1985

Wildlife Response to Stand Structure of Green Ash Woodlands

Robert A. Hodorff

WILDLIFE RESPONSE TO STAND STRUCTURE OF GREEN ASH WOODLANDS

by

Robert A. Hodorff

A thesis submitted

in partial fulfillment of the

requirements for the degree master of science,

Major in Wildlife and Fisheries Sciences,

South Dakota State University.

1985

WILDLIFE RESPONSE TO STAND STRUCTURE

OF GREEN ASH WOODLANDS

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Dr. Kay L. Linder
Thesis Advisor

Date

WILDLIFE RESPONSE TO STAND STRUCTURE OF GREEN ASH WOODLANDS

Abstract

ROBERT A. HODORFF

Vegetation, birds and mammals were sampled over two years In two types of green ash woodlands in extreme northwestern South Dakota. Woodlands referred to as closed canopy stands consisted of dense stands of various species of trees and shrubs in different size and age classes. Woodlands referred to as open canopy stands had sparse stands of older trees, with intermediate seedling, sapling and tall shrub layers nearly absent. Closed stands had significantly greater (P = .002) coverage of shrubs in the understory than open stands while open stands had significantly greater (P = .004) total coverage of grasses than closed stands. Green ash (Fraxinus pennsylvanica) was the dominant tree and western snowberry (Symphoricarpos occidentalis) was the most common shrub in both stand types. Chokecherry (Prunus virginiana) cover was much higher in the closed stands than the open stands while cover of Kentucky bluegrass (Poa pratensis) was greater in the open stands than the closed stands.

Nearly twice as many birds were observed on line transects in the closed stands as in open stands. Rufous-sided towhees (Pipilo erythrophthalmus), field sparrows (Spizella pusilla), black-capped chickadees (Parus atricapillus), American goldfinches (Carduelis

tristis), and orange-crowned warblers (Vermivora celata) were found in significantly higher numbers (P 5 .10) in closed stands than in open stands during both 1983 and 1984. A significantly greater number (P < .10) of western meadowlarks were found in open stands than closed stands. Bird species composition was 84% similar between open and closed stands and Spearman's rank order was significant (P = .001) with a correlation coefficient of r = .7, indicating little difference in species ranking between stand types.

Total numbers of small mammals captured were similar in 1983 in both stand types while there were significantly (P = .05) more mammals captured in closed stands than in open stands during 1984. Voles (Microtus spp.) were the most common mammals captured in both stand types. Deer mice (Peromyscus maniculatus) were captured in significantly greater numbers (P ^{5} .05) in closed stands than open stands during both years.

Tracking stations were used to sample intermediate-sized mammals. Cottontails (Sylvilagus spp.) were the only species found in significantly higher (P =.006) numbers in closed stands than open stands; jackrabbits (Lepus spp.) were more abundant (P = .03) in open stands than in closed stands.

Tracking stations and pellet surveys indicated closed canopy stands were more important than open canopy stands for deer (Odoccileus spp.) during fawning and in the winter.

ACKNOWLEDGEMENTS

Sincere thanks are extended to my graduate advisor Dr. R. L. Linder and to Carolyn H. Sieg for their guidance and assistance throughout this study. I would also like to thank the members of my committee Dr. L. D. Flake, Dr. G. E. Larsen and Dr. R. R. Rue for their review and comments in the preparation of this manuscript.

Funding for this study was provided by the USDA Forest Service, Rocky Mountain Forest and Range Experiment Station and the Custer National Forest. Special thanks are extended to Dr. A. J. Bjugstad who provided me an opportunity to pursue an advanced degree and to the rest of the experiment station personnel including Dale Becker, Steve Denison, Harold Messner, Larry Beagle, Brian Engle, Debbie Paulson, John Coons, Mark Rumble, Dr. D. W. Uresk, Rudy King, and Shary Kennedy who helped with collection of field data, analysis or administration of the project.

Special thanks is given the Wildlife Fisheries Department of South Dakota State University and to the South Dakota Cooperative Fish and Wildlife Research Unit for support during my graduate program.

I am especially grateful to the Millet family, Benny, Mark, Janie and Erik, who provided a place to park a trailer, friendship and a family while I was away from home.

I would also like to thank my parents John and Mary Hodorff and the rest of my family for providing encouragement and support during the study.

The greatest thanks of all must be extended to my two boys, John and Josh, for their patience and support with their dad during the study and to my wife Terry. Terry helped with the collection of field data, compiling of data, and initial editing and typing of the manuscript. Without her love and support I would have never made it.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

INTRODUCTION

Deciduous woodland communities provide a unique habitat component in the generally treeless expanse of the northern Great Plains. These habitats comprise less than 5% of the total area of the plains (Boldt et al. 1976), but provide critical areas for many plant and animal species
and contribute to the species diversity of the northern Great Plains. Seabloom et al. (1978) found that wooded habitats comprised less than 9% of an area sampled in North Dakota, yet contained 33% of all observed fauna. Presently there is evidence that these woodlands are in a serious state of decline (Boldt et al. 1978).

Woodland communities occur along rivers, streams, and draws in isolated localities with favorable moisture and climatic conditions. Topography has been closely linked to the establishment and maintenance
of woody vegetation, with densities of deciduous vegetation higher on the north-facing slopes of the green ash woodlands (Butler 1983, Mack 1981). Retention of soil moisture is a limiting factor for woody vegetation on the northern Great Plains (Williamson et al. 1981).

Visher (1914) first described the deciduous woodland community in northwestern South Dakota. **He** stated that the canyons were more or less filled with deciduous trees with narrow extensions along the streams and that conditions for plant growth were more favorable there than on the plains. Hansen and Hoffman (1982) described the major

deciduous habitat type in the area as green ash (Fraxinus pennsylvanica) / chokecherry (Prunus virginiana) . These green ash-chokecherry draws (hereafter called green ash woodlands) were characteristically found in the upper reaches of grassland drainages and existed as tree belts of varying lengths along drainages.

Many of the green ash woodlands have been replaced by grass / forb communities, some are deteriorating and a few exist in a healthy productive condition (Boldt et al. 1978). Stands in late stages of decline (hereafter referred to as open stands) are characterized by: sparse decadent overstory trees, shrubs that are nonexistent or in scattered remnants, ground devoid of duff or litter, and rare or absent regeneration of trees and shrubs. Healthy productive woody draws (hereafter referred to as closed stands) are characterized by a moderately dense stand of trees, vigorous mixed shrubs, a deep litter and duff layer, and trees and shrubs of varying age classes, showing signs of regeneration (Boldt et al. 1978).

Heavy livestock grazing is thought to be the major contributor to the decline of green ash woodlands (Severson and Boldt 1978, Swenson 1981). Insect and disease damage and protection from fire are possible contributors to this decline (Severson and Boldt 1978). Overgrazing has been found to significantly impact deciduous trees and shrubs of riparian zones (Thomas et al. 1979, Smith and Flake 1983). Shade, a longer green season, and available water attract and hold livestock in deciduous woodlands (Severson and Boldt 1978). Livestock damage woodlands by (1) compacting soils which reduces moisture infiltration

and increases runoff (Lusby 1965), (2) constantly removing herbage which increases soil temperature and evaporation from the soil surface, and (3) rubbing, trampling, and browsing which physically damages plants (Severson and Boldt 1978).

Some research on green ash woodland has focused on vegetational characteristics and wildlife use. Nelson (1961) and Hansen and Hoffman (1982) described vegetation, composition, and structure of green ash woodlands. Faanes (1984) described the importance of woody draws to breeding birds in North Dakota. Gaines and Kohn (1982) discussed use of hardwood draws by raptors. Cassel et al. (1982) compared avian and small mammal use of woody draws with other habitat types. Uresk (1982) documented the importance of green ash woodlands to small mammals, birds, and deer. On the northern plains, Severson and Carter (1978) concluded that deciduous woodlands were critical to mule deer survival, and Peterson (1984) felt that woodlands were the most important habitat for white-tailed deer. Boldt et al. (1978) attempted to stimulate declining green ash stands by various treatments (fencing, cutting, and planting). Research on effects of ecological conditions of green ash woodlands on wildlife use has not been conducted.

The purpose of this study was to provide information to assist land managers in making decisions on land use practices affecting green ash woodlands. Vegetative characteristics, avian and mammalian utilization of open and closed green ash stands were compared in the Slim Buttes of northwestern South Dakota.

Hypotheses were:

Relative densities of mammals and birds do not differ between open and closed green ash stands.

There are no differences in monthly use of green ash woodlands by associated wildlife.

There is no difference in vegetative composition and structure between open and closed green ash woodland stands.

STUDY AREA

This study was conducted in the Slim Buttes of Harding County, located in northwestern South Dakota (Fig. 1). The climate of the area is typically semi-arid and continental. The mean annual temperature at Camp Crook, South Dakota for 1896-1967 was 7°C. The normal annual range is -34 to 40°C; January and July are the coldest and warmest months, respectively. The average annual precipitation is 35 cm, with a range of 17 cm to 61 cm. Seventy-eight percent of the total precipitation occurs from April to September (Spuhler et al. 1971). Periodic drought is common (USDA 1976). The average wind speed is 16 km per hour with wind over 80 km per hour not uncommon (Spuhler et al. 1971).

Northwestern South Dakota is part of the northern plateau and is characterized by a series of plateaus and isolated buttes, underlain by the Fox Hills Sandstone and younger cretaceous strata (Westin et

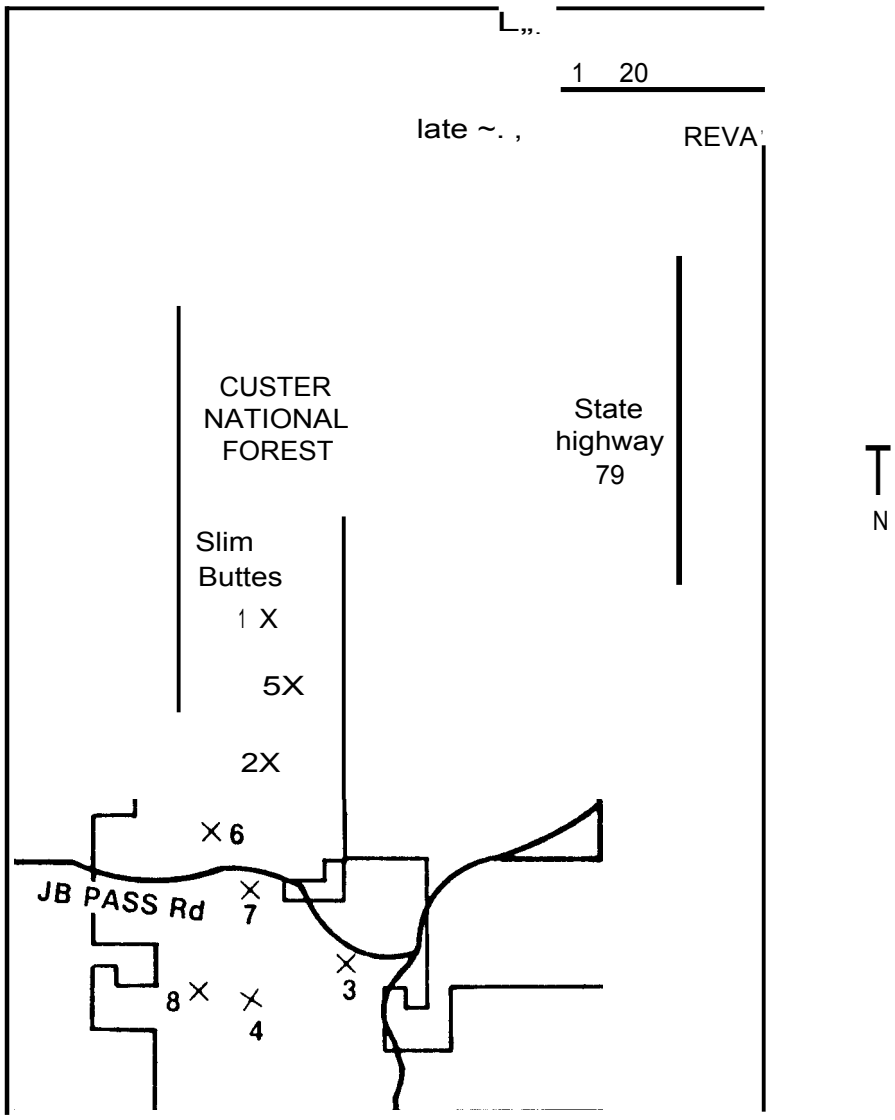

Figure 1. Map of the Slim Buttes study area showing location of the 8 study sites.

al. 1967). The buttes of the area are the result of erosion of soft rock beneath a resistant cap (Rothrock 1943). Most of the northern plateau is covered by mixed grass prairie which includes species such as western wheatgrass (Agropyron smithii), needle and thread (Stipa comata), green needle grass (Stipa viridula), blue grama (Bouteloua gracilis), and fringed sage (Artemisia frigida).

The Slim Buttes rise 160 m. above the surrounding plain and are oriented north and south. The formation is approximately 45 km long and generally less than 2 km wide. The elevation of the study sites range from 975 m to 1100 m above sea level. Plant communities of the Slim Buttes include mixed grass prairie, ponderosa pine (Pinus ponderosa), and green ash woodlands.

Soils of the green ash woodlands are moderately deep to deep silty and clayey sands and shales. Often the upper end of the draws have silty sands to fine sands; lower portions are generally alluvial (USDA 1976).

The dominant plant species of green ash woodlands are green ash, chokecherry, and long-beaked sedge (Carex sprengelii). Other characteristic species are saskatoon serviceberry (Amelanchier alnifolia), Woods rose (Rosa woodsii), northern bedstraw (Galium boreale), and Canada wild rye (Elymus canadensis). Species that indicate disturbance include western snowberry (Symphoricarpos occidentalis), Kentucky bluegrass (Poa pratensis), common yarrow (Achillea millefolium), white sage (Artemisia ludoviciaia), and common dandelion (Taraxacum officinale) (Hansen and Hoffman 1984).

Some wildlife species found in green ash woodlands in this area include mule deer (Odocoileus hemionus), white-tailed deer (0. virginianus), cottontails (Sylvilagus spp.) and many bird species, including sharp-tailed grouse (Tympanuchus phasianellus) and rufous-sided towhees (Pipilo erythrophthalmus) (Swenson 1981).

The major domestic use of green ash woodlands in the Slim Buttes area is cattle grazing. The area is a part of the Sioux District, managed by the U.S. Forest Service and grazed on a permit basis by local ranches. Closed sites 1-3 and open sites 1-3 were located on a two pasture deferred grazing system and were grazed from May 15 to November 15. Closed and open site 4 were located in winter pastures which were grazed from August 16 to January 15 (Table 1). Hunting of big and small game ranks as the major recreational use (USDA 1976).

METHODS

Eight, green ash study sites, which were 800-m long were selected in April 1983. Four sites were established in stands which were subjectively rated as closed stands, and four were established in stands which were subjectively rated as open stands (Fig. 1). A closed stand had a dense overstory of several age classes and sizes of trees, several species and age classes of shrubs, and a highly variable understory of shrubs, forbs, and grasses. An open stand had a sparse overstory of mainly decadent trees, little or no tree reproduction, few species of shrubs (of which only western snowberry

Table 1. Grazing systems on the green ash woodland study sites in the Slim Buttes of South Dakota.

Allotment Name	Size of Allotment (ha)	Number of cow/calf	Period of grazing	Grazing system	Number of study sites
Cedar Canyon	2948	307	Aug. 16-Jan. 15	Winter pasture	Closed 4 Open 4
J.B. Wammen	1620	238	May 16-Oct. 15	Two pasture deferred	Closed 1 & 2 Open 1 & 2
Road Draw	1031	195	May 16-Nov. 15 (June 16-July 7 cattle are out)	Two pasture deferred	Closed 3 Open 3

showed signs of reproduction), and a groundcover of mainly grasses and increaser forks.

Vegetation

Understory

Plant canopy cover of the understory vegetation was visually estimated in 30, 20x50 cm quadrats placed 1 m apart along permanent 30 m transects . Five transects per site provided a total of 150 quadrats on each site. Total percent canopy cover, bare ground, plant litter and cover by individual plant species were estimated by the use of six cover categories: 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100% (Daubenmire 1959). Each of the five transects were sampled in June and in early August of 1983 and 1984. In addition, in each quadrat, maximum heights of shrubs and seedlings less than 2 m tall were recorded by species during the dune session only. Van Bruggen (1976) was used as the authority for common and scientific names.

Over story

Fifteen 7x7 m macroplots were established on each site for sampling overstory vegetation. Heights of all trees and shrubs in the plot over 2 m in height were recorded by species. Percent canopy cover of overstory was sampled using a box prism with readings made at 100 points in the draw. Presence or absence of overstory was recorded and cover was calculated as number of positive hits = % cover.

Small mammals

Relative small mammal densities were determined for each study site by the use of Sherman live traps. Twenty traps (8x9x25 cm), spaced 10 m apart, were placed on each line transect. Three transects were established on each site for a total of 60 traps per site. The transects were 50 m apart, with a 50 m buffer on each end of the transect.

Trapping was conducted once a month from May through August in 1983 and 1984. Each trap session consisted of one night prebaiting, followed by five consecutive nights of trapping. Rolled oats mixed with creamy peanut butter were used as bait. Cotton batting and a sufficient food supply were placed in the traps to sustain animals. Traps were checked at dawn each day. Captured animals were identified as to species, sex, age category (adult or juvenile), and reproductive condition. Animals were marked by toe amputation (Taber and Cowan 1971), assigned a unique four digit number, weighed, and released. Jones et al. (1983) served as the source for common and scientific mammal. names.

Birds

bird populations associated with each site were sampled following methods outlined by Emlen (1971, 1977) on 800 m band transects. The surveyor walked the transect and recorded the number and species of birds seen and/or heard 30 m on either side of the transect. The surveys were conducted for four consecutive mornings once a month from

May through October of 1983 and 1984, The surveys were conducted on days of favorable weather conditions, beginning within one-half hour of sunrise. The sequence in which the sites were surveyed was altered daily. American Ornithologists' Union (1983) was used as the authority for common and scientific names.

Intermediate to large mammals

One-meter diameter track counting stations were established every 50 m along the 800 m transect on established game trails. Track stations were cleared of all vegetation, debris and rocks and covered with approximately 1 cm of sifted soil. Each station was visited once a day for nine days a month (with exception of September 1983 during which stations were checked for 4 days), the species of animal whose tracks were found was determined, and numbers of individuals were estimated. The stations were then cleared of tracks by raking the area. The tracking stations were checked from June through September of 1983 and May through October of 1984.

Pellet transects

Deer pellets were cleared along a belt transect 800 m long and 2 m wide in May 1983. These transects were walked and all deer pellets were counted and cleared from the belts in September of 1983 and 1984, and in May of 1984.

Compaction

Penetrometer readings were taken in each draw, once a month from June through September in 1983 and from May through September in 1984, with a pocket penetrometer. The penetrometer was inserted into the soil at a distance of 3 m from the small mammal transects on alternate sides at 20 m intervals. There were ten samples along each transect totaling 30 for each woodland site.

Statistical analysis

Small mammal numbers were reported as unique individuals per site. Birds and track data were presented as total observations per site. Stand type differences for mammals, birds, total estimated individuals as determined from track counts, and compaction data were determined by using repeated measures analysis of variance (Hull and Nie 1981). If a stand type and month interaction was detected by the repeated measures analysis of variance, stand type differences were determined using a one-way analysis of variance by stand type on each month individually and seasonal differences were determined by one-way analysis of variance by month and Tukey's multiple comparison procedure (Nie et al. 1975). Yearly differences were determined by two-way analysis of variance by year by stand type.

Understory plant canopy coverage was compared by using three-way analysis of variance by year by stand type by month. Overstory tree and shrub species densities were calculated as numbers per hectare; differences were determined using one-way analysis of variance by

stand type. Percent canopy coverage of the overstory was compared using one-way analysis of variance by stand type.

Spearman's rank order correlation was used to compare rank order of bird species between stand types for both years combined (Nie et al. 1.975). A similarity index of bird species was calculated using the formula: S= 2C/A+b, where A is the number of species present in open stands, b is the number of species in closed stands and C is the number of species common to both (Odum 1971).

Heights of trees and shrubs under 2 m measured in the understory plots were separated into 2 categories (0-1 m and 1-2 m). For each species in each category, a percent frequency was calculated and compared using two-way analysis of variance by year by stand type. Heights of trees over 2 to tall measured in the macroplots were separated into 4 categories: 2-5 m, 5-8 m, 8-11 m, and over i'. meters. Heights of shrubs were separated into 2 categories (2-3 m and over 3 m). Density for total number of trees or shrubs in each category was compared using one-way analysis of variance by stand type.

RESULTS AND DISCUSSION

Understory vegetation

Understory total plant canopy coverage (P = .67), litter (P = .16), and bare ground (P = .99) were similar between stand types for all sample sessions combined (June and August of 1983 and 1984).

Total cover averaged 79% in closed stands and 78% in open stands. Litter cover averaged 67% in the closed stands and 61% in the open stands; bare ground averaged 12% in both closed and open draws (Table 2). Total coverage was similar for both years (P = .75), bare ground was lower (P = .002) in 1983 compared to 1984, and litter was lower (P .001) in 1983 than in 1984.

Western snowberry was the most common species present in both open and closed stands with canopy coverage averaging 30% and 34%, respectively, for all sample sessions combined (Table 2). In closed stands, chokecherry, sedges (Carex spp.), and Kentucky blue grass had mean canopy coverages of 14%, 14%, and 13%, respectively, for all sample sessions. In open stands, Kentucky blue grass, sedges, and western whoatgr.ass had mean canopy coverages of 27%, 13%, and 8% respectively, for all sample sessions.

Total shrub coverage (woody plants less than 2 m tall) was higher (P = .002) in closed stands averaging 55% compared to 39% in the open stands for all sessions combined (Table 2). Plant cover of western snowberry was similar (P = .25) in both stand types. Shrubs with higher canopy coverage on closed sites were chokecherry (P = .001), saskatoou serviceberry (P = .001), poison ivy (Toxicodendron rydbergii) (P = .02), green ash (P = .05), common juniper (Juniperus communis) (P = .03), Woods rose (P = .05), and buffalo currant (Ribes odoratum) (P = .004) (Table 2). There were no shrub species with significantly higher (P ` .1) plant canopy cover in open stands than

Table 2. Canopy cover of understory plants (less than 2m tall) in open and closed green ash woodlands in the Slim Buttes of South Dakota, 1983 and 1984.

Life form	Mean (±SE) percent	
	Closed	Open
Shrubs and trees		
Symphoricarpcs occidentalis	34 ± 2	30 ± 3
Prunus virginiana	14 ± 2	4 ± 1*
Amelanchier alnifolia	4 ± <1	1 ± <1*
Toxicodendron rydbergii	2 ± <1	1 ± <1*
Fraxinus pennsylvanica	2 ± <1	<1 ± <1*
Juniperus communis	2 ± <1	<1 ± <1*
Rosa woodsii	1 ± <1	<1 ± <1*
Ribes odoratum	1 ± <1	1 ± <1*
Artemisia cana	<1 ± <1	1 ± <1
Total shrubs and juvenile trees	55 ± 3	39 ± 4*
Grasses or grasslike		
Carex spp.	14 ± 1	13 ± 2
Poa pratensis	13 i 2	27 ± 3*
Agropyron smithii	2 .. <1	8 ± 1*
Bromus spp.	<1 ± <1	2 ± <1
Bouteloua gracilis	<1 ± <1	1 ± <1*
Buchloe dactyloides	<1 ± <1	1 <1*
Andropogon scoparius	<1 ± <1	1 ± <1
Total grass[1]	35 ± 4	53 ± 4*
Forbs		
Galium boreale	5 ± 1	5 ± 2
Monarda fistulosa	3 ± <1	3 ± <1
Smilacina stellata	3 ± <1	1 ± <1
Galium aparine	3 ± 1	<1 ± <1
Cystopteris fragilis	3 ± <1	<1 ± <1*
Fragaria vesca	2 ± <1	<1 ± <1*
Sanicula warilandica	2 ± <1	<1 ± <1*
Thalictrum venulosum	2 ± <1	<1 i <1
Artemisia ludoviciana	1 ± <1	3 ± <1*
Achillea mi.11efolium	1 ± <1	2 ± <1*
Taraxacum officinale	<1 ± <1	3 ± <1*
Total forbs[1]	27 3	22 ± 4
Total coverage	79 t 2	78 ± 3
Bare ground	12 ± 2	12 ± 2
Litter	67 ± 4	61 ± 3

Table 2 (continued)

[1]measured only in 1984.
Plant species <1% include: Acer negundo, Artemisia tridentate, Berberis repens, Chrysothamnus nauseosus, Cornus stolonifera, Crataeps spp., Juniperus horizontalis, Juniperus scopulorum, Opuntia polyacantha, Prunus americana, Rhus aromatica, Ribes odoratum, Shepherdia argentea,
Agropyron cristatum, Agropyron intermedium, Agrohordeum macounii, Agrostis stolonifera, Agropyron trachycaulum, Andropogon gerardi, Bouteloua curtipendula, Dactylis glomerata, Distichlis stricta, Elymus canadensis, Elymus virginicus, Festuca octoflora, Hordeum jubatum, Juncus balticus, Koeleria pyramidata, Muhlenbergia spp., Oryzopsis hymenoides, Oryzopsis micrantha, Poa canbyi, Poa reflexa, Poa sandbergii, Stipa comata, Stipa viridula, Agastache foeniculum, Agoseris glauca, Anemone cylindrica, Antennaria neglecta, Anemone patens, Apocynum androsaemifolium, Artemisia frigida, Astragalus agrestis, Aster ericoides, Capsella bursa-pastoris, Campanula rotundifolia, Chrysopsis villosa, Cirsium arvense, Cirsium vulgare, Convolvulus arvensis, Draba reptans, Erigeron glabellus, Fragaria virginiana, Gaura coccinea, Geum canadense, Geranium pusillum, Geum triflorum, Glycyrrhiza lepidota, Grindelia squarrosa, Heuchera richardsonii, Humulus lupulus, Lactuca oblongifolia, Lepidium densiflorum, Lupinus pusillus, Medicago lupulina, Melilotus officinalis, Osmorhiza longistylis, Panicum virgatum, Phlox hoodii, Plantago major, Psoralea esculenta, Ratihida columnifera, Senecio integerrimus, Smilax herbacea, Solidago spp., Solanum triflorum, Trifolium dubium, Vicia americana, Viola canadensis.

*Closed vs. open is significantly different at P .05.

in closed stands. Plant canopy coverage did not differ significantly (P - .1) between years or between months for any shrub species.

Western snowberry had the highest mean percent frequency for shrubs in the 0-1 m category in both stand types averaging 85% in the closed stands and 79% in the open stands (Table 3). Chokecherry was the next most common species averaging 457 iv closed and 17% in the open stands. Western snowberry (P = .37) and Woods rose (P = .30) were similar in both stand types; however, percent frequencies for chokecherry (P = .02), saskatoon serviceberry (P = .006), buffalo currant (P = .02), green ash (P = .07), and American plum (Prunus americana) (P = .02) were higher in closed stands.

Chokecherry had the highest mean per cent frequency for shrubs in the 1-2 m category in closed stands followed by western snowberry (Table 3). This layer was lacking in open stands. Percent frequencies of chokecherry (P = .04), western snowberry (P = .06), saskatoon serviceberry (P = .08), green ash (P = .07), buffalo currant (P = .04), Woods rose (P = .08), and American plum (P = .05) were all higher in closed stands than in open stands.

Total grass canopy coverage was higher (P = .004) in open stands averaging 53% compared to 35% in closed stands during the 1984 sample sessions (not measured in 1983) (Table 2). Grass species which had significantly higher cover values in open sites than in closed sites for all sample sessions combined (,rune and August of 1983 and 1984) were Kentucky bluegrass (P = .001), western wheatgrass (P = .001),

Table 3. Percent frequency of understory shrubs and trees in two height categories (0-1 m and 1-2m) in green ash woodlands in the Slim Buttes of South Dakota, 1983, 1984.

	Mean (±SF) percent			
	0-1 m		1-2 m	
Species	Closed	Open	Closed	Open
Symphoricarpos occidentalis	85 ± 2	79 ± 5	11 ± 5	1 ± <1*
Prunus virginiana	45 *_ 8	17 ± 6*	12 ± 5	<1 ± <1*
Amelanchier alnifolia	15 ± 3	4 ± 2*	6 ± 3	<1 ± <1*
Ribes odoratum	3 ± <1	1 ± <1*	2 ± <1	<1 ± <1*
Fraxinus pennsylvanica	12 ± 3	4 f _	6 ± 3	0 ± U*
Prunus americana	3 ± 1	<1 ± <1*	1 ± <1	0 ± 0*
Rosa woodsii	s ± 1	6 ± 1	2 ± 1	<1 ± <1*

*Closed vs. open is significantly different at P ` .10.

blue grama (P = .005), and buffalo grass (Buchloe dactyloides)(P = .02). None of the grass species had higher (P .1) cover values in closed stands than in open stands and coverage was similar between years.

Total forb coverage was similar between stand types (1' = .239) averaging 277 in closed stands and 227 in open stands during 1954 (Table 2). Northern bedstraw had the largest percent canopy coverage of any forb in either stand type. Species with significantly higher cover values in closed stands than in open stands were common bladder fern (C topteris fragilis)(P = .001), European strawberry (Fragaria vesca) (P = .01), and black sanicle (Sanicula marilandica) (P = .01). Species which had higher cover values in open stands than in closed stands were white sage (P = .05), common yarrow (P = .02), and common dandelion (P = .03). There were no forb species which differed in cover values between years (P - .1).

Kentucky bluegrass, white sage, common yarrow, common dandelion, western snowberry, and horsemint (Monarda fistulosa) are indicators of disturbance in green ash woodlands (Hansen and Hoffman 1954). All of these species were well represented in the canopy coverage of the understory in open stands, and some of these species (western snowberrv, Kentucky bluegrass, and horsemint) were also common in closed stands. Presence of these species indicate that both stand types have been exposed to disturbance with open stands showing signs of greater disturbance. Western wheatgrass, buffalo grass and blue grama, which occur more often in open stands, than in closed stands,

are common species of the prairie (Baumberger 1977) indicating these stands may be converting to a grass forb community. Presence of tree and shrub species such as green ash, chokecherry, and saskatcon serviceberry in the less than 2 m category indicates that these species are reproducing in closed stands and these communities should continue to survive.

Overstory

Density of trees and shrubs over 2 m tall (Table 4) and percent canopy coverage of the tree overstory were higher (P .01) in closed stands than in open stands. Closed stands averaged 999 trees / ha, 809 :shrubs / ha, and 62% overstory canopy coverage while the open stands averaged 398 trees / ha, 81 shrubs / ha, and 30% overstory canopy coverage.

Green ash was the major tree species for both stand types; were boxelder (Acer negundo) and American elm (Ulmus americana) present as minor components (Table 4). Densities of both green ash (P = .0001) and boxelder (P = .01) were significantly higher in closed stands than in open stands.

The major shrub species present in closed stands were chokecherry (465/ha) and saskatoon serviceberry (160/ha)(lable 4). Dominant shrubs in open stands were silver buffaloberry (Shepherdia argentea) (44/ha) and hawthorn (Crataegus spp.) (17/ha). Densities of chokecherry (P = .02) and saskatoon serviceberry (P = .03) were higher in closed stands than in open stands and were the only shrub species which showed a significant difference between standtypes.

Table 4. Densities (pc?' ha) of trees and shrubs over 2 m tall in green ash woodlands in the Slim Buttes of South Dakota (1983).

Life form	Mean (±SE) percent	
	Closed stands	Open stands
Trees		
Fraxinus pennsylvanica	952 ± 35	391 ± 55*
Acer negundo	44 ± 9	7 ± 7*
Ulmus americana	3 t 3	0 ± 0
Total	999 - 35	398 ± 52*
Shrubs		
Prunus virginiana	465 ± 138	10 ± 10*
Amelanchier alnifolia	160 ± 56	7 ± 7 *
Crataegus spp.	51 ± 34	17 ± 13
Prunus americana	31 ± 15	3 ± 3
Shepherdia argentea	27 ± 23	44 ± 26
Cornus stolonifera	74 t 74	00
Total	809 ± 180	81 ± 40*

*Closed vs. open is significantly different at P s .05.

Tree densities were higher (P = .0007) in closed stands than in open stands in all height categories measured with the exception of the trees over 11 m, which were similar (P = .30) in both stand types (Table 5). Densities of shrubs in both tight categories were higher (P .02) in closed stands than in open stands.

The closed green ash woodlands in the Slim Buttes appeared to be regenerating. Open stands showed little sign of reproduction and appeared to be reverting to a grass fort) community. The structure of closed stands exposed a multilayered community with different size and age classes of trees and shrubs. Open stands consisted of a low shrub layer of western snowberry and a sparse tree layer of mature green ash with intermediate layers absent. Western snowberry was the only "woody" species which showed signs of perpetuating itself. Boldt et al. (1978) reported lack of regeneration as a major problem and that many woodlands are in the process of being replaced by grass / forb stands.

Vegetative characteristics of open stands were similar to woodlands which have been subjected to heavy grazing. Butler (1983) studied the effects of grazing intensity on green ash woodlands in North Dakota. Be found that percent canopy coverage of grasses was highest on heavily grazed sites and that tall shrub, sapling, and mature tree densities were reduced with increased grazing pressure. 'Densities of western snowberry were highest on all of his sites ((light, mcdcrrtte and heavy grazing' with chokecherry and saskatoori serviceberry increasing in importance on lightly grazed sites. Nelson

Table 5. Densities of overstory trees and shrubs of different height categories in open and closed green ash woodlands in the Slim Buttes of South Dakota,1983.

Height (m)	Mean (±SE) densities Closed (I /ha)	Open (II/ha)
Shrub		
2 - 3	677 ± 184	78 ± 44*
3 and above	132 ± 26	3 ± 3*
Tree		
2 - 5	313 ± 36	54 t 19*
5 - 8	360 ± 43	146 ± 20*
S - 11	261 ± 31	125 ± 14*
11 and above	48 ± 23	20 ± 9

*Closed vs. open is significantly different at P .05.

(1961) noted a considerable difference in the herbaceous layer of lightly and heavily grazed green ash woodlands in North Dakota. Most notable was a change in dominance from long-beaked sedge and northern bedstraw in lightly grazed stands to Kentucky bluegrass and common dandelion in heavily grazed stands. he also found that shrub and sapling cover was considerably reduced and :estern snowberry became the principle shrub with chokecherry assuming a secondary position in green ash stands subjected to heavy cattle grazing.

Slopes were not measured during the study, but from observation the north exposure of the draws was judged to be steeper and more extensive in closed stands than open stands. The steep slopes of closed stands could discourage livestock use even though they were located in the same pastures as open stands and exposed to similar grazing pressure. Mueggler (1965) found that slope steepness significantly influenced distribution of cattle in southwestern Montana. He found cattle use decreased as slope increased. Also, steeper north racing slopes receive less sunlight and are cooler and more moist than other more exposed areas (Richardson and Wollenhaupt 1963). The combination of reduced cattle grazing and increased moisture could provide more suitable growing conditions for plants in closed stands than in open stands.

Compaction

Penetrometer readings were significantly higher in open stands in 1963 (P = .004) and 1984 (P = .006) than in closed stands indicatin

greater degree of soil compaction. The mean ± standard error penetrometer readings for open and closed sites during 19fb3 were 2.43 .22 and 1.24 i .15 respectively. During 1954 the mean _t standard error penetrometer readings for open and closed sits were 2.55 *_ .11 and 1.90 ± .11 respectively.

Grazing animals in moist areas tend to compact soils (Stoddart et al. 1975). Compacted soils are poor absorbers of moisture and restrict normal root development (Barton et a]. 1966). Lusby (1970) found that runoff increased by *307* in grazed vs. unglazed areas in Colorado and listed soil compaction as a contributor. Soils of open stands *were* compacted to a greater degree than closed stands, probably resulting in less infiltration and greater runoff of water. Since moisture is a critical factor, increased compaction affects establishment and maintenance of green ash woodlands.

Small mammals

The total number of small mammals captured during the study was 16£6. Voles (1`licrotus spp.) and deer mice (Peromyscus maniculatus) were the most common animals captured on both stand types (Table 6). Other species captured included white-footed mice (Peromyscus leucopus), bushy-tailed woodrats fteotoma cinerea), plains pocket mice (Perognathus flavoscens), hispid pocket mice (Perognathus hispidus), and house mice (Mus mus; ulus).

Table 6. Number of small mammals captured in green ash woodlands in the Slim Buttes of South Dakota, 1963 and 1984.

Species	Individuals Captured 1983		Individuals Captured 1984	
Microtus spp.	1085	(77)[1]	254	(53)*
Peromyscus maniculatus	295	(21)	202	(42)*
Peromyscus leucopus	7	(1)	16	(3)
Neotoma cinerea	8	(I)	8	(1)
Mus musculus	4	(1)	1	1
Perognathus flavesceus	4	(1)	0	0
Perognathus hispidus	1	(1)	2	1
Total	1404		483	

r'ercent of total rapture.

*1983 vs. 1984 is significantly different at P .05.

Nearly three times as many small mammal:. were captured in 1983 as in 1984 (1403 in 1953, 483 in 1964) (Table 6). Mammal species which were captured in significantly higher numbers in 1983 compared to 1984 were deer mice (P = .04) and voles (P .001). Deer mice captures dropped from 295 in 1983 to 202 in 1984; vole captures decreased from 1085 in 1983 to 254 in 1984. These changes in numbers captured may be expected since voles are subject to periodic increases in numbers followed by an abrupt population decline and deer mouse numbers tend to fluctuate between years (Jones et al. 1983).

There was no significant difference between stand types for total numbers of small mammals captured (P = .66) or for total number of voles captured (P = .57) in 1983, but deer mice (P = .03) and bushy-tailed woodrats (P = .02) were captured in higher numbers in closed stands than in open stands (Table 7). During 1984 total numbers of small mammals (P = .005), deer mice (P = .01) and white-footed mice (P = .03) were captured in higher numbers in closed :stands than in open stands; however vole captures were similar between stand types (1' _ .24). No stand type and month interactions were detected.

Two species of voles, prairie vole (M. ochrogaster) and meadow vole (M. pennsylvanicus), were- present in Harding County, (Andersen and Jones 1971) but because of the difficulties differentiating these two species, they were combined for analysis in this study. Both species requilt heavy vegetative cover to flourish (Birney et al. 1976). Voles were present in green ash woodlands of southeastern

Table 7. Small mammals captured in open and closed green ash woodlands in the Slim Buttes of South Dakota, 1983 and 1954.

	Mean (±SE)			
	1983		1984	
yecies	Closed	en	Closed	en
Microtus spp.	127 ± 31	144 ± 24	39 ± 9	25 ± 5
Peromyscus maniculatus	53 ± 7	21 ± 3*	35 ± 5	16 ± 4*
Peromyscus leucopus	2 ± <1	<1 ± <1	4 ± 1	<1 ± <1*
eotoma cinerea	2 ± <1	0*	2 ± <1	<1 + <1
Total	164 ± 33	167 ± 25	80 ± 8	41 ± 4*

*Open vs. closed is significantly different at F .05.

Montana, and were positively correlated to canopy coverage of western snowberry (MacCracken et al. in press). Voles may be attracted to the green ash woodlands of the Slim Buttes because of the stands moist condition and high canopy coverage. The similarity of total canopy coverage and coverage by western snowberry in open and closed stands may explain the comparable numbers of voles in both stand types.

Deer mice, a ubiquitous species in the northern great plains, (Jones et. al 1983) were found more abundant in closed stands than in open stands of the Slim Buttes. Hansen and Warnock (1978) found that in Illinois the best habitat for deer mice was on reclaimed coal mires which contained large stemmed vegetation such as sweet clover (Melilotus officinalis) and wild parsnip (Pastinaca sativa), with high canopy coverage and low stem densities. They also reported a negative response of deer mice to dense stands of grass. In the Slim Buttes, higher shrub coverage and lower grass coverage of closed stands would result in lower stem densities at ground level in closed stands than in open stand:, which may explain the greater number of deer mice found there.

Few white-footed mice and bushy-tailed woodrats were captured in the Slim Buttes. In 1983, more woodrats were captured in closed stands than in open stands; in 1984 white-footed mice were present in higher numbers in closed stands than in open stands. Jones et al. (1983) stated that optimum woodrat habitat consists of rocky areas, while white-footed mice prefer woodlands or brushy areas. In the Slim Buttes, woodrats may he attracted to the steep, north exposures of the

closed stands, while the white-footed mice may he attracted to the more extensive shrub and tree cover.

Birds

Total numbers of birds observed in 1983 (3486) and 1984 (3535) were similar (P = .89). However, for both years combined twice as many birds were observed in the multilayered closed canopy stand., than in open canopy stands (4701 in closed, ?320 in the open). There were significantly more birds in the closed stands than in open stands in 1983 (P = .0004) and in 1984 (P = .01) (Fig. 2).

Physical structure of the habitat is an important niche dimension for birds because it provides courtship and display stations, nesting substrata, protection from predators, shelter from physiological stress and additional substrate for food (Wiens and Rotenberry 1981). Carothers and Johnson (1975) found that an increase in tree density resulted in an increase in bird densities in cottonwood (Populus fremontii) dominated riparian zones of Arizona. In habitats sampled with similar tree densities but different shrub cover and understory structural diversity, areas with high shrub cover and high structural diversity had more birds (Crouch 1981, Dambauch 1944). In the Slim Buttes study sites, tree and shrub densities were greater in closed stands than in open stands which resulted in twice as many birds observed in closed stands

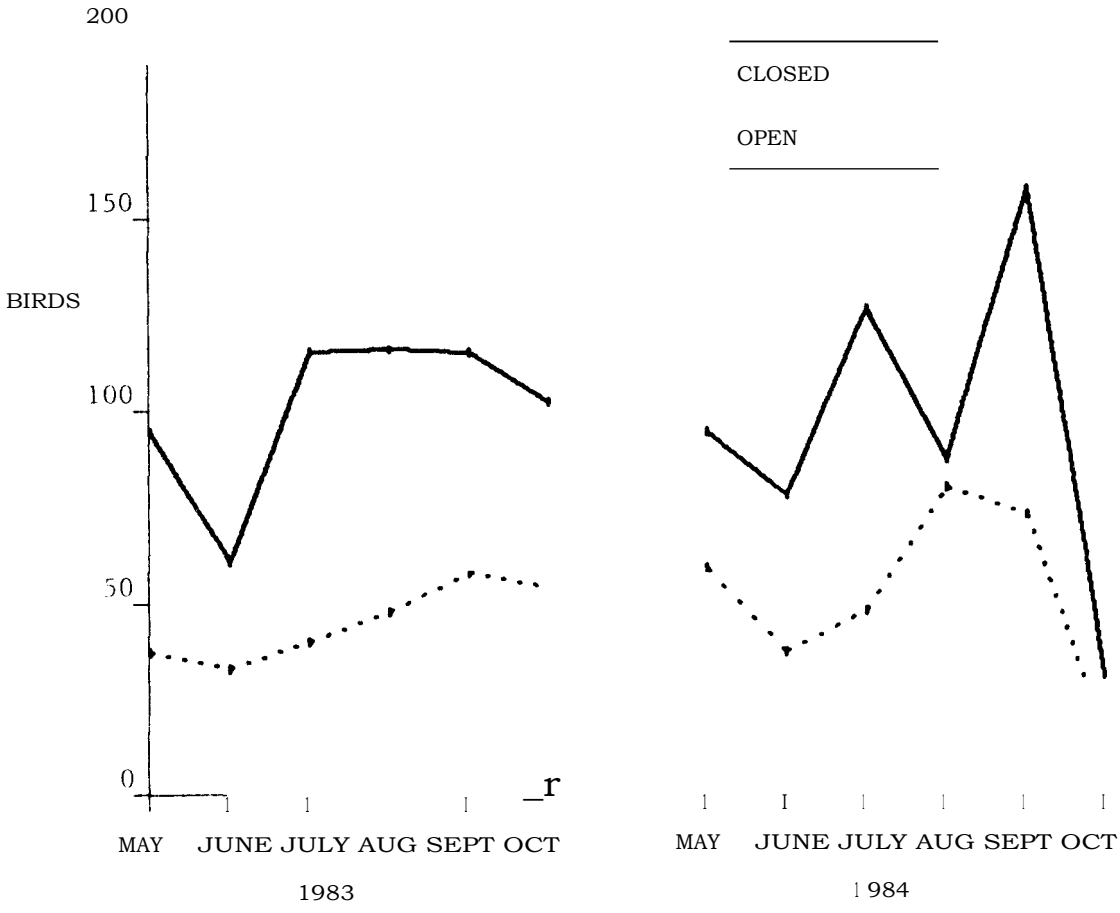

FIGURE 2. MEAN MONTHLY OBSERVATIONS OF BIRDS IN GREEN ASH W'O0DLAND CTUDY SITES IN THE SLIM BUTTES OF SOUTH DAKOTA.

Eighty-two species of birds were observed during the study. Fifty-nine species were observed in both stand types. Closed stands had 17 unique species; open stands had 6. Thirty species were seen only in May, August, September, or October and were considered non-breeding birds. Rufous-sided towhees and field sparrows (Spizella pusilla) were the most abundant species in both open and closed stands. The next most commonly observed birds in closed stands were black-capped chickadees (Parus atricapillus), American robins (Turdus migratorius), empidonax flycatchers (Empidonax spp.), and American goldfinches (Carduelis tristis) (Table 5) and in open stands mountain bluebirds (Sialia currucoides), American robins, sharp-tailed grouse and western meadowlarks (Sturnella neglect-.) (Table 9).

Bird species composition in open and closed stards in the Slim Buttes were relatively similar. Species encountered were b4 similar in both stand types. The Spearman's rank order correlation was significant (P = .001) with a correlation coefficient of r = .70, indicating that the rank order of bird species was similar between stand types. Because of the somewhat disturbed nature of closed stands, they did not exist as homogeneous stands of trees and shrubs, but rather as large dense patches of trees and shrubs intermingled with more open stands of trees with a sparse intermediate shrub layer; also, the entire south exposure of closed woodlands exhibited the more open characteristics. Open stands existed as sparse stands of trees intermingled with grasslands mixed with isolated patches of dense shrubs. This mosaic pattern resulted in many of the same habitat

Table 8. Rank order of bird species observed in closed green ash woodlands in the Slim Buttes of South Dakota, 1983 and 1984.

Common name	Scientific name	Observed
Rufous-sided Towhee	Pipil.o ervtiirophthalmus	844
Field Sparrow	Spizella pusilla	687
Black-capped Chickadee	Pares atrica>illus	62)
American Robin	Turdus mig,ratorius	399
Unknown		224
Empidonax flycatchers	Empicicn.ax spp.	220
American Goldfinch	Carduelis tristis	187
Chipping Sparrow	i :ella passerina	131
Lark Sparrow	Chondc:,tes _rammacus	127
Lincoln's Sparrow	Nel.ospiza lincolnii+	126
Dark-eyed Junco	Junco hycmalis +	113
Douse Wren	Troglodytes aedon	69
Lazuli Bunting	Passerina amoena	54
Yellow-rumped Warbler	Dendroica coronata	52
Mourning Dove	Zenaida macroura	50
Mountain Bluebird	Siali~ currucoides	48
Long-eared Owl*	Asio otus	44
Sharp-tailed Grouse	Tv,mpanuchus phasianellus	42
Unknown sparrow		42
Cedar Waxwing	Bombycilla cedrorum	41
Clay-colored Sparrow	Spizella pallida +	40
Wilson's Warbler.	Wilsonia usilla +	40
Black-billed Magpie	Pica pica	38
Orange-crowned Warbler	V ermivora celata +	35
Swainson's Thrush	Catharus ustulatus	34
Brown-headed Cowbird	Molothrus ater	31
Fed-breasted Nuthatch	Sitta canadensis	28
Northern Flicker	Colaptes auratus	27
Indigo Bunting	Passerina cyanea	2.6
White-crowned Sparrow	Zonotrichia leucophrys	25
Great Horned Owl	Bubo virginianus	2.1
Yellow Warbler	Dendroica petechia	20
Common Yellowthroat	Geothlypis trichas	17
Northern Harrier	Circus cyaneus	12
Hairy Woodpecker	Picoides villosus +	12
Black-billed Cuckoo	Cuccyzus ervthroptbalmus	11
Western Meadowlark	Sturnella neglecta	11
Unknown Warbler		11
American Tree Sparrow	Spizellai arborea +	10
Vesper Sparrow	Fooecetes gramineus +	9
Rock Wren	`ilpinctes obsoletus	9

Table 8 (continued)

White-throated Sparrow	Zonotrichia albicollis +	9
Ovenbird	Sciurus aurocapillus +	8
Sharp-shined Hawk	Accipiter striates	7
Mallard	Anus platvrhynchos	6
Common nighthawks	Chordeiles minor	6
Blue Jay	()yanocitta cristata	6
Brown Thrasher	Toxostoma rufum	6
Eastern Bluebird	Sialia sialis	5
Red-eyed Vireo*	Vireo olivaceus	5
Yellow-breasted Chat	Icteria virens	4
Song Sparrow	Melospiza melodia +	4
American Kestrel	Falco sparverius +	3
American Redstart*	Setophaga ruticilla +	3
Swainson's Hawk*	Biiteo swainsoni	
Brown Creeper	Certhia americans +	2
Downy Woodpecker*	Picoides pubescens +	
Gray Catbird*	Dumetella carolincnsis +	2
Brewer' Blackbird	Luphagus cyanocephalus	
Northern Oriole	Icterus galbula	2
Black-headed Grosbeak	Pheucticus melanocephalus +	2
Common Crackle	Quiscalus quiscula +	2
Eastern Phoebe*	Sayornis phoebe -I	2
Unknown Hawk		
Solitary Vireo	Vireo solitarius +	2
Cooper's Hawk*	Accipiter cooperii	1
Northern Goshawk`	Accipiter gentilis +	1
Red-tailed Hawk	Buteo jamaicensis	
Unknown Finch*	Carpodacus spp.	1
Western Wood-Pewee*	Contopus sordidulus +	1
Blackpoll_ Warbler*	Dendroica striata +	1
Prairie Falcon*	Falco mexicanus	1
Evening Grosbeak*	Coccothraustes vespertinus +	1
Loggerhead Shrike	Lanius ludovicianus +	1
Red--headed Woodpecker*	Melanerpes erythrocephalus +	
Wild Turkey*	Meleagris gallopavo	1
Townsend's Solitaire*	Mvadestes townsendi +	1
MacCillivray's Warbler	Oporornis tolmiei +	1
Pine Siskin	Carduelis pinus +	1
Eastern Kingbird	Tvrannus tyrannus +	1

*Observed only in closed stands.
+Observed only in May, August, September, or October.

Table 9. Rank order of bird species in open green n h woodlands in the Slim Buttes of South Dakota, 198, and 1984.

Common name	Scientific name	i/ Observed
Rufous-sided Towhee	Yipilo erythrophthalmus	363
Field sparrow	S~i::ella pusilia	316
Mountain Bluebird	Sialia currueoides	210
American Robin	Turdus migratorius	164
Sharp-tailed Grouse	Tvirpanuchus phasianellus	129
Western Meadowlark	Sturnella neglect.	127
Black-capped Chickadee	Parus atr.icapillus	122
Chipping Sparrow	Spizella passerina +	1. 14
Lincoln's Sparrow	Melospiza lincolnii +	78
Unknown		77
Lark Sparrow	Chondestes grammacus	69
American Goldfinch	Carduelis tristis	61
Brown-headed Cowbird	Molothrus ater	42
Black-billed Magpie	Pica pica	40
Empidonax Flycatchers	Empidonax spp.	32.
Unknown Sparrow		11
Dark-eyed Junco	Junco hyemalis +	
Northern Flicker	Colaptes auratus	22
Clay-colored Sparrow	Spizella pallida +	22
Red-breasted Nuthatch	Sitta canadensis	17
Brown Thrasher	Toxostoma rufum	15
Vesper Sparrow	Pooececes Eramineus	15
Mourning Dove	Zenaida macrour. a	14
White-crowned Sparrow	Zonotrichia leucophrys +	14
House Wren	Troglodytes aedon	13
American Tree Sparrow	Spizella arborea 4	12
Loggerhead Shrike	Lanius ludovicianus	12
Yellow-rumped Warbler	iiendroica coronata	11
Black-billed Cuckoo	Coccyzus erythropthalmus	11
Lazuli Bunting	Passerina amoena	11
Common Crackle	(iuiscalus quiscula	11
Brewer's Blackbird	Euphagus cvanocephaius	9
Eastern Bluebird	Sialia sialis 4	9
Rock Wren	Salpinctcs obsoletus +	S
Pine Siskin	Carduelis pinus +	8
Orange-crowned Warbler	v'ermivora celata +	7
Northern Harrier	Circus cyaneus +	6
Indigo Bunting	Passerina cyanea	6
White-throated Sparrow	Zonotrichia albicolli.s +	6
American)Kestrel	Falco sparverius +	5
Mallard	Anas platyrhynchos +	4
lilldeer*	Charadrius vociferus +	4
American Crow*	Corvus brachyrhynchos	4
Yellow Warbler	Dendroica petechia +	4
Common Yellowthroat	Geothlypis trichas	4

Table 9 (continued)

Easters. Kingbird	Tvrannus tyrannus
Wilson's Warbler	Wil ;oui.a pusilla +
Common Nighthawk	Chordeiies minor +
Blue Jay	Cvr.nocitta erist ata
Ovenbird	Seiurus nurocapillus
Unknown Warbler	
Great Horned Owl	Bubo virginianus
Gray Partridge*	Perdix perdix
Sharp-shined Hawk	Accipiter striatus
Upland Sandpiper*	Bartramia longicauda
Cedar Waxwing	Bombycilla cedroruw +
Red-tailed Hawk	Buteo jamaicensis +
Brown Creeper	Certhia americana +
Hairy Woodpecker	Picoides villosus ±
Merlin*	Falco culumharius +
Swainson's Thrush	Catharus ustulatus +
Northern Oriole	Icterus galhula +
Yellow-breasted Chat.	lcteria virens
Song Sparrow	Nelospiza melodia +
Black-and-White Warbler*	Mtiiotilta varia +
MacGi 11 i vray' s Warbler	Oporornis tolmioi +
Black-headed Grosbeak	Pheucticus melanocephalus +
Solitary Vireo	Vireo solitarius +

*Observed only in open stands.
+Observed only in May, August, September, or October.

characteristics occurring in both stand types. Rotenherry and Wiens (1980) stated that both horizontal and vertical structure are important to bird populations of the shrub steppe environment. Because of this patchiness the same species of birds were present in each stand type, but in different numbers in the Slim Buttes. Birds characteristic of dense shrubs, such as the rufous-sided towhee were present in higher numbers in the closed stands than in the open stands; however birds characteristic of grasslands, such as the western meadowlark, were present in higher numbers in the open stands than in the closed stands. Because the open woodland was a large component of both stand types, birds that prefer the open environment (eg. bluebirds) were observed in similar numbers in both stand types.

Size of the habitat is another important characteristic that can affect bird use. 'Hopkins (1983) found that species richness of deciduous woodlands increased as size of the habitat increased and felt that increase in size attracted interior woodland species such as the ovenbird (Sciurus aurocapillus). Most of the birds found in the Slim Buttes were considered edge species and very few of the interior species were present. The absence of interior species would indicate that the patches of dente shrubs were not large enough to attract them.

Bird species found in significantly greater numbers in closed stands than in open stands during both 1983 and 1984 sampling sessions were rufous-sided towhees (P .01), field sparrows (P .05), black-capped chickadees (P .01), Amen or goldfinches (P = .07), and

orange-crowned warbler.. (Vermivora celata) (P .06) (Table 10). Empidonax flycatchers (P = .004), yellow-romped warblers (Dendroica coronata) (P = .06), dark-eyed juncos (Junco hvecmalis) (P = .01) and red-breasted nuthatches (Sitta canadensis) (P = .Ch) were observed in significantly higher numbers in closed stands than in open stands in 1983. In 1984 American robins (P = .05), Wilson's warblers (Wilsonia pusilla) (P = .10), house wrens (_I_rog;lodvtes aedon) (P = .08), Swainson's thrushes (Catharus ustulatus) (P = .03), yellow warblers (Dendroica petechia) (P = .07) and Cedar waxwings (Bombycilla redrorum) (P = .06) occurred in significantly higher numbers closed stands compared to open stands. The only species found in significantly higher numbers in open stands than in closed stands wan the western meadowlark (P = .02) during the 1983 sampling sessions (Table 10).

Bird species which occurred in significantly greater numbers in closed stands than in the open stands were characteristic of wood margins or deciduous woodlands . In green ash woodlands of North Dakota, the rufous-sided towhee, field sparrow, house wren, yellow warbler, and American goldfinch were associated with high shrub densities (Faanes 1983). Closed stands in the Slim Buttes had higher shrub densities than open stands, which could explain why these species were present in greater numbers in closed stands than in open stands. The black--eapned chickadee inhabited the middle sapling *layer* in deciduous woodlands ,n Pennsylvania (Case,; and Hein 1983). This layer was more extensive in closed stands than in open stands, which

Table 10. Birds observed in significantly different (P .1) numbers in closed vs. open green ash woodlands in the Slim Buttes of South Dakota, 1983 and 1984.

	Mean (±SE) Observations			
	1983		1984	
Species	Closed	Open	Closed	Open
Rufous-sided towhee	99 t 8	40 ± 5*	113 ± 7	5i ± 10*
Field sparrow	72 t 12	27 + 5*	100 t 19	52 ± 6**
Black-capped chickadee	93 t 14	15 t 4*	63 ' 13	16 t 5*
American Robin	55 ± 19	35 t 16	45 t 16	6 ± 2**
American goldfinch	19 t 4	b ± 3***	26 _	7 ± 1*
2r;pidonax flycatcher	47 ± 9	5 ± 2*	8 ± 2	3 t 1
Ye' low-rumped warbler	6 t 2	<1 ± <1**	8 ± 4	2 ± <1
ii1son's warbler	3 1 3	0	7 ± 3	I F <1***
Dark-eyed junco	24 t 5	4 ± 1*	4 ± 1	2 ± 1
Orange-crowned warbler	6 ± 2	2 - <1***	3 ± 1	1 + <1**
Douse wren	7 :_ 4	2 ± 1	10 ± 4	
Western meadowlark	3 * 2	26 ± 7**	1 t 1	d ± 4
Swainson ' s thrush	3 r 2	0	5 I 2	<1 ± <1**
Red-breasted nuthatch	2 ± <1	<1 + <1***	5 ± 1	4 , 2
Cedar waxwing	0	0	10 - 4	<1 t <1***
Yellow warbler	± 2	<1 ± <1	2 ± 1	<1 t <1***

* closed vs. open is significantly different at P .01.
** closed vs. open is significantly different at P f .05.
*** closed vs. open is significantly different at P = .10.

could be the reason for the large numbers of black-capped chickadees in closed stands. Empidonax flycatchers, yellow-romped warblers, Wilson's warblers, dark-eyed juncos, and orange-crowned warblers were mostly migrants in the Slim buttes. Johnsgard (197c) classified these species as characteristic of dense deciduous woodlands, which likely explains their preference for closed stands in the Slim Buttes during migration. The cedar waxwing was associ,nted with dense shrub cover in North Dakota (Faanes 1983) and was attracted to chokecherries and serviceberries (Stewart 1975). The dense shrub cover and abundance of chokecherries and serviceberries could explain the cedar waxwings preference for closed stands during 1984. The Swainson's thrush is characteristic of dense moist coniferous forests (.iohnsgard 1979). Closed deciduous woodlands in the Slim Buttes appeared to be important for them during migration. During the breeding season, American robins were associated. with green ash woodlands supporting low tree and shrub densities (Faanes 1983). In the fall. American robins were present in large numbers in the Slim Buttes and favored closed stands.

Western meadowlark, a grasland species, was the only bird species found in significantly higher numbers it open stands compared to closed stands. However, sharp-tailed grouse were especially abundant on the study area in 1983 in open stands and large flocks of mountain bluebirds were prey rt in two of the open stands in 1984. Sharp-tailed grouse select open grasslands during the summer and shifted to hardwood cover during the winter (Evans 1965). Mountnin

bluebirds use open woodlands (Johnsgard 1979), which likely explains the tendency of higher use of open stands in the Slim Buttes.

During 1983, the peak number of hirds occurred in August in the closed stands and in September in the open stands, while in 1984 the peaks occurred during September in the closed stands and in August in the open stands (Fig 2). Puring 1983 there were nc significant differences (P .05) in number of birds observed between months in either stand type. in closed stands during 1984, observations in September were significantly (P .05) higher than all months sampled with the exception of July; October observations were significantly.' (P ` .05) lower than all months except June. No monthly differences were found (P .05) in open stands during .1984. Trends showed a decline in bird observations during June, and peak number of observations in either August or September. During June many of the females are incubating eggs and are less likely to be observed, which could explain the drop in numbers. The increased number of observations in August and September may he explained by the young birds having fledged and fall migration occurring.

More birds were observed in closed stands than in open stands during every month sampled (Fig. 2) even though a stand type and month interaction (P 5 .1) was detected during both 1983 and 1984. In 1983, significantly (P 5 .02) more birds were observed during each month in closed stands than in open stands with the exception of September (P = .21). During 19f/, months wrath significantly greater observations in closed de than in open stands were June

(P = .002), July (P = .0001), August (P = .08), and September (P = .02); however bird observations in May (P = .12), and October (P = .38) were considered similar between stand types. At no time were total bird numbers higher in open stands than in closed stands.

Closed green ash woodlands were used significantly (P .05) more than open stands by breeding birds (birds counted in June and July). Rufous-sided towhees, field sparrows, house wrens, American goldfinches, yellow warblers, and black-capped chickadees were breeding birds found in significantly higher 'umbers in closed stands than in open stands.

Although bird numbers observed in the closed stands during migratory months (May, August, September, and October) were not always significantly higher (P .1) than in open stands, closed stands were found to be valuable to migrating birds. During migration, large flocks of birds which were present one day and gone the next caused large variability in the data. This high variability, rather than an increase of birds in open stands resulted in non-significant differences between stand types during some of the months sampled. Bird species found in significantly higher numbers in closed stands compared to open stands during migration were Empidonax flycatchers, yellow-rumped warblers, Wilson's warblers, dark-eyed juncos, cedar waxwings, orange-crowned warblers, Swainson's thrushes, and American robins. Since many species of birds preferred closed stands during migration and peak bird observations occurred during this period, it can be concluded that closed stands were important to migratory birds.

Large and intermediate mammals

Mule deer and white-tailed deer were the most common mammal tracks detected at tracking stations in both open and closed stands. Tracks of other species included cottontails, jackrabbits (Lepus spp.), porcupines (Erethizon dorsatum), striped skunks (Mephitis mephitis), raccoons (Procyon lotor), coyotes (Canis latrans), red foxes (Vulpes vulpes), bobcats (Felts rufus), and weasel (Mustela spp.). The only significant difference in number of tracks between stand types was cottontail (P = .006), and jackrabbit (P = .03) in 1983 and deer (P = .05) in 1954. Numbers of deer tracks and cottontail tracks were higher in the closed stands; however jackrabbit tracks **were** more plentiful in open stands (Table 11).

Porcupines, raccoons, red foxes, and striped skunks can be found anywhere on the plains, but are common species of woodland habitats (Jones et al. 1983). Similar numbers in open and closed stands in the Slim Buttes suggested that both of these wood Y no types provided habitat for these animals. Coyotes, weasels, and bobcats are carnivorous species, occuring in a wide range of habitat. These species used both open and closed stands in the Slim Buttes but did not show a preference for either stand types. Iwo species of cottontails were found in brushy areas in Harding County, the desert cottontail (Sylvilag;us audubon i i) and the eastern cottontail (S. floridanus) (Andersen and Jones 1971). The dense shrub cover in the closed stands in the Slim Buttes was preferred by cottontails. The

Table 11. Number of individual animals crossing tracking stations in open and closed green ash woodlands in the Slim Buttes in South Dakota, 1983 and 1984.

	Number of individuals			
	1983[1]		1984[`]	
Species	Closed	Open	Closed	Open
Deer (Odocoileus spp.)	30i	246	422	231*
Cottontail (Sylvilagus spp.)	37		10	
Jackrabbit (Lepus spp.)	0	11*	0	0
Porcupine (Erethizon dorsetum)	12	7	11	3
Striped skunk (Mephitis mephitis)	25	10	2.4	10
Raccoon (Procyon lotor)	0	2	4	13
Coyote (Canis latrans)	1	5	3	11
Red fox (Vulpes vulpes)	6	9	3	8
Bobcat (Fells rufus)	1	1	2	0
Weasel (Mustela spp.)	1	0	1	3
Unknown	10	18	32	25

[1] Data was collected from June through September.
[`] Data was collected from Nay through October.
* Closed vs. open was significant at P ` .05.

white-tailed jackrabbit (lepustownsenaii) ,s the only jackrabbit species found in Harding County and was typically a mammal of the open plains (Andersen and Jones 1971). Even though white-tailed jackrabbit tracks were found in greater number: in open stands than closed stands, green ash woodlands in any condition would not be critical to their survival.

Traek counts in the Slim Buttes showed that deer numbers peaked and were significantly higher (P = .04) in closed stands than in open stands in June, which corresponds to the peak of the fawning period (Steigers 1981) (Fig. 3). Steigers (1981) found that mule deer used chokecherry habitat extensively as fawning sites and for early fawn rearing activities in South Dakota. He found that height and density of the shrub cover were importart to deer for hiding and shade. Closed stands in the Slim Buttes fulfilled these habitat requirements for lawn survival to a graater extent than open stands.

The numbers of deer tracks steadily declined from June to September in both open and closed green ash woodlands in the Slim Buttes (Fig. 3). Steigers (1981) found that deer fawn use of chokecherry habitat decreased in the late summer and fall and Severson (19bl) reported that rule deer tended to move farther from cover as the season progressed. however the constant disturbance from researchers may have influenced deer behavior. Ward et al. (1980) found that humans walking was the most serious disturbance of all stimuli applied to mule deer. In the Slim Buttes, deer, after being

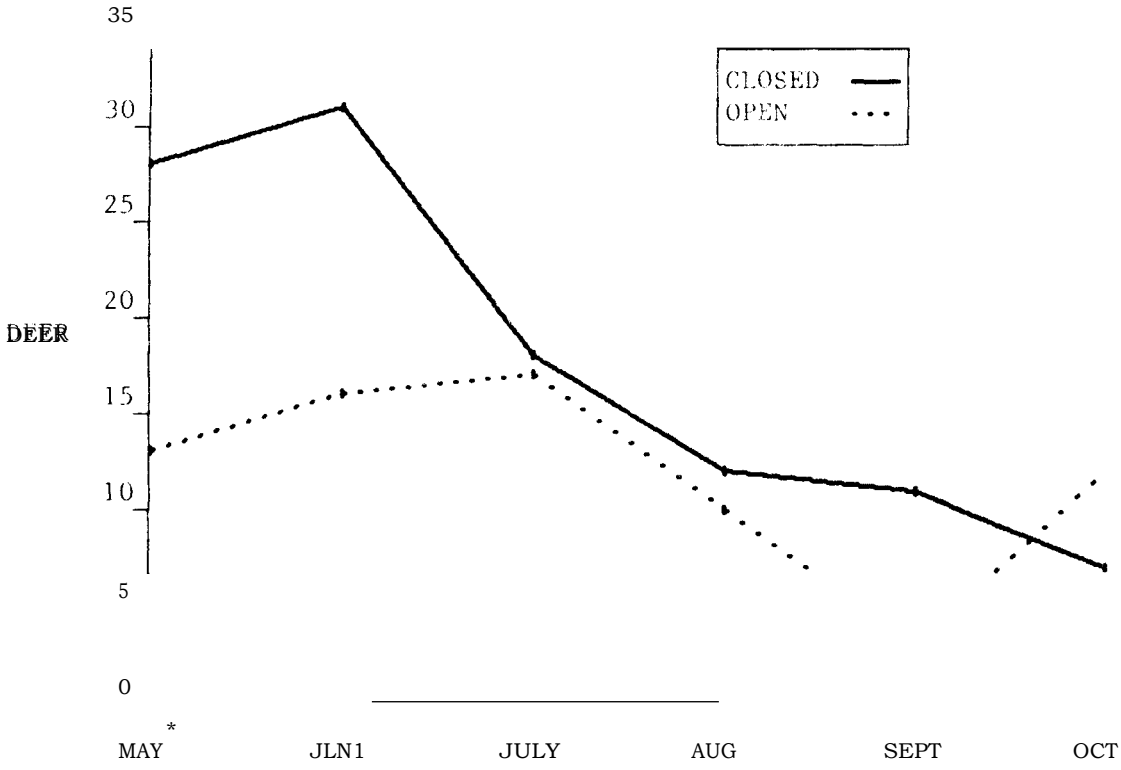

FIGURE 3. MEAN NUMBER OF DEER 1 G CROSS THE TRACKING STATIONS EACH MONTH IN THE GREEN ASH ItiOODI.AND STUDY SITES OF THE SLIM BUTTES OF SOUTH DAKOTA DURING 1983 AND 1984.

* DATA WAS COLLECTED) IN 1984 ONLY.

repeatedly flushed out of the draws, may have started to avoid the study sites.

Eighty-eight deer pellet group: were found during the study, 66 in closed stands and 22 in open stands (1'ig. 4). Significantly more pellets groups (P = .005) were found in the winter months (October-April) than in the summer months in the closed stands; however no seasonal differences (P = .16) were detected in numbers of pellet groups in open stands. During the winter significantly more pellets (P = .01) were found in closed stands compared to open stands.

1'el.let surveys in the Slim Buttes revealed that deer used closed stands more than open stands in the winter and they used closed stands more in the winter than the summer. Swenson et al. (1983) found that green ash woodlands were important to both mule and white-tailed deer in southeastern Montana during the winter months, because they provided some protection from the weather and contained abundant browse. l're:>k and Dietr (1980) fcund that the proportion of woody plants in diets- cf Black rills white-toiled deer increased during the winter. Severson (1981) stated that use of green ash woodlands in winter depends on the configuration of the draw. Narrow shallow draws tended to with snow, making their. inaccessible to deer. In wider, deep steep sided draws snow drifts accumulate on the upper sides leaving the wooded bottoms relatively snow free. The topography of the closed stands in the Slim Buttes caused less snow accumulation, and this combined with more browse plants and better cover may explain the heavier deer ose.

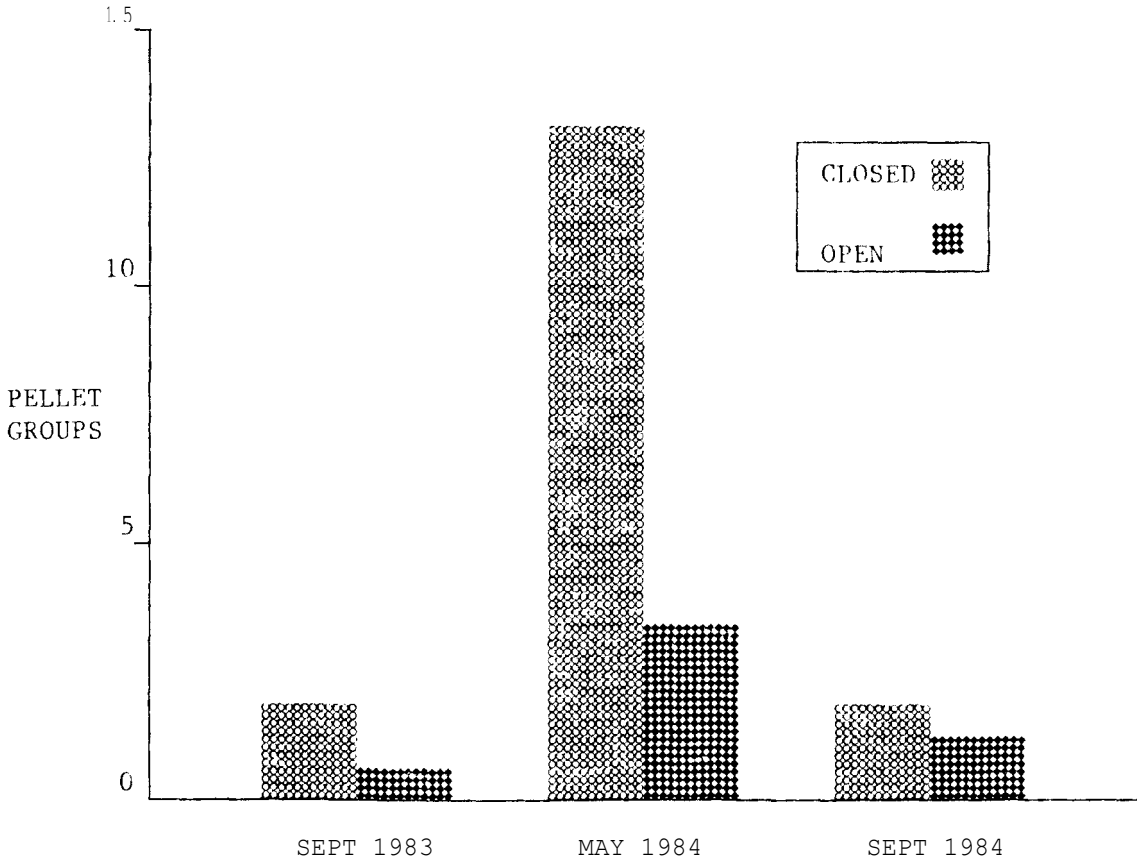

FIGURE 4. MEAN NUMBER OF DEER PELLETS FOUND ON THE GREEN ASH WOODLAND STUDY SITES IN THE SLIM BUTTES OF SOUTH DAKOTA.

CONCLUSIONS

The results of this study indicate that most animal species inhabiting closed condition green ash woodlands were also found in open stands. The major differences occurred in the number of individuals of each species found in the two stand types. Twenty species of animals were found in significantly greater (P .1) numbers in closed stands than the open stands; only two species were found in significantly higher (P -f-. .1) numbers in open stands than in closed stands. It can be concluded that more species of animals select the multiia}eyed closed canopy stands over open canopy woodlands, in which the intern.odiate shrub sapling! layer was nearly absent.

Deer mice, white-footed mice, and bushy-tailed woodrats were small mammals found in significantly greater numbers in closed stands compared to the open stands in the Slim Buttes. Deer mice and bushy-tailed woodrats flourish in areas without trees so closed canopy green ash woodlands are probably not critical to their survival. White-footed mice prefer forested habitats and closed canopy green ash woodlands could be important to the survival of this species on the plains.

Fifteen bird species were found to prefer the multilayered closed canopy woodlands to the open canopy stands in the Slim Buttes. Some of these species were breeding birds while others were present only during the r ;ration. It is important to the avian community that

green ash woodlands be maintained in the closed condition to keep a healthy population of breeding birds in the area and to aid migrating birds. If open stands are convert to grass forb communities many bird species which use them would no ;anger exist in the area, since most of these birds are limited to woodland communities.

Large differences in numbers of intermediate sized mammals between open and closed green ash woodlands were not detected in this study. Only the cottontail was found to inhabit closed stands more than open stands. However, green ash woodlands, in general, were valuable to many intermediate size mammals in the Slim buttes, including porcupines, red foxes, striped skunks, raccoons, coyotes, bobcats, and weasels.

Deer used closed green ash woodlands more than open stands especially during fawning and the winter. Because these are two very critical. times for deer, areas with more extensive closed stands will support greater deer poruiations.

The only species of animals which were found in significantly higher numbers (P .1) in open stands compared to closed stands during this study were western meadowlarks and jackrabbits. There is little need to maintain woodlands in the open condition for these species because they arc primarily grassland dwellers and open green ash woodlands are not crucial to their survival.

Reproduction of tall shrub and tree species was limited in the open stands. As trees and shrubs die in open stands and young plants are not present to replace them, these stands will be replaced by a

low shrub, grass and forb community. If these woodlands are converted to grass forb communities they will attract only animals adapted to life on the grasslands which would limit the species richness in the arca. It is imperative to manage green ash woodland for seedling and sapling growth to ensure the occurrence of this habitat type on the northern Great Plains. There is little reason to manage for the open condition stands because they do not offer unique habitat for any species. The closed condition stands allow for reproduction of trees and shrubs and provide habitat for a variety of wildlife.

Literature Cited

American Ornithologists' Union. 1983. Checklist of North American birds, sixth edition. Allen Press, Inc., Lawrence Kan. 877 pp.

Andersen, K. W. and J. K. Jcnes, Jr. 1971. Mammals of northwestern South Dakota. Univ. of Kansas publ., Yus. of Nat. Dist. 19:361-393.

Barton, H., W. G. McCully, H. M. Taylor, and J. F. Box, Jr. 1966. Influence of soil compaction on emergence and first-year growth of seeded grasses. J. Range Manage. 19:118-121.

Baumberger, R. 1977. Rangeland resources of South Dakota. Soc. Range Manage. Old West Reg. Range Program. 150 pp.

Birney, F. C., W. E. Grant, and D. P. Baird. 1976. Importance of vegetation cover to cycles of Microtus populations. Fcology 57:1043-1051.

Boldt, C. E. D. W. Uresk, and K. W. Severson. 1978. Riparian woodlands in jeopardy on the northern high plains. Pages 184-189 in R. F. Johnson and J. F. McCormick, Tech. Coord. Strategies for protection and management of fiecdplain wetlands and other ecosystems. Proc. s:-tip. December 11-13, 1976, Calioway Gardens, Ca., Gen. 'Tech. Rep. WO-12, U.S. For. Serv., Wash., D.C. 410 pp.

Butler, J. L. 1983. Grazing and topographic influences on selected green ash (Fraxinus pennsylvanica) communities in the North Dakota Badlands. M.S. Thesis. North Dakota State Univ., Fargo. 130 pp.

Carothers, S. W., and k. R. Johnson. 1975. Water management practices and their effect on nongame birds in range habitats. Pages 210-222 in D. R. Smith, Tech. Cooru. Proceedings of the symposium on management of forest and range habitats for nongame birds. [Tucson Ariz., May 6-9, 19751 U.S. Dept of Agric. For. Serv. Gen. Tech. Rep. WO-1. Wash., D.C. 343 pp.

Casey D. and D. Hein. 1983. Effects of heavy browsing on a bird community in deciduous forest. J. Wildl. Manage. 47:829-836.

Cassel, J. F., F. B. Hopkins, M. D. Schwartz, and *J. M.* Wiehe. 1982. Avian ecology of natural woodland habitats in southwestern North Dakota. Final report prepared for Rocky Mt. For. arid Range Exp. Sta., U.S. For. Serv. Coop. Agreement 16-870-CA. Zool. Pep., North Dakota State Univ., Fargo. 94 pp.

Crouch, G. L. 1981. Wildlife on ungrazed and grazed hottomlands on the South Platte River, northeastern Colorado. Pages 166-197 in J. V. Peek, and P. D. Dalke, ed. Wildlife-livestock relationships sympcfinm: Proceedings 10.[Coeur d'Alene id., Apr. 20-22,19811 [niv. of Idaho, For. Wildl. and Range Exp. Sta. Moscow. h14 pp.

Damhach, C. A. 1944. A ten-year ecological study of adjoining grazed and ungrazed woodlands in northeastern Ohio. Ecol. Mono. 14:256-270.

Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. Northwest Sci. 33:43-64.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323-342.

Emlen, J. T. 1977. Estimating breeding season bird densities from transect counts. Auk 94:455-468.

Evans, K. F. 1968. Characteristics and habitat requirements of the greater prairie chicken and sharptaiied grouse-a review of the literature. U.S. Dept. of Agric. For. Serv. Conserv. Res. Rep. No. 12. Rocky Mt. For. and Range Exp. Sta., Fort Collins, Colo. 32 pp.

Faanes, C. A. 1983. Breeding birds of wooded draws in western North Dakota. Prairie Nat. 15:173-187.

Faanes, C. A. 1964. Wooded islands in a sea of prairie. Am. Birds 38:3-6.

Gaines, R. C., and S. C. Kohn. 1982. Raptor use of hardwood draws in central North Dakota. Prairie Nat.

hansen, L. P., and J. E. Warnock. 1978. Response of two species of Peromyscus to vegetational succession on land strip-mined for coal. Am. Midi. Nat. 1UC:416-423.

Hansen, P. L., and C. R. Hoffman. 1952. Habitat classification in South Dakota. Progress Report prepared for Rocky Mt. For, and Range Exp. Sta., Study Plan No. RC-859, Rapid City, South Dakota.

Hansen, P. L., and C. R. Hoffman. 1954. Habitat classification in South Dakota. Progress report prepared for Rocky Mt. For. and Range Exp. Sta., Study Plan No. RC-859, Rapid City, South Dakota.

Hopkins, R. B. 1983. Ucodland bird ecology-southwestern North Dakota. Ph.D. Thesis. North Dakota State Univ., Fargo. 104 pp.

Hull, C. H., and N. H. Pie, ed. 1981. SPSS update 7-9:New procedures and facilities for release 7-9. MacCraw-Hill Book Company, New York, N.Y. 401 pp.

JoI.nsgard, P. A. 1979. Birds of the great plains breeding species and their distribution. University I. Nebraska Press, Lincoln. 539 pp.

Jones, Jr., J. K., D. M. Armstrong,, R. S. Hoffman, and C. Jones. 1983. Mammals of thF northern Great Plains. Univ. of Nebraska Press, Lincoln. 379 pp.

Lusby, G. C. 1965. Causes of variations in runoff and semiment yield from small drainages basins in western Colorado. U.S. Dept. Agric. Misc. Pub. 970, paper 1 i:94-98.

Lusby, G. C. 1970. Hydrologic and biotic effects of grazing vs. non-grazing near Grand Junction, Colorado. J. Range Manage. 23:256-260.

MacCracken, J. C., D. W. Uresk, and R. M. Hansen. In Press. Rodent-vegetation relationships in southeastern Montana. Northwest Sci.

Mack, S. E. 1981. Hardwood ravines and associated vegetation in west-central North Dakota. M. S. Thesis. North Dakota State Univ., Fargo. 168 pp.

Mueggler, W. F. 1965. Cattle distribution on steep slopes. J. Range Manage. 18:255-257.

Nelson, J. R. 1961. Composition and structure of the principal woody vegetation types in the North Dakota Badlands. M. S. Thesis. North Dakota State Univ., Fargo. 188 pp.

Nie, Norman H., D. Hadlai Hull, Jean G. Jenkins, Karin Steinhrenner,and Dale H. Brent. 1.975. SPSS-statistical package for the social sciences, 2nd edition. McGraw-Hill Book Company, New York, NY. 675 pp.

Odum, E. P. 1971. Fundamentals of Ecology. W. B. Sanders Company, Philadelphia and London. 574 pp.

Petersen, L. F. 1984. Northern plains. Pages 441-448 in L. K. Halls, ed. White-tailed deer ecology and management. The Stackpole Co., Harrisburg, Pa., and The Wildl. Manage. Inst., Washington, DC. 870 pp.

Richardson, J. L., and N. C. Wellenhaupt. 198 Natural soil and landscape development. Pages 59-67 in Can mined land he made bet et than before mining? N.D. Energy Development Impact Office. Bismarck, N.D. 99 pp.

Rotenberry, J. T., and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in north American steppe vegetation: a multivariate analysis. Ecology 61:1228-1250.

Pethrock, E. P. 1943. A geology of South Dakota. Part I: The Surface. South Dakota Geological Survey Bulletin 13. 88 pp.

Seabloom, Robert W., Richard D. Crawford,and Michael C. McKenna. 1978. Vertebrates of southwestern North Dakota: Amphibian,reptiles, birds and mammals. Institute for Ecological Studies, Univ. of North Dakota, Crank Forks. 549 pp.

Severson, K. E. 1981. Plains habitat. Pages 459-L.86 in O. C. Wallmo, ed. Mule and black-tailed deer in North American. Univ. of Nebraska Press, Ii.ncoln, and The Wild]. Manage. inst., Washington, DC. 605 pp.

Severson, K. E., and C. L. lioldt. 1978. Cattle, wildlife and riparian habits t; in the western Dakota. Pages 90-103 in Proceedings of management and use of northern plains rangeland, regional rangeland symposium [Bismarck, N.D.,Feh. 27-28, 1978] North Dakota State Oniv.,Dickinson. 142 pp.

Severson, K. E., and Carter, A. V. 1978. Movements and habitat use by mule deer in the northern Great Plains, South Dakota. Pages 466-468 in D. N. Hvder ed. Proceedings: First International rangelands congress. Soc. Range Manage. Denver,Cole. 742 pp.

Smith, R. I,., and J. D. Flake. 1983. The effects of grazing on forest regeneration along prairie river. Prairie Nat. 15:41-44.

Spuhler, W., W. F. Lytle, and P. Moe. 1971. Climate of South Dakota. South Dakota State Univ. Agric. Fxp. Sta. Bull. 582. Brookings. 30 pp.

Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota. 295 pp.

Steigers, W. D. 1981. Habitat use and mortality of deer fawns in western South Dakota. Ph.D. Thesis. Brigham Young Univ., Provo. 193 pp.

Stoddart, L. A., A. D. Smith, and T. W. Box. 1975. Range Management, third edition., McGraw-Hill Book Co., New York, N.Y. 532 pp.

Swenson, J. E. 1981. The hardwood draws of southeastern Montana: their importance to wildlife and vulnerability to man's activities. Pages 37-61 in .1. P. Ormisten, ed. Management of riparian ecosystems. Proc. 1981 Annu. Meet., Montana Chapter, The Wild]. Soc.

Swenson, J. E., S. J. Knapp, and 1i. J. Wentland. 1983. Winter distribution and habitat use by mule deer and whitetailed dear in southeastern Montana. Prairie Nat. 15:97-112.

Taber, R. D., and I. McT. Cowan. 1971. Capturing and marking wild animals. Pages 277--317 in R. H. Giles, Jr., ed. Wildlife Management Techniques, 3rd edition. The Wildlife Society, Washington, DC. 623 pp.

Thomas, J. W'., C. Maser, and J. E. Rodiek. 1979. hiparian zones in managed rangelands-Their importance to wildlife. Pages 21-31 in O.R. Cope, ed. Prot, of the forum-grazing and riparian/stream ecosystems. Denver, Colo. Trout Unlimited, Inc., Denver Colo. 94 pp.

USDA. 1976. Backround reports for the Sioux planning unit, Custer National Forest. U.S. For. Serv. Custer Nat. For., Dickinson, North Dakota. 222 pp.

Uresk, D. W., and D. R. Dietz. 1960. White-tailed deer habitat studies in the Black Hills-an overview. Pages 20-21 in D. I: Uresk and L. Fager, ed. Froc.: Black Pills deer management workshop [Rapid City, SD. Jan. 9-10, 19801 South Dakota Schoo[1] of Mines and Technology, Rapid Cite. 39 pp.

Uresk, D. W. 1982. Importance of woodlands to wildlife and livestock use on the northern High Plains. Pages 7-12 in Proceedings of Great Plains Agric. Count., North Platte, Nebr., June 7-9, 1982. 81 pp.

Van Bruggen, T. 1976. The vascular plants of South Dakota. Iowa State University Press, Aires. 536 pp.

Visher, S. S. 1914. A preliminary report on the biology of Harding County, northwestern South Dakota. South Dakota Geological Survey Bull. 6. 103 pl.

Ward, L. A., N. E. lot-await, S. F. henry, and R. A. Hodorff. 1980. Effects of highway operation practices and facilities on elk, mule deer, and pronghorn antelope. Report F11WA-RD-79-143. Fed. Highway Adm., Off. of Res. Div. Washington. B.C. 48 pp.

Westin, F. C., C. L. Buntley, and L. F. Puhr. 1967. Soils of South Dakota. South Dakota State Univ., Agri. Exp. Sta. Soil Survey Serv. No. 3. 32 pp.

Wiens, J. A., and J. T. Rotenherrv. 1981. Habitat associations and community structure of herds in shribsteppe environments. Pool. Monogr. 51:21-41.

Williamson, R. 1,., J. L. Richardson, G. Clamhv, B. J. Bermes, and In. Keammerer. 1981. Physical and environmental factors of woodland ecosystems on the Glenharold Mine reserve in western North Dakota. Proc. of North Dakota Academy of Sci. 35:8.