Effects of ecological changes induced by various sagebrush control techniques on small mammal populations
by Ottley Paul Tschache

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE i n Fish and Wildlife Management
Montana State University

Abstract:
Small mammal populations and vegetation on each of six study plots in central Montana were studied during the summers of 1968 and 1969 to determine the effects of habitat changes following sagebrush control operations; The plots were subjected to one or the other of the following treatments: total kill,-partial kill,strip kill, defer control, or open, control., To achieve a kill of sagebrush (Artemisia tridentata), 2,4-D, was applied in June, 1968. The study plots comprised a sagebrush-grass-land habitat type and treatment with 2,4-D usually produced an increase in grass cover and a decrease in the cover of forbs and shrubs, Population indices, including home range, movement, and density, were determined for the only abundant small mammal, the deer mouse , (Peromyscuus maniculalatus osgoodi), from live trapping data; Increases or decreases, in the magnitude of these indices were approximately the same on all plots; treatment and control. There was no significant difference in the total populations of deer mice, when comparing the populations on the control plots to those on the treatment plots for the pre-treatment years, 1966-1968 (1966-67 data from Cada 1968), to the post-treatment year, 1969. Home ranges and movement indices were inversely related to the population densities. Deviations from the hypothetical 1:1 sex ratio were of the same magnitude on all plots, treatment,and control; and were correlated with population densities. The relative proportion of males was inversely related to density. Captures and observations on small mammals other than the deer mouse indicated no particular preference as to treatment or control plots. Thus it appears that habitat changes resulting from strip, partial or total kill of big sagebrush, had no measurable effects on the small mammal populations in this area 1 year after treatment.

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Signature Otto Paul Tschache

Date May 20, 1970

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ABSTRACT

Small mammal populations and vegetation on each of six study plots in central Montana were studied during the summers of 1968 and 1969 to determine the effects of habitat changes following sagebrush control operations. The plots were subjected to one or the other of the following treatments: total kill, partial kill, strip kill, defer control, or open control. To achieve a kill of sagebrush (*Artemisia tridentata*), 2,4-D was applied in June, 1968. The study plots comprised a sagebrush-grassland habitat type and treatment with 2,4-D usually produced an increase in grass cover and a decrease in the cover of forbs and shrubs. Population indices, including home range, movement, and density, were determined for the only abundant small mammal, the deer mouse (*Peromyscus maniculatus osgoodi*), from live trapping data. Increases or decreases in the magnitude of these indices were approximately the same on all plots, treatment and control. There was no significant difference in the total populations of deer mice, when comparing the populations on the control plots to those on the treatment plots for the pre-treatment years, 1966-1968 (1966-67 data from Cada 1968), to the post-treatment year, 1969. Home ranges and movement indices were inversely related to the population densities. Deviations from the hypothetical 1:1 sex ratio were of the same magnitude on all plots, treatment and control, and were correlated with population densities. The relative proportion of males was inversely related to density. Captures and observations on small mammals other than the deer mouse indicated no particular preference as to treatment or control plots. Thus it appears that habitat changes resulting from strip, partial or total kill of big sagebrush, had no measurable effects on the small mammal populations in this area 1 year after treatment.

INTRODUCTION

The chemical control of sagebrush to increase grass for livestock has long been practiced in Montana. Although the effects of range treatment on vegetation have received considerable study, its effects on animal life are largely unknown. Due to the continued practice of sagebrush manipulation on public as well as private lands, the Montana State Fish and Game Department, in cooperation with the Bureau of Land Management, initiated a 10-year study in 1965 to ascertain the ecological effects of this manipulation upon certain animal populations.

The effects of habitat changes following sagebrush control operations on small mammal populations is a part of that project. Population indices were measured on each of six study plots prior to planned sagebrush control operations of varying intensities according to plot by Cada (1968) during the summers of 1966 and 1967. My study, conducted during the summers of 1968 and 1969, initiated the post-treatment phase of the project. Procedures were the same as those carried out by Cada. Due to a delay in the treatment procedures, the results from the summer of 1968 are considered pre-treatment.

STUDY AREAS

The six study plots were the same as those used by Cada (1968) in the pre-treatment study. These plots are located on one or the other of two study areas in central Montana near the town of Winnett (Figure 1). Both areas are on lands administered by the Bureau of Land Management and have been used principally for livestock grazing. For the purpose of this and other studies the grazing was discontinued on all but one plot.

These study areas support a sagebrush-grassland vegetation type and consist of a moderately flat terrain adjoined by gently rolling hills and gully bottoms. The soils are clay loam and are generally exposed between sagebrush plants.

Gieseker (1938) describes the climate as semi-arid, "...characterized by a comparatively low rainfall, great temperature extremes, a large number of sunny days, and a relatively low humidity." Precipitation averages 12.57 inches annually (U. S. Department of Commerce Weather Station at Flat Willow). The total rainfall for the summers (June-September) of 1968 and 1969 were 3.21 and 0.12 inches above normal, respectively. The average summer temperatures for 1968 and 1969 were 62.3 and 64.4 degrees Fahrenheit, respectively. These were slightly below the normal average.

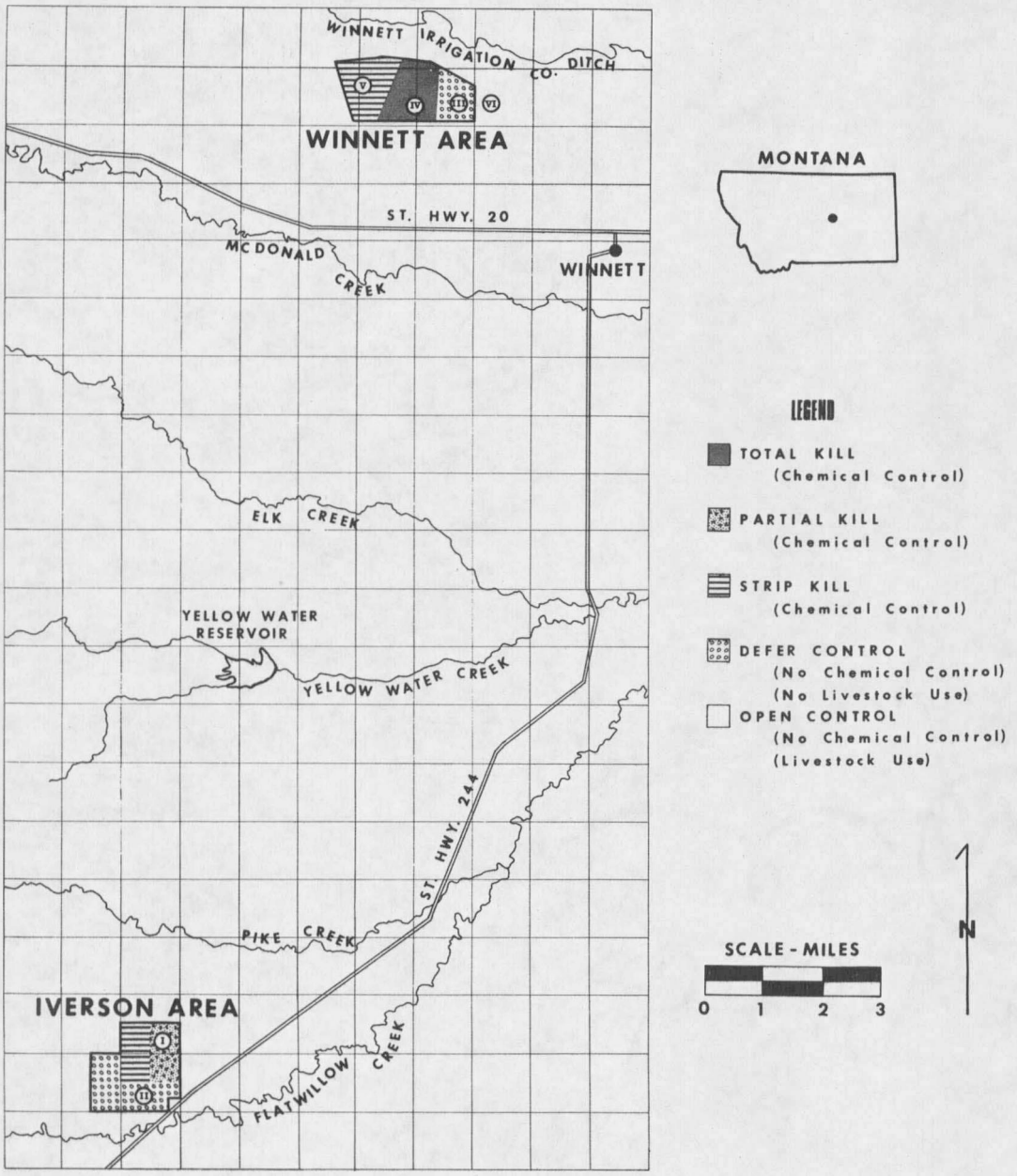

Figure 1. Map showing the two sagebrush control study areas, with special reference to the locations (I-VI) of the six small mammal study plots in relation to the various treatments.

METHODS

The study plots, with the exception of No. VI, were deferred from livestock grazing by November of 1967. Some were treated aerially with 2,4-Dichlorophenoxyacetic acid in June of 1968. Plot I was treated with 2,4-D amine at the rate of 1 pound in 6 gallons of water per acre to achieve a partial kill of sagebrush. A 2,4-D low volatile ester was used on Plot IV at the rate of 2 pounds in 6 gallons of water per acre to accomplish a total kill of sagebrush. Plot V was sprayed with the same concentration as the latter but only on alternate 100-foot strips. Plots II, III, and VI received no chemical control (Figure 1).

To make valid comparisons with the pre-treatment study, methods and materials were the same as those used by Cada (1968), but for the convenience of the reader these are described.

Trapping procedures were similar to those described by Blair (1941). Each of the six, 900-foot square study plots was gridded to 60-foot quadrates. A numbered stake at each quadrate corner marked the trapping stations. Traps were placed at alternate stations along rows and columns each day, making them operational for three nights at each station during a trapping period of 6 days. Two plots were usually trapped simultaneously.

Single-catch Sherman live traps, baited with oatmeal and provided with cotton for nesting and protection, were set in late afternoon and examined each morning. The traps were made non-operational during the day.

Animals were removed from the traps by dropping them into a small plastic bag, in which they could easily be handled. Each animal was marked according to a system of toe-clipping and ear-punching. All animals were examined at each capture for species, sex, age, and breeding condition. They were released at the point of capture. Mammal nomenclature was that of Hall and Kelson (1959) or Hoffmann and Pattie (1968).

Each plot was trapped for two, 6-day periods each summer. The consecutive trapping of Plots I through VI for 6 days each was considered a trapping series. Series I and II extended from June 22 to July 20 and from August 5 to August 27 in 1968, and from June 18 to July 20 and from August 5 to August 24 in 1969, respectively.

Population indices, including home range, movement, and density, were determined for the only abundant small mammal, the deer mouse (*Peromyscus maniculatus osgoodi*). For others, their occurrence on plots was tabulated.

Indices of home range, "...that area habitually traversed ... within a specific period of time" (Shillito 1963), were calculated from points of capture for individuals captured five or more times, and whose geometric center of capture points (Hayne 1949) were 120 feet or more within the peripheral row or column of traps. Both the "inclusive boundary strip" (Blair 1942) and the "minimum home range" (Mohr 1947) methods were used.

The average distance from points of capture to an individual's calculated geometric center, "recapture radii" (Dice and Clark 1953 as cited in Cada 1968), was considered as an index of movement for that individual. Movement indices were determined for individuals captured three or more times, and whose geometric center of capture points were 120 feet or more within the peripheral row or column of traps.

To calculate population densities, the degree of residency (Hodgson 1969) was determined for all *Peromyscus* captured. Individuals captured once or twice, if only on consecutive nights, were considered "partial residents," one-sixth and two-sixths, respectively. Individuals captured three or more times, or twice, if not on consecutive nights, and those captured at least once in each of two trapping periods were considered "full residents" (six-sixths). The total of all degrees of residency during a trapping period for a plot constituted the population. Population densities per unit area for each plot were determined by adding a border strip along each side to account for individuals having only a portion of their home range covered by the trapping grid (Blair 1941). Since movement indices between plots were similar, the average movement index of all individuals of an age class for all six study plots in a trapping series was used as the width of all border strips for that series. No boundary strip was added when calculating juvenile population densities in 1969. Insufficient captures prevented the determina-

tion of a movement index.

Regular, systematic observations on and off the study plots were made to determine species composition, number, distribution and habitat preferences for larger mammals.

Vegetational surveys were taken at four sites on each plot. These sites were located as close to those used by Cada (1968) as possible. The same sites were sampled each year. The method of vegetational analysis was a modification of the method of Daubenmire (1959), whereby 20, 2 x 5 decimeter plot frames were placed at regular intervals along two, 100-foot lines at each analysis site. The percent canopy cover by cover classes and height of each species, and percentage of bare ground, rock, and plant litter were estimated within each plot frame. Frequency among plot frames and constancy among analysis sites were also determined. Sagebrush height and crown coverage were determined from intercept measurements (Canfield 1941) along one of the 100-foot lines at each of the analysis sites. Plant nomenclature was according to Booth (1950) and Booth and Wright (1959).

RESULTS

Vegetation

Each of the six study plots was characterized by an *Artemisia/Agropyron* community. The dominant shrub on all plots was big sagebrush (*Artemisia tridentata*). The principal grasses were western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), Junegrass (*Koeleria cristata*), green needlegrass (*Stipa viridula*), and various species of bluegrasses (*Poa* spp.). Needleleaf sedge (*Carex eleocharis*) was also abundant. The predominant forbs were Hood's phlox (*Phlox hoodii*), fringed sagewort (*Artemisia frigida*), American vetch (*Vicia americana*), and plains pricklypear (*Opuntia polycantha*).

On the bases of dominant or co-dominant grasses, each study plot was divided into vegetation sub-types similar to those described by Cada (1968). Sagebrush characteristics for each sub-type of each plot are given in Table 1. Since the effects of the herbicide were not evident in the 1968 results, these are considered pre-treatment.

Canopy coverage, frequency and constancy for taxa on Plots I-VI, with reference to vegetation sub-types, sagebrush density, and other noticeable physiographical features are given in Tables VII-XII in the appendix.

To show treatment effects, the mean canopy coverage of all grasses (including sedges), forbs (including half-shrubs), and shrubs (big sagebrush), with reference to vegetation sub-types, sagebrush density, and

other noticeable physiographical features for each plot, from the 1969 results are compared with the 1968 and 1966-67 results (Figures 2, 3, and 4).

Differences in the coverage of grasses and forbs between the pre-treatment results of 1966-67 and 1968 were probably due to variations in precipitation, differences between observers in coverage estimates and/or difference in analysis site position. Since the analysis sites used in 1969 were identical to those used in 1968, only the percent changes in canopy coverage between these 2 years will be discussed.

Grasses showed little response to treatment on the partial kill plot (Plot I). A comparison of the combined data for the plot by years, showed a mean increase in coverage of 8 percent for 1969 as compared to 1968, while on the nearby control plot (Plot II) there was a mean increase in coverage of 22 percent.

From 1968 to 1969 there was a noticeable increase in the mean coverage of grasses on the total kill plot (Plot IV) and the strip kill plot (Plot V) of 52 and 12 percent, respectively. Control plot III had a 5 percent decrease and control plot VI had a 4 percent increase in mean coverage.

When comparing control to treatment, the treatment plots had 1 percent less coverage of grasses in 1968 and 14 percent greater coverage in 1969 than the control plots. This increase can be considered treatment effect.

TABLE 1. AVERAGE NUMBER AND INTERCEPT OF BIG SAGEBRUSH PLANTS ON EACH OF THE STUDY PLOTS AS DETERMINED BY MEASUREMENTS ALONG A 100-FOOT LINE AT VARIOUS SAMPLING SITES.

Plot No.	Vegetation Sub-Type	No. Sites	SAGEBRUSH CHARACTERISTICS: Mean Intercept/Site 1968	Mean Intercept/Site 1969	Mean Number Plants/Site 1968 Live/Dead	Mean Number Plants/Site 1969 Live/Dead
I	*Atremisia tridentata/ Agropyron smithii/ Bouteloua gracilis*	3	35 (dense)[1]	15 (common)	47/4	33/28
	Artemisia tridentata/ Bouteloua gracilis	1	15 (common)	10 (common)	24/1	24/8
II	*Artemisia tridentata/ Agropyron smithii/ Bouteloua gracilis*	2	16 (common)	13 (common)	35/6	26/8
	Artemisia tridentata/ Agropyron smithii	2	33 (dense)	25 (dense)	45/6	44/10
III	*Artemisia tridentata/ Agropyron smithii*	1	55 (very dense)	43 (very dense)	63/5	63/6
		2	28 (dense)	29 (dense)	32/2	41/2
		1	15 (common)	15 (common)	19/0	37/2
IV	*Artemisia tridentata/ Agropyron smithii*	1	28 (dense)	0 (rare)	48/3	0/42
		1	31 (dense)	0 (rare)	51/1	0/42
		2	31 (dense)	1 (rare)	53/1	1/57
V	*Artemisia tridentata/ Agropyron smithii*	1	26 (dense)	3 (scattered)	40/2	13/44
		1*	16 (common)	6 (scattered	19/2	16/20
		2**	13 (common)	11 (common)	25/2	22/9
VI	*Artemisia tridentata/ Agropyron smithii*	1	35 (dense)	25 (dense)	41/1	44/4
		2	15 (common)	11 (common)	25/0	29/1
		1**	6 (scattered)	4 (scattered)	17/2	9/5

[1]Sagebrush density categories: Rare = 0-1 percent; Scattered = 1-10 percent; Common = 10-25 percent; Dense = 25-40 percent; and Very Dense = 40 percent and greater shrub intercept.
*Indicates "Gully Bottom" physiography. **Indicates "Hard Pan" physiography.