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DISTRIBUTION, HABITAT SELECTION AND SURVIVAL OF TRANSPLANTED COLUMBIAN SHARP-TAILED GROUSE (*Tympanuchus phasianellus columbianus)* IN THE TOBACCO VALLEY, MONTANA

by

Michael Glen Cope

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

May 1992

APPROVAL

of a thesis submitted by

Michael Glen Cope

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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ABSTRACT

Distribution, habitat use and survival of transplanted Columbian sharp-tailed grouse in the Tobacco Plains, Montana were studied from April, 1990 to August, 1991. For transplant purposes, 12 grouse (5 female and 7 male) were trapped on dancing grounds near Douglas Lake, British Columbia, Canada during spring, 1990. In April, 1991, trapping of 4 female and 2 male grouse for transplant occurred on the Sand Creek Wildlife Management Area in southeast Idaho while 3 additional males were transplanted from Douglas Lake. Minimum annual survival of transplanted grouse in the Tobacco Plains is relatively high (47%). High survival is possibly due to 2 factors: 1) topography and habitat characteristics that discourage dispersal and 2) the presence of limited but relatively good habitat. Two of 18 radio-equipped grouse dispersed out of the study area, while 2 others survived in the area for over 590 days. A negative correlation in distances moved between consecutive relocations and length of survival was seen in radio-equipped grouse in this study. Data collected during this study showed the importance of habitat associated with the Dancing Prairie Preserve. Three of 5 females transplanted in 1990 attempted to nest after being released. Nesting and brood rearing sites were characterized by dense grass cover with an average effective height ≥ 20 cm. Shrub cover was associated only with brood rearing sites. Overall habitat use by transplanted Columbian Sharp-tailed grouse showed an apparent avoidance of agricultural land and use of other habitat types in proportion to their availability.

INTRODUCTION

The Columbian sharp-tailed grouse *(Tympanuchus phasianellus columbianus)* is one of six sub-species of sharp-tailed grouse found in the United States and Canada (Johnsgard 1973). They historically occupied Intermountain areas west of the continental divide from central British Columbia south through Montana and Washington with a southern range in California, Utah and Colorado. Their current distribution has been drastically reduced (Fig. 1). The sub-species has been extirpated from California and Oregon while only remnant populations exist in Colorado, Utah, Wyoming, Idaho, Washington and Montana (Miller and Graul 1980). British Columbia is the only remaining area in which 80% or more of its historical range is still occupied (Miller and Graul 1980). In 1989, the Columbian sharp-tailed grouse was listed as a "Category 2" species on the United States List of Threatened and Endangered Wildlife. This classification lists species which are becoming rarer, but for which conclusive information on vulnerability is not available (Federal Register 1989).

The Columbian sharp-tailed grouse once occupied grasslands in intermountain valleys throughout western Montana and were considered to be "fairly common". However, by 1969, they existed only in Lake, Powell, and Lincoln counties (Hand 1969). By 1980, the only documented population in the state was located in Lincoln county on the Tobacco Plains, in the Kootenai Valley (Bown 1980). Presently, this population remains, and additional sightings of a few birds have been made in the Blackfoot Valley near Helmsville (R. Green, Montana Department of Fish Wildlife and Parks [MDFWP] pers. commun.).

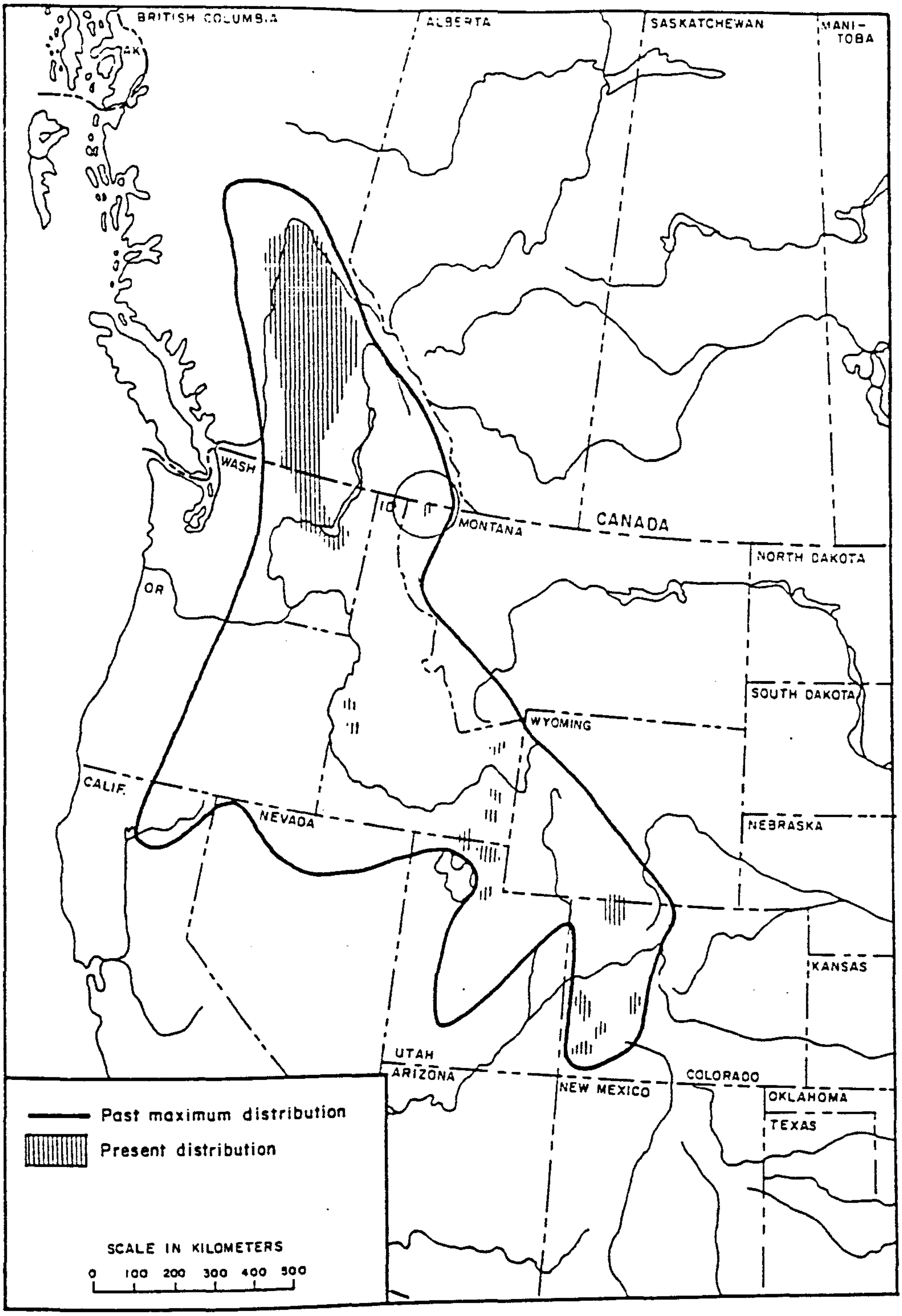


Figure 1. Past and present distribution of Columbian sharp-tailed grouse in North America (Modified from Miller and Graul, 1980). Circle denotes Tobacco Plains population.

In the past, 6 dancing grounds have been observed in the Kootenai Valley with a maximum of 4 active at one time in the early 1970's (Bown 1980). In 1980, Bown reported two active dancing grounds (A and B, Fig. 2). Thirteen and 10 males attended dancing ground A during 1979 and 1980, respectively, while 7 and 6 were seen on ground B during the same time periods (Bown 1980). Dancing ground B was abandoned in 1984, leaving only one known active dancing ground in the state (Manley 1989). Semi-yearly counts of displaying males on ground A from 1969 through 1987 showed a large decrease in numbers. By 1987, only 4 males were displaying, a drastic decrease in numbers from the high count of 33 in 1971 (Manley 1989).

In reaction to low numbers of grouse found in 1987, the Montana Department of Fish, Wildlife and Parks (MDFWP), and the Nature Conservancy of Montana, began an augmentation project. A population of Columbian sharp-tailed grouse near Kamloops, British Columbia was chosen to provide grouse for the transplant program. Fourteen and 18 male grouse were captured and transplanted onto the Tobacco Plains in 1987 and 1988, respectively. In 1989, trapping efforts yielded 9 females and 4 males. The maximum number of grouse counted on the dancing ground after the 1989 release was 14, which included 8 males from the 1988 release (M. Wood, MDFWP, pers. commun.).

The limited success of Columbian sharp-tailed grouse transplants into the valley led the MDFWP to conduct a winter survey and habitat evaluation in 1989 in order to identify possible limiting factors for the Tobacco Plains population. This resulted in locating isolated wintering habitat in the valley, as well as raising questions about limiting factors other than winter habitat (Manley 1989).

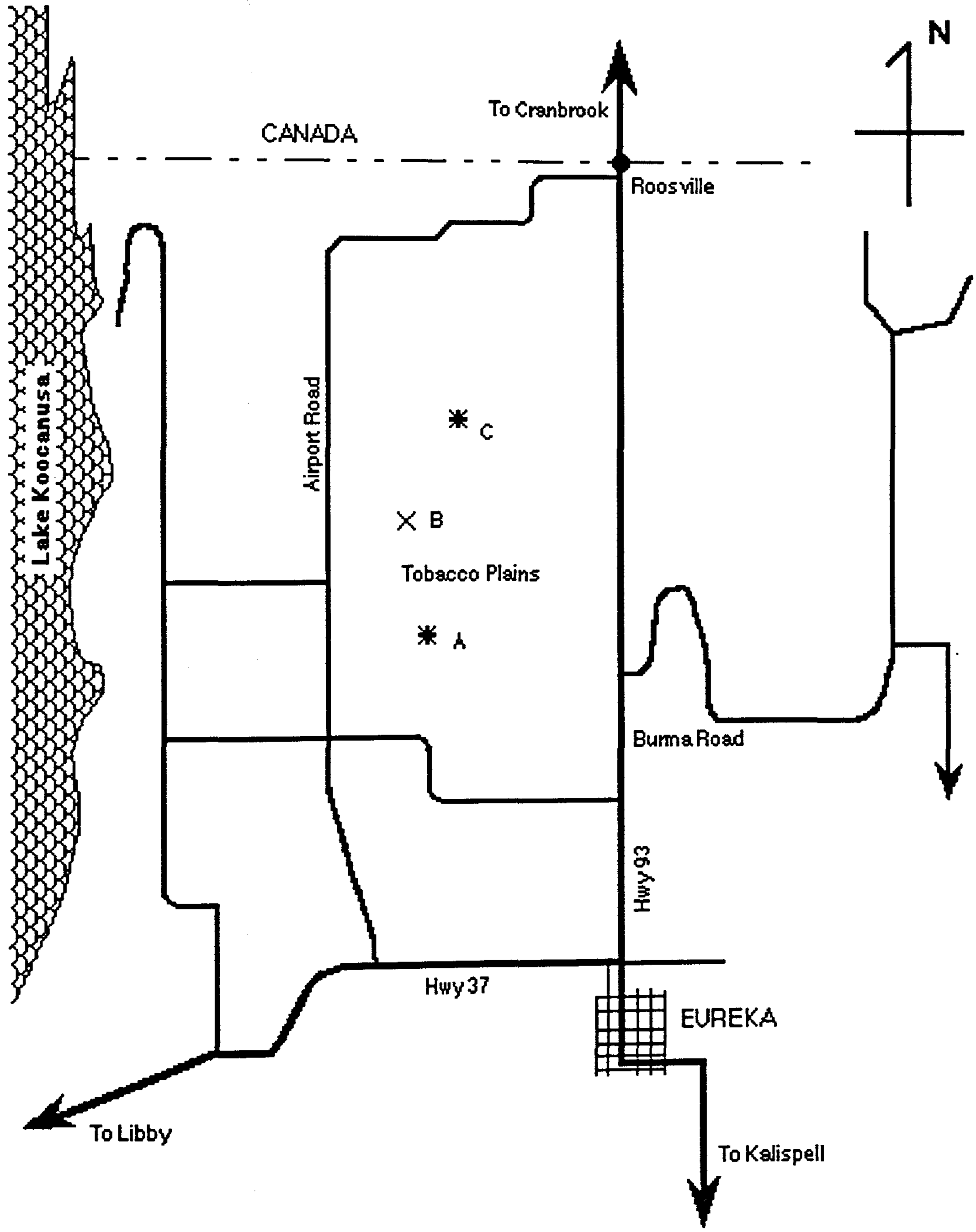


Figure 2. Diagram of the Tobacco Plains study area. Dancing grounds A and C (*) are currently active. Dancing ground B was abandoned in 1984.

This study was funded by Bonneville Power Inc., fulfilling mitigation responsibilities following the construction of Libby Dam on the Kootenai River in 1972 (Wood pers.comm.), and was initiated to gain knowledge of habitat use and requirements of sharp-tailed grouse in the Tobacco Valley. The project's primary goals were to collect information on availability and distribution of nesting and brood rearing habitat, evaluate general habitat utilization, and document survivorship of transplanted sharp-tailed grouse. These goals were to be met through examination of habitat selected by radio-equipped individuals that were transplanted into the valley. The information collected during the project will be incorporated into management decisions for the Tobacco Valley population.

STUDY AREA DESCRIPTION

The Tobacco Plains are a portion of the floor of the Tobacco Valley in northwestern Montana. The valley, part of the Rocky Mountain Trench, encompasses approximately 150 square kilometers and extends from the town of Eureka to the Canadian border (Fig. 2). It is bordered on the east by the Whitefish Range, the west by the Purcell Range, the south by the Salish Mountains, and is open to the north into Canada. Elevation in the valley ranges from 777 meters (2549 ft) to 1059 meters (3474 ft) with an approximate mean elevation of 807 meters (2648 ft) on the valley floor. Major land formations in the valley include several drumlins and kettle lakes formed by glaciation, Phillips Creek that traverses the northern third of the valley, and Lake Koocanusa that makes up the western border of the Tobacco Valley. Coffin et al. (1971) described the Tobacco Valley area by stating that "Except for the Tobacco Plains, the area is mountainous or hilly and is densely covered by pine, fir, spruce, and larch trees."

The Tobacco Plains are approximately 50 km^2 and are historical palouse prairie habitat (Adderhold 1990). Dominant grasses in the area are rough fescue (*Festuca scabrella*) and needle and thread (*Stipa comata*). Bluegrass (*Poa spp.*), Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), and junegrass (*Koelaria cristata*) also being present in significant densities (Lesica, 1986). Major forbs include tufted phlox (*Phlox caespitosa*), hairy golden-aster (*Chrysopsis villosa*), twin arnica (*Arneca sororia*), fringed sagewort (*Artemisia frigida*), and Spalding's catchfly (*Silene* *spaldingii*), an endangered forb found in relatively large numbers on the Tobacco Plains. Shrubs can be found in small pockets throughout the valley. The most common are snowberry (*Symphoricarpos occidentalis*), and pearhip rose (*Rosa woodsii*) (Lesica 1986). Riparian zones are not abundant in the valley (Manley 1989) but, when present, often contain the shrubs previously mentioned as well as trembling aspen (*Populus tremuloides*). Ponderosa pine (*Pinus ponderosa*) is common on the valley floor, mainly along the margins of the Tobacco Plains and in the bottoms of kettles found throughout the valley. As the foothills begin, the habitat becomes heavily forested, primarily by Douglas fir (*Pseudotsuga menziesii*). Although this study did not focus on identification of specific plant species, Table 7 (Appendix A) contains a complete list of the flora found in the area around dancing ground A (Lesica 1986).

Annual precipitation for the Tobacco Valley averaged 30 cm from 1960 through 1989. Highest precipitation occurs during the month of June while the lowest occurs during February. Mean annual temperature during the same time period is 14 C°. Maximum and minimum temperatures in July average 35 and 24 C°. Average maximum and minimum temperatures for January are -3 and -23 C° respectively. Annual snowfall averaged 120 cm from 1960 to 1989 with the most falling during December and January (Climatedata 1990).

The majority (87%) of the Tobacco Valley is privately owned. About 9% is owned by the state and 4% by either federal or county departments (Manley 1989). Land uses include grazing, which occurs mainly on the northern portion of the Tobacco Plains, and agriculture, mainly alfalfa and small grains. In 1987, the Nature Conservancy of Montana purchased 280 acres of land near the center of the Tobacco Plains. In 1991, 400 additional adjacent acres were purchased. This 680 acre parcel of land was designated the Dancing Prairie

Preserve in the summer of 1991. The Nature Conservancy hopes to use this land to help preserve the Tobacco Plains population of Columbian sharp-tailed grouse and the population of Spalding's catchfly (B. Hall, Montana Nature Conservancy, pers. commun.).

METHODS

Trapping of transplant birds took place from April 15 to May 8, 1990, near Douglas Lake, British Columbia. In April, 1991, a 16-day trapping effort was conducted on the Sand Creek Wildlife Management Area in Southeast Idaho. Three trapping methods were used. At Douglas Lake, both the "W" and "circle" systems were used (Toepfer et al. 1988) (Figures 3 and 4), while only the "W" system was used on the Sand Creek Wildlife Management Area. Summer trapping of radio-tagged males in British Columbia was attempted with limited success using a night "spotlighting" method (R. Eng, Montana State University pers. commun.). A light was used to "freeze" the bird while a second individual attempted to capture it using a long-handled net. In June, 1991, radioed grouse on the Tobacco Plains were recaptured using the spotlight method in order to replace radio packages. Background noise from a portable external speaker was found to be beneficial, allowing easier close maneuvering. Vehicles and dark, covered boxes were used for transportation of captured birds in both years. No bird was held longer than 3 days before being released. Food and water were made available to the birds during transport, although use was not noted.

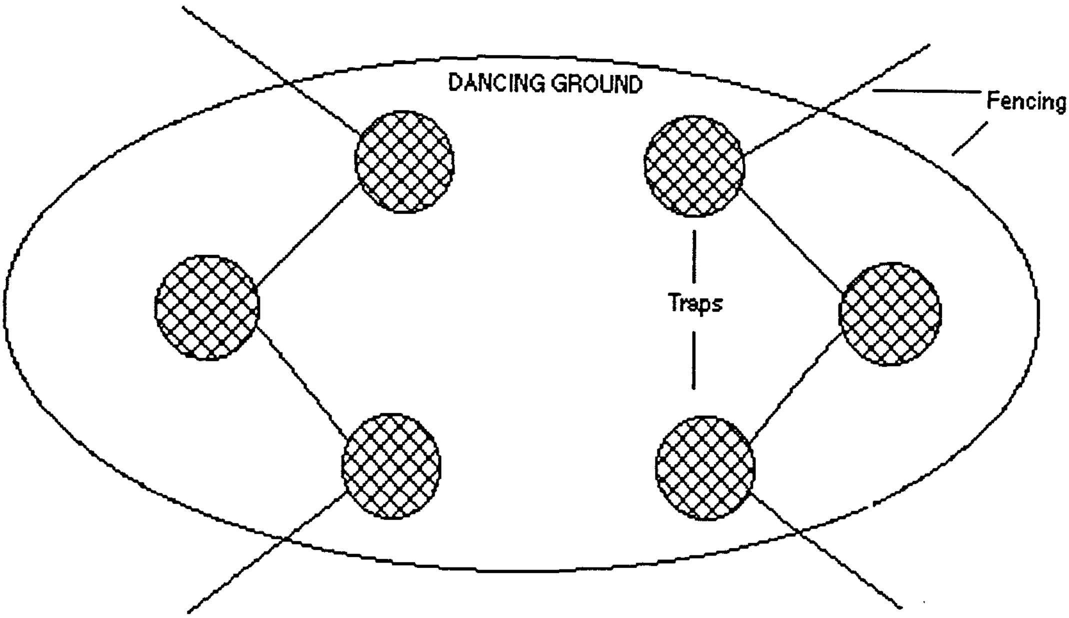


Figure 3. Diagram of the "W" wing trap system used to capture sharp-tailed grouse on display grounds during spring 1990 and 1991.

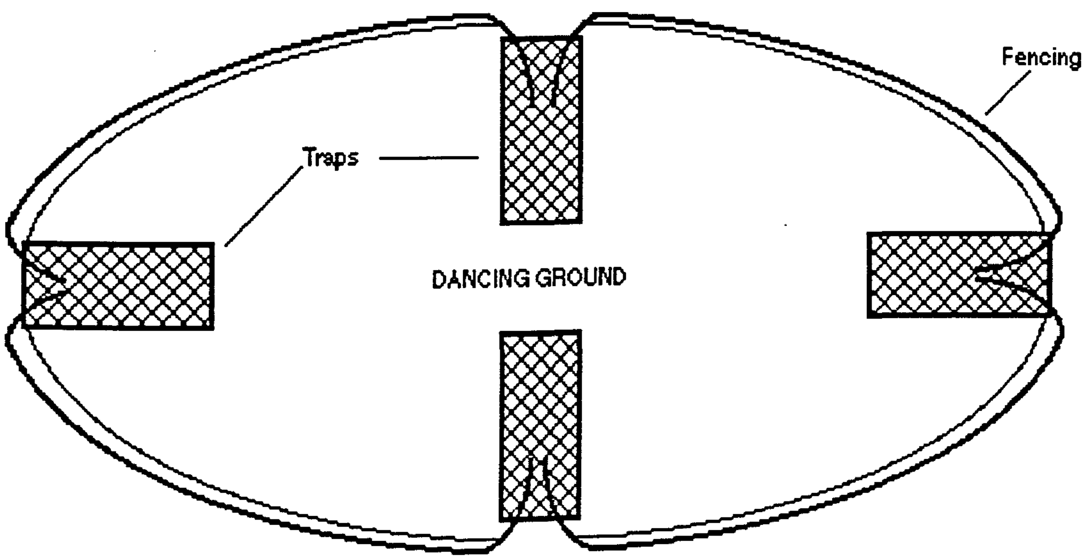


Figure 4. Diagram of the "circle" trapping system used to catch sharp-tailed grouse on the dancing ground during the spring mating season in British Columbia.

Before release, each grouse was banded with two color-coded, numbered leg bands and a necklace-style radio transmitter with a nickle-cadmium battery. The transmitter, made by Holohil Systems, Ltd., Ontario, Canada, weighed approximately 11 grams and had a 1-year life expectancy (M. Wood, MDFWP, pers. commun.).

Birds were released on dancing ground A during both morning and evening. Grouse were placed in release boxes equipped with individual cells and a sliding door that was operated from a blind on the edge of the dancing ground. The boxes were placed on the arena just before resident males arrived. A tape recording of sharp-tailed grouse lekking noises was played as birds were individually released.

Radio-equipped grouse were tracked using a two element "H" style antenna and a Telonics receiver working on a "loudest-signal method" (Springer 1979). Additional relocations were collected using two "H" style antennas mounted on the struts of a small aircraft, also employing the "loudest signal method." Ground relocations were collected using 2-point triangulation (White and Garrott 1990). Three-point triangulation was not used due to lack of prominent points within reasonable distances of one another. Grouse were located up to 4 times per day (morning - 0600 to 0930 hours, mid-day - 0930 to 1800, evening - 1800 to 2000, and night - 2000 to 0600 hours) from May 10 to September 20, 1990, and from June 15 to August 20, 1991 resulting in over 700 relocations. Hens suspected of nesting were flushed once to confirm their activity and to make an initial determination of clutch size and nest location. Nest sites were not visited again until daily relocations indicated that nesting activities had ceased. At that point, nest fate was determined, and vegetation analysis completed. Hens with broods were monitored by occasional visual sightings (approx. once every 2-3 weeks), as well as remote means in order to document brood success. Birds were not flushed unless relocation data showed little or no movement. Disturbance of transplanted birds was minimized to prevent disruptive behavior.

TELEM89, a computerized telemetry program designed by the Department of Fisheries and Wildlife Sciences at Virginia Ploytechnic Institute, was used to calculate Universal Transverse Mercator (UTM) coordinates of transmitter locations, Geographic Activity Center (GAC) coordinates, and distances of daily movements. Home ranges were determined using the 100% minimum-convex-polygon method (Mohr 1947, White and Garrott 1990). Home range size was evaluated for all grouse during two time periods (J. Toepfer, Little Hoop Comm. College, pers. commun.); an adjustment period in which the released bird moved long distances (over 1000 m) while exploring the Tobacco Plains and the post adjustment period, the time when daily movements became less than 1000 m (Appendix B). At this time, birds were considered to be resident. Home range and distance of daily movement were also evaluated for nesting hens and hens with broods during early (weeks 1 - 3), middle (weeks 4 - 7), and late (weeks 8 - 11) post-hatch periods in order to determine differences in movement as related to chick development.

Ground telemetry error was calculated by relocating radio transmitters that had been covertly placed in locations throughout the valley. Accuracy of relocations made from 200 to 800 meters was within 192 meters. In order to minimize bias, time spent triangulating test radios was approximately equal to the time spent triangulating radio-equipped grouse (Mills and Knowlton 1989).

Adjustment and post adjustment home ranges of males and females were compared using the Mann-Whitney-U method of comparison. Difference in home range size between adjustment and post adjustment periods within sexes was also calculated using the Wilcoxin's Signed-Rank Test (Daniel 1990). In addition, distances from individual GACs to dancing grounds, roads, developed areas, coniferous forest edge, riparian forest edge, agriculture, and from the release site were calculated. These values were statistically analyzed for differences between sexes using the Mann-Whitney-U method of comparison. In all statistical evaluations, a P-value of ≤ 0.10 was considered significant.

During 1990 and 1991, vegetation analyses of 6 plot types were completed in order to characterize the habitat used by radio-equipped individuals. These included nesting (actual nest location), brood rearing (areas used by hens with broods), day-use, roosting, dancing ground, and non-use sites. Non-use sites were selected randomly from sections of land in which no radio relocations had been taken. The center of each plot was determined by either the actual location from which a radio-equipped grouse was flushed or, in the case of the brood rearing and dancing ground sites, the center of an overall area. After determining plot center, four 10-meter transects were established in the 4 cardinal directions. Two photo plots were taken at plot center from a distance of 3 meters and a height of 1 meter using a 1 m^2 pegboard backdrop as a reference (Newell 1987). This was then used to evaluate maximum height and effective height (the point of total visual obstruction) for the location being used for hiding or nesting cover. Additionally, a 0.1-m^2 plot was evaluated (Daubenmire 1959) every meter for 10 meters along the established transects. Data were collected following Daubenmire (1959) and placed into three vegetation classes: grasses, forbs, and shrubs. Each plot type was evaluated for vegetative cover, composition of cover, and prominence of bare ground and compared using the Kruskal-Wallace non-parametric method of comparison (Daniel 1990) in order to evaluate differences.

A third aspect of habitat analysis involved examination of use versus availability using a chi-squared statistical method and Bonferroni confidence intervals ($P < 0.05$). This was facilitated by using the computer program HABUSE provided by the Montana Department of Fish, Wildlife and Parks. The area designated as available to each individual was determined using the distance from a bird's Geographic Activity Center (GAC) to the point furthest away. This distance was then used to establish a radius for construction of a circular area around the GAC. The assumption made here is that an individual will only range a certain distance in any direction from the GAC of its home range. This method is based on the premise that each individual grouse made an initial decision to reside in a particular section of the valley. After making that decision, habitat choices were made according to what was available within an area that was defined by each individual bird. The original decision may have also been important but was not considered to be available to the grouse after it settled into a home range.

Survivorship of transplanted grouse was analyzed for both 1990 and 1991. The number of days survived by individuals transplanted in 1990 were compared to the distance of movements made between consecutive relocations in the post adjustment period as well as home range size. This provided a comparison relating survivorship to movement. This aspect was important to consider due to the fact that poor habitat quality may result in increased movements and decreased survival. In addition, survival time of 1990 transplants was compared to that of 1991 transplants using the Mann-Whitney-U non-parametric analysis (Daniel 1990) in order to document preliminary evidence of differential survival.

RESULTS

Population Dynamics

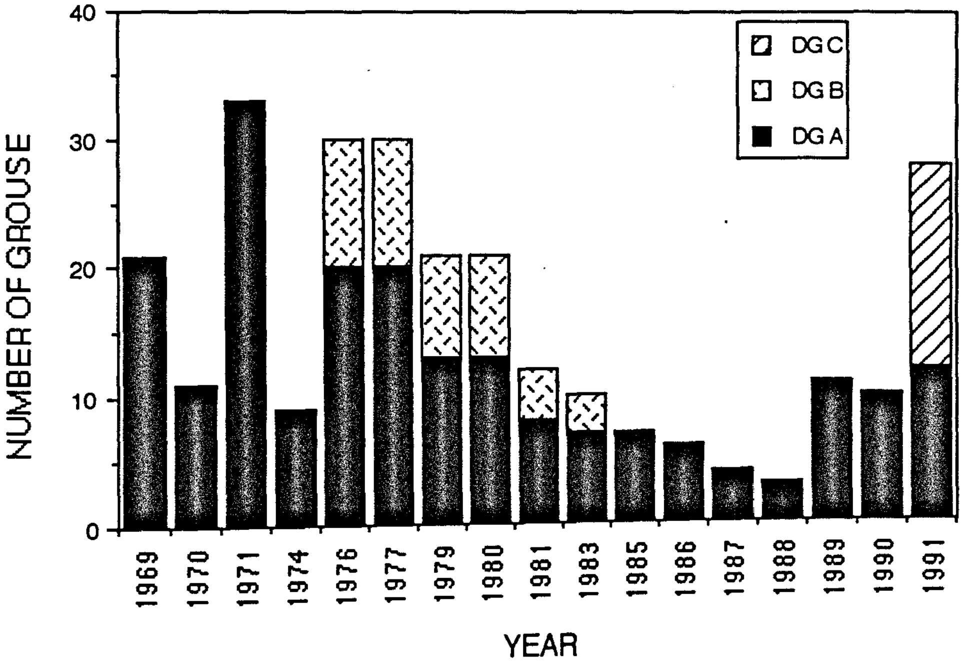
Historical Numbers and Transplant Efforts

A total of 26 Columbian sharp-tailed grouse were transplanted into the Tobacco Plains in 1990 and 1991 to supplement the existing population. The Tobacco Plains Columbian sharp-tailed grouse population had declined since 1971 to three dancing males in 1988 (Fig. 5). Through supplementation efforts in 1988 and 1989, the spring male population in 1990 was 8. In the spring of 1990, 12 male and 5 female grouse were added to the population. During the 1990 breeding season, 3 of 5 radio-equipped male sharp-tailed grouse were located on or near dancing ground A. In April, 1991, 6 additional grouse, 2 male and 4 female, were transplanted into the valley from the Sand Creek Wildlife Management Area in southeast Idaho. When 3 males brought in from British Columbia in 1991 are included, transplant efforts from 1987 through 1991 brought 70 Columbian sharp-tailed grouse into the valley. All of the birds transplanted from Idaho died within 40 days post release; therefore, the following analyses rely on data collected from grouse released in 1990 (See table 8 [Appendix A] for transplant details).

Spring dancing ground counts in 1991 showed marked improvement in the Tobacco Plains population. In April, 1991, an additional dancing ground was found (M. Wood, MDFWP, pers. commun.). It was located approximately

2.3 km north of dancing ground A (Ground C, Figure 2). A total of 12 males were documented on the new ground and an additional 10 were displaying on ground A. This was a near three-fold increase in the number of known dancing males from 1990.

Figure 5. Maximum number of grouse observed on 3 dancing grounds (DG A, DG B, and DG C) from 1969 to 1991. Modified from Manley, 1989.



Survival

Minimum yearly survival of male Columbian sharp-tailed grouse transplanted into the Tobacco Valley from 1987 through 1989 was determined by counts of color banded males attending the dancing ground(s). Mean survival was 48.3 % from 1988 to 1991(survival data from 1988-1989 collected by M. Wood, Montana Department of Fish, Wildlife and Parks) (Figure 6). Low survival of the 1987 year-class in 1988 could possibly be due to minimal observation time that occurred that year; no 1987-birds were observed after

1988. Other year-classes showed a near 50 % survival rate through most years with a high of 100% in 1989 for the 1987 year-class (one individual surviving) and a low of 20 % in 1991 for the 1988 year-class.

Survival data for grouse transplanted in 1990 and 1991 was limited at the conclusion of the study. Figure 6 includes available data for these years. Grouse transplanted in 1990 had a 42% survival rate for the first year and lived from 60 to over 680 days with a mean survival time of 328 days. Survival did not differ for males and females (P = 0.1432).. The 1991 year-class had a known survival rate of 0% for birds trapped in Idaho, but survival of the three birds trapped in British Columbia is not known. At the end of the study, one radio-equipped grouse transplanted in 1990 was alive. Survival of the birds transplanted in 1990, but not equipped with radio packs, is unknown.

Since the conclusion of the field work for this study, the area near dancing ground C has undergone changes in order to complete construction of a new airport. This has caused the dancing ground to either be moved or abandoned; therefore, male attendance could not be accurately evaluated in the spring of 1992.

Mean movement between consecutive relocations ranged from 354 - 1278 m for males and 545-1549 m for females. Males showed significantly less movement (P = 0.0446) (Table 1). The figures in Table 1 were used to construct a graphical relationship between movement and days survived. This relationship suggests a significant negative correlation (R^2 = 0.865) between bird movement and survivability (Fig. 7). Figures 10 - 20 (Appendix B) show distances of movements between consecutive relocations for 11 grouse transplanted in the spring of 1990.

Figure 6. Survival of 4 cohorts of transplanted male Columbian sharp-tailed grouse 1987-1990.

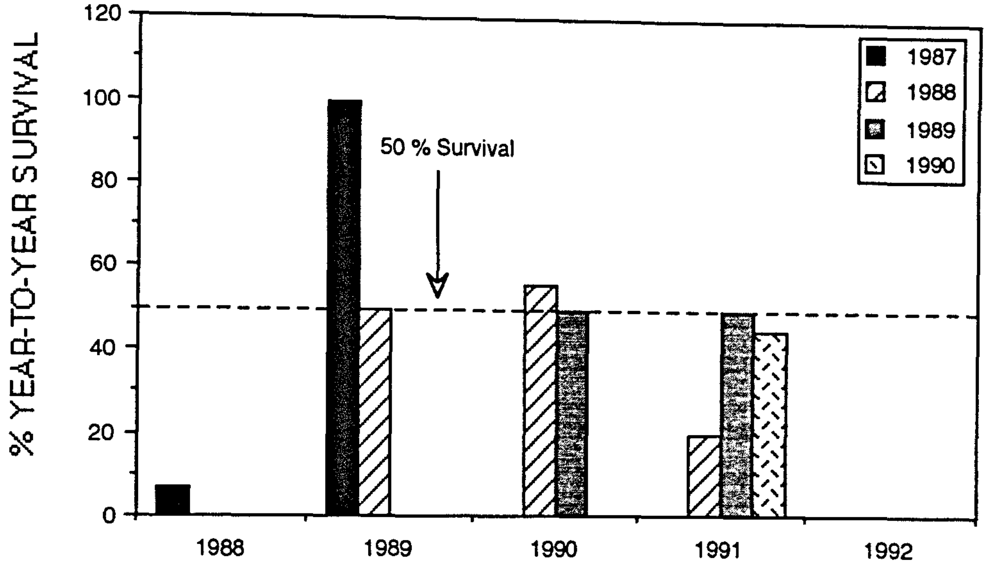
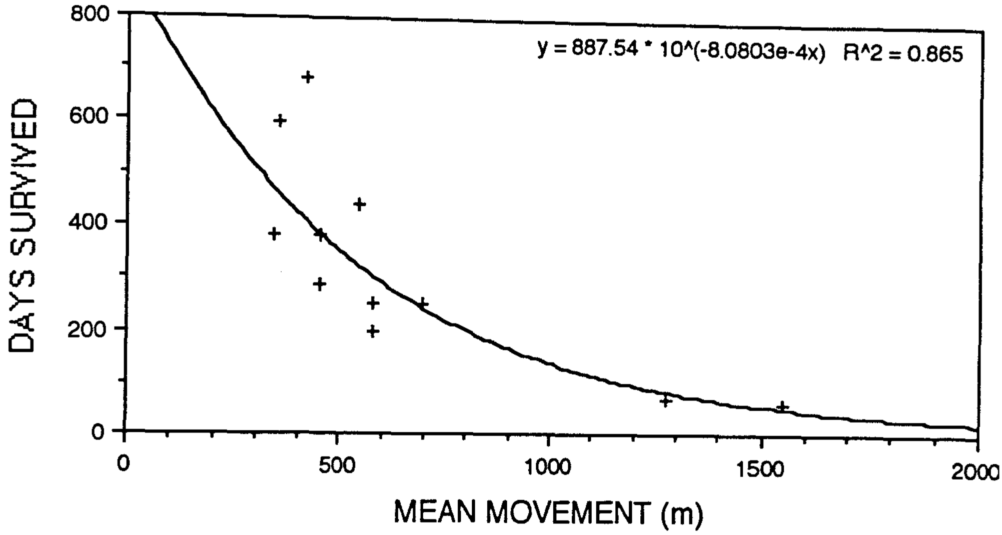


Table 1. Mean and median movement between consecutive relocations of 11 sharp-tailed grouse transplanted into the Tobacco Valley in 1990.

Grouse Number	Mean Movement (m)	Median Movement (m)	Days Survived
Males			
049	355	331	598
069	1278	1010	69
089	342	338	378
108	500	409	378
229	453	451	288
356	414	373	680+
Females			
127	691	1311	252
149	579	417	198
168	1549	438	60
208	578	323	252
417	545	387	441
Mean	662	526	368

Figure 7. Relationship between survivability and mean distance between consecutive relocations for Columbian sharp-tailed grouse in the Tobacco Valley, Montana.



Nest Success

Three of 5 transplanted radio-equipped females attempted to nest in 1990. Nests were located 0.5-3.7 km from the nearest dancing ground with a mean distance of 1.5 km. Mean distance to the nearest road or developed area was 0.3 km, while the mean distance to agricultural land was 1.0 km. Only one radio-equipped hen survived to the next nesting season, and she did attempt to nest. One additional nest was found incidentally in 1991. Nest initiation, determined by back-calculating from known incubation or hatching dates, occurred during 18-30 May in 1990 and on 30 May in 1991.

Clutch sizes from 2 nests were 11 and 12. Other nests were not located during incubation; therefore, clutch size was not determined. Two nests were successful and 2 were destroyed. Renesting was not documented for either of the hens whose nests were destroyed.

Nests that had fallen to predation were not heavily damaged. Eggs were often missing from these nests, leaving the remains of only partial clutches. Remaining eggs had holes on the side approximately 3 cm in diameter, or were totally crushed. All nests that were destroyed showed characteristics of both avian (punctured as well as removed from the nest) and mammalian (crushed) predation (Rearden 1951). In each case of known nest predation, hens escaped injury as was later documented by normal flushing behavior.

Hatching occurred in 2 nests on June 17 and 24 in 1990. Brood sizes were 8 and 5 on 29 June and 21 July, respectively. The brood of 5 had been flushed on 29 June, but chicks were so young that only one was seen. On 27 July, brood sizes were 6 and 5 and did not change by mid-September. Chicks were near adult size by 30 September and presumably recruited into the population.

Home Range

Adjustment and Post Adjustment

Home range size was determined for grouse transplanted in the spring of 1990 (Table 2). After being released, grouse were observed to have wide ranging initial movements (adjustment period) usually followed by less extensive movements for the remainder of their relocations (post adjustment) (See Figs 10-20 [Appendix B]).

Mean adjustment home range size was 589 ha and did not differ between males and females (P = 0.9168). Male and female post adjustment home range sizes averaged 262 ha, and were not significantly different (P = 0.2207). There was a difference between adjustment and post adjustment home ranges for males (P = 0.0796), but not for females (P = 0.4652) (Table 2).

Table 2. Home range size (ha) of all grouse transplanted in 1990 for different time periods. Nesting and brood rearing (BR) home ranges were calculated only for successful hens. Adjustment home range size for females was calculated using a combination of adjustment and pre-nesting home ranges. Birds without an identifiable adjustment or post adjustment home range were determined not to have one.

	Males							Females					
	049	069	089	108	229	356		127	149	168	208	417	
Number of Relocations	78	49	54	54	23	83		60	57	25	77	86	
Home Range Type							$\bar{X}$ Male						$\bar{X}$ Fem
ADJST.	330	902	81	305		1443	612	614		754		892	566
PST. ADJST.	86		102	188	155	300	166	765				318	357
PRE-NEST									243		327		
NESTING									3		10		7
EARLY BR									67		37		52
MID BR									30		48		39
LATE BR									41		87		64
NEST + BR									100		243		172
YEAR-LONG	149					699	424					1066	1066

Nesting and Brood Rearing

Radio relocations of nesting hens showed a mean home range size of 7 hectares (Table 2). Home ranges for hens with broods (including nesting area) were 100 and 243 ha, averaging 172 ha (Table 2). Movement of broods away from the nest site resulted in large mean home range sizes during early brood rearing. Data gathered from two broods during this study show that brood range size can vary significantly. One brood used a large area (home range size = 67 ha) during the first three weeks after hatching, while the other's was relatively small (37 ha). Home range size increased from middle to late brood rearing (Table 2).

Geographic Activity Centers (GAC) of nesting and brood rearing home ranges were 0.3 and 0.5 km from the nearest dancing ground, respectively. Activity centers were also 0.9 and 1.0 km from the nearest road, and 1.5 and 1.8 km from the closest developed or residential area, respectively (Table 3). Broods ranged no further than 1.7 km from the nest site and were within 1.3 km of the nearest dancing ground.

Statistical comparison of home range size between hens with and without chicks was not possible due to small sample sizes. Numerical comparison, however, suggests radio marked hens with broods had a smaller home range ($\bar{X}$=172 ha) than hens without ($\bar{X}$=357 ha).

Table 3. Distance (in meters) from Geographic Activity Centers of individual birds to the nearest dancing ground, road, developed area, coniferous forest, riparian forest, agricultural field, and to the release site. (* denotes hens with broods)

	Males							Females					
GAC TO:	049	069	089	108	229	356	$\bar{X}$ male	127	149*	168	208*	417	$\bar{X}$ fem.
Dancing G	100	1125	50	100	400	350	354	875	500	2600	325	775	1015
Road	850	450	800	800	775	850	754	700	850	475	950	625	720
Develop.	1650	1600	1600	1700	1250	900	1450	1750	1500	750	1875	425	1260
Con. For.	300	350	325	250	750	550	421	50	700	600	150	100	320
Rip. For	2675	2100	2725	2775	2400	1350	2338	2325	2250	1700	2700	1200	2035
Agricult.	875	700	800	825	875	1500	929	775	975	875	1025	1200	970
Rel. Site	100	1125	50	100	400	2000	629	875	500	2600	325	2675	1395

Year-long Home Range

Three radio-marked birds, one female and two males, survived through two breeding seasons. Year-long home range size for these birds ranged from 149 ha to 1066 ha with a mean home range size of 638 ha (Table 2). Comparable home range sizes from spring through fall ranged from 86 to 318 ha and averaged 235 ha. This shows a considerable extension of grouse movements during the winter.

Cumulative Home Range Data

On average, sharp-tailed grouse transplanted into the Tobacco Valley established home ranges approximately 1.0 km from the release site (Dancing Ground A). There was a difference in the distance of the GAC from the release site between sexes (0.6 km for males and 1.4 km for females), but it was not significant ($P = 0.1432$). The distances of female GACs from the nearest dancing ground ranged from 0.3 to 2.68 km (Table 3). Male GACs were 0.05 to 1.1 km from dancing grounds and were significantly different compared to females (P = 0.0996). Activity centers for all birds averaged 0.74 km from the nearest road, 0.97 km from agricultural land, and 2.2 km from the nearest riparian area which could potentially be used for winter habitat. These distances did not differ for males and females (P > 0.25). The distance to the nearest adjacent geographic activity center averaged 0.42 km for all birds. Distances ranged from 0.05 km to 0.73 km for males and from 0.23 km to 1.4 km for females. The difference between males and females was not statistically significant (P = 0.141).

Habitat Use

Habitat Composition

Habitat use of transplanted sharp-tailed grouse was evaluated for spring and summer, 1990 and 1991. Grass was the most common vegetation component on all plots (Table 4). Forbs made up a small percentage of the total coverage in each of the plot types. Shrubs were found in significant densities only in the brood plot type and were absent in all other types except for a small percentage in the non-use sites. Differences in vegetation composition between types were evident (Chi-Square approximation P = 0.043).

Table 4. Vegetational composition on the Tobacco Plains for six sampling plot types. Values represent percent ground cover.

PLOT TYPE	GRASS	FORB	SHRUB	TOTAL % COVER	% BARE GROUND
NESTING (N = 4)	69.9	5.3	0.0	75.2	24.8
BROOD REARING (N = 5)	58.4	7.1	22.0	87.5	12.5
DANCING GROUND (N = 2)	48.2	1.8	0.0	50.0	50.0
DAY-USE (N = 5)	53.8	6.6	0.0	60.4	39.6
ROOSTING (N = 5)	59.6	4.6	0.0	64.2	35.8
NON-USE (N = 4)	31.7	4.4	0.1	36.2	63.8

Although sample sizes were not large, statistical analysis still showed brood rearing cover to be significantly more dense than dancing ground, day-use, and non-use areas ($P < 0.023$) (Table 5). Roosting cover was less dense than brood rearing cover ($P = 0.080$), but nesting cover was not significantly different ($P = 0.314$). Other significant differences include non-use areas being less dense than both nesting and roosting cover ($P < 0.064$). Overall, nesting and brood rearing cover were the most dense, followed by roosting cover. Day-use areas and dancing ground locations had at least 50% cover, with the majority of the cover provided by grasses.

Dancing Ground Habitat

Dancing grounds were located in grassland habitat with a mean canopy cover of 50% (Table 4). Mean effective height of the vegetation was 7 cm on ground A, and 6 cm on ground C (Fig. 8). The effective height of vegetation on dancing grounds was significantly lower than in nesting or brood rearing areas ($P < 0.055$).

Dancing grounds averaged 0.7 km from the nearest road, 1.0 km from agricultural land, and 1.9 km from the nearest riparian area. Neither of the grounds were located on ridges or drumlins but rather on flat open areas that privided good visibility. Dancing ground C was near the edge of a 25-m sloping drop but was actually located on a flat area.

Table 5. P-values, calculated using the Kruskal-Wallace test, showing statistical differences in vegetative cover between plot types. An * denotes P-values of statistical significance (P < 0.10).

	NESTING	BROOD REARING	DANCING GROUND	DAY-USE	ROOSTING
BROOD REARING	0.314				
DANCING GROUND	0.127	0.023 *			
DAY-USE	0.175	0.018 *	0.609		
ROOSTING	0.486	0.080 *	0.294	0.468	
NON-USE	0.020 *	0.001 *	0.635	0.219	0.064 *

Nest Site Habitat

All nests found were located in dense native grass with mean vegetation cover of at least 75 % (Fig. 9). Vegetation at nest sites averaged 62 cm maximum height and had a mean effective height of 20 cm (Fig. 8). Effective height of nesting vegetation was significantly higher than on the dancing ground or in sampled non-use sites (P < 0.055).

Nest scrapes were partially covered by residual native bunch grass and lined with dry grass and small amounts of feathers. Only one nest was located within 50 meters of shrub cover. Nests were placed on slopes from 5 to 50 degrees. Aspect was not a factor in nest site selection as nests were found on north (n = 1), southeast (n = 1), and west facing slopes (n = 2).

Brood Habitat

Hens with broods were located in dense vegetation consisting primarily of native grasses (58.4%) (rough fescue, bluebunch wheatgrass, or bluegrass) or shrubs (22.0%) (snowberry or pearhip rose) (Fig. 9). Mean maximum height of brood rearing vegetation was 76.4 cm and mean effective height was 34.3 cm (Fig. 8). The effective height of brood rearing habitat was significantly higher than all other areas except nesting and day-use ($P < 0.020$). Brood rearing areas consisting of shrubs were located in small potholes surrounded by native grass. In this study, hens and their broods were the only birds with documented use of shrub communities during spring, summer, and early fall.

Figure 8. Mean effective height (the height of visual obstruction) for the six plot types used to describe habitat use.

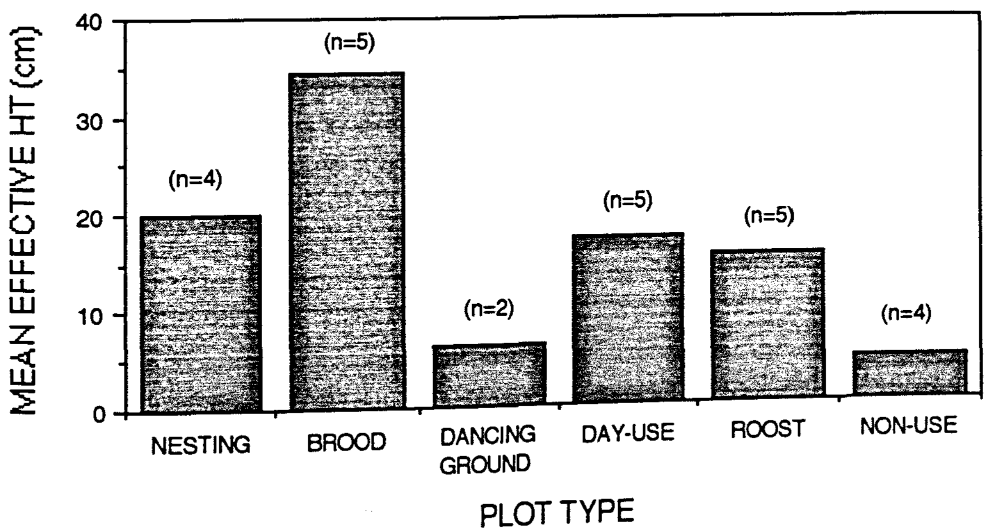
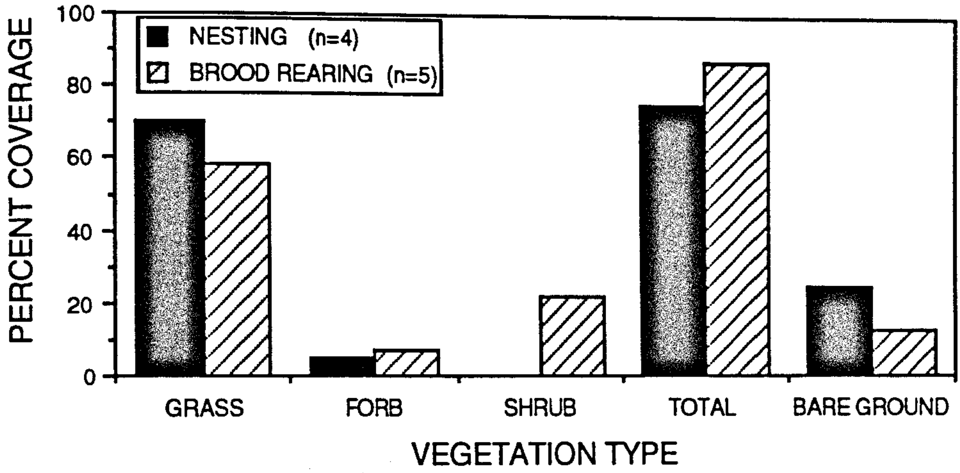


Figure 9. Percent coverage of nesting and brood rearing vegetation on the Tobacco Plains, Montana.



Use versus Availability

Relocations of radio-equipped grouse provided information for analysis of use versus availability. Habitat within designated availability circles was broken into seven types. Grassland habitat, which averaged 89% in each area, was used in proportion to its availability (Table 6). The same was true for coniferous forest habitat which averaged 3 % in use areas. Coniferous habitat included shrubs (snowberry and pearhip rose) often associated with ponderosa pine habitat on the Tobacco Plains.

Agricultural land was apparently avoided. Six out of 9 grouse selected against agricultural lands within their use areas. Agricultural land, generally alfalfa and wheat, made up an average 7 % of each bird's use area. Avoidances were not noted for other habitat types.

Table 6. Results of use versus availability analysis for 9 transplanted sharp-tailed grouse. A + indicates use of a habitat type with greater frequency than its abundance, a - shows selection against a particular habitat type, and a 0 indicates neither preference nor avoidance of a habitat type ($P < 0.05$).

	MALES					FEMALES			
HABITAT	049	089	108	229	356	127	149	208	417
Native Grass	0	0	0	0	0	0	0	0	0
Coniferous Forest	0	0	+	0	0	0	0	0	0
Riparian Forest	na[1]	na	na	na	-	0	na	na	-
Shrubs	na	na	na	na	-	0	na	na	-
Developed Land	na	na	na	-	-	0	na	na	0
Water	0	0	0	na	-	0	na	0	0
Agriculture	-	-	-	0	-	-	0	0	-

na[1] = habitat type did not exist within designated availability circles.

DISCUSSION

Columbian sharp-tailed grouse numbers and range have declined drastically since the early 1900's (Buss and Dziedzic 1955). This decline prompted supplementation or reintroduction efforts throughout much of its historic range. From 1950 though 1991 there have been at least 13 attempts to reestablish different subspecies of sharp-tailed grouse (primarily Plains and Columbian). These transplant efforts either did not succeed, or resulted in only temporary populations that soon disappeared (Toepfer et al. 1990, K. Durbin, Oregon Dept. of Wildlife, pers. commun.). Inadequate use of available information on basic biology and ecology is believed to be the major cause of most transplant failures. Specifically, 2 major problems arise: 1) consideration of suitability and amount of habitat essential for transplant survival and 2) dispersal away from the release site (Toepfer et al. 1990).

The Tobacco Plains population declined nearly every year from 1977 to 1987. Yearly transplant efforts on the Tobacco Plains have taken place since 1987. Four males were attending the only remaining dancing ground when reintroductions began. Although population levels were low (n = 8), they remained stable from 1989 - 1990. With the initiation of a new dancing ground in 1991, the known male population increased dramatically (n = 22).

High annual survival of transplanted birds was possibly a major contributor to the increase in the Tobacco Plains population. Based on dancing ground attendance, annual survival of transplanted males averaged 47 % during 1988 -1991, higher than that reported previously (24 to 35 %) for resident populations of sharp-tailed grouse (Brown 1966, Robel et al. 1972). Radio-equipped grouse released on the Tobacco Plains in 1990 had an annual survival rate of 42 % from 1990 to 1991. This is high compared to 0 % survival of radio-equipped sharp-tailed grouse in Southwest Idaho and Northeast Oregon (Marks and Marks 1987, K. Durbin, Oregon Dept. of Wildlife, pers. commun.). None of the birds transplanted from the SCWMA in 1991 survived after release on the Tobacco Plains. The fact that the SCWMA is composed of shrub-steppe habitat and the Tobacco Plains is a bunchgrass prairie may have played a role in the low survival of the 1991 transplants. Although more testing of this hypothesis is needed, differential mortality of transplants from different habitat types seems to exist.

Survival of transplanted radio-equipped grouse in the Tobacco Valley was negatively correlated with distances between consecutive relocations ($R^2 = 0.865$). Similar relocation procedures were used on all radio-equipped individuals, and unlike transplanted prairie-chickens in Wisconsin (Toepfer 1988), movement did not differ between males and females ($P = 0.1432$). These data support the theory that increased movement leads to decreased survival possibly due to increased exposure to predators.

This relatively high survival rate for grouse transplanted into the Tobacco Plains may be partially due to 2 factors: 1) topography and habitat characteristics that discouraged dispersal and 2) the presence of limited but relatively good habitat. The area is surrounded on three sides by mountain ranges and on the fourth by coniferous forest. This island of native palouse prairie may minimize the tendency of transplants to disperse from the release site. Only two radio-equipped grouse (one male and one female) dispersed from the study area. Although this did occur, dispersal does not seem to be a limiting factor in the success of the transplanting program. If it were, survival rates, which are based on dancing ground returns, would be much lower than reported.

Possibly the most important factor affecting the survival of sharp-tailed grouse on the Tobacco Plains is the availability of quality native palouse prairie habitat. In 1991, the Nature Conservancy of Montana and the Montana Department of Fish, Wildlife and Parks acquired 680 acres of land supporting the areas best sharp-tailed grouse habitat, as well as the only known active dancing ground at that time (Ground A). In the summer of 1991, the area was designated the Dancing Prairie Preserve.

Six radio-equipped grouse established home ranges on the Preserve, while the remaining birds home ranges were within 2 km of the Preserve boundary. Six of 11 radio-equipped grouse exhibited adjustment behavior soon after being released. Large wandering movements, similar to those reported for prairie chickens in Wisconsin (Toepfer 1988) were apparent. These adjustment periods lasted from 14 to 27 days. They were followed by more limited movements and smaller home ranges indicative of an established individual.

Post-adjustment spring and summer home range size varied from 86 to 765 ha, having a mean of 251 ha, with a median home range size of 155 ha. Mean home range size was larger than reported in other Columbian sharp-tailed grouse studies where home range size averaged 162 to 187 ha (Giesen

1987, Marks and Marks 1987). Studies of Plains sharp-tailed grouse reported mean home range sizes of 268 to 274 ha (Gunderson 1990, Northrup 1991). Although Toepfer (1988) reported that transplanted prairie chickens often had larger home ranges because of the presence of resident birds, no home range data for Columbian sharp-tailed grouse on the Tobacco Plains was available to compare with home ranges for transplanted birds.

Another possible explanation for the large mean home range size is variation in habitat quality. The Dancing Prairie Preserve contains the highest quality habitat, but covers only 2 km^2. Smaller parcels of quality habitat are found throughout the remainder of the plains. This patchwork pattern may have forced birds in those areas to range further in order to fulfill their daily or seasonal requirements. This assumption is supported by the fact that radio-equipped grouse centered in the Preserve (n = 6) had a mean home range size of 146 ha while birds not centered on the Preserve (n = 3) had a mean home range size of 458 ha.

Home ranges enlarged during the winter months ($\bar{X}$ = 638 ha). Although winter relocations were limited, grassland habitat continued to be used frequently, and few grouse were relocated in deciduous trees and shrubs. Similar yearlong use of grassland habitat has been reported by others (Marshall and Jensen 1937, Hart et al. 1950, Hamerstrom and Hamerstrom 1951, Swenson 1985). Use of grasslands in winter was attributed to the fact that snow cover was minimal, and food may not have been a limiting factor. Complete snow cover on the Tobacco Plains is rare, so this assumption might also be applied to the Tobacco Valley.

In addition to high survival, another factor indicating success of a transplant effort is reproduction by transplanted individuals. Toepfer et al. (1990) thought that a transplanted population was not functional until the individuals established territories and produced offspring. In the Tobacco Plains, transplanted males were observed displaying on the dancing ground, indicating successful recruitment into the resident population of birds. In 1990 and 1991, 5 nesting attempts were recorded . Clutch sizes averaged 11.5 (n=2) which is similar to clutch sizes reported for sharp-tailed grouse in other areas (Hamerstrom 1939, Hart et al. 1950, Pepper 1972, Hillman and Jackson 1973, Giesen 1987, Marks and Marks 1987, Gunderson 1990, and Meints 1991).

Others have reported nesting success for Plains and Columbian sharp-tailed grouse ranging from 50 to 72 % (Hamerstrom 1939, Hart et al. 1950, Pepper 1972, Giesen 1987, Marks and Marks 1987, Gunderson 1990, Meints 1991). Relatively low nest success on the Tobacco Plains (40 %, n = 5) could be attributed to a high corvid population. Since the opening of a public landfill in the **1980's**, raven (*Corvus corax*) numbers have dramatically increased (J. Roberts, MDFWP, pers. commun.). Coyotes (*Canis latrans*) are also abundant in the valley, and may be contributing to nest predation. Additionally, predation rates could be a reflection of habitat quality.

Nests on the Tobacco Plains averaged 1.5 km from the nearest dancing ground. Similar distances have been reported by others (Hamerstrom 1939, Gunderson 1990, Meints 1991). Although the number of nests used for this analysis is small, it seems important that areas within a 1.6 km radius of an existing dancing ground be the focus of management efforts designed to increase nesting habitat.

Nest sites of radio-equipped hens were characterized by dense grass cover (residual and new growth) with an mean maximum height of 62 cm, and a mean effective height of 20 cm. Gunderson (1990) reported an effective height of 17-18 cm for plains sharp-tailed grouse nest site vegetation (juniper [*Juniperus spp.*] and big sagebrush), while Kohn (1976) reported nesting habitat of 20 cm or more for the same sub-species.

Nesting habitat of sharp-tailed grouse in other areas has been described by numerous researchers. Vegetation height and density seems more important to nesting sharp-tailed grouse than species composition (Hillman and Jackson 1973, Gunderson 1990). This is supported by reports of nesting occurring in a wide range of habitat types. Hart et al. (1950) documented the majority of Columbian sharp-tailed grouse in Northern Utah nested in alfalfa and crop stubble due to limited amounts of quality native grassland. In Michigan, Baumgartner (1939) reported Plains sharp-tailed grouse nests in heavy grass, concealed under logs or brush, or found at the base of small trees. In Idaho, Marks and Marks (1987), documented Columbian sharp-tailed grouse nests under big sage (*Artemesia tridentata*) and arrowleaf balsamroot (*Balsamorhiza sagittata*). In south-central Wyoming, nests were found under snowberry bushes (Oedekoven 1985).

Grassland comprised approximately 85 % of designated availability circles of nesting radio-equipped hens. Nests (n = 2) were not found in shrub, alfalfa, or crop stubble, although all three habitat types existed within availability circles. Since no nests were found in these types, it seems, based on the limited nesting data collected, that native habitat capable of providing nesting cover does exist on the Tobacco Plains. The majority of nesting cover is within a 1.6 km radius of dancing ground A. Although nesting did occur, management efforts to increase the availability of nesting cover thoughout the Tobacco Plains are needed if the population is to expand.

Mean brood size within one month after hatching was 6.5. Early post-hatch brood sizes in other studies ranged from 7.8 to 9.5 (Hart et al. 1950, Hillman and Jackson 1973, Marks and Marks 1987). Brood size decreased to 5.5 by two months after hatching and remained the same size through mid-September. Hart et al. (1950), Marks and Marks (1987) both reported similar decreases in brood size reporting means of 4.6 and 4.5 respectively. Although brood sizes within 1 month after hatching in my study were relatively small, the limited data prevent any conclusion about those differences.

Habitat used by radio-equipped hens with broods had the highest vegetative cover (88%) and effective height (34 cm) of all radioed grouse. Habitat was primarily grass (58%) and shrubs (22%). Broods were the only birds observed to use shrub habitat during spring, summer or fall. Other studies have reported the use of grassland and grassland-shrub transition zones by broods (Hamerstrom 1963, Moyles 1981, Gunderson 1990). Columbian sharptail broods in Wyoming used shrub cover (especially snowberry) more often than did male grouse (Oedekoven 1985). This same pattern was seen on the Tobacco Plains. This suggests that shrubs are important hiding cover for broods, and should be considered in developing habitat management goals.

Overall habitat use by transplanted Columbian sharp-tailed grouse on the Tobacco Plains showed apparent avoidance of cultivated land. Columbian sharp-tailed grouse were historically associated with grassland and shrub-steppe habitat (Johnsgard, 1973). Through the 1900's, populations decreased as cultivation increased (Buss and Dziedzic 1955). Early cultivation could have possibly increased winter survival, but extensive cultivation and increased grazing has eliminated the majority of the historical habitat in many areas (Hart et al. 1950, Miller and Graul 1980).

Areas other than the Dancing Prairie Preserve have been exposed to high grazing pressure. Sharp-tailed grouse are known to be poorly adapted to areas where grazing reduces the vigor of the rangeland (Brown 1966, Mattise 1978, Autenrieth et al. 1977). In Montana, plains sharp-tailed grouse appeared to avoid areas being used by cattle (Nielsen and Yde 1982). On the Tobacco Plains, radio-equipped grouse released in 1990 were relocated more often in areas where cattle were not present. They used areas averaging 64% ground cover, while non-use areas averaged 36% ground cover. Autenrieth et al. (1977) felt that a grazing system that would perpetuate diversity in the rangeland would be beneficial to upland game. Different grazing systems should be tested to identify the best way to increase the density and abundance of existing vegetation for the benefit of cattle as well as sharp-tailed grouse.

The Tobacco Plains population of Columbian sharp-tailed grouse approached extinction in the late 1980's. Through transplanting efforts, the population has apparently begun to recover. Although success of the reintroduction is still questionable, favorable signs like documented production, population expansion, and land acquisitions give reason for positive speculation. Management efforts, many of which are being planned for implementation (Wood unpbl. rept.), should center around securing and enhancing existing habitat. This would ensure quality habitat for the existing population, and allow for further expansion.

This study was based around collecting data to document habitat selection and survivability of transplanted grouse on the Tobacco Plains. Additional research in the Tobacco Valley is needed to detail other aspects including food habits and population trends. Further telemetry research is needed in order to define winter habitat use in the Tobacco Valley. A hypothesis that differential mortality of transplanted birds is based on habitat differences needs to be tested. Experimental manipulation of habitat and its impacts on nesting, brood rearing and ultimately recruitment needs evaluation. Another potential evaluation would be impacts of raven depredations on sharptail nesting success. By altering the operation of the public landfill or acquiring a predator control permit, it may be possible to reduce corvid populations in the Tobacco Valley. Through these measures, nesting success and population numbers of Columbian sharp-tailed grouse on the Tobacco Plains may increase.

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APPENDICES

APPENDIX A

TABLES

Table 7. Vascular Plant Species Observed at the Proposed Dancing Prairie Preserve June 6, 1985; June 5, 1986; July 17, 1986. An asterisk (*) indicates exotic species. Species observed only in forested areas are indicated by (F). Species associated only with ponds are indicated by (P). Modified from Lesica, 1986.

Aceraceae

Acer glabrum

Anacardiaceae

Rhus glabra

Apiaceae

Lomatium macrocarpum
Lomatium triternatum

Apocynaceae

Apocynum sp.

Asteraceae

Achillea millefolium
Agoseris glauca
Antennaria dimorpha
Antennaria microphylla
Antennaria parviflora
Antennaria racemosa (F)
Arctium minus * (F)
Arnica cordifolia (F)
Arnica sororia
Artemisia frigida
Aster flacatus
Aster laevis
Aster pansus
Balsamorhiza sagittata
Centaurea maculosa *
Chrysopsis villosa
Cirsium undulatum
Conyza canadensis
Crepis intermedia
Erigeron compositus
Erigeron corymbosus
Erigeron divergens
Erigeron pumilus
Erigeron strigosus
Filago arvensis *
Gailardia aristata
Gnaphalium palustre (P)
Gnaphalium viscosum
Grindelia squarrosa
Hieracium cynoglossoides
Lactuca serriola *
Matricaria matricarioides *
Ratibida pinnata
Scorzonera laciniata *
Senecio canus
Senecio integerrimus
Senecio pauperculus (F)
Solidago missouriensis
Taraxacum officinale *
Tragopogon dubius *

Boraginaceae

Cynoglossum officinale *
Lappula redowskii
Lithospermum incisum
Lithospermum ruderale
Mertensia oblongifolia
Myosotis micrantha *
Plagiobothrys scouleri (P)

Brassicaceae

Allysum allysoides *
Arabis holboellii
Arabis nuttallii
Camelina microcarpa *
Draba verna
Lepidium perfoliatum
Lepidium viginicum (?)
Sisymbrium altissumum *

Campanulaceae
Campanula rotundifolia
Triodanis perfoliata

Caprifoliaceae
Symphoricarpos occidentalis (F)

Caryophyllaceae
Arenaria serphyllifolia *
Cerastium arvense
Dianthus armeria *
Holosteum umbellatum
Lychnis alba *
Silene antirrhina *
Silene spaldingii
Stellaria longifolia (F)

Chenopodiaceae
Chenopodium album *

Cornaceae
Cornus stolonifera (F)

Crassulaceae
Sedum lanceolatum

Cupressaceae
Juniperus communis (F)
Juniperus scopulorum (F)

Cyperaceae
Carex concinnoides (F)
Carex filifolia
Carex micoroptera (F)

Ericaceae
Arctostaphylos uva-ursi (F)
Pyrola secunda (F)

Euphorbiaceae
Euphorbia glypotosperma

Fabaceae
Astragalus agrestis
Astragalus canadaensis
Astragalus falcatus *
Astragalus lotiflorus
Astragalus miser
Lupinus sericeus
Medicago lupulina *
Medicago sativa *

Gentianaceae
Gentiana amarella

Geraniaceae
Erodium cicutarium *
Geranium bicknellii
Geranium viscosissimum

Grossulariaceae
Ribes inerme (F)

Hydrangeaceae
Philiadelphus lewisii (F)

Hydrophyllaceae
Phacelia hastata
Phacelia linearis

Hypericaceae
Hypericum performatum *

Iridaceae
Sisyrinchium angustifolium

Juncaceae
Juncus balticus (P)
Juncus bufonius (P)

Lamiaceae
Monardafistulosa
Stachys palustris (P)

Lemnaceae

Lemna minor (P)

Liliaceae

Allium cernuum
Brodiaea douglasii
Calochortus macrocarpus
Disporum trachycarpum (F)
Fritillaria pudica
Smilacina stellata
Zigandenus venenosus

Linaceae

Linum perenne

Lycopodiaceae

Lycopodium annotinum (F)

Onagraceae

Epilobium glaberrimum (P)
Epilobium paniculatum

Orchidaceae

Spiranthes romanzoffiana

Pinaceae

Larix occidentalis (F)
Pinus ponderosa (F)
Pseudotsuga menziesii (F)

Plantaginaceae

Plantago major *
Plantago patagonica
Plantago aristata

Poaceae

Agropyron intermedium
Agropyron smithii
Agropyron repens *
Agropyron spicatum
Agrostis alba
Agrostis interrupta
Agrostis scabra
Alopecurus alpinus (P)
Aristida longiseta
Bromus inermis *
Bromus japonicus *
Bromus tectorum *
Calamagrostis rubescens (F)
Dactylis glomerata *
Elymus glaucus (F)
Festuca idahoensis
Festuca octoflora
Festuca scabrella
Hordeum jubatum (P)
Koelaria cristata
Oryzopsis hymenoides
Panicum capillare *
Phleum pratense *
Poa compressa *
Poa interior (?)
Poa pratensis *
Poa sandbedrgii
Stipa comata
Stipa lettermanii
Stipa occidentalis (F)
Stipa spartea

Polemoniaceae

Collomia linearis
Microsteris gracilis
Phlox caespitosa

Polygonaceae

Eriogonum flavum
Eriogonum heracleoides
Eriogonum ovalifolium
Polygonum amphibium (P)
Polygonum aviculare *
Polygonum douglasii
Rumex crispus * (P)
Rumex maritimus (P)

Polypodiaceae
Cystopteris fragilis (F)
Woodsia oregana (F)

Portulacaceae
Lewisia rediviva

Primulaceae
Dodecatheon conjugens

Ranunculaceae
Anemone multifida
Anemone nuttalliana
Clematis ligusticifolia (F)
Delphinium bicolor
Ranunculus acris (P)
Ranunculus aquatilis (P)
Ranunculus glaberrimus
Ranunculus pensylvanicus (P)

Rosaceae
Amelanchier alnifolia (F)
Fragaria vesca (F)
Fragaria virginiana
Geum triflorum
Potentilla anserina (P)
Potentilla glandulosa
Potentilla recta *
Prunus virginiana (F)
Rosa nutkana (F)
Rosa woodsii (F)
Rubus idaeus (F)
Spiraea betulifolia (F)

Rubiaceae
Galium asperrimum (F)
Galium boreale

Salicaceae
Populus tremuloides (F)

Santalaceae
Comandra umbellata

Saxifragaceae
Heuchera cylindrica
Lithophragma sp.
Saxifraga integrifolia

Schophulariaceae
Castilleja lutescens
Collinsia parviflora
Orthocarpus tenuifolius
Penstemon confertus
Penstemon eriantherus
Penstemon nitidus
Verbascum blattaria *
Verbascum thapsus *
Veronica americana (P)
Veronica peregrina (P)
Veronica serpyllifolia (P)

Selaginellaceae
Selagenella densa

Verbenaceae
Verbena bracteata

Violaceae
Viola adunca

Table 8. Capture, release dates and ultimate fate of Columbian sharp-tailed grouse transplanted into the Tobacco Valley during 1990 and 1991. Also included are various legband color schemes used to mark transplanted birds. (* Kamloops, British Columbia ** Sand Creek Wildlife Management Area, Idaho *** refers to approximate date of death **** refers to an idividual that relocations were not recorded before death, r= radio recovery if actual date of death is unknown)

Anml ID #	Sex	Lgbnd R	Lgbnd L	Capt. Lctn.	Capture Date	Release Date	Status	Date
5 Males		Pink	Pink	Kam*	5-3-90	5-4-90	Unkn.	No Radios
049	M	Pink	Pink	Kam	5-3-90	5-4-90	Dead	12-23-91
069	M	Pink	Pink	Kam	5-3-90	5-4-90	Dead	7-12-90
089	M	Pink	Pink	Kam	5-3-90	5-4-90	Dead	5-17-91 r
108	M	Pink	Pink	Kam	5-3-90	5-4-90	Dead	5-17-91 r
129	F	White	White	Kam	5-6-90	5-8-90	Dead	1-15-91 *** 3-31-91 r
149	F	White	White	Kam	5-1-90	5-4-90	Unkn.	Bkn nklace
168	F	White	White	Kam	5-4-90	5-4-90	Dead	7-3-90
208	F	White	White	Kam	5-6-90	5-8-90	Unkn.	Bkn nklace
229	M	Pink	Pink	Kam	7-16-90	7-17-90	Dead	3-31-91 r
356	M	Pink	Pink	Kam	4-18-90	4-20-90	Alive	New #659
377	M	Pink	Pink	Kam	4-18-90	4-20-90	Dead	5-13-90****
417	F	White	White	Kam	4-18-90	4-20-90	Unkn.	Bkn nklace
148	F	Green	Green	ID **	4-20-91	4-23-91	Dead	6-2-91
210	F	Green	Green	ID	4-28-90	4-29-90	Dead	6-3-91 r
437	F	Green	Green	ID	4-27-91	4-29-91	Dead	5-18-91
478	M	Yell.	Yell.	ID	4-28-91	4-29-91	Dead	5-4-91
498	M	Yell.	Yell.	ID	4-28-91	4-29-91	Dead	6-7-91
658	F	Green	Green	ID	4-27-91	4-29-91	Dead	6-7-91
3 Males		Yell	Yell	Kam	4-6-91	4-8-91	Unkn.	No Radios

APPENDIX B

FIGURES

Figure 10. Graph of daily movements of male Columbian sharp-tailed grouse # 049 transplanted into the Tobacco Valley in the spring of 1990.

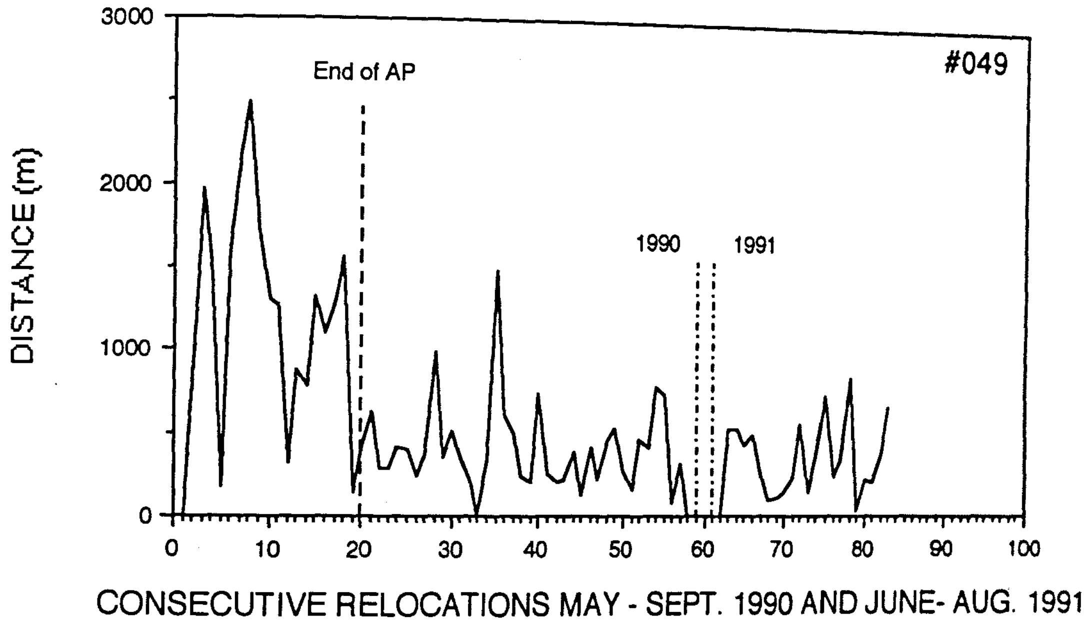

Figure 11. Graph of daily movements of male Columbian sharp-tailed grouse # 069 transplanted into the Tobacco Valley in the spring of 1990.

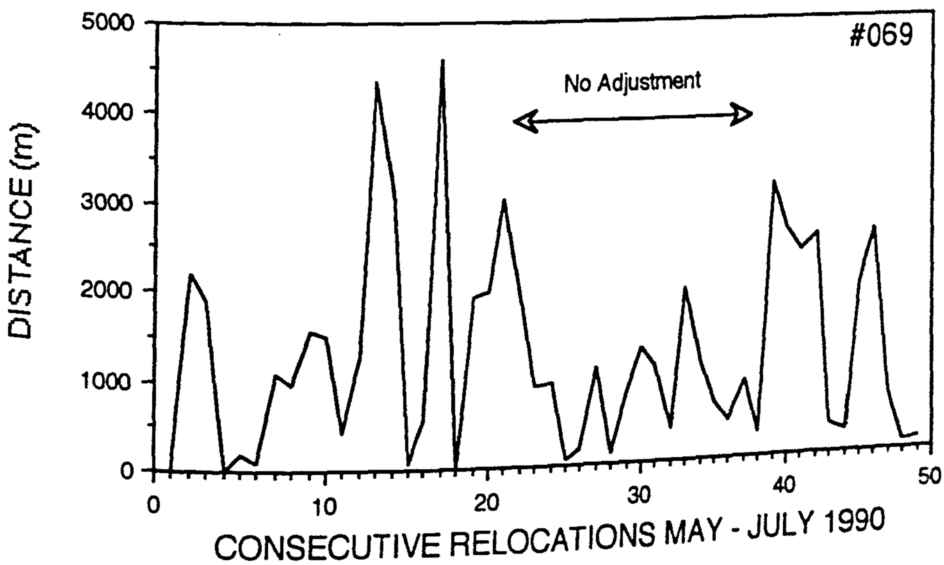

Figure 12. Graph of daily movements of male Columbian sharp-tailed grouse # 356 transplanted into the Tobacco Valley in the spring of 1990.

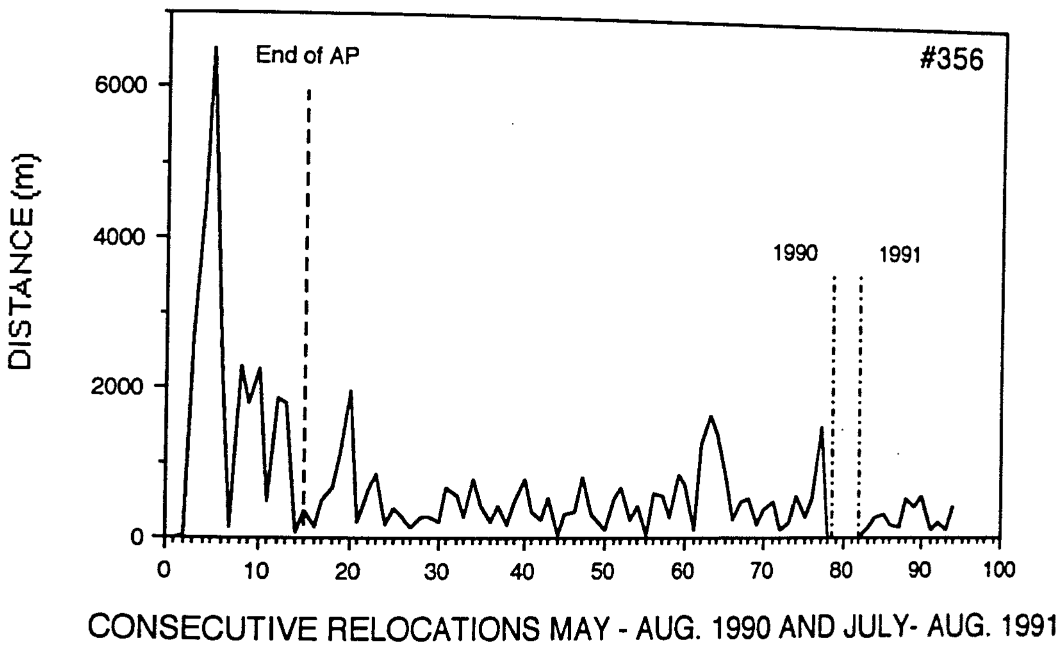

Figure 13. Graph of daily movements of male Columbian sharp-tailed grouse # 089 transplanted into the Tobacco Valley in the spring of 1990.

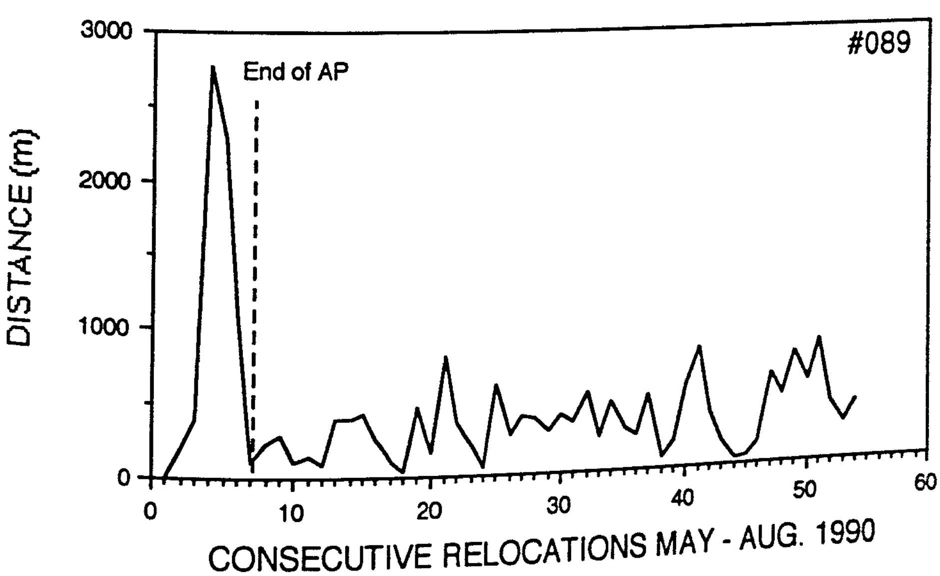

Figure 14. Graph of daily movements of male Columbian sharp-tailed grouse # 108 transplanted into the Tobacco Valley in the spring of 1990.

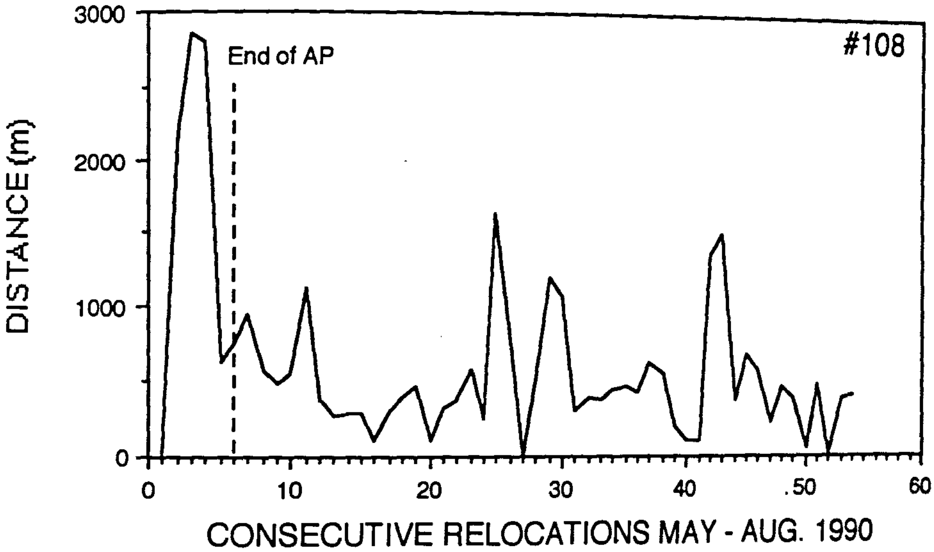

Figure 15. Graph of daily movements of male Columbian sharp-tailed grouse # 229 transplanted into the Tobacco Valley in the spring of 1990.

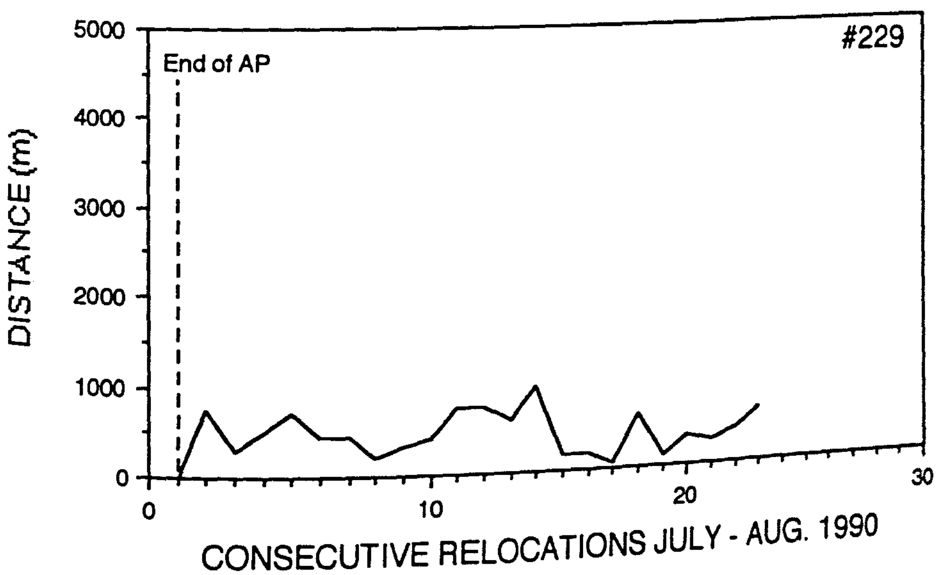

Figure 16. Graph of daily movements of female Columbian sharp-tailed grouse # 149 transplanted into the Tobacco Valley in the spring of 1990 (* denotes female).

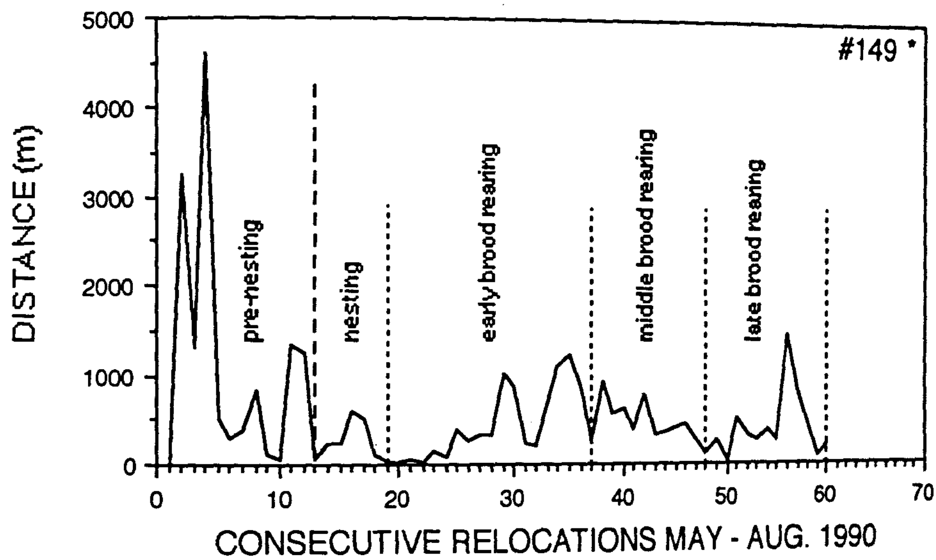

Figure 17. Graph of daily movements of female Columbian sharp-tailed grouse # 208 transplanted into the Tobacco Valley in the spring of 1990.

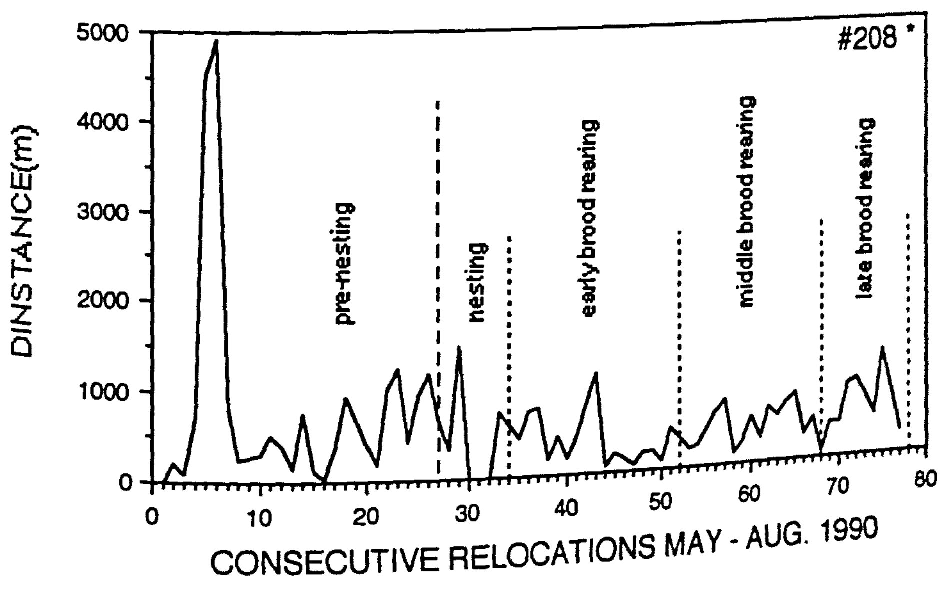

Figure 18. Graph of daily movements of female Columbian sharp-tailed grouse # 417 transplanted into the Tobacco Valley in the spring of 1990.

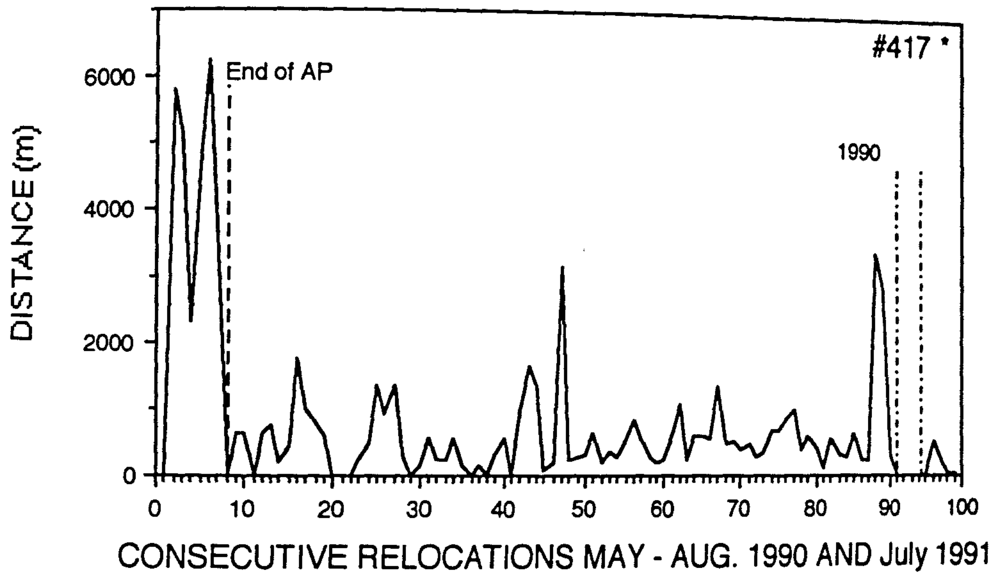

Figure 19. Graph of daily movements of female Columbian sharp-tailed grouse # 127 transplanted into the Tobacco Valley in the spring of 1990.

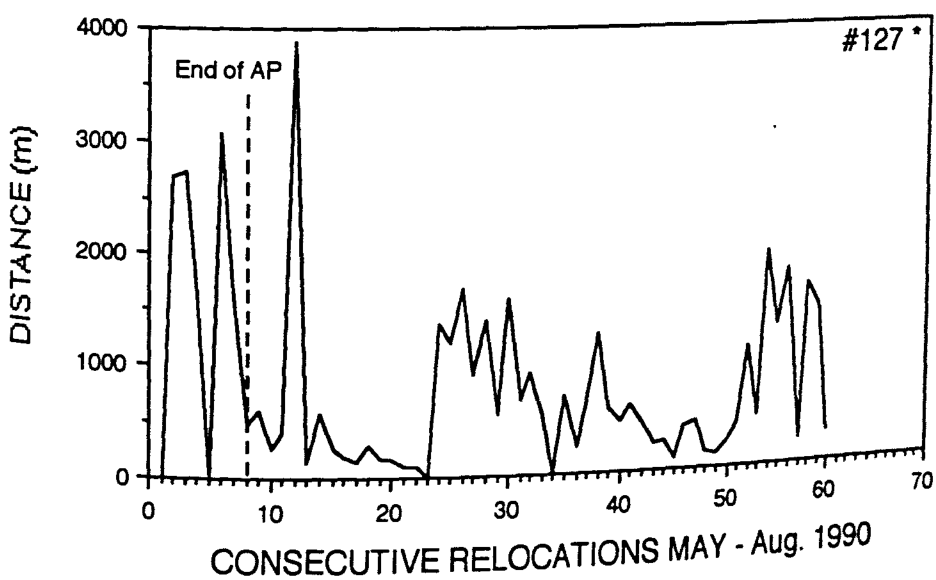

Figure 20. Graph of daily movements of female Columbian sharp-tailed grouse # 168 transplanted into the Tobacco Valley in the spring of 1990.