Wildlife use of fire-disturbed areas in sagebrush steppe on the Idaho National Engineering Laboratory by William Edward Moritz

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:
From June, 1984 through June, 1987, a study was conducted on the Idaho National Engineering Laboratory (INEL) in southeast Idaho to collect data on sage grouse (Centrocercus urophasianus), pronghorn (Antilocapra americana) and small mammal use of nine burned areas (fire s cars) of various ages in sagebrush steppe- Information on plant community composition of burned areas and adjacent nonburned (control) areas was reported. Fire scars were characterized by an absence of sagebrush, although revegetation was not clearly directional or predictable. Two years of seasonal use by sage grouse and pronghorn of fire scars and control areas were determined. Sage grouse use of a newly burned area was significantly greater ($p<0.05$) than controls. Fire scars dominated by cheatgras s (Bromus textorurn) were used by sage grouse significantly less than controls. Incomplete burns created a mosiac pattern of vegetation which sage grouse used significantly more than adjacent controls.

Significant trends in use by sage grouse of older burned areas, dominated by perennial grasses/rabbitbrush (Chrysothamnus viscidiflorus) were not detected. The lush growth of grasses and forbs following disturbance attracted pronghorn, as use of the fire scar was significantly higher than controls. Pronghorn use of cheatgrass-dominated fire scars was significantly greater than controls. Overall use of incompletely-burned areas was not significantly different than controls, although seasonal- differences existed. Results of pronghorn use of perennial grass/rabbitbrush fire scars,indicated that fire did not reduce use of areas, although use of fire scars was not significantly greater in all areas. Mule deer (Odocoileus hemionus) and elk (Cervus elaphus) use of burned areas appeared greater than controls. Small mammal populations on fire scars were similar in composition but of lesser density than adjacent populations in sagebrush.

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by

William Edward Moritz

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APPROVAL

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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

From June, 1984 through June, 1987, a study was conducted on the Idaho National Engineering Laboratory (INEL) in southeast Idaho to collect data on sage grouse (Centrocercus urophasianus), pronghorn (Antilocapra americana) and small mammal use of nine burned areas (fire scars) of various ages in sagebrush steppe. Information on plant community composition of burned areas and adjacent nonburned (control) areas was reported. Fire scars were characterized by an absence of sagebrush, although revegetation was not clearly directional or predictable. Two years of seasonal use by sage grouse and pronghorn of fire scars and control areas were determined. Sage grouse use of a newly burned area was significantly greater ($p<0.05$) than controls. Fire scars dominated by cheatgrass (Bromus tectorum) were used by sage grouse significantly less than controls. Incomplete burns created a mosiac pattern of vegetation which sage grouse used significantly more than adjacent controls. Significant trends in use by sage grouse of older burned areas, dominated by perennial grasses/rabbitbrush (Chrysothamnus viscidiflorus) were not detected. The lush growth of grasses and forbs following disturbance attracted pronghorn, as use of the fire scar was significantly higher than controls. Pronghorn use of cheatgrass-dominated fire scars was significantly greater than controls. Overall use of incompletely-burned areas was not significantly different than controls, although seasonal differences existed. Results of pronghorn use of perennial grass/rabbitbrush fire scars indicated that fire did not reduce use of areas, although use of fire scars was not significantly greater in all areas. Mule deer (Odocoileus hemionus) and elk (Cervus elaphus) use of burned areas appeared greater than controls. Small mammal populations on fire scars were similar in composition but of lesser density than adjacent populations in sagebrush.

INTRODUCTION

Fire has historically been a major source of disturbance in sagebrush-grass ecosystems (Mueggler 1976, Wright et al. 1979, Shinn 1980, Gruell 1985). Historically, lightning was the primary cause of fire, while man has become a significant source of ignitions in more recent times (Whitlock 1985). Indians used fire for hunting, food gathering, agriculture, and other purposes (Huston 1973). Since the appearance of white man in the Intermountain West during the last century, burning has been both suppressed and encouraged. Wildfire was feared because of its destructive potential and a lack of efficient control methods, while controlled fires were considered an effective means of improving sagebrush rangeland for livestock grazing. Today the role of fire is becoming better understood, and prescribed burning has become an important, if not fully accepted tool for improving livestock range (Britton and Ralphs 1978). However, management plans involving prescribed burning generally have given less consideration to the impact on wildlife species (Urness 1978).

Fire in sagebrush ecosystems has a highly variable impact on wildlife populations (Starkey 1985). Effects

are dependent on the size and season of burn, preburn plant composition and condition, fire intensity and many other factors (Urness 1978), causing variation in the conclusions of wildlife impact studies.

The most significant impact of fire is modification of the vegetation composition of the burned area (Wright 1974). Animal populations can be positively or negatively affected depending on their specific habitat requirements.

Numerous studies have recorded the immediate postburn effects of fire on wildlife use of an area (Chew et al. 1958, Best 1979, Peek et al. 1979, Keay and Peek 1980, Halford 1981, Hedlund and Rickard 1981, Castrale 1982, Gano and Rickard 1982, McGee 1982, Gates 1983, Winter 1984). Few studies have examined the extent and duration of habitat modification caused by sagebrush burning on wildlife species.

This paper investigates the long-term impacts of fire in a sagebrush steppe community by examining wildlife use of 9 fire-disturbed areas (fire scars), ranging from 0 to 75 years old, on the Idaho National Engineering Laboratory. Objectives were: 1) to describe the vegetation of fire scars and surrounding unburned areas; 2) to determine relative use of fire scars of various ages and adjacent control areas by sage grouse (Centrocercus urophasianus), pronghorn (Antilocapra americana) and various small mammals; 3) investigate the duration of

habitat modification by fire on these species. The study is part of an overall research program funded by the Department of Energy (DOE) to determine responses of vegetation, insects, birds and mammals to land treatments and perturbations.

STUDY AREA

The study areas were located on the Idaho National Engineering Laboratory (INEL) Site, a nuclear reactor testing facility under the jurisdiction of the United States Department of Energy (DOE). The Site is located on the upper Snake River Plain in southeastern Idaho. It occupies 23,315 km2 at the foothills of the Lemhi and Lost River Mountain ranges. The topography is flat to rolling with frequent lava outcrops. Elevation ranges from 1,454 to 1,554 m ASL, the median being about 1,500 m (Reynolds 1978).

The climate is semi-arid, characterized by hot summers and cold winters. Annual precipitation averaged 21 centimeters (cm) during the 1950-1978 period (Anderson and Holte 1981). The months of May and June have maximum rainfall while July through September is generally a dry period (French and Mitchell 1983).

Big sagebrush (Artemesia tridentata) is the most common shrub on the INEL Site (McBride et al. 1978). Other prevalent shrubs include green rabbitbrush (Chrysothamnus viscidiflorus), saltbush (Atriplex nuttallii), winterfat (Ceratoides lanata) and horsebrush (Tetradymia canescens). Common grass species are

bottlebrush squirreltail (Sitanion hystrix), thickspike wheatgrass (Agropyron dasystachyum), Indian ricegrass (Oryzopsis hymenoides), needle and thread grass (Stipa comata), bluebunch wheatgrass (Agropyron spicatum) and Great Basin wildrye (Elymus cinereus).

Nine study areas, each consisting of a fire scar and an adjacent unburned sagebrush area, were included in this investigation (Table 1 and Figure 1), which was conducted from 1984 to 1987. Maps of each area are found in Appendix 1.

Table 1. Study area fire history.

AREA #	NAME	DATE OF FIRE	ORIGIN	SIZEb
1a	7MIRD	6/85	lightning	236ha
2	INEL	8/81	controlled burn	405
3	RABBIT EARS	8/81	lightning	67
4	UTAH P&L	7/80	lightning	207
5	FIRE STATION	9/74	controlled burn	113
6	ARCO HWY	7/74	unknown	73
7	N IDAHO 22	<1949	unknown	216
8	B&B CO.	<1949	unknown	1150
9	TRAC FLAT	1910	unknown	2728c

a) see Fig. 1 for relative location of study areas
b) size measured from recent aerial photos
c) McBride et al. (1978) report a 4050 ha fire occured in this general area in 1910.

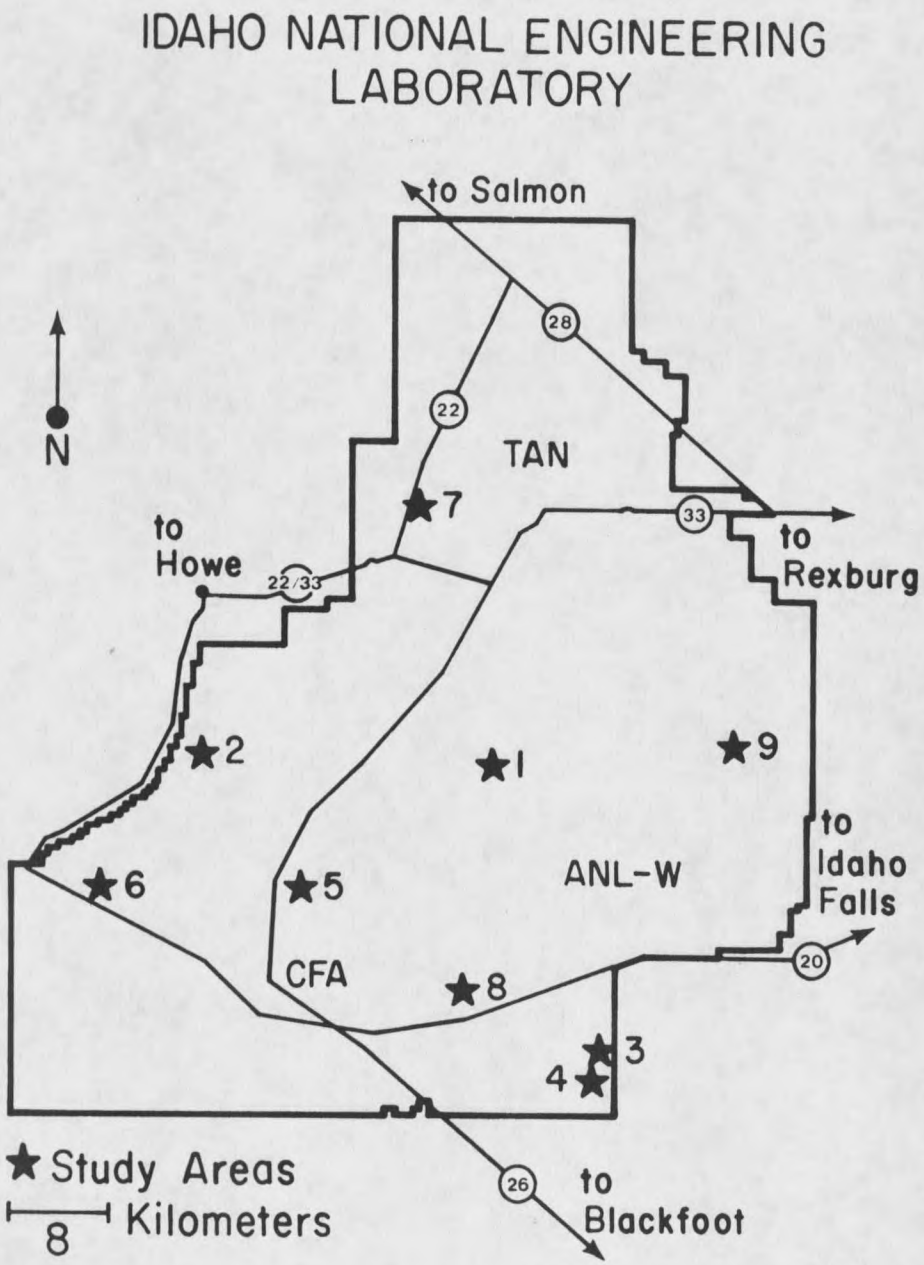

Figure 1. Location of study areas within the INEL.

METHODS

Introduction

A basic study design, modified from Gates (1983), was used on all study areas (Fig. 2). Each study area consisted of an area that had been burned (the burn site), and an adjacent unburned area (the control site). The mosiac of burned and non-burned area on the edge of the fire scar was designated as the interzone.

On both burn and control sites, three 6.25 ha grids were randomly selected from a block of potential locations (Neil Hamm, pers. commun.). Special consideration was made to ensure that grids were outside the interzone when possible. Within each grid, 25 points were located at 50 m intervals in a 5 x 5 arrangement. Twenty-four point grids, in a 3 x 8 arrangement, were used on burn sites that were too narrow to accomodate the square grid. One 3 x 8 grid was necessary on the Rabbit Ears, Fire Station and Arco Hwy burn sites.

Each point was marked with a wooden stake cut to a height that did not exceed the height of surrounding vegetation. Stakes were painted orange to aid in the location of the points. Data describing the vegetation

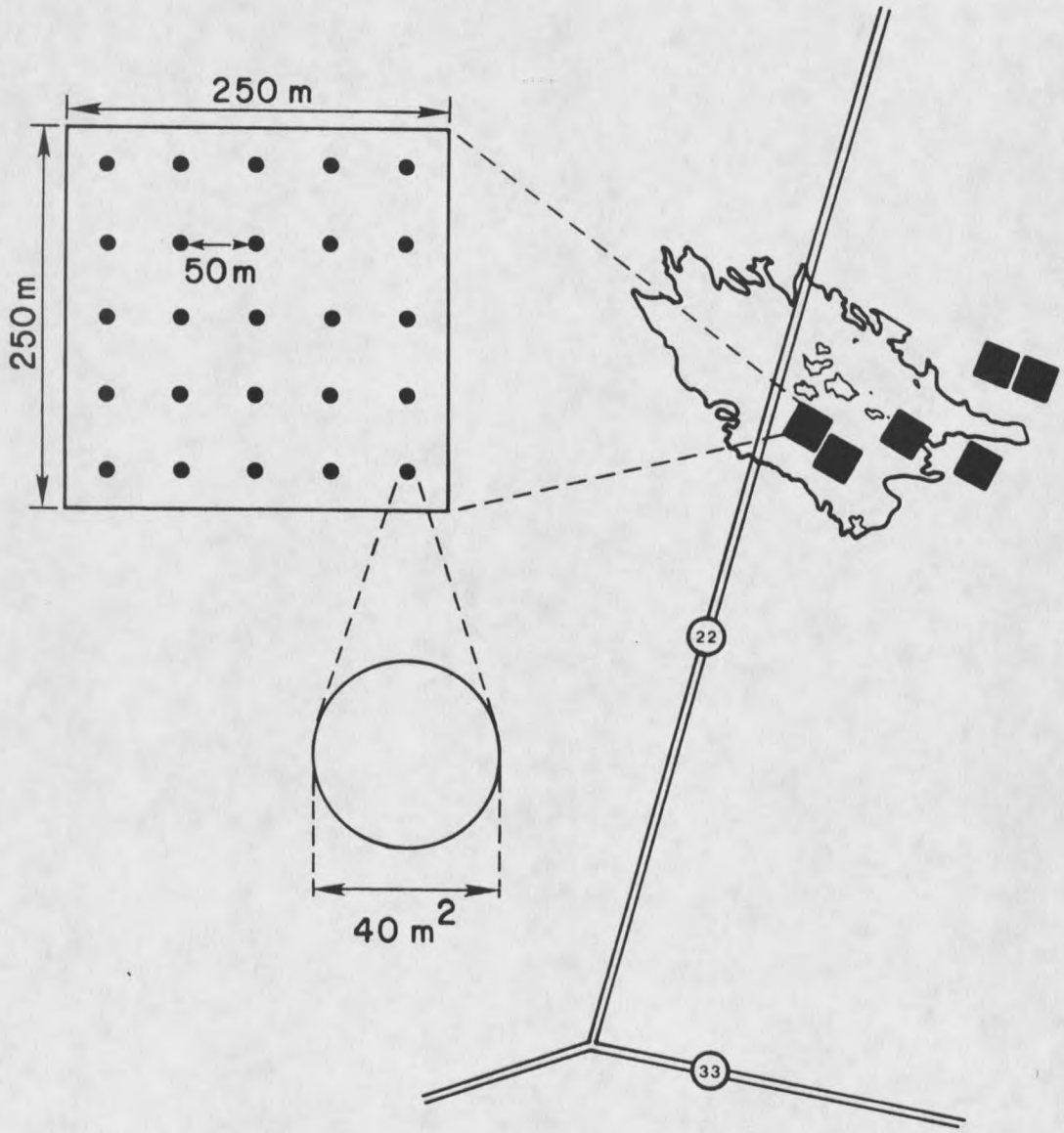

Figure 2. Study design (modified from Gates (1983)) with configuration of pellet plots and focal points within grids.

and use by sage grouse, pronghorn and small mammals were collected on these study grids, with each stake a focal point for intensive study.

Vegetation Measurements and Analysis

Data concerning flora of all study areas were not available at the time of this study. A brief survey was conducted to identify a general pattern of community composition in each study area.

Vegetation sampling was conducted on one burn grid and one control grid on each study area. Two of the 25 focal points on each grid were randomly selected as starting points for sampling. A 50 m tape was tightly stretched from the starting point to the next point to the east (or south if the starting point was in the eastern-most column of points). Transects were discarded and new starting points selected if the sampling line was dominated by bare rock. These transects were used for all measurements describing the vegetation.

All shrubs intercepted by the line were counted and their maximum height measured to the nearest centimeter. Shrub canopy coverage (Canfield 1941) was measured as was the canopy coverage of each species of shrub. Total shrub canopy coverage was distinguished from the sum total of individual species canopy coverage because of interspecific plant overlap. The vigor of Artemisia

plants was determined by estimating the percentage of live plant crown by classes (dead, 0-5%, 6-25%, 26-50%, 51-75%, 76-100%). Dead plants were not included in canopy coverage measurements. Erect stems and branches were used to distinguish dead plants from litter.

Two by five decimeter (dm) canopy coverage quadrats (Daubenmire 1959) were used to determine abundance and frequency of grasses and forbs. Half-shrubs were measured as forbs and were not included in shrub measurements. Twenty-five canopy coverage quadrats were placed on odd-numbered meter marks along the sampling line. Total forb and grass canopy coverage were measured as well as individual species coverage.

Plant nomenclature follows Hitchcock and Cronquist (1974). Plants not immediately recognized in the field were identified by comparison with specimens in the INEL Site herbarium.

Analysis was limited to descriptive measures of site characteristics. The vegetation of the INEL is quite variable and its characteristics can change in short measures of distance or time. A considerably larger sample would have been necessary to obtain a statistically adequate representation of each area.

Trends in the vegetation recovery are presented for later analysis of the duration of the impacts of fire on wildlife. Fire scars are grouped by age (5 years old, 10-

15 years old, >35 years old) and vegetation characteristics are a composite representation of study areas. The INEL study burn is omitted in these calculations because the fire did not consume the entire shrub canopy as in the other study areas.

Measurement of Sage Grouse and Pronghorn Use

Fecal pellet counts (Neff 1968) were used to determine relative use on burn and control grids by sage grouse and big game animals. While pronghorn were the focus of the game animal segment, the presence of elk (Cervus elaphus) and mule deer (Odocoileus hemionus) on some study areas provided insight into relative use of burn areas by these species. Mule deer fecal pellets are not morphologically distinguishable from pronghorn pellets (Howard 1967), therefore pellet origins were identified by observation of the species present. On one study area where both species were infrequently observed, the few ungulate pellet groups found were recorded as of unknown ungulate origin.

Fecal pellets were counted in a 40 m2 circular plot centered on each point (Fig. 2). Single pellets and roost droppings (groups of 10 or more pellets) were counted for sage grouse. Big game pellet groups were recorded if more than 50% of a pellet group (groups of >15 pellets) were

inside the sample area (Gates 1983). All plots were cleared of pellets as they were counted.

Two years of seasonal use are reported for 8 study areas, beginning with summer 1985 and concluding with spring 1987. These areas were originally cleared during June, 1985. The ninth study area, 7MIRD burned in late June, 1985. Pellets were first cleared in September, 1985 and counted for each seasonal period thereafter. The counts were temporally distributed to determine relative use as a function of seasons. Seasons of use, based on sage grouse movements recorded by Connelly (1982) and Gates (1983), were:

Spring	March 16 - June 15
Summer	June 16 - August 31
Winter	Sept. 1 - March 15

Spring included the interval when strutting and nesting activities occurred, summer the time spent on summer range, and winter included time spent moving from summer range to winter range, time on winter ranges, and time spent moving to strutting arenas.

Hoskinson and Tester (1980) studied pronghorn movements in this area. Spring movements were related to loss of snow cover and occurred during Febuary and March in their study. Fall movements began after 1 October and appeared to be related to the moisture content of the vegetation. My sampling periods would best represent winter range use by pronghorn, early summer use (when new

grass and forb growth occurs) and late summer use (when grasses and forbs are cured).

Pellet count data were not adjusted for differences in time intervals between counts since they represented seasonal periods of use (Gates 1983). Counts for each species were converted to pellets (pellet groups) per hectare.

Paired t-tests were used to evaluate seasonal differences between burn and control habitats for all study areas as well as for overall trends of use on each study area. Chi-square tests were used to compare specific differences occurring in seasonal samples.

All statistical analyses were conducted using the MSUSTAT program (1986 microcomputer version 3.2--MSDOS) developed by Richard E. Lund, Montana State University, Bozeman, Mt. 59717. Values were considered significant if $p < 0.05$ for all tests.

Measurement of Small Mammal Use

Small mammal trapping was conducted on two burn grids and two control grids on each study area. Small mammals on one grid of each type were trapped during August-September, 1985 on each study area. Remaining grids were sampled during April-May, 1986.

Small mammal populations on study areas were sequentially sampled during each trapping period. The

sequence of study areas was not constant between fall and spring samples because of limited access to some areas during inclement weather.

Each grid was comprised of 12 systematically located traplines with 5 trap stations per trapline, providing a total of 60 trap stations per grid (Fig. 3). Each trap station consisted of four traps: one Sherman Live trap, one Victor M4 rat trap and two Museum Special snap traps. Traps were placed within 1 m of a centrally located surveyors flag, without directional orientation. The Sherman Live traps were baited with wheat kernals, the snap traps with peanut butter.

Trapping was conducted for three consecutive nights on each grid with no prebaiting. The traps were checked and baited each morning. Trap status was recorded as unsprung, sprung with no catch, or sprung with catch. Captured animals were identified and removed from the study area.

Configuration of small mammal trap grids.

Measurement of Population Indices

Species diversity (H') was calculated with a transformation of the Shannon-Weaver index (Zar 1984):

$$H' = (n \log n - (\ fi \log fi))/n$$

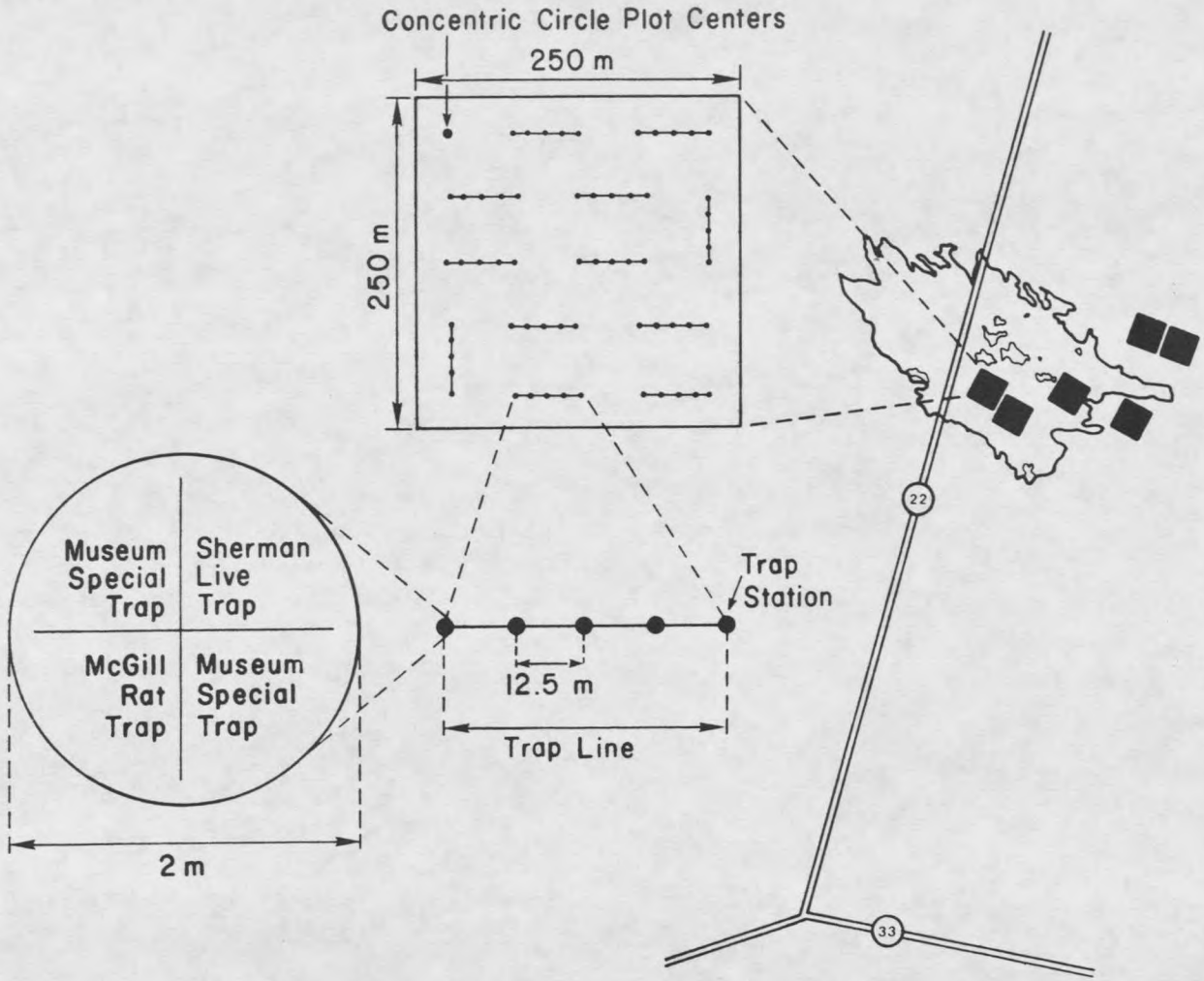

Figure 3. Configuration of small mammal trap grids.

where n is the sample size, fi is the number of observations of animals of species i, and k is the number of species observed.

Species evenness (J')(Pielou 1966) was calculated with the formula (Zar 1984)

$$J' = \frac{H'}{H'max}$$

where H'max equals log k.

Calculations of relative abundance were used to compare use of burn and control areas. Relative abundance was determined by the number of animals of each species caught per 100 trap nights.

Paired t-tests (Snedecor and Cochran 1980) were used to compare total captures of all animals and of individual species. Presentation and statistical analysis of data follow the form reported for the pellet count data.

RESULTS AND DISCUSSION

Vegetation

7MIRD Study Area (Area 1 in Fig. 1)

The dominant shrub on the control grid was big sagebrush, which comprised 85% of living shrub canopy. Mean sagebrush height was greater than on any other study area except Utah P&L (Table 2). Green rabbitbrush was the only other shrub intercepted. Total shrub canopy coverage was 13.8%. Mean shrub height was 61.4 cm (Fig. 4).

Cheatgrass (*Bromus tectorum*) was the only grass encountered in sampling. It occurred in 94% of the quadrats and had a canopy coverage of 15.7%. Other grasses on the burn site included basin wildrye, bottlebrush squirreltail, bluegrass (*Poa* spp.) and wheatgrass (*Agropyron* spp.).

Total forb canopy coverage was 5.4%, and frequency was 84%. The forb component was dominated by the weedy annuals tansey mustard (*Descurainia pinnata*), tumble mustard (*Sysmbrium altissimum*) and stickseed (*Lappula redowski*).

Further evidence of a disturbed community was the presence prickly pear (*Opuntia polycantha*).

Table 2. Average canopy height (cm) of *Artemisia tridentata* on burn and control sample lines on all study areas, 1986 (number of plants measured in parenthesis).

STUDY AREA	CONTROL		BURN	
7MIRD	67.8	(11)	0.0	(0)
INEL	46.7	(42)	40.6	(40)
RABBIT EARS	68.5	(17)	0.0	(0)
UTAH P&L	80.9	(50)	0.0	(0)
FIRE STATION	51.4	(57)	0.0	(0)
ARCO HWY	50.8	(49)	27.0	(1)
N IDAHO 22	47.8	(24)	0.0	(0)
B&B CO	63.5	(70)	40.0	(5)
TRAC FLAT	64.7	(39)	95.8	(4)
X	59.7	(359)	44.7	(50)

Litter was found in all of the quadrats and covered 82.8% of the ground surface. Bare ground occurred in 74% of the sampling frames and represented 16.4% of the area sampled.

The study area is located in an area of extensive sagebrush dieoff of unknown cause (Table 3). High densities and flammability of cheatgrass combined with dead sagebrush created a high fire potential. A lightning ground strike would readily have ignited this fire.

The fire, which occurred during the night of June 30, 1985 consumed all shrubs on the burn grid. Surviving shrubs were occasionally found in areas where rock outcrops or a lack of fuel were barriers to advancing flames. Resprouting rabbitbrush was noted in some areas on the burn site.

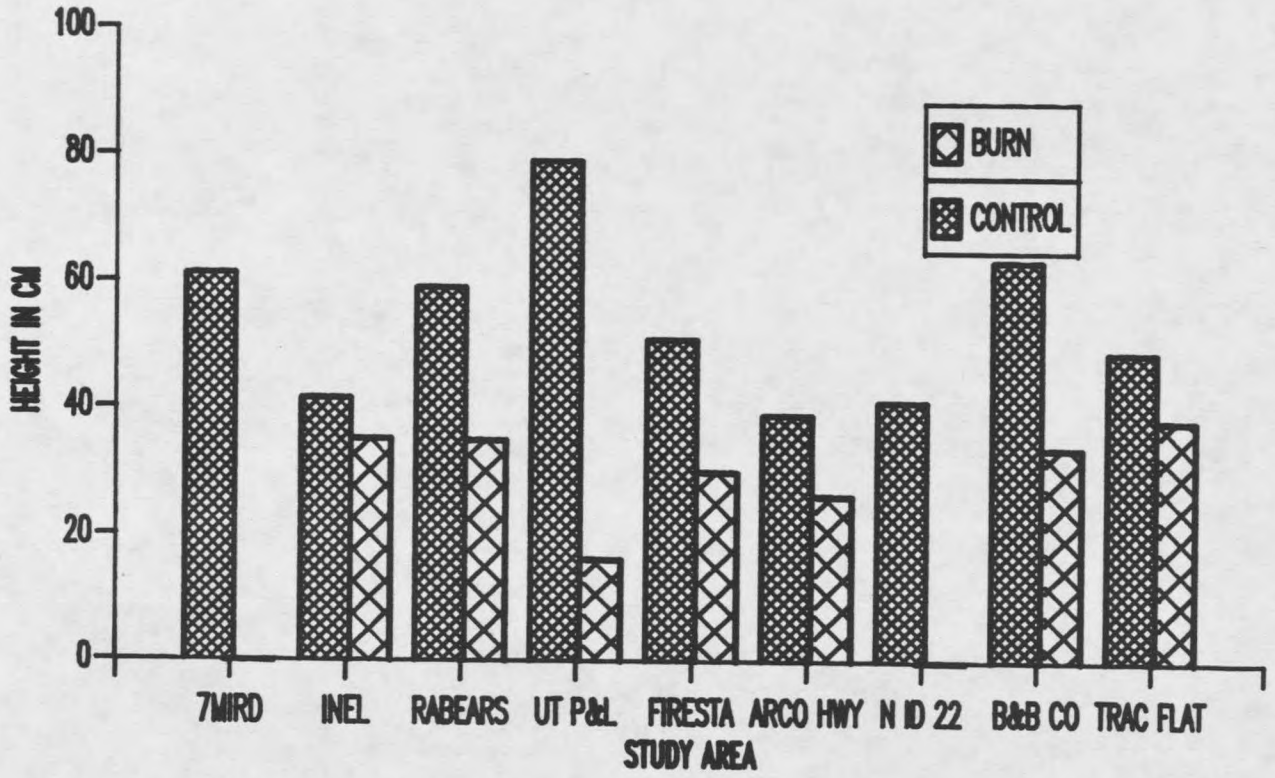

Figure 4. Mean height of shrubs occurring on study areas, 1986.