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LIFE HISTORY AND HABITAT REQUIREMENTS OF SAGE GROUSE IN CENTRAL MONTANA

by
Richard Wallestad

Game Management Division
MONTANA DEPARTMENT OF FISH AND GAME

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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Merriam's Turkeys in Southeastern Montana, Robert Jonas, 1966.

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Forest grouse and experimental spruce budworm insecticide studies, Thomas W. Mussehl and Phillip Schladweiler, 1969.

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FOREWORD

Sage grouse, commonly called sage hens or sage chickens, are one of Montana's most unique and important game birds. No matter what these birds are called their name usually includes "sage" denoting their dependence upon sagebrush. Ever since its initial discovery by Lewis and Clark in 1806, the sage grouse has stimulated the interest and whetted the curiosity of all observers. Perhaps no other species through the years has been subjected to closer and more protracted attention.

It is impossible to consider the future of sage grouse without considering the future of the sagebrush ranges they inhabit. Since sage grouse have not adjusted to patterns of land use which eliminate or seriously disturb any of their seasonal ranges, their existence depends upon man's ability and willingness to maintain vital habitat.

This bulletin describes the results of ten years of intensive research on the life history of the sage grouse and is a tribute to those individuals concerned with the welfare of this unique bird.

Wynn G. Freeman

Wynn G. Freeman, Administrator
Game Management Division

ACKNOWLEDGMENTS

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CONTENTS

LIST OF FIGURES xi

LIST OF TABLES xiii

INTRODUCTION 1

DISTRIBUTION AND DESCRIPTION 3

- Sex Determination 3
- Age Determination 5

DESCRIPTION OF STUDY AREA 7

- Geography 7
- Geology and Soils 9
- Climate 9
- Vegetation 9
- Sagebrush Treatment Areas 11

METHODS 13

LIFE HISTORY 17

- Breeding Activities 17
- Nesting and Brood Rearing 19
- Fall and Winter Distribution 20
- Food Habits 21
- Weights 23
- Annual Turnover 25

HABITAT REQUIREMENTS 29
Breeding Habitat 29
Nesting Habitat 30
Brooding Habitat 32
Wintering Habitat 33
Effects of Habitat Alteration 35

LIMITING FACTORS 41
Habitat 41
Weather 41
Predation 42
Disease and Parasites 42
Accidents 43

HUNTING 45

SUMMARY 49

LITERATURE CITED 51

APPENDIX 57

LIST OF FIGURES

1. Sage grouse distribution in North America, 1975 4

2. Sage grouse distribution in Montana, 1975 5

3. Yellow Water Triangle Area in central Montana 8

4. Sagebrush study areas showing treatments 10

5. Sage grouse hen in pre-copulatory position 18

6. Inter-strutting ground movements of hens in the Yellow Water Triangle. 19

7. Mortality curve for adult sage grouse hens 26

8. Typical sagebrush cover over nest site 30

9. Distribution of sage grouse by cover types and sagebrush density in the Yellow Water Triangle, 1970 32

10. Sage grouse wintering grounds in the Yellow Water Triangle 34

11. Distribution of major sagebrush stands in relation to the North Yellow Water strutting ground 37

12. Sage grouse hunting seasons in Montana, 1938-1974 46

13. Percent of sage grouse shot by time period, 1962-1967 47

14. Montana upland game bird harvest, 1960-1974 48

Appendix Figures

1. Sage grouse hatching chronology for the Yellow Water Triangle, 1962-1964 58

2. Sage grouse hatching chronology for the Yellow Water Triangle, 1965-1967 59

3. Sage grouse hatching chronology for the Yellow Water Triangle, 1968-1970 60

LIST OF TABLES

1. Percent of reobservations of hens banded on five major strutting grounds in the Yellow Water Triangle 18

2. Percent frequency and volume of food items commonly utilized by 1 through 12-week old sage grouse collected during 1966 and 1968 (Peterson 1970a) 22

3. Percent frequency and volume of plant and animal food items found in 299 adult sage grouse crops in Montana 24

4. Breeding season weights of Montana sage grouse (in pounds) 23

5. Life equation model for stable sage grouse population in central Montana 27

6. Breeding season distribution of 110 sage grouse cock observations by sagebrush canopy coverage classes 29

7. Comparison of sagebrush characteristics between successful and unsuccessful nests 31

8. Percent of locations that occurred in sagebrush of greater than 20 percent canopy coverage, by monthly intervals, during the winter 1970-71 35

9. Number of male sage grouse on strutting grounds Pre- and Post-treatment 38

10. Parasites of sage grouse (Simon 1940) 43

APPENDIX TABLES

1. Aging key for juvenile sage grouse based on feather replacement (Eng 1955b) 61

2. Aging key for juvenile sage grouse (Pyrah 1963) 62

3. Summary of sage grouse strutting ground counts in the Yellow Water Triangle, 1966-1972 63

4. Montana sage grouse hunting seasons prior to 1938 64

INTRODUCTION

Less than a century ago, sage grouse *(Centrocercus urophasianus)* were considered the leading upland game bird in nine western states (Rasmussen and Griner 1938). Today it is considered important only in parts of Idaho, Montana and Wyoming. In 1968 these three states accounted for 77 percent of the total sage grouse harvest of 180,000 birds (June 1969). This decline in sage grouse abundance can be largely attributed to agricultural encroachment on sage grouse habitat.

The dependence of sage grouse upon sagebrush *(Artemisia* spp.) has been well documented by naturalists as well as casual observers (Coues 1874, Girard 1937, Patterson 1952 and others). Patterson (1952) stated it was impossible to consider sage grouse distribution without first considering sagebrush distribution.

White man has waged war against sagebrush since the first settlers carved farms from the native prairies. Through the years he has used a variety of techniques (burning, plowing, rotobeating, chaining, railing and spraying) to convert sagebrush ranges to grasslands. Sagebrush ranges also deteriorated under continual grazing pressure from domestic livestock. Patterson (1952) pointed out that sage grouse population declines were not of recent occurrence, but coincided with the period of maximum livestock utilization from 1900 to 1915. It seems more than mere coincidence that states supporting the lowest human population densities presently contain the greatest acreages of sagebrush habitat and the largest populations of sage grouse.

In the 1950's sagebrush destruction increased at an alarming rate after the discovery that sagebrush could effectively be killed with aerial applications of the herbicide, 2,4-D. Elimination or reduction of sagebrush to increase grass production became a common practice on public and private rangelands by the early 1960's. By the time wildlife agencies realized the seriousness of this new tool, as a threat to wildlife habitat, several million acres had been sprayed, and many more projects were in the planning stage. In 1965 the Montana Department of Fish and Game and the Bureau of Land Management initiated a 10-year study to determine the ecological effects of sagebrush control on associated plants and animals. This bulletin deals with sage grouse ecology studies which were a part of this cooperative project. Conclusions in this report were based on observations of 395 poncho tagged and 73 radio-marked sage grouse.

DISTRIBUTION AND DESCRIPTION

The Lewis and Clark Expedition was generally credited with the first historical account of sage grouse. They first encountered sage hens around the Missouri River headwaters and referred to them as the "Cock of the Plains". Coues (1874) related that the bird was very plentiful and was well known to nearly all explorers and early settlers of the western prairies (Fig. 1).

In Montana, sage grouse distribution was historically, and is today, primarily throughout the eastern non-forested regions of the state (Fig. 2). Records indicate sage grouse have never ranged into mountainous areas west of the continental divide, although isolated sagebrush ranges occur there (Wright and Hiatt 1943). Sage grouse are presently found on approximately 11 million acres of sagebrush-grassland in 39 counties of eastern, central and southwestern Montana.

Live trapping and transplanting were conducted in 1942 in an attempt to establish sage grouse in several once-occupied and new locations. A total of 242 birds were released at eight separate locations in seven counties, including two locations west of the continental divide. The introductions and attempts at re-establishment were not successful.

The sage grouse often referred to as sage hen or sage chicken, is the largest member of the North American grouse family, *Tetraonidae*. Three subspecies of sage grouse have been described. *Centrocercus urophasianus urophasianus* (derived from the Latin, a spiny-tailed pheasant) is the subspecies native to Montana.

The sage grouse is grayish-brown with a dark belly and long tapering tail feathers. Wing under-surfaces are white. Legs are densely covered with soft, downlike, gray feathers, which extend down to the toes. The toes are black, and on each side are small narrow scales which act as snowshoes during winter. Males have two olive-colored air sacs, one on each side of the throat which are mostly covered by feathers except when inflated during strutting activities.

Sex Determination

Most sage grouse workers have sexed birds on the basis of size and plumage characteristics. Courtship plumage is so markedly different between sexes that there can be no question about classification during breeding season. Dalke et el.

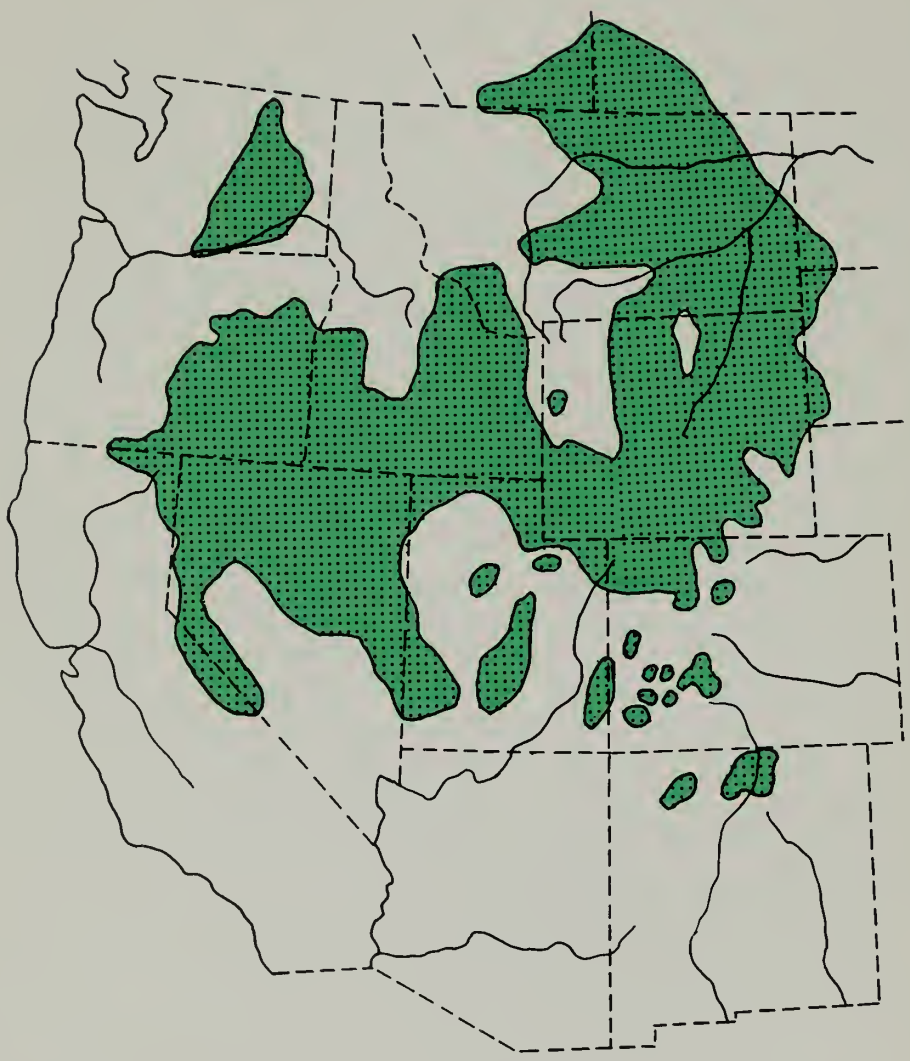


Figure 1. **Sage grouse distribution in North America-1975.**

(1963) gave a detailed description of plumage differences between hens and cocks. They used undertail coverts and minor wing coverts (tetrices) to differentiate sexes. Minor wing coverts of females show more white throughout than males.

Eng (1955a) described a method for sexing sage grouse using length of primary feathers. The primary measured depended upon molt stage. Primaries 1,2 and 6 appeared to be the most valid for determining sex.

Dalke et al. (1963) found primaries 5 and 6 to be the most reliable indicators.

Patterson (1952) used middle toe length as an indicator of sex while Baldwin et al. (1931) used folded wing length as an indicator. Techniques of Eng (1955a) and Dalke et al. (1963) are used in Montana for determining the sex of sage grouse.

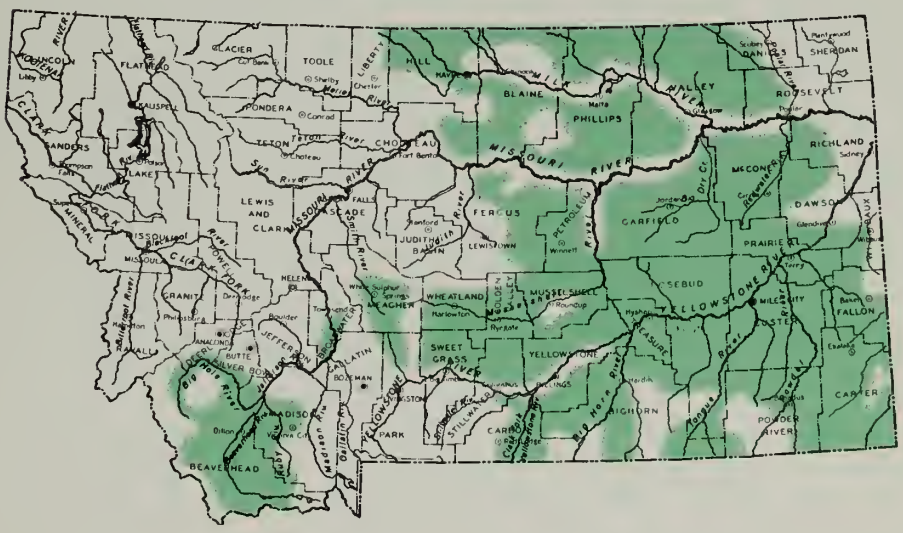
Age Determination

Gower (1939) described the presence of a bursa of Fabricius, a saclike diverticulum in the dorsal cloaca, as a criterion of age in upland game birds. It has commonly been accepted as the most reliable means of distinguishing adults from juveniles, but involves considerable time, consequently it has not been widely used.

Petrides (1942) determined that the outer two primaries of a wing could be used to separate adult sage grouse from juveniles. This technique recognizes that juveniles molt 8 and retain two primaries throughout their first winter whereas adults molt all 10. If adults were holding 1 and 2 at the time of examination they were easily distinguished from juveniles by either the rounded shape or faded condition of the outer primaries. Sage grouse were considered unclassified adults if the molt had progressed to the outer primary; as two years plus if either the outer or adjacent primary had a rounded tip and was faded; or as a yearling if the outer and/or adjacent primary had a pointed tip and was worn and faded.

Eng (1955a) described a method for separating adult and juvenile sage grouse when three or more primaries were not molted. For all adults he examined, primary 3 was greater in length than 2, whereas for all juveniles, 3 was less than 2. Patterson (1952) described several methods of separating adult and juvenile sage grouse (mandible test, ossification of sternum, toe coloration and body weights). These methods never gained widespread acceptance. Eng (1955b) and Pyrah (1963) developed a key for aging juvenile sage grouse based on feather replacement and primary length (Appendix Table 1 and 2 respectively). Techniques of Petrides (1942), Eng (1955a and b) and Pyrah (1963) have been used in Montana for determining the age of sage grouse.

Figure 2. **Sage grouse distribution in Montana-1975.**



DESCRIPTION OF STUDY AREA

Geography

This study was conducted in the Yellow Water Triangle Area of Fergus and Petroleum Counties, Montana (Fig. 3). The study area, roughly triangular in shape, was bounded on the west by U.S. Highway 87, on the north by State Highway 200, on the east by State Highway 244, and on the south by the Flatwillow Creek Road. The triangle comprised approximately 171,712 acres of which 67.3 percent (115,640 acres) was privately owned and 32.7 percent (56,080 acres) publicly owned and managed by the Bureau of Land Management (Bayless 1969). Gieseker (1938) described the physiography as chiefly high, broken, shaly ridges sloping east and grading into rolling, clay hills with some surface gravel. Stream valleys were chiefly alkali flats, bordered by barren, shaly slopes. McDonald, Elk, Yellow Water and Pike Creek, branches of Flatwillow Creek, drain the area. Numerous stock water ponds, including the 211 acre Yellow Water Storage Reservoir were found on the area. Elevations range from 4,500 feet at Button Butte in the west to 2,900 feet at the town of Winnett in the northeast corner.

Petroleum County, created in 1925 from the eastern part of Fergus County, owes its existence and name to the discovery of petroleum in the Cat Creek Field in 1920. Agricultural development dates from the 1880's when stockmen drove herds into the area under protection of Fort Maginnis. Most early livestock companies were large and grazed stock successfully without providing winter feed or shelter until the severe winter of 1886-87, when nearly 60 percent died of exposure and/or starvation. These large companies were followed by smaller ones that acquired title to lands suitable for wild hay production and winter grazing.

Between 1909 and 1915 the better grades of public range land were homesteaded and fenced. During the homesteading period intense grazing pressure destroyed most native vegetation, resulting in elimination of antelope and sage grouse from thousands of acres of range land. Most homesteads were abandoned during the droughts of the 1920's and 30's and never reclaimed.

Today the area is primarily cattle range. The larger stream bottoms were irrigated for the production of alfalfa. Dry-land farming on some of the better soils produces crops of wheat, barley, and oats. Total Yellow Water Triangle area planted into grain, estimated from 1970 aerial photographs, was 2,471 acres with an additional 8,400 acres in alfalfa (Jorgensen 1974).

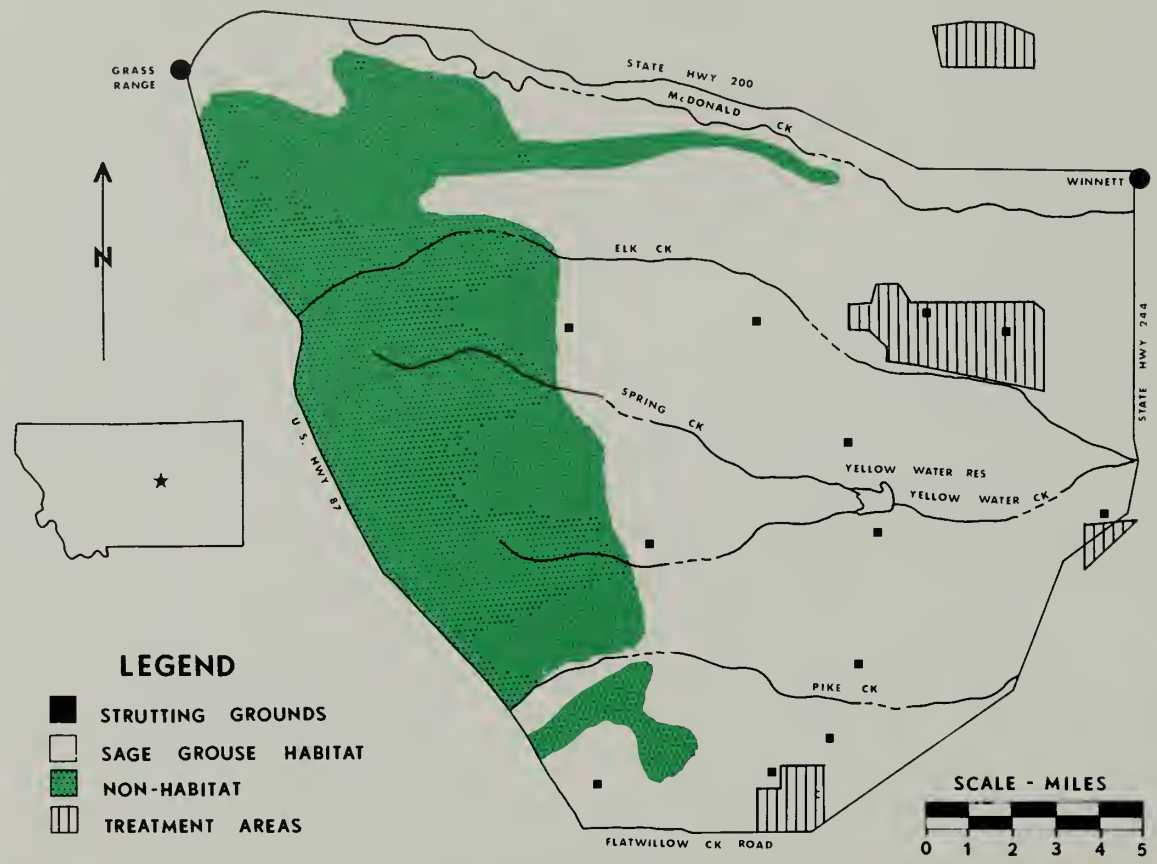


Figure 3. **Yellow Water Triangle Area in central Montana.**

Geology And Soils

Most of the Triangle is underlain by cretaceous shales of the Colorado formation (Reeves 1927). The soils have been described by Gieseker (1938), Andrews et al. (1944) and personnel of the Soil Conservation Service (1968). Upland soils range from heavy clays to shaly clay loams. On many benches the Colorado shales were buried beneath layers of gravel washed out from the Snowy Mountains during Pleistocene time. Numerous igneous intrusions occur throughout the Triangle. Bottomlands have soils with thin loamy surface horizons, barren spots of salt-impregnated soils, and clay soils with dense saline-alkaline subsoils.

Although the vegetation of the Triangle appears to be an unintelligible mosaic at first sight, certain relationships of habitat types to geology become apparent following extended study (Jorgensen 1974). Reeves (1927) recognized 16 members (distinguishable layers) of the Colorado shale formation; each of which produces an edaphic condition resulting in a certain type of vegetation.

Beneath the Colorado shale formation was the Kootenai formation; which outcropped in the western part of the Triangle around Button Butte. Vegetation associations found on the Kootenai were strikingly different than those on the Colorado, the major difference being the almost complete absence of sagebrush from the Kootenai formation. Jorgensen (1974) stated this absence was almost certainly due to edaphic conditions rather than fire or other disturbances since it follows the exact exposure of the Kootenai formation.

Climate

The climate has been described as semiarid, characterized by low rainfall, great temperature extremes, a large number of sunny days, and a relatively low humidity (Gieseker 1938). Hot summers (maximum 107° F), cold winters (minimum -48° F), and scanty precipitation were typical of areas of mild relief remote from the tempering ocean influence and deprived of precipitation by the presence of high mountains in the paths of prevailing winds (Blaisdell 1958). Average annual precipitation at Flatwillow (U.S. Department of Commerce Weather Station), located on the eastern edge of the Triangle, was 12.57 inches. In an average year, 40 percent of the annual precipitation occurred during May and June when it was most needed by developing vegetation. Mean annual temperature was 45.4° F, ranging from means of 21.1° F in January to 70.2° F in July. The frost-free season ranged from 115 to 125 days. The average date of last freeze in spring and first freeze in fall were 25 May and 17 September, respectively.

Vegetation

Jorgenson (1974) classified vegetation of the Triangle by habitat types, based on three categories according to life form of dominant plants: shrub-grassland, coniferous forest, and grassland. The shrub stratum on higher elevations was dominated by big sagebrush *(Artemisia tridentata)*, and bottomlands by greasewood *(Sarcobatus vermiculatus)*. Sagebrush covered a greater percentage of land in the Triangle than any other shrub and grew vigorously on soils with a clay loam topsoil. Low lying areas with poor drainage and high salt content supported little or no sagebrush. Sagebrush and greasewood were found together in varying degrees where

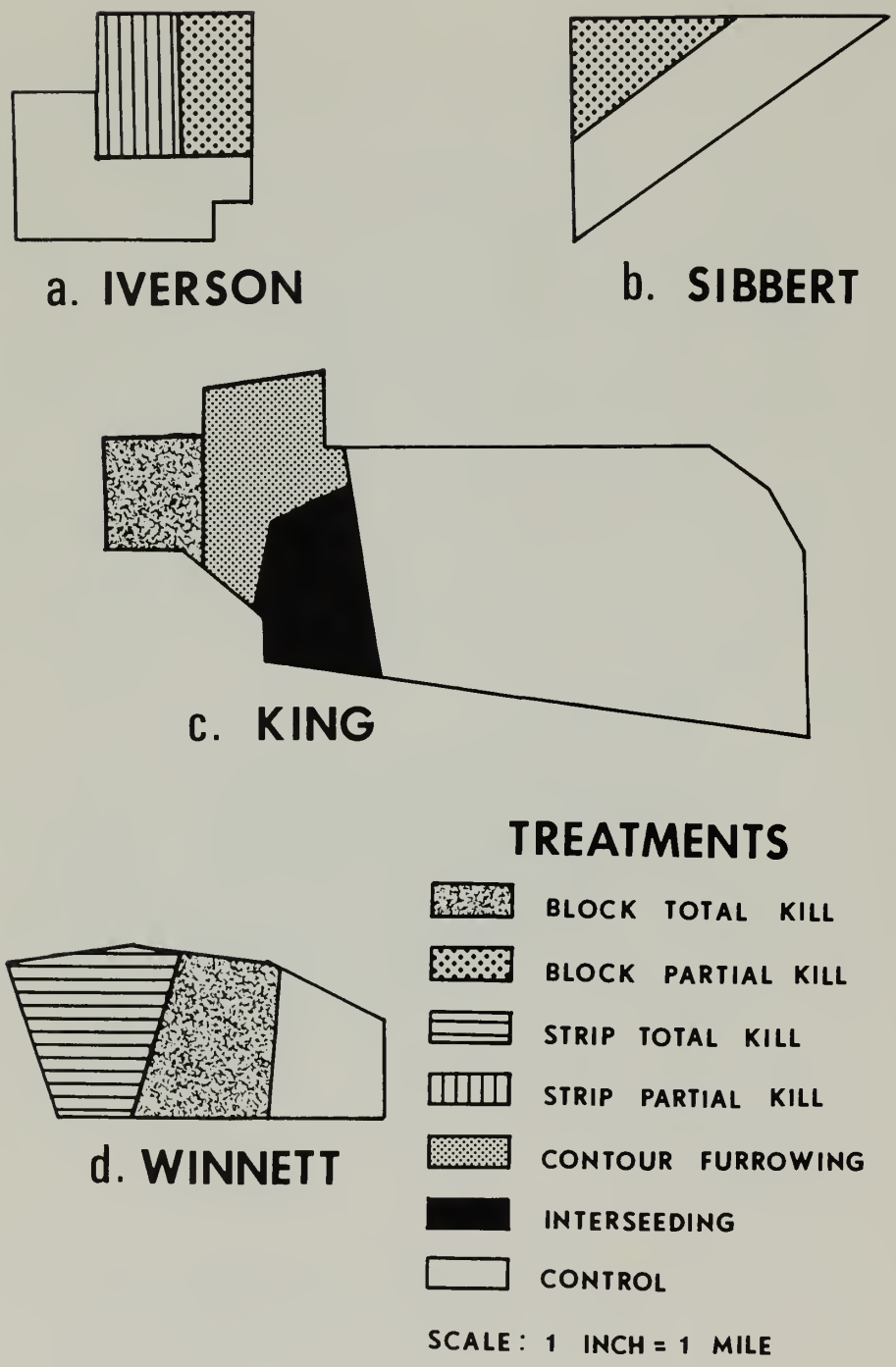


Figure 4a-d. **Sagebrush study areas showing treatments.**

soils were relatively non-saline and/or non-alkaline. Silver sagebrush *(Artemisia* cana) was usually restricted to areas along streams.

The dominant habitat type occurring in the western part of the Triangle was a grassland type interspersed with ponderosa pine *(Pinus ponderosa)*. Unstable shale slopes throughout the Triangle had over-stories of ponderosa pine, creeping and common juniper *(Juniperus horizontalis* and *communis)*, rubber rabbitbrush *(Chrysothamnus nauseosus)* and longleaf sage *(Artemisia longifolia)*, either separately or in combination with each other.

Numerous grasses and forbs comprise the understory vegetation. Common grasses include several species of wheatgrass *(Agropyron* spp.*)*, green needle-grass *(Stipa viridula)*, needle-and-thread *(Stipa comata)*, blue grama *(Bouteloua gracilis)* and June grass *(Koleria cristata)*. Major forbs included fringed sagewort *(Artemisia frigida)*, common dandelion *(Taraxacum officinale)*, yarrow *(Achillea millefolium)*, American vetch *(Vicia americana)*, and plains pricklypear *(Opuntia polycantha)*.

Sagebrush Treatment Areas

Sagebrush treatment areas were selected in 1966 and fenced in the fall of 1967. Chemical and mechanical treatments were applied in 1967 and 1968 to effect varying degrees of sagebrush removal. Chemical control was accomplished using aerial applications of 2,4-D.

The Iverson (Fig. 4a) comprised approximately 1,240 acres and was located in the extreme southern portion of the Triangle. Three hundred and twenty acres were sprayed to obtain a partial kill of sagebrush. An additional 320 acres were treated in alternate 100-foot wide spray and leave strips. The remainder served as a control.

The Sibbert (Fig. 4b), located on the eastern edge of the Triangle, comprised about 910 acres. Two hundred and fifty-three acres on the west side of Highway 244 were treated to obtain a partial kill of sagebrush. The remaining 657 acres on the east side served as a control.

The King (Fig. 4c), largest of the study areas, covered nearly 4,000 acres in the northern part of the Triangle. Two hundred and forty acres were sprayed to obtain a total sagebrush kill. In the fall of 1967, 511 acres were treated mechanically to improve watershed conditions and control sagebrush. Of this acreage 321 acres were treated with a model B contour-furrowing machine which plowed to a depth of 12 to 14 inches. Seventy of the 321 acres treated by furrowing were also interseeded. An additional 190 acres were also interseeded using a machine which scalped the soil surface 2 to 4 inches in depth and 18 inches wide. The remaining 3,249 acres served as a control.

The Winnett (Fig. 4d), the only area outside the Triangle, was located approximately 3 miles northwest of the town of Winnett. Of the 1,220 acres in the area, 480 were sprayed for a total sagebrush kill and 400 were treated in alternate 100-foot wide spray and leave strips. The remaining 340 acres served as a control.

METHODS

Initially, all portions of the Triangle were searched by vehicle and airplane (Eng 1953) for strutting grounds. Each located ground was censused for cocks as prescribed by Patterson (1952). This involved counting the number of cocks present on each ground during the period one-half hour prior to and immediately following sunrise (Appendix Table 3). The final census figure for each ground was the maximum count obtained from censuses taken on a minimum of three different mornings. Hen counts were made incidental to trapping and no effort was made to obtain maximum counts.

Average brood size, percent unsuccessful hens, distribution by cover types and reobservations of marked grouse were obtained while traveling vehicle routes. Direction and length of routes was not predetermined, nor was there a specific time interval between routes. Attempts were made to cover the entire sage grouse range within the triangle.

Trapping techniques varied depending upon the time of year sage grouse were needed for marking. Large numbers of hens were readily captured on strutting grounds using a modified version of Dill and Thornsberry's (1950) cannon-net trap. Two 100 x 60-foot mesh nets were set parallel to each other, so that when fired they would overlap approximately 10 feet in the center. Nets were placed to intercept clusters of hens as they entered the strutting ground. Trapping sites were determined from previous observations of clusters and/or locations of droppings. Cocks were easily injured when using this technique because of their insistence on fighting the net.

Adult cocks needed for placement of radios were captured at night with the aid of a hand-held spotlight (Pyrah 1959) and a long-handled net using a three man crew consisting of a driver, netter and spotlighter. This technique was also used with some success for trapping grouse in winter.

In early summer, hens with broods were lured within range of a long-handled net by imitating the distress call of a chick. In late summer when hens no longer responded to chick calls, broods were herded by vehicle into a drive trap consisting of a 4 x 4 x 4-foot wire cage and two 100-foot wings.

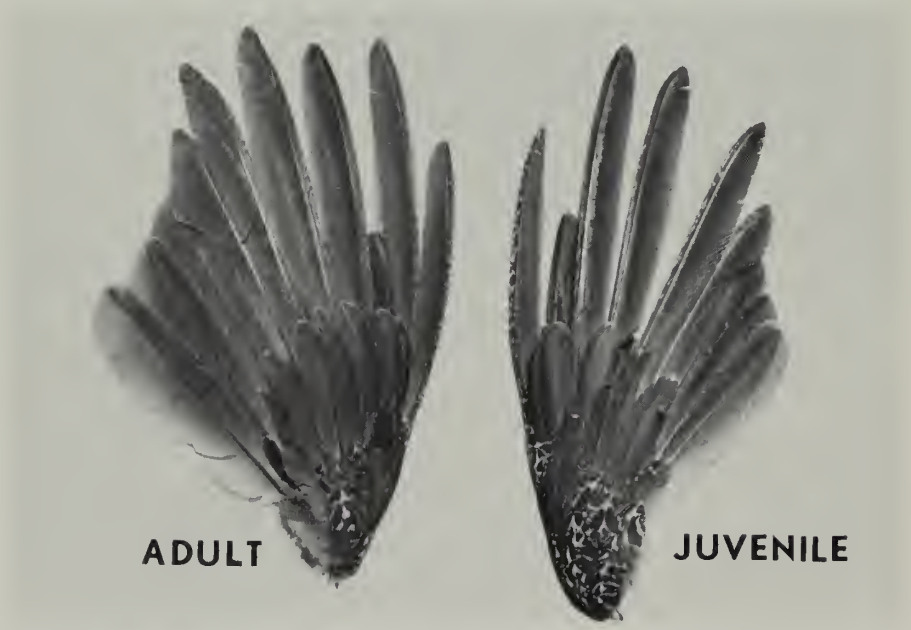
Captured sage grouse were "sexed" (Pyrah 1954, Eng 1955a), "aged" (Petrides 1942, Patterson 1952), weighed and leg banded with numbered aluminum bands. In addition to banding, all female sage grouse were poncho tagged for visual

identification (Pyrah 1970a). Chicks were assigned to weekly age-classes (Eng 1955b, Pyrah 1963) and wing-tagged with numbered metal clips. Field identification of marked grouse was aided by use of binoculars (8 X 30) and spotting scopes (20 X and 15-60 X).

Radio equipment and harnessing techniques used were similar to those described by Marshall (1963) and Marshall and Kupa (1963). Transmitters and portable receivers were designed and constructed by Sidney Markusen, Electronics Specialties, Esko, Minnesota. Portable receivers were used with a handheld, or vehicle-mounted directional antenna. The receiver was equipped with 12 channels which operate at discrete frequencies in the range of 150-151 megacycles. Transmitters were equipped with 12-inch whip antennas and, with batteries, weighed approximately 50 grams.

Vegetation at nest sites was described and measured using methods outlined by Pyrah (1970b). Number of sagebrush plants and their intercepts were tallied by 6-inch height classes along a 100-foot line over the nest site and in a 100-square foot plot around the nest. The number of sagebrush plants within 24-inches of the nest, and height and number of shrubs covering the nest, were also recorded. Canopy coverage data were recorded for sagebrush that occurred along the 100-foot line over the nest site.

Canopy coverage of sagebrush and associated plants was measured for different habitat types by a method similar to that of Daubenmire (1959). Canopy coverage of sagebrush was also determined by measuring shrub intercept (Canfield 1941). A visual estimate was made of sagebrush at all locations of radio-equipped birds. The following categories were arbitrarily chosen to describe sagebrush canopy: rare = 0-1 percent ground cover; scattered = 1-10 percent ground cover; common = 10-25



Age difference between adult and juvenile sage grouse, using outer primaries.
—(F&G photo by Richard Wallestad)

percent ground cover; and dense = 25 percent and greater ground cover. Using a method designed by Pyrah (1970b), sage grouse droppings were counted on each study area to estimate winter use.

Other than the systematic collecting of sage grouse chicks by Peterson (1970a), crop collections came from a variety of Montana locations and personnel since 1952. Supplemental crops were obtained from predator, road and hunter-killed sage grouse during the study. All crops were forwarded to the wildlife laboratory in Bozeman for analysis. Measurements of food items were made volumetrically by the displacement of water.

Production ratios, hatching distributions and percent harvest by time periods of the hunting season were obtained from examination of wings collected at hunter check stations and by postal collections. Checking stations were operated by game management personnel on the opening week-ends of each prairie grouse season. Stations were placed at strategic locations to intercept the majority of hunters. A wing was clipped from each bird for later analysis of sex and age.

LIFE HISTORY

Breeding Activities

During late winter or early spring sage grouse gather on traditional breeding areas commonly referred to as "strutting grounds". These grounds were usually on bare areas adjacent to dense stands of sagebrush. Many strutting grounds in central Montana were found on old homestead sites where sagebrush had been cleared. Strutting grounds were the center of activity during the breeding season and possibly throughout the year.

The strutting display of sage grouse has been described in detail by Scott (1942), Lumsden (1968), Wiley (1970) and Hartzler (1972). Cocks establish territories on traditional strutting grounds in early March, assembling on grounds an hour or so before dawn and strutting until approximately one hour after sunrise. Strutting ground activity was greatest during peak hen attendance (about April 15) and even occurred in evening. Scott (1942) reported that a few birds remained active throughout moonlit nights.

Hens visit strutting grounds several days before copulating; they assemble in groups called "clusters" which varied in size from a few to a 100 or more. Hens arrived on strutting grounds after cocks and departed while they were still displaying. When a hen was ready to mate she invited copulation by spreading her wings and crouching motionless on the ground (Fig. 5). Following copulation she vigorously shook her body, ruffled her feathers and flew off, not to return until the next spring.

Lumsden (1968) described the sage grouse strutting display as an elaborate performance combining elements homologous with parts of the hooting, head jerk and circling displays of the blue grouse *(Dendragapus obscurus)*. Cocks fight standing head to tail, shoulder to shoulder, striking downward at one another with their wings. Seldom do they seize one another and wrestle.

Eng (1963) correlated testis development of subadult males and their appearance on strutting grounds. He reported that, as with adult males, testis development in subadults appeared to occur slightly behind regular strutting ground attendance. However, maximum subadult testis volume was only approximately half that of adults. Even though subadults were capable of producing viable sperm and breeding (Eng 1963), most observations show they contributed little if anything to the breeding effort (Lumsden 1968 and Hartzler 1972).

Figure 5. **Sage grouse hen in pre-copulatory position.**

—(photo by Harry Lumsden)

Cocks were seldom found very far from a strutting ground even after breeding had ceased. The maximum distance an undisturbed radio-equipped cock was located from the strutting ground was 1.1 miles. Wallestad and Schladweiler (1974) reported movements of breeding cocks up to 0.8 mile from strutting grounds were common and 82 percent of all locations were greater than 0.2 mile from the ground. Carr (1967) followed sage grouse cocks as they left four Colorado strutting grounds and found maximum cruising radii of 0.8 - 1.2 miles.

Inter-strutting ground movements were regularly observed among tagged hens (Fig. 6) (Eng, unpublished data.) Of the hens banded on South Pike Creek, North Pike Creek, South Yellow Water, North Yellow Water and King Grounds, 71, 74, 73, 71 and 58 percent of reobservations respectively, occurred on the same ground (Table 1). Inter-strutting ground movements were common with both adult and yearling hens. Usually, movement was to the next closest ground.

Table I. **Percent of reobservations of hens banded on five major strutting grounds in the Yellow Water Triangle.**

PERCENT REOBSERVATION	SOUTH PIKE CREEK	NORTH PIKE CREEK	SOUTH YELLOW WATER	NORTH YELLOW WATER	KING RANCH
SOUTH PIKE CREEK	71	3	2	3	0
NORTH PIKE CREEK	16	74	14	2	0
SOUTH YELLOW WATER	4	19	73	12	17
NORTH YELLOW WATER	0	3	2	71	25
KING RANCH	0	0	0	12	58
OTHER	9	1	9	0	0

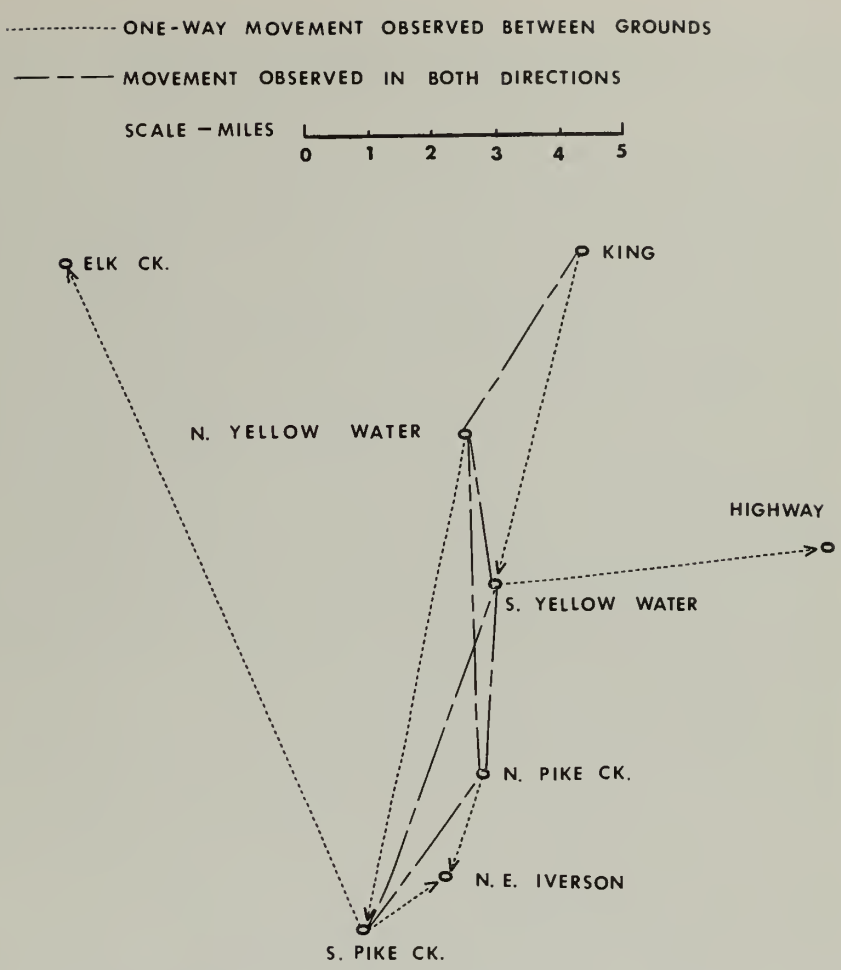


Figure 6. **Inter-strutting ground movements of hens in the Yellow Water Triangle.**

Nesting and Brood Rearing

Thirty-one sage grouse hens (17 adults and 14 yearlings) were captured, radio-equipped and tracked during spring and early summer resulting in the subsequent locating of 22 nests (13 adults and 9 yearlings) (Wallestad and Pyrah 1974). Of the 22 nests, 14 (64%) hatched successfully, 5 (23%) were abandoned (2 of these were caused by hen entanglement in radio harness) and 3 (13%) were destroyed.

Nest sites were usually located within two miles of a strutting ground. Wallestad and Pyrah (1974) found that 68 percent of all radio marked hens nested within 1.5 miles of a strutting ground. Nest sites of 13 adult and 9 yearling hens averaged 1.5 and 1.7 miles, respectively, from the strutting ground. The greatest distance a radioed hen traveled to nest was 5.7 miles. Once a hen was bred she moved into a vicinity close to the location of the final nest site, and remained relatively sedentary until she nested.

Nests were made by scratching out a shallow depression, usually beneath or be-

tween two sage bushes, and then lined with dead grass. Adults (77%) were more successful than yearlings (44%) in bringing off a brood; Wallestad and Watts (1973) also found this to be true. Adult hens also laid larger clutches than yearlings (statistically significant at the .005 level). Adults averaged 9.0 eggs per clutch (range 7-11) whereas yearlings averaged 6.9 (range 4-10). Average clutch size for adult and yearling hens combined was 8.2 eggs, which was similar to the 7-8 eggs per clutch reported by Griner 1939, Patterson 1952 and Schlatterer 1960. Incubation required 26 days (Pyrah 1963).

Known hatching dates were obtained for 93 percent of successful nests. By backdating from the hatching date, accounting for the 26-day incubation period plus 10 days for egg laying (Patterson 1952), the earliest nests were started about April 17. This was 2½ weeks after hens were trapped on strutting grounds and would indicate they do not begin to nest immediately after mating as reported by Patterson (1952).

In central Montana, the peak of hatch usually occurs during the 2nd week of June (Appendix Fig. 1-3). Until broods were 2-3 weeks old movements were quite restricted even though two week-old chicks could fly short distances. Brood hens did not usually associate with other hens and broods early in summer. As important food plants desiccated on upland sagebrush ranges, broods moved to lower, more mesic sites, and associated with other broods. Late summer hen flocks varied in size from several broods to several hundred sage grouse. These associations may have been the initiation of fall and winter hen flocks.

Average daily movement of radio marked broods was between 0.25 and 0.5 mile (Wallestad 1971). In early summer there was no apparent movement that indicated a daily need or use of free water. Even though broods concentrated their late summer activities around areas that supported succulent vegetation, use of free water was not observed. By late August and early September many broods had moved to fall and winter sagebrush ranges.

Unsuccessful hens usually grouped in small summering flocks of three to five birds which joined the successful hens and the young in fall.

Fall and Winter Distribution

Sage grouse populations in eastern Montana were considered non-migratory (Eng and Schladweiler 1972) even though they retire to special wintering areas. There was no elevational migration as in populations inhabiting the high intermountain sagebrush plains. On the Snake River plains in Idaho, sage grouse wintering and summering areas were separated by 30-50 miles (Dalke et al. 1963), with the extent of movement dependent on snow depth. In eastern Montana, movements to wintering areas greater than 10 miles were considered uncommon. In most places wintering, nesting and brooding habitat were interspersed and required no large seasonal movements.

With the exception of nesting hens, sage grouse were extremely gregarious throughout the year. Patterson (1952) stated that group behavior aids in survival of individual birds in that the entire flock generally exhibits synchronous responses to influences threatening their number. Eng and Schladweiler (1972) and Wallestad (1972) noted considerable variability in size of winter flocks. Hen flocks varied from 4 to 50 birds except during severe weather (deep snow) when several hen flocks

joined to form large winter concentrations of more than 200 birds. During moderate weather, flocks broke into small groups and dispersed throughout the wintering area.

Hen flocks remained intact until the beginning of the strutting season, normally the first part of March. At this time young males departed from the hen flock. Not yet accepted by adult cocks, they remain in groups on the edge of the strutting ground. By the peak of breeding (April 15th) most young males had developed nuptial plumage and held down peripheral territories on strutting grounds (Eng 1963). Hens remained with the flock until bred. Following copulation they began a solitary existence that lasted through incubation.

Winter cock flocks usually varied from 5 to 15 birds. Throughout winter they were observed near the hen flocks, and at times appeared to follow the hen flocks around the wintering area. During severe weather they often joined hen flocks. Large strutting grounds had several cock flocks associated with them whereas smaller grounds probably had only one. Once young cocks were tolerated on strutting grounds, they were also apparently accepted into the cock flocks.

Minimum daily movements, determined from locations of radio-equipped birds made on consecutive days ranged from a low of no measurable movement to a high of 2.5 miles (Wallestad 1972). A total of 79 minimum daily movements averaged slightly over 0.5 mile. Eng and Schladweiler (1972) reported that 75 percent of minimum daily winter movements were less than 0.75 mile and that observed winter ranges used by radio equipped birds varied in size from 2,615 to 7,760 acres. Sage grouse winter ranges were considerably larger than the 100-200-acre summer ranges reported by Wallestad (1971). Broods were restricted in summer months to ranges supporting succulent vegetation.

Food Habits

Sage grouse do not possess a muscular gizzard like other game birds and therefore lack the capability of grinding and digesting seeds. The year-round diet consists of leafy vegetation with the exception of some insects taken during summer. During winter sage grouse depend entirely on sagebrush for survival. As an evergreen shrub, sagebrush provided available food throughout the year, regardless of weather conditions. Patterson (1952) stated that the welfare and continued survival of sage grouse populations was more closely influenced by the availability and distribution of sagebrush than by any other factor in the bird's environment.

Juvenile

The average diet of juvenile sage grouse consisted of 76 percent vegetable and 24 percent animal matter (Peterson 1970a) (Table 2). Common dandelion and common salsify were the two most important plant items in the diet, occurring in 55 and 63 percent, respectively, of the 127 crops analyzed. Other plants commonly utilized by juvenile sage grouse were prairie pepperweed *(Lepidium densiflorum)*, prickly lettuce *(Latuca serriola)*, fringed sagewort, curlcup gumweed *(Grindelia squarrosa)*, and alfalfa *(Medicago sativa)*.

Sagebrush did not form an important part of the juvenile diet until birds were 12 weeks old. Prior to that time it comprised only one percent of the total volume. *Orthoptera* (grasshoppers), *Coleoptera* (beetles) and *Hymenoptera* (ants) were the most common animal matter items in the diet.

Table 2. **Percent frequency and volume of food items commonly utilized by 1-through 12-week-old sage grouse collected during 1966 and 1968[1] (Peterson 1970a).**

Age in Weeks Number of Birds	(1 & 2) 9	(3 & 4) 17	(5 & 6) 25	(7 & 8) 22	(9 & 10) 30	(11 & 12) 24
Plant Matter	fr/vo[2]	fr/vo	fr/vo	fr/vo	fr/vo	fr/vo
FORBS						
Achillea millefolium	- -	- -	4/tr	- -	3/tr	13/1
Artemisia frigida	- -	12/tr	28/1	41/4	30/8	71/29
Camelina microcarpa	- -	18/2	4/tr	- -	- -	- -
Grindelia squarrosa	11/tr	6/tr	24/2	32/3	23/2	54/6
Lactuca serriola	- -	- -	8/1	45/20	67/37	54/14
Lepidium densiflorum	78/40	18/3	4/1	- -	3/tr	- -
Medicago sativa	- -	- -	24/1	18/3	23/2	21/3
Taraxacum officinale	44/13	82/52	68/32	50/14	47/18	38/20
Tragopogon dubius	33/tr	59/19	84/35	82/24	53/8	67/2
Unidentified Forbs	56/5	18/1	32/2	23/tr	27/tr	33/1
SHRUBS						
Artemisia tridentata	- -	12/tr	4/tr	- -	23/tr	58/6
Rhus trilobata	- -	- -	- -	5/7	- -	- -
GRASSES						
Triticum aestivum	- -	- -	- -	- -	- -	17/6
Other Plant [3]	5	0	2	0	1	2
TOTAL PERCENT PLANT VOLUME	63	77	77	75	76	90
Animal Matter						
Coleoptera	78/11	77/4	64/1	23/1	6/tr	29/tr
Hymenoptera	87/5	65/9	60/2	41/tr	40/tr	50/tr
Immature Insects	67/8	41/1	32/1	14/tr	- -	- -
Orthoptera	33/tr	24/3	44/18	36/23	40/24	33/10
Unidentified Insects	44/tr	24/3	32/1	9/tr	10/tr	8/tr
Other Animal[3]	13	3	0	0	0	0
TOTAL PERCENT ANIMAL VOLUME	37	23	23	24	24	10

[1] Other food items utilized by the chicks but which did not represent more than a trace of the volume (less than 1 cc.) in any individual age division, are listed here: Forbs - *Artemisia ludoviciana, Astragalus* spp., *Lactua pulchella, Leguminosae* (unidentified), *Melilotus officinalis, Medicago lupulina, Orobanche fasciculata, Potentilla* spp., *Sisymbrium loeselii, Solidago missouriensis, Trifolium* spp., and *Vicia americana;* Shrubs - *Artemisia cana, Rosa* spp., and certain unidentified shrubs; Grasses - species not identified; Grass-like - *Carex* spp.; Animal - Arachnoidea, Diptera, Hemiptera, Homoptera, Lepidoptera, Odonata, and Plecoptera.

[2] fr/vo = percent frequency/percent volume.

[3] Percent volume of plant matter obtained by the combined measurement of those species found in trace quantities (less than 1 cc.)

Studies by Rasmussen and Griner (1938) and Klebenow and Gray (1967) also noted reliance of juvenile grouse on forbs and animal matter as food items. Peterson (1970a) concluded that the availability of forbs played an important role in seasonal use of these plants as well as in the distribution of birds.

Adult

The year-around average diet of adult sage grouse, as determined from 299 crops consisted of 97 percent vegetable and 3 percent animal matter (Wallestad et al. 1975) (Table 3, see next page). Sagebrush comprised 62 percent of the volume of all foods consumed throughout the year. During the months of December, January and February sagebrush was the only food item found in all crops, and only during the months of June, July, August and September did sagebrush make up less than 60 percent of the diet.

Patterson (1952) in Wyoming found that only during summer did sagebrush make up less than 80 percent of the volume of food consumed. In Utah, Griner (1939) found that crops of adult birds collected from May through October contained almost 98 percent plant material, 77 percent of which was sagebrush. Studies in Wyoming (Girard 1937), Colorado (Dargan et al. 1942), Oregon (Nelson 1955) and California (Leach and Hensley 1954) also indicated the importance of sagebrush as a sage grouse food item.

Use of fringed sagewort (a perennial *Artemisia*) began in March and continued through November, comprising a greater percentage of the annual diet than any other forb. Peterson (1970a) considered fringed sagewort a transitional food item between the summer forb diet and the winter diet of sagebrush. Other commonly utilized forbs included prickly lettuce, common salsify, common dandelion and curlcup gumweed.

In Montana, May and October were considered transitional months when sage grouse exhibited major changes in food habits. In May they shifted from a diet of sagebrush to one dominated by forbs and in October they shifted back to sagebrush. Palatability and availability of forbs appears to be the reason for shifts.

Weights

Contrary to seasonal weight trends exhibited by other game birds, sage grouse of both sexes attain maximum weights, not in late fall, but early spring (Patterson 1952). Breeding season weights of 132 male and 374 female sage grouse are presented in Table 4 (Eng. unpublished data). Adult males (2+) averaged nearly one pound more than yearling males whereas adult females (2+) averaged only 0.3 pound more than yearling females. Adult males averaged nearly twice the weight of adult females.

Table 4. **Breeding season weights of Montana sage grouse (in pounds).**

Sex	Age	Sample Size	Maximum	Minimum	Average
Males	Adults (2+)	80	8.6	5.4	6.3
	Yearlings	52	6.5	4.9	5.5
Females	Adults (2+)	193	4.3	2.8	3.5
	Yearlings	181	3.9	2.1	3.2

Table 3. **Percent frequency and volume of plant and animal food items found in 299 adult sage grouse crops in Montana.**

Food Item	22[1] JAN F/V[3]	38 FEB F/V	20 MAR F/V	22 APR F/V	24 MAY F/V	18 JUN F/V	45 JUL F/V	26 AUG F/V	29 SEP F/V	13 OCT F/V	21 NOV F/V	21 DEC F/V	Total[2] F/V
PLANT													
Artemisia tridentata	100/100	100/100	100/97	90/71	96/84	39/19	13/1	32/4	38/10	92/66	100/93	100/100	75/68
Artemisia frigida	- -	- -	40/3	55/18	21/6	39/21	31/7	52/13	28/12	69/12	33/5	- -	31/8
Lactuca serriola	- -	- -	- -	9/5	- -	- -		36/14	45/39	38/7	28/2	- -	13/6
Tragopogon dubius	- -	- -	- -	- -	8/2	39/20	71/25	60/20	14/tr[4]	- -	- -	- -	16/6
Taraxacum officinale	- -	- -	- -	5/2	17/2	22/11	47/6	44/13	38/12	31/tr	5/tr	- -	17/4
Grindelia squarrosa	- -	- -	- -	- -	- -	- -	- -	19/1	7/tr	38/14	- -	- -	5/1
Achillea millefolium	- -	- -	- -	9/tr	4/tr	- -	- -	4/tr	14/4	31/tr	14/tr	- -	6/tr
Trifolium repens	- -	- -	- -	- -	- -	- -	- -	4/5	17/3	- -	10/tr	- -	3/tr
Lomatium species	- -	- -	- -	9/3	- -	- -	- -	- -	- -	- -	- -	- -	1/tr
Melilotus officinalis	- -	- -	- -	- -	4/2	- -	- -	- -	- -	15/tr	- -	- -	2/tr
Artemisia ludoviciana	- -	- -	- -	- -	- -	5/2	7/tr	15/2	- -	- -	- -	- -	2/tr
Artemisia cana	- -	- -	- -	- -	- -	- -	9/1	- -	3/2	- -	- -	- -	1/tr
Aster species	- -	- -	- -	- -	- -	- -	18/9	4/1	3/tr	- -	- -	- -	2/tr
Triticum species	- -	- -	- -	- -	- -	- -	4/2	- -	- -	- -	- -	- -	3/tr
Medicago sativa	- -	- -	- -	- -	- -	- -	- -	15/2	3/tr	- -	- -	- -	2/tr
Leguminosae	- -	- -	- -	- -	- -	- -	- -	- -	14/9	- -	- -	- -	1/tr
Gramineae	- -	- -	- -	- -	- -	11/tr	- -	15/tr	- -	- -	- -	- -	2/tr
Unidentified Plants	- -	- -	- -	- -	8/3	50/26	76/30	52/10	10/6	- -	- -	- -	16/6
TOTAL PERCENT PLANT VOLUME	100	100	100	100	99	99	81	86	99	100	100	100	97
ANIMAL													
Hymenoptera	- -	- -	- -	- -	12/tr	11/tr	16/1	27/tr	7/tr	- -	- -	- -	6/tr
Orthoptera	- -	- -	- -	- -	- -	5/tr	42/16	35/14	- -	- -	- -	- -	7/3
Coleoptera	- -	- -	- -	- -	- -	- -	2/tr	4/tr	7/tr	- -	- -	- -	1/tr
Unidentified Insects	- -	- -	- -	- -	- -	5/tr	33/2	8/tr	- -	- -	- -	- -	4/tr
TOTAL PERCENT ANIMAL VOLUME	- -	- -	- -	- -	1	1	19	14	1	- -	- -	- -	3

[1] Number of birds in each month
[2] Totals are derived by aggregating the percentages from every month.
[3] Frequency/Volume
[4] Trace refers to any volume less than 1 percent.

Annual Turnover

Leopold (1933) defines productivity as the rate at which breeding stock provides a removable crop or additional breeding stock. Most birds produce young in relation to their life expectancies and their susceptibility to hazards. Tree nesting species produce only two to four eggs in a clutch, while ground nesting species, whose young are more vulnerable to destruction, may produce up to 16 eggs per clutch, (Trefethen 1964).

Sage grouse laid an average of 8.2 eggs per clutch (Wallestad and Pyrah 1974); by September brood size had been reduced through natural mortality to an average of 3.6 chicks per female (Wallestad and Watts 1973). This amounted to a 56 percent mortality rate from egg laying until the hunting season. Mortality did not stop at this point, but since data necessary to calculate over-winter mortality of juvenile birds was not available, it was assumed that mortality continued at a rate at least comparable to that of yearling hens.

Numerous sage grouse were captured, banded and marked for observations during studies in central Montana. *—(F&G photo by Duane Pyrah)*

Average annual mortality rates for sage grouse hens as computed from reobservations of poncho tagged birds were 60 and 65 percent for adult (Fig. 7) and yearling hens, respectively (Eng, unpublished data). Hamerstrom and Hamerstrom (1973), working with an unhunted population of prairie chickens *(Tympanuchus*

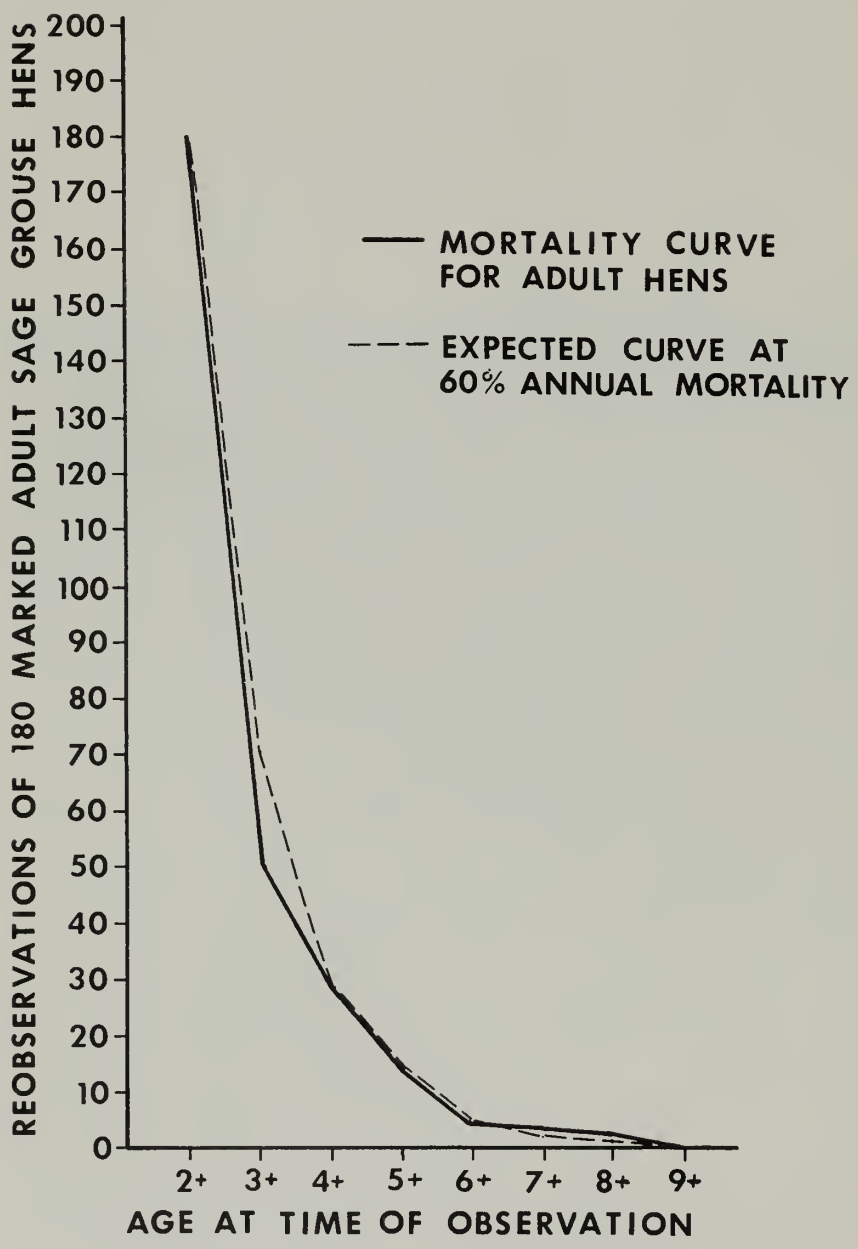


Figure 7. **Mortality curve for adult sage grouse hens.**

cupido pinnatus), reported an annual mortality rate of 51 and 59 percent for adult and yearling hens, respectively. They concluded that there was no significant difference between age classes and lumped all data to obtain an average mortality rate of 54 percent for the population. In the two years in which hunting was allowed on their study areas, average annual mortality rates were 59 and 63 percent, respectively.

Assuming that the 65 percent mortality rate of yearling hens (assuming most yearling mortality occurs over winter) applies for over-wintering mortality of juveniles, an annual juvenile mortality rate of 85 percent was indicated. Allen (1954) reported an 84 percent mortality for young pheasants on a Wisconsin refuge where hunting was not a factor. A life equation model for a stable sage grouse population is presented in Table 5. A survival rate to fall of 360 juveniles per 100 hens appeared necessary to maintain a stable population of sage grouse in central Montana. When productivity dropped below that rate as it did in 1964, 1965, 1967 and 1969 the population declined.

Table 5. **Life equation model for stable sage grouse population in central Montana.**

Date	Item and Computation			Gain	Loss	Juvenile Population
April 1	100 hens on strutting ground			- -	- -	0
May 1	Eggs = 8.2 x 100			820	- -	820
June 1	Nest mortality 820 x 30%[1]	56%	85%	- -	246	574
Sept. 1	Juvenile mortality 574 x 37%[2]			- -	214	360
April 1	Overwintering (including hunting mortality) 360 x 65%[3]			- -	234	126

Assume 50:50 sex ratio 126/2 = 63 hens one year later to replace 60-65% loss of 100 original hens.

[1]Nest mortality based on 10 year average (Wallestad and Watts 1973).
[2]Juvenile mortality based on 10 year average of wing data (Wallestad and Watts 1973).
[3]Assumed that juveniles expire at a rate at least as fast as yearling hens.

A sage grouse that lived three or four years was considered an old-timer. Eng (unpublished data) observed one marked hen that reached a maximum known age of eight years. With an average annual turnover rate of 60-65 percent, the probability of a bird attaining that age was .002 percent.

Allen (1954) stated "Our populations of game birds operate under a one-year plan of decimation and replacement; and Nature habitually maintains a wide margin of over-production. She kills off a huge surplus of animals whether we take our harvest or not". Game bird seasons in Montana are largely based on that philosophy, that most birds will not survive the winter, hence replacing natural mortality with hunting mortality.

HABITAT REQUIREMENTS

Breeding Habitat

Strutting grounds were key activity areas within wintering-nesting complexes. Of the twelve strutting grounds in the Yellow Water Triangle, seven were established on ground cleared by homesteaders. One was established on an old burn and others on natural clearings.

Wallestad and Schladweiler (1974) recorded sagebrush height and canopy coverage at 110 daytime feeding and loafing sites of strutting cocks (Table 6). Eighty percent of the locations occurred in sagebrush with a canopy coverage of 20-50 percent. Both Eng and Schladweiler (1972) and Wallestad (1972) found over 80 percent of winter sage grouse locations occurred in sagebrush stands exceeding 20 percent canopy coverage. Unfortunately, that was also the range of canopy coverage in which vegetal control was most likely to occur. No cocks were observed in areas having less than 10 percent canopy coverage.

Table 6. **Breeding season distribution of 110 sage grouse cock observations by sagebrush canopy coverage classes.**

	Percent Canopy Coverage					
	0.1-10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1+
Number of Cocks	0	15	38	29	20	8
Percent	0.0	13.6	34.5	26.4	18.2	7.3

Sagebrush canopy coverage for the 110 sites measured during the breeding season averaged 32 percent and compared with an average of 28 percent recorded for winter feeding and loafing sites (Eng and Schladweiler 1972). Sagebrush in the 6- to 12-inch height class accounted for slightly over half the total plants measured at sage grouse locations. Measurements possibly represented height distribution of sagebrush plants and not selection by birds.

Nesting Habitat

It has been well documented that sage grouse prefer sagebrush for nesting cover (Fig. 8). Patterson (1952) reported that 92 percent of approximately 300 nests found in Wyoming were located under sagebrush. All of 50 nests found by Girard in Wyoming (1937) were under sagebrush as were 95 percent of those located by Keller et al. (1941) in Colorado. The 35 nests found by Klebenow and Gray (1969) in Idaho were all below a sagebrush canopy, as were the 41 nests located in Montana by Wallestad and Pyrah (1974).

Figure 8. **Typical sagebrush cover over nest site.**

—(F&G photo by Richard Wallestad)

Concealment was the basic requirement of nesting cover. Wallestad and Pyrah (1974) analyzed cover over 41 nests in The Yellow Water Triangle and separated them on the basis of whether or not the nest was successful. They found that successful nests had significantly greater sagebrush cover within 24 inches of the nest, within a 100 sq. ft. plot around the nest and were located in stands of sagebrush with a higher average canopy coverage than those of unsuccessful nests (Table 7). Brush density preference for nesting appears to vary, but stands of 20-30 percent canopy coverage were most frequently selected. Average height of sagebrush cover over nests was 15.9 inches as compared to an average height of 9.2 inches for sagebrush in adjacent areas. These differences were significantly different (.005 Level) and indicate sage grouse seek out taller sagebrush plants when looking for nest sites.

Nesting habitat in eastern Montana was synonymous with sage grouse wintering habitat and therefore considered as a wintering-nesting complex. Chances were good that any management practice that benefits or destroys one will affect the other in a similar manner.

Table 7. **Comparison of sagebrush characteristics between successful and unsuccessful nests.**

Sagebrush Characteristics	Successful Nests 31[1]	Unsuccessful Nests 10	Significance Level[2]
Number of sagebrush plants within 24 inches of nest.	6.4[3]	4.5	.005
Number of sagebrush plants in 100 sq. ft. plot around nest site.	34.5	23.4	.005
Intercept (in feet) of sagebrush in 100 sq. ft. plot around nest site.	33.3	20.7	.005
Canopy coverage of sagebrush in stand where nest was located.	27%	20%	.005
Average height (inches) of sagebrush plants covering nest.	15.6	15.9	Not Sig.
Average height (inches) of tallest sagebrush plants covering nest.	17.9	18.2	Not Sig.

[1] Sample size.
[2] T test
[3] All entries in table represent the mean for all nests in each category.

Brooding Habitat

Studies to date have concluded that succulent forbs, preferred food of sage grouse broods, were the key to summer habitat for sage grouse (Gill 1965, Savage 1968, Klebenow 1969, Martin 1970, Wallestad 1971 and Oakleaf 1971). As food plants mature and became unpalatable as forage, sage grouse moved to moist areas still supporting succulent vegetation. This movement was often to alfalfa fields or borrow pits in eastern Montana while in Nevada, movements to higher mountain meadows were documented by Savage (1968) and Oakleaf (1971). In years of abundant precipitation and long lasting succulent vegetation sage grouse remained scattered throughout their summer range.

Sage grouse broods preferred relatively open stands of sagebrush compared to those selected at other times of the year. The distribution of 1,599 sage grouse obser-

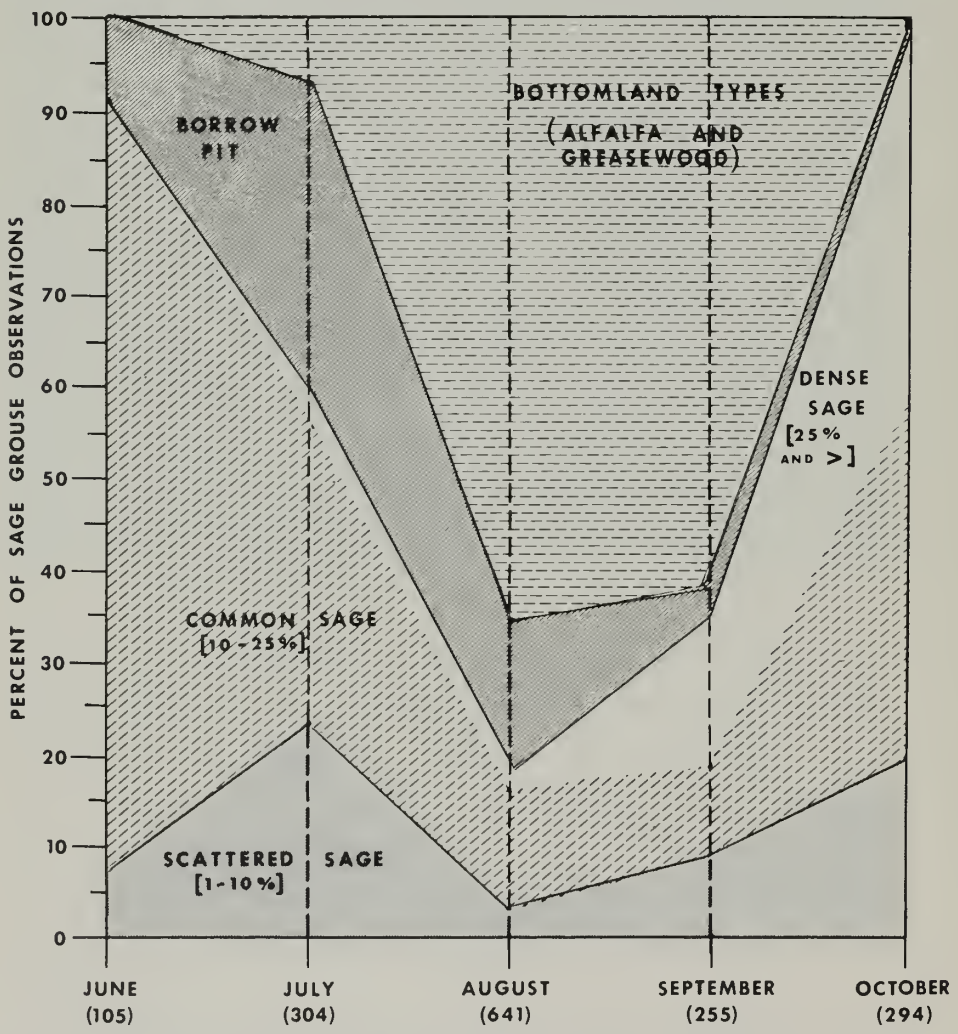


Figure 9. **Distribution of sage grouse by cover types and sagebrush density in the Yellow Water Triangle, 1970.**

vations by cover types and sagebrush density is presented by monthly intervals (June through October) in Figure 9. Throughout June and July common sagebrush (10 to 25 percent canopy coverage), scattered sagebrush (1 to 10 percent canopy coverage) and borrow pits received 90 percent of utilization by broods. Martin (1970) reported an average of 14 percent canopy coverage of sagebrush at brood sites in southwestern Montana while Klebenow (1969) found an average of 8.5 percent at brood sites in southern Idaho. During the summer less than 15 percent of observations occurred in dense (25 percent and greater canopy coverage) sagebrush until October, when 40 percent of the birds were observed using sagebrush of this density. Use of sagebrush types in October represents a return to the winter diet of sagebrush. During August and September, approximately 65 percent of all grouse observations were recorded in bottomland types (alfalfa fields and greasewood bottoms). Borrow pits were also used by sage grouse broods in July and August as forbs on the more open sites started to dry up.

This shift in use of cover types and sagebrush densities throughout summer was similar to what Wallestad (1971) found for 13 radio-equipped sage grouse broods. The time of shift from ranges dominated by sagebrush to bottomland types was dictated by the condition of vegetation as influenced by moisture conditions in any given year. The first killing frost of the season usually occurred any time after September 1. With the frost, many forbs were destroyed, forcing sage grouse to turn to sagebrush for food. Jorgensen (personal communication 1973) reported moisture content of sagebrush leaves increased with fall rains. The increased moisture content may make sagebrush more palatable than during summer. Many years the shift occurred just prior to the hunting season, baffling hunters who consistently hunted alfalfa fields.

Most summer observations of male flocks were made within 2 to 3 miles of a known strutting ground. Throughout summer and early fall, male sage grouse tended to be segregated from broods and hen flocks. This segregation tends to be of a social nature since adult cocks were observed to be utilizing the same type of areas used by broods and hen flocks. Unsuccessful hen flocks were typically found in areas of dense sagebrush throughout summer.

While large tracts of dense sagebrush appear to have limited value as sage grouse brood habitat (Klebenow 1969 and Wallestad 1971), sagebrush stands of moderate densities are an essential part of sage grouse brood habitat, particularly during early and late summer.

Wintering Habitat

Habitat requirements of sage grouse flocks were studied during the winters of 1965-66, 1966-67 (Eng and Schladweiler 1972), 1970-71, and 1971-72 (Wallestad 1972 and 1973). There were approximately 25,500 acres of sagebrush available to sage grouse as winter range in the Yellow Water Triangle in a normal winter (snow depth less than 10 inches). When snow depth exceeded 12 inches, as it did three of the last seven winters, sage grouse were restricted to taller sagebrush stands on about 1,700 acres, or only seven percent of the range available to them in a normal winter. Bean (1941) reported that when snow depth reached 13-15 inches in Idaho sage grouse immediately moved to taller sagebrush types and remained there

for approximately two weeks. Critical wintering areas (areas that will support sage grouse populations when snow depth exceeds 12 inches), in relationship to normal sage grouse winter ranges, are plotted in Figure 10.

Eng and Schladweiler (1972) described winter ranges in eastern Montana as being large expanses of dense (20 percent and greater canopy coverage) sagebrush with an average height of 10 inches on land having little if any slope. This association with dense stands of sagebrush usually begins in September (Wallestad 1971) and continues through the breeding (Wallestad and Schladweiler 1974) and nesting seasons (Wallestad and Pyrah 1974).

Approximately 58 percent of the South Pike Creek wintering ground falls into the category of 20 percent or greater sagebrush canopy coverage. Seventy-eight percent of 151 winter locations of radioed sage grouse occurred in the greater than 20

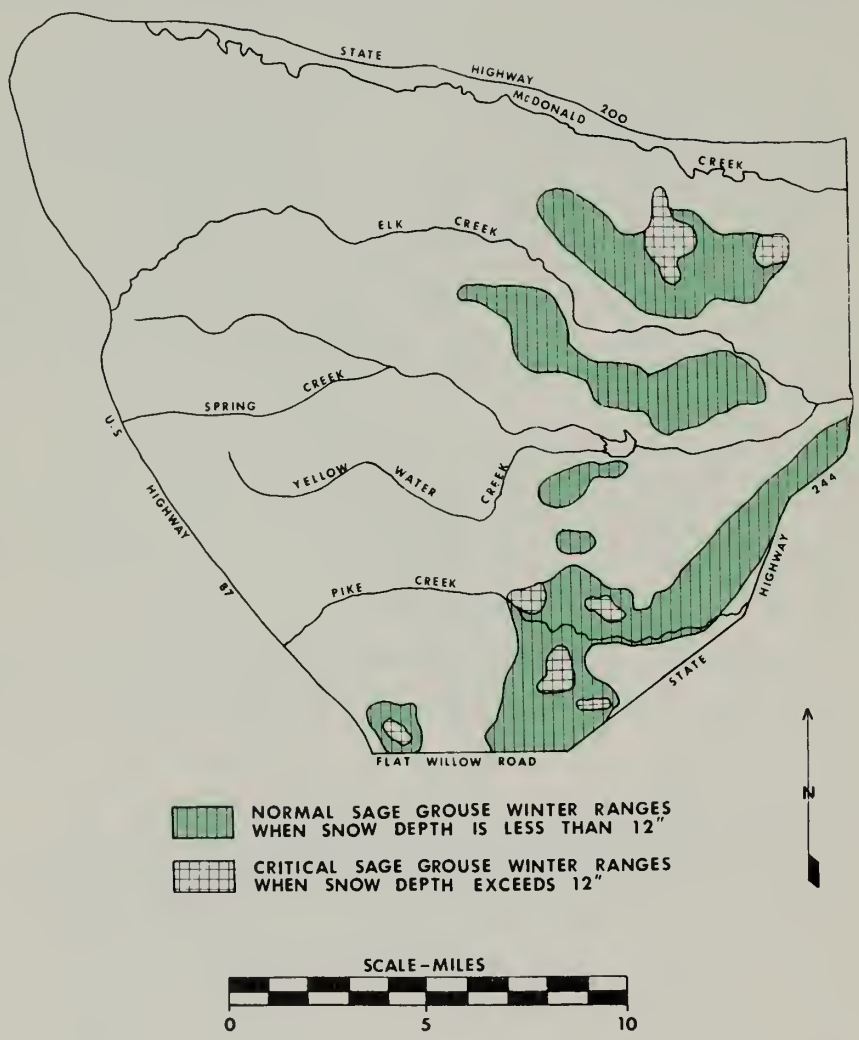


Figure 10. **Sage grouse wintering grounds in the Yellow Water Triangle.**

Sage grouse winter area in eastern Montana. —*(F&G Photo)*

percent canopy-coverage class. Eng and Schladweiler (1972) reported 82 percent of 60 winter observation sites actually measured occurred in the greater than 20 percent category (55 percent of the area) on the North Pike Creek wintering ground. Percent of radio locations that occurred in dense sagebrush stands are presented by monthly intervals in Table 8.

Table 8. **Percent of locations that occurred in sagebrush with greater than 20 percent canopy coverage, by monthly intervals, during the winter 1970-71.**

	October	November	December	January	February	March
Sample Size	44	35	15	26	17	14
Percent in Greater than 20% Class	80	86	87	92	53	50

As weather moderated in February activities shifted to more open stands of sagebrush. The first strutting on a ground was observed on February 24 and by the first week in March all known strutting grounds were active.

Effects of Habitat Alteration

Sage grouse habitat has declined steadily since 1955 throughout the western United States as a result of sagebrush control programs. Biologists have long recognized the close tie between sage grouse and their sagebrush environment (Girard 1937, Rasmussen and Griner 1938 and Patterson 1952). Despite this fact, actual population changes following sagebrush removal were largely unstudied and therefore undocumented.

The effect of sagebrush removal on a population of sage grouse can be evalu-

ated three basic ways: 1) presence or absence and relative use by birds of treated areas as indicated by dropping counts; 2) changes in population levels as indicated by numbers of strutting males; and 3) direct observation of birds on and around treated areas.

Study areas were treated with 2,4-D for sagebrush control. —*(F&G photo by Tom Mussehl)*

Depending upon the size of the area treated in relation to total habitat available, sagebrush control may not have an immediate noticeable effect on the sage grouse population. Rogers (1964) reported that a spray project which treated 1,700 acres of sagebrush in western Colorado apparently had little effect on the sage grouse population using the area. Two years later an additional 1,300 acres were treated and the entire sage grouse population appeared to emigrate from the area.

Dropping Counts

Pyrah (1972) reported that sage grouse winter use of an area was proportional to the severity of treatment. Those treatments doing the least damage to sagebrush affected sage grouse use the least and the duration of the adverse effect was shortest. In areas he studied, partial kill strip spraying was substantially better for sage grouse than block partial kill. Block partial kill damaged sage grouse winter habitat less than mechanical treatments and total kill spray did the greatest damage.

Strutting Ground Counts

Higby (1969) reported that a 12,000 acre sagebrush spray project in Wyoming was responsible for the elimination of sage grouse from a winter range that supported 1,000 sage grouse prior to treatment. Four strutting grounds on the treatment area declined from a total population of 50 to 0 four years after treatment with 2,4-D. Eight years following treatment the grounds had partially recovered to a total of 31 males. When he compared the numbers of males on treated grounds to those on untreated grounds he concluded that the population fluctuation was almost entirely due to eradication of sagebrush.

Probably one of the best documented instances of the detrimental effects of sagebrush removal was reported by Peterson (1970b) on an isolated sage grouse population in Meagher County, Montana. He reported that a 49 percent decrease (11,808 acres) in sagebrush types, as a result of sagebrush spraying and conversion to cropland, eliminated five strutting grounds.

Treatment of 751 acres (24 percent of the total suitable habitat adjacent to the King Ranch Strutting Ground) resulted in a 50 percent reduction in cocks the following year. However, 3 years post-treatment the population had recovered to pre-treatment levels. Spraying of 640 acres (11 percent reduction in suitable habitat) resulted in no significant post-treatment population change on the adjacent South Pike Creek Strutting Ground. A new ground (possibly because of spraying) was established 1.5 miles to the northeast, the year following treatment. Two hundred fifty-three acres adjacent to the Highway Strutting Ground was scheduled for a partial kill of sagebrush (65 percent reduction in crown coverage); however, the small size of the area, combined with a light actual kill (25 percent reduction in coverage) produced no major effect on the strutting ground cock population.

Of the 1,090 acres of sagebrush sprayed adjacent to the North Yellow Water Strutting Ground, 839 (31 percent of the total suitable habitat) had a canopy coverage exceeding 15 percent prior to treatment. The sprayed area was also the largest block of continuous habitat in the area (Fig. 11). In the two post-treatment years

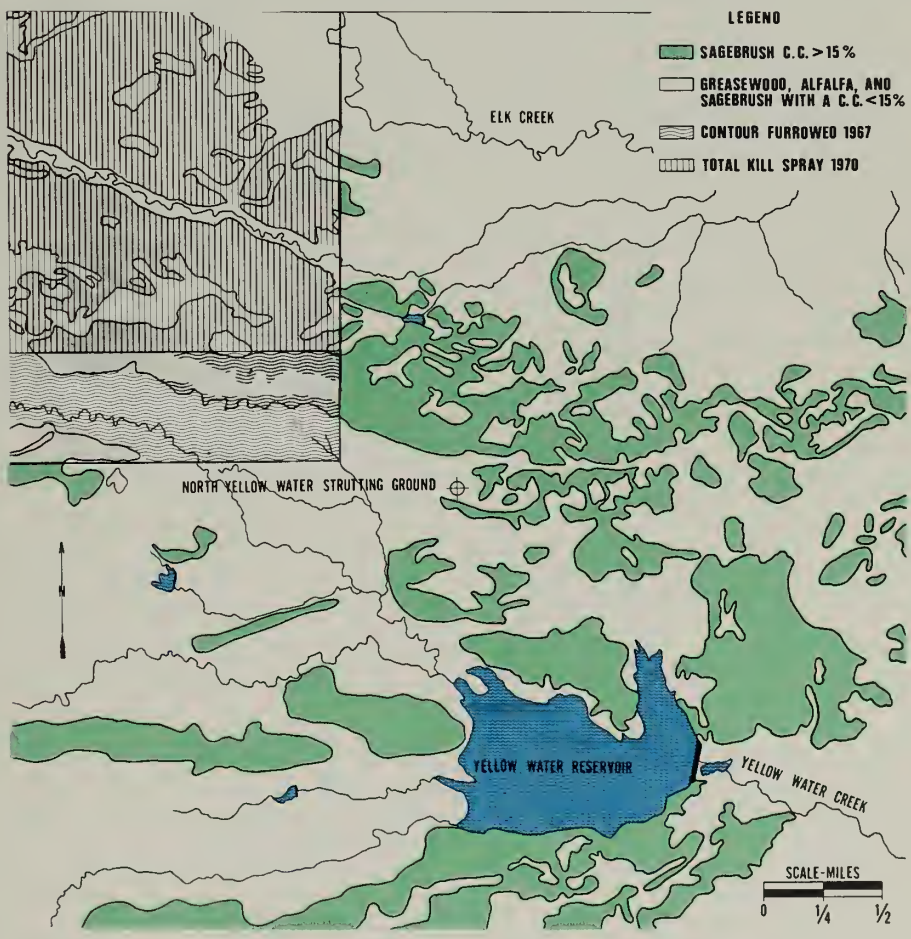


Figure 11. **Distribution of major sagebrush stands in relation to the North Yellow Water Strutting Ground.**

Table 9. **Number of male sage grouse on strutting grounds pre- and post-treatment.**

	Pre-Treatment			Post-Treatment			
	1966	1967	1968	1969	1970	1971	1972
Strutting Grounds within ½ mile of treated area (three grounds)	32	32	32	30	42	51	42
Strutting Grounds further than 2 miles from treated area (two grounds)	23	17	26	98	88	89	97

there was a 63 percent loss in cocks on the strutting ground while other grounds in the Triangle remained relatively stable.

Total numbers of male sage grouse on three grounds within 0.5 mile of treated area increased an average of 28 percent from pre- to post-treatment years (increase was not significant $P > .05$) (Table 9). In the face of an increasing population it appeared that sagebrush treatment had no effect on the sage grouse population. However, when compared to control grounds in the same population the effect becomes more pronounced. Total numbers of males on two grounds further than 2 miles from treated areas increased an average of 323 percent (increase is highly significant $P < .001$) during the same period, (Wallestad 1975). Number of sage grouse observed on grounds within 0.5 mile of treated areas and those further than 2 miles led to the conclusion that differences were related to sagebrush spraying.

Direct Observation

In southwestern Montana, Martin (1970), studied the distribution of sage grouse broods in relation to a 1,900 acre area that had been strip sprayed. Although the sprayed strips were approximately nine times the area of the unsprayed, they provided only four percent of the 415 sage grouse observed. He concluded that differences were related to vegetation composition as a result of sagebrush spraying.

LIMITING FACTORS

Habitat

Destruction of habitat has been the main factor limiting the distribution of sage grouse populations. As Patterson (1952) stated, "sage grouse habitat and sagebrush are synonymous". Any factor or combination of factors which causes deterioration of native sagebrush ranges inhabited by sage grouse cannot help but be detrimental to this unique game bird.

Written accounts of early travelers through the semi-arid prairies of eastern Montana indicate that sage grouse were abundant prior to settlement by white man. In 1897 the bag limit on sage grouse was 20 birds per day. As the land was opened up by homesteading ,sage grouse range deteriorated rapidly under the pressures of the cow and the plow. By the 1930's sage grouse populations in many areas had been eliminated and many felt the species was threatened by extinction.

During the depression years, homesteads reverted back to rangeland as settlers discovered the climate was not suited for dryland agriculture. This change in land use gave new life to declining sage grouse populations. As the land healed from this period of intensive use (often abuse), sage grouse populations increased.

In the 1950's sage grouse populations faced a new threat, that of the spray plane. In an effort to increase grass production for cattle, native sagebrush ranges were treated with 2,4-D to convert them to grasslands. Approximately 10 percent of the sagebrush range in Montana has been rendered unsuitable for sage grouse because of that land practice.

Weather

Sage grouse inhabit the semi-arid plains of the western United States which experience varied and extreme climatic conditions. Severe weather conditions (unless snow completely covers the sagebrush) have little effect on the birds.

The success or failure of sage grouse in a particular year has generally been attributed to weather conditions during hatching. Cold, rainy weather were the conditions usually blamed for poor productivity. According to Lack (1954) birds have evolved to hatch their eggs at the most favorable time of the year for survival of young. June predictably has heavy (3 inches) rainfall in Montana's semi-arid, prairie grouse habitat. Why would sage grouse have evolved to hatch their young

during the rainiest period of the year if it was detrimental to their survival?

In an attempt to answer that question, Wallestad and Watts (1973) analyzed 10 years of sage grouse production data from central Montana to isolate factors affecting productivity. Their results are summarized as follows:

1. No correlation existed between productivity and rainfall during the hatching period.
2. An inverse correlation existed between productivity and rainfall during the egg-laying period. Heavy rain (greater than 1 inch) during the egg-laying period caused a late hatch resulting in poor productivity (less than 400 juveniles:100 females).
3. Total spring precipitation, as it potentially affected spring greenup of vegetation, further explained variations in productivity. Even if rainfall was optimum during the egg-laying period, production would be poor if total spring precipitation during the growing season was inadequte for necessary plant growth (less than 3 inches from mid-April through mid-June).
4. No correlations existed between temperature and productivity.
5. Adult sage grouse (average 78 percent) were predictably more successful than yearlings (average 62 percent) in bringing off a brood.
6. On the basis of sheer numbers, the yearling female was the single most important age class producing young. Therefore, years of poor productivity occurred because of factors working primarily against the yearling segment of the population.

Predation

In Montana a large variety of animal species are potential sage grouse nest predators. Of 22 nests located by Wallestad and Pyrah (1974) three (13%) were destroyed by predators. They also noted that nests which had greater sagebrush cover were more successful than nests with lesser amounts of cover.

Between the time of hatching and the hunting season about 40 percent of the hatch succumbed to some form of mortality. It was not known what part was attributed to predators. The golden eagle and hawks, including the marsh, swainson's, red-tailed and rough-legged, were common in eastern Montana and pose a threat to young birds. Predation on adult birds was not as common. Of the approximately 70 adult sage grouse that were radio-equipped on this project, only three were killed by predators, while they were radio-tagged.

Disease and Parasites

Simon (1940) described the parasites commonly found in sage grouse in Wyoming (Table 10). The incidence of all parasites except the protozoan *Tritrichomonas* was higher in young birds than adults; young were also more heavily infested. Most sage grouse were infected with tapeworms but no serious ill effects were noted. Simon (1940) concluded that there were two species of coccidia infecting sage grouse: *Eimeria angusta* and *Eimeria centrocerci*. Outbreaks of coccidiosis were known to locally decimate populations of sage grouse. Occasionally diseased birds were observed in Montana, particularly in the vicinity of irrigation ditches and alfalfa fields. The birds appeared weak, unable to fly, exhibited symptoms of partial

Table 10. **Parasites of sage grouse (Simon 1940)**

ENDOPARASITES	
	Protozoa (one-celled animals)
	1. *Eimeria angusta*
	2. *Eimeria centrocerci*
	3. *Tritrichomonas* sp.
	Cestoda (tape worm)
	4. *Raillietina centrocerci*
	5. *Rhabdometra nullicollis*
	Nematoda (round worms)
	6. *Habronema urophasiana*
	7. *Cheilospirura centrocerci*
	8. *Heterakis gallinae*
ECTOPARASITES	
	Mallophaga (biting lice)
	9. *Gonoides centrocerci*
	10. *Lagopecus perplexus*
	Acarine (ticks and mites)
	11. *Haemophysalis cinnabarina*
	12. *Haemophysalis leporis-palustris*

paralysis and had a diarrhetic discharge. Autopsy revealed coccidiosis. Outbreaks usually occurred in late July and August when sage grouse concentrated around water sources. The problem was alleviated with dispersal of birds to fall and winter ranges.

Accidents

Sage grouse were known to fly into wires and fences but the most common accident was collision with vehicles. Roadkills were quite common during dry summers when sage grouse concentrated along highway borrow pits to take advantage of green vegetation that persisted there long after range plants had dried up.

HUNTING

Initially, hunting regulations were imposed to limit the kill of each species on each parcel of land to its productive capacity (Leopold 1933). The most common tools used to regulate game numbers have been bag limits and season length. In theory, bag limits were designed to more equitably distribute the kill among hunters, while season length was to regulate total harvest.

Prior to 1870 there were no regulations limiting the taking of sage grouse in Montana. In 1870 regulations were adopted closing the season on native grouse from March 1 - August 15 of each year. Anyone caught shooting birds during the closed season was fined from $5-30. In 1877 the selling of native game birds was made illegal. In 1897 a daily bag limit of 20 native grouse was imposed by the legislature. In 1909 the daily bag limit was reduced to five, and in 1939 further reduced to three. Length of season was drastically reduced and in 1927 was closed completely. A detailed account of seasons prior to 1938 can be found in Appendix Table 4. The trend in recent years has been toward more liberal seasons, both in length and quota (Fig. 12). Currently most areas in Montana provide a sage grouse season of 65 days with a daily bag limit of four birds.

Hunting pressure on most bird species in Montana is extremely light (average harvest over a 10 year period was 3 birds/sq. mile) because of the abundance and diversity of hunting opportunities available to hunters. The Yellow Water Triangle Area was a popular place to hunt sage grouse, yet it was estimated that less than five percent of the sage grouse in the Triangle were harvested annually, in spite of a 65 day season. Based on the annual turnover of sage grouse, hunters could take 30 percent of the birds annually without affecting breeding populations.

In areas like Montana where the sage grouse harvest is annually less than 3 birds/sq. mile of habitat, season lengths and quotas have been liberal because hunting was basically self-regulating. Leopold (1933) stated that hunting, as now "controlled" in most states, would have long since decimated many additional species were it not for the "law of diminishing returns," to which the hunter's effort, like all other efforts to make land yield an increase, is subject. When game becomes scarce there is an automatic tendency for hunters to hang up their guns, and thus limit the kill.

Montana hunters are like hunters everywhere - they enjoy being out opening

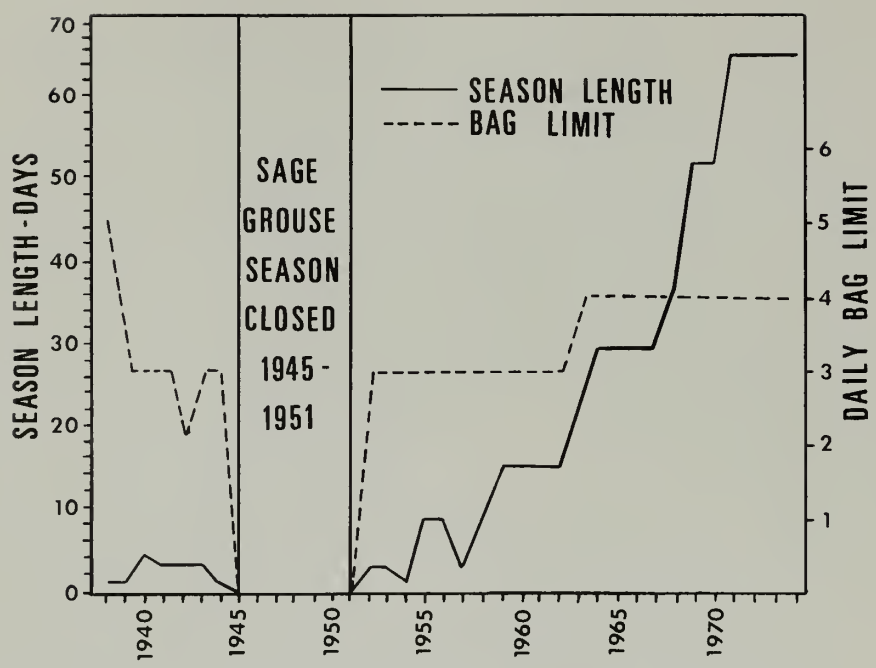


Figure 12. **Sage grouse hunting seasons in Montana, 1938-1974.**

day. Many Montana hunters spend opening weekend hunting grouse and then switch to big game hunting. Figure 13 shows the percent of sage grouse harvested by time period for the years 1962-1967. Season length varied from 15 days in 1962 to 29 days in 1967. Despite the season length, 35-55 percent of the season harvest occurred on opening day and 70-80 percent during the first week.

Length of season does not have a proportionate effect on total bird harvest. Watts et al. (1972) compared administrative district four (Great Falls) sage grouse harvests among years with seasons of: (a) 15 days, (b) 22-29 days, and (c) more than 37 days. They found no significant differences in harvests between periods and concluded that season harvest varies with harvest on opening day, and not with season length. The philosophy behind a long season was to provide maximum recreation and not to increase harvest.

Any factor or combination of factors that created poor hunting on opening weekend affected hunter success and total harvest. Weather was one of the most critical factors in determining opening day hunter success. Cold, wet or windy weather made sage grouse naturally wild and they frequently flushed out of gun range. Wet conditions also prevented access to most roads in eastern Montana. Hunter success was highest in years when warm weather prevailed, and hunters turned out in good numbers, and were able to gain access to most roads.

Sage grouse tend to be widely scattered throughout the sagebrush in years when there has been adequate summer moisture. This reduced opening day success and total kill and resulted in many complaints from hunters that there were no birds. In summers with little moisture, birds congregated in large flocks around alfalfa fields and roadside ditches, resulting in good opening day success and a higher total kill.

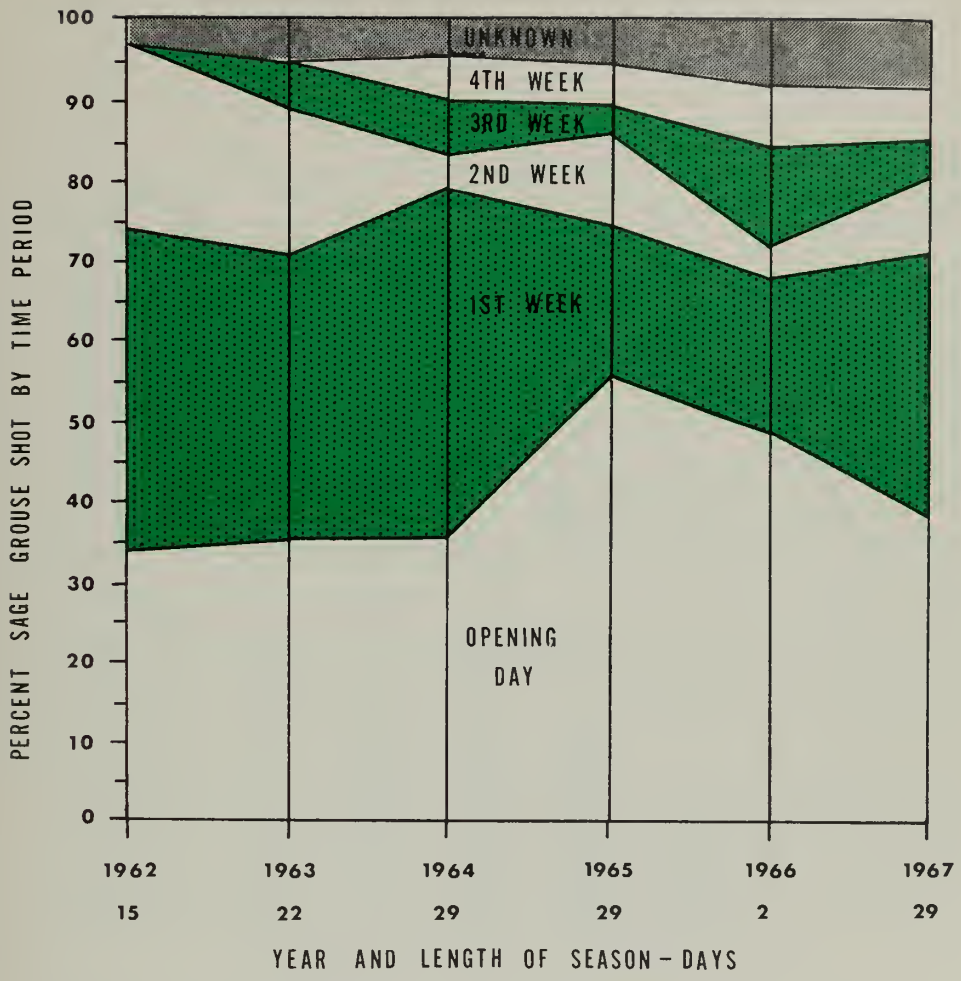


Figure 13. **Percentage of sage grouse shot by time period, 1962-1967.**

During the last 14 years Montana hunters have harvested an average of 46,000 sage grouse per year, while providing approximately 90,000 hours of annual recreation for bird hunters. In pioneer times the sage grouse was considered the leading upland game bird in 9 western states, including Montana (Patterson 1952). At present it ranks behind the pheasant, Hungarian partridge, sharp-tailed grouse, ruffed grouse and blue grouse in total birds harvested (Fig. 14). Several factors have caused the sage grouse to decline from the leading upland game bird to one of the lowest. Successful and widespread introduction of the pheasant and Hungarian partridge into agricultural areas around population centers has reduced hunting pressure on the sage grouse which inhabits the more remote areas of the state. Probably the greatest single factor in this decline in popularity has been the population decline caused by destruction of their habitat. This has occurred in many ways including: fire, plowing, overgrazing and spraying. Spraying alone has destroyed nearly 700,000 of the 11 million acres of Montana sagebrush range capable of sustaining sage grouse populations. Because many of the areas destroyed

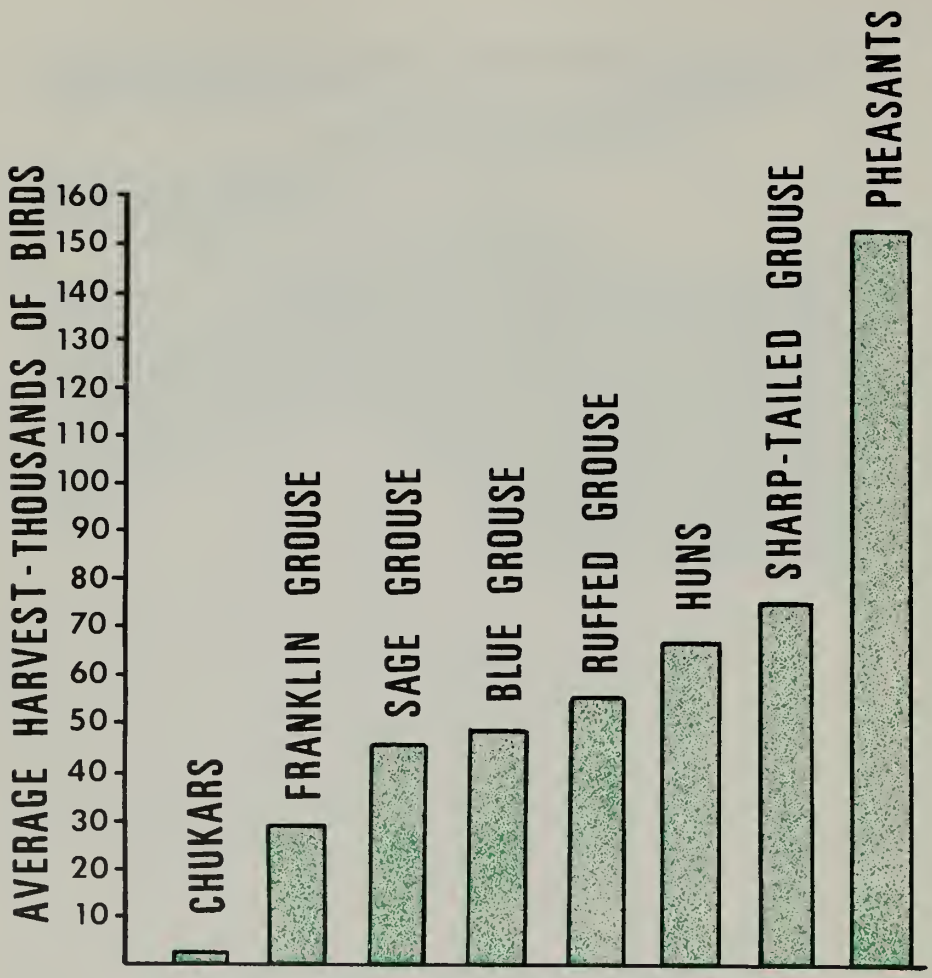


Figure 14. **Montana upland game bird harvest, 1960-1974.**

were dense stands of sagebrush critical for wintering and nesting populations of sage grouse, the detrimental impact was probably many times greater.

Sage grouse populations naturally fluctuate in numbers like all other wildlife populations. Biologists annually make strutting ground and brood censuses to evaluate overall population trends. Wings collected at checking stations in fall are examined to determine hatching dates and productivity. Despite the apparent ups and downs in sage grouse populations, Montana has maintained liberal sage grouse seasons based on the following phenomena:

1. "High annual turnover" - nature traditionally produces a surplus of animals above the carrying capacity of the habitat.
2. "Law of diminishing returns" - when hunting becomes unproductive there is an automatic tendency for hunters to hang up their guns, thus limiting the kill and guaranteeing an adequate breeding stock the next year.
3. "Opening day phenomena" - total harvest varies with success on opening day and not with season length.

SUMMARY

Intensive studies were initiated in 1965 to study the ecological relationships between sage grouse and sagebrush. Conclusions in this report are based on observations of 395 poncho-tagged and 73 radio-marked sage grouse and results of other studies.

Sage grouse are presently found on approximately 10 million acres of sagebrush-grassland in 39 counties of eastern, central and southwestern Montana. Approximately 10 percent of their native range has been destroyed by man, mainly in his effort to eliminate sagebrush and increase grass production for domestic livestock forage.

Sage grouse bred in March and April, nested in May, and usually brought off a brood during the first week in June. A typical sage grouse nest contained 7-9 eggs which hatched following a 26 day incubation period. Adult hens laid significantly more eggs and were more successful in bringing off a brood than yearling hens. Average annual mortality rate for sage grouse hens was 60-65 percent and for juveniles it approached 85 percent. At this rate, a sage grouse population turns over completely within eight years.

Sage grouse populations in eastern Montana were considered non-migratory. The strutting ground was the center of activity during the breeding season and possibly throughout the year. Movements of cocks of up to 0.8 mile from strutting grounds were common and 82 percent of all locations were greater than 0.2 mile. Sixty-eight percent of all radio-marked hens nested within 1.5 miles of a strutting ground. Inter-strutting ground movements were regularly observed among tagged hens.

Sagebrush canopy coverage at locations of radio-equipped cocks during breeding season averaged 32 percent. All 41 nests located occurred under sagebrush and averaged 25 percent canopy coverage. Successful nests had significantly greater sagebrush cover than unsuccessful ones. Brood habitat was largely determined by the availability of succulent vegetation. Broods used sagebrush areas early in summer and then shifted to bottomland types as uplands desiccated. In fall, as green forbs dried, sage grouse shifted back to sagebrush types for food and cover. Winter ranges in eastern Montana were large expanses of sagebrush (20 percent and greater canopy coverage) on land having little if any slope.

Food habits data were obtained from crop contents of 299 adult and 127 juve-

nile sage grouse. Sagebrush comprised 62 percent of all foods consumed by adults. During December, January and February, sagebrush was the only food item used and only during the months of June-September did it make up less than 60 percent of the adult diet by volume. Important forbs eaten by juveniles and adults during the summer included fringed sagewort, dandelion, common salsify and prickly lettuce.

Treatment of sagebrush with 2,4-D resulted in decreased use by sage grouse. Numbers of male sage grouse on grounds within .5 mile of treated areas increased an average of 28 percent post-treatment, while on grounds further than 2 miles from treated areas they increased an average of 323 percent. A 31 percent loss of habitat adjacent to the North Yellow Water Strutting Ground resulted in a 63 percent decrease of strutting males over a two year period. Evidence from dropping counts indicated that treatment least damaging to the sagebrush stand (strip spraying in this study) affected sage grouse utilization the least and duration of the adverse effect was shortest.

Montana hunters have annually harvested an average of 46,000 sage grouse, most during opening week. Despite the ups and downs in trend information, Montana has maintained liberal bird seasons based on: 1) high annual turnover, 2) law of diminishing returns, and 3) opening day phenomena.

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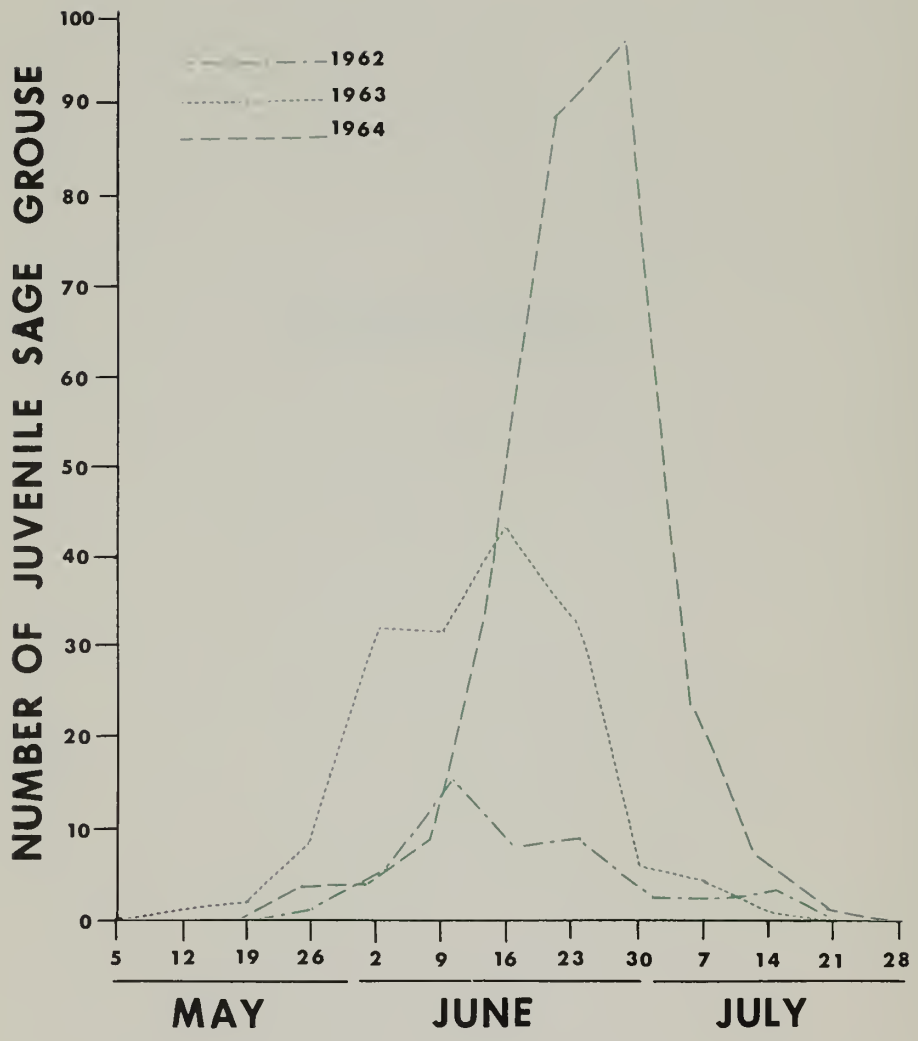
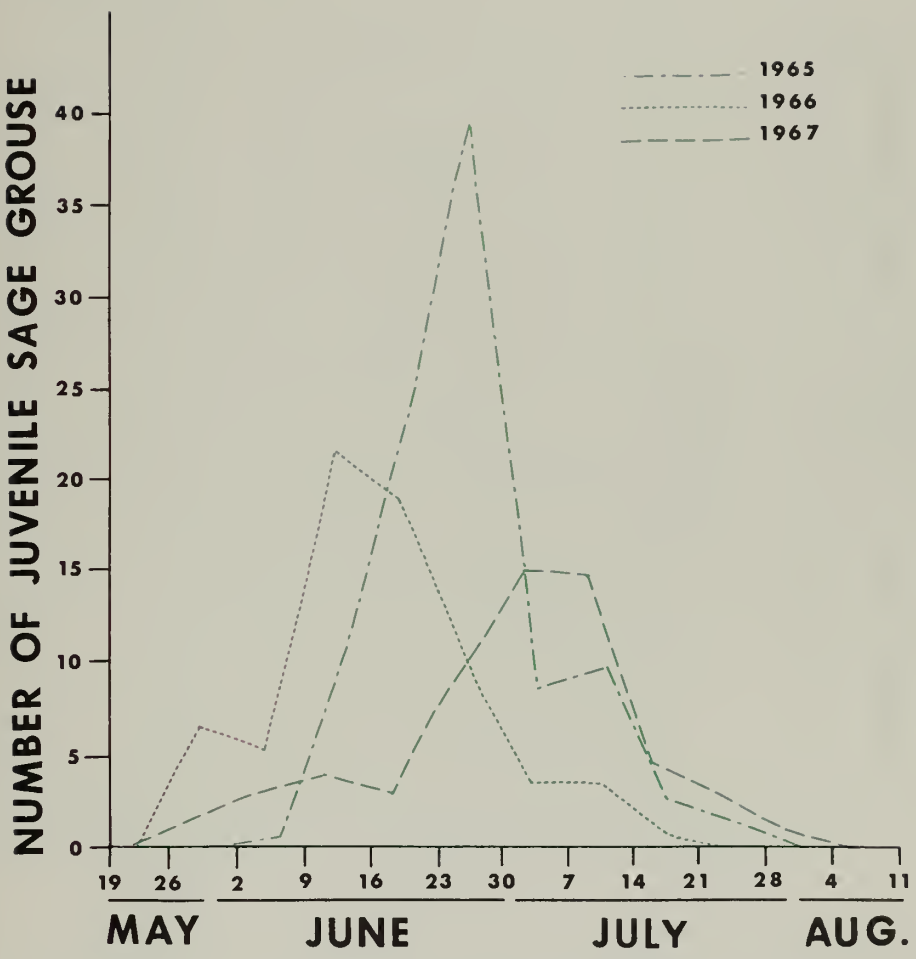
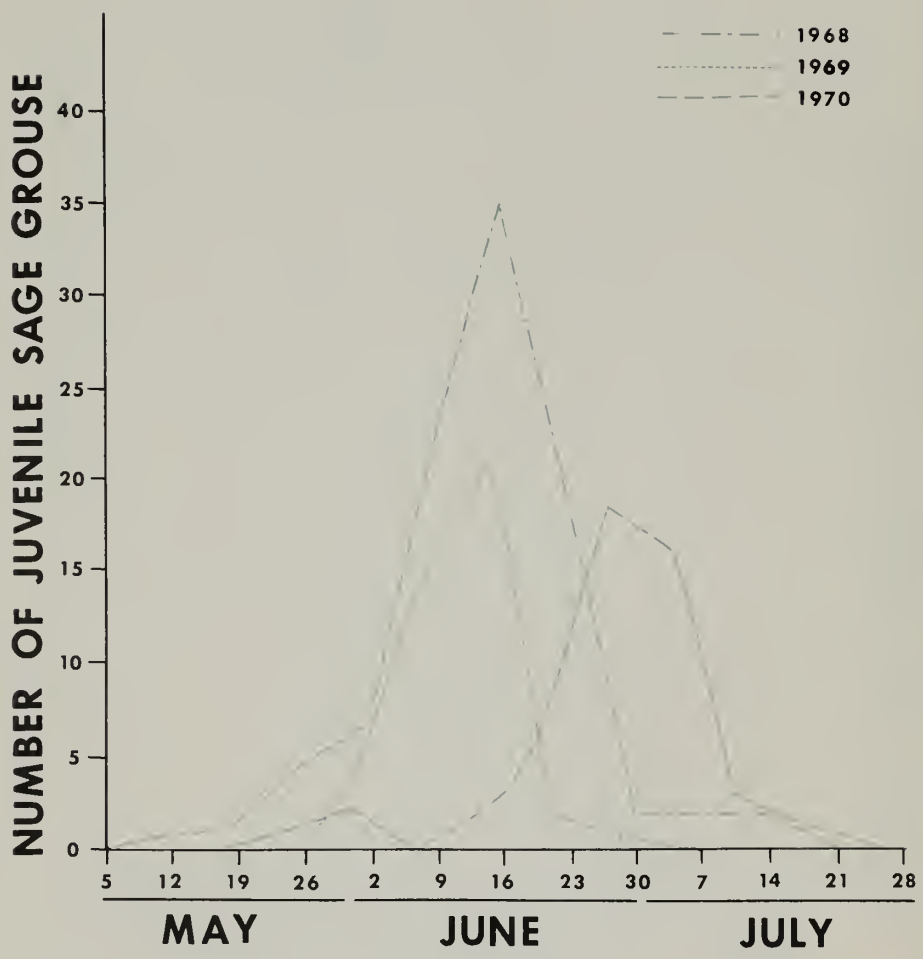
APPENDIX



Appendix Figure 1. **Sage grouse hatching chronology for the Yellow Water Triangle, 1962-1964.**



Appendix Figure 2. **Sage grouse hatching chronology for the Yellow Water Triangle, 1965-1967.**



Appendix Figure 3. **Sage grouse hatching chronology for the Yellow Water Triangle, 1968-1970.**

Appendix Table 1. **Aging key for juvenile sage grouse based on feather replacement (Eng 1955b).**

Age Class in Weeks	Primary Numbers (Proximally to distally)										Sample Size
	10	9	8	7	6	5	4	3	2	1	
1	J	J	J	J	J	J	J	AB	AB	AB	22
2	J	J	J	J	J	J	J	J[1]	AB	AB	18
3	J	J	J	J	J	J	J	J[2]	AB	AB	13
4	AD-AB	J-AB	J	J	J	J	J	J	J	J-AB	13
5	AD	AD	J-AB	J	J	J	J	J	J	J	13
6	AD	AD	J-AD	J-AB	J	J	J	J	J	J	13
7	AD	AD	AD	AD[3]	J-AB	J	J	J	J	J	11
8	AD	AD	AD	AD[4]	J-AB	J	J	J	J	J	9
9	AD	AD	AD	AD	AD	J	J	J	J	J	4
10	AD	AD	AD	AD	AD	J	J	J	J	J	1
11	AD	AD	AD	AD	AD	AB	J	J	J	J	1

[1]Average length 24 mm
[2]Average length 50 mm
[3]Average length 36 mm
[4]Average length 65 mm

AB = Absent
AD = Adult primary
J = Juvenile primary

Appendix Table 2. **Aging key for juvenile sage grouse (Pyrah 1963).**

Age in Weeks	Post Juvenal Primary Number and Length in mm (Proximally to distally)									
	10	9	8	7	6	5	4	3	2	1
3	0-13									
4	14-58	0-21								
5	59-103	22-71	0-27							
6		72-121	28-74	0-40						
7			75-121	41-86	0-37					
8				87-133	38-80	0				
9					81-123	1-44				
10					124-166	45-88				
11						89-132	0-42			
12						133-176	43-84			
13							85-126			
14							127-168	0		
15							169-210	1-39		
16								40-78		
17								79-117		
18								118-152	0-35	
19								153-187	36-70	
20			MALES					188-222	71-105	0-32
21									106-140	33-64
22									141-175	65-96
23										97-121
24										122-146
4	0-44	0-26								
5	45-88	27-71	0-34	0						
6	89-132	72-117	35-81	1-7	0					
7			82-128	48-93	1-45					
8				94-135	46-90	0-35				
9					91-135	36-76				
10						77-117	0-38			
11						118-158	39-76			
12							77-114			
13							115-152	0-25		
14								26-61		
15								62-97		
16								98-127		
17								128-157	0-35	
18								158-187	36-70	
19									71-105	0-32
20			FEMALES						106-140	33-64
21									141-175	65-96
22										97-121
23										122-146
24										147-171

Appendix Table 3. **Summary of sage grouse strutting ground counts in the Yellow Water Triangle, 1966-1972.**

Strutting Ground	1966 M[1]	1966 F[1]	1967 M	1967 F	1968 M	1968 F	1969 M	1969 F	1970 M	1970 F	1971 M	1971 F	1972 M	1972 F	Average Males
South Pike Creek	8	41	12	36	16	24	18	12	21	13	9	14	11	8	14
North Pike Creek	8	41	9	19	11	25	36	19	32	35	25	23	18	15	20
South Yellow Water	15	42	8	12	15	29	62	12	56	75	64	115	79	68	43
North Yellow Water	26	38	32	20	27	40	42	40	35	25	21	0	13	27	28
King Ranch	14	13	14	16	12	11	6	3	9	7	14	6	17	28	12
Highway	10	22	6	17	4	5	6	1	22	30	28	12	14	5	13
Elk Creek	6	10	6	4	12	12	16	20	0	0	9	0	35	9	12
SUBTOTALS	87	197	87	124	97	151	186	70	175	185	170	170	187	160	
Northeast Iverson[2]	- -	- -	- -	- -	- -	- -	28	0	32	45	35	35	33	44	32
Snoose Creek[3]	- -	- -	- -	- -	- -	- -	13	0	55	36	41	- -	80	11	47
Gjerde Ranch[4]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	23	5	33	7	28
Pike Creek Hills[4]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	27	0	18	2	23
Red Rock[5]	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	97	30	97
TOTALS	87	197	87	124	97	151	227	70	262	266	296	210	448	254	

[1]M - Male; F - Female.
[2]Strutting ground established in 1969.
[3]Strutting ground discovered in 1969.
[4]Strutting ground discovered in 1971.
[5]Strutting ground discovered in 1972.

Appendix Table 4. **Montana sage grouse hunting seasons prior to 1938.**

Year	Opening Date	Closing Date	Bag Limit	Possession Limit	Special Regulations
	No regulations prior to 1870				
1870-1873	Aug 15	Mar 1	none	none	Fine of $5-30 for hunting native birds during closed period.
1873-1876	Jul 15	Mar 1	none	none	
1876-1883	Aug 10	Jan 1	none	none	Unlawful to sell native game birds after 1877.
1883-1887	Aug 15	Jan 1	none	none	Unlawful to destroy nests or take eggs after 1883.
1887-1896	Aug 15	Nov 15	none	none	
1897-1900	Aug 15	Dec 15	20	none	First bag limit established in 1897.
1901-1902	Sep 1	Dec 15	20	none	First license required to take game birds - $15 (nonresidents only).
1903-1904	Aug 15	Dec 1	20	none	
1905-1908	Sep 1	Dec 1	10	none	First resident license required - $1. Only 1 license per family required. Bag limit reduced.
1909-1914	Oct 1	Nov 1	5	none	
1915-1916	Sep 1	Oct 1	5	none	Open: Valley, Rosebud, Fallon, Custer, Dawson, Richland, Sheridan, Phillips, Big Horn, Prairie.
	Sep 15	Oct 15	5	none	Other portions of State.
1917-1918	Sep 15	Oct 1	5	5	License fee raised from $1 - $1.50 in 1917.
1919-1920	Sep 15	Oct 1	5	5	
1921	Oct 1	Oct 7	5	5	Fish and Game Comm. granted power by 1921 Legislature to open or close any county or portion at request of residents of the area.
1922	Oct 1	Oct 15	5	5	
1923-1925	Sep 15	Sep 24	5	5	
1926	Aug 1	Aug 5	5	5	Commission granted power to advance sage grouse season, in counties requesting this before July 1 of each year.

Appendix Table 4. **Continued.**

Year	Opening Date	Closing Date	Bag Limit	Possession Limit	Special Regulations
1927	Closed season on all upland game birds				
1928	Sep 16	Sep 25	5	5	
1929	Aug 17	Aug 21	5	5	
1930	Aug 3	Aug 5	5	5	
1931	Aug 16	Aug 18	5	5	Fergus and Petroleum Counties only
1932	Sep 18	Sep 20	5	5	
1933	Aug 26	Aug 28	5	5	
1934	Aug 5	Aug 7	5	5	
1935	Aug 4	Aug 6	5	5	
1936	Sage grouse season closed statewide because of severe drought				
1937	Sage grouse season closed statewide because of severe drought				

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