the creek; in summer 1983, one of these does moved to the W. Gallatin River during fawning season and returned to Hyalite Creek for postfawning. The third doe moved southeast to Baxter Creek during summer/fall (Fig. 6).

Comparisons Between Location Methods

Two relocation regimes were used during this and the previous study. All radio-collared deer were located twice per month in late morning flights from 1981-1984. Valley Center mule deer and Penwell Bridge white-tailed deer were also relocated during 15 ground telemetry sessions each month during 1983-1984. These additional ground locations might invalidate comparisons between deer in other areas, and with previous years' data. Two areas of concern were home range size indices, and geographic activity centers (GACs). Convex polygon (CP) values are known to be strongly affected by the number of locations; average activity radii (AARs) and standard diameters (SDs) are less affected (Dusek and Wood 1986). Ground sessions covered dawn to midnight periods, and could produce different GACs

than late morning flights.

Because I wished to use all locations available to me, rather than omitting a large body of data, I tested the hypothesis that home range size indices differed more between location methods than between seasons. Seasonal home ranges both from flight locations alone and from all (pooled) locations were generated for Valley Center mule deer and Penwell Bridge white-tailed deer for these comparisons.

As expected, addition of ground locations to flights altered seasonal home range CP index values more than AAR or SD values. CP values from flight locations alone were significantly smaller than values from all locations, for Valley Center mule deer and Penwell Bridge white-tailed deer (paired Student's T, P=0.025 and 0.011, respectively). AAR and SD values from flight locations alone did not differ significantly from values from all locations, for either species (all P-values > 0.20).

GACs for different subyearly periods were a greater distance apart than GACs for flights and all-locations from the same subyearly period. Mean distances between flight and all-location home range GACs were 202 m (S.D. $\pm$ 203) and 401 m (S.D. $\pm$ 378) for mule deer and white-tailed deer, respectively. The mule deer mean was significantly smaller than the mean distance between subyearly home range GACs, 1,573 m (S.D. $\pm$ 1,553) (grouped Student's T, P=0.01), but

the white-tailed deer mean was not significantly different (subyearly mean, 2,280 m with S.D. ± 4,477; grouped Student's T, P=0.17).

Comparisons with ground locations aided interpretation of flight locations. Ground sessions showed use of some areas that flights missed. However, the heaviest concentration of flight locations coincided with that of ground locations. Flight locations outside this heavily used "core area" (which were a small portion of the total) most often coincided with secondary concentrations of ground locations.

Ground and flight locations were pooled and then separated by time of day to test the effect of time on home range indices. Midday home range CP, AAR, and SD indices were not significantly different from those for crepuscular periods (paired Student's T, all P-values > 0.25). Mean distances between midday and crepuscular GACs were 313 m (S.D. ± 207) and 274 m (S.D. ± 209) for mule deer and white-tailed deer, respectively. These were significantly less (P=0.01 and 0.04 for mule deer and white-tailed deer, respectively) than the mean distances between subyearly home range GACs (listed above).

I concluded that the effects of sample size and interval were less than the seasonal or subyearly differences in AAR, SD, and GAC indices, and that flight-only and all-location home ranges were comparable.

Changes Between Seasons

Does typically had four subyearly GACs, with dates of movement varying between deer and years (Fig. 7). Fifteen of 16 does shifted to new GACs between spring and fawning seasons, 10 does shifted to new GACs between late fall and winter, and 7 between postfawning and early fall. Other responses varied.

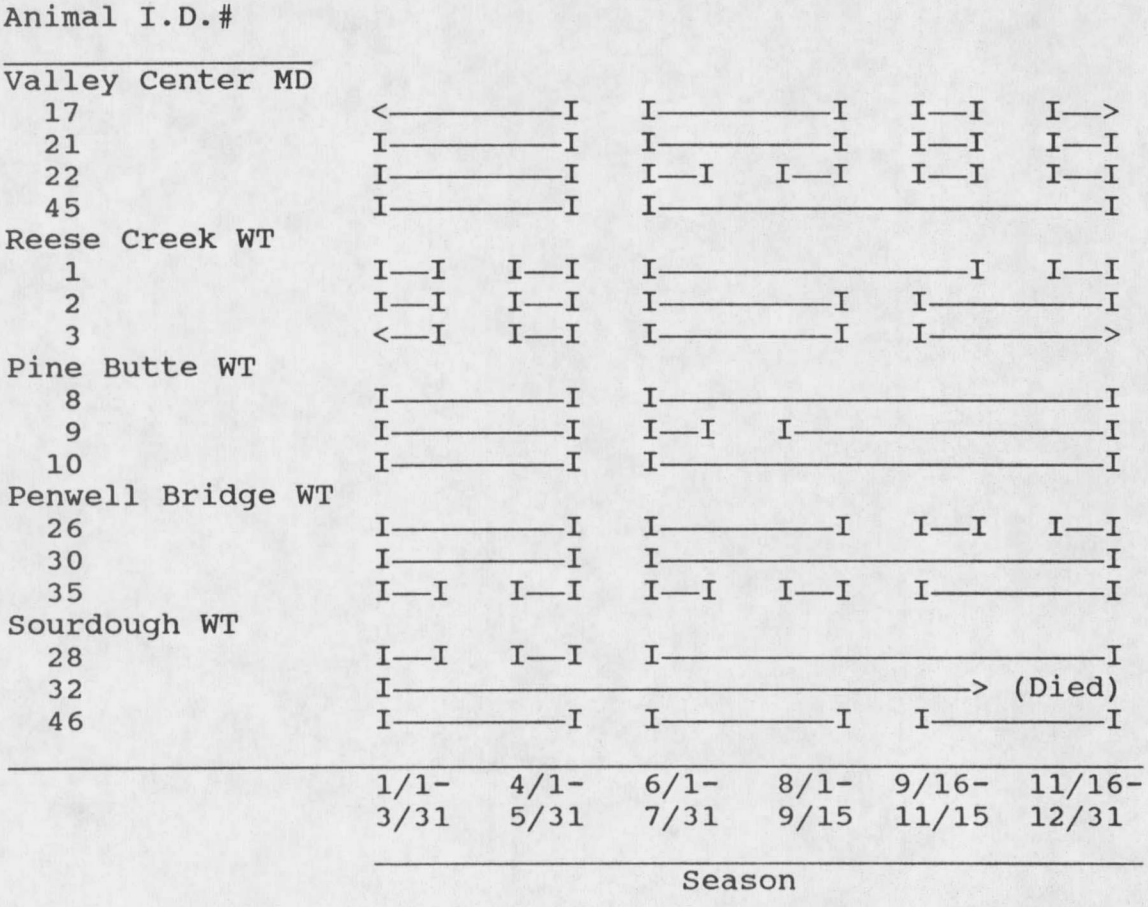

Figure 7. Duration of use of Geographic Activity Centers (GACs) by radio-collared does. (WT = white-tailed deer, MD = mule deer) (I—I) indicates continuous use of the same GAC; (I I) indicates movement to a new GAC; (<——) indicates continued use of a GAC to the previous/next season.

Means for home range size indices of white-tailed deer (Table 1) significantly differed between seasons (ANOVA, P=0.001, 0.000, and 0.002 for AAR, SD, and CP respectively), but not between areas nor between an interaction of area and season (all P-values > 0.05). Fawning and postfawning indices were significantly smaller when compared to other seasons', but not to each other.

Means for home range size indices of mule deer (Table 1) did not differ significantly over all seasons (ANOVA, P=0.122, 0.152, and 0.784 for AAR, SD, and CP respectively). However, spring and late fall indices were significantly larger than other seasons (all P-values < 0.05).

Means for home range size indices did not differ significantly between the two species for any season (grouped Student's T, all P-values > 0.05). Index values appeared to vary more within than between species and areas.

The relative sizes of seasonal home ranges for both species were judged from AARs to be: fawning = postfawning < early fall = late fall > winter < spring > fawning. However, size relationships between late fall, winter and spring home ranges varied with the index: winter CPs were larger, while winter AARs and SDs were smaller, than late fall and spring values. This suggests that late fall and spring home ranges were more linear than

Table 1. Mean home range size and shape indices by season, for white-tailed (WT) and mule deer (MD) radio-collared does in the Gallatin Valley from March 1981 to June 1984. (CP = convex polygon, AAR = average activity radius, SD = standard diameter, SI = CP/SD, shape index)

	Season																							
	4/1–5/31				6/1–7/31				8/1–9/15				9/16–11/15				11/16–12/31				1/1–3/31			
Animal I.D. #	CP (km^2)	AAR (km)	SD (km)	SI	CP (km^2)	AAR (km)	SD (km)	SI	CP (km^2)	AAR (km)	SD (km)	SI	CP (km^2)	AAR (km)	SD (km)	SI	CP (km^2)	AAR (km)	SD (km)	SI	CP (km^2)	AAR (km)	SD (km)	SI
Valley Center MD																								
17	.89	.78	1.72	.52	.15	.13	.32	.47	.22	.18	.41	.54	1.30	.48	1.23	1.06	1.28	.72	1.57	.82	2.11	.62	1.51	1.40
21	5.31	1.04	2.34	2.27	4.08	.81	1.89	2.16	3.91	.83	1.81	2.16	2.81	.86	1.84	1.53	1.15	.70	1.48	.78	2.98	.16	.55	5.42
22	.75	.67	1.47	.51	1.78	.80	2.10	.85	1.46	.48	1.12	1.30	2.36	.77	1.73	1.36	.94	1.51	3.04	.31	2.79	.55	1.47	1.90
45	.11	.56	1.32	.08	.00	.21	.57	.00	.00	.38	.80	.00	.00	.38	.80	.00	.33	.49	1.17	.28	.33	.49	1.17	.28
Reese Creek WT																								
1	2.17	1.09	2.53	.86	.02	.33	.67	.03	.07	.30	.54	.13	.46	1.23	2.56	.18	1.06	2.38	4.77	.22	1.41	.95	2.53	.56
2	1.57	.88	2.00	.79	.19	.33	.72	.26	.76	.78	1.72	.44	.97	.84	1.81	.54	.40	.67	1.29	.31	.42	.61	1.29	.33
3	.96	.67	1.44	.67	.25	.42	1.18	.21	.22	.50	1.13	.19	3.94	1.28	2.90	1.36	.01	.51	1.10	.01	3.80	.90	2.03	1.87
Pine Butte WT																								
8	1.28	.69	2.37	.54	.11	.52	1.17	.09	.10	.42	.98	.10	.12	.34	.85	.14	1.24	1.60	3.54	.35	1.35	1.01	2.30	.59
9	.30	.81	1.89	.16	.00	.22	.56	.00	.03	.16	.43	.07	.06	.30	.67	.09	1.45	.95	1.96	.74	.64	.53	1.14	.56
10	.67	1.25	2.46	.27	.00	.00	.00	.00	.07	.24	.61	.11	.26	.41	.92	.28	.00	.09	.19	.00	.68	.57	1.30	.52
Penwell Bridge WT																								
26	2.09	.67	1.47	1.42	.15	.18	.44	.34	.35	.28	.62	.56	1.47	.69	1.49	.99	.98	.48	1.09	.90	2.63	.90	2.12	1.24
30	3.48	1.23	2.65	1.31	–	–	–	–	.00	.11	.24	.00	.47	.40	.96	.49	.10	.57	1.26	.08	5.88	.55	1.58	3.72
35	.76	.40	.89	.85	2.36	.84	2.07	1.14	2.40	.74	1.80	1.33	1.04	.41	.95	1.09	.55	.41	.91	.60	7.28	.82	1.90	3.83
Sourdough WT																								
28	.46	.64	1.44	.32	.04	.15	.36	.11	.07	.21	.49	.14	.08	.26	.58	.14	.00	.34	.76	.00	.06	.39	.84	.07
32	.21	.30	.65	.32	.00	.16	.40	.00	.00	.06	.13	.00	.00	.06	.13	.00	–	–	–	–	.05	.28	.60	.08
46	1.98	1.10	4.10	.48	.20	.31	.73	.27	.20	.31	.73	.27	4.41	2.90	6.01	.73	4.41	2.90	6.01	.73	1.98	1.10	4.10	.48

winter, a conclusion that is supported by the shape indices (SI = CP / SD) (Table 1). Smaller SI values are correlated with a more linear shape (Vogel 1983).

Four home range patterns were shown by deer of both species (Table 2, Figs. 2-6). Pine Butte white-tailed does all displayed pattern 3, but does at other areas displayed several patterns.

Table 2. Home range patterns of radio-collared does in the Gallatin Valley from March 1981 to June 1984. (WT = white-tailed deer, MD = mule deer)

Animal I.D.#	Pattern	Animal I.D.#	Pattern
Reese Creek WT		Penwell Bridge WT	
1	4[a]	26	1
2	4	30	3
3	1	35	2
Pine Butte WT		Valley Center MD	
8	3	17	1
9	3	21	3
10	3	22	2
Sourdough WT		45	1
28	3		
32	1		
46	4		

[a] Home range patterns:
1-A doe occupies the same small area each summer, expanding it to include other areas in fall through spring.
2-A doe has a fawning home range separate from her home range of the rest of the year.
3-A doe has separated summer/fall and winter/spring home ranges.
4-A doe has separate small summer and winter home ranges, which are incorporated into large spring and fall ranges.

Does were occasionally relocated several kms away from the core area. I considered such locations not repeated in the same season to be exploratory movements (Baker 1978). Two white-tailed does from Reese Creek were relocated on Dry Creek in winter 1982; one mule deer doe from Valley Center was seen along the W. Gallatin River, on her previous fawning range, in winter 1984; and two white-tailed does from Penwell Bridge were observed on Reese Creek, one in spring 1983 and the other in spring 1984.

Changes Between Years

Two radio-collared white-tailed does at Reese Creek changed to new summer ranges between 1981 and 1982/1983. They used drainages as their core areas in 1982 and 1983 that in 1981 were used only occasionally (as evidenced by one or two aerial locations). A third doe changed her spring range between 1981 and 1982/1983. All other seasonal ranges were consistent in all years.

At Pine Butte, all three radio-collared white-tailed does spent most of winter 1983 on their summer/fall ranges. Two does were located on the winter range only once each (in November 1982 and April 1983, respectively) and the third doe was never located there. One doe changed her summer GAC between 1982 and 1983, by moving 0.8 km down the W. Gallatin River. As a 2-year-old in 1981 she had moved over a 5 km portion of the river, and her two subsequent summer ranges fell within this area.

Only one white-tailed doe radio-collared at Sourdough lived more than one year after trapping. She made a major change in her winter/spring range. Her 1982 range was on south Sourdough Creek; no locations were made in winter 1983, but her spring locations were at Elk Grove Slough, near Pine Butte. She returned to south Sourdough Creek in December-January 1984, then spent winter and spring at Pine Butte and Elk Grove Slough, respectively. She spent each summer/fall at Sourdough Creek, shifting her summer 1983 movements closer to a new irrigation pond.

White-tailed does at Penwell Bridge showed few changes in home ranges. One doe showed no changes. Another doe, trapped in February as a yearling, moved her winter range southeast of the trap site in subsequent years, though she continued to use the trap site as part of her spring range. This second doe had a summer range in Bridger Canyon, 14 miles away; in May 1984, she made the move overnight. The third doe used a new fawning season range in 1983, then returned to her 1982 summer range during postfawning.

Mule deer does at Valley Center showed similar patterns to Penwell Bridge white-tailed deer. One doe showed no changes. Another doe changed her fawning season range from the previous year, into a new area outside of her other seasonal ranges. The third doe made extensive movements between her separate winter, summer and fall home ranges, from mid-April to early July 1983, then settled

down on her previous year's summer range; she did not show this pattern the previous year. She continued to move between home ranges before shifting to the new range each season. This doe died in January 1984, before a third year of observations could be made.

More changes between years were observed in summer ranges than in other seasons. Six does were observed for three consecutive summers, and another six for two. Of 18 possible changes in summer ranges between years, six occurred. No changes in fall ranges were observed. Pine Butte white-tailed does spent most of winter 1982-1983 on their summer ranges. Nine does from other areas were observed for three consecutive winters and one doe for two. Of 19 possible changes in winter ranges for these does, only two occurred. Only two changes of 31 possible were observed in spring ranges, of 5 does radio-tracked for four consecutive springs and 8 does for three. The distances between old and new seasonal ranges varied from 0.8 to 1.6 km.

Habitat Use

Mule deer and white-tailed deer fed in most agricultural fields, especially alfalfa, but they also day-bedded in crops that had reached 1 m or more in height. They occasionally fed in pastures when livestock was present, but stayed near brushy cover or fencerows. Deer

were not observed feeding in summer fallow fields. The non-agricultural types, such as linear herbaceous, mixed brush and deciduous forest, were used as travel corridors and for day-bedding sites.

Seasonal Point Locations

Habitat use by Valley Center mule deer differed from availability in all seasons (X^2, all P = 0.000), and habitat use differed between seasons (Tables 3 and 5). Mule deer used less alfalfa and more small grains in fall/winter than spring/summer. Deciduous forest was preferred in winter and spring only.

Table 3. Proportions of mule deer locations in habitat classes and proportions of available habitat classes at Valley Center from April 1983 to June 1984.

Habitat Class	Mule Deer Habitat Use				Valley Center Habitat Availability		
	Sum[a]	Fall	Win	Spr	Sum	Fall/Win	Spr
Pasture/Grass Hay	.09	.07	.11	.02	.35	.34	.35
Alfalfa	.30	.22	.19	.35	.21	.19	.20
Spring Wheat	0	0	0	0	.02	.02	.01
Winter Wheat 83	.02	.04	0	-	.06	.05	-
Winter Wheat 84	-	.04	.05	.13	-	.07	.07
Barley/Oats	.17	.09	.18	.06	.14	.14	.16
Summer Fallow	0	.01	.03	.02	.06	.03	.06
Linear Herbaceous	.13	.17	.03	.11	.11	.10	.10
Mixed Brush/Willow	.24	.33	.28	.15	.03	.02	.02
Deciduous Forest/Cottonwood	.04	.02	.11	.15	.02	.02	.02
Total Observations (n)	119	114	115	46	4402	4407	4396

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

Table 4. Proportions of white-tailed deer locations in habitat classes and proportions of available habitat classes at Penwell Bridge from June 1983 to June 1984.

Habitat Class	White-tailed Deer Habitat Use				Penwell Bridge Habitat Availability		
	Sum[a]	Fall	Win	Spr	Sum	Fall/Win	Spr
Pasture/Grass Hay	.21	.03	.06	.14	.21	.21	.19
Alfalfa	.33	.31	.18	.32	.21	.20	.21
Spring Wheat	.01	0	.02	.02	.09	.09	.07
Winter Wheat 83	0	.05	.12	-	.08	.07	-
Winter Wheat 84	-	0	.17	.09	-	.13	.13
Barley/Oats	.07	.04	.05	.03	.10	.09	.14
Summer Fallow	0	0	.01	.02	.16	.06	.11
Linear Herbaceous	.07	.14	.11	.12	.07	.07	.07
Mixed Brush/Willow	.07	.12	.18	.14	.04	.04	.04
Deciduous Forest/Cottonwood	.23	.29	.10	.12	.03	.03	.03
Total Observations (n)	84	90	158	94	4499	4522	4538

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1/84 - 6/1/84.

Habitat use by Penwell Bridge white-tailed deer also differed from availability (X^2, all P = 0.000 for all seasons), but the preferred/avoided types differed from mule deer patterns (Tables 4 and 5). Small grains and summer fallow were avoided more, and pasture, alfalfa and deciduous forest were used more by white-tailed than mule deer. White-tailed deer appeared to substitute small grains for pasture between spring/summer and fall/winter. Use of winter wheat varied between harvested and growing types during fall through spring.

Mule deer and white-tailed deer habitat use differed

Table 5. Seasonal habitat selection and habitat availability for mule deer at Valley Center and white-tailed deer at Penwell Bridge from April 1983 to June 1984, as determined from deer locations.

Habitat Class	Sum[a]	Fall	Win	Spr
Mule deer habitat selection at Valley Center				
Pasture/Grass Hay	--[b]	--	--	--
Alfalfa	+	0	0	+
Spring Wheat	0	0	0	0
Winter Wheat 83	-	0	-	
Winter Wheat 84		0	0	0
Barley/Oats	0	0	0	(-)
Summer Fallow	--	0	0	0
Linear Herbaceous	0	+	-	0
Mixed Brush/Willow	++	++	++	++
Deciduous Forest/Cottonwood	0	0	++	++
White-tailed deer habitat selection at Penwell Bridge				
Pasture/Grass Hay	0	--	--	0
Alfalfa	++	++	0	+
Spring Wheat	--	--	--	(-)
Winter Wheat 83	--	0	+	
Winter Wheat 84		--	0	0
Barley/Oats	0	0	0	--
Summer Fallow	--	-	--	--
Linear Herbaceous	0	+	(+)	0
Mixed Brush/Willow	0	++	++	++
Deciduous Forest/Cottonwood	++	++	++	++
Mule deer habitat use contrasted with white-tailed deer				
Pasture/Grass Hay	-	0	0	-
Alfalfa	0	0	0	0
Spring Wheat	0	0	0	0
Winter Wheat 83	0	0	--	
Winter Wheat 84		+	--	0
Barley/Oats	+	0	++	0
Summer Fallow	0	0	0	0
Linear Herbaceous	0	0	--	0
Mixed Brush/Willow	++	++	+	0
Deciduous Forest/Cottonwood	--	--	0	0

Table 5 - continued.

Habitat Class	Sum	Fall/Win	Spr
Valley Center habitat availability contrasted with Penwell Bridge			
Pasture/Grass Hay	++	++	++
Alfalfa	0	0	0
Spring Wheat	--	--	--
Winter Wheat 83	--	0	
Winter Wheat 84		--	--
Barley/Oats	++	++	++
Summer Fallow	--	--	--
Linear Herbaceous	++	++	++
Mixed Brush/Willow	0	0	0
Deciduous Forest/Cottonwood	0	0	0

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

[b] Summaries of Z-tests. - and + indicate significance at $P < 0.05$, -- and ++ indicate significance at $P < 0.01$, (-) and (+) indicate significance at $P < 0.10$, 0 indicates test not significant at $P > 0.10$.

significantly in all seasons (X^2, all $P = 0.00$). Mule deer and white-tailed deer use differed in the most types in winter and in the fewest in spring (Table 5). The availability of habitat types in the two areas also differed significantly, however (X^2, all $P = 0.00$ for all seasons). Valley Center had more pasture, barley and linear herbaceous, while Penwell Bridge had more spring wheat, winter wheat, and summer fallow (Table 5). White-tailed deer and mule deer used winter wheat and barley opportunistically, but used spring wheat very infrequently. Mixed brush and deciduous forest were equal between the two

areas; mule deer used mixed brush and white-tailed deer used deciduous forest more.

Some apparent differences between the areas were not quantified. Woody cover and agricultural land appeared more interspersed at Valley Center than at Penwell Bridge. Mixed brush and deciduous forest occurred in wide patches at Penwell Bridge, and in narrow strips along stream courses at Valley Center. In both areas, spring wheat was patchy in distribution; the other habitat classes appeared evenly distributed.

White-tailed deer in other areas were relocated mostly during late morning flights and were predominantly in woody cover classes (Table 6). Use of mixed brush/willow

Table 6. Numbers of observations of white-tailed deer in habitat classes in the Gallatin Valley, excluding Penwell Bridge, from March 1983 to June 1984.

Habitat Class	Sum[a] n	Fall n	Win n	Spr n
Deciduous Forest/ Cottonwood	19	32	11	6
Mixed Brush/Willow	16	31	16	22
Juniper	0	0	2	1
Linear Herbaceous	2	1	6	1
Pasture/Grass Hay	1	3	5	7
Alfalfa	0	0	0	5
Small Grains	0	3	3	0
Summer Fallow	0	0	1	0
Misc. Agric.	2	3	13	1

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

Table 7. Proportions of quadrant scores in habitat classes for mule deer locations and for random points at Valley Center from April 1983 to June 1984.

Habitat Class	Mule Deer Locations				Valley Center Random Points			
	Sum[a]	Fall	Win	Spr	Sum	Fall	Win	Spr
Pasture/Grass Hay	.16	.23	.16	.09	.37	.43	.44	.36
Alfalfa	.39	.32	.28	.45	.25	.22	.17	.22
Spring Wheat	0	0	0	0	.02	.01	.01	.01
Winter Wheat 83	.07	.09	.01	-	.06	.05	.07	-
Winter Wheat 84	-	.04	.09	.16	-	.05	.06	.08
Barley/Oats	.22	.16	.29	.15	.12	.10	.13	.21
Summer Fallow	.01	.01	.04	.03	.07	.04	.01	.03
Linear Herbaceous	.05	.05	.02	.03	.08	.07	.07	.07
Mixed Brush/Willow	.08	.08	.06	.06	.01	.01	.01	.01
Deciduous Forest/Cottonwood	.01	.01	.03	.03	.01	.01	.02	.01
Total Observations (n)	592	570	574	230	714	802	759	643

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

equalled that of deciduous forest/cottonwood from summer through winter, and exceeded it in spring. Spring use of mixed brush reflected heavy use of willow stands (an uncommon type at Penwell Bridge). Pine Butte and Sourdough does more often used deciduous forest than does at Reese Creek where this type was less common. Does at Reese Creek used predominantly mixed brush.

Seasonal Quadrant Scores

Deer quadrant scores (habitat classes occurring in areas around the deer point locations) were compared to random point quadrant scores (Tables 7 and 8). Mule deer

Table 8. Proportions of quadrant scores in habitat classes for white-tailed deer locations and for random points at Penwell Bridge from June 1983 to June 1984.

Habitat Class	White-tailed Deer Locations				Penwell Bridge Random Points			
	Sum[a]	Fall	Win	Spr	Sum	Fall	Win	Spr
Pasture/Grass Hay	.21	.09	.12	.18	.24	.21	.28	.15
Alfalfa	.50	.48	.23	.43	.24	.22	.24	.25
Spring Wheat	.02	.01	.03	.02	.06	.09	.08	.06
Winter Wheat 83	.01	.11	.17	-	.08	.06	.07	-
Winter Wheat 84	-	.05	.23	.12	-	.14	.10	.14
Barley/Oats	.10	.11	.07	.04	.11	.05	.05	.11
Summer Fallow	.01	0	.01	.06	.17	.10	.06	.14
Linear Herbaceous	.03	.03	.03	.05	.06	.06	.04	.07
Mixed Brush/Willow	.04	.03	.05	.06	.03	.02	.04	.04
Deciduous Forest/Cottonwood	.07	.08	.05	.03	.01	.01	.04	.03
Total Observations (n)	421	452	790	470	735	759	760	690

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1/84 - 6/1/84.

and white-tailed deer habitat use differed significantly from availability in all seasons (X^2, all P = 0.00 for both species) (Table 9). Quadrant scores showed greater or lesser use by deer of some habitat classes than had point locations, but no habitat class was preferred under one method and avoided under the other. Many of these differences could be due to smaller confidence intervals, resulting from the larger sample sizes of the quadrant scores.

A second reason for differences is that the point

Table 9. Seasonal habitat selection and habitat availability for mule deer at Valley Center and white-tailed deer at Penwell Bridge from April 1983 to June 1984, as determined from quadrant scores.

Habitat Class	Sum[a]	Fall	Win	Spr
Mule deer habitat selection at Valley Center				
Pasture/Grass Hay	--[b]	--	--	--
Alfalfa	++	++	++	++
Spring Wheat	0	0	0	0
Winter Wheat 83	0	++	--	
Winter Wheat 84		0	++	++
Barley/Oats	++	++	++	-
Summer Fallow	--	--	0	0
Linear Herbaceous	-	0	--	-
Mixed Brush/Willow	++	++	++	++
Deciduous Forest/Cottonwood	0	0	0	0
White-tailed deer habitat selection at Penwell Bridge				
Pasture/Grass Hay	0	--	--	0
Alfalfa	++	++	0	++
Spring Wheat	--	--	--	--
Winter Wheat 83	--	+	++	
Winter Wheat 84		--	++	0
Barley/Oats	0	++	0	--
Summer Fallow	--	--	--	--
Linear Herbaceous	0	0	0	0
Mixed Brush/Willow	0	0	0	0
Deciduous Forest/Cottonwood	++	++	0	0
Mule deer habitat use contrasted with white-tailed deer				
Pasture/Grass Hay	-	++	+	--
Alfalfa	--	--	+	0
Spring Wheat	0	0	--	0
Winter Wheat 83	++	0	--	
Winter Wheat 84		0	--	+
Barley/Oats	++	+	++	++
Summer Fallow	0	0	++	0
Linear Herbaceous	0	0	0	0
Mixed Brush/Willow	+	+	0	0
Deciduous Forest/Cottonwood	--	--	0	0

Table 9 - continued.

Habitat Class	Sum	Fall	Win	Spr
Valley Center habitat availability contrasted with Penwell Bridge				
Pasture/Grass Hay	++	++	++	++
Alfalfa	0	0	--	0
Spring Wheat	--	--	--	--
Winter Wheat 83	0	0	0	
Winter Wheat 84		--	--	--
Barley/Oats	0	++	++	++
Summer Fallow	--	--	--	--
Linear Herbaceous	0	0	++	0
Mixed Brush/Willow	0	0	++	--
Deciduous Forest/Cottonwood	0	0	0	0

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

[b] Summaries of Z-tests. - and + indicate significance at $P < 0.05$, -- and ++ indicate significance at $P < 0.01$, 0 indicates test not siginificant at $P < 0.05$.

locations were skewed toward the linear herbaceous, mixed brush and deciduous forest types; quadrant scores included the agricultural crops around these locations. These surrounding areas reinforced the preferences shown by point locations; therefore, deer were bedding in areas near their feeding sites, and not adjacent to crops rarely used. Since the habitat classes seemed evenly distributed, the deer were likely choosing complexes of habitat that include preferred cover and forage types.

Time of Day

Habitat use (from point locations) did not differ significantly between day and night in summer for either mule deer or white-tailed deer (X^2, P = 0.20 and 0.10, respectively). Mule deer habitat use differed between day and night in fall and winter (X^2, P = 0.00 and 0.02, respectively); but small sample sizes precluded testing for differences in spring. White-tailed deer used habitat similarly during day and night in fall (X^2, P = 0.24) but differently in winter and spring (X^2, P = 0.00 and 0.01, respectively). More mule deer and white-tailed deer day locations were in mixed brush and deciduous forest, and more night locations were in winter wheat, barley, alfalfa and linear herbaceous types. However, day and night locations in pasture were equal in all seasons (Table 10).

Social Organization

Age and Sex Proportions

Age and sex proportions significantly varied with season (X^2, P=0.000 for both species). Males were seen most often in the postfawning and fall seasons, were less common in late fall and winter, and sighted rarely during spring and fawning (Table 11). White-tailed fawns were least seen during fawning. Mule deer fawn observations were high during fawning season, but this probably is an artifact of small sample size: many of these were repeat

Table 10. Day and night habitat selection by mule deer at Valley Center and white-tailed deer at Penwell Bridge from April 1983 to June 1984, as determined from deer locations.

Habitat Class	Sum[a]	Fall	Win	Spr
Contrasting day and night habitat selection by mule deer				
Pasture/Grass Hay	0[b]	0	0	0
Alfalfa	0	-	-	0
Spring Wheat	0	0	0	0
Winter Wheat 83	0	0	0	
Winter Wheat 84		-	0	-
Barley/Oats	+	0	-	-
Summer Fallow	0	0	0	0
Linear Herbaceous	-	0	-	0
Mixed Brush/Willow	0	+	+	0
Deciduous Forest/Cottonwood	0	0	+	+
Contrasting day and night habitat selection by white-tailed deer				
Pasture/Grass Hay	0	0	0	0
Alfalfa	0	0	-	-
Spring Wheat	0	0	0	0
Winter Wheat 83	0	0	0	
Winter Wheat 84		0	+	0
Barley/Oats	-	-	-	0
Summer Fallow	0	0	0	0
Linear Herbaceous	-	0	0	-
Mixed Brush/Willow	0	+	+	0
Deciduous Forest/Cottonwood	0	0	+	+

[a] Sum = 6/1/83 - 9/15/83, Fall = 9/16/83 - 12/31/83, Win = 1/1/84 - 3/31/84, Spr = 4/1 - 5/31 (83 and 84).

[b] Summaries of Z-tests. - indicates day < night at $P < 0.05$, + indicates day > night at $P < 0.05$, 0 indicates day = night ($P > 0.05$).

Table 11. Sex and age ratios of deer by season, derived from observations made in the Gallatin Valley from March 1983 to June 1984.

Season	Mule Deer			White-tailed Deer		
	F:D[a]	B:D	n	F:D	B:D	n
4/1 - 5/31	.28	-	41	.52	.01	180
6/1 - 7/31	.54	-	20	.14	-	33
8/1 - 9/15	.63	.22	50	.65	.23	130
9/16 - 11/16[b]	.81	.20	173	.79	.21	879
11/16 - 12/31	.67	.05	67	.52	.06	164
1/1 - 3/31	.15	.03	46	.33	.03	265

[a] D = does, F = fawns, B = bucks.

[b] includes the Sept. 1983 survey.

observations of the same individuals at Penwell Bridge. Numbers of fawns seen for both species peaked in fall, declined through winter and increased again slightly during spring. These results probably reflect both changes in numbers of fawns with adults, and increased difficulty in recognizing fawns as they grow larger.

Group Size and Composition

Social groups ranged in size from 1 to 20. Groups over 20 individuals never met the behavior and spacing restrictions of one social group, and were classified as aggregations and multiple social groups.

Mean social group size significantly varied between seasons (ANOVA, P = 0.000 for both species) (Table 12). White-tailed deer social groups were smallest during

Table 12. Mean numbers of deer in social groups and aggregations by season, derived from observations made in the Gallatin Valley from March 1983 to June 1984. (MD = mule deer, WT = white-tailed deer)

Season	MD Soc. Gr. mean	S.D.	n	WT Soc. Gr. mean	S.D.	n	WT Aggregation mean	S.D.	n
4/1 - 5/31	7.00	5.57	13	4.96	3.84	83	17.73	8.31	10
6/1 - 7/31	2.27	2.05	15	1.65	.93	20			
8/1 - 9/15	2.16	1.18	25	2.48	1.94	56	9.50	4.46	6[a]
9/16-11/15[b]	3.39	2.36	51	3.24	2.79	275	7.60	5.76	30
11/16-12/31	6.69	4.48	13	4.34	2.90	32	24.38	6.93	8
1/1 - 3/31	5.89	4.47	28	5.63	4.04	116	28.65	17.94	20

[a] pooled data for 6/1 - 9/15, due to small sample sizes.

[b] includes the Sept. survey.

fawning season, increased to a winter peak, and decreased slightly during spring. White-tailed deer aggregations showed a similar trend. Mule deer social groups were the same size between fawning and postfawning periods, and were close to white-tailed deer postfawning size. Mule deer social group size showed trends of increase throughout the fall and winter similar to white-tailed deer.

Mule deer social groups were larger than white-tailed deer. The Valley Center mule deer herd (of up to 20 individuals) behaved as one social group when feeding throughout the fall to spring seasons. No subunits were detectable because individuals constantly shifted from one group to another, and the entire herd maintained close spacing. They bedded in two to three groups. I had only six records of mule deer aggregations and therefore have not

Table 13. Percent occurrence of white-tailed deer social groups by season, derived from observations made in the Gallatin Valley from March 1983 to June 1984.

Social Group	Season 4/1-5/31 %	6/1-7/31 %	8/1-9/15 %	9/16-11/15 %	11/16-12/31 %	1/1-3/31 %
1D[a]	27	65	30	12	16	23
2D	9	5	11	7	10	7
3D	9	20	-	-	-	-
4D	7	-	-	-	-	11
5+D	-	-	-	-	9	18
1D 1F	7	-	11	13	6	5
1D 2F	9	10	22	23	19	9
2D 2F	5	-	-	6	10	5
2D 3F	5	-	-	-	-	-
3D 3F	-	-	-	-	6	-
4+D 1+F	14	-	-	-	13	11
1B	-	-	7	-	-	-
1+B 1+D 1+F	-	-	-	5	-	-
Total (n)	44	20	54	275[b]	31	44

[a] D = does, F = fawns, B = bucks.

[b] includes Sept. survey (n=225).

reported statistics on them.

The most common social groups observed in both species over all seasons were 1 doe, 2 does, 1 doe-1 fawn, and 1 doe-2 fawns (Tables 13 and 14). These were also the most common social groups within white-tailed deer aggregations (Table 15). They correspond to family (doe with fawns) and extended family (doe with adult offspring) groups (Hawkins and Klimstra 1970, Hirth 1977).

The most common social groups for both species varied

Table 14. Percent occurrence of mule deer social groups by season, derived from observations made in the Gallatin Valley from March 1983 to June 1984.

Social Group	Season 4/1-5/31 %	6/1-7/31 %	8/1-9/15 %	9/16-11/15 %	11/16-12/31 %	1/1-3/31 %
1D[a]	16	75	30	24	18	14
2D	-	-	13	4	-	21
3D	16	-	-	2	-	7
5+D	16	-	-	-	-	21
1D 1F	-	8	-	10	9	14
1D 2F	16	8	13	12	9	-
2D 1F	-	-	-	-	-	7
2D 2F	-	-	-	-	9	-
2D 4F	-	8	-	-	-	-
3D 2F	-	-	-	-	9	-
3D 5F	-	-	-	6	-	-
4+D 1+F	33	-	-	6	27	7
2+B	-	-	9	6	-	-
1+B 1+D	-	-	9	6	-	-
1+B 1+D 1+F	-	-	-	12	18	7
Total (n)	6	12	23	51[b]	11	14

[a] D = does, F = fawns, B = bucks.

[b] includes Sept. survey (n=28).

seasonally. Bucks were uncommon in white-tailed deer social groups except during postfawning and fall, while in mule deer groups they were common during all seasons except spring and fawning. During these periods bucks may have been more secretive, or absent from the five areas where observations were concentrated. Single does were very common in all seasons. Fawns were most visible in the postfawning through late fall seasons.

Table 15. Percent occurrence of white-tailed deer social groups within aggregations over all seasons, derived from observations made in the Gallatin Valley from March 1983 to June 1984.

Social Group	%	Social Group	%	Social Group	%
1D[a]	16	6D	2	2D 2F	5
2D	9	1D 1F	9	1+F	7
3D	6	1D 2F	20	1B	7
4D	3	2D 1F	3		

Total (n) = 149.

[a] D = does, F = fawns, B = bucks.

Association Between Individuals

In both species, marked individuals were more likely to be seen together during winter and spring than other seasons (Table 16). Individuals were thought to be related (trapped as fawns with does--Hawkins and Klimstra 1970) in 40 of 82 observations. Bucks were seen with their mothers only as fawns. Female offspring were seen with does as fawns and yearlings in all seasons, but only during the fall, winter and spring as adults. In two cases, an adult doe was known to establish her home range close to her mother's home range. All other adult doe offspring were not seen during the summer seasons, implying that their home ranges were more remote from their mothers'.

Color-collared does related to radio-collared does were more likely to be seen than unrelated does, in years

Table 16. Occurrences of marked deer together by association type and season, derived from observations made in the Gallatin Valley from March 1981 to June 1984.

Association Type	Season 4/1-5/31 n	6/1-7/31 n	8/1-9/15 n	9/16-11/15 n	11/16-12/31 n	1/1-3/31 n
1+D 1+F[a]	8	-	-	-	-	14
1+D 1+Y	4	2	3	2	-	-
2+D(dif. age)	10	-	-	2	5	16
2+D(same age)	3	-	-	-	-	-
2+Y	-	1	1	1	-	-
2+B	2	-	-	-	-	-
2+F	-	-	-	-	-	1
1B 1D 1YorF	3	-	-	-	-	-
1B 1D	2	-	-	-	-	2

[a] D=adult doe, Y=yearling doe, B=adult or yearling buck, F=fawn.

Table 17. Coefficients of Association[a] for radio-collared deer, derived from observations made in the Gallatin Valley from March 1981 to June 1984. (WT = white-tailed deer, MD = mule deer)

Animal ID#	C[a]	Animal ID#	C
Reese Creek WT		Penwell Bridge WT	
1,2	0	26,30	.04
1,3	.12	26,35	0
2,3	0	30,35	.04
Pine Butte WT		Valley Center MD	
8,9	.03	17,21	0
8,10	.06	17,22	.21
9,10	0	17,45	.24
Sourdough WT		21,22	0
28,32	.06	21,45	0
28,46	0	22,45	.11
32,46	.13		

[a] Coefficient of Association (Knight 1970), C = 2ab/a+b, where a = # observations of A, b = # observations of B, and ab = # observations of A and B together.

subsequent to trapping. Eight of 13 color-collared white-tailed does were related to radio-collared does. Seven were seen in 2nd and 3rd years following trapping, one was not. Only one of five unrelated color-collared white-tailed does was seen in subsequent years. Neither of two color-collared mule deer does, and none of 15 color-collared bucks of both species, were seen in subsequent years. It is possible that these deer still occupied home ranges in the trap areas. Four bucks were shot during hunting seasons in the vicinity of their trap sites.

Frequent relocations enabled me to quantify associations between radio-collared does. Coefficients of Association (Knight 1970) were small in all cases, but the largest were for mule deer does at Valley Center (Table 17). Coefficients of Association rely upon visual relocations, and therefore were not applicable to telemetry locations. The average distance between each pair (Association Index, AI) was calculated from telemetry data (Table 18). I subtracted the average AARs for each doe from the AI to determine the degree of overlap between the home ranges (the Distance Index, DI). Negative DI values show potential overlap. The results varied between areas, but spacing of marked deer was closest during late fall, winter and spring. Deer were furthest apart during fawning season, and at intermediate distances during postfawning and early fall.

Table 18. Association (AI[a]) and Distance (DI[b]) Indices by season for radio-collared does, derived from observations made in the Gallatin Valley from March 1981 to June 1984.

Animal I.D. #	Season											
	4/1-5/31		6/1-7/31		8/1-9/15		9/16-11/15		11/16-12/31		1/1-3/31	
	AI (km)	DI (km)	AI (km)	DI (km)	AI (km)	DI (km)	AI (km)	DI (km)	AI (km)	DI (km)	AI (km)	DI (km)
Valley Center MD												
17,45	.44	-0.88	.31	-0.28	.00	-0.59	.42	-0.34	.00	-1.32	.15	-1.17
22,45	.38	-0.83	1.13	.33	1.43	.53	1.55	.36	1.67	-0.39	.95	-0.26
17,22	.43	-1.00	2.01	1.46	.51	-0.14	.88	-0.23	1.27	-1.01	.44	-0.99
21,45	.51	-0.68	4.36	3.14	4.46	3.74	4.66	3.38	3.24	2.40	.66	-0.14
21,22	.98	-0.32	5.10	3.92	5.00	3.69	4.97	3.34	4.47	2.67	1.25	.34
21,17	.99	-0.42	3.90	2.93	4.90	3.90	4.28	3.08	4.09	3.03	.99	-0.03
Penwell Bridge WT												
26,35	1.51	.30	2.53	1.89	2.09	1.46	1.71	.60	1.92	.80	1.84	.67
26,30	1.67	.42	21.27	-	21.20	-	20.95	-	14.42	-	1.98	.67
30,35	2.59	1.79	-	-	23.65	-	22.28	-	16.39	-	2.87	1.89
Reese Creek WT												
1,3	.80	-1.09	.78	-0.03	1.44	.63	2.24	.28	.66	-2.11	.87	-0.48
1,2	1.67	.00	1.95	.25	2.06	1.36	2.89	1.07	1.09	-2.25	3.08	1.94
2,3	1.44	.06	2.40	1.53	2.69	1.82	3.37	1.13	1.64	.11	2.28	.75
Pine Butte WT												
9,10	1.37	.42	.61	.10	.25	-0.38	.28	-0.35	1.37	.68	.75	-0.44
8,9	2.86	1.72	4.33	3.43	4.40	3.50	4.82	3.92	2.56	1.76	1.29	-0.08
8,10	2.73	1.24	4.36	3.73	4.33	3.58	4.70	3.95	2.91	2.00	.90	-0.60
Sourdough WT												
28,32	.96	.09	2.29	1.88	2.41	2.00	2.20	1.79	-	-	.12	-0.55
28,46	1.68	.01	5.85	5.25	5.22	4.62	.71	-2.48	6.02	2.83	.26	-1.23
32,46	2.03	.63	8.08	7.65	7.51	7.08	2.42	-0.60	-	-	.07	-1.31

[a] AI = average distance between two animals' locations on same day/time.

[b] $DI = AI - (AAR_x + AAR_y)$, for animals X and Y.

Inferences of relatedness between marked animals were made from visual observations and distance calculations.

Valley Center: All mule deer were frequently seen to interact as a herd during winter. Marked fawns were seen with all radio-collared does at least once, although most observations were of mother-fawn pairs. The DI was highly negative, indicating great overlap, from winter through spring. Three of the does had low positive DI's during the other seasons. These deer probably formed three closely related social groups.

Penwell Bridge: The three radio-collared white-tailed does had separated home ranges even in winter and were observed with each other only once or twice. DI's were always positive, although small during spring. I concluded that these three does were not related, and belonged to separate social groups.

Sourdough: All white-tailed does were seen with each other in winter and spring, as supported by the DI's. I inferred that the 3 radio-collared does and 2 color-collared does were one social group of one older doe and her offspring from successive years.

Reese Creek: Two radio-collared white-tailed does were seen together often in the spring following

trapping, and the yearling offspring of one doe was seen with the other several times. The third white-tailed doe was seen with them once in winter. The other color-collared deer were seen with this third doe many times. Negative DIs in fall were due more to large home ranges than close spacing. The marked deer probably composed two social groups.

Pine Butte: Each radio-collared white-tailed doe occurred with another once, during late fall, winter or spring. Over eighty deer in large aggregations fed on the Pine Butte winter range, and occurrence together may have been by chance. Two does had very small, neighboring summer home ranges on the East Gallatin River, but were not seen together. The collared deer were probably from several social groups.

DISCUSSION

Movements and Home Ranges

Size

Home ranges of deer in forest habitats tend to be smaller than those of open areas. Summer AARs for mule deer vary from 0.36 to 1.16 in grasslands and from 0.33 to 0.62 in forests (Wood 1987). White-tailed deer summer CPs vary from 16 ha to 221 ha in forests and from 87 ha to 326 ha in agricultural-hardwoods (Herriges 1986). The indices of home range size for Gallatin Valley mule deer span the entire range observed in other studies; the white-tailed deer home range indices are among the smaller values, and comparable to those reported by Herriges (1986) for white-tailed deer in river bottom habitat.

Home ranges for summer and winter were smaller than those for spring or fall in both species. Summer movements coincided with birth of fawns. A doe moves within the vicinity of her fawn during its first two months of life, when its movements are limited (Ozoga et. al. 1982). Winter movements of both species typically were concentrated around a restricted patch of cover and expanded to either side. Ozoga and Gysel (1972) and Drolet (1976) found that deer restricted movements, even in low

snow years, to conserve energy requirements during cold temperatures.

Individual does of both species moved between winter and summer home ranges and surrounding areas during spring and fall. Exploratory movements may check the "readiness" of summer habitat (Baker 1978). A few does established fall and spring home ranges in areas between widely separated (up to 14km) winter and summer ranges, similar to those documented by Loft et. al. (1984). These spring/fall ranges were comparable in size to winter and summer ranges. They contrasted with one white-tailed doe's overnight move of 14km to her summer range in Bridger Canyon. Nyberg (1980) also observed mule deer to complete migrations overnight.

Patterns

Nearly all radio-collared does of both species occupied different home ranges between spring and summer. This coincided with a decrease in average social group size to single does, breakup of winter/spring feeding aggregations, and onset of fawning. Gallatin Valley does may move to discrete summer home ranges to isolate their fawns from other does, and to reduce competition for forage. Isolation is necessary for proper bond formation between doe and fawn (Ozoga et. al. 1982), and lactation requires greater amounts of high quality forage (Kline 1965, Hubert et. al. 1980).

Gallatin Valley does appeared to seek denser, apparently higher quality, woody cover in winter than in other seasons. GACs for all but 2 does changed from fall to winter. White-tailed deer on the Yellowstone River (Herriges 1986) and Columbian black-tailed (Odocoileus hemionus columbianus) does in residential areas (Happe 1983) used preferred cover patches year-round. Woody cover habitat types occurred in large tracts on the Yellowstone River, while they occurred in small isolated patches and strips in much of the Gallatin Valley. Vogel (1983) found that white-tailed deer in the valley concentrated along the larger rivers and streams, sources of densest cover, during the winter. The mule deer winter range was marked by numerous parallel branches of mixed brush and willow stands. Both species preferred both mixed brush and deciduous forest in winter. Deer seek denser cover during winter for its moderating effects upon wind and temperature (Ozoga and Gysel 1972, Drolet 1976, Youmans 1979).

Woody cover habitat types were the least available on the study area. An area that supported large numbers of deer in winter and spring could probably accomodate only a few deer on fawning ranges. The four different home range patterns I observed represent deer dispersing to occupy most of the valley during summer, and sharing the best cover areas in winter.

Fidelity

Studies spanning three or more years (Robinette 1966, Nelson and Mech 1984, Schoen and Kirchhoff 1985, Tierson et. al. 1985, Wood 1987, Pac, pers. comm.) have reported high home range fidelity for white-tailed deer and mule deer. Ninety-five percent of adult mule deer in the Bridger Mountains, Montana showed fidelity to home ranges (Pac, pers. comm.). Robinette (1966) observed no changes in summer ranges of adult mule deer does. Wood (1987) observed high home range fidelity in a prairie mule deer population, but low fidelity in a prairie white-tailed deer population.

Gallatin Valley deer showed high fidelity to a general area, but frequent changes over short distances (0.8 - 1.6 km) in seasonal ranges between years. Schoen and Kirchhoff (1985) found that Sitka black-tailed (Odocoileus hemionus sitkensis) deer's consecutive summer ranges partially overlapped, but the GACs were 0.5 km apart. White-tailed deer in South Dakota had summer ranges composed of a number of subareas, used when needed; their winter ranges were restricted portions of their yearly ranges (Sparrowe and Springer 1970). Nyberg (1980) observed subseasonal ranges in mule deer in the Bridger Mountains, Montana. These could be interpreted as changes in habitat use.

I believe short-distance changes between years in Gallatin Valley deer home ranges were responses, in part,

to changing habitat availability, caused by crop rotation. Deer preferred alfalfa and avoided wheat fields during summer. Alfalfa must be irrigated in the valley, and every year after planting it becomes less vigorous, with a larger percentage of grass. After 4-5 years it is predominantly grass, and ranchers replant the field in barley or winter wheat, and replace small grains with alfalfa elsewhere. Therefore 20-25% of the alfalfa fields were being rotated each year. Because a summer home range incorporated only a few fields, a doe would have to shift her range with the change in crops every few years. Vogel (1983) observed white-tailed does at Reese Creek to alter their spring ranges in response to winter wheat field rotation. Thirty percent of the doe summer ranges changed during 3-1/2 years of observations, an average of one change every three years per doe.

Yearling movements may result in establishment of a "familiar area" (Baker 1978), from which an adult doe selects her changing yearly range. Yearling does often moved to other areas of the Gallatin Valley, then as adults established home ranges near the area at which they were trapped. They briefly visited these other areas in subsequent springs. Does trapped on the same site as yearlings had separate winter ranges as adults. Winter conditions at Sourdough may have become unfavorable due to subdivisions, prompting previous year-round resident does

to winter at Pine Butte, which they had visited as yearlings. Adult does may make occasional long-distance visits to other areas to maintain familiarity with them.

Habitat Use

The Valley Center mule deer herd is unusual in its year-round occupancy of agricultural lands, although mule deer frequently use alfalfa during late summer and winter (Egan 1957, Martinka 1968, Kamps 1969, Dusek 1975, Wood 1987). A mule deer population that used agricultural croplands year-round on the Missouri River Breaks preferred barley and avoided spring wheat (Ball, pers. comm.). Black-tailed deer in residential areas in Oregon fed in lawns and pastures year-round (Happe 1983).

Habitat preferences of Penwell Bridge white-tailed deer were similar to those in other studies. Murphy et. al. (1985) reported that white-tailed deer used more types of crops during spring and fall than in summer. Compton (1986) and Herriges (1986) noted that white-tailed deer used little grain in summer, but preferred growing winter wheat and ungrazed summer fallow in winter. Vogel (1983) observed both mule deer and white-tailed deer using winter wheat, and Rongstad and Tester (1969) observed white-tailed deer using fall-planted rye during spring greenup.

A food habits study of Gallatin Valley deer (Vogel 1983) showed that diets were generalized in fall and winter and more specialized in summer. Mule deer used native

foods (forbs, browse and grass) during summer, and increased alfalfa and small grains in their fall, winter and spring diets. White-tailed deer followed a similar pattern, however they used less alfalfa and browse and more small grains and grass than mule deer. Kamp's (1969) food habits study showed that white-tailed deer increased use of wheat in winter, and mule deer used grass only in spring. Vogel (1983) noted that alfalfa and grains are easily digested and might yield reduced rumen volumes; but deer may be eating more native plants than crops in agricultural fields in summer.

Use of agricultural fields by deer may reflect the condition of the plants and the agricultural practices during each season. Fields that were not disturbed by spring planting (alfalfa, pasture and winter wheat) were used more in spring. Fields not disturbed by yearly plowing were preferred in summer. Plant dormancy may have reduced the value of alfalfa fields and prompted shifts to waste grain in harvested fields, and extended occupancy by cattle may have discouraged pasture use in fall and winter.

Mule deer and white-tailed deer used more barley than other small grains in summer, indicating a preference for it. Farmers complained of heavy mule deer depredations on barley at Valley Center; no like complaint for winter wheat was received in either area.

Social Organization

A single doe was was the most common social unit for Gallatin Valley deer. The smallest mean group size was 1.65 for white-tailed deer from June 1 to July 31, which agrees with other studies (1.7, Scanlon and Vaughan 1983, 1.54, Gavin et. al. 1984, and 1.25, Wood 1987). Single does were the most common social unit observed by Hirth (1977). The mean group size for mule deer during the same period was 2.27, in contrast with 1.4 for prairie mule deer (Wood 1987). I saw few mule deer groups during the summer (n=20); does are most secretive during fawning season (Hawkins and Klimstra 1970, Hirth 1977) and single does are less likely to be seen than groups (Michael 1965). Also, does without fawns will seek other does during the fawning season (Ozoga et. al. 1982); the second most common mule deer group size I observed was three does.

Mean group sizes for winter were larger in the Gallatin Valley than that reported for most other studies (white-tailed deer winter means: 3.4, Scanlon and Vaughan 1983, 2.5, Gavin et. al. 1984, 6.5, Wood 1987; mule deer winter means: 10.0, Wood 1987), but the observed trend was the same. The observed group size was lowest during fawning season, and increased to peak levels in winter and spring.

I did not find good evidence for dispersal of female

fawns and yearling does in the valley. Observability of color-collared does depended on proximity to radio-collared does; unobserved does may have still occupied areas adjacent to the trapping sites. Two color-collared female mule deer fawns, known to be related to a radio-collared doe, were not seen in subsequent years. These may have dispersed. Landowners thought that the Valley Center mule deer population was increasing.

Many does using a winter range were probably maternally related, composing several generations. Yearling white-tailed does rejoined their mothers in late summer and fall and moved with them onto winter ranges. Related older white-tailed does occupied adjacent summer ranges and continued to use the same winter ranges. This was also reported by Robinette (1966), Hirth (1977), and Ozoga et. al. (1982). Tierson et. al. (1985) observed white-tailed deer groups to expand their winter ranges at the edges as the population grew.

Valley Center mule deer appeared to be isolated from other mule deer populations. During summers mule deer were observed in two other locations in the valley, at Penwell Bridge and on south Hyalite Creek, but winter distributions were confined to Valley Center. All other observations of mule deer were on the perimeter of the valley. If these two groups were already part of the Valley Center herd, then no mule deer populations existed to move into the area

should it die out. It might be replaced by white-tailed deer.

It seems likely that the presence of mule deer does, rather than habitat preferences, excluded white-tailed does from Valley Center. Although Penwell Bridge white-tailed deer appeared to prefer the deciduous forest type, white-tailed deer in other areas used mixed brush where deciduous forest was not plentiful, and the winter habitat uses of both species were similar. A few white-tailed deer were observed on the perimeter of Valley Center, and mule deer groups were at Penwell Bridge, during summer and fall, but the winter ranges appeared to be mutually exclusive.

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