Sage grouse use of burned, non-burned, and seeded vegetation communities on the Idaho National Engineering Laboratory, Idaho
by Carolyn Anne Sime

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


Abstract:
Sage grouse (Centrocercus urophasianus) depend on sagebrush (Artemisia spp.) communities to meet their life history requirements throughout the year. Alteration of sagebrush communities by chemical, mechanical, or biological means affects sage grouse distribution and abundance. From March 1988 through September 1989, a study was conducted on the Idaho National Engineering Laboratory to investigate sage grouse response during spring and summer to a sagebrush community altered by fire and artificial seeding of crested wheatgrass (Agropyron cristatum). Relative seasonal use of burned, non-burned, and seeded areas was investigated using radio telemetry, roadside counts, and pellet census techniques. In 1988, a drought year, telemetry efforts focused on males utilizing the seeding for strutting activities. Males left the study area at the conclusion of the breeding season. In 1989, a year of normal precipitation, females which bred on these same arenas were radio-tracked to evaluate brood-rearing potential. Telemetered females remained in the study area, attempting to nest and raise broods. In both years, sage grouse were observed during roadside counts through early-September. Due to inherent biases in data collection techniques and variable conditions between years, telemetry, route counts, and pellet census results revealed slightly different movement and relative use patterns. However, all data indicated that sage grouse took advantage of the variety of vegetation types available. Non-burned areas provided essential sagebrush cover and food for wintering and nesting sage grouse. Burned areas provided open overhead canopies attractive to young grouse seeking palatable forbs. The artificial seeding will maintain an opening in the sagebrush canopy for strutting grounds. On this study area, alteration of the sagebrush community did not appear to discourage sage grouse use.

# SAGE GROUSE USE OF BURNED, NON-BURNED, AND SEEDED VEGETATION COMMUNITIES ON THE IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO

by

Carolyn Anne Sime

A thesis submitted in partial fulfillment
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APPROVAL

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Carolyn Anne Sime

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.

March 12, 1991 — Robert S. Eng

Date — Chairperson, Graduate Committee

Approved for the Major Department

12 March 1991 — Robert S. Moore

Date — Head, Major Department

Approved for the College of Graduate Studies

March 18, 1991 — Henry L. Parsons

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# ABSTRACT

Sage grouse (Centrocercus urophasianus) depend on sagebrush (Artemisia spp.) communities to meet their life history requirements throughout the year. Alteration of sagebrush communities by chemical, mechanical, or biological means affects sage grouse distribution and abundance. From March 1988 through September 1989, a study was conducted on the Idaho National Engineering Laboratory to investigate sage grouse response during spring and summer to a sagebrush community altered by fire and artificial seeding of crested wheatgrass (Agropyron cristatum).Relative seasonal use of burned, non-burned, and seeded areas was investigated using radio telemetry, roadside counts, and pellet census techniques. In 1988, a drought year, telemetry efforts focused on males utilizing the seeding for strutting activities. Males left the study area at the conclusion of the breeding season. In 1989, a year of normal precipitation, females which bred on these same arenas were radio-tracked to evaluate brood-rearing potential. Telemetered females remained in the study area, attempting to nest and raise broods. In both years, sage grouse were observed during roadside counts through early-September. Due to inherent biases in data collection techniques and variable conditions between years, telemetry, route counts, and pellet census results revealed slightly different movement and relative use patterns. However, all data indicated that sage grouse took advantage of the variety of vegetation types available. Non-burned areas provided essential sagebrush cover and food for wintering and nesting sage grouse. Burned areas provided open overhead canopies attractive to young grouse seeking palatable forbs. The artificial seeding will maintain an opening in the sagebrush canopy for strutting grounds. On this study area, alteration of the sagebrush community did not appear to discourage sage grouse use.

# INTRODUCTION

Because sage grouse depend on sagebrush communities, their distribution in western states reflects the distribution of sagebrush (Artemisia spp.) (Wallestad 1975) (Fig. 1). Sage grouse populations have declined from historical levels, disappearing altogether from areas where sagebrush has been extensively removed (Call and Maser 1985).

Much of the land area dominated by sagebrush within the intermountain west has been altered mechanically, chemically, and/or biologically. Sagebrush reduction was historically conducted to "improve depleted range" and removal was followed by grass seedings to accommodate agricultural interests (Braun et al. 1976). Swenson et al. (1987) documented declining sage grouse populations as a result of mechanical alteration of sagebrush stands. Reduced wintering, breeding, nesting, and brood rearing activities by sage grouse have been reported following chemical treatment (Klebenow 1970, Martin 1970, Pyrah 1972, Wallestad 1975). As of 1974, 627,500 ha of U. S. Forest Service and Bureau of Land Management (BLM) lands in Idaho had been subjected to sagebrush control projects (Vale 1974).

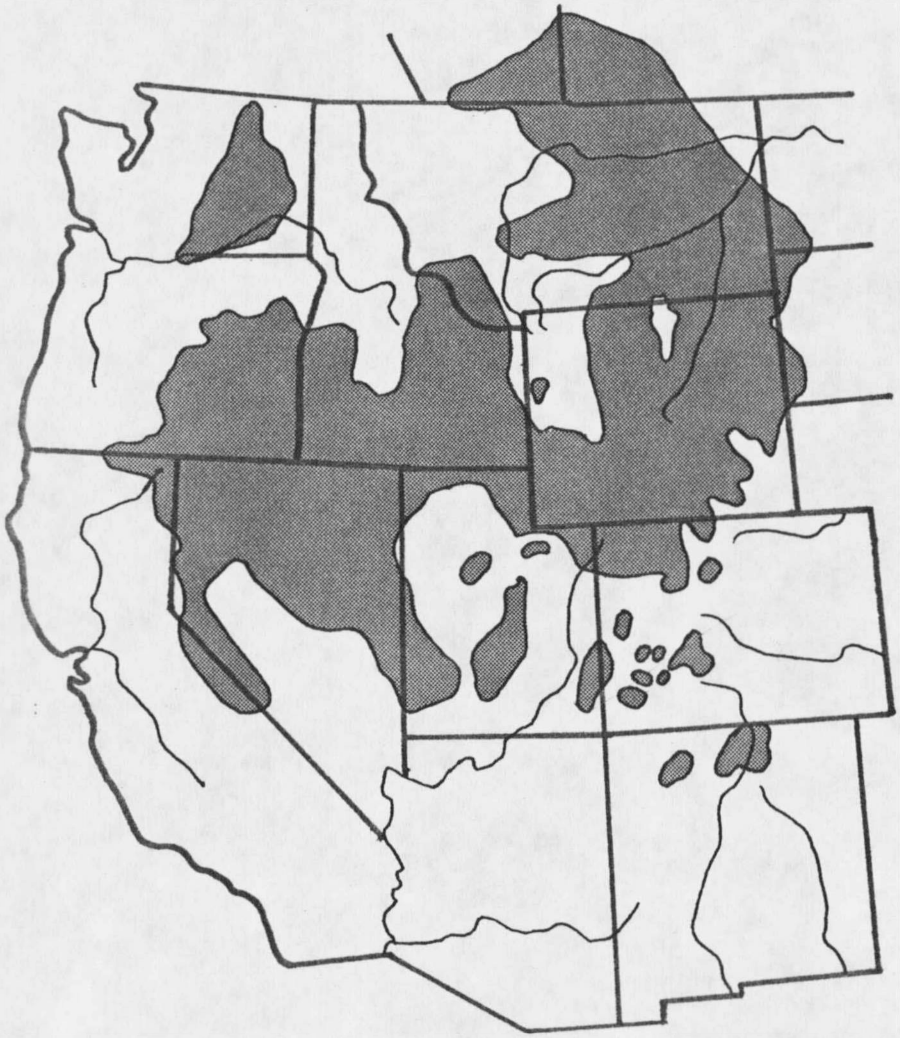

Figure 1. Sage grouse distribution in 1975, taken from Wallestad (1975).

Drought and livestock overgrazing have also altered sagebrush communities and may have contributed to grouse declines. Patterson (1952) pointed out that the decline in sage grouse populations coincided with the maximum livestock utilization of range resources between 1900 and 1915. Woody species dominated pre-grazing vegetation in the intermountain west while grasses and forbs were less conspicuous (Vale 1974). Under heavy, unregulated grazing regimes, perennial forbs decreased the most while woody species increased (Vale 1974). Although increased densities of sagebrush may have enhanced sage grouse winter range, spring and summer ranges deteriorated significantly. With the regulation of grazing provided by the Taylor Grazing Act of 1934, grouse declines reversed; populations increased but did not reach historical levels (Klebenow 1972).

Sage grouse/livestock interactions have not been extensively studied. Although Patterson (1952) believed that moderate use by sheep did not impair sage grouse occupancy of an area, he reported considerable nest desertion when bedgrounds were in the vicinity of grouse nesting activity.

Fire has historically been an important source of disturbance in sagebrush-grass communities (Gates 1983, Anderson and Shumar 1989). Fire may be beneficial or detrimental to sage grouse, depending on the particular setting and location relative to seasonal ranges (Call and Maser 1985). While sagebrush is easily killed by fire, late summer or early fall fires usually do not damage perennial grasses and forbs. Perennial grasses, forbs, and shrubs like rabbitbrush (Chrysothamnus spp.) resprout after burning and are aided by the release of nutrients following a fire event (Anderson and Shumar 1989). Once sagebrush is removed, the subsequent decrease in competition for moisture and nutrients benefits other plant species in the community (Gates 1983).

Since sagebrush only reinvades burned areas by seed, 30 years or more may be required to regain pre-burn densities (Harniss and Murray 1973). As sagebrush recovers, grass and forb densities decrease (Harniss and Murray 1973). Thus fire-induced changes to sagebrush-grassland communities should have long-term effects on the quality and quantity of forage and cover available to sage grouse (Gates 1983).

Some qualitative discussions emphasize that fire can be a useful sage grouse habitat management tool to enhance habitat diversity by creating openings ideal for brood feeding sites (Klebenow 1972, Call and Maser 1985). Where openings suitable for sage grouse strutting grounds are limited, fire can open dense stands of sagebrush and encourage the establishment of new breeding complexes (Connelly et al. 1981). Moritz (1988) concluded that fire improved spring and summer range for sage grouse. However, he did not detect significant differences in seasonal use between fire scars with a perennial grass/rabbitbrush community and adjacent unburned vegetation. Variable grouse use of fire scars with different ages and vegetation characteristics was attributed to the degree to which the fire scar satisfied sage grouse needs at that time of year.

Fire can also be detrimental to sage grouse. Connelly (1987) hypothesized that the negative impacts of chemical sagebrush control on sage grouse winter and nesting habitat could also be caused by a controlled burn on these seasonal ranges. Gates (1983) reported that sagebrush burning on winter range negatively impacted sage grouse populations, especially in areas of limited sagebrush cover.

Little is known about the response by sage grouse to artificial plantings of crested wheatgrass (<u>Agropyron cristatum</u>). Although Connelly (1982) observed sage grouse on display arenas in crested wheatgrass stands during spring, he never observed birds in such stands at any other time of the year. He concluded that crested wheatgrass plantings are totally unsuitable as winter and summer range. Beck (1977) also witnessed little use of crested wheatgrass plantings by sage grouse during winter.

This study was designed to describe sage grouse distribution and movement patterns in and around vegetation communities altered by fire and an artificial seeding of crested wheatgrass. Field work was conducted from mid-March to early-September in 1988 and 1989.

More specifically, the objectives were:

(1) To determine sage grouse movement patterns in and around different vegetation types within a fire scar complex

(2) To compare relative seasonal use by sage grouse of burned, non-burned, and seeded areas, and

(3) To characterize vegetation types within the fire scar complex.

# STUDY AREA

The Idaho National Engineering Laboratory (INEL) occupies 2315 $km^2$ of sagebrush steppe in Bingham, Bonneville, Butte, Clark, and Jefferson counties, Idaho (Fig. 2). As a large reserve, it supports biota typical of cool desert habitats on the Upper Snake River Plain (Harniss and West 1973). The site adjoins foothills of the Lost River, Lemhi, and Bitterroot mountain ranges. Elevations vary between 1,424 and 1,624 m on flat to gently rolling topography punctuated by lava outcrops.

Of the entire Upper Snake River Plain, the INEL is thought to have the lowest mean annual precipitation and temperatures (Harniss and West 1973). Although total annual precipitation varies widely, 2 peaks are evident: December/January in the form of snow and May/June as rain (Harniss and West 1973). Annual precipitation averages 21 cm at the Central Facilities Area, with 40% falling during April, May, and June (Gates 1983). Temperatures vary little year to year, ranging from -41 to 38 C (Harniss and West 1973). January is the coldest month and July the hottest.

McBride et al. (1978) identified 20 vegetation types on the site. Within those types having a shrub component, big sagebrush (<u>Artemisia</u> <u>tridentata</u> ssp. <u>tridentata</u> and

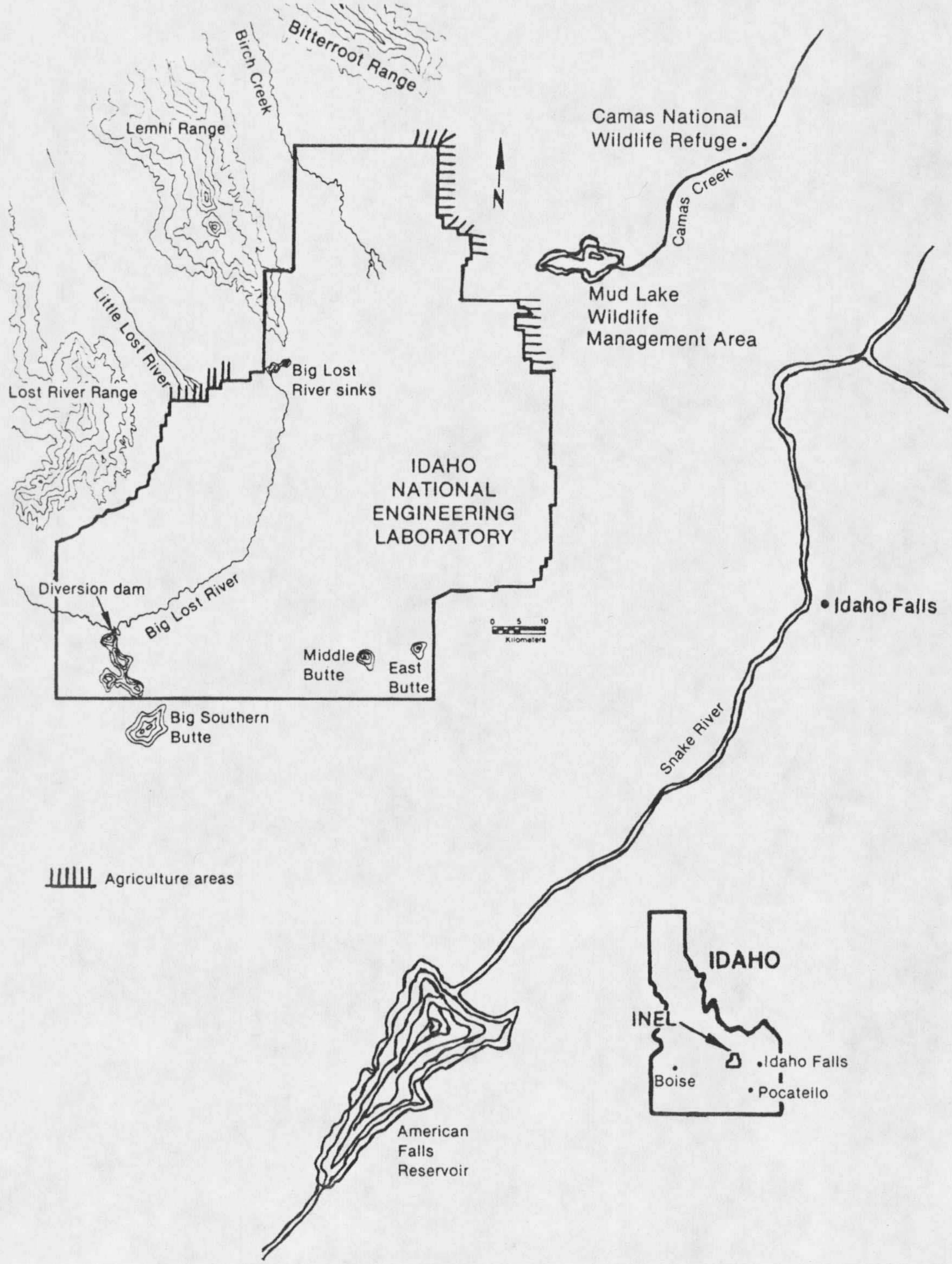


Figure 2. The Idaho National Engineering Laboratory, in southeastern Idaho, relative to surrounding topographic features. Taken from Arthur et al. (1984).

A. t. ssp. wyomingensis) dominate (Anderson and Shumar 1989). Other common shrubs on the site include the rabbitbrushes (Chrysothamnus vicidiflorus and C. nauseosus), gray horsebrush (Tetradymia canescens), Gardner saltbush (Atriplex gardneri), and winterfat (Ceratoides lanata). Prevalent grasses are: bottlebrush squirreltail (Sitanion hystrix), Indian ricegrass (Oryzopsis hymenoides), basin wildrye (Elymus cinerus), needle and thread (Stipa comata), and wheatgrasses (Agropyron spp.).

Of the many fire scars visible on INEL aerial photos, I selected one for intensive study and another for general comparison: Tractor Flats and Arco Highway, respectively (Fig. 3). The Arco Highway fire, on the western INEL boundary, occurred in July, 1974. Although the ignition source is unknown, 0.76 $km^2$ burned. There was no artificial manipulation of the burn site.

The Tractor Flats study area was near the eastern boundary. Historical records of this area are vague. McBride et al. (1978) reported that in 1910, approximately 40.5 $km^2$ burned in this general area. Although the ignition source is unknown, it is common southern Idaho lore that sheepmen set many range fires (Yensen 1981).

In 1956, approximately 10.6 $km^2$ at the Tractor Flats site were seeded to crested wheatgrass to help control the spread of halogeton (Halogeton glomeratus), a noxious weed, and to provide additional opportunity for livestock grazing

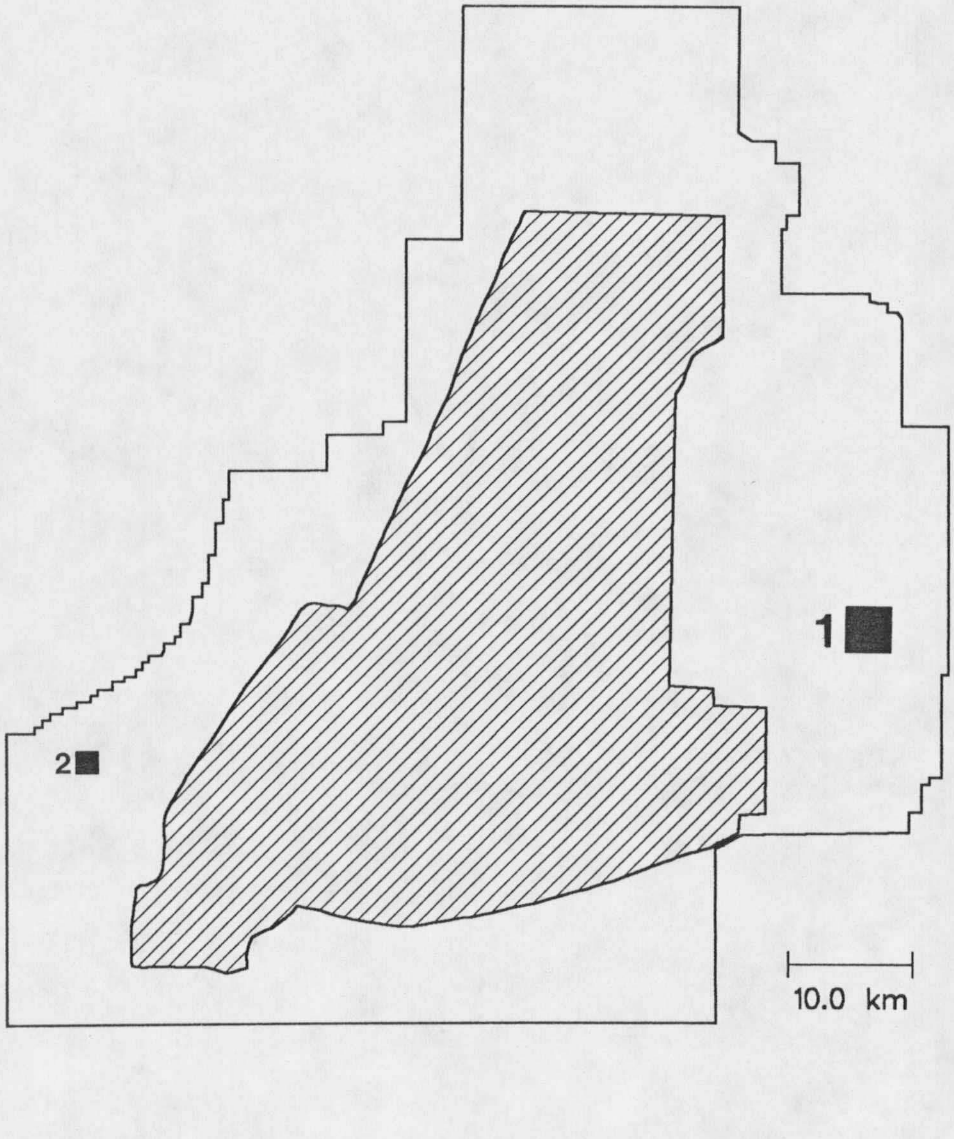


Figure 3. Locations of the Tractor Flats (1) and Arco Highway (2) study areas on the INEL. The shaded area indicates where livestock grazing is prohibited.

(M. Stoddard, BLM, pers. comm.). The remainder of the fire scar to the north was allowed to recover naturally. This 30.3 $km^2$ area consists of perennial grasses and shrubs. Although the Tractor Flats study area was divided into 2 post-fire treatments, the crested wheatgrass seeding and the naturally revegetated area (Fig. 4), "Tractor Flats" will refer to the entire fire scar complex unless a subunit is specified.

Domestic livestock have grazed the Snake River Plain since the late 1800s (Harniss and West 1973). By 1900, overgrazing severely damaged native plant communities (Yensen 1981). Sheep were traditionally turned onto the range in spring as soon as adequate forage was available. Grazing continued until forage on summer mountain ranges was ready. Sheep were then brought back to the desert for fall/winter grazing until lambing (Harniss and West 1973). This type of grazing persisted on what was largely unappropriated public domain. The sagebrush-grasslands linked summer and winter ranges, supporting cattle and sheep during spring and fall (Patterson 1952).

Tractor Flats in the late 1800's, was a "common use" area wherein forage was utilized on a first-come, first-served basis. Operators utilized range resources at their own discretion, simply trying to avoid mingling of different sheep bands (M. Stoddard, pers. comm.). Under current BLM regulation, the principle of "common use" still

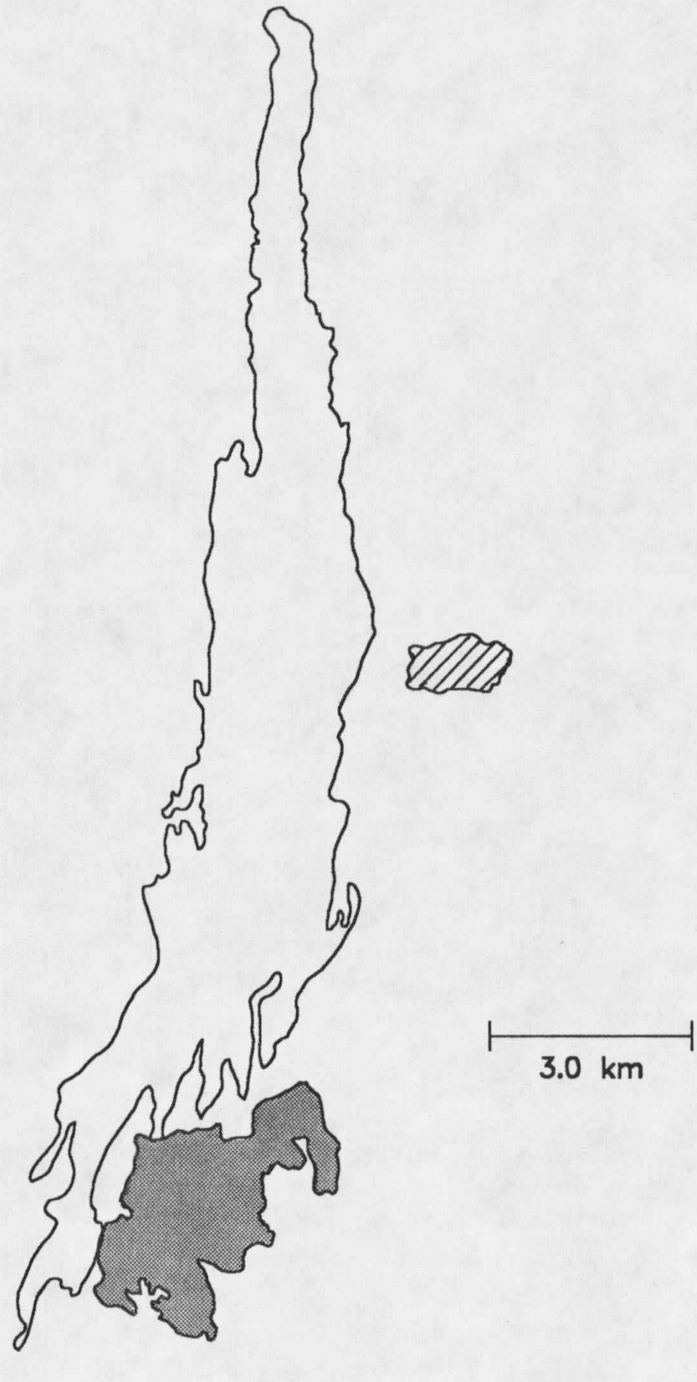


Figure 4. Map of the Tractor Flats fire scar complex, illustrating vegetation communities. The shaded area was seeded to crested wheatgrass and the unshaded area was allowed to revegetate naturally. The striped area was dominated by basin wildrye. Unaltered sagebrush stands prevail outside these boundaries.

applies. However, permittees must adhere to a "take 50%--leave 50%" forage utilization protocol and must limit their sheep numbers according to BLM specifications for current range conditions. Operators still graze their sheep herds in spring and fall on Tractor Flats and largely determine their own range starting dates and grazing locations. Typically, Tractor Flats is grazed from early-April until early June and November to February by 3 or 4 permittees, though not concurrently. Tractor Flats was grazed both years of the study whereas Arco Highway was not grazed during either year.

# METHODS

Three approaches were taken to determine sage grouse use of burned, non-burned, and artificially seeded areas on the Tractor Flats fire scar complex. Movement patterns were determined by radio telemetry. Relative use of these vegetation communities was determined using roadside counts of observed sage grouse and pellet counts. Pellet counts were also conducted on the Arco Highway study area.

## Movement Patterns

### Capture

During 1988, cannon-net traps (Dill and Thornsberry 1950) and night spot lighting techniques (Giesen et al. 1982) were used to capture grouse on 2 strutting grounds within the Tractor Flats crested wheatgrass seeding. During 1989, walk-in traps (Toepfer et al. 1987) were used to capture hens on these same display arenas. In both years, sage grouse chick distress calls were imitated to capture brood hens after the breeding season. The primary focus of this study was the Tractor Flats fire scar complex. No attempt was made during either year to capture sage grouse on the Arco site.

Monitoring

Captured grouse were fitted with aluminum leg bands and radio transmitter collars (Amstrup 1980) in both years. Males not receiving transmitters were marked with patagial tags.

Birds were relocated from the ground using 1 of 3 receivers (Cedar Creek, AVM, or Telonics) and a 3-element Yagi antenna. A vehicle-mounted omni antenna was also used. When birds could not be located from the ground or when other field work precluded regular relocation intervals, birds were located from a light aircraft with wing-mounted "H" and Yagi antennas.

At the conclusion of breeding activities, an attempt was made to locate each telemetered bird at least once a day. However, rugged terrain and limited road systems precluded intensive monitoring. To avoid biasing movement patterns, birds were not flushed with each relocation. Occasionally triangulated positions were approached on foot to intentionally flush a bird or recover a transmitter. This served as a means of assessing triangulation accuracy. No formal estimation of triangulation error was attempted.

In 1989, hen nesting chronology was calculated once day-to-day movements became minimal. During the final stages of incubation, hens were flushed from nests at sunrise to measure clutch size.

Triangulated relocations were plotted on 1:24,000 topographic maps. Using transparencies, relocations were referenced to orthophotographic maps to classify locations as to vegetation type. Only those relocations within the Tractor Flats burn complex were considered. Aerial photographs (1:40,000) were also consulted during vegetation classification. Five types were identified: crested wheatgrass (CW), unburned sagebrush (SB), basin wildrye (WR), naturally recovered fire scars (TF-N), and a 0.5 km interzone (I) which was characterized by dead overhead sagebrush canopy, rabbitbrush, and an understory of grasses and forbs. This classification was included because shrub encroachment into fire scar boundaries has undoubtedly occurred over the years. The crested wheatgrass type included few other plant species. Unburned sagebrush typically had a mixed understory of grasses and forbs. Naturally revegetated fire scars were typically dominated by green rabbitbrush, perennial grasses, and forbs. In the basin wildrye type, wildrye provided the overhead canopy while the understory consisted of native forbs.

Sage grouse home range sizes and daily movement distances were determined using the computer program TELDAY (Lonner and Burkhalter 1988). Home range sizes are based on the convex polygon, minimum area method (Mohr 1947).

## Relative Use

### Road Census

Roadside counts of sage grouse were made along predetermined routes in the Tractor Flats study area during 1988 and 1989 (Kozicky et al. 1952). Each census began at sunrise and was conducted under similar conditions of weather, vehicle speed, and number of observers. Visual observations were made, noting date, time, number of birds, sex, location, and activity if discernible. As with telemetry data, these observations were plotted on maps and classified by the same vegetation types as used for telemetry relocations. Observations were further classified by season. Spring included the breeding and nesting season from March to mid-June whereas summer extended from mid-June to September. These dates were based on previously documented shifts in sage grouse seasonal distribution (Connelly 1982).

Route 1 included the crested wheat seeding and surrounding undisturbed sagebrush stands to the south. Route 2 included a short segment of the seeding, a considerable proportion of the naturally revegetated fire scar and surrounding undisturbed sagebrush (Fig. 5).

Sage grouse observed while conducting other field activities were also noted. The majority of these incidental observations were made while traveling roads in the Tractor Flats study area. In keeping with the primary

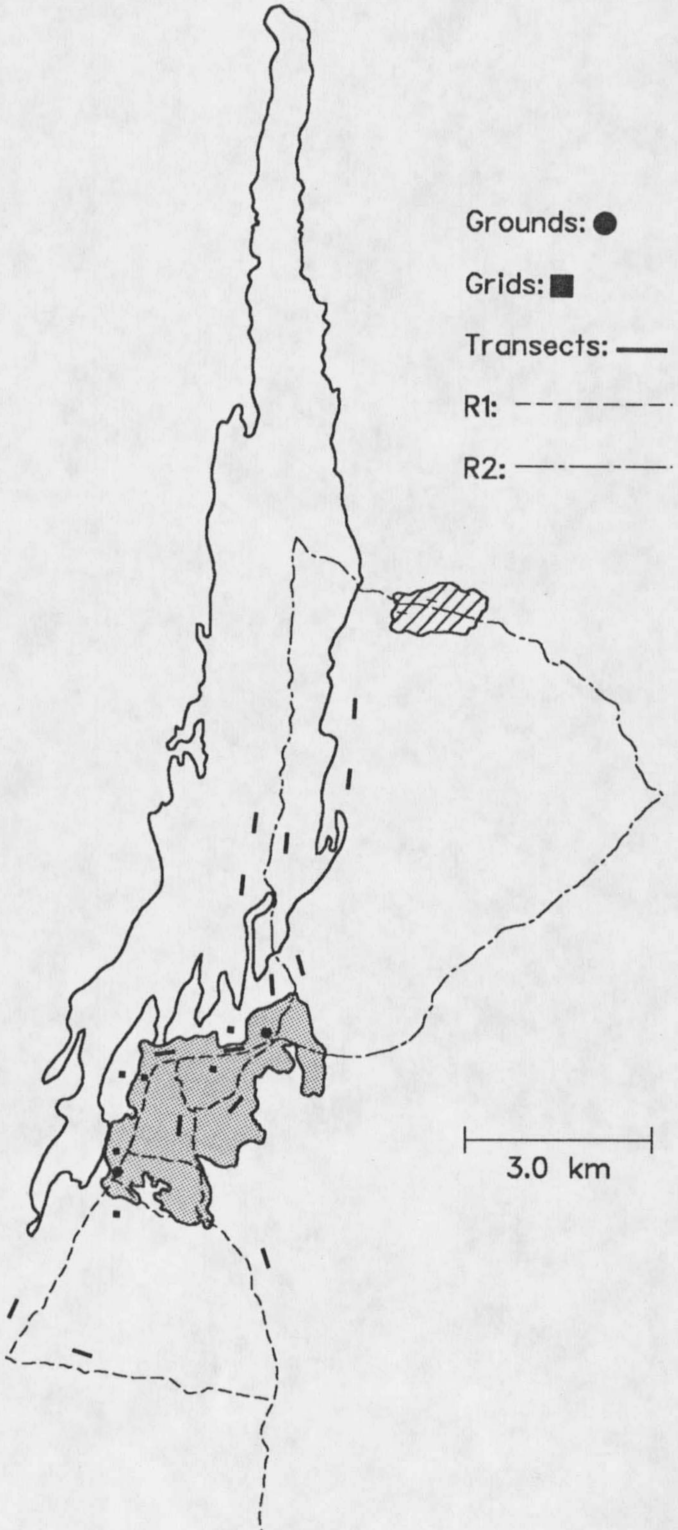


Figure 5. Road census routes, strutting grounds, and vegetation/pellet sampling grids and transects on the Tractor Flats fire scar complex.

objectives of the study and because of the small size and limited road system, roadside counts were not conducted on the Arco Highway study site. Thus no information is available on seasonal distribution of sage grouse in the burned and non-burned vegetation communities of that area.

Pellet Counts

Pellet group count grids were established in 1989 on Tractor Flats study areas following protocol outlined by Moritz (1988). Grids were also established on the Arco site for comparative purposes. Each grid measured 0.065 $km^2$, consisting of 25 points arranged in a 5x5 manner. On each study site, 6 grids were set up, 3 in the fire scar (burn) and 3 in the surrounding sagebrush (control) (Figs. 5, 6). A 3x8 point arrangement was necessary for 1 burn grid on Tractor Flats and Arco Highway because of narrow fire scar dimensions.

The Arco Highway grids duplicated those used by Moritz (1988). Six new grids were established on the Tractor Flats study area. They were placed randomly, although the interzone was purposely avoided. The Tractor Flats burn grids were all within the crested wheatgrass seeding, placed away from known strutting grounds. Grids studied by Moritz (1988) were in the unseeded portion of the Tractor Flats fire scar allowed to recover naturally (TF-N).

As monitoring the 0.065 $km^2$ grids was labor intensive, 100 m transects were also established to collect

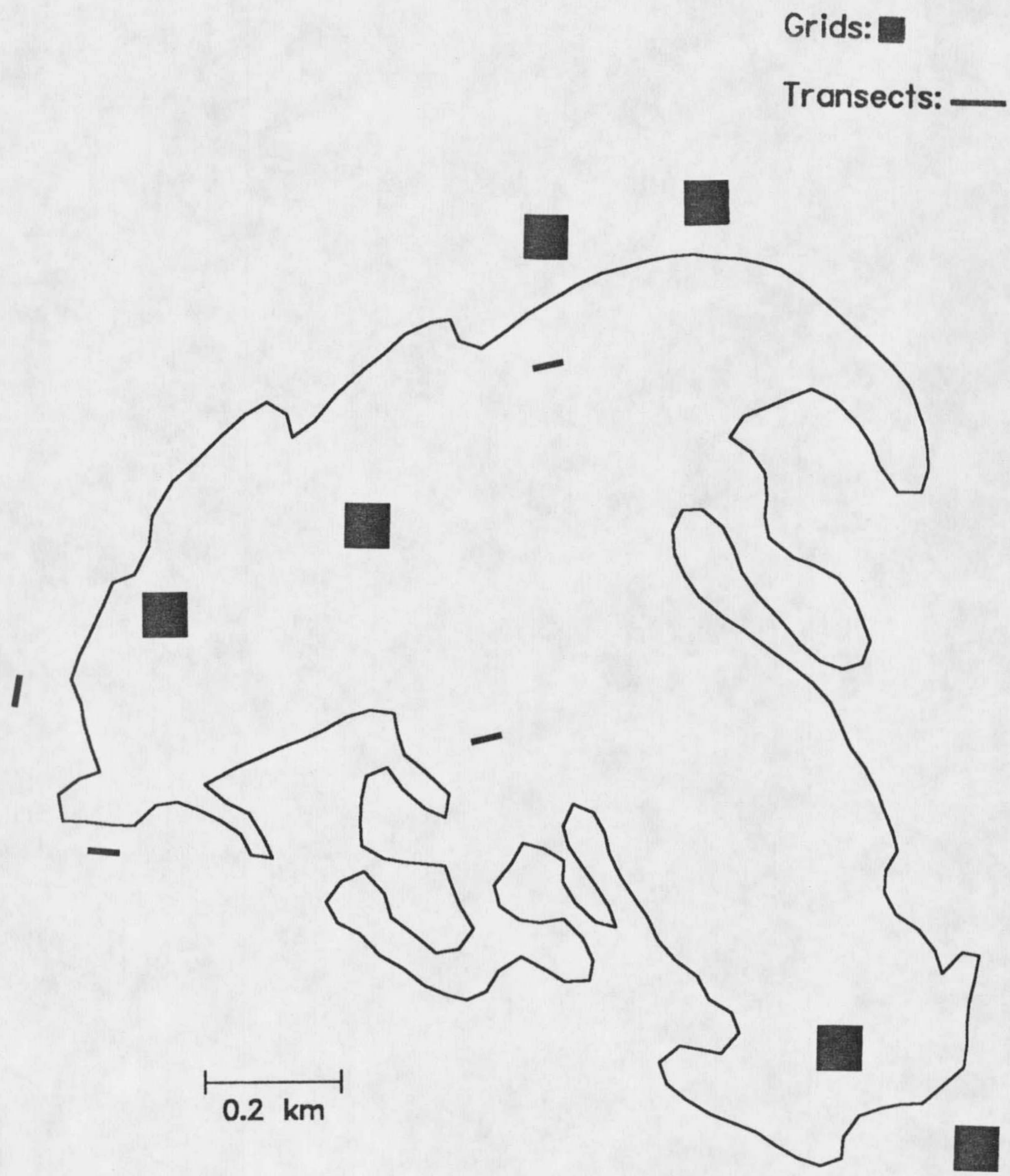


Figure 6. Vegetation/pellet sampling grids and transects on the Arco Highway fire scar.

information from additional locations on the study areas. Eight transects (4 burn and 4 control) were established on the Tractor Flats study area. Four transects were established (2 burn and 2 control) on the Arco Highway site. Three burn and 3 control transects were also monitored on TF-N. They were on or very near to the original grids used by Moritz (1988).

All grids and transects were originally cleared in April, 1989. Single pellets and roost piles (>10 single pellets) were counted in a 40 $m^2$ circular plot centered on each grid point. Five 40 $m^2$ circular plots were sampled along each transect at 25 m intervals. Pellets were counted and removed. Pellets collected in June reflected spring season use while pellets collected in September reflected summer season. These seasons were based on documented shifts from breeding/nesting to brood-rearing areas in mid-June (Connelly 1982). Data from all circular plots within each grid were pooled with transect data to evaluate sage grouse use of burned and non-burned areas, respectively.

## Vegetation

Methods described by Floyd and Anderson (1982) were used to characterize vegetation on the Arco Highway and Tractor Flats areas. Vegetation data were collected in the same 5x5 point grids used to collect pellet information. Eight points out of 25 were randomly chosen. From each point, a 50 m steel tape was stretched to the next point to the east. Along the 50 m tape, a 20 m sub-sample was chosen randomly. Point interception frames were read at 2, 5, 8, 11, 14, 17 m along the 20 m subsample. As vegetation is very heterogeneous on the INEL, it was best to sample many sites as opposed to intensively sampling only a few sites (J. Anderson pers. comm.). Vegetation intercepted by each point was recorded. If more than one species was encountered, both were recorded to reflect understory and overstory vegetation. Bare ground and litter (dead plant material) were also recorded.

Big sagebrush heights were measured to the nearest centimeter. Percent live crown was visually estimated using the following classes: 0-5%, 6-25%, 26-50%, 51-75%, and 76-100%.

Vegetation sampling began in early-July, 1989. At this time, early season plants were senescent but late season plants were mature enough to identify. Some desiccated specimens were compared with INEL herbarium specimens for positive identification. All vegetation data were pooled to reflect each community type.

Because vegetation on the INEL is highly variable in space and time, the sampling intensity required to obtain a statistical representation was prohibitive. Thus, vegetation data were descriptive only. Nomenclature follows Hitchcock and Cronquist (1974).

## Precipitation

Rain gauges were placed on each study area to compare precipitation patterns between the Tractor Flats and Arco Highway. A third gauge was placed approximately halfway between the 2 study areas. Gauges were checked and emptied after each suspected precipitation event.

## Statistics

Statistical analyses were conducted using the microcomputer software MSUSTAT (Lund 1988). Non-parametric signed-rank tests were used to determine if differences existed in observational data between years and between road census routes. Incidental observations were also tested against road census data. Where no significant differences were detected, data sets were combined for subsequent analyses. Movement patterns and relative use data were analyzed using chi-squared procedures. If significant differences were found, residual analysis was used to indicate which cells in the contingency tables contributed to significance (Everitt 1977). Maximum likelihood estimates (marginal probabilities) were also calculated for all contingency tables. Statistical tests were considered significant if $p<0.05$.

# RESULTS

## Movement Patterns

### Capture

1988. Twelve sage grouse were trapped on Tractor Flats strutting grounds. Six adult males received patagial tags. Five adult males and 1 yearling male were radio-tagged. One additional transmitter was placed on a hen escorting a young brood.

1989. Thirteen grouse were trapped on Tractor Flats strutting grounds. Of 3 adult males caught, only 1 received a patagial tag while 2 were released. Of 10 females caught, 3 adults and 4 yearlings were radio-tagged. One additional hen of unknown age received a radio transmitter.

### Monitoring

1988. All telemetered males left the study area at the conclusion of breeding activity in mid-May (Table 1). Thus, males only used Tractor Flats during part of the spring season. Grouse movements away from the study area were direct and sudden. Four males apparently moved long distances. Throughout the field season, 4 attempts to relocate birds from a light aircraft at high altitudes failed. As these transmitters were not equipped with

Table 1. Telemetry summary for adult (Ad.) and yearling (Ylg.) sage grouse trapped on Tractor Flats, INEL, 1988.

| Radio frequency | Age/ sex | Capture date | # of fixes[a] | Home range[b] | Last found | Maximum distance[c] | Status[d] |
|---|---|---|---|---|---|---|---|
| 580 | Ad. M | 3/30 | 20 | 0.8 | 5/25 | 3.5 SW | radio failure |
| 800 | Ad. M | 3/27 | 50 | 35.1 | 7/18 | 12.4 S | predator mortality |
| 640 | Ad. M | 3/30 | 17 | 81.0 | 8/22 | 33.2 SE | season complete |
| 829 | Ad. M | 4/7 | 31 | 38.8 | 6/27 | 20.2 NW | unknown; NS |
| 810 | Ad. M | 3/27 | 11 | 4.7 | 5/5 | 2.1 N | unknown; NS |
| 839 | Ylg. M | 4/5 | 32 | 63.9 | 5/25 | 23.7 SE | unknown; NS |
| 699[e] | Ad. F | 5/29 | 20 | 3.9 | 9/1 | 3.9 E | season complete |

[a] Total number of relocations
[b] Season long home range size ($km^2$) calculated from TELDAY
[c] Maximum straight line distance (km) moved from point of capture and direction
[d] Status at end of field season, 1988; NS=no signals received from light aircraft
[e] Caught while escorting young brood

mortality sensors, it was unknown whether these birds died, the transmitters became inoperative, or whether movements were long enough to place the birds out of receiving range. None of the marked males were relocated or observed thereafter. Mean home range size for all telemetered males known to have left Tractor Flats which were relocated at least 17 times was 43.9 $km^2$.

The use pattern of vegetation types by male sage grouse was influenced by age ($X^2$=14.1, p=0.003). Residual analysis indicated that adults and yearlings used 3 vegetation types, CW, TF-N and SB, significantly differently (Table 2). Differences between adults and yearlings may be due to the fact that only 1 yearling was monitored whereas 5 adults were monitored.

Table 2. Percent of male sage grouse relocations by age class and vegetation type, Tractor Flats, 1988.

| Vegetation type[a] | Adult male (n=78) | Yearling male (n=31) | Age classes combined (n=109) |
|---|---|---|---|
| CW | 28.2*[b] | 6.5 | 22.0 |
| TF-N | 2.6* | 12.9 | 5.5 |
| I | 6.4 | 0.0 | 4.6 |
| SB | 62.8* | 80.6 | 67.9 |
| WR | 0.0 | 0.0 | 0.0 |

[a] CW=crested wheatgrass seeding; TF-N=naturally revegetated subunit of Tractor Flats fire scar complex; I=interzone; SB=sagebrush

[b] Significant difference between adult and yearling

All age classes combined used SB significantly more than CW, TF-N, and I. CW was used more than TF-N and I. The prevalent use of CW on Tractor Flats probably reflects males associated with strutting grounds during early spring.

1989. All telemetered females remained in the Tractor Flats fire scar complex throughout spring and summer (Table 3). Thus, distinct seasonal movements were not observed. There was no evidence to suggest that birds moved toward agriculture, irrigated INEL lawns, or to other mesic sites. Instead, birds used a localized area, typically from May to early-August before shifting 1-2 km to a different area. Frequently movement was toward the strutting ground on which the bird was trapped. Mean home range size for adults was 5.9 $km^2$ and 11.8 $km^2$ for yearlings (Appendix A).

All yearlings were believed to have initiated a nest, but subsequent movement patterns were not characteristic of nesting hens or hens with young broods. Two adults nested; 1 lost its nest to a predator while the other successfully raised a brood. The hen of unknown age initiated a nest but abandoned it, apparently disturbed by sheep activity. A second nest was initiated but destroyed by a predator.

Four female grouse were preyed upon within a 4.8-km radius of where they were trapped. These mortalities permitted examination of gizzard contents. Large amounts of Cicada parts (Family Cicadidae, Order Homoptera) were

Table 3. Telemetry summary for adult (Ad.) and yearling (Ylg.) female sage grouse trapped on Tractor Flats, 1989.

| Radio frequency | Age/ sex | Capture date | # of fixes[a] | Home range[b] | Last found | Maximum distance[c] | Status[d] |
|---|---|---|---|---|---|---|---|
| 560 | Ad. | 4/5 | 5 | 0.0 | 4/10 | 1.2 SW | radio failure |
| 821 | Ad. | 4/4 | 68 | 2.4 | 6/24 | 3.9 NE | predator mortality |
| 920 | Ad. | 4/1 | 64 | 1.9 | 6/19 | 2.4 NW | predator mortality |
| 630[e] | Ylg. | 4/1 | 7 | 0.0 | 6/18 | 0.5 N | predator mortality |
| 721 | Ylg. | 4/4 | 90 | 11.7 | 8/22 | 5.8 S | season complete |
| 730 | Ylg. | 4/3 | 83 | 2.5 | 8/3 | 2.3 E | unknown; NS |
| 739 | Ylg. | 4/5 | 79 | 21.1 | 8/22 | 4.7 SW | season complete |
| 690 | unk.[f] | 3/31 | 99 | 13.1 | 8/18 | 5.7 SW | predator mortality |

[a] Total number of relocations
[b] Season long home range size ($km^2$) calculated from TELDAY
[c] Maximum straight line distance (km) from point of capture and direction
[d] Status at end of field season, 1989; NS=no signals from light aircraft
[e] Caught while escorting young brood
[f] Unknown age

found. One female, banded as a yearling in 1989, was shot in the fall of 1990 by a hunter approximately 44 km south of Tractor Flats. She was harvested at an interface of agriculture and sagebrush.

Use of vegetation types by female sage grouse varied with age ($X^2$=31.7, p<0.001). Marginal probabilities showed that adults used TF-N significantly more than yearlings but used SB significantly less than yearlings (Table 4). All age classes combined used SB more than CW. Nonetheless, CW was used more than either TF-N or I.

Table 4. Percent of female sage grouse relocations by age class and vegetation type, Tractor Flats, 1989.

| Vegetation type[a] | Adult female (n=221) | Yearling female (n=235) | Age classes combined (n=456) |
|---|---|---|---|
| CW | 13.1 | 17.9 | 15.6 |
| TF-N | 14.5*[b] | 0.9 | 7.5 |
| I | 8.1 | 7.2 | 7.7 |
| SB | 64.3* | 74.0 | 69.3 |
| WR | 0.0 | 0.0 | 0.0 |

[a] CW=crested wheatgrass seeding; TF-N=naturally revegetated subunit of Tractor Flats fire scar complex; I=interzone; SB=sagebrush
[b] Significant difference between adults and yearlings

## Relative Use

### Road Census

1988. Route 1 (24.8 km) was driven 17 times between May 6 and August 21. Route 2 (25.5 km) was driven 16 times between May 8 and August 18. No significant differences in sage grouse observations were detected between routes or between routes and incidental observations. Data from roadside counts were combined with incidental data. Because of life history differences during spring and summer, males and females were treated separately.

More sage grouse were observed prior to July 1 than after (Table 5). Fewer birds of both sexes were observed as the season progressed (Fig. 7). Nesting females and females escorting their young broods may have been less visible until mid-summer. The number of males observed dropped sharply in mid-May. This corresponded to the time when telemetered males left the study area. Despite the decline, there seemed to be a small group of sage grouse which remained in the study area season-long.

Over the entire study season, the sex ratios of birds observed along roadsides varied with date ($X^2$=13.8, $p<0.001$). During spring, significantly more males were observed than females ($X^2$=66.4, $p<0.001$). However, as the season progressed, sexes were observed in more equal proportions ($X^2$=4.35, $p=0.36$).

The sex ratios of observed sage grouse appeared related to vegetation type during spring ($X^2$=52.0, $p<0.001$). Females were more frequently observed in WR but less frequently observed in TF-N compared to males (Table 6).

Table 5. Percent of sage grouse observations by 2 week intervals, Tractor Flats, 1988.

| Date | Males (n=305) | Females (n=245) | All observations (n=550) |
|---|---|---|---|
| 5/6 | 19.3*[a] | 12.2 | 16.2 |
| 5/20 | 49.5* | 24.9 | 38.5 |
| 6/3 | 7.2* | 22.0 | 13.8 |
| 6/17 | 7.9* | 13.5 | 10.4 |
| 7/1 | 2.3* | 6.9 | 4.4 |
| 7/15 | 9.5 | 11.0 | 10.2 |
| 7/29 | 2.3 | 5.3 | 3.6 |
| 8/12 | 2.0 | 4.1 | 2.9 |

[a] Significant difference between males and females

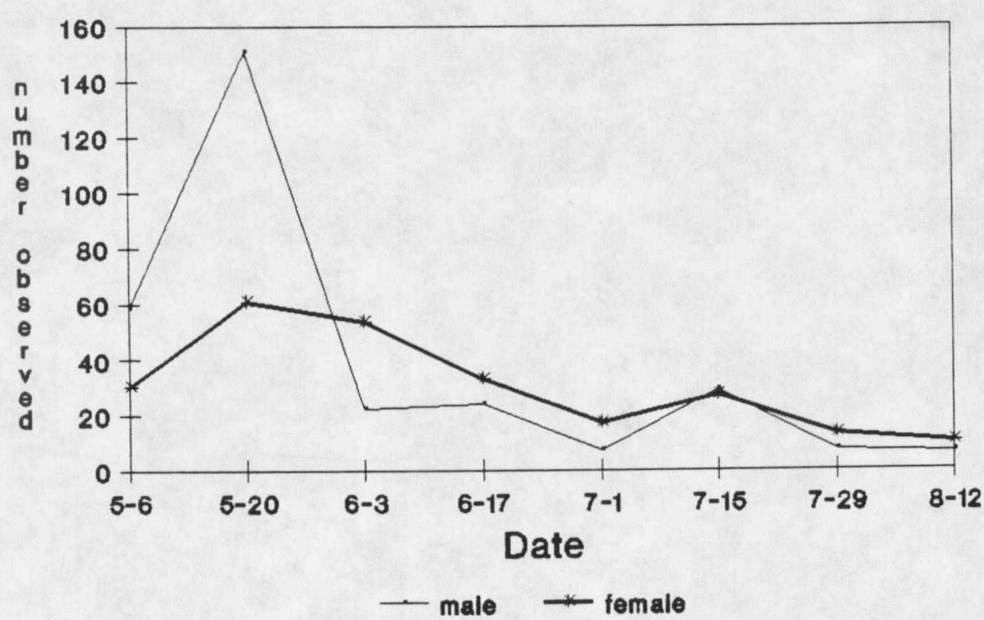


Figure 7. Number of sage grouse observed by 2 week intervals, Tractor Flats, 1988.

During summer, males were most frequently observed in CW whereas females were most frequently observed in TF-N ($X^2$=17.5, p=0.002). Both males and females used CW during spring, but were observed more frequently in CW during summer (Table 6).

Table 6. Percent of sage grouse observations by vegetation type, Tractor Flats, 1988.

| Vegetation type[c] | SPRING[a] Male (n=231) | SPRING[a] Female (n=166) | SUMMER[b] Male (n=63) | SUMMER[b] Female (n=90) |
|---|---|---|---|---|
| SB | 32.9 | 24.1 | 19.0 | 20.8 |
| I | 7.4 | 6.6 | 3.2 | 9.9 |
| TF-N | 48.4*[d] | 31.3 | 17.5 | 24.2 |
| CW | 7.4 | 9.1 | 42.8* | 14.3 |
| WR | 3.9* | 28.9 | 17.5 | 30.8 |

[a] 5/6 through 6/16
[b] 6/17 through 8/31
[c] SB=sagebrush; I=interzone; TF-N=naturally revegetated subunit of Tractor Flats fire scar complex; CW=crested wheatgrass seeding; WR=wild rye grass
[d] Significant difference between males and females

<u>1989.</u> Route 1 was driven 18 times between May 17 and August 21. Route 2 was driven 17 times between May 18 and August 29. No significant differences in bird observations between routes and incidental observations were detected so all data were combined for analysis. Males and females were treated separately.

Prior to July 1, the sex ratios of observed birds were approximately 1:1 ($X^2$=2.9, p=0.24). However, after

July 1, females were observed more frequently than males ($X^2$=42.3, p<0.001) (Table 7).

Table 7. Percent of sage grouse observations by 2 week intervals, Tractor Flats, 1989.

| Date | Males (n=83) | Females (n=235) | All observations (n=318) |
|---|---|---|---|
| 5/6 | 14.5*[a] | 4.7 | 7.2 |
| 5/20 | 6.0 | 6.0 | 6.0 |
| 6/3 | 7.2 | 3.8 | 4.7 |
| 6/17 | 6.0 | 3.4 | 4.1 |
| 7/1 | 0.0* | 11.5 | 8.5 |
| 7/15 | 7.2* | 14.5 | 12.6 |
| 7/29 | 15.7* | 38.7 | 32.7 |
| 8/12 | 43.4* | 17.9 | 24.2 |

[a] Significant difference between males and females

The numbers of males and females observed increased as the season progressed (Fig. 8), just the reverse of 1988. In 1989, temperatures were not as extreme and greater precipitation may have created more favorable conditions for vegetation growth allowing birds to be well dispersed.

During spring 1989, there was no evidence of a relationship between bird sex and the vegetation type where it was observed ($X^2$=3.3, p=0.35). However, during summer, there was evidence that vegetation types were used differently by males and females ($X^2$=30.9, p<0.001).

Females were more frequently observed in I, but less frequently observed in CW compared to males (Table 8).

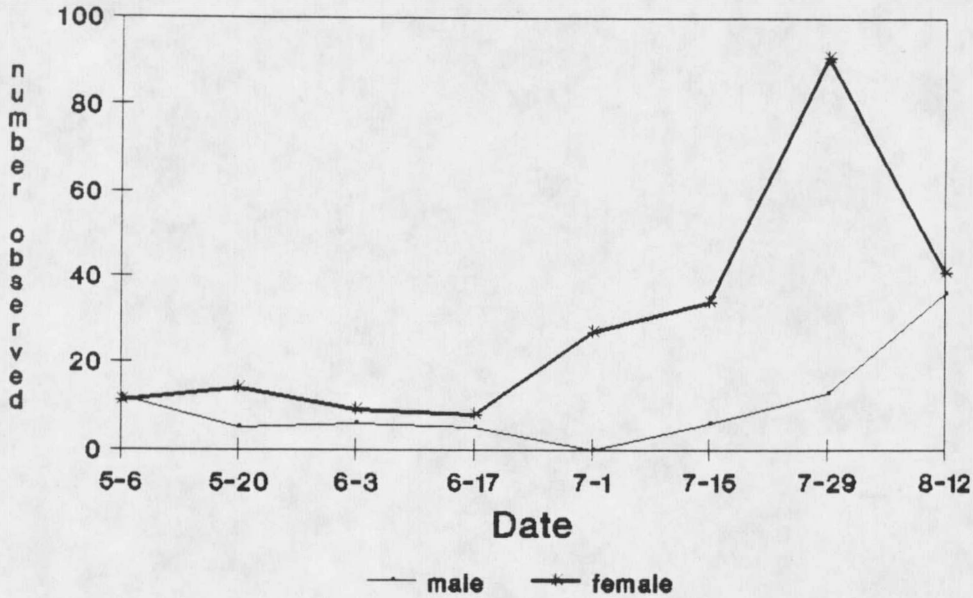


Figure 8. Number of sage grouse observed by 2 week intervals, Tractor Flats, 1989.

Table 8. Percent of sage grouse observations by vegetation type, Tractor Flats, 1989.

| | SPRING[a] | | SUMMER[b] | |
|---|---|---|---|---|
| Vegetation type[c] | Male (n=23) | Female (n=30) | Male (n=60) | Female (n=205) |
| SB | 26.7 | 20.8 | 28.1 | 20.7 |
| I | 33.3 | 12.5 | 5.3*[d] | 31.6 |
| TF-N | 33.3 | 58.3 | 15.8 | 25.3 |
| CW | 6.7 | 8.4 | 43.8* | 14.9 |
| WR | 0.0 | 0.0 | 7.0 | 7.5 |

[a] 5/6 through 6/16
[b] 6/17 through 8/31
[c] SB=sagebrush; I=interzone; TF-N=naturally revegetated subunit of the Tractor Flats fire scar complex; CW=crested wheatgrass seeding; WR=wild rye grass
[d] Significant difference between males and females

Pellet Counts

Pellet data from the 0.063 $km^2$ grids were combined with data from 100 m transects within each study area. On Tractor Flats, sage grouse pellet deposition was related to season and to vegetation status (burn or control) ($X^2=11.36$, $p<0.001$). More pellets were counted in non-burned areas during both spring and summer (Table 9). From these data, it is not clear whether greater numbers of birds used non-burned areas than burned areas or whether birds just spent more time in non-burned areas. Sage grouse use was also related to season and vegetation status on Arco Highway ($X^2=11.9$, $p<0.001$). Sage grouse appeared to use the burn most heavily in spring (Table 9).

Table 9. Percent of pellets counted by season and vegetation status, 1989.

| Season | TRACTOR FLATS Burn (n=36) | TRACTOR FLATS Control (n=217) | ARCO HIGHWAY Burn (n=32) | ARCO HIGHWAY Control (n=12) |
|---|---|---|---|---|
| Spring[a] | 21.4 | 78.6 | 85.3 | 14.7 |
| Summer[b] | 6.6 | 93.4 | 30.0 | 70.0 |

[a] 4/15 through 6/15
[b] 6/16 through 8/31

Pellet density (number of pellets counted/sampled area) was calculated for each study area. The highest densities were on the Tractor Flats controls during spring and summer (Fig. 9). Assuming, that the number of pellets/area/time is proportional to numbers of sage grouse or actual time spent in an area, control areas with SB vegetation types were used more than burned areas.

To indicate the degree of correlation between pellets counted and birds observed in the Tractor Flats area, birds observed in the vicinity of the pellet sampling locations were counted separately. Observations were classified as to vegetation status (burn or control) and season (spring or summer). Based on these observations, there was no evidence to suggest that season or vegetation status affected grouse use ($X^2$=0.1699, p=0.68). Higher proportions of birds were observed in the burn relative to the control during both spring and summer, just the opposite of bird use measured by pellet deposition.

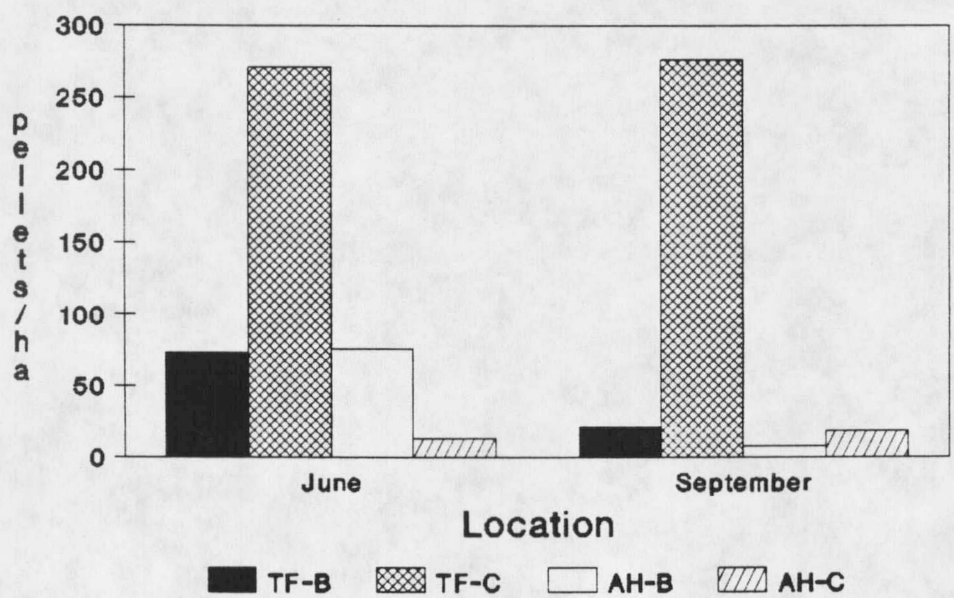


Figure 9. Pellet density (single pellets/sampled area) for Tractor Flats (TF) and Arco Highway (AH) by vegetation status (burn=B or control=C) and collection date, 1989.

## Vegetation

Arco Highway had a greater species diversity than Tractor Flats for all growth forms: shrubs, grasses, and forbs (Appendix B). The only shrub species sampled on the Tractor Flats study area were big sagebrush and green rabbitbrush (Chrysothamnus vicidiflorus). Although these species were found both in burned and non-burned areas, the percent shrub canopy in the burn was only 1.3% compared to 22.3% in non-burned areas (Fig. 10).

These 2 shrub species, and 3 others, were recorded on the Arco Highway site. Big sagebrush was absent from the burn but dominated control areas with a shrub canopy of 26.2%. Green rabbitbrush was the dominant shrub in the burn, contributing significantly to the overall 22.9% shrub canopy.

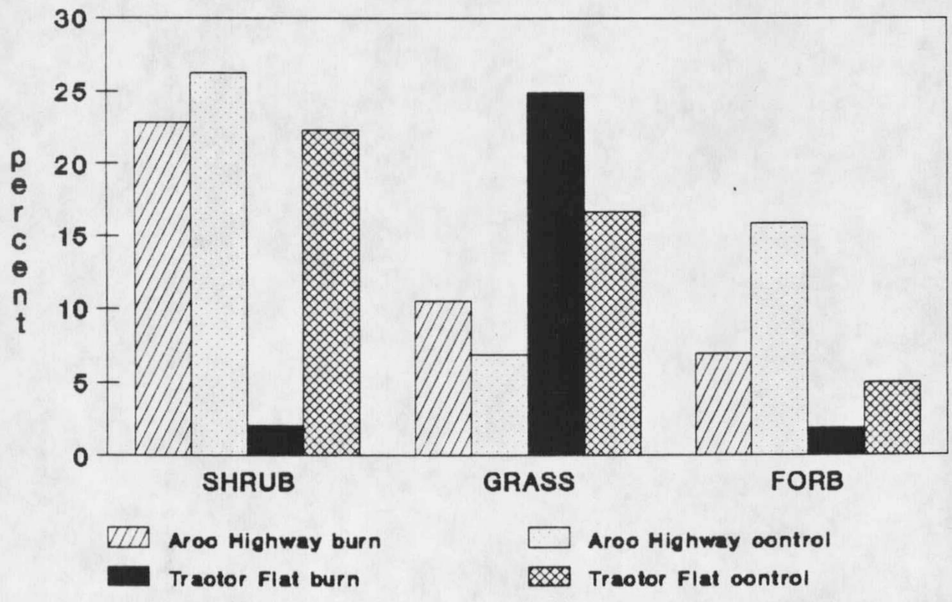


Figure 10. Percent canopy coverage by growth form of Arco Highway and Tractor Flats burn and control grids, 1989.

Although the 24.9% grass canopy on the Tractor Flats burn was the highest of any area sampled, it was entirely composed of crested wheatgrass. This species also dominated the grass community on non-burned Tractor Flats grids. Crested wheatgrass and 4 other grass species summed to a 16.7% total grass canopy. Crested wheatgrass was not found on any Arco Highway sampling location. Bluebunch wheatgrass (Agropyron spicatum) dominated the grass community in both burned and non-burned areas at the Arco Highway site. Six species of grasses contributed to the 10.5% grass canopy measured on the Arco fire scar. Only 5 species contributed to the 6.8% canopy recorded on control areas.

Of the 26 forb species sampled on the Arco burn and control grids, only 10 were found on the Tractor Flats study area. Of all sampled areas, the Tractor Flats fire scar had the lowest percent forb canopy, 1.9%, closely followed by the Tractor Flats control, 5.0%. Halogeton dominated the forb community throughout the entire Tractor Flats area. Phlox (Phlox hoodii) dominated the forb community on the Arco Highway burn and control areas. Other prominent forbs included stoneseed (Cordylanthus ramosus), hawk's beard (Crepis acuminata), and prickly phlox (Leptodactylon pungens). All other forbs were recorded in frequencies of <1.0%.

Tractor Flats burn grids were the only sampling locations where the majority of Artemisia spp. encountered had <50% live crown (Fig. 11). The average height of all Artemisia spp. individuals recorded was 18.7 cm compared to 40.7 cm on non-burned areas. The average heights on Arco Highway were 26.3 cm and 51.8 cm on burn and control grids, respectively.

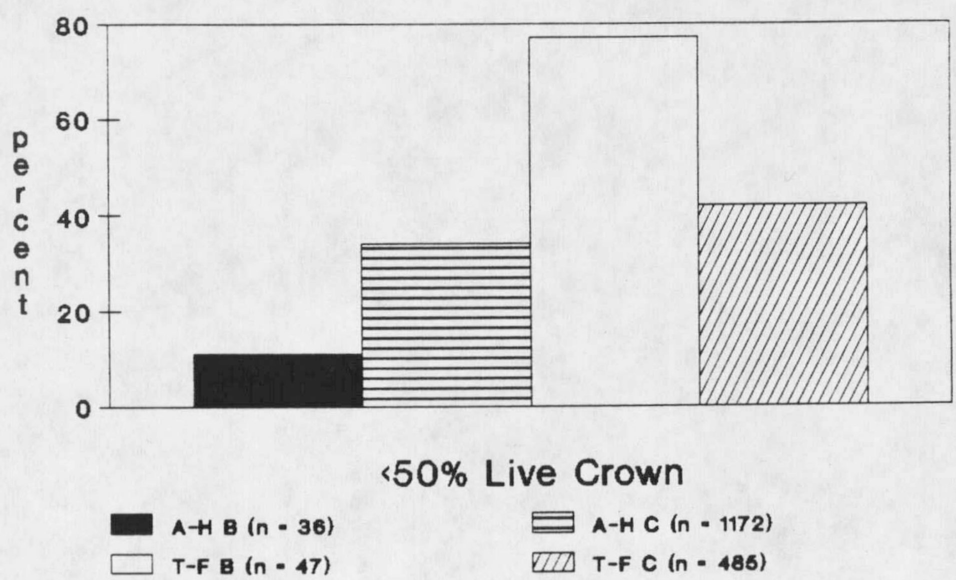


Figure 11. Percent of Artemisia spp. with <50% live crown on Arco Highway (AH) and Tractor Flats (TF) burn and control grids, 1989.

## Precipitation

Because precipitation gauges were not calibrated prior to this study, absolute amounts of precipitation were not available. Relative amounts were recorded instead. Gradients of precipitation existed between the study areas (Fig. 12). The Arco Highway site received the most, probably due to its proximity to the Lemhi and Lost River mountain ranges to the west. The relatively high amount of precipitation likely accounts for the greater vegetation diversity, particularly forbs, on the Arco Highway site. Tractor Flats received an intermediate amount of precipitation while the site between Arco and Tractor Flats received the least. Precipitation events tended to be localized such that some areas received more rain than others during any single precipitation event. Moisture frequently saturated the low-lying areas such as intermittent stream channels. Late-season precipitation was probably important in maintaining the mesic characteristics of these secondary drainages and in sustaining growth of forbs late in the summer.

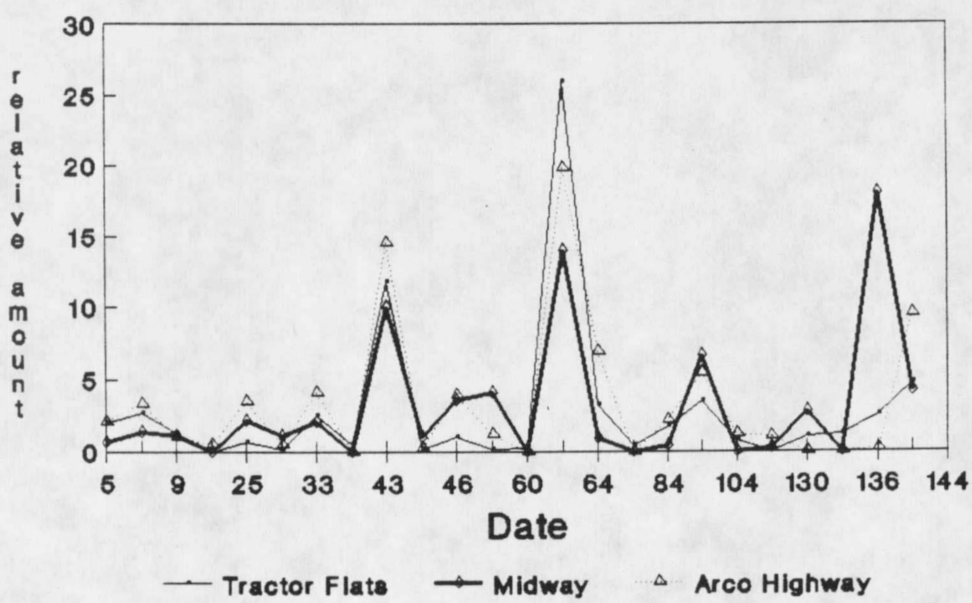


Figure 12. Precipitation (relative amount per precipitation event) on the Tractor Flats and Arco Highway study areas, 1989. Midway is located halfway between the study areas. Day 5 corresponds to March 26, 1989.

# DISCUSSION

Users of western rangelands have altered native vegetation patterns through agricultural development, livestock grazing, artificial seeding, human encroachment, and now industrial development. Human use of fire to alter sagebrush communities has different implications for sage grouse than other methods of alteration. Fire is a natural component of sagebrush ecosystems and sage grouse evolutionarily adapted to its occurrence (Klebenow 1972).

Although the Tractor Flats vegetation community has been altered by fire, some sage grouse remained on the study area during spring and summer. Despite the proximity of alternate spring/summer range (INEL facilities and agriculture) and sheep grazing disturbance, grouse use of Tractor Flats has continued uninterrupted since at least the 1950s (Dick Egbert, sheep operator, pers. comm.). Sage grouse occupancy and use of certain areas is thought to be traditional (Eng and Schladweiler 1972, Berry and Eng 1985). Sage grouse may still use traditional seasonal ranges even when human disturbance created suitable habitat within migratory distance (Connelly et al. 1988). Whereas both Connelly (1982) and Moritz (1988) identified Tractor Flats as sage grouse winter range, only Moritz noted sage grouse occupancy during spring and summer.

During this study of the Tractor Flats population, males tended to migrate whereas females appeared to be sedentary. In contrast, Connelly (1982) reported that both sexes in mountain and plains populations were migratory on the upper Snake River plain. In his study, males moved longer distances than females, usually in a different direction. In addition spring movements by males were rapid whereas movements by successful and unsuccessful females were slow and meandering. He suggested that different movement patterns between males and females could reduce competition.

Movements in 1988 and 1989 varied with precipitation. In extreme drought years like 1988, sage grouse were forced to leave Tractor Flats, retreating to alternate spring/summer range because palatable forbs had desiccated by July. However, in more normal years such as 1989, sage grouse could meet life history requirements on Tractor Flats. Even within a single population, differences in precipitation and habitat quality lead to different movement patterns between years (Klebenow 1981).

The sage grouse which exploit Tractor Flats year-round survive and pass these strategies to new recruits by associating with immature birds (Berry and Eng 1985). Birds dispersing from Tractor Flats are vulnerable to hunter harvest whereas those which remain are not. Loss of those individuals from the population prevents the passing along of migratory strategies, thus reinforcing traditional, sedentary use patterns.

Although vegetation patterns largely determine sage grouse seasonal distributions, diet is important in determining how sage grouse use a particular area. Since some sage grouse occupying Tractor Flats did not migrate in response to vegetation desiccation except in the most extreme drought conditions, food was presumably adequate. In order to meet dietary requirements, sage grouse may have sought microhabitats such as intermittent stream channels which provided succulent forbs throughout the summer. These physiographic features were prominent in the home ranges of females using Tractor Flats during 1989 (Appendix B). One telemetered hen was flushed from an intermittent stream channel because limited movement led me to believe she had been killed by a predator. Inspection of the site revealed an abundance of prickly lettuce (<u>Lactuca serriola</u>), a favored diet item during summer (Peterson 1970). By the next day, she had returned to the same location. Three weeks later, this sequence was repeated with the same result. Klebenow (1970) also referenced sage grouse reliance on stream channels in Colorado. Idaho

Food plants did not have to be abundant to support sage grouse. Prickly lettuce contributed less than 1% to the total forb canopy in both crested wheatgrass and non-burned vegetation communities. Few intermittent stream channels were included in vegetation sampling grids and prickly lettuce was likely underestimated. Klebenow (1969) also found that some plants, though not common enough to be sampled adequately, were present and sought for food.

That sage grouse summered in and around Tractor Flats was unexpected given the large homogeneous stand of crested wheatgrass. Spring and summer are the only seasons when sage grouse significantly depart from their sagebrush diet. During these times of year, all age classes and both sexes switch to forbs and insects (Peterson 1970, Wallestad et al. 1975). Isolated forbs could be found in the seeding but were uncommon. Although frequently seen near adjacent sagebrush stands, many birds were either observed or relocated feeding, resting, and roosting in crested wheatgrass. Sage grouse seldom ventured far from the sagebrush edge of sagebrush because crested wheatgrass provided little security. Two radio-tagged hens in 1989 were killed by predators inside or at the edge of the crested wheatgrass stand.

Sage grouse may have searched crested wheatgrass stands for invertebrates, another important diet item in spring, especially for chicks under 3 weeks of age (Johnson and Boyce 1990). Hewitt and Burleson (1975) studied arthropods in 2 crested wheatgrass pastures in central Montana. On the basis of abundance and above ground biomass, grasshoppers and ants were 2 of 5 important groups of arthropods. Cicadas, although absent in 1988, were abundant throughout the Tractor Flats complex beginning in late spring, 1989. They are large, conspicuous, and easily taken by young grouse.

As sage grouse activity is closely linked to vegetation, domestic livestock may affect grouse movement patterns indirectly by altering composition, structure, or density of vegetation (Call and Maser 1985). Sheep grazed Tractor Flats primarily in spring and early summer. Early spring grazing by livestock may reduce cover and forb availability which would be detrimental to nesting and brood-rearing grouse (Laycock 1967, Hall 1985, Call and Maser 1985). Sheep grazing could be more detrimental than cattle grazing because sheep select forbs (Call and Maser 1985). Direct competition may ensue where winter and spring sheep ranges overlap sage grouse winter and brood ranges (Autenrieth et al. 1982).

In addition, livestock on arid rangeland are attracted to mesic sites like stream bottoms, potentially removing forbs which grouse depend on for late season forage (Call and Maser 1985). During years of below normal moisture and limited forb growth such as 1988, plant phenology is either accelerated or truncated. Thus more forbs may be removed by early livestock grazing before the peak of grouse hatch.

BLM manuals suggest delaying livestock grazing on sage grouse nesting areas until after June 1. This practice on

Tractor Flats would help minimize disturbance of nesting hens. Even with deferments, trailing livestock through the area in route to other allotments could be a problem, especially in dry years because food preferences of grouse and sheep overlap.

Domestic livestock may affect sage grouse movement patterns directly by disrupting nesting activity. Sheep were driven through the Tractor Flats strutting/nesting complex 3-5 times during a field season and could arrive as early as mid-April when hens initiated their nests. Further disruption to nesting activity may have occurred as sheep were moved from 1 part of the burn complex to another every 2-4 days. Although only 1 marked hen in this study was thought to have abandoned a nest because of livestock activity, the potential that unmarked hens were similarly disrupted is high.

Autenrieth et al. (1982) recommended that nesting areas within a 3.2 km radius of strutting grounds remain undisturbed until mid-June. Hens in the egg-laying stage may abandon nests with little provocation. Yearlings are known to abandon nests even during incubation (Autenrieth et al. 1982). Furthermore, these authors expressed concern for the well-being of nesting hens and young broods in the path of livestock drives. During this study, drives also were observed to disrupt breeding activity, flushing sage grouse from display areas.

Telemetry, roadside counts, and pellet count results indicated slightly different habitat use patterns of Tractor Flats during spring and summer. Telemetered males in the spring of 1988 used the same vegetation types as telemetered females during spring and summer in 1989. Sagebrush received the highest use followed by crested wheatgrass, interzone, and naturally revegetated burned areas (TF-N). Roadside counts indicated that in 1988 and 1989, naturally revegetated burned areas were valuable to both males and females. Although used less than TF-N, sagebrush use was also significant. Forb canopies were greatest in non-burned stands of sagebrush and may have attracted sage grouse. Those males which summered in the Tractor Flats area used crested wheatgrass the most but also relied on sagebrush. Basin wildrye and interzone types were most important to females in the summer while use of sagebrush also continued.

Overall patterns of vegetation use observed in 1988 were similar to those in 1989. However, the heavy use of WR in 1988 by males and females was not observed in 1989. Grouse use of WR increased in 1988 as the season progressed. WR may represent a vegetation community that can support birds when habitat conditions are poor. A large bunchgrass, WR provides a moderate overhead canopy while forbs can grow between individual plants. In contrast, sage grouse use of I in 1989 increased over 1988.

Functionally, I resembles WR in providing moderate overhead cover and forb understory growth. Despite differences in precipitation, patterns of SB and CW use were similar for both years. The percent of observations in CW in spring and summer, 1988, was virtually identical to 1989. Both showed increased sage grouse use as the season progressed.

Pellet counts indicated that sage grouse use of non-burned areas was greater than artificially seeded areas. This, too, may relate to the greater forb canopies in sagebrush stands relative to the crested wheatgrass stand.

The inherent biases of each of these 3 techniques likely accounts for discrepancies in the results (Neff 1968 and Eng 1986). However, taken collectively, these data indicated that perennial grass/rabbitbrush communities like TF-N were as important to sage grouse occupying Tractor Flats as sagebrush types. The data provided evidence that sage grouse occupied Tractor Flats during spring and summer by taking advantage of a variety of vegetation types throughout the fire scar complex.

Even though males and females have similar diets during spring and summer, differences between vegetation types sought by males and females could be related to life history differences. As males do not participate in brood rearing activities, their movements are not restricted by the specific requirements and limited mobility of young grouse. Thus, males occupying Tractor Flats were able to use vegetation types such as crested wheatgrass where forbs were less abundant. Even in a population where neither males or females were migratory, males and females were usually socially segregated (Wallestad 1975) during spring and summer.

Sage grouse research has shown that alteration of sagebrush communities may either benefit or harm sage grouse populations depending on the type, severity, and location of disturbance relative to seasonal ranges (Pyrah 1972, Wallestad 1975, Gates 1983, Moritz 1988). Thus the perpetuation and enhancement of sage grouse populations requires that all seasonal habitats necessary for life processes be identified and protected (Beck 1977).

Tractor Flats appears to meet sage grouse requirements throughout the year since occupancy has been documented during all seasons (Connelly 1982, Moritz 1988). Some sage grouse wintering ranges include strutting grounds and associated nesting areas. On Tractor Flats, 3 strutting grounds in the fire scar serve as activity centers within a wintering-nesting complex (Eng and Schladweiler 1972, Moritz 1988). Although crested wheat stands are well suited for strutting grounds, crested wheatgrass cannot meet the needs of sage grouse during winter without adjacent sagebrush. In most cases, sagebrush removal from sage grouse winter range reduces the capacity of that area to support grouse during winter months. Fire and artificial seeding disturbance have not decreased sagebrush canopies enough to damage Tractor Flats winter range.

The wintering-nesting complex on Tractor Flats provided suitable nesting sagebrush within 1-5 km of the strutting grounds. Two adult hens initiated nests less than 2 km from the ground on which they bred. Furthermore, litter values were relatively high on non-burned areas and may have contributed additional nesting cover. Since crested wheatgrass plants spread beyond seeding boundaries, it, too, may provide an element of security to hens nesting near Tractor Flats strutting grounds.

Large tracts of dense sagebrush (20-40% canopy) provide essential winter habitat and potential nesting areas. However, sage grouse brood hens seek areas providing a 1-10% overhead canopy cover interspersed with openings (Klebenow 1969, Wallestad 1971, Dunn and Braun 1986). The monotypic stand of crested wheatgrass offered limited opportunity for young grouse to locate palatable forbs. Small, isolated islands of sagebrush provided the only cover within the seeding boundary. The naturally revegetated subunit of the Tractor Flats fire scar was a more favorable brood-rearing area because overhead canopy and understory vegetative diversity were greater than the crested wheatgrass subunit (Moritz 1988).

Despite the alteration of the sagebrush community by fire and artificial seeding, the Tractor Flats complex appears to meet the requirements of nesting sage grouse hens and broods during spring and summer. The network of stream channels throughout the area appeared to be particularly valuable.

# MANAGEMENT IMPLICATIONS

Sage grouse are so specific in their habitat requirements, Patterson (1952) expressed little hope that sage grouse could readjust their life processes to accommodate land use patterns which significantly disturb or eliminate large tracts of sagebrush. Reservation of Tractor Flats within the Department of Energy site precludes further alteration by agriculture, industry, and/or human encroachment--barring establishment of a new facility. Sagebrush communities on Tractor Flats, however, have been disturbed by fire, seeding, and grazing. The effects are expected to persist for at least 75 years (Moritz 1988).

Grazing activity by sheep during the breeding and nesting season has occurred on Tractor Flats for many decades. However, without empirical information, it is not known to what degree physical disturbance by sheep during the nesting season may adversely affect sage grouse production. Also, it is unknown whether sheep remove enough forbs to significantly decrease forb availability for sage grouse. These questions merit further study.

Tractor Flats serves as an example where fire has created openings in the sagebrush canopy which were heavily used by sage grouse during this study. Using fire to open dense sagebrush canopies in other parts of occupied sage grouse range may enhance brood-rearing areas by increasing forb production. Prescribed burning could also be used to mitigate for spring/summer habitat lost to agricultural, industrial, or human development and would benefit both sexes and all ages of a sage grouse population. It is imperative, however, that winter sagebrush habitat be protected.

Before attempting to use fire as a tool in occupied sage grouse range, several factors should be considered. Radio telemetry rather than observation should be employed to insure proper identification of seasonal ranges of specific population segments as some segments may be sedentary while others may be migratory (Berry and Eng 1985). Openings in the overhead canopy should be restricted to 0.4 to 4.0 ha (Call and Maser 1985). Fire should only be used when desirable vegetation is dormant so as not to harm the plant species sage grouse rely on for food and/or cover (Wright 1974). The burn site should not be grazed until a vigorous stand of self-perpetuating vegetation is well established (Call and Maser 1985). Furthermore, this tool would be most effective in areas where adequate annual precipitation enables rapid revegetation and in areas with a limited potential for invasion of the disturbed site by weedy, undesirable species. When few propagules from the native vegetation community are available or when fire is used in areas of low precipitation, the disturbed site may require artificial seeding.

Although the Tractor Flats population has readjusted life processes to continue using an area where sagebrush and small openings created by fire were replaced by a monotypic stand of crested wheatgrass, seeding crested wheat in sage grouse range is not recommended. As sage grouse require forbs during spring and summer, crested wheatgrass seedings could seriously limit forb availability if alternatives like meadows or intermittent stream channels were not also available. Seeded crested wheatgrass stands on the INEL are very stable (Anderson and Marlette 1986). Seedings can resist invasion by native species for at least 30-50 years (Hull and Klomp 1966). Seedings persist as monocultures because of the paucity of native propagules relative to the prolific seed production of crested wheatgrass (Marlette and Anderson 1986). Although planted 33 years ago, the Tractor Flats seeding showed no signs of weakened resistance to invasion. The only circumstance where crested wheatgrass seedings may be appropriate is for the establishment of persistent openings in sagebrush canopy for strutting grounds, as long as suitable resting cover and nesting habitat is available nearby. Such a seeding should be carefully considered because even when sown in mixtures with native species, crested wheatgrass may quickly dominate and spread beyond seeding boundaries (Hull and Klomp 1967). Instead, a mixture of native grasses and perennial forbs is recommended to maintain openings for display grounds as well as to assist sage grouse seeking palatable forbs during spring and summer.

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# APPENDICES

# APPENDIX A

## FIGURES RELATING TO SAGE GROUSE HOME RANGE ON TRACTOR FLATS

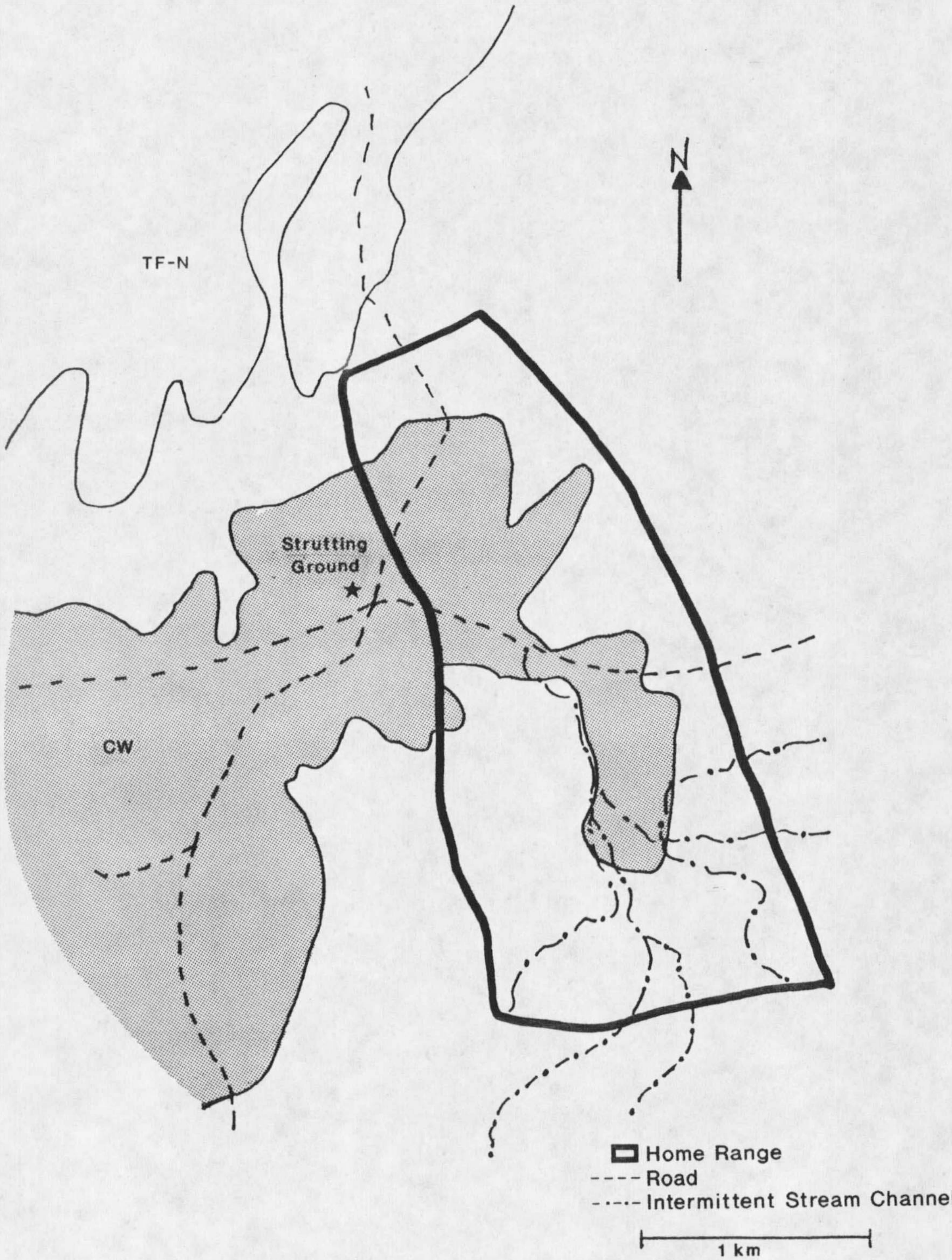


Figure 13. Home range illustration of frequency 730, a yearling female, 1989.

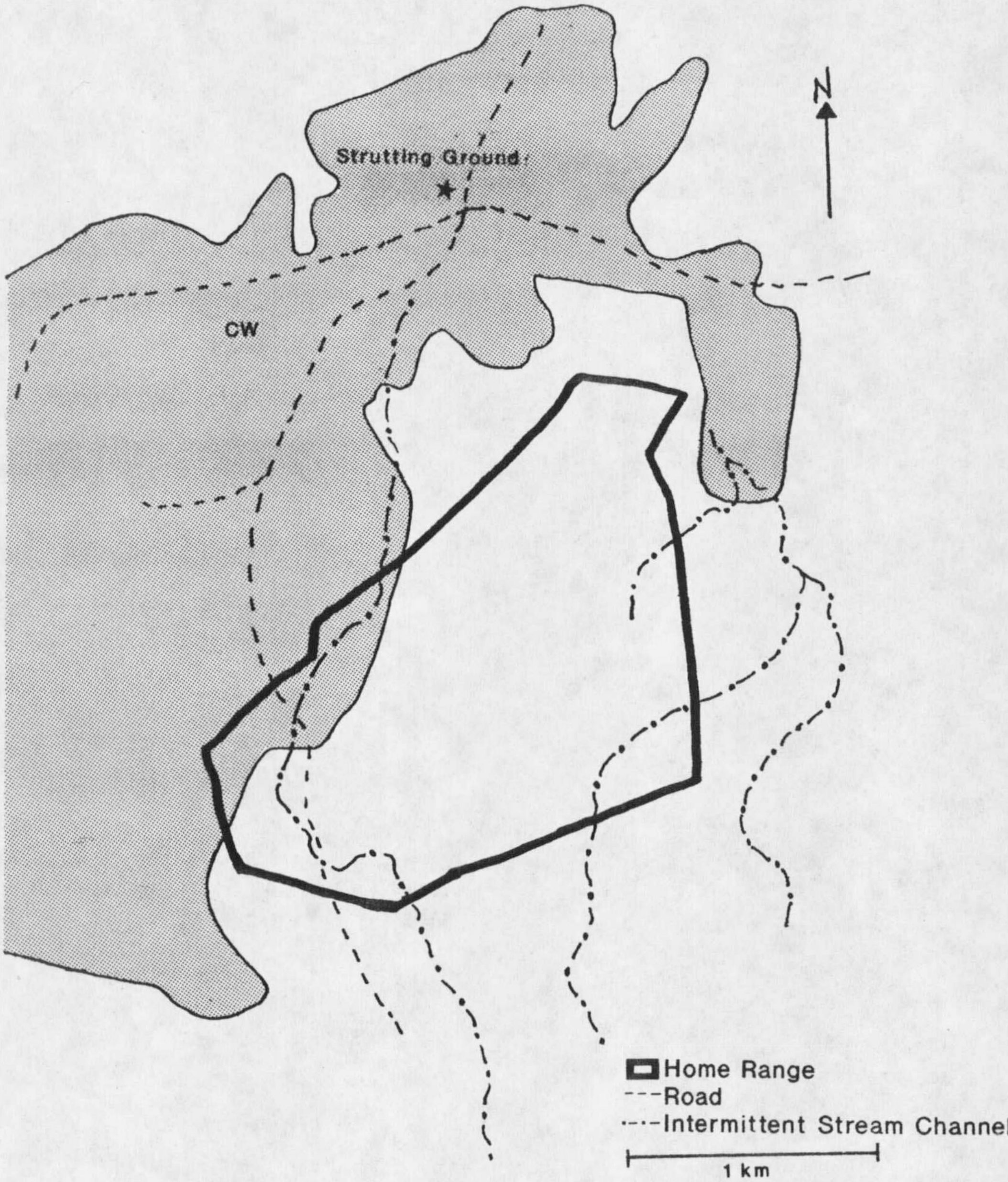


Figure 14. Home range illustration of frequency 821, an adult female, 1989.

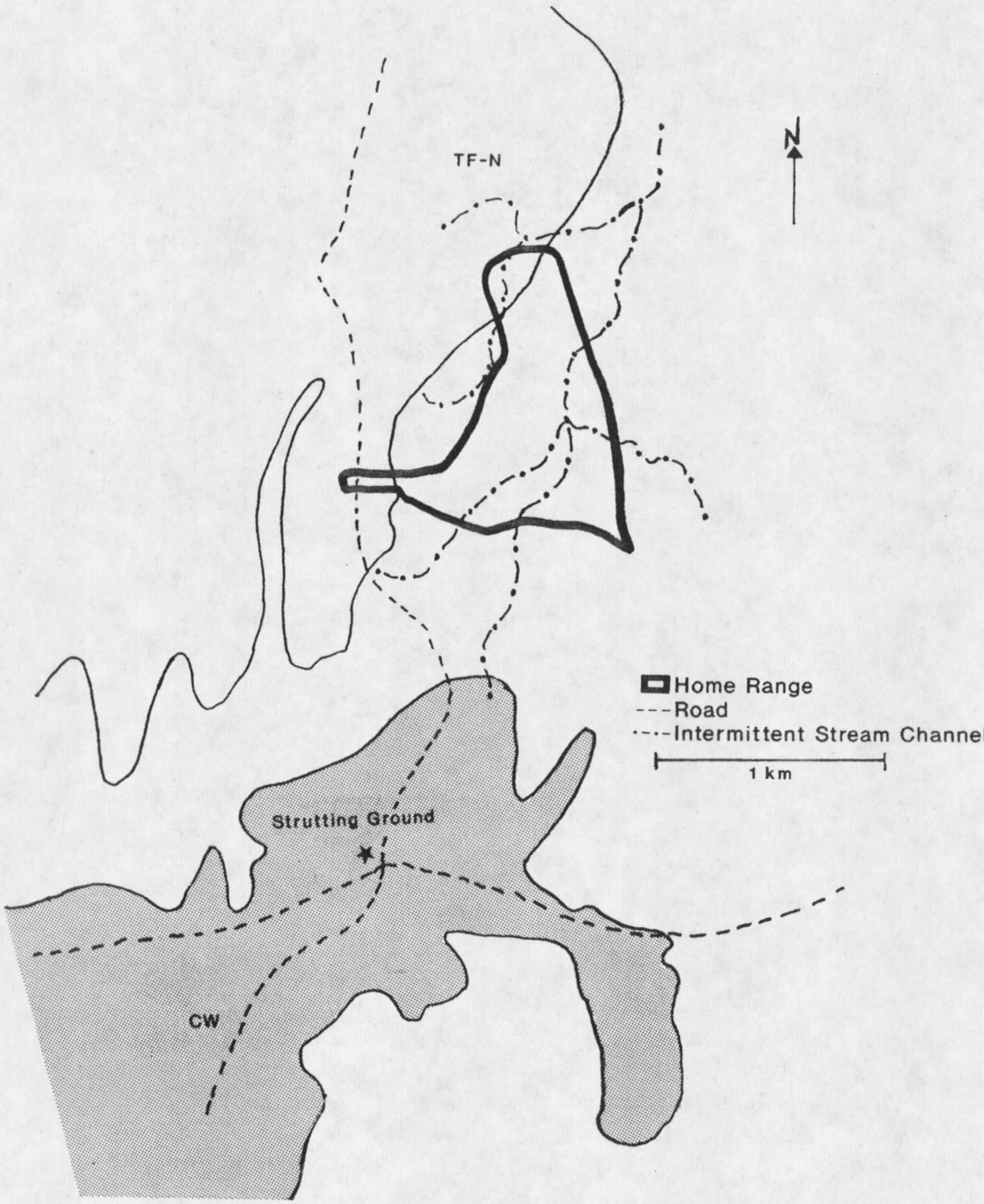


Figure 15. Home range illustration of frequency 920, an adult female, 1989.

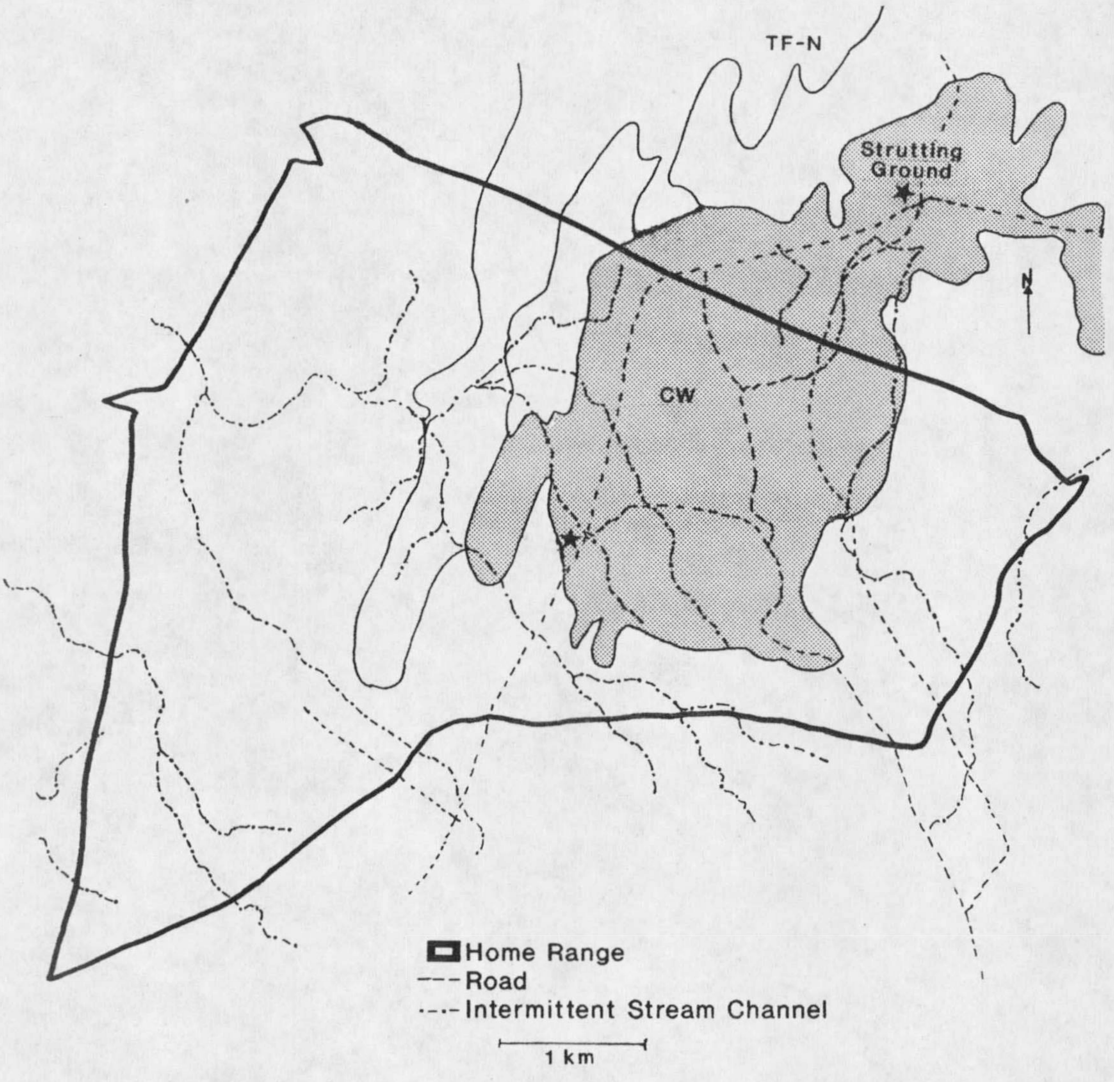


Figure 16. Home range illustration of frequency 739, a yearling female, 1989.

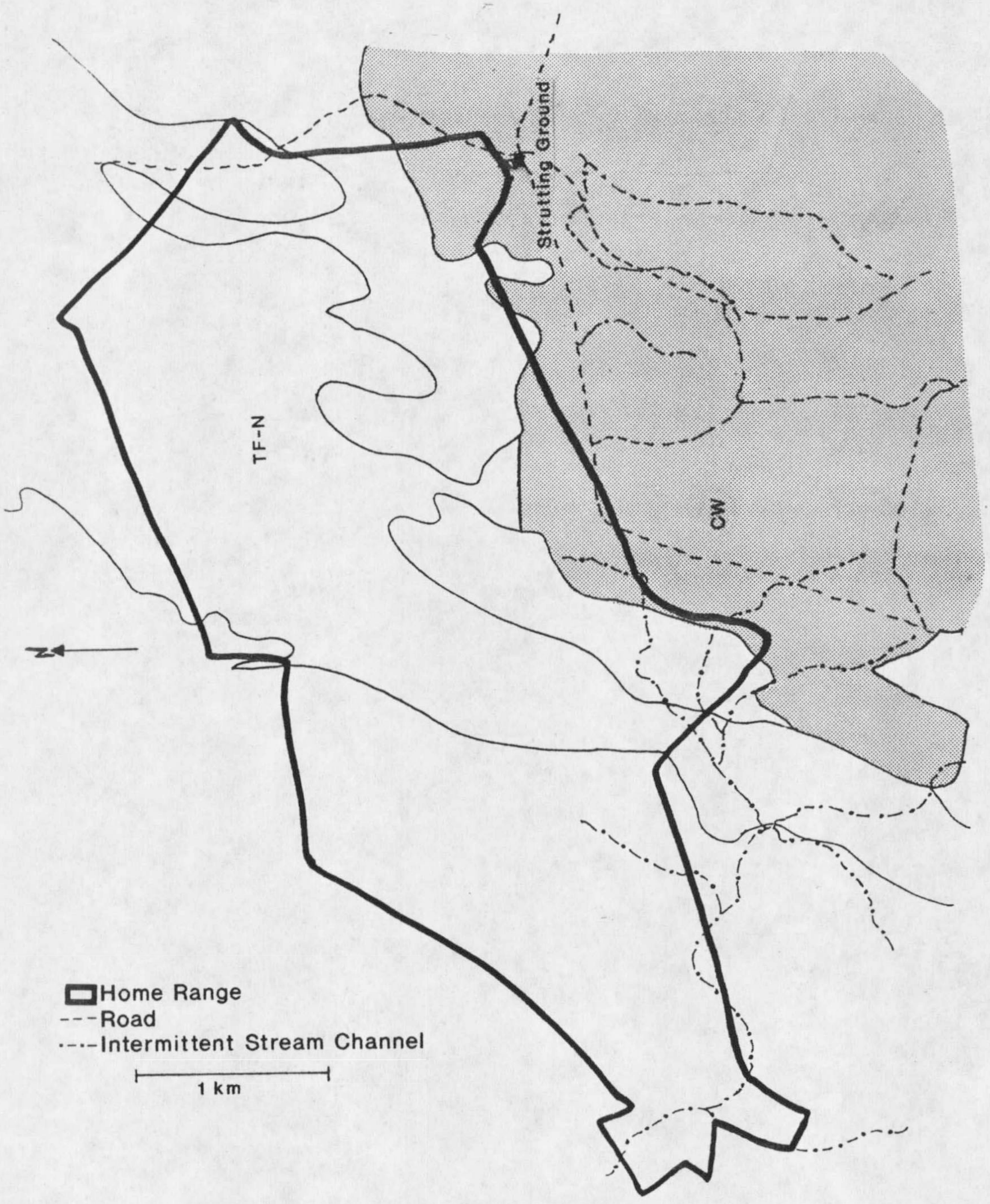


Figure 17. Home range illustration of frequency 690, a
female of unknown age, 1989.

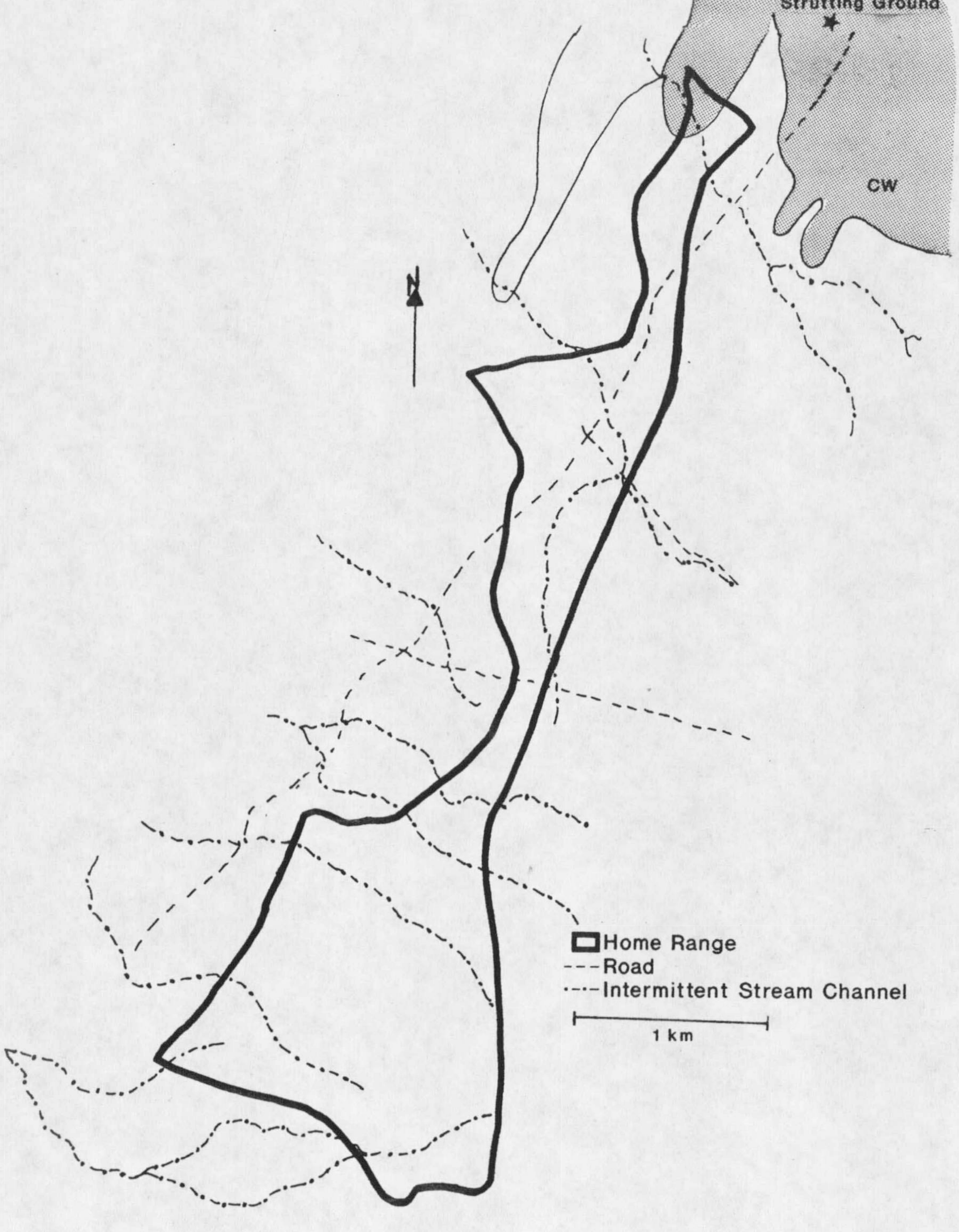


Figure 18. Home range illustration of frequency 721, a yearling female, 1989.

# APPENDIX B

## TABLES RELATING TO VEGETATION

Table 10. Percent canopy coverage by growth form and species on the Tractor Flats and Arco Highway vegetation grids (burn and control), 1989. Nomenclature follows Hitchcock and Cronquist (1974).

| | TRACTOR FLATS | | ARCO HIGHWAY | |
|---|---|---|---|---|
| Species | Burn | Control | Burn | Control |
| SHRUBS: | | | | |
| Artemisia tridentata | *.*[a] | 9.3 | *.* | 19.1 |
| Artemisia tripartita | *.* | *.* | 0.7 | 1.9 |
| Chrysothamnus nauseosus | *.* | *.* | 0.7 | 1.1 |
| Chrysothamnus vicidiflorus | *.* | 13.0 | 18.9 | 2.9 |
| Tetradymia canescens | *.* | *.* | 2.6 | 1.2 |
| TOTAL SHRUB CANOPY: | 1.3 | 22.3 | 22.9 | 26.2 |
| GRASSES: | | | | |
| Agropyron cristatum | 24.9 | 12.0 | 0.0 | 0.0 |
| Agropyron dasystachyum | 0.0 | 0.0 | 1.1 | 0.0 |
| Agropyron spicatum | 0.0 | *.* | 4.5 | 4.8 |
| Bromus tectorum | 0.0 | *.* | *.* | *.* |
| Oryzopsis hymenoides | 0.0 | *.* | 3.4 | 1.3 |
| Sitanion hystrix | 0.0 | 2.3 | *.* | *.* |
| Stipa comata | 0.0 | 0.0 | *.* | *.* |
| TOTAL GRASS CANOPY: | 24.9 | 16.7 | 10.5 | 6.8 |
| FORBS: | | | | |
| Allium acuminatum | 0.0 | 0.0 | 0.0 | *.* |
| Alyssum desertorum | 0.0 | 0.0 | 1.1 | 0.0 |
| Antennaria rosea | 0.0 | 0.0 | *.* | 0.0 |
| Artemisia dracunculus | 0.0 | 0.0 | *.* | 0.0 |
| Astragalus filipes | 0.0 | 0.0 | *.* | *.* |
| Astragalus purshii | 0.0 | 0.0 | *.* | *.* |
| Basamorhiza sagittata | 0.0 | 0.0 | 0.0 | *.* |
| Calochortus bruneaunis | 0.0 | 0.0 | *.* | 0.0 |
| Cordylanthus ramosus | *.* | 0.0 | *.* | 3.7 |
| Crepis acuminata | 0.0 | 0.0 | *.* | 1.8 |
| Descurainia pinnata | 0.0 | *.* | 0.0 | 0.0 |
| Descurainia sophia | 0.0 | *.* | *.* | *.* |
| Eriastrum sparsiflorum | 0.0 | 0.0 | *.* | *.* |
| Erigeron pumulis | 0.0 | 0.0 | *.* | *.* |

Table 10. Continued

| Species | TRACTOR FLATS | | ARCO HIGHWAY | |
|---|---|---|---|---|
| | Burn | Control | Burn | Control |
| Erigonum microthecum | 0.0 | 0.0 | *.* | *.* |
| Erigonum ovalifolium | 0.0 | 0.0 | 0.0 | *.* |
| Gilia minutiflora | 0.0 | 0.0 | *.* | 0.0 |
| Halogeton glomeratus | 1.3 | 2.9 | 0.0 | 0.0 |
| Lactuca serriola | *.* | *.* | *.* | *.* |
| Lappula echinata | 0.0 | *.* | *.* | 0.0 |
| Lepidium perfoliatum | 0.0 | 0.0 | 0.0 | *.* |
| Leptodactylon pungens | 0.0 | 0.0 | 1.3 | 4.1 |
| Lomatium dissectum | 0.0 | 0.0 | *.* | *.* |
| Oenothera caespitosa | *.* | 0.0 | *.* | 0.0 |
| Phlox hoodii | 0.0 | *.* | 2.0 | 4.0 |
| Sisymbrium altissimum | 0.0 | 0.0 | *.* | 0.0 |
| Sphaeralcea munroana | 0.0 | 0.0 | *.* | *.* |
| Taraxacum officinale | *.* | 0.0 | 0.0 | *.* |
| Thlaspi arvense | 0.0 | 0.0 | 0.0 | *.* |
| Tragopogon dubius | *.* | 0.0 | 0.0 | *.* |
| TOTAL FORB CANOPY: | 1.9 | 5.0 | 7.0 | 15.9 |

[a] indicates <1.0% canopy

Table 11. Percent litter, bare ground, and total vegetative canopy on the Tractor Flats and Arco Highway study grids (burn and control), 1989.

| | TRACTOR FLATS | | ARCO HIGHWAY | |
|---|---|---|---|---|
| | Burn | Control | Burn | Control |
| Litter | 44.6 | 32.2 | 28.2 | 23.1 |
| Bare ground | 27.8 | 25.8 | 33.7 | 32.8 |
| Total vegetative canopy | 27.8 | 44.0 | 40.3 | 50.0 |