The effect of fire on Merriams turkey brood habitat in southeastern Montana
by John Edward Gobeille

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

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Broods in unburned areas preferred ponderosa pine/chokecherry cover types early in the brood-rearing period and later moved to hardwood draws when poults became more mobile. Broods in burned areas used habitat types in proportion to availability, however broods during the early rearing period showed a preference for severely burned areas. No broods were found in logged areas. A woody understory interspersed with openings of herbaceous cover was important for young and older poults. Feeding areas were mainly within the hardwood draw-grassland ecotone and the pine/cherry-open meadow ecotone. Roost trees were large mature ponderosa pine and green ash trees (average DBH = 59.2 cm).

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MONTANA STATE UNIVERSITY
Bozeman, Montana

January 1992

APPROVAL

of a thesis submitted by

John E. Gobeille

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

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ACKNOWLEDGMENTS

I would like to express my sincere thanks to my advisor, Dr. R.L. Eng, for his guidance and assistance in preparing the manuscript; Drs. R.J. Mackie, H. Picton, and W.R. Gould, Montana State University, for critically reviewing the manuscript. I am especially grateful to Dr. John P. Weigand, Terry Lonner, and Neil Martin, Montana Department of Fish, Wildlife, and Parks, for their advice on the project and providing vehicles and field equipment. I would also like to thank Mark Sexton of the Sioux District, Custer National Forest, and the Rocky Mountain Forest and Range Experiment Station in Rapid City, S.D. for use of equipment. My thanks to W. Thompson who assisted in study design and collecting data. Special thanks to S.L. Hopkins for his friendship during the project. Special appreciation is due to the landowners of Ekalaka and Mill Iron, Montana for their hospitality and permission to access private land. Finally, I thank my father for his many years of support.

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ABSTRACT

Radio telemetry was used to analyze brood habitat of Merriam's turkey (Meleagris gallopavo merriami) in southeastern Montana after a major forest fire had occurred. Eighteen broods were monitored from hatching until September 30 in 1989 and 1990 with a total of 416 relocations. Average home range sizes of broods in burned and unburned areas were similar. Daily movements were greater in burned areas. Broods in unburned areas preferred ponderosa pine/chokecherry cover types early in the brood-rearing period and later moved to hardwood draws when poults became more mobile. Broods in burned areas used habitat types in proportion to availability, however broods during the early rearing period showed a preference for severely burned areas. No broods were found in logged areas. A woody understory interspersed with openings of herbaceous cover was important for young and older poults. Feeding areas were mainly within the hardwood draw-grassland ecotone and the pine/cherry-open meadow ecotone. Roost trees were large mature ponderosa pine and green ash trees (average DBH = 59.2 cm).

INTRODUCTION

Merriam's turkeys (Meleagris gallopavo merriami) originally occupied the southwestern ponderosa pine and oak forests of Arizona, New Mexico, west Texas, and southern Colorado. The bird was first described by Nelson (1900) as a subspecies of the eastern wild turkey (Meleagris gallopavo sylvestris). Unlike its eastern counterpart, Merriam's turkey is notable for its affinity for more open and rugged terrain and its close relationship with ponderosa pine (Pinus ponderosa) forests.

Based on the success of turkey introductions in other western states, Merriam's turkeys were introduced into Montana by the Montana Fish and Game Department in the Judith Mountains near Lewistown, and in the Long Pines near Ekalaka, in 1954 and 1955, respectively. Populations were soon established and became the sources for subsequent introductions throughout the state. An initial investigation by Rose (1956) detailed the success of the Long Pines population. Jonas (1966) studied the movements , general habitat use, population characteristics, and life history of Merriam's turkeys in the Long Pines.

The Long Pines turkey population grew rapidly and turkeys were introduced into the nearby Ekalaka Hills in

1958, although some birds from the Long Pines may also have emigrated to the Ekalaka Hills via connecting woody draws. Merriam's turkeys have since spread into the adjacent Little Missouri River and Box Elder Creek drainages, the Chalk Buttes to the southwest of the Ekalaka Hills, and the Sheep Mountains to the south of the Long Pines. Hunting seasons, both in the spring and fall, have been established in the Long Pines and Ekalaka Hills since the early 1960's and attract sportsmen from all over the United States.

Several aspects of turkey ecology in southeastern Montana, such as brood habitat, the influence of fire, and land use impacts from logging and grazing, have not been adequately investigated. On June 20, 1988 two lightning-induced wildfires quickly spread and joined together to form the Brewer Fire. When this fire was finally brought under control on June 29, 74 % of the Long Pines unit had been affected. The fire burned 20,923 hectares (ha) of public land and 2639 ha of private land. The Ekalaka Hills were not affected. The Brewer Fire situation established a unique opportunity to study the effects of a natural wildfire on turkey ecology in a fire-adapted forest-grassland ecosystem such as that found in southeastern Montana.

This study was undertaken to investigate brood habitat requirements of Merriam's turkeys and the influence of fire in the Long Pines and Ekalaka Hills. Field work was performed during February-August in 1989, and from April-

August in 1990. This is part of a larger study on the ecology and biology of Merriam's turkeys and the influence of logging and fire. The study was conducted through the Fish and Wildlife Program at Montana State University and was funded by Montana Department of Fish, Wildlife, and Parks, the U.S. Forest Service, and the National Wild Turkey Federation.

DESCRIPTION OF STUDY AREA

The Long Pines and the Ekalaka Hills are located in Carter County in extreme southeastern Montana (Figs. 1 and 2). They make up two units of the Sioux Ranger District on the Custer National Forest. Surrounding lands consist primarily of private rangelands and Bureau of Land Management lands. The predominant land use is livestock grazing but some small-grain farming also occurs. Logging operations are small and limited. Two mills, one in Ekalaka and one in nearby Camp Crook, S.D., have small and sporadic timber operations in the area.

The Ekalaka Hills and the Long Pines rise approximately 366 meters (m) from the surrounding prairie and are often described as "islands of forest in a sea of prairie". Although ponderosa pine is the predominant woody vegetation, there exists a mosaic of open park-like forests, various-sized grassland meadows, aspen (Populus tremuloides) groves, shrub communities, deciduous woody draws, canyons, and badlands scattered throughout both units. Parent rocks are tertiary clays and sandstone deposits which form soils with high alkali contents and low water penetration. Shallow, rocky soils are commonly found in steeper areas. Both units are highly dissected by drainageways but none contain

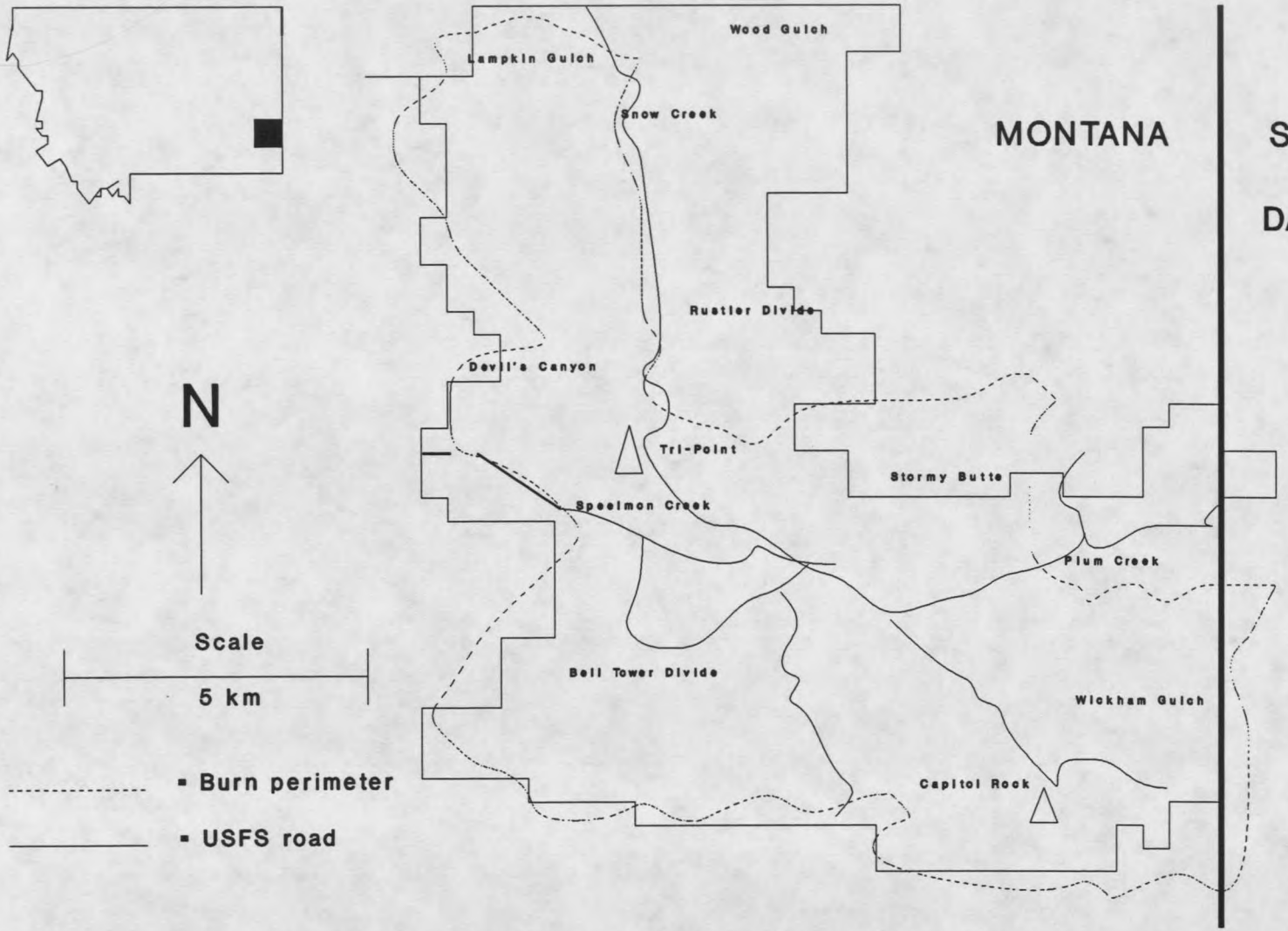

Figure 1. Long Pines unit of the Sioux District, Custer National Forest.

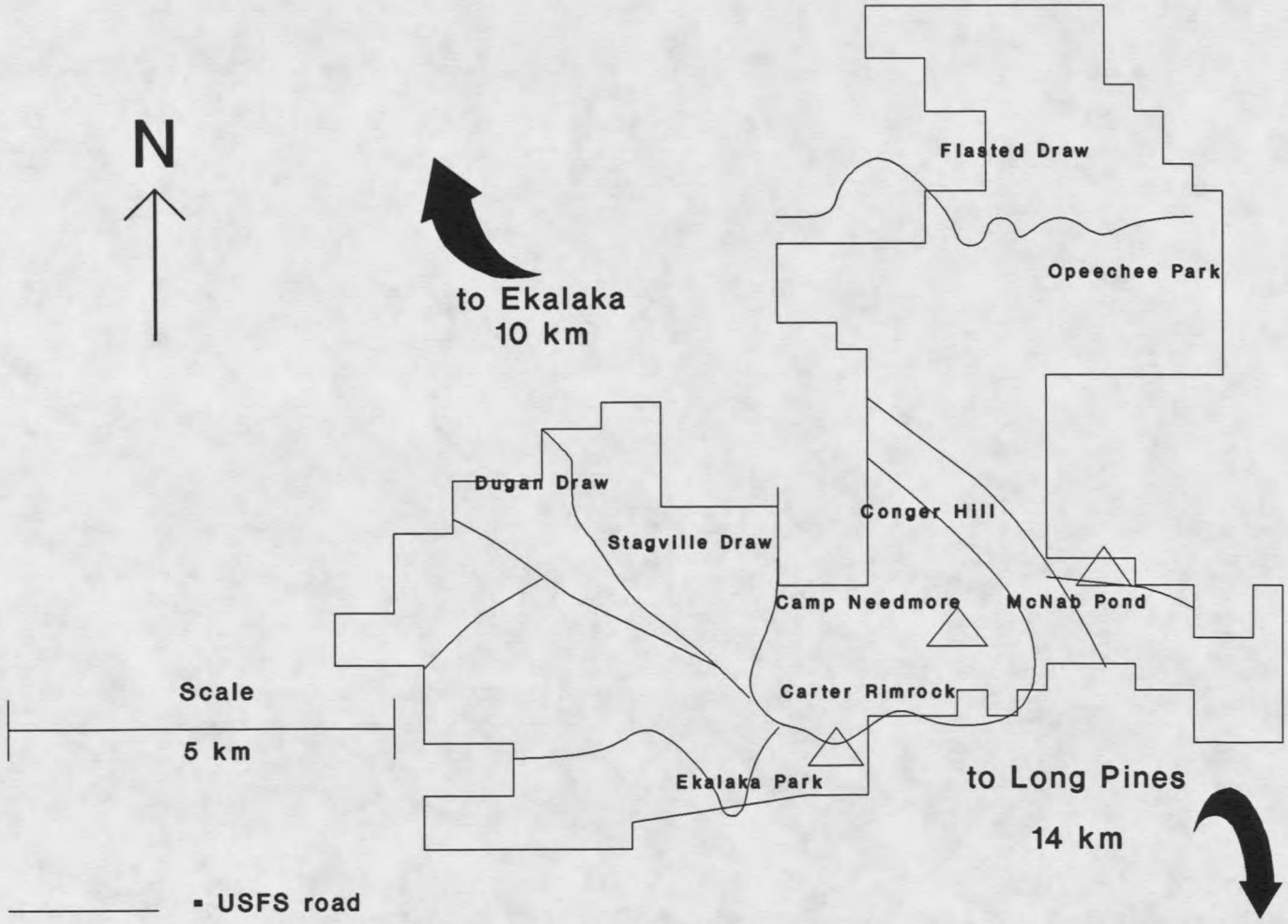

Figure 2. Ekalaka Hills unit of the Sioux District, Custer National Forest.

running water, on an average year, for their entire length. The area contains many springs, however, and the U.S. Forest Service and local landowners have cooperated to construct many small water impoundments and stock tanks for livestock.

The climate of the area is semi-arid. The mean annual temperature is 6.7 degrees centigrade (C.) with extremes of -41 C and 42 C. The average annual precipitation is 33.7 cm, one-half of which falls during the months of May, June, and July. During this study the annual precipitation was 40.8 cm in 1989 and 31.6 cm in 1990 (U.S. Forest Sevice).

Habitat Types

The following describes the existing vegetative conditions in the Ekalaka Hills and the pre-fire conditions in the Long Pines (Table 1). Forest and shrub habitat types are adapted from Hansen and Hoffman (1988). Grassland habitat types are adapted from Weaver and Albertson (1956). Scientific names of plant species follow the terminology by Scott and Wasser (1980).

The Pinus ponderosa/Prunus virginiana (PIPO/PRVI) habitat type (h.t.) is the major forest type in the Long Pines and Ekalaka Hills. It occurs on moist sites (north slopes, drainages, canyons) and typically consists of mature ponderosa pine forests with at least 40% canopy closure and a chokecherry dominated understory.

Table 1. Vegetation conditions for Long Pines prior to Brewer Fire, June 20,1988. (From Timber Stand Management System, Sioux Ranger District, Custer National Forest).

Vegetation/Strata	Hectares	% of Area
Seedling-Sapling	153	0.6
Poletimber	271	1.0
Sawtimber-Low Stocking	3,050	11.5
Sawtimber-Mod Stocking	7,260	27.3
Sawtimber-High Stocking	2,447	9.2
Two-storied-Low Stocking	631	2.4
Two-storied- Mod Stocking	766	2.9
Two-storied-High Stocking	218	0.8
Aspen	115	0.4
Juniper	21	0.1
Mixed/Other	306	1.2
Water	2	0.01
Scoria/Sandstone	1,040	3.9
Dry Grasslands	9,947	37.3
Wet Grasslands	360	1.4
Total	26,587	100

Associated understory species include green needlegrass (Stipa viridula), needle-and-thread (Stipa comata), Kentucky bluegrass (Poa pratensis), northern bedstraw (Galium boreale), Oregon grape (Berberis repens), Louisiana sagewort (Artemesia ludoviciana), and rose (Rosa spp).

A second major forest type is the Pinus ponderosa/Agropyron spicatum (PIPO/AGSP) h.t. which occurs on dry sites (south and west slopes, exposed ridges). This type has canopy closures of less than 40 %. Associated understory species include fragrant sumac (Rhus aromatica), common snowberry (Symphoricarpos albus), western coneflower (Rudbeckia occidentalis), milkvetch (Astragalus spp.), and

prairie thermopsis (Thermopsis rhombifolia). This type is especially common in the north half of the Long Pines where pine forests are very open and occur as small scattered patches.

The Fraxinus pennsylvanica/Prunus virginiana (FRPE/PRVI) h.t. occurs as wooded draws within the upland pine forest and extending into the adjacent prairie. Quaking aspen appears as a codominant in upland areas while boxelder (Acer negundo) is a codominant in prairie draws. Large ponderosa pine may occur sporadically within this type. Plains cottonwood (Populus sargentii) appears in larger drainages or as solitary trees further out on the prairie. Understory species may be relatively diverse and appear in several strata beneath the overstory. The diverse flora include various grasses and forbs, and most conspicuously, woody shrubs such as chokecherry, silver buffaloberry (Shepherdia argentea), hawthorns (Crataegus spp.), serviceberry (Amelanchier alnifolia), and American plum (Prunus americana). Most of these riparian areas do not reach climax condition due to persistent livestock damage and human disturbances.

The main shrub habitat type is Symphoricarpus albus/Monarda fistulosa (SYAL/MOFI) and appears as pure stands in many areas. This type is commonly found as large clumps (15-60 m) in wide, shallow drainages within grassland meadows. Pure stands of buffaloberry and of wild plum are

very rare. Pure hawthorn stands, however, are locally common along springs.

The dominant grassland habitat type in the study area is the Agropyron smithii/Stipa viridula (AGSM/STVI) habitat type. During my study, needle-and-thread (Stipa comata) replaced green needlegrass in importance within this type. Jonas (1966) recognized threadleaf sedge (Carex filifolia) and blue grama (Bouteloua gracilis) as being more important components of this h.t. than green needlegrass during his study. Several vegetation strata are associated with the AGSM/STVI h.t. In the duff layer (0-5 cm.) is found phlox (Phlox spp.), field pussytoes (Antennaria neglecta), clubmosses (Selaginella spp.), and lichens. The middle stratum (5-10 cm.) consists of blue grama, sedges, field pennycress (Thlaspi arvense), and yarrow (Achillea millifolium). The upper layer (> 10 cm.) consisted of white prairie aster (Aster falcatus), yarrow, penstemon (Penstemon spp.), lambstongue groundsel (Senecio integerrimus), and silvery lupine (Lupinus argenteus).

Other important grassland habitat types include (Andropogon scoparius/Carex filifolia) (ANSC/CAFI) and (Juniperus scopulorum/Agropyron spicatum) (JUSC/AGSP). The former occurs in small pockets, the latter on the foothills of the Ekalaka Hills and Long Pines.

Disturbed areas such as roadsides and overgrazed areas consist of a multitude of invading species such as bindweed

(Convolvulus arvensis), cheatgrass (Bromus tectorum), wild licorice (Glycyrrhiza lepidota), Rocky mountain beeplant (Cleome serrulata), curlycup gumweed (Grindelia squarrosa), yellow sweetclover (Melilotus officinalis), annual sunflower (Helianthus annuus), mullein (Verbascum thapsus), skeletonplant (Lygodesmia juncea), thistle (Cirsium spp.), Russian thistle (Salsola kali), houndstongue (Cynoglossum officinale), and pricklypear (Opuntia polyacantha). Pricklypear was especially prevalent in severely overgrazed areas.

Post-Fire Conditions in the Long Pines

The Brewer Fire significantly changed stand distribution and plant communities over much of the Long Pines. A mosaic of burn intensities occurred. Severely burned areas totaled 34% of the burn, moderately burned areas covered 28%, and lightly burned areas accounted for 38%. The latter did not include severely burned pockets within the low intensity burns. Stands with moderate to high stocking levels and fertile forest soils experienced high fire mortality while those stands with low stocking on poorer soils escaped severe damage (Resource Opportunity Analysis 1988). In stands where understories of chokecherry and aspen existed, and where woody draws were burned, sprouting of these species was evident in 1989 and 1990.

In many severely burned areas several plants have invaded including dock (Rumex spp.), spreading dogbane (Apocynum androsaemifolium), horseweed (Conyza canadensis), and woolly plantain (Plantago patagonica). In many areas, these species and a few others provided the only plant cover.

Grassland communities in the Long Pines are well adapted to fire and sustained little permanent damage, although the ecological status of some communities may have been altered. Lush re-growth was evident in many areas in the spring of 1989 due to an increase in nutrients from ash. In open grasslands (less than 10% tree cover), 950 ha (7.5%) experienced a high intensity burn, 1940 ha (15%) were burned at moderate intensity, 4170 ha (33%) were burned at a low intensity, and 5545 ha (44%) acres were unburned.

METHODS AND MATERIALS

Capture and Monitoring

Seven turkey hens were captured during December 1988 through March 1989 and 11 hens were captured from December 1989 through March 1990. The trap used was a walk-in drop gate trap. A commercial poultry feed was spread inside and around the trap near known feeding areas. Once conditioned to the trap the birds would move inside to feed and the drop gate could be tripped by the observer from a vehicle a short distance away.

After capture, turkey hens were placed in burlap sacks and weighed to the nearest 0.1 kg. Age determination was based on 2 criteria: examination of the outer 2 primaries (Amman 1944) and by using weight as an indication between juveniles and adults (Larson and Taber 1980). All hens were marked with a Montana Department of Fish, Wildlife, and Parks leg band for identification.

All 18 hens were equipped with 94 gram radio-transmitters (AVM Instrument Co., Livermore, CA.) with a backpack harness that extended around the base of each wing; the radio was positioned on the bird's back. Radio-tagged

turkeys were relocated using a Telonics (Mesa, AZ.) TR-2 portable receiver and a 2-element hand-held Yagi antennae.

Brood relocations were determined by triangulation. This consisted of a minimum of 3 bearings, each separated by at least 20 degrees. Relocations were plotted on 1:24,000 U.S. Geological Survey topographical maps of the study area. Most broods were relocated at least 3 times per week or every alternate day. Each telemetry fix was categorized by brood activity based upon time period: sunrise to 1000 hours = feeding, 1001 hours to 1400 hours = loafing, 1401 to dusk = feeding, dusk to sunrise = roosting. An effort was made to rotate each relocation to incorporate each brood activity at least once a week.

Hens with broods were observed from a safe distance by walking in to the brood vicinity and remaining concealed so as not to haze the birds. Visual sightings such as these were limited by constraints of time, weather, topography, and restricted access to private property. Visual sightings from roads provided additional relocations.

Relocation error was determined by placing radios at known locations and relocating them several times a week (Springer 1979). Relocation error was influenced by topography, distance of the radio from the observer, vegetation density, and bird movement. Relocations suspected of containing an unacceptable amount of error (> 5 ha.) were discarded.

Home Range Analysis

Home range analysis included overall home range size and stratified home range areas based on the age of the poults. I chose ≤ 15 days (young broods), and > 15 days (older broods) as a criterion in analyzing home range and habitat use. This is based on the age at which most gallinaceous birds are capable of minimal flight, prior to which they are most vulnerable to harsh weather and predation (Williams 1981). Relocations were analyzed using the TELDAY home range system (Lonner and Burkhalter 1988) which calculated home range size based upon the convex polygon method (Mohr 1947). TELDAY also calculated rate of movement (km/day), distance (km) travelled between successive relocations, and the average daily movement (km).

Shifts in home range were determined by measuring the distance between geographical activity centers (GAC). TELDAY calculates the GAC as the center of a circle which encompasses 68% of the relocations. Mann-Whitney U tests were used to determine differences in home range sizes between age classes, broods inhabiting burned areas vs. non-burned areas, and brood home range sizes in the Ekalaka Hills vs. those in the Long Pines.

Habitat Sampling

Feeding Sites

All vegetation sampling of feeding habitat used by broods was based on visual observations. Sampling employed a 50 m transect, and was based on the method by Daubenmire (1959). Transects were placed with the axis in the direction of travel by the brood. Plots (0.1 m^2) were placed every 2 m along the transect. Plant species and percent coverage by each species within all plots was recorded. Frequency was determined by the percentage of plots along the transect in which the species occurred. Horizontal coverage within plots and frequency of occurrence were summed for each species to give species importance values. Species were then grouped by class such as grass, shrub, forb, litter, or bare ground and averaged to give mean percent coverage values.

Vegetation density was recorded after Robel et al. (1970). A pole marked off in decimeters (dm) was placed at the center of each Daubenmire frame and observed from a distance of 1 meter away and 1 meter above ground in each of the 4 cardinal directions. The lowest visible dm mark on the pole was then recorded and the 4 readings averaged to give 1 reading. These readings from each of the 25 plots were averaged to give an average site density value.

Random sites were chosen and measured using the same methodology for statistical comparison.

Roosting Sites

A 10 x 10 m quadrat was used to analyze vegetation at roost sites for young broods. A 25 x 25 m quadrat was used for older broods in order to account for the larger area used when broods joined together.

All tree species with a diameter at breast height (dbh) > 1 cm were measured at sites used by young broods, and all tree species > 4.5 cm (dbh) were measured at roost sites for older broods. Height of trees (m) and the height of the first live limb (m) were measured with an Abney level. Aspect and slope were determined by compass. Distance to the nearest opening and to the nearest water source was recorded from topographic maps or by pacing in the field (Boeker and Scott 1968). Canopy closure was determined using an ocular tube with readings taken from plot center and corners for young broods. These were averaged to give a site value. For older broods, ocular tube readings were taken at the base of each roost tree. Robel pole readings were taken at each plot center and corner and averaged to give one reading. These readings were compared with similar data recorded for random sites using the same methodology.

Data Analysis

Data were analyzed using the MSUSTAT program (Lund 1991). Home ranges were overlayed on the most recent U.S. Forest Service forest stand inventory maps and typed

according to the 5 major habitat types on the study area: PIPO/PRVI, PIPO/AGSP, FRPE/PRVI, AGSM/STVI, and SYAL/MOFI. A planimeter was used to measure the areas of the habitat types within each brood home range.

Stand inventory maps were also used to analyze variables such as timber class (seedling-sapling, pole, or mature), timber stocking (low, medium, or high) as a measure of relative stand density, understory (herbaceous or woody), and burn severity (low, moderate, severe, or unburned).

Use-availability analyses were performed with chi-square goodness of fit tests (Neu et al. 1974). Habitat use in proportion to availability was determined by using the Bonferroni z-statistic and the methods of Byers et al. (1984). Habitat availability was determined by the average amount (ha) of each habitat type within the home range (Bidwell et al.1989).

The natural logarithm of the Shannon index (Hill 1973, Peet 1974, Pielou 1977) was used to test for differences in species diversity between observed and random sites. Mann-Whitney tests were used to analyze differences between canopy coverage, height and diameter of roost trees, distance to cover, distance to water, and distance to nearest opening. All tests were computed as two-tailed and with a significance level of $P < 0.05$ with +/- one standard deviation unless otherwise specified.

RESULTS

Relocations

A total of 416 relocations was obtained from May-September 1989 and May-September 1990. Several brood hens were lost during the study (appendix Table 17). In 1989, 1 hen was killed by an avian predator and 1 was taken by a hunter in the early fall. In 1990, 3 brood hens were lost to mammalian predators, 2 during mid-season and 1 in September.

Precipitation data indicated a slightly wetter spring in 1989 with a + 2.06 cm departure from normal, while in 1990 a - 4.7 cm departure was noted (Table 2).

Table 2. Monthly precipitation totals (cm) and departures from the normal mean during April-August 1989 and 1990 for Ekalaka, Montana. *

Month	Normal Mean	1989		1990	
		Pcpt.	Dep.	Pcpt.	Dep.
April	2.28	7.14	+4.85	5.13	+2.84
May	5.82	4.67	-1.14	3.02	-2.79
June	6.27	5.79	-0.48	6.81	+0.53
July	4.42	5.13	+0.71	1.37	-3.05
August	4.19	2.31	-1.88	1.95	-2.23

* Data from U.S. Forest Service weather records.

Home Ranges

Home range sizes varied with age of the poults and among different brood flocks (Appendix Table 18). For young broods, the average home range size was 16.3 ha (n=5, SD=16.3) in burned areas and 14.5 ha (n=9, SD=14.5) in unburned areas. For older broods, the average home range size was 139.5 ha (n=6, SD=99.1) in burned areas and 123 ha (n=12, SD=127.6) in unburned areas. There was no significant difference between home range sizes of broods in burned areas and those in unburned areas (Table 3).

Table 3. Comparison of home range sizes (ha) of young broods and older broods between burned and unburned areas in the Long Pines and Ekalaka Hills, May-September 1989 and 1990.

Age Category	Burned areas	Unburned areas	p*
≤ 15 days old	**16.3** (n=5) (SD=16.3)	**14.5** (n=9) (SD=14.5)	.689
> 15 days old	**139.5** (n=6) (SD=99.1)	**123.8** (n=12) (SD=127.6)	.607

* Computed with Mann-Whitney U-tests.

Home range sizes were typically small for young broods (range = 2.0 - 26.6 ha.). It was obvious that some broods were much more nomadic than others due to the wide range in home ranges once the poults reached 15 days in age (range = 21.9 - 444.2 ha). This difference between nomadic and sedentary brood flocks was not related to age of the hen.

Only 3 radioed hens raised broods in both 1989 and 1990. All 3 set up home ranges in the same areas both years (Figs. 3, 4, 5). All 3 moved from their wintering grounds to these areas to nest and raise their broods on both years. Home range sizes were smaller in 1989 for all 3 hens. Although based on a small sample size, there appears to be a rather high degree of fidelity to brood-rearing areas by turkeys in the Long Pines and Ekalaka Hills.

Daily Movement

Broods in burned areas had larger daily movements than broods in unburned areas (Table 4). The average daily movement by broods in burned areas was 0.72 km/day compared to 0.44 km/day for broods in unburned areas. This should be regarded as an index of relative activity in burned versus unburned areas and not as an indicator of the amount of area covered in a 24 hour period.

Home Range Shifts

Sixty-nine percent of hens with known nest locations established initial brood home ranges at least 295 meters from the nest site. On average, adult hens established the brood home range closer (average = 820 m, SD=500) to the

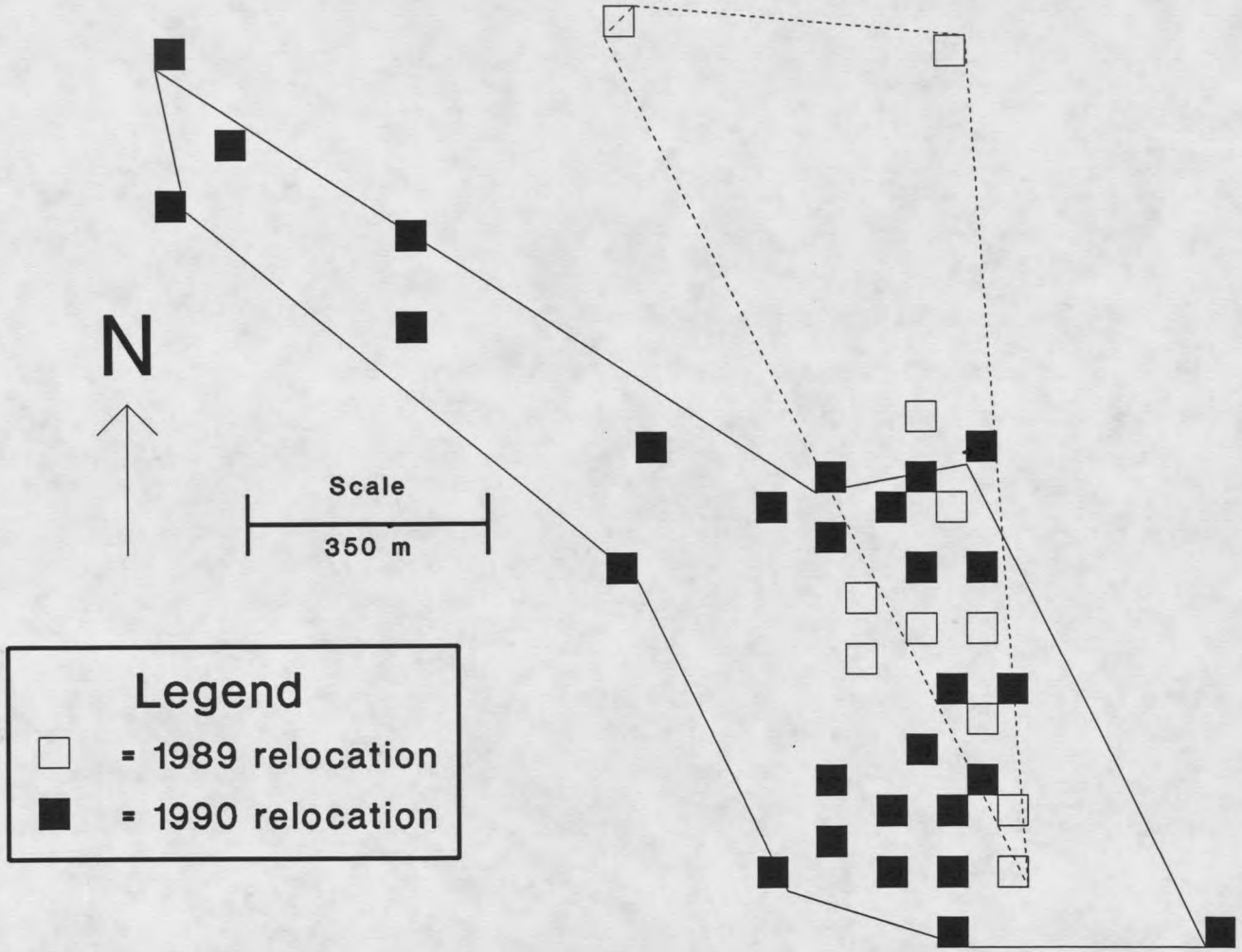

Figure 3. Home ranges of brood hen #0953 in 1989 and 1990 in the Ekalaka Hills.

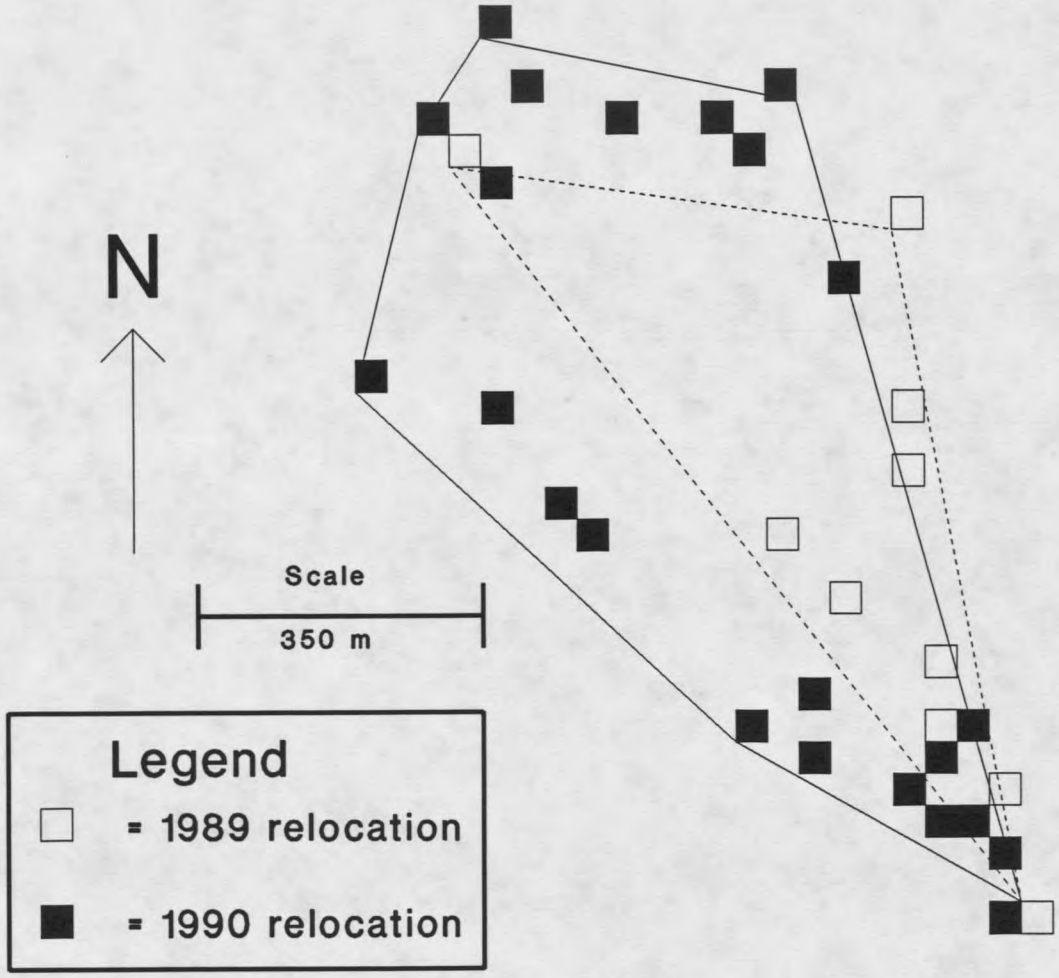

Figure 4. Home ranges of brood hen #1297 in 1989 and 1990 in the Ekalaka Hills.

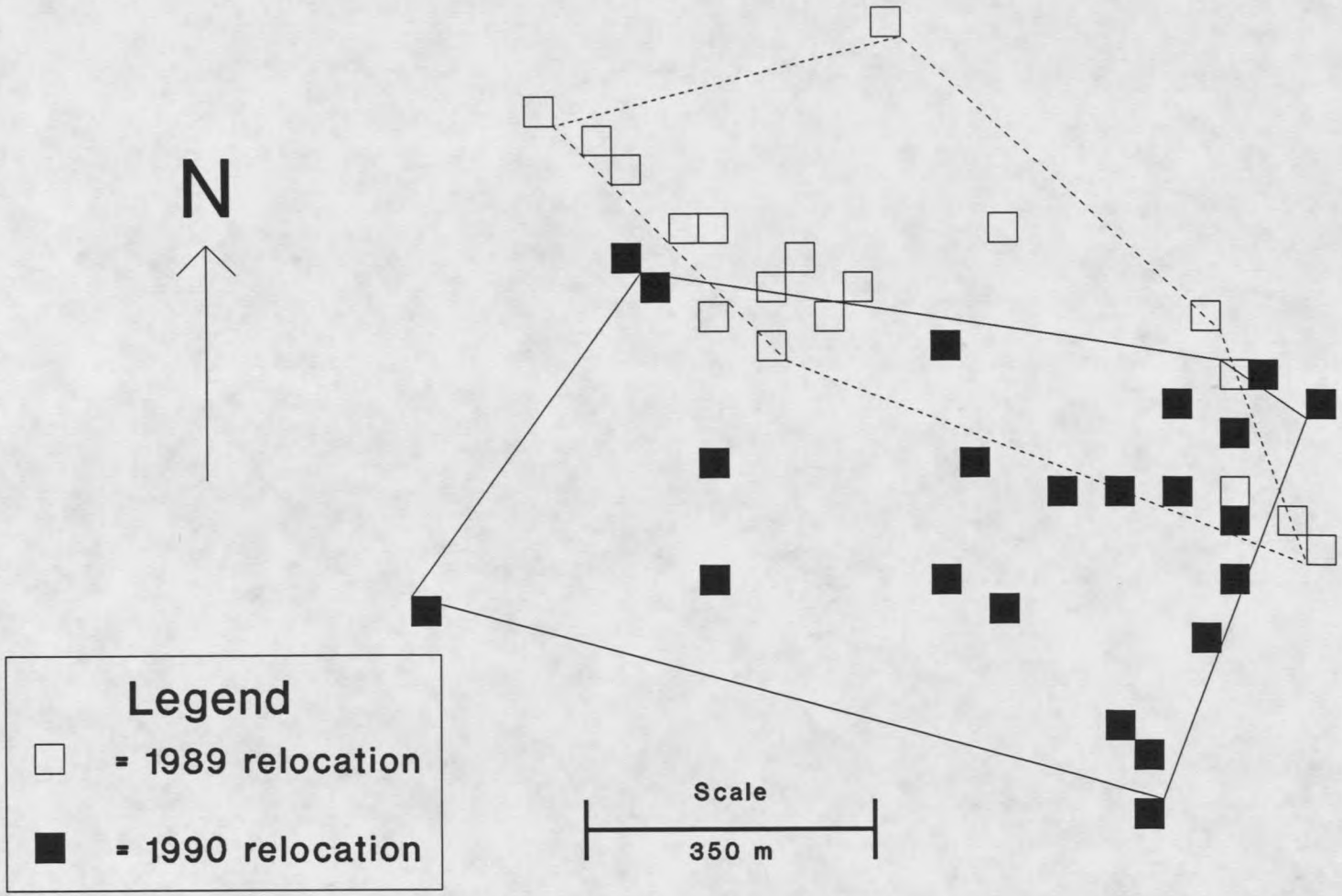

Figure 5. Home ranges of brood hen #0841 in 1989 and 1990 in the Long Pines.

Table 4. Mean daily movements (km/day) of broods in burned and unburned areas, May-September 1989 and 1990.

Brood I.D. #	Burned	Unburned
0841	0.694	
1270	0.470	
0700	1.000	
1843	0.454	
0161	0.966	
1177		0.503
1047		0.179
1297		0.459
0953		0.459
1588		0.590
Average	0.717	0.438
SD	0.261	0.154

nest site than juvenile hens (1373 m, SD=830). Seventy-eight percent of hens exhibited a home range shift when poults reached two weeks of age. Again, adult hens shifted a lesser distance than juvenile hens (Table 5).

Table 5. Comparison of mean distance (m) travelled by brood hens from nest site to first GAC and subsequent GAC.

	Nest to GAC #1				GAC #1 to GAC #2			
Age	Mean	SD	N	p*	Mean	SD	N	p
Juvenile	1373	830	6	.401	1821	2590	6	.747
Adult	820	500	14		928	712	14	

* Computed with Mann-Whitney U-test.

Macrohabitat Use

Figures 6 and 7 display observed relative to expected use of habitat types by broods irrespective of age and burn conditions in the Long Pines. Young broods occupied home ranges wherein FRPE/PRVI occurred in greater proportion than generally available, and selected against large dry grasslands. Other types occurred in proportion to availability. Older broods also selected the FRPE/PRVI habitat type. All other types occurred in home ranges in lesser proportion than their availability.

Broods in Unburned Areas

Table 6 compares macrohabitat use by broods in unburned areas with relative availability of habitat in the Long Pines and Ekalala Hills. The FRPE/PRVI habitat type was used more than expected ($p = \leq .10$) by broods in both age categories, while AGSM/STVI was used less. PIPO/PRVI, PIPO/AGSM, and SYAL/MOFI types were used in proportion to availability by young broods. In the case of older broods, PIPO/PRVI and PIPO/AGSM types were used less than expected, while SYAL/MOFI was used in proportion to availability.

Young broods did not select for a particular type of timber stand size class, although 88% of the relocations in timbered areas (including FRPE/PRVI) were in pole (12.7cm - 22.6cm DBH) or mature (22.9cm - 35.3cm DBH) stands (Table 6). Older broods showed a strong preference for pole stands