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Lynn A. Griner
Utah State University

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**A STUDY OF THE SAGE GROUSE (CENTROCERCUS UROPHASIANUS),
WITH SPECIAL REFERENCE TO LIFE HISTORY, HABITAT
REQUIREMENTS, AND NUMBERS AND DISTRIBUTION**

by

Lynn A. Griner

Lynn A. Griner

A thesis submitted in partial fulfillment of the requirements
for the degree of
Master of Science
in

School of Forestry

A thesis submitted in partial fulfillment of the requirements

for the degree of

Master of Science

Utah State Agricultural College

in

1939

School of Forestry

Approved:

Major Professor

For English Department

Dean of the School

Utah State Agricultural College

1939

Chairman of Committee on Graduate Work

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The author wishes to acknowledge the assistance of Dr. D. I. Rasmussen, who supervised this study; of Lee Kay, Educational Director for the Utah State Fish and Game Department, for his help in collecting field material and for the pictures that he furnished; and of Dr. Clarence Cottam, in charge of the Food Habits Division of the United States Biological Survey, under whose direction analysis and identification of the sage grouse foods were made.

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Acknowledgment is also due many other people, notably wardens of the Utah State Fish and Game Department, for their assistance in answering queries, both personal and in questionnaire form.

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have been proposing that something be done for this game species. In recent years along with this interest of the conservationists, there has been an increasing local interest among the sportsmen of the West, with the result that several groups have become interested in making a study of the sage grouse and determining reasons for the marked decline in its numbers. Partly because of this aroused interest, the study of the sage grouse was selected as a research project.

The only detailed previous study that has been made of the sage grouse was conducted by Olver, in 1934, in Wyoming (6).

The study conducted with in this thesis was financed by the Utah Cooperative Wildlife Research Unit, which is located at Logan, Utah, and was under the direction of Dr. D. I. Hammeken. The cooperating agencies are the United States Biological Survey, the Utah State Fish and Game Department, the American Wildlife Institute, and the Utah State Agricultural College.

This study was made over a 2-year period, from May 1934 to May 1936. During 3½ summer months (in June, July, August, and September) of each year, residence was maintained in the field, where field observations were made. In addition to the summer residence in the field, numerous and lengthy field trips were made during all seasons of the year.

INTRODUCTION

The sage grouse or sage hen Centrocercus urophasianus (Bonaparte) was formerly the most important upland native game bird of the Western States, but has steadily been declining in numbers over most of its range in recent years. This reduction in numbers has aroused the interest of the conservationists of the nation, who, for the past decade or more, have been proposing that something be done for this game species. In recent years along with this interest of the conservationists, there has been an increasing local interest among the sportsmen of the West, with the result that several groups have become interested in making a study of the sage grouse and determining reasons for the marked decline in its numbers. Partly because of this aroused interest, the study of the sage grouse was selected as a research project.

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The purposes of this investigation were: (1) to obtain life history data on the sage grouse; (2) to study the environmental factors influencing the distribution and numbers of the sage grouse; (3) to attempt to outline a plan of management, which may stabilize the sage grouse numbers on areas where they are now present, and which may possibly restock areas where they once occurred.

The material contained in this paper was collected from 4 sources, namely: (1) direct field observations and studies; (2) personal interviews with people acquainted with the areas where sage grouse have been found or are now present; (3) use of a questionnaire, which was distributed to interested persons throughout most of the present sage grouse range; and (4) a review of the available literature pertaining to the sage grouse.

Intensive field observations were made in Strawberry Valley and adjacent areas in east central Utah. In addition, observations were made at the following localities: Portage and Penrose in Box Elder County, Avon and vicinity in Cache County, Croydon and adjacent areas in Morgan County, Randolph and vicinity in Rich County, Forshay range and Parker Mountain in Piute and Garfield Counties in Utah; areas in southeastern Idaho near Soda Springs, Montpelier, Paris, and St. Charles; and areas in southwestern Wyoming near Evanston.

While in the field, observations on the following activities of the grouse and range conditions were stressed: nesting, food habits, dusting, watering, roosting, and resting; type of range chosen; types of range most used by the sage grouse; cover types and their effectiveness as nesting cover; water and its distribution; use of the range by the various classes of stock and their relationship to the sage grouse;

predatory and buffer species inhabiting the sage range; and the effects of winter snow on the range and the distribution of the sage grouse.

Notes on nesting activities were recorded on an especially prepared form (fig. 5). Mortality and information relative to stomachs collected were also kept on form sheets. All other field information was recorded as general notes in the form of a daily diary, or was written up as special reports or memorandums.

While visiting the sage grouse areas of Utah, Idaho, and Wyoming, interviews were had with persons who were well acquainted with and well informed about those particular localities. The purposes of these interviews were to obtain information, both historical and present, pertaining to the sage grouse in those areas, and to obtain information from the people as to the causes of the decreases or increases in the sage grouse numbers, as the local case might be. These interviews showed a variety of ideas, which have been very interesting as well as valuable to this study.

For the questionnaire survey, which was conducted during the winter and early spring of 1936-37, 5,000 survey cards (plate 1) were distributed to district agents of the Biological Survey, to county agricultural agents throughout the entire present range of the sage grouse, to high school biology teachers of Utah, and to Boy Scouts of parts of Idaho and Utah. In addition, cards and maps of all Utah counties were sent to the game wardens and to the County Fish and Game Protective Associations throughout Utah. The purpose of this survey was to determine the extent of the present sage grouse range and to obtain an indication to their present numbers. Approximately 500 cards were returned, plus all of the Utah county maps, with sage grouse distributions mapped on them.

RANGE AND DISTRIBUTION

United States Department of Agriculture
Bureau of Biological Survey
Logan, Utah.

Penalty for private use to avoid
payment of postage \$300

Official Business

U. S. BUREAU OF BIOLOGICAL SURVEY,
Cooperative Wildlife Research Station,
Utah State Agricultural College,
Logan, Utah.

Attention
D. I. RASMUSSEN

SAGE GROUSE DISTRIBUTION RECORD

Use a card for observations in one locality, use several cards if necessary.

Write in or underscore the word or words that makes the best answer.
Have you seen any Sage Grouse, (also called sage hen, sage chicken), in your
part of the state?-----YES or NO.

If so how far and in what direction from what town were these sage hens
found? -----

In what years were they seen?----- Month-----

In what year were they last seen?----- If at the present time there are
sage hens, are they MORE, or EQUALLY, or LESS, numerous in 193⁷, than
they were in 193⁶?

The range where sage hens are is--UNUSED, or USED by SHEEP, GOATS,
HORSES, CATTLE, or TURKEYS? At the present time the sage hens
in this area are VERY SCARCE, SCARCE, FAIRLY NUMEROUS, ABUND-
ANT, VERY ABUNDANT?

What is your estimate of the number of sage hens in this area?-----

What is your estimate of the size of this area in square miles or sections.-----

Name----- Address-----

When card is filled out, drop in the mail, no postage is required.

Plate 1. Questionnaire cards used in making the sage
grouse distribution study

RANGE AND DISTRIBUTION

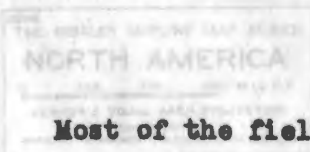
Native. The range of the sage grouse is limited to the arid plains of the Northwestern States and the southwestern Provinces, where the sagebrush (*Artemisia tridentata* and other species) grows; hence it is well named sage grouse or cock of the plains. Its range stops where the sagebrush is replaced by greasewood in the more southern deserts. Like the prong-horned antelope, another child of the arid plains, it has disappeared from much of its former range, as the country became more thickly settled.... It has been said that the sage was made for this grouse and this grouse for the sage, where it is thoroughly at home, and where its colors match its surroundings so well that it is nearly invisible while squatting among the lights and shades of the desert vegetation. It seldom wanders far from the sagebrush.

The full range apparently extended north to (casually) the interior of southern British Columbia (Osoyoos Lake); southern Saskatchewan (casually Skull Creek, Val Marie, and casually Pinto Creek); North Dakota (Marmarth, Deep Creek, and formerly Fort Berthold); and formerly northeastern South Dakota (Grand River Agency and Fort Sisseton). East to South Dakota (formerly Fort Sisseton, Indian Creek, formerly Rapid City, and formerly Sage Creek); northwestern Nebraska (Antelope Creek); southeastern Wyoming (Marshall, Arlington, and Cheyenne); Colorado (Walden, Kremmling, Dillon, Lone Cone, and Dolores); and formerly northern New Mexico (Tres Piedras). South to formerly New Mexico (Tres Piedras and Tierra Amarilla); southern Utah (Grass Valley and Hamblin); Nevada (Belmont and Queen); and eastern California (Big Pine and the headwaters of the Owens River). West to eastern California (the headwaters of the Owens River, Long Valley, Ravendale, Madeline Plains, Eagleville, and Tule Lake); Oregon (Klamath Falls, Silver Lake, Fort Rock, Silvies River, Turtle Cove, and Haines); Washington (Battlesnake Mountain Yakima and Ellensburg); and (casually) the interior of southern British Columbia (Osoyoos Lake) (2). (See plate 2).

With the exception that there has been a general shrinkage in the sage grouse range, the present general distribution (1937-38) is similar to the original distribution. In total numbers the present population is, however, only a fraction of former numbers. They were formerly reported as game birds in 13 states and Canada, being the leading game bird in 9 of these. During the 1937 season a regular open season was had only in Montana. A greatly restricted season was inaugurated in

Idaho, and closed seasons were inaugurated in Wyoming and Nevada. Previously all other states containing sage grouse had had closed seasons. They now occur naturally in only 10 states and Canada, namely: Utah, Idaho, Wyoming, Montana, Colorado, Nevada, California, Oregon, Washington, and South Dakota, and have been re-introduced into New Mexico. (See page 104.)

The questionnaire survey indicates that the sage grouse in Utah are now mainly restricted to the higher benchlands and mountain areas of the state. Most of the birds reported were inhabiting either the upper benchland or mountain range lands, such as those along the Wasatch, Uintah, and LaSal Mountains. There appears to have been a gradual shrinkage not only in numbers of birds, but also in suitable range. The Utah questionnaire also shows that 34.86 percent of those people answering think that the sage grouse are decreasing, while 27.6 percent think that they are holding their own, and 18.7 percent say that they increased in 1937 over 1936 (table 1). The accompanying maps (plates 3 and 4) will show the distribution of the sage grouse in Utah and Idaho and their former native distribution. These maps show that the majority of the sage grouse flocks reported are distributed near the boundaries of the national forests either within the forests or just outside. In most cases these areas are the foothills or benchlands, and the vegetation consists primarily of sagebrush.



DESCRIPTION OF THE AREA

Most of the field work for this sage grouse study was made in the Strawberry Valley, Wasatch County, located south of the Uintah Mountains and east of the Wasatch Mountains. The valley is approximately 14 miles

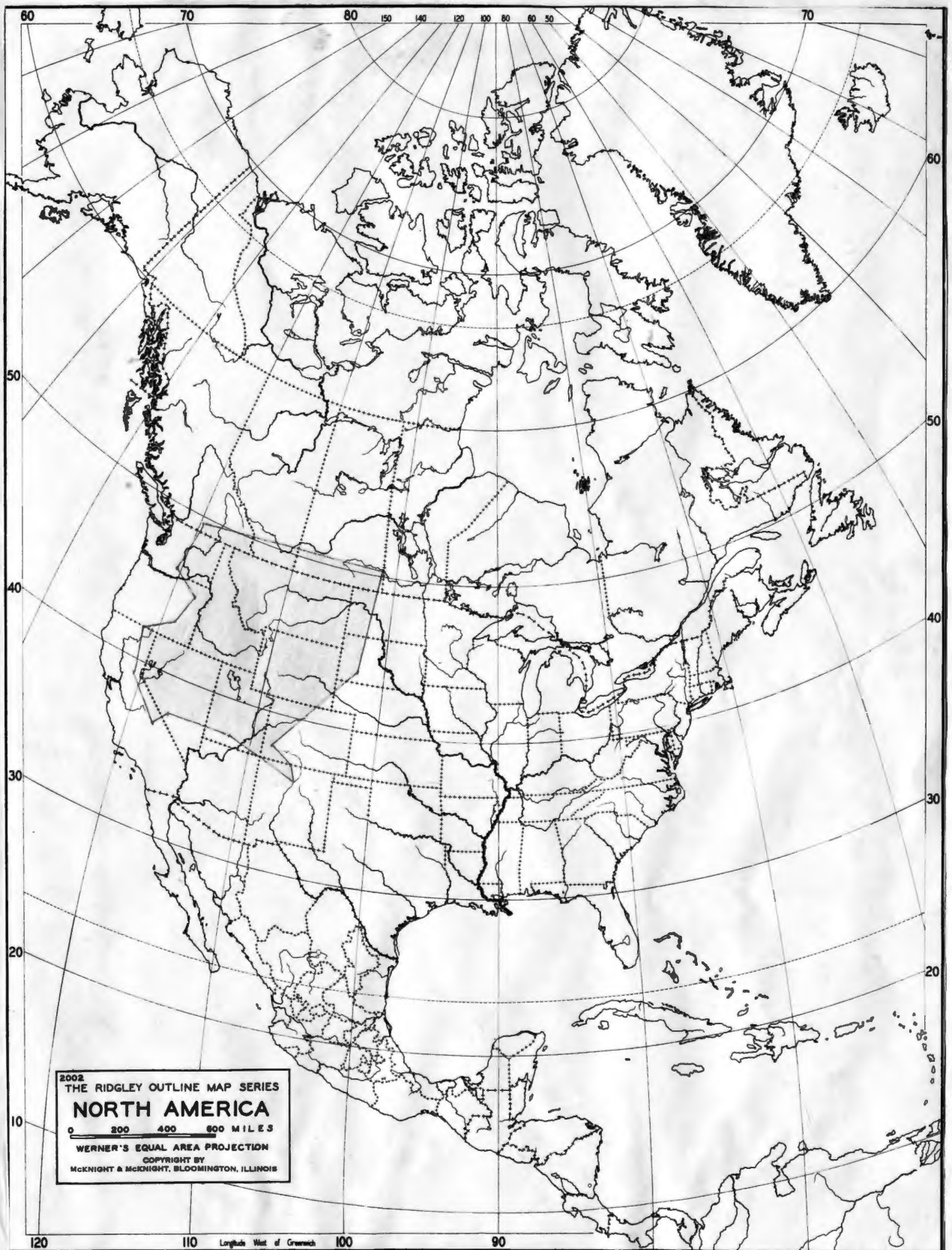


Plate 2. Native distribution of the sage grouse (2)

Table 1. Relative status of the sage grouse in Utah and Idaho for 1936-37, according to public opinion, as obtained from the questionnaire survey

Types of answers received in questionnaires	Utah (1)		Idaho (2)	
	No.	%	No.	%
Estimate that there were more in 1936 than 1937	49	18.7	3	2.4
Say that there were less in 1936 than 1937	91	34.86	78	64.6
Say that there are the same number	72	27.6	28	23.13
Do not know	46	17.62	12	9.91
Same or more	3	1.1	0	0

- (1) Utah based on 261 reports
(2) Idaho based on 121 reports

Plate 3a Sage grouse distribution in Utah. (See legend
page 11.)

SAGE GROUSE DISTRIBUTION IN UTAH

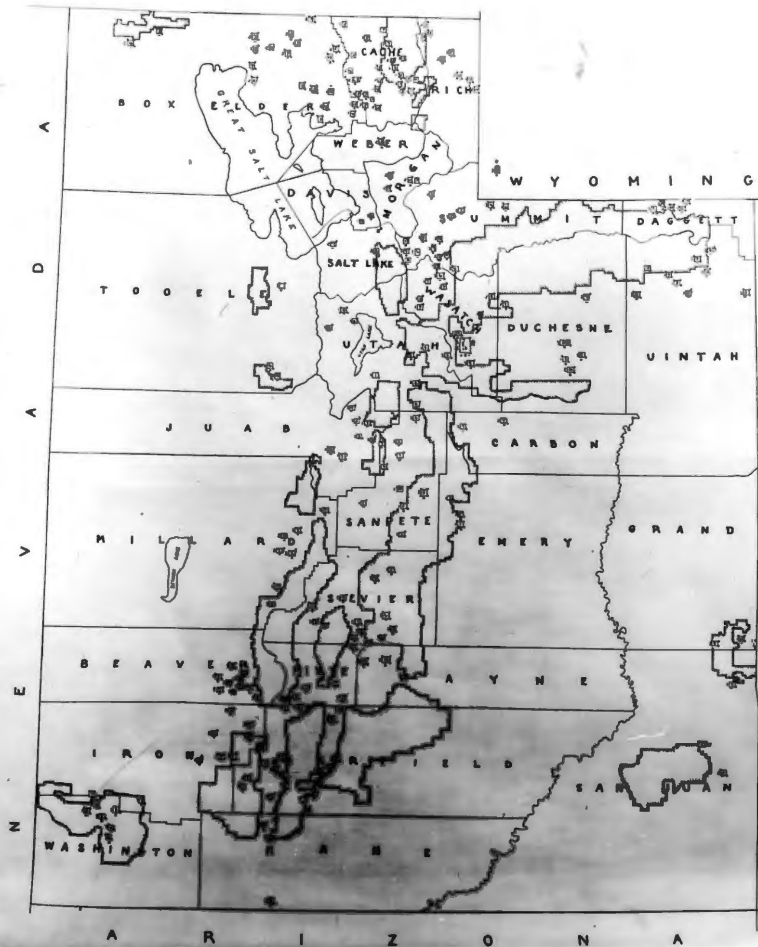


Plate 3. Sage grouse distribution in Utah. (See legend on p. 11.)

Plate 4. Sage grouse distribution in Idaho. (See legend on p. 11.)

Legend for Maps of Snake and Idaho Sage Grouse Distribution

SAGE GROUSE DISTRIBUTION IN IDAHO

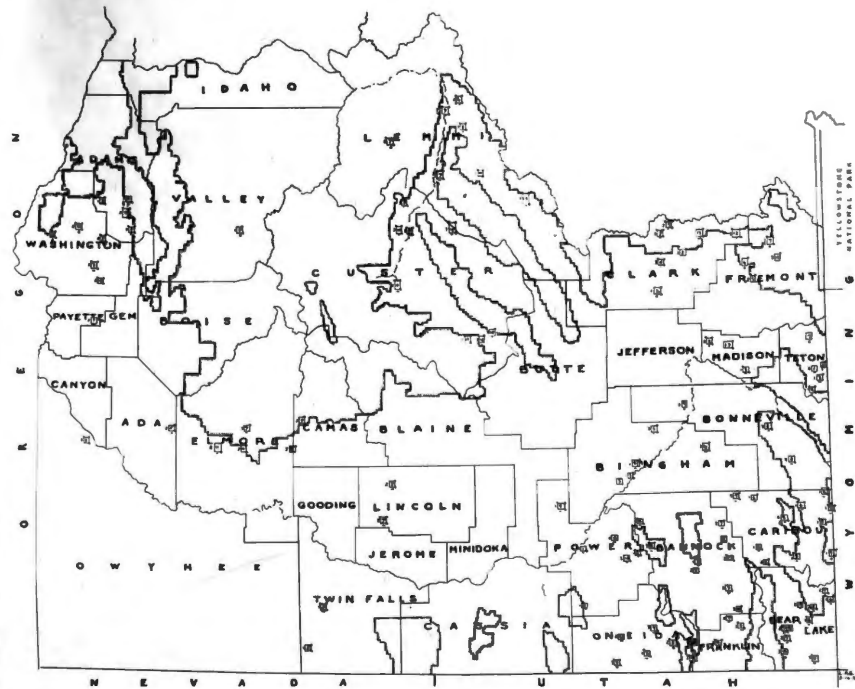


Plate 4. Sage grouse distribution in Idaho. (See legend on p. 11.)

long and 6 miles wide and has an elevation of from 7,500 to 8,000 feet. Some 60,000 acres within the valley were under observation during this study.

Legend for Maps of Utah and Idaho Sage Grouse Distribution

The Strawberry Valley is one of the few areas in the state of Utah

Size Classes of Flocks

1. 0 to 10 ☐ Range used by sheep
2. 11 to 19 ☐ Range used by cattle
3. 20 to 33 ☐ Range used by horses
4. 34 to 59 ☐ Range used by goats
5. 60 to 100 ☒ Farm lands
6. 101 to 190 ☐ Common use of range
7. 191 to 330 ☐ Birds are very scarce
8. 331 to 590 ☐ " " fairly abundant
9. 591 to 1,000 ☐ " " abundant
10. 1,001 to 1,900 ☐ " " very abundant
11. 1,901 to 3,300 ☐ One flock of sage grouse
12. 3,301 to 5,900
13. Size of flock unknown

☒ Size classes as given above

☐ More sage grouse in 1936 than in 1935

☐ Less sage grouse in 1936 than in 1935

☐ About the same number of sage grouse in both years

☐ Two estimates for the same flock of birds

long and 6 miles wide and has an elevation of from 7,550 to 9,000 feet. Some 50,560 acres within the valley were under observation during this study.

The Strawberry Valley is one of the few areas in the state of Utah where the present range is believed to approach in condition that of the native range of 30 or 40 years ago.

Reminiscences of old-time cowboys, herders, and freighters of this area draw a vivid picture of the past glories of the valley. In an interview Mr. Joe J. Madsen, of the State Fish and Game Department, recalled the times (during the early 1890's) when he and his brothers made trips through the valley. He stated: "At times the grasses would be as high as our wagon beds, and stock grazing in the meadows could be completely hidden from view by the luxuriant growth of meadow plants and grasses."

In 1912-13, as a United States Reclamation project for the Payson Water Users' Association, a dam was constructed across the Strawberry River at the head of the narrows, creating a large reservoir that varies in size from about 4,000 to 7,000 acres.

The valley is surrounded on all sides by the higher peaks of the mountains. These mountains are covered with aspen and conifers, with the aspen and a few conifers extending down to an elevation of about 7,700 feet. To the east of the valley, following the natural drainage of the river, is a lower sagebrush range, which extends east nearly to Colorado. It is to this lower range that the sage grouse migrate when the snow becomes too deep in the valley and the available food is covered over.

72773

There is a very adequate water supply throughout the valley in the form of seeps, springs, mountain creeks, a river, and a reservoir. It would be hard to find any spot within this sage grouse range that is over 800 yards from water.

✓ There is an abundance of native meadow broad-leaved plants, grasses, willows, and sagebrush. All of these play an important part in the daily activities and life of the sage grouse. A detailed description of the plant cover of the study area is contained in the discussion of nesting cover.

It is estimated that there were approximately 3,500 sage grouse in this area in 1937, which was probably a slight increase over the number there in 1936.

DESCRIPTION OF THE BIRD

The sage grouse is a true grouse, by far the largest of our American species, and is the largest in the world except for the European capercaillie, which far exceeds it in size. The sage grouse differs in many ways from the prairie chicken and ranges farther westward, making its home wherever the sagebrush grows in sufficient density to afford it food and shelter (2).

The sage grouse (Centrocercus urophasianus), commonly known as the sage hen, and referred to as such by the American Ornithologists' Union, was discovered by Lewis and Clark about the headwaters of the Missouri River and on the plains of the Columbia River. They named it the "cock of the plains" and gave the first account of it. The technical description of it and the scientific name, urophasianus, were supplied by Bonaparte in 1827 (2).

Adult Male. The bill of the adult male is short and black, and the area immediately bordering the lores is densely feathered with short, buffy, gray-tipped, black feathers. The iris of the eye is brown, and the pupil a shiny black. Above each eye is a small orange-colored superciliary membrane or tissue. The crown is a mixture of black, gray, and tan; a white superciliary line extends from in front of the eye back to the ear opening. The ear coverts are of gray and brown filoplume feathers. The backs of the head and nape are gray, with an occasional line of black or tan. The black and white blotched chin is separated from the throat by a narrow white collar, extending from the eye down under the head. The upper throat is covered with gray and white-tipped, black feathers, which increase in size as they extend down the neck. The sides of the neck are gray and white-trimmed, with long filoplume feathers which are white at the base; the distal half is very narrow and black, with an occasional small white tip. On the foreneck are some loose rolls of skin, which function as air sacks or pouches, covered with short, stiff, scale-like, white feathers. These specialized feathers surround 2 olive-colored bare spots, 1 on each side of the throat. The breast feathers are white with a black rachis and a black tip. As these feathers extend down the breast toward the abdomen, they become larger, and the amount of black on the tip increases, until, when the abdomen is reached, they appear to be solid black. The abdomen is black in appearance; however, the basal portion of these feathers is white or gray. The back and sides are black, marked with bars and spots of white, gray, tan, and brown. The rachis and central line of the side and flank feathers are white. The wings are grayish-brown, with a slight mottling of tannish-gray. The primaries are solid grayish-brown. The under surface of the

wings are white. The legs and tarsi are densely covered with soft, down-like, gray feathers, which extend down to the toes. The toes are black, and on each side are small narrow scales, which act as snow webs during the winter. The upper tail feathers are black and gray, blotched with light shades of brown. The tail feathers are pointed in the nuptial, as well as at all other times. The number of tail feathers in the males that appeared to have a complete plumage, varied from 18 to 21. The under-tail coverts are glossy black, tipped with pure white round spots. The tail, when in natural position, tapers to the distal end.

Regarding the stiff upper breast feathers, Major Allan Brooks says that the feathers of the breast and neck of the male sage grouse are specialized feathers only and are not worn away by rubbing on the ground during the display while strutting (2). Some other observers say that these feathers are worn down to the scale-like appearance by dragging them on the ground or rubbing them against the wings during the strutting period.

Two male sage grouse were collected in Strawberry Valley on January 26, 1937, before the strutting activities began. The white breast feathers on these 2 birds were practically the same as they were on birds later in the spring, which indicates that they do not become materially shortened and stiff from rubbing them against their wings or against the ground, but are in reality a specialized feather.

Adult Female. The adult female is similar to the male, but is smaller and more drab in appearance. The abdomen is not as solid black in appearance as is that of the male. The abdomen feathers are at times edged in white. The breast is white, with blotches of tan, gray, and black. The female does not have air pouches nor the specialized white feathers

on the foreneck. The filoplume feathers on the sides of the neck are also lacking. The back, rump, flanks, and tail are lighter in color, with more gray and tan markings and less black. The tail feathers are much shorter and somewhat lighter than are those of the males.

Juveniles. The natal plumage, or down, is a mottled grayish-black. The juvenile is similar to the adult females; however, the breast feathers of the juveniles are lighter in color, there being more brown, and less black. The entire plumage of the juveniles has more tan, gray, and brown, and less white and black than has that of the adult female.

Size. The males will vary in size from 26 to 30 inches in length and from 4 to 8 pounds in weight. The females are somewhat smaller, measuring 19 to 23 inches in length, and weighing from 3 to 5 pounds (1).

Table 2. Weights and measurements of 4 sage grouse collected in Strawberry Valley during the winter of 1937-38

		Weight (lbs.)	Length (in.)
Adult females	1*	2.5	19
	2	2.6	22.25
Adult males	1	5.17	27
	2	5.3	27.8

* Believed to have been hatched in 1937.

Table 3. Strutting activities, showing the dates that strutting activities began and ended

Morning					
Year	Area	Start	Reported by	End	Reported by
1936	Strawberry, Utah	4/15	Lee Kay and road crew	5/18	Author
1936	Parson, Wyoming	1/6	Elgin Bone to A. S. Hamm		
			U.S.B.S.		
1937	Strawberry	4/15	Lee Kay and road crew	5/22	Author
Evening					
1936	Strawberry	4/15	Lee Kay and road crew	5/14	Author
1937	Strawberry	4/15	"	5/22	Author

Mating. The first signs of strutting by the male sage grouse in Strawberry Valley, reported to the author, was on April 15, 1936. Reports for 1937 seem to indicate that strutting began at about the same time. The earliest observation of the strutting of the sage grouse came from Adolph S. Hamm, District Agent of the United States Biological Survey, in Wyoming, who, in a personal letter said: "On January 6, 1936, one of our hunters, Elgin Bone, at Farson, observed about 200 sage chickens, cocks and hens mixed. He says the cocks were strutting their stuff. I do not know what the temperature was that particular day, but for several nights following the temperature was 40 below."

The author's first visit to Strawberry Valley was on the morning of May 4, 1936, at which time notes on the strutting activities were first taken. In 1936 the males continued to strut until May 16, and in 1937, until May 23. Practically all the evening strutting had stopped by May 14 in 1936, and by May 22 in 1937 (table 3).

The strutting activities begin sometime before daybreak, but the exact time is not known. The males were often heard strutting before it was light enough to see them. At, or before, 4:00 a.m., the males would be strutting. Strutting activities would continue until 8:30 or 9:00 a.m. The amount of time spent in strutting (and the lateness in the day) seem to depend upon the light intensity, weather conditions, and whether or not they are disturbed. The morning of May 4, 1936, was cold and hazy, and the sage grouse continued to strut until 8:30 a.m. The strutting activities are resumed in the evening about 5:00 or 5:30 p.m. and continue until the sun sets.

The male, in preparing for his display, starts from a standing position. He fans his tail into an arc of nearly 180 degrees, with the long,

pointed tail feathers radiated out. The white-tipped, black, undertail feathers are also erected, making a beautiful black and white fan, backed with the mottled, gray-brown tail feathers. (Above each eye may be seen a yellowish-orange superciliary tissue. This tissue fades to an olive green after the strutting season is over.) The next move is to raise and spread the wings, with the elbow joint pointed forward, and upward; the primary feathers of the wings are pointed down, and at times the tips may come in contact with the ground or sagebrush. The head is raised up and backwards, showing the large fronted breast pouches, which until they are inflated hang in folds. The cock in this performing position looks much like a strutting tom turkey.

His next movement is to lower his head and walk a few steps forward. He will then raise his head, inhaling air, the presence of which can readily be noticed in the air sacs. This action is repeated several times until the sacs are distended. When they are distended in this manner, 2 yellowish-olive spots may be seen, one on either side of the neck and about in the middle of the air pouches. The cock in his full-dress parading regalia struts around among the other birds, making a slight tsk, tsk, tsk, noise. This noise may be caused by the short stiff breast feathers rubbing against his partially-raised wings. After a few such strutting steps, the head is lowered, and then brought back into position, and a slight nod is then made. Following this nod the head is again lowered and extended and then quickly withdrawn upward and slightly forward. When the head is withdrawn the third time, the air pouches are quickly thrown upward and forward, making a plopping noise, similar to that made when a soft piece of leather is quickly drawn tight. This strutting is repeated over and over again until the birds are disturbed,

or until they quit of their own accord. The cocks move about slowly while strutting, except when another male comes too close. Then one may chase the other away, running after him, while still in strutting display, except that the head and neck may be extended a bit forward; or, if both birds are in a fighting mood, they may fight for a few seconds.

The male sage grouse apparently do not establish strutting territories. On 1 small strutting area under observation the number of birds using the area varied daily. For example, on May 11, 1936, there were 6 males strutting on this area, while on the following morning, May 12, 1936, there were 14 males using the same area.

While the males are strutting and parading about, the few females which may be on the parade ground feed about on the sage and meadow plants, paying little or no attention to the pompous males. The females seem very calm and go about their feeding as if nothing were happening. When a male approaches a female, she quickly runs a few yards away from him. The males have often been observed chasing a female for 20 or 25 yards.

This strutting of the sage grouse is probably a means of attracting attention and not a necessary part of the actual mating. Similar displays are found among domestic poultry, and other wild fowls, for example, the strutting of the turkey, crowing of the domestic chicken and pheasant, and the drumming of the ruffed grouse. These performances are coincident with the activities of the gonads, but do not last as long as the active period of the gonads. It is possible, then, that mating is not restricted to the period of strutting, but may take place either before the strutting activity begins or after strutting has ceased. In domestic fowls the males will continue to mate with a hen that is ready to, or is producing

eggs, even after he has stopped making his sexual displays. This is probably also true of wild fowls.

Only once during this study was a female observed to remain in place as a strutting male made advance to her. This was on the morning of May 10, 1936. Quoting from the author's field diary notes: "This morning while watching the sage grouse strut, I saw a male grouse strut up to a feeding female, slowly walk around her, and then give a few quick beats of his wings, and he was mounted on her. She held perfectly still while he covered her. After remaining on her for just about one minute he fluttered off. While he was covering her their tails were held tightly together, and he seemed to hold her by spreading his wings around her. After he was once on he did not seem to hold or peck her on the head with his beak. When he dismounted he flapped his wings and then went back to strutting; the female resumed her feeding activities." This observation is of special interest, as it is probably the first and only report of this type that has been recorded.

After spending some 10 to 12 mornings and evenings watching the sage grouse strut, the author is of the opinion that their mating habits would be classed as promiscuous. The number of males seen on a strutting area varied to some extent, but during the season was rather constant. However, the number of females seen on the strutting grounds varied from day to day, and was never constant. From the account given of the only actual mating which was seen, it will be recalled that after serving the hen, the cock continued to strut among the other males.

Following the mating activities the males gather in bunches of from 10 to 30 birds in the aspen-bordered sagebrush areas along the ridge top.

The males continue to use these areas until the latter part of the summer, thus leaving the females to the task of nesting and rearing the young.

In domestic fowls breeding takes place when the female is ready to start laying. Fertile eggs have been produced as soon as 20 hours after mating, while others have been produced 30 days after mating has taken place. In poultry husbandry 3 weeks is generally considered the life of the spermatozoa cells within the oviducts of the female after mating; however, it is generally found that domestic poultry will mate about every 4 or 5 days during the egg-laying period.*

These facts are probably true in wild fowls as well as domestic fowls, although this investigation offers no direct evidence to support the theory.

Nesting Activity. It is believed, from this study, that some of the hens begin making their nests before other females have mated, as several nests with eggs were located before the strutting activities had ceased, and, in other cases, eggs were being added to nests after all strutting had stopped. For example, nest number 3 had a complete clutch on May 15, 1936, while the hen at nest number 35 was still laying eggs on June 13, 1936.

During the 2 years of this investigation observations were made on 161 sage grouse nests. During 1936 notes on nests located were recorded in a daily diary; however, in 1937, a nesting study form was prepared (plate 5), which aided in making a more uniform set of observations. The compilations of the data on nests appear in table 4. Nests found

* Information obtained from Professors Alder and Frischknecht, Utah State Agricultural College, Poultry Department.

NESTING STUDY RECORD

Date _____, Species _____

General Locality _____

Nest No. _____ Nest location _____

No. eggs first seen _____

Are they being incubated? YES NO. Total No. of
eggs present. _____.

Distance from water _____ Yds. Slope N E S W N

Flushing dist. _____ yds. Percent of slope _____

Cover type where nest is located.

Salt grass	Grass	Browse
Scirpus	Meadow	Willows
Typha	Woods	Aspen
Pigwood	Cultivation	Conifers

Sagebrush _____

Nest composed of: _____

Bare	Sticks	Reeds
Leaves	Twigs	Feathers
Dry grass	Litter	_____

Nest construction is, GOOD FAIR POOR.

Nest protection, GOOD FAIR POOR.

Nest OK DESERTED DESTROYED HATCHED

Are eggs covered? YES NO. If so, with what? _____

Remarks _____

Observer _____

RETURN VISITS TO NEST. No. _____

Date _____ Time _____

Progress of nest. No. of eggs. _____

Hen on nest? YES, NO. Nest is, OK, DESERTED, DESTROYED.

If destroyed what was cause? SHEEP COYOTE SKUNK
WEASEL RAVEN SEAGULL CAT _____

Remarks _____

Date _____ Time _____ . Progress. No. of eggs _____

Was hen on nest? YES NO. Nest is OK, DESERTED

DESTROYED. If nest is destroyed, what cause? SHEEP
COYOTE SKUNK WEASEL RAVEN HAWK SEAGULL
CAT. _____

Remarks _____

Date _____ Time _____ . Progress, No. of eggs _____

Was hen on nest? YES NO. Nest is OK DESERTED

DESTROYED. If nest is destroyed, what was cause?
SHEEP COYOTE SKUNK WEASEL RAVEN HAWK
SEAGULL CAT. _____

Remarks _____

Hatching date _____ Time _____

Incubation period _____ days

Number of eggs:-

Hatched _____ Per cent _____

Fertile eggs _____ Per cent _____

Infertile _____ Per cent _____

Time hen and brood left nest _____

Length of time chicks spent in nest _____

during 1938--are given a number, and a flagged stake, consisting of an ordinary lath, with the corresponding number, was driven into the ground 3 to 5 yards north of the nest. This system made it possible to re-locate the nests more readily and provided a means of definite identification. Motion and still pictures were taken of several nests, showing activities of birds on and near the nest. These pictures permitted a more intensive study, as they showed the small details that might otherwise have been overlooked.

Table 4. Summary of nesting

Nests hatched		Nests destroyed		Nests deserted		Total nest mortality	
No.	%	No.	%	No.	%	No.	%
97	60.25	41	25.46	23	14.29	64	39.75

is usually later in the higher parts of the sage grouse range than at lower levels.

On June 4, 1936, on the Fager property in the mountains northwest

	No. of eggs	Brood size	Distance to water	Flushing distance	Degrees of slope	No. eggs hatched	Eggs deserted or destroyed	In-fertile
Max.	9	9	880 yds.	30 ft.	45	619	300	34
Min.	1	1	1 yd.	0.5 ft.	0			
Avg.	6.8	6.72	155 yds.	5.7 ft.	4.5			

Allowing 25 days for incubation, 5 days for egg-laying, and 5 days for nest preparation, making a total of 35 days, would mean that the nesting activities of this hen began sometime near April 30. The season in which the broods had been hatched out for some time would indicate that the nesting activities around Fortage, Utah, began sometime between April 15 and April 25 in 1936.

during 1937 were given a number, and a flagged stake, consisting of an ordinary lath, with the corresponding number, was driven into the ground 2 to 3 yards north of the nest. This system made it possible to re-locate the nests more readily and provided a means of definite identification. Motion and still pictures were taken of several nests, showing activities of birds on and near the nest. These pictures permitted a more intensive study, as they showed the small details that might otherwise have been overlooked.

The beginning of nesting is believed to be subject to variations, depending upon weather conditions and soil temperatures, which in turn influence food supplies and breeding activities. Differences in altitude are known to be associated with differences in nesting dates, for nesting is usually later in the higher parts of the sage grouse range than at lower levels.

On June 4, 1936, on the Facer property in the mountains northwest of Portage, Utah, at an altitude of approximately 4,500 feet, a sage grouse nest was found in which the 3 eggs were beginning to hatch. A nearby sheepherder gave the information that there were originally 7 eggs in the nest before the hen had been disturbed by sheep and dogs. He also stated that he had seen several broods of very young chicks during the past week in the surrounding territory.

Allowing 22 days for incubation, 8 days for egg-laying, and 5 days for nest preparation, making a total of 35 days, would mean that the nesting activities of this hen began sometime near April 30. The cases in which the broods had been hatched out for some time would indicate that the nesting activities around Portage, Utah, began sometime between April 15 and April 20 in 1936.

The earliest hatching date recorded during this study was on May 21, 1938. This nest was located near Paradise, Utah, at an elevation of approximately 4,700 feet. This would also indicate that the nesting activity began about April 15, 1938.

A nest of 8 eggs was found in a winter wheat field under a cover of Russian thistle (Salsola pestifer) on May 11, 1936, at Holbrook, Idaho.

In 1936 in Strawberry Valley the nesting activities began about the first of May, as several nests were found between the twelfth and sixteenth of May, with clutches of from 4 to 8 eggs. Nest number 18 (plate 6), which was first located on the fifteenth of May with the hen on the nest, had a clutch of 8 eggs, which were being incubated. Other nests were found to be completely hatched out by the eighth of June. The nesting activities in 1937 probably began at about the same time, since 46 nests, some with complete clutches, were found on May 22 and 23.

The nesting period in 1936 and 1937 extended into the first 2 weeks of July. The last hatching of which there is a definite record was on July 5, 1936; however, reports from reliable sources state that on July 7, 1936, a brood of 3 chicks, which were not over a day old, was seen. Other reports of newly-hatched chicks were received as late as July 16, 1936.

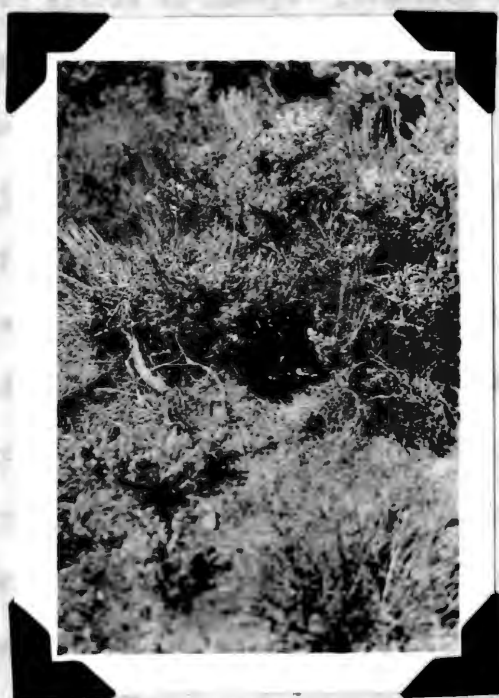
Nests. All nests observed were located on the ground, usually under a sheltering sagebrush, in a slight depression scratched out by the hen. The size of the nest form was generally 8" x 7" x 2". This size was fairly constant, there being very few exceptions. However, the capacity of the nest increases slightly with use. In size and shape, the nest forms greatly resemble those forms made by a hen when taking a dust bath. The hen makes these dust bath forms by loosening and scratching out the



Plate 6. Nest no. 18 showing the hen on her nest



Plate 7. Nest no. 34 with 9 eggs



Plates 8 and 9. Nest no. 59, with the hen on and off the nest. In plate 8 the sagebrush is parted to show the eggs.

soil, and then shaping it by flipping the dirt out with her feet, beak, and wings, as she squats and twists back and forth in the loosened soil. It is possible that nest forms are made in a similar manner. In some cases the hen may have had a few sticks or grass blades; however, the nests are usually made under a sagebrush, where humus material has collected, and little nest lining is added. As egg-laying and incubation progress, the hen loses a few feathers, which accumulate in the nest, so that by the time the chicks are hatched there will be a meager soft protective lining.

Most of the nests are open on all but 1 or 2 sides, depending for their protection upon the overhead covering and upon the coloration of both the eggs and the hen. In all cases examined there were at least 2 sides open, making escape possible in either direction.

The denseness of the cover of these sagebrush nesting sites varied from sparse to heavy. Likewise, the degree of protection varied from very poor, in some instances, to excellent in others, depending, of course, upon the cover type and density. Nest number 18 was located beneath an Artemisia tridentata, 24 inches high, which had a very sparse crown, offering little protection to the hen and her eggs. The pictures of nest 18 (plate 6) illustrate the sparsity of the cover, while nests 19 and 59 illustrate the amount of protection that the sagebrush offers to the nests. The location of nest 12, which is an exception to the general type of nesting sites chosen, illustrates the protection offered by the dense rye grass (Elymus condensatus). Table 4 gives a summary of the nests studied.

The flat, or nearly flat, areas seemed to be preferred for nest location rather than the hill-side areas. Nesting sites, however, varied

from flat areas to sites located on hill-sides with slopes as great as 45 percent. The average percent of slope for 161 nests was 4.5 percent. The direction of the slope had little or no bearing on the choice of nesting sites, as nests were found on all slopes leading into the valley. In all cases where the nests were located on slopes of over 3 percent, the hen and nest would be facing the slope horizontally, and never facing up- or down-hill. The cardinal direction in which the hen faced while on the nest apparently had no significance, as they were seen to be facing in all directions; however, they were always facing toward the best path of escape. The nest openings are as likely to face toward one point of the compass as another, there being no noticeable preference in this respect.

The distance a nest may be from water has been a disputable question among observers. Some believe that they must be within easy flying distance and close enough that the chicks may get to water within a few hours after hatching. This idea of some observers is based on the theory that the young chicks, in order to remain alive, must be able to reach water inside of a few hours after hatching, and that it will take them about 1 hour to go 150 to 200 yards (6). This will be discussed in more detail later. From the 161 nests located and studied during the course of the investigation, the average distance from water was found to be 155 yards. The maximum distance that a nest was found from water was 880 yards, and the minimum distance, 1 yard. In the sage grouse summer range in Strawberry Valley, areas more than 500 yards from fresh water were very limited.

Egg-Laying. Following the completion of the nest, the first egg is deposited and, apparently, each succeeding day an additional egg is

dropped. Observations indicated that each new egg is probably dropped from 1 to 3 hours later each day, and, if this is the case, there may be a break in the continuity of the daily laying activity. Nest number 2 was found on May 12, 1936, containing 5 eggs. At 8:50 the next morning the hen was present on the nest, and at 10:20, when she was flushed, there were 6 eggs. On May 14, she remained on the nest until 1:35 p.m., at which time she flushed and left her nest, which now had 7 eggs. A similar observation was made on a second nest, and these 2 would tend to indicate that it is probably a normal procedure. Stoddard (14) found this to be true with the bobwhite quail; Gorsuch (8) also found this to be true with the gambel quail in Arizona.

The coloration and markings of the eggs act as an excellent camouflage. The ground colors of the eggs vary from olive buff, or tan, to whitish-sage-green. They are generally marked with spots and fine dots of dark brown, or, in cases of eggs with a lighter base, the brown spots will be lighter. (These markings are very easily washed off.) This marking of the eggs enables them to blend in with the grayish brown soil beneath the sagebrush, and the shadows and lights made by the sun's rays increase their protective concealment. The egg shells are smooth, with little gloss, and vary in shape and size. "The measurements of 110 eggs average 55 by 38 mm" (2). Three eggs out of 1 nest measured 55.5 by 40 mm., 55.5 by 40 mm., and 55.5 by 41.5 mm., showing that the egg sizes will vary within the clutch.

The number of eggs to a clutch laid by the sage grouse usually varies from 6 to 9. Bent (2) gives some localities in which 10 to 13, and as high as 17, eggs were found in a nest.

Tables 5 and 6 show the clutch and brood frequency of the nests under observation during the 2-year study. The size of the clutch varied from 1 to 9, with an average of 6.82 eggs (based on 147 nests); and the size of the brood, determined from observations at the time of hatching, also varied from 1 to 9, with an average size of 6.73 (based on 91 nests).

Incubation. As indicated by the separation of sexes, the task of incubation is accomplished by the females alone. During this period, the female leaves the nest for feeding, exercising, resting, and dusting purposes, once or twice each day. These periods are usually at about 8:00 a.m. and 6:00 or 8:00 p.m. On June 12, 1937, at 7:30 p.m., the hen from nest A-20 returned to her nest following her evening activity period. On a few occasions a female was observed leaving the nest during the middle of the day. The resting periods spent away from the nest vary from one-half to 2 hours. As the incubation period progresses, the amount of time spent away from the nest becomes shorter, until, during the last few days, it is doubtful if she leaves the nest at all.

On June 19, 1937, while making a motion picture of a nesting sage grouse, the hen was flushed from nest J-1, and the hen left the nest, but returned again in 5 or 6 minutes. During the afternoon, she was flushed from her nest 4 or 5 times, but each time she returned within 5 to 15 minutes. Upon visiting the nest the next day, it was found to have hatched out.

It is believed that the chicks hatch out between 20 and 22 days after incubation begins. In the field it is difficult to tell just when the last egg was laid and when incubation began. This accounts for the lack of complete information concerning the incubation period. Bent (2) cites

Landis as believing the incubation period to be between 20 and 22 days; Girard (6) and other investigators all indicate that this period is the same.

Pipping is started near the large end of the shell, and, when the chick emerges from the shell, the large end of the egg will break off in

Table 5. Tabulation of clutch size. (Final number of eggs per nest)

Number of eggs	9	8	7	6	5	4	3	2	1	Average	Two-year average
Clutch 1936 frequency (147 nests)	2	13	17	14	1	2	1	0	1	6.7	6.82
1937	6	29	31	22	4	2	1	1	0	6.95	

Table 6. Tabulation of brood size. (Number of chicks hatched per nest)

Number of chicks	9	8	7	6	5	4	3	2	1	Average	Two-year average
Brood 1936 frequency (91 nests)	1	6	14	6	2	0	0	1	0	6.74	6.73
1937	2	16	18	19	3	2	0	0	1	6.72	

Bendire as believing the incubation period to be between 20 and 22 days; Girard (6) and other investigators all indicate that this period is the same.

Pipping is started near the large end of the shell, and, when the chick emerges from the shell, the large end of the egg will break off in a definite circular pattern, leaving an egg cap (plate 12). The presence of these characteristic egg caps in vacated nests indicates that the eggs have hatched and have not been destroyed by predators. The time necessary to break through the shell varies, but is usually from 2 to 6 hours. The following field notes will illustrate this point: "On June 10, 1936, at 9:30 a.m., nest number 19 had begun hatching, five of the eight eggs had hatched, the remaining three were pipping. Two of the hatched chicks were very weak, and unable to support themselves. At 3:30 p.m. the last chick was just emerging from the shell. The hen and chicks remained at the nest until sometime after 8:30 p.m., as the last visit was made at that time.... At nest number 60 the chicks began to pip at 10:00 a.m. on July 1, 1936, and finished hatching at 6:00 p.m." From these stated observations and others, the amount of time taken for a clutch of eggs to hatch is shown to vary from 6 to 7 hours. In the 5 cases where nests were observed during the hatching period, it took over 6 hours for all the eggs to hatch.

While the eggs are hatching, the hen will remain on the nest until she is nearly reached before flushing, relying upon coloration for protection for herself and her eggs. When she does flush from the nest, she may feign injury, such as a crippled wing or leg, or she may fight the intruder. The hen on nest number 34 (plate 7) would fight the observer in order to attract his attention away from her nest.

[illegible]

Plate 10. Nest no. 13 destroyed by some carnivore--
probably a coyote

thus drawing the skeleton of the tubular away from the part or parts.

In all cases where infection was observed, the host animal at first

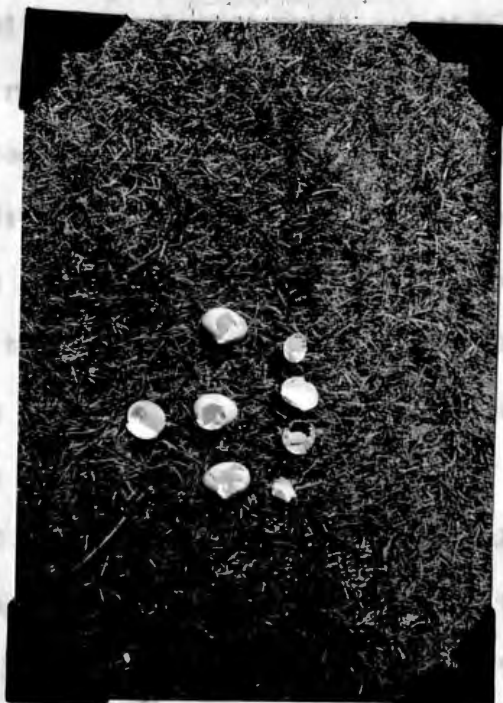


Plate 11. Showing 3 types of broken eggs: (1) mechanical break, (2) eggs destroyed by a raven, and (3) eggs destroyed by a carnivore (coyote)



Plate 12. Egg shells taken from a hatched nest, showing caps, loosened membrane, and circular break

On June 11, 1936, at 10:00 a.m., I went to take pictures of a sage hen on her nest (nest 60). As I was preparing and adjusting my camera, she jumped from her nest, spread her wings and tail like a strutting cock, and, making a noise like that of a disturbed incubating domestic hen, tried to drive me away from the nest. She would run around trying to keep behind me, and each time that the opportunity arose, she would fly at my neck and shoulders, but she never came close enough to strike me. When I moved toward her, she crouched, and very slowly went off into the sagebrush some 10 yards away, beating her wings on the ground as she went. She remained in this crouching position until the nest was again approached, when she made another fluttering dash toward me. She would approach within a foot or two of me, then fly to one side or the other, and again repeat the attack from another direction. After I left the area, she moved back into the sagebrush. The next morning, when the nest was visited, it was found that she had hatched her clutch 100 percent, and had left the nest.

Other hens attempt to protect their clutch or brood by feigning injury, thus drawing the attention of the intruder away from the nest or brood.

In all nests where hatching was observed the hens remained at their nests with their broods until sometime after dusk. The hen on nest number 60 remained at the nest until 8:00 p.m., at which time she moved her brood 10 to 15 feet away from the nest and there remained until after 9:00 p.m. In 1 case the brood was observed at the nest at 9:30 p.m., but was gone the next morning. These observations tend to support the theory that the brood does not leave the nest immediately after hatching, but may remain at the nest until dusk or until a time when escape protection is best.

Of the 161 nests studied, 97 of them hatched. Forty-one, or 26.02 percent, of the nests were destroyed; the remaining 23, or 14.29 percent, of the 161 nests were deserted (table 7). Of the 953 eggs under observation, 334, or 35.0 percent did not hatch, due to destruction, desertion, and infertility. Of these 334 eggs, 34 were infertile.

The average hatch for the 2 years (1936-1937) was 60.25 percent. The percent hatch was higher in 1937 than in 1936, as is indicated in

table 7. Fourteen and twenty-eight hundredths percent of the nests were deserted, and 26.02 percent were destroyed.

Table 7. Record of nest histories

Year	Nests studied	Successful nests	Nest (1) failures	Nest desertions	Nests (2) destroyed
		Percent	Percent	Percent	Percent
1936	63	(36) 57.14	42.85	14.28	28.57
1937	98 ⁽³⁾	(61) 62.24	37.75	14.28	23.47
Total average	161	(97) 60.25	40.30	14.29	25.46

(1) All causes.

(2) Nests destroyed by natural enemies.

(3) 106 nests were located but final record was not obtained on 8 of them.

Number of Broods. Sage grouse are believed to hatch and rear only 1 brood during the season. The average time necessary for a sage hen to breed, select, and construct her nest, complete egg-laying and incubation, is probably from 35 to 45 days. Young sage grouse do not reach a stage of independence for $2\frac{1}{2}$ or 3 months. The duties of the sage grouse mother, then, appear to last from 4 to $4\frac{1}{2}$ months, or, from a period beginning around the first of May, extending to the first or fifteenth of August. If a hen hatched a second brood in August, the young chicks would not be able to reach a state of independence until December. The fact that young chicks have never been reported after the first of August would add further evidence to this theory. The idea that more than 1 brood was reared per year arises from observations in which chicks of 2 different sizes have been seen in a single group. The probable answer to this is that brooding sage hens are highly maternalistic, and will

adopt chicks of another brood which become lost, deserted, or orphaned by the death of a hen. Due to the mounting number of females which are killed on the highway during the summer, it is not at all uncommon to see 2 or 3 different sizes of chicks in a single brood. During the summer of 1936, 1 brood of 24 chicks of 3 distinct sizes was seen feeding in the yard of the road camp. This brood remained around the camp for over 3 weeks. Two of the chicks in this brood were banded. If a nest is destroyed or deserted during the first part of the nesting season, it is possible that the hen may make an attempt to re-nest. The newly-hatched chicks that are seen in July could possibly be hatched from these second nests.

The Chick. When hatched, the soft, downy chick, "is well-colored to escape detection when crouching on the ground in the gray shadows of the desert. The crown, back, and rump are mottled and marbled with black, dull brown, pale buff, and dull white, the sides of the head and neck are boldly spotted and striped with black; there are two large spots of 'saya' brown bordered with black, underparts grayish white, suffused with buff on the chest" (2).

For a short time after hatching, and until the chicks are thoroughly dry, which requires from 15 minutes to 1 hour, they are quite helpless and weak. As soon as the chicks are dry, they may wander a few steps away from the nest, but will not go far, as the hen immediately calls them back. The hen, in all nests observed during the time of hatching (6 nests), kept her brood at the nest until they were able to move away under the protecting cover of darkness. If the hen covering a newly-hatched brood should be disturbed, she will fly off into the sagebrush, feigning injury, or she may attempt to fight off the intruder, thus

allowing the small inconspicuous chicks time to scurry off into the nearest cover and there remain still and motionless.

The following observations, from the author's field notes, illustrate the methods used by a sage hen to protect her young:

On June 9, 1936, 10:00 a.m., while walking through the sagebrush, I found a hen with seven chicks. The hen was covering her young on the bare ground in an open space on a flat of small and somewhat sparse sagebrush. By crouching and spreading over her brood, the hen had gone unnoticed until the observer was nearly upon her, and when he approached within a few yards of where she was attempting to hide, the hen flew up from her brood, leaving them to hide. She flew only a few yards, then dropped to the ground, making several attempts to again regain her flight. She ran a short distance, then, with a few weak wing beats, she attempted to fly again. During all of these movements, she would drag and allow one wing to hang free as if it were broken. The small chicks remained squatting, so still and motionless that they appeared to be stuck to the ground. They continued to remain perfectly still until an object was dropped, when all but one of them scattered into the sagebrush. I then hid behind some sagebrush, in order that observations might be made on how the hen would again assemble her brood. No sound was made for more than thirty minutes. After that time, a crying call was heard from one of the chicks. This call, wherrto, wherrto, was repeated four times, after which all was again silent. At the sound of the second call, the hen flew from where she had been hiding in the sagebrush to a place about 30 yards opposite from where I was. After a few minutes more the hen called her chicks. The call was very similar to that of a domestic hen, a coarse clucking kup, kup. Again one of the chicks made a few high-pitched whistling calls. These calls were answered by the clucking hen. I remained until 12:00, but neither saw nor heard any more from the hen or her chicks.

Brooding during the day takes place on the ground in some well-sheltered place, which offers a maximum of protection. Night brooding is done in areas where the sagebrush is more dense. After the first 2 weeks little day-brooding is practiced by the hen, and night-brooding probably ceases when the chicks are old enough to stand the chill of the night. Young sage grouse develop rapidly and soon become active enough to keep up with the adult birds.

Concerning the development of the sage grouse chick Bent (2) says the following:

...juvenile plumage comes in first on the wings, while the chick is very small, then on the scapulars, back, tail, sides of the breast, and flanks, lastly on the rump, head, and belly. The juvenile plumage is much like that of the adult female; but the breast is more buffy and more spotted than barred; the feathers of the black breast patch are tipped with white; and the feathers of the mantle are conspicuously marked with a broad shaft streak of white. Young males seem to be much darker than young females. A nearly complete post juvenile molt, including all but the outer two primaries on each wing produces the first winter plumage, which is practically adult and in which the sexes are fully differentiated.

The hen acts as the center about which the family activities revolve, and she acts as their sole support. From the observations that have been made, the hen appears to indicate some food for the chicks to eat. It seems, however, that the chicks choose and feed on more insects than does the adult. She leads them about through the area, broods them at night, and is usually ready to protect them from any threatening danger. Often a female sage grouse will risk her life, by feigning injury or by fighting off an intruder, to protect her brood. This motherly care and protection continues until the chicks are about 3 months old. By that time the chicks have grown to a sufficient size to protect themselves, being able to fly from 50 to 100 yards.

Daily Routine. The daily routine of feeding, watering, resting, dusting, and roosting of the sage grouse varies with the local range conditions, weather, and seasons of the year. In most cases, the activities begin at dawn, or shortly after in the summer; however, this also varies, due to the above-mentioned conditions. These activities are followed by most of the birds, both young and adult, and by both sexes; however, the 2 sexes, after separating in the spring, are not together again until late summer or fall.

As a new day breaks, the sage grouse may move from their roosting places, which are located on rocky open-ridge tops or on areas of low-growing sagebrush, ruff their feathers, and stretch their wings and legs. After stretching, the birds may either go to water, if it is available, or they may go to the road, or other available areas, and dust. In cases where water is not available, the birds must depend upon the succulence of the vegetation or dew for their water supply.

In Strawberry Valley practically all of the morning and evening dusting, in the early summer, takes place on the dirt roads, which are often the only available places to dust. Later in the summer, the open ridges and old dry stream beds also offered dusting areas.

From the morning dusting areas the birds may move to water or to the feeding grounds. "On May 13, 1936, between 8:10 and 8:17 a.m., I watched the activities of three female sage grouse. When first seen, they were dusting on the road, then, one at a time, they left the road and walked to the bar pit, where there was some fresh running water. After drinking, the birds flew about 10 yards across the water into an area of water sage where there was an abundance of understory meadow plants. Here they fed until they saw me."

The place and direction of the feeding movements are dependent upon the food and cover supply. Feeding takes place in areas of sagebrush, meadows, willows, and agricultural lands (grain fields, alfalfa, etc.). At first the feeding activities are generally slow, and some of the birds are very busily feeding. By 9:00 a.m. most of the birds have finished feeding and are hunting for a resting place.

The resting places chosen are generally under the protection of sagebrush, willows, or some other cover where sufficient protection can

be had. During this period, the birds may sleep, sun themselves, shade, preen, or dust. Figure 1 shows the daily routine, but does not show dusting taking place during the resting period, as few observations have been made of the birds actually in the process of dusting at that time. Nevertheless, when birds have been flushed during the resting periods, many of them will have flown from a "form" similar to those made when dusting. There is little doubt that most of the dusting takes place during the resting period of the day. During midday, while the birds are resting, fewer observations can be made, as the birds will "sit-tight", and will not flush unless forced to do so, depending for protection upon their blending coloration and their place of hiding.

By 4:00 p.m., or when the shadows begin to lengthen, the movement away from the resting places to the evening feeding areas begins. On cloudy days, however, only a short time is spent resting, and feeding dominates the activities of such days. This explains the drop in the resting activities and the increase in the feeding activities at 11:00 a.m. as shown in figure 1. The evening feeding is generally in or near the same areas that were used in the morning. Feeding continues, in much the same manner as it did in the morning, until about dusk, at which time some birds are observed drinking or dusting before returning to the roosting grounds.

On only 2 occasions was a sage grouse seen acting as a sentry while the other birds were feeding. Both times, this happened in a large meadow along the highway, where a large stone was protruding out of the bar-pit; and on 2 different evenings a hen was seen standing on this rock while several broods were feeding in the meadow.

Several times in the evening in the late summer large flocks of sage grouse, probably of all ages and sexes, were flushed from the flat,

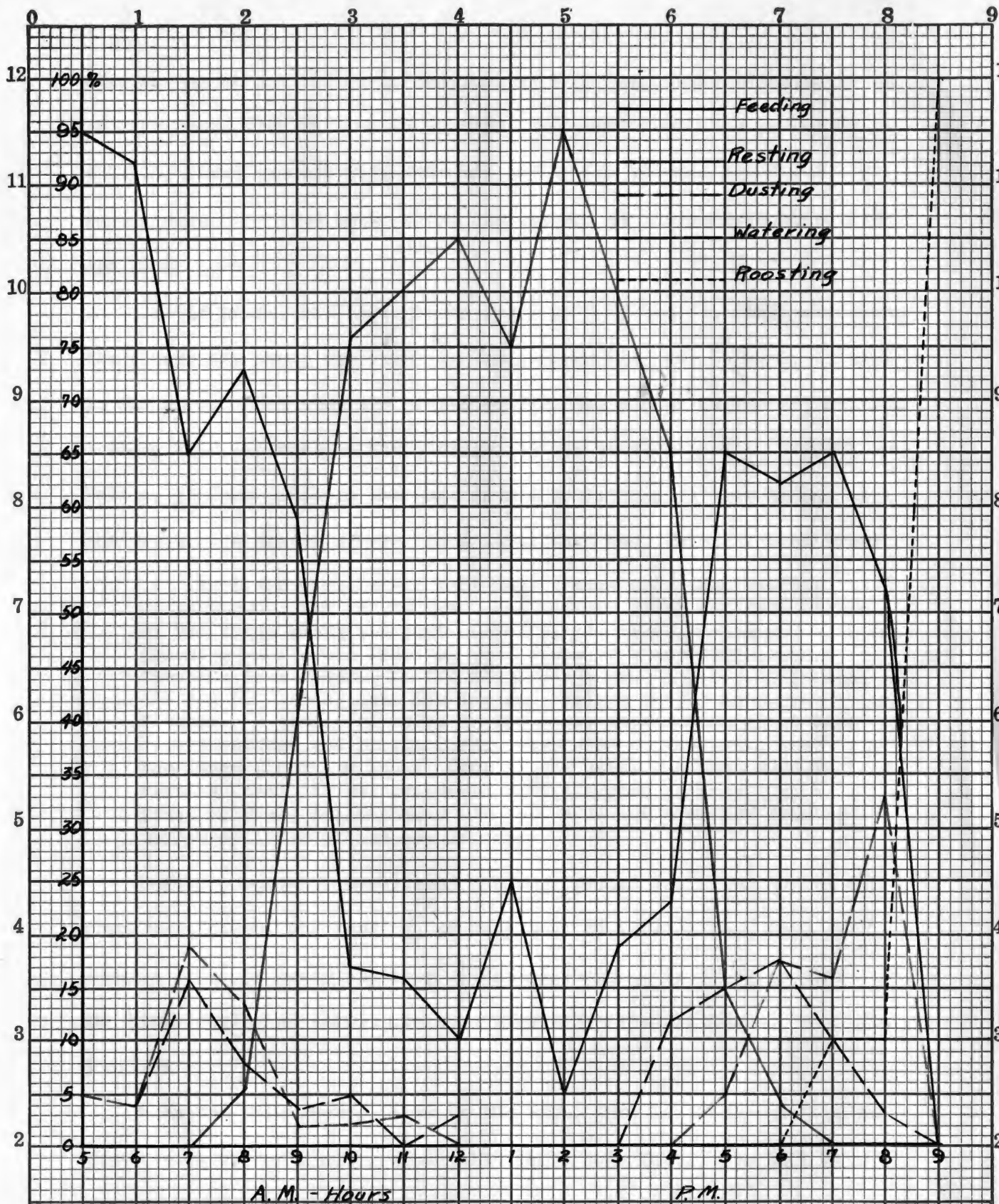


Fig. 1. Daily activity of the sage grouse, based on 2585 observations, May to September 1936.

open sagebrush areas. On 1 occasion, at 9:00 p.m., approximately 50 to 75 birds were flushed from an area of dead sagebrush. The period of activity often extends well into the night. On several occasions sage grouse have been seen on the highway and in the meadows after 9:00 and 10:00 p.m.

In the winter the sage grouse spend part of the day in flocks along the ridges and among the rocks in the sun, or they may be seen in holes in the snow, where they are protected from the wind. On January 26, 1938, a study trip was made to Windy Ridge, in the eastern part of Strawberry Valley, to take notes on the sage grouse activities at that season of the year. The following are field notes that were taken at that time:

At 11:00 a.m., eight male sage grouse were seen feeding on sagebrush, and at the same time another flock was seen on top of the ridge among the exposed rocks. At 12:30, 23 sage grouse were flushed from the west slope of Windy Ridge, where they had been feeding on the sagebrush tops. A flock of between 400 and 450 birds, seen feeding and resting in the snow, was flushed. A number of holes in the snow, which appeared to have been scratched out by the birds, was found on the areas where the large flock had been. Some of the holes had been used for resting forms, as was evidenced by the amount of droppings found in them, while others had been made and used for feeding purposes. (See plates 13, 14, 15.)

During periods of heavy snow the sage grouse are often forced to spend most of the day feeding, as they have to scratch down into the snow in order to reach the tops of the sagebrush. In these periods the birds are quite mobile and will have a cruising radius of from 1 to 3 miles.

When the sage grouse light on the snow, they land on both feet and then bounce or hop 1 step, again hitting on both feet. The tail generally hits the snow and leaves a very distinct track.

Coveying. Beginning in the latter part of August 2 or 3 broods



Plate 13. (1/26/38) A group of holes and tracks made by the sage grouse on Windy Ridge, Strawberry Valley



Plate 14. (1/26/38) A hole made by a sage grouse and used for resting; note the droppings in the hole

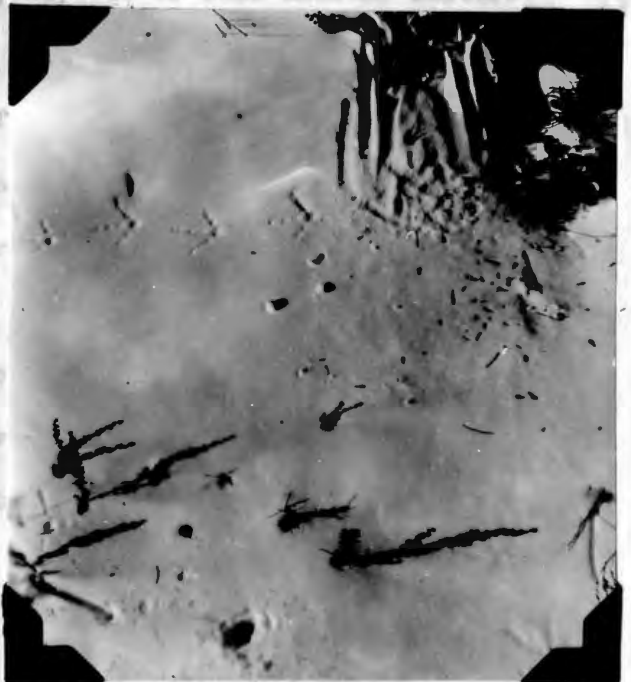


Plate 15. (1/26/38) A hole by a sage grouse and used for feeding

may unite to form a small covey of from 10 to 20 birds. This union of broods into coveys will increase by the addition of other flocks or stray birds, so that by the last of October coveys of 100 to 200 birds in one flock will occasionally be seen. However, the average covey contains from 30 to 75 birds, both old and young. By the last of October most of the old male birds have joined with the adult females and the young birds, which at that time appear very similar to the adult females, except for size. Table 8 illustrates the varied flock size during the fall and winter months.

During part of the day these large coveys may break up into several smaller units. Often one of these smaller units is composed of the old males and a few of the young birds. In the evening these smaller units generally re-assemble and roost together. Even when the large flocks are divided into smaller coveys, they are usually found in comparatively close range to each other, and only in case of some unusual disturbance do they become greatly separated and broken off from the main unit. On October 20, 1936, several flocks of birds were seen on Trout Creek Flat in Strawberry Valley. When flushed, these birds flew east to a small ridge and joined a flock of approximately 150 birds that were already on the ridge.

The formation of flocks is probably due to seasonal changes. At present there is no direct evidence available which will indicate that flocking is coincident with, or results from, the effect of the changing weather conditions.

Table 8. Flock sizes at different times showing the variations in size of flocks

Date	Size of flock	Date	Size of flock
9/16/36	75	12/31/37	25
	90		30
10/17/36	8		27
	12		18
10/20/36	36		40
	175		6
10/21/36	10	1/26/38	8
11/28/36	150		20
	12		23
	100		40
	41		450
	8	1/27/38	40
1/26/37	12		12
2/1/37	19	2/11/38	23
	24		9
9/23/37	38	2/13/38	10
	60		17
12/31/37	75		14
	75		35
Average flock size 49.1			

Migration. In the strict sense of the word, the sage grouse do not make a true winter migration; however, they do move either up to the exposed ridge tops or out to the edges of the more level plateau areas, where the wind keeps the area open and comparatively free from deep snow during periods of heavy snows.

Of special interest is this winter migration or movement of the sage grouse from the lower valleys and bench lands up to, or out to, the ridge tops, or breaks, in areas of low-growing sagebrush, where the wind keeps the tops bare and makes the sagebrush available for food. This movement may be noticed on many areas throughout the sage grouse range.

On the study area in Strawberry Valley, following the fall bunching, the sage grouse are observed to move eastward from the valley proper to the wind swept ridges around Stinking Springs and Windy Ridge, where they

congregate in large flocks, sometimes numbering several hundred. If the snow depths increase, as they normally do, most of these birds move on further east, into the agricultural lands of Fruitland and the sagebrush areas near Dead Ox Flat, north and east of Fruitland.

During the winter of 1937-1938 many of the sage grouse remained on the ridges in Strawberry Valley, as there was no apparent food shortage. In the winter the sage grouse are dependent upon the exposed sagebrush for their food. All winter droppings that have been examined, and the stomachs that have been taken during the winter, tend to indicate that the winter food is near 100 percent sagebrush.

In other years, such as the winters of 1935-1936 and 1936-1937, the snowfall was so heavy that, possibly due to food shortage, the birds were forced to move to new areas, where sufficient food, in the form of sagebrush, was available to maintain them over the winter. This is probably the explanation for the absence of birds in Strawberry Valley during those winters.

On January 27, 1938, a number of small flocks, of from 10 to 40 sage hens, along with 1 flock of approximately 450 birds, were flushed on Windy Ridge. It was estimated that there were 1,000 birds on Windy Ridge at that time; while in February, 1938, when the amount of snow had increased to 3 feet, there were only 39 birds found on Windy Ridge (plates 16 and 17).

Observers at Fruitland report that during the winter months they have seen large flocks of sage hens fly from the plateaus west of town to the sagebrush areas north and east of Fruitland. Sage grouse, numbering up to the thousands, are frequently seen during the winter in this area, but are absent during the summer. There has not been enough



Plate 16. (1/26/38) Part of a flock of 450 sage grouse on Windy Ridge



Plate 17. (1/26/38) The same group of birds beginning to fly. Note how the wind has drifted the snow exposing the sagebrush

Nesting Cover. Cover is the first and perhaps the most important banding done to prove that these birds are those from Strawberry Valley. It is possible that some of the birds around Fruitland during the winter may have moved down from Tabiona, north and east of Fruitland. However, the large number of birds seen during the winter at Fruitland is far more than the number to be found at Tabiona during the summer.

Because of the lack of direct information regarding migration, a more complete study of this movement should be made.

COVER REQUIREMENTS

Kinds of Cover. Cover may be defined as any kind of material that offers shelter and protection for game. "Strictly speaking, cover is the kind of material of which a covert is composed. Cover may refer to a single plant or a very small area; covert is a geographical unit of cover" (9).

Cover may be divided into 5 classes based upon the function of use.

They are, according to Leopold (9):

1. Nesting cover--vegetation which offers protection to the hen and nest during the nesting period.
2. Loafing, or resting cover--a place not necessarily large, one which offers shade and protection from the sun and wind.
3. Roosting cover.
4. Refuge cover--vegetation from which game cannot be driven by hunters.
5. Winter cover--vegetation offering invisibility or mechanical protection during the snow periods.

To this classification may be added a sixth, that of feeding cover, or vegetation which offers a maximum of protection and allows a maximum of movement in an area where food is present.

Nesting Cover. Concealment is the first and perhaps the most important requisite of a good sage grouse nesting site. No apparent attempt is made by the hen at concealment of her eggs when she is absent from the nest, other than that afforded by the natural cover.

Of the 161 nests studied during the 2 years all were found on the ground, usually protected by sagebrush and never a great distance from these shrubs. Two nests were found constructed in bunches of giant rye grass, but in a sagebrush vegetation type. Records from areas other than the Strawberry Valley indicate that occasionally a bird uses some type other than sagebrush. For example, near Holbrook, Idaho, a nest was located in a wheat field protected by old and dry Russian thistle (Salsola pestifer). Another nest was found at Paradise, Utah, in a weed-grass area, and was protected by sunflowers (Helianthus annuus).

A limited number of vegetation types for nesting sites was used by the sage grouse. For the purpose of this study, the vegetation of the study area in Strawberry Valley was classed into 13 natural groupings, easily recognizable in the field, designated as 7 types and 6 sub-types, as follows:

1. Willow, approximately 770 acres.
2. Meadow, approximately 3,230 acres.
- 3.* Water sagebrush (Artemisia cana), approximately 3,370 acres.
4. Undisturbed sagebrush, consisting of Artemisia tridentata having a more or less litter present.
 - 4b. Less than 14 inches high, approximately 765 acres.
 - 4c. Fourteen to 25 inches high, more or less open, approximately 5,520 acres.
 - 4d. Over 25 inches, with crowns nearly closed, approximately 610 acres.

* The 7 types used in nesting are designated with letters a to g.

5. New growth sagebrush (Artemisia tridentata), resulting from burning or flooding.

5e. Sagebrush less than 15 percent cover, approximately 925 acres.

5f. Sagebrush 15 to 50 percent cover, less than 18 inches high, approximately 200 acres.

5g. Sagebrush over 50 percent cover and over 18 inches high, approximately 270 acres.

6. Aspen, approximately 2,560 acres.

7. Waste, approximately 320 acres.

As determined from the detailed type map (figure 2) prepared for this study, there are 11,675 acres of nesting cover on the study area of 22,240 acres.

During 1936, 63 nests were located and studied, and in 1937 a total of 106 nests were located, but no final check was possible on 8 of these. Table 9, therefore, accounts for only 98 nests in 1937. All of the 161 nests were studied in relation to failures of all kinds and in relation to the cover types in which they were located.

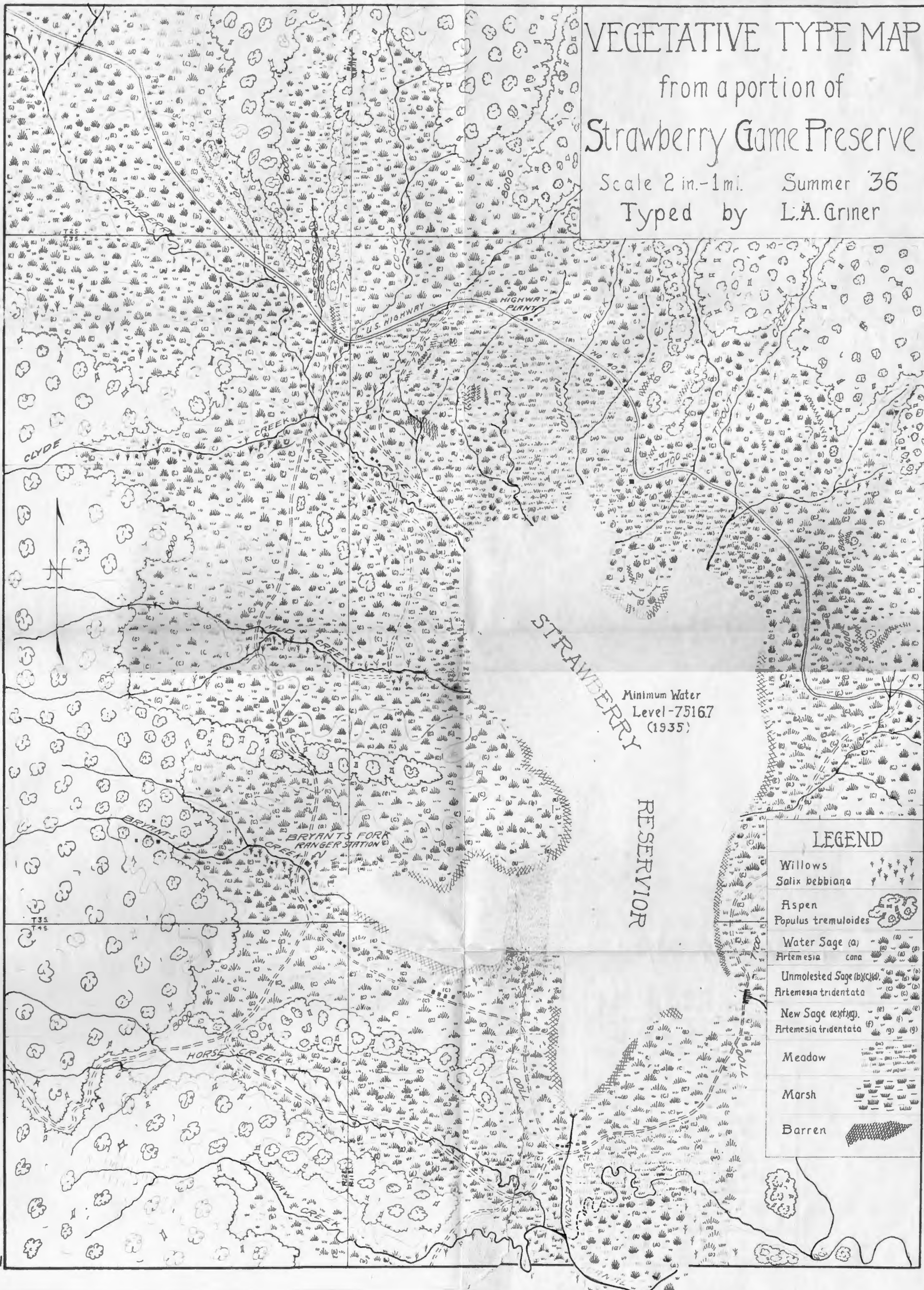
Table 10 indicates the size of the types, number of nests within the type, and the percent of nesting success and mortality by years.

More nests were constructed under the protection of cover type 3a* (see page 49) than under any of the other types. There may be several factors which influenced this preference, namely, its near location to feeding grounds, its general composition, the relatively large amount of the type within the summer range, and its relation to various other covers. Artemisia cana offers a medium dense cover, forming a lacy pattern of sunlight and shadows on the ground, which is undoubtedly important, as the birds must depend upon their coloration for protection. The cover offered by this type is dense enough to make a good

VEGETATIVE TYPE MAP

from a portion of
Strawberry Game Preserve

Scale 2 in.-1 mi. Summer '36
Typed by L.A. Griner



LEGEND

- Willows
Salix bebbiana
- Aspen
Populus tremuloides
- Water Sage (a)
Artemisia cana
- Unmolested Sage (b)(c)(d)
Artemisia tridentata
- New Sage (exting.)
Artemisia tridentata (f)
- Meadow
- Marsh
- Barren

Table 9. Nesting results of 1936 and 1937 by types. (161 nests studied)

Vegetative types	No. of nests within the type		Hatched nests		Deserted nests		Destroyed nests	
	No.	%	No.	%	No.	%	No.	%
3a	54	33.54	35	36.08	9	39.13	10	24.39
4b	16	9.94	6	6.18	3	13.04	7	17.07
4c	38	23.60	21	21.65	4	17.39	13	31.71
4d	18	11.18	7	7.22	3	13.04	8	19.51
5e	1	.63	0	0.0	1	4.34	0	0.0
5f	13	8.07	8	8.25	2	8.69	3	7.31
5g	21	13.04	20	20.62	1	4.34	0	0.0
Total	161	100	97	100	23	100	41	100

Table 10. Tabulation of nesting success by vegetation types

Types	Percentage of total nesting area	Nests under observation				Nests hatched successfully			
		1936	1937	Total	Percent of total nests in the type	1936	1937	Total	Percent of total nests in the type
3a	28.8	19	35	54	33.54	13	22	35	36.08
4b	6.6	8	8	16	9.94	1	5	6	6.18
4c	47.4	16	22	38	23.60	10	11	21	21.65
4d	5.3	12	6	18	11.18	4	3	7	7.22
5e	7.9	0	1	1	0.62	0	0	0	0.00
5f	1.7	1	12	13	8.07	1	7	8	8.25
5g	2.3	7	14	21	13.04	7	13	20	20.62
Total	100	63	98	161	100	36	61	97	100

hiding screen and is also open enough to permit escape without being hindered by plant growth obstructions. An important growth habit of this plant, in regard to nesting cover, is that it will grow in a medium dense stand and is usually associated with a good understory of grasses and forbs. In some cases the grasses and other meadow plants will grow as high as the sagebrush, making a very dense stand of plant growth. In addition to having a high percentage of total nests this type ranked second in nesting success, with a 64.81 percent hatch. This type, which composes 28.85 percent of the total area, had 33.54 percent of the total nests located in it.

Some areas of sagebrush were either burned off or flooded, and the new growth of sagebrush that reappeared on these areas formed a very dense crown and made excellent cover. This new sagebrush, which as a type is designated by the number 5, was divided into 3 sub-types, based on density and height of the new sage, the most important of which is 5g. The amount of this sub-type in the study area is fairly small, as it amounts to only 2.3 percent of the total area, but, when chosen as a nesting site, it becomes rather important. Thirteen and four-hundredths percent of all the nests were located in this sub-type, and of these, 95.2 percent hatched.

Sub-type 5f, which is only 1.7 percent of the total area, had 8.07 percent of the nests located in it, but it ranked third in nesting success, with a 61.53 percent hatch.

Only 1 nest (0.63 percent of the total nests) was located in sub-type 5e, which comprises 7.9 percent of the total area. The sagebrush found in this sub-type is possibly too small and scattered to be desirable as a nesting cover.

Sub-type 4b, which makes up 6.6 percent of the total area, had 9.94 percent of all the nests located in it. However, only 6.18 percent of the successful nests were located in this sub-type.

The largest of the types or sub-types was 4c, a very characteristic sagebrush type comprising 47.4 percent of the total study area. This sub-type had 23.60 percent of the total nests located in it and 21.65 percent of the successful nests. This is a very common present-day type of sage, not extremely dense, but lacking in an understory of grasses and forbs that is believed to be the original condition.

Five and three-tenths percent of the total area was made up of sub-type 4d. This sub-type had 11.18 percent of all the nests located in it, and 7.22 percent of the successful nests.

The other vegetative types were not used as nesting areas, but were used primarily as resting and feeding cover.

The nesting mortality was highest in type 4, especially in sub-types 4b and 4d, sub-type 4b having a 62.5 percent nesting loss, and 4d a 61.2 percent mortality. In third place was sub-type 4c, which had a 44.71 percent nesting loss. This high percent of mortality may be due to the sparseness of the basal growth and lack of understory grasses and forbs. In this type the crown, as a general rule, is high and fairly dense, but beneath there is very little growth, which, due to sparseness, may permit predators an easier access to the nests.

In figure 3 the total acreage of nesting cover is represented by the total length of the wide solid bars, the total number of nests by the total length of the stippled bars, and the total successful nests by the cross-striped bars. The ratio of the area of each nesting type to the number of nests present in that type and to the number of successful

nests is shown by the comparative length of the X bars for each type designation and is calculated in table 11. (The percentages of cover of the total types, of nests, of total nests, and successful nests is indicated at the top of each bar.) The average amounts of mesquite, arroyo, and willows included in the study area are not calculated in the nesting types, as no nests were present in any of these. The length of the X bars represents the coverage of these types at the

Table 11. Ratio of percent of cover, percent of nests, and percent of successful nests within each cover

Types	Ratio of		
	Cover	Nests	Successful nests
3a	1	1.249	1.88
3b	1	1.58	0.94
3c	1	0.90	0.43
4a	1	2.35	2.57
5a	1	0.04	0.0
5f	1	2.78	4.90
5g	1	5.74	9.05

Figure 3. Nesting records of sage grouse in relation to cover types

The key indicates a direct correlation between the type of nesting cover selected and the success of the nesting. The 3 subtypes of original sagebrush, which a good undergrowth of vegetation, show a much lesser nesting success than does the Artemisia type, 4a, where a good undergrowth of grasses and forbs was present. One subtype of the new sagebrush area in the early process of revegetation, having less than 15 percent cover and being less than 18 inches tall, was rarely

nests is shown by the comparative length of the 3 bars for each type designation and is calculated in table 11. (The percentages of area of the total type, of nests, of total nests, and successful nests is indicated at the top of each bar.) The average amounts of meadow, aspen, and willows included in the study area are not calculated in the nesting types, as no nests were present in any of these. The length of the 3 narrow black bars represents the acreage of these types on the large study area, and the average for the 3 years is shown in figure 2.

Table 11. Ratio of percent of cover, percent of nests, and percent of successful nests within that cover

Types	Ratio of		
	Cover	Nests	Successful nests
3a	1	1.144	1.26
4b	1	1.58	0.94
4c	1	0.50	0.43
4d	1	2.37	1.37
5e	1	.084	0.0
5f	1	3.76	4.90
5g	1	5.74	9.05

The 2-year study indicates a direct correlation between the type of nesting cover selected and the success of the nesting. The 3 subtypes of original sagebrush, without a good understory of vegetation, show a much lower nesting success than does the Artemisia cana type, (3a), where a good understory of grasses and forbs was present. One subtype of the new sagebrush area in the early process of revegetation, having less than 15 percent cover and being less than 18 inches tall, was rarely

chosen for nesting and gave a very low nesting success. Two sub-types of the new sagebrush area gave better than average nesting densities and nesting success. In type 5g an exceptionally dense growth of mature sagebrush had revegetated the area and had provided a very desirable nesting cover, as is indicated by the fact that nesting success was highest in this type during both years. The ratio of the number of nests and nesting successes in the various cover types was very consistent in the 2 years, and the average for the 2 years is shown in figure 4.

The highest nesting density was noted in the sub-type 5g, which was also the area of most successful nests. The highest nesting density found in the 2 years was 23 nests located on 160 acres, or a density of 1 nest per 6.95 acres.

It is believed from observations made on the nests located during the present study on the 11,675 acres of suitable nesting cover that the survey did not over-emphasize any 1 type.

Feeding Cover. Feeding cover may vary with the time of the day, the season, and the climatic conditions. In the spring, summer, and fall, during the early morning hours and the hours around dusk, the sage grouse feed out into the open areas that offer very little protection, such as open meadows or very sparse sagebrush. This is probably due to the fact that they feel more secure because of the poor visibility at these hours. In the mornings, as the light begins to intensify and visibility improves, the sage grouse move back from the meadows into the sagebrush, which offers much better protection. Any feeding which takes place during midday is done under the cover of sagebrush, willows, or other plants offering a maximum of protection.

Resting Cover. In midday, when the temperatures and light intensities are the highest, the sage grouse seek out a well-protected place where they

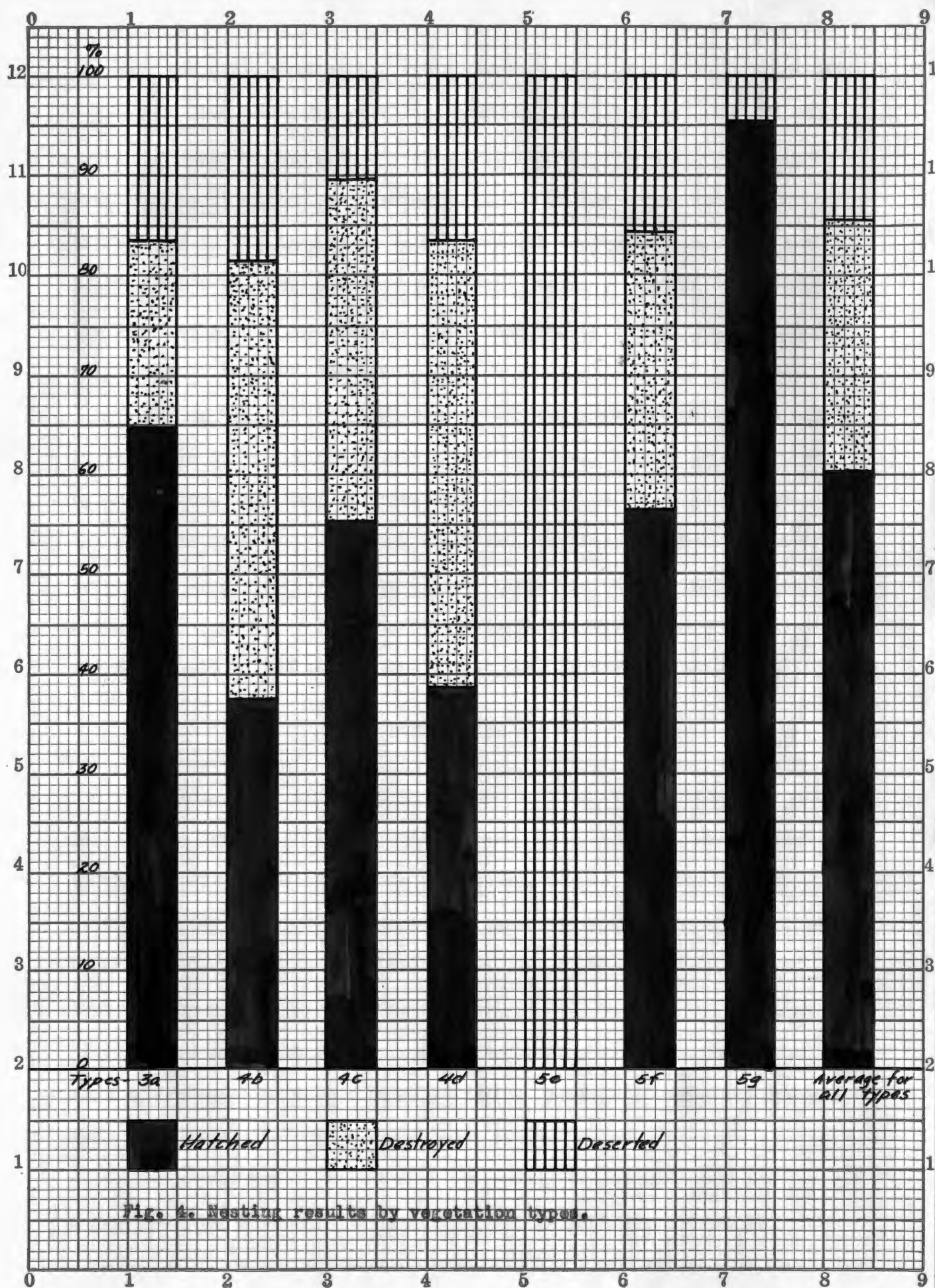


Fig. 4. Nesting results by vegetation types.

can rest until the feeding activities begin again. There are 2 types of cover that seem to be the most in demand for resting areas. The first type, and probably the most important, is the willows with their sagebrush (A. cana) and grass understory. These willow areas border many of the streams in the Strawberry Valley, and the sage grouse use them for resting purposes. The second type is the general sagebrush areas, where the birds make forms beneath the protecting sagebrush and spend the day resting, preening, and dusting.

Roosting Cover. Sage grouse generally roost on the ground and not in trees, as do many of the other grouse species. Little cover is used by these birds when they are roosting. The most common roosting sites are areas of sparse, low-growing sagebrush, usually an old sheep bed-ground; or they may roost along a rocky ridge top, a type most commonly chosen in the winter. These areas of sparse vegetation are probably chosen because of the easy, quick escape that is possible at night.

FOOD HABITS

For the purpose of making a food-habit study 107 stomachs were collected from both adult and juvenile birds. Data, however, are present on only 62 of these stomachs, as the others, due to an unavoidable accident, were destroyed. The majority of these stomachs were collected from birds killed by cars on the highway that passes through the area. United States Highway 40 is graveled at this point, and, in addition to those birds killed while crossing it, many other birds visited it during the morning and evenings to use it as a dusting ground. A number of stomachs were also collected from fresh predator kills.

When a specimen or stomach was collected, it was numbered, tied in a piece of cheese cloth, and preserved in a 10 percent solution of

formaldehyde. Each stomach was carefully recorded in note form. The stomachs were then submitted to the section of Food Habits Research of the United States Biological Survey, where the food material contained in the crops and stomachs was identified. A summary of their contents is shown in tables 12 and 13. The only series of sage grouse stomachs examined, previous to the present study, was a set of 33 stomachs obtained by Girard during July and August, 1934, in Sublett County, Wyoming.

The adult sage grouse, as shown from this and other studies, is primarily a vegetarian. Although it varies its diet quite markedly by the seasons, it is plant material that provides the bulk of its food. From the present study of stomachs taken in 6 months of the year 1937, May to October inclusive, 97.64 percent of the adult bird's diet was plant material, and of this, 77.50 percent consisted of the 2 species, Artemisia tridentata and A. cana. Eighty-five and eighty-four hundredths percent of the total diet was plants of the family Compositae. Other important plant foods were grasses, which made up 3.91 percent of the total contents; Leguminosae, (principally Trifolium), constituted 2.35 percent; and Ranunculaceae, 2.95 percent. The remainder consisted of various items, which were apparently chosen at random. Only 2.4 percent of the adult's summer food was animal material, and this consisted almost entirely of Hymenoptera of the family Formicidae. The second item was Coleoptera, principally members of the Carabidae, and Tenebrionidae families. A few Hemiptera and Orthoptera made up the balance of the animal diet of the adults (figs. 5, 6, 7).

In the case of the very young sage grouse, the diet was entirely different from that of the mature birds, as is shown in tables 12 and 13, and figures 8 and 9. It is not deemed desirable to average the results

Table 12. Summary of plant material eaten by sage grouse (1), Strawberry Valley, Utah, 1936-37

	May	June		July		August		September		October		Adult average
Age and number (61) (A-Adult, J-Juvenile)	A-11	A-2	J-4	A-3	J-13	A-1	J-8	A-3(2)	J-10	A-3	J-3	22
Plants percentage of total diet	98.3	98.5	52.5	94.6	56.4	99.0	95.5	95.0	94.5	99.0	99.5	97.64
Compositae (misc.)					.4		5.0		10.3		1.0	
Artemisia (2 spp.)	80.1	95.0	25.0	75.2	22.1	30.0	36.3	42.0	66.4	98.3	92.5	77.50
Taraxacum	1.8	3.5			4.2		9.8	45.5	.6			5.35
Solidago	.1				4.1	57.0	1.3	2.5			3.3	2.85
Achillea lanulosa					2.2	1.0	9	1.0			1.5	.14
Gramineae (misc.)	5.1			5	2.8	11	18.1	1.0	7.8	.66		3.91
Polemoniaceae (Gilia)			25.2	9.6	10.3							1.31
Leguminosae (misc.)			1.2					3.0				.30
Trifolium	4.1				7.6		4.7		6.9			2.05
Ranunculaceae	5.9											2.95
Chenopodiaceae							2.5					
Rubiaceae					1.2							
Berberidaceae					.2		1.3					
Geraniaceae									.5			
Cruciferae	.4			.3							1	.24
Cyperaceae					.1		1.2					
Juncaceae					.8		.6					
Undetermined	.4			3.3	.2		5.5		1			.65
Misc. (3)	.4		1.1	1.2	.2		.2		1.0	.04	.2	.35

(1) Includes all plant items that constituted 1 percent, or over, of any one of the 61 sage grouse stomachs analyzed.

(2) Averages determined from 2 stomachs; the third was 99% unidentifiable plant material.

(3) Items that occurred only as traces often were lumped in the volume tabulation, and accounts for a volume value here. Eighteen different identifiable plant items occurred only as traces. Fifty-six traces were recorded for these items. Four items included in the group Polygonaceae comprised 33 of the traces. No other item occurring only as a trace was recorded over twice.

Table 13. Summary of animal material eaten by sage grouse (1), Strawberry Valley, Utah, 1936-37

	May	June		July		August		September		October		Adult average
Age and number (61) (A-Adult, J-Juvenile)	A-11	A-2	J-4	A-3	J-13	A-1	J-8	A-3 (2)	J-10	A-3	J-3	
Percentage animal material in total diet	1.70	1.50	47.50	5.30	43.60	1.0	4.5	5.0	5.5	1.0	0.5	2.34
Hymenoptera (misc.)					24							
Formicidae (6 genera)	1.34		35.75	5.30	26.30	1.0	3.13	3.0	1.5	1.0	0.5	1.90
Coleoptera (misc.)	.09	1.5	2.0		1.75			2.0	.50			.31
Tenebrionidae			2.75		5.50		.13		1.10			
Coccinellidae	.27		.50		1.00		.40		.40			.14
Carabidae			.50		1.08		.13					
Cureulionidae			.75		.54				.10			
Hemiptera			5.0		6.30		.13		.10			
Orthoptera					.08		.51		1.70			
Lepidoptera			.25		.22							
Diptera					.15							
Gen. misc. (3)					.4		.07		.10			

(1) This table includes all animal items that constituted 1 percent, or over, of any one of the 61 grouse stomachs analyzed.

(2) Average of 2 stomachs, as third was 99% unidentifiable plant material.

(3) Items that occurred only as traces often were lumped in the volume tabulations, and accounts for a volume value here. Thirty-four different identifiable animal items occurred only as traces. Nineteen items occurred only as 1 percent in a single stomach. Gravel did not constitute any volume of stomach contents, occurring only as a trace in 21 of the 61 stomachs.

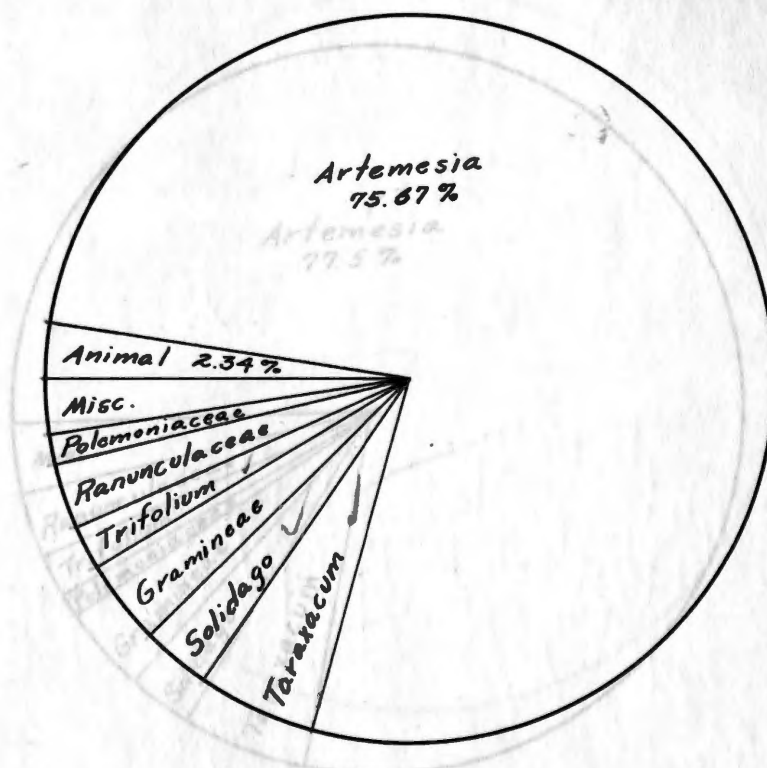


Figure 5. Foods eaten by adult sage grouse during a 6-month period, May to October 1937

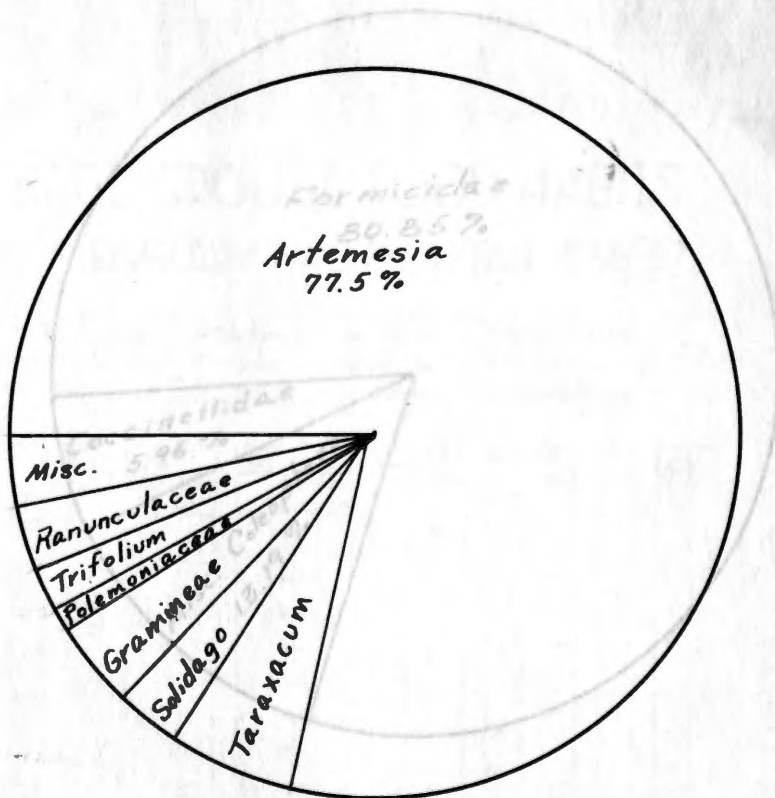


Figure 6. Plant material eaten by adult sage grouse over a 6-month period, May to October 1937

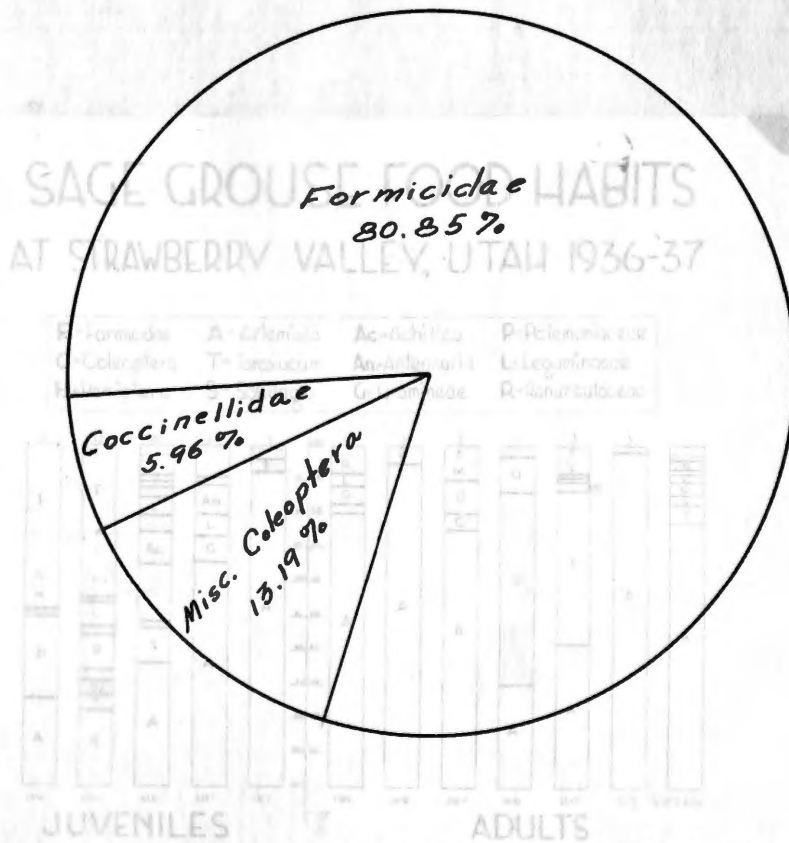


Figure 7. Principal animal foods of the adult sage grouse over a 6-month period, May to October 1937

Figure 8. Sage grouse food habits at Strawberry Valley, Utah, 1936-37

SAGE GROUSE FOOD HABITS AT STRAWBERRY VALLEY, UTAH 1936-'37

F = Formicidae A = Artemisia Ac = Achillea P = Polemoniaceae
 C = Coleoptera T = Taraxacum An = Antennaria L = Leguminosae
 H = Hemiptera S = Solidago G = Gramineae R = Ranunculaceae

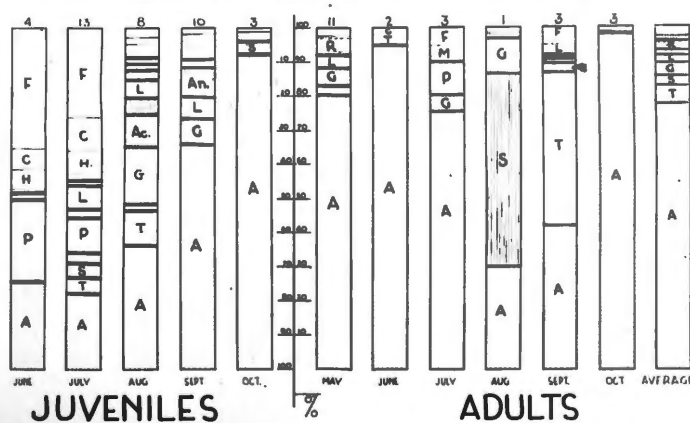


Figure 8. Sage grouse food habits at Strawberry Valley, Utah, 1936-37

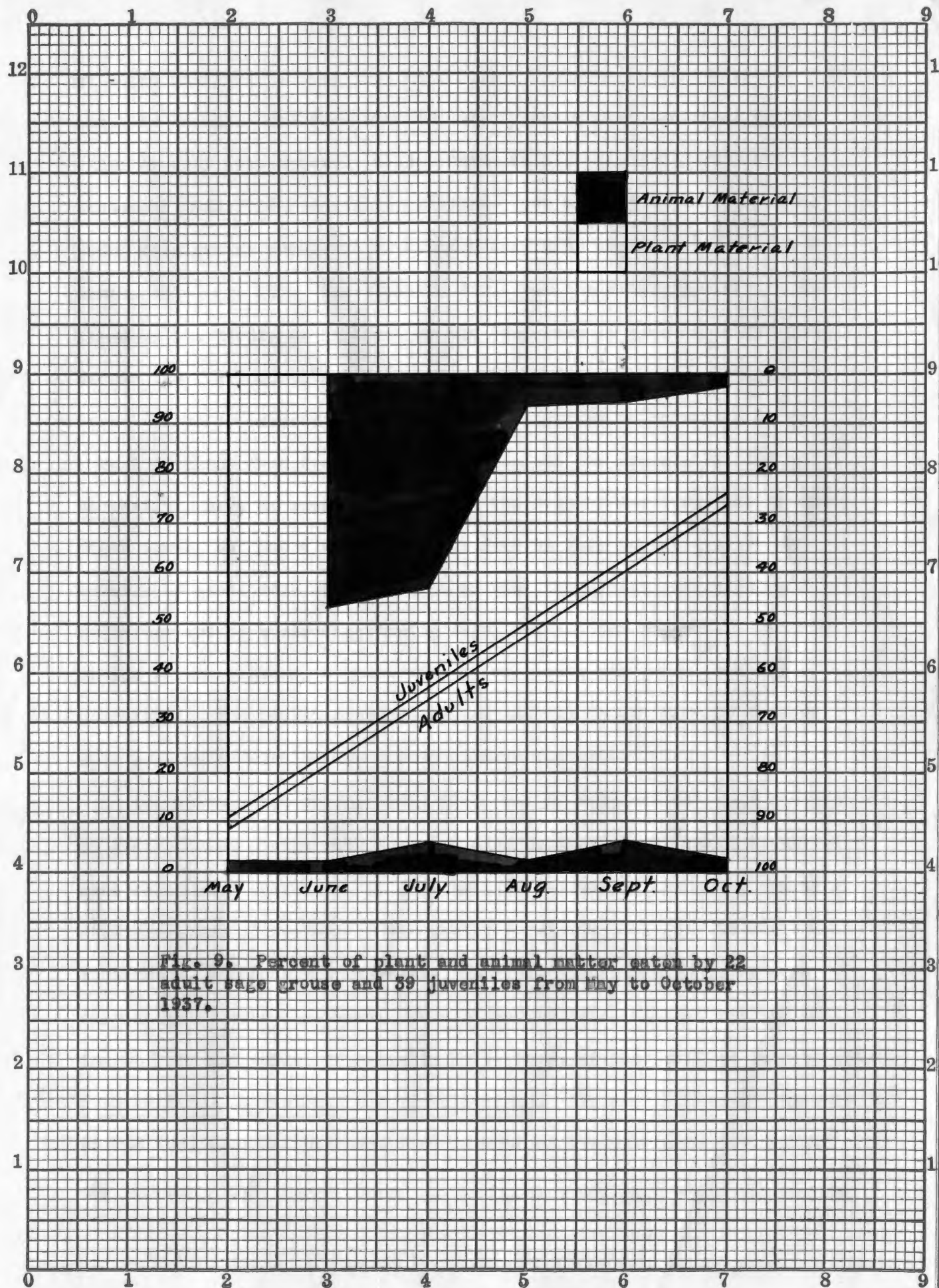


Fig. 9. Percent of plant and animal matter eaten by 22 adult sage grouse and 39 juveniles from May to October 1937.

of these analyses because they represent a changing diet, associated with increase in age. The juveniles ate 52.5 percent plant material during June; in July 56.4 percent; 95.5 percent in August; 94.5 percent in September; and 99.5 percent in October. From this it appears that the young sage grouse change to an adult grouse diet when they are about 3 months old (fig. 10). The appetite for Artemisia develops early in the lives of the birds, as is shown by the fact that 25 percent of the food during the first month consists of plants of this genus. Some small vernal annuals, present on the area, were observed to provide a large amount of plant food for the young grouse, and one especially, Gilia harknessii, made up over 25 percent of the diet of the birds during their first month, and was a very important food in July as well. Various species of grass were of importance to the young grouse and made up a definite part of their diet during July, August, and September. In addition to these items, a great variety of plants was eaten in small quantities. The table, however, indicates only those items which made up 1 percent or more of any bird's stomach contents.

The animal diet of the young birds was of interest not only because of its definite change with age, but also because of the large amount of ants which were consumed. In June over 36 percent of the young grouse's diet consisted of members of the family Formicidae; in July it was over 26 percent, but this had decreased, until in August the contents were only slightly over 3 percent. In addition to ants, a great variety of insect life was taken, principally Coleoptera, of the families Tenebrionidae, Coccinellidae, Carabidae, and Curculionidae. Six and five-tenths percent of the June diet was beetles, 9.87 percent of the July diet, but only .66 percent of the August diet. In addition, some Hemiptera, and, during

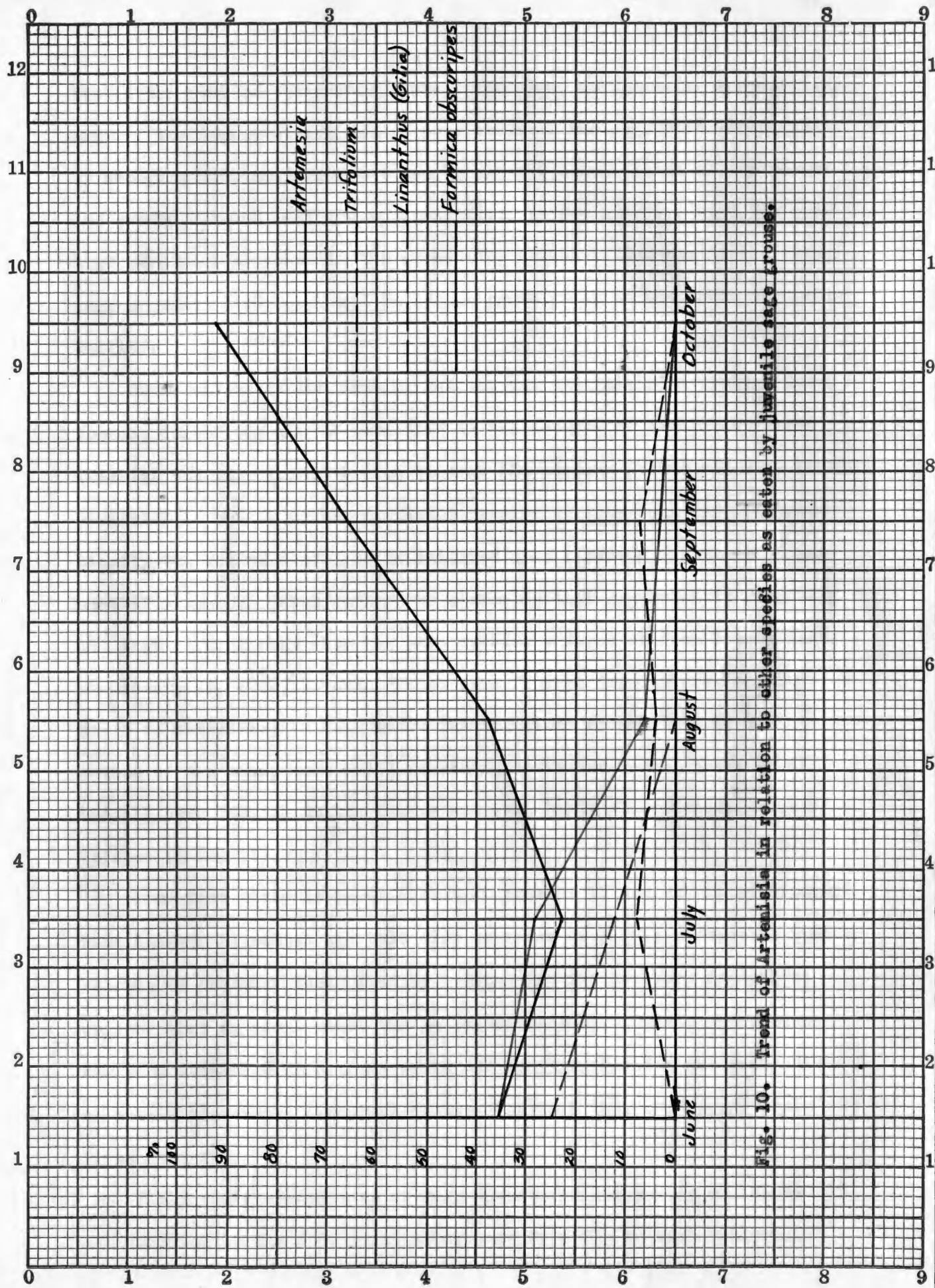


Fig. 10. Trend of *Artemisia* in relation to other species as eaten by juvenile sage grouse.

can rest until the feeding activities begin again. There are 2 types of cover that seem to be the most in demand for resting areas. The first type, and probably the most important, is the willows with their sagebrush (A. cana) and grass understory. These willow areas border many of the streams in the Strawberry Valley, and the sage grouse use them for resting purposes. The second type is the general sagebrush areas, where the birds make forms beneath the protecting sagebrush and spend the day resting, preening, and dusting.

Roosting Cover. Sage grouse generally roost on the ground and not in trees, as do many of the other grouse species. Little cover is used by these birds when they are roosting. The most common roosting sites are areas of sparse, low-growing sagebrush, usually an old sheep bed-ground; or they may roost along a rocky ridge top, a type most commonly chosen in the winter. These areas of sparse vegetation are probably chosen because of the easy, quick escape that is possible at night.

FOOD HABITS

For the purpose of making a food-habit study 107 stomachs were collected from both adult and juvenile birds. Data, however, are present on only 62 of these stomachs, as the others, due to an unavoidable accident, were destroyed. The majority of these stomachs were collected from birds killed by cars on the highway that passes through the area. United States Highway 40 is graveled at this point, and, in addition to those birds killed while crossing it, many other birds visited it during the morning and evenings to use it as a dusting ground. A number of stomachs were also collected from fresh predator kills.

When a specimen or stomach was collected, it was numbered, tied in a piece of cheese cloth, and preserved in a 10 percent solution of

formaldehyde. Each stomach was carefully recorded in note form. The stomachs were then submitted to the section of Food Habits Research of the United States Biological Survey, where the food material contained in the crops and stomachs was identified. A summary of their contents is shown in tables 12 and 13. The only series of sage grouse stomachs examined, previous to the present study, was a set of 33 stomachs obtained by Girard during July and August, 1934, in Sublett County, Wyoming.

The adult sage grouse, as shown from this and other studies, is primarily a vegetarian. Although it varies its diet quite markedly by the seasons, it is plant material that provides the bulk of its food. From the present study of stomachs taken in 6 months of the year 1937, May to October inclusive, 97.64 percent of the adult bird's diet was plant material, and of this, 77.50 percent consisted of the 2 species, Artemisia tridentata and A. cana. Eighty-five and eighty-four hundredths percent of the total diet was plants of the family Compositae. Other important plant foods were grasses, which made up 3.91 percent of the total contents; Leguminosae, (principally Trifolium), constituted 2.35 percent; and Ranunculaceae, 2.95 percent. The remainder consisted of various items, which were apparently chosen at random. Only 2.4 percent of the adult's summer food was animal material, and this consisted almost entirely of Hymenoptera of the family Formicidae. The second item was Coleoptera, principally members of the Carabidae, and Tenebrionidae families. A few Hemiptera and Orthoptera made up the balance of the animal diet of the adults (figs. 5, 6, 7).

In the case of the very young sage grouse, the diet was entirely different from that of the mature birds, as is shown in tables 12 and 13, and figures 8 and 9. It is not deemed desirable to average the results

Table 12. Summary of plant material eaten by sage grouse (1), Strawberry Valley, Utah, 1936-37

	May	June		July		August		September		October		Adult average
Age and number (61) (A-Adult, J-Juvenile)	A-11	A-2	J-4	A-3	J-13	A-1	J-8	A-3(2)	J-10	A-3	J-3	22
Plants percentage of total diet	98.3	98.5	52.5	94.6	56.4	99.0	95.5	95.0	94.5	99.0	99.5	97.64
Compositae (misc.)					.4		5.0		10.3		1.0	
Artemisia (2 spp.)	80.1	95.0	25.0	75.2	22.1	30.0	36.3	42.0	66.4	98.3	92.5	77.50
Taraxacum	1.8	3.5			4.2		9.8	45.5	.6			5.35
Solidago	.1				4.1	57.0	1.3	2.5			3.3	2.85
Achillea lanulosa					2.2	1.0	9	1.0			1.5	.14
Gramineae (misc.)	5.1			5	2.8	11	18.1	1.0	7.8	.66		3.91
Polemoniaceae												
(Gilia)			25.2	9.6	10.3							1.31
Leguminosae (misc.)			1.2					3.0				.30
Trifolium	4.1				7.6		4.7		6.9			2.05
Ranunculaceae	5.9											2.95
Chenopodiaceae							2.5					
Rubiaceae					1.2							
Berberidaceae					.2		1.3					
Geraniaceae									.5			
Cruciferae	.4			.3							1	.24
Cyperaceae					.1		1.2					
Juncaceae					.8		.6					
Undetermined	.4			3.3	.2		5.5		1			.65
Misc. (3)	.4		1.1	1.2	.2		.2		1.0	.04	.2	.35

(1) Includes all plant items that constituted 1 percent, or over, of any one of the 61 sage grouse stomachs analyzed.

(2) Averages determined from 2 stomachs; the third was 99% unidentifiable plant material.

(3) Items that occurred only as traces often were lumped in the volume tabulation, and accounts for a volume value here. Eighteen different identifiable plant items occurred only as traces. Fifty-six traces were recorded for these items. Four items included in the group Polygonaceae comprised 33 of the traces. No other item occurring only as a trace was recorded over twice.

Table 13. Summary of animal material eaten by sage grouse (1), Strawberry Valley, Utah, 1936-37

	May	June		July		August		September		October		Adult average
Age and number (61) (A-Adult, J-Juvenile)	A-11	A-2	J-4	A-3	J-13	A-1	J-8	A-3 (2)	J-10	A-3	J-3	
Percentage animal material in total diet	1.70	1.50	47.50	5.30	43.60	1.0	4.5	5.0	5.5	1.0	0.5	2.34
Hymenoptera (misc.)					24							
Formicidae (6 genera)	1.34		35.75	5.30	26.30	1.0	3.13	3.0	1.5	1.0	0.5	1.90
Coleoptera (misc.)	.09	1.5	2.0		1.75			2.0	.50			.31
Tenebrionidae			2.75		5.50		.13		1.10			
Coccinellidae	.27		.50		1.00		.40		.40			.14
Carabidae			.50		1.08		.13					
Cureulionidae			.75		.54				.10			
Hemiptera			5.0		6.30		.13		.10			
Orthoptera					.08		.51		1.70			
Lepidoptera			.25		.22							
Diptera					.15							
Gen. misc. (3)					.4		.07		.10			

(1) This table includes all animal items that constituted 1 percent, or over, of any one of the 61 grouse stomachs analyzed.

(2) Average of 2 stomachs, as third was 99% unidentifiable plant material.

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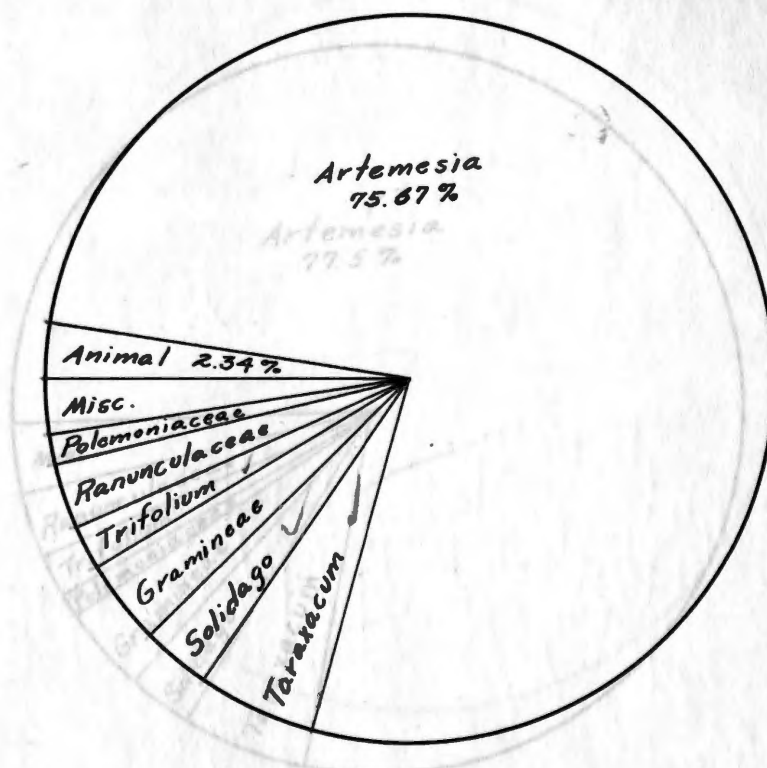


Figure 5. Foods eaten by adult sage grouse during a 6-month period, May to October 1937

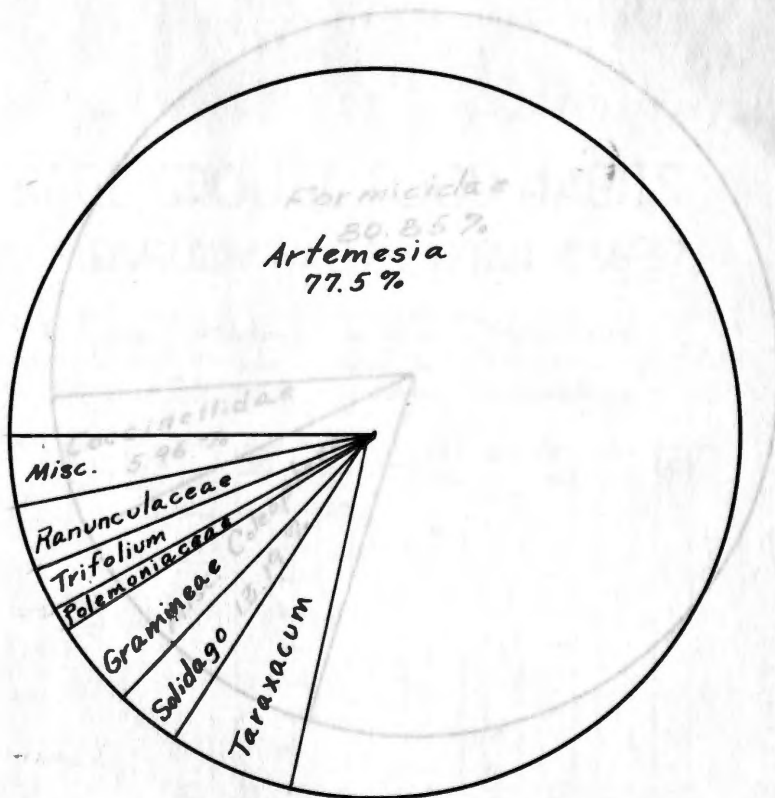


Figure 6. Plant material eaten by adult sage grouse over a 6-month period, May to October 1937

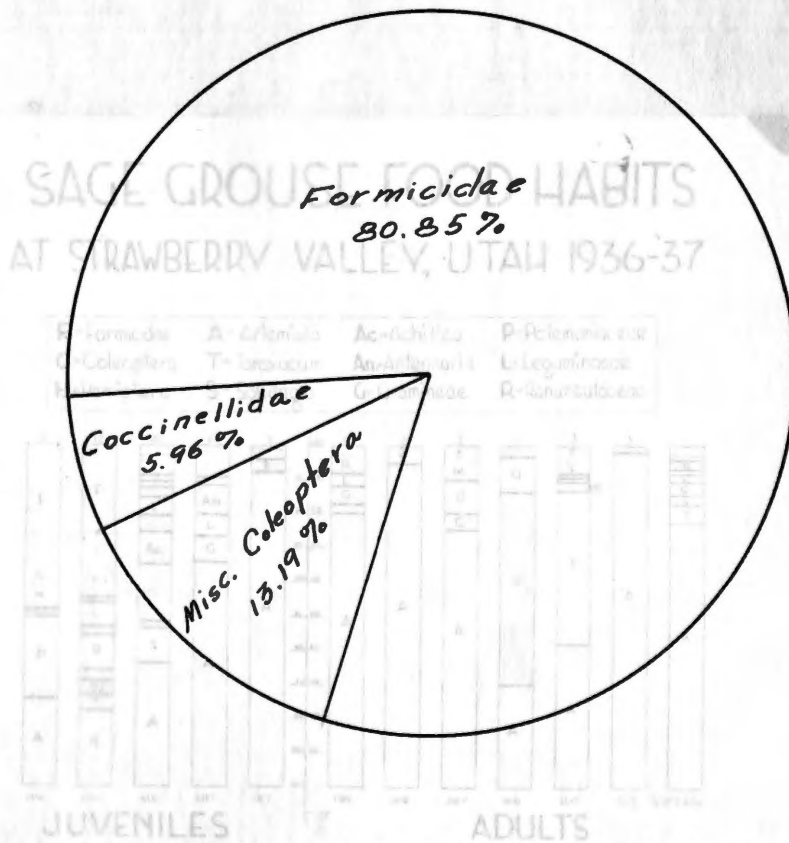


Figure 7. Principal animal foods of the adult sage grouse over a 6-month period, May to October 1937

Figure 8. Sage grouse food habits at Strawberry Valley, Utah, 1936-37

SAGE GROUSE FOOD HABITS AT STRAWBERRY VALLEY, UTAH 1936-'37

F = Formicidae A = Artemisia Ac = Achillea P = Polemoniaceae
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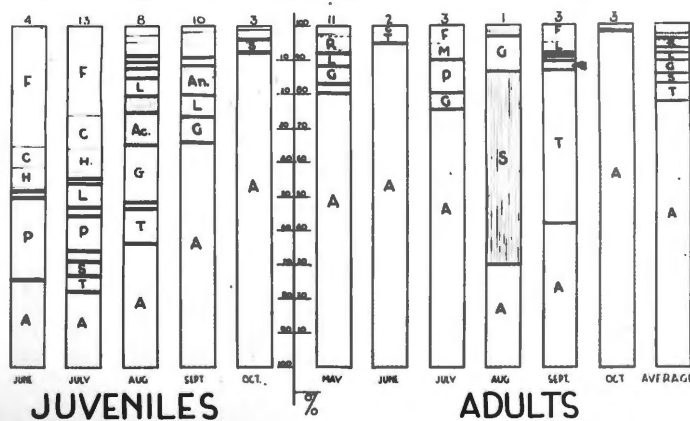


Figure 8. Sage grouse food habits at Strawberry Valley, Utah, 1936-37

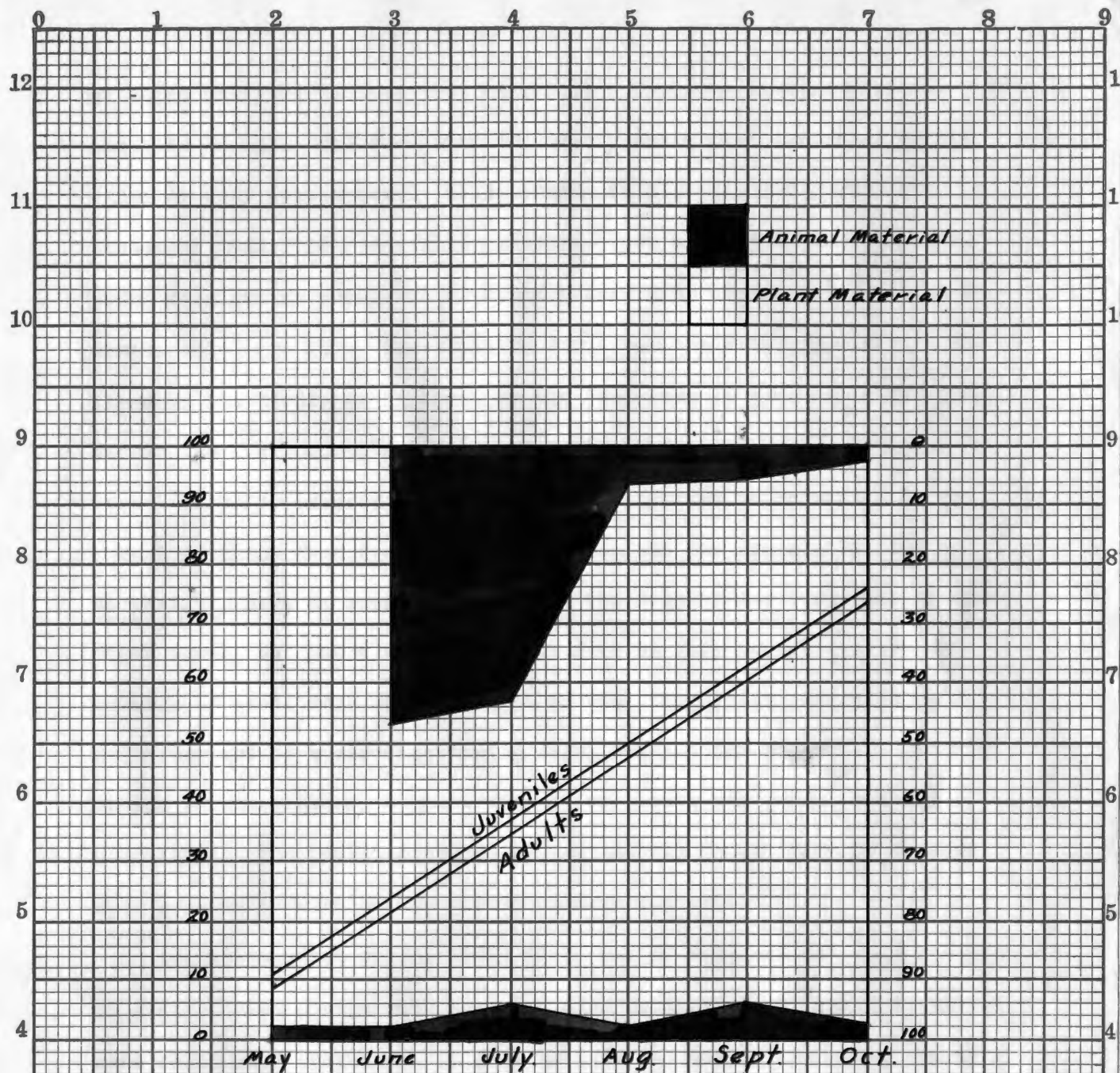


Fig. 9. Percent of plant and animal matter eaten by 22 adult sage grouse and 39 juveniles from May to October 1937.

of these analyses because they represent a changing diet, associated with increase in age. The juveniles ate 52.5 percent plant material during June; in July 56.4 percent; 95.5 percent in August; 94.5 percent in September; and 99.5 percent in October. From this it appears that the young sage grouse change to an adult grouse diet when they are about 3 months old (fig. 10). The appetite for Artemisia develops early in the lives of the birds, as is shown by the fact that 25 percent of the food during the first month consists of plants of this genus. Some small vernal annuals, present on the area, were observed to provide a large amount of plant food for the young grouse, and one especially, Gilia harknessii, made up over 25 percent of the diet of the birds during their first month, and was a very important food in July as well. Various species of grass were of importance to the young grouse and made up a definite part of their diet during July, August, and September. In addition to these items, a great variety of plants was eaten in small quantities. The table, however, indicates only those items which made up 1 percent or more of any bird's stomach contents.

The animal diet of the young birds was of interest not only because of its definite change with age, but also because of the large amount of ants which were consumed. In June over 36 percent of the young grouse's diet consisted of members of the family Formicidae; in July it was over 26 percent, but this had decreased, until in August the contents were only slightly over 3 percent. In addition to ants, a great variety of insect life was taken, principally Coleoptera, of the families Tenebrionidae, Coccinellidae, Carabidae, and Curculionidae. Six and five-tenths percent of the June diet was beetles, 9.87 percent of the July diet, but only .66 percent of the August diet. In addition, some Hemiptera, and, during

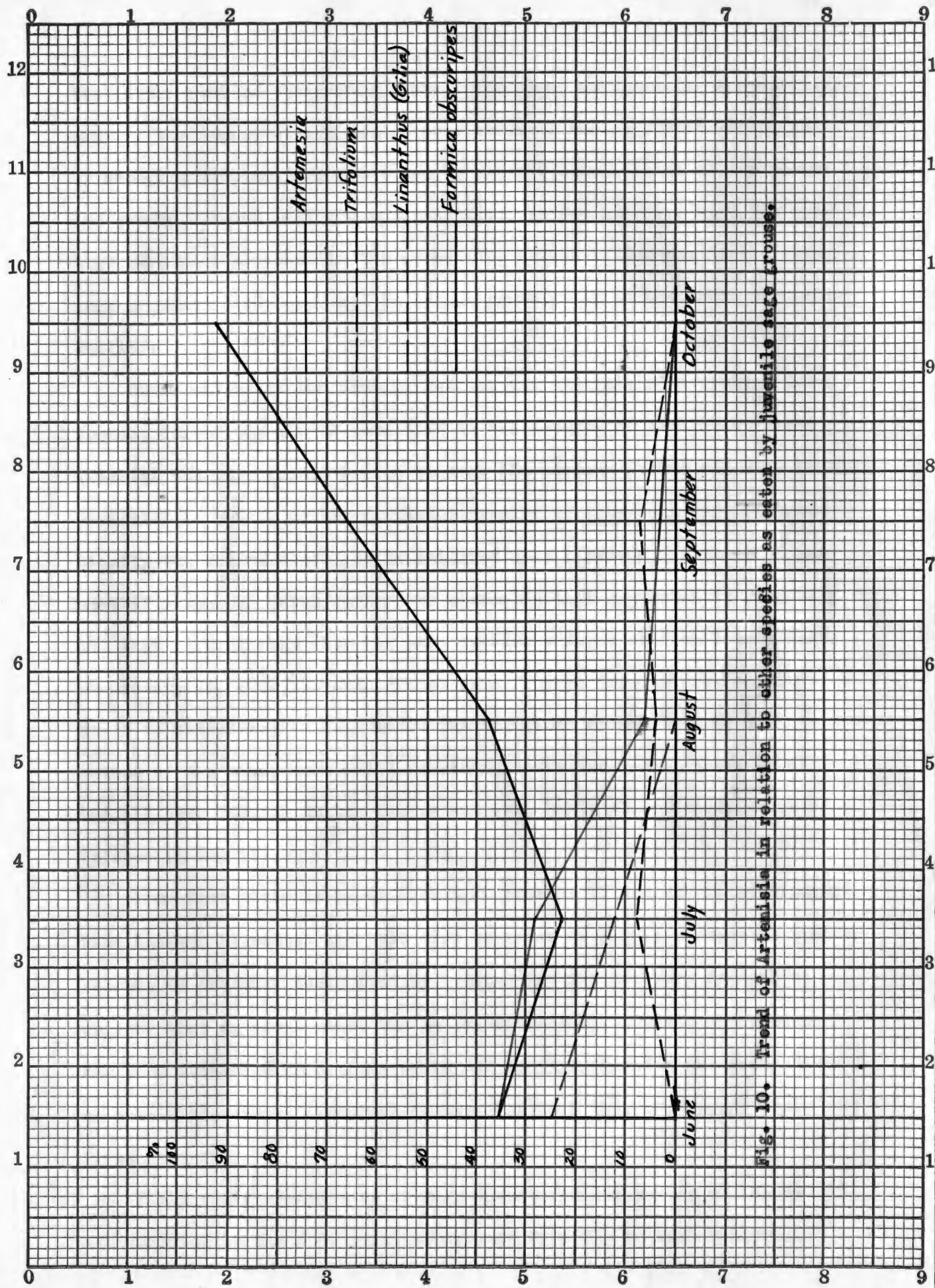


Fig. 10. Trend of Artemisia in relation to other species as eaten by juvenile sage grouse.

the latter part of the summer, some Orthoptera, were taken. Examinations made of the summer season insect population of the sagebrush areas, made by sweeping with an insect net and by general examinations of the plants and ground, showed that the species listed in the analyses were the ones that were most abundant in the area. The choice of insects in the young sage grouse's diets appeared to be due principally to the order of availability.

Observations of the feeding habits, and analysis of droppings collected, during the winter show that in the absence of available insect material the sage grouse's diet is near 100 percent plants and very little variation is shown, as the different species of Artemisia provide practically the entire diet. It is believed that 1 reason for the high percent of sagebrush eaten during the winter is that sagebrush is generally all that is available when the snow reaches a depth of from 1 to 2 feet. On January 26, 1938, 23 sage grouse were flushed from an area on Windy Ridge in Strawberry Valley, where the sagebrush crowns, due to the action of the wind, were still remaining above the snow. These birds had all been feeding on the leaves and seed heads of Artemisia tridentata (plates 16 and 17).

From this study it is difficult at present to see any direct competition between livestock and this bird on areas of highly productive summer ranges, as concerns their feeding habits. It is, however, logical to suppose that in areas where the entire understory of weeds and grasses has been destroyed conditions would not be favorable for the young birds to obtain the varied plant and insect diet that they use during their first summer.

Field observations made of sage grouse feeding during the summer are verified by the food habit study made from the stomach analyses.

While in the field the following plants were listed as having been used as food by the sage grouse:

<u>Artemisia cana</u>	-----	Water sagebrush ✓
<u>Artemisia tridentata</u>	-----	Common sagebrush ✓
<u>Taraxacum officinales</u>	-----	Dandelion ✓
<u>Achillea lanulosa</u>	-----	Yarrow ✓
<u>Polygonum douglasii</u>	-----	Knotweed ✓
<u>Gilia (Linanthus harknessii)</u>	-----	Chickweed ✓
<u>Androsace</u>	-----	Chickweed
<u>Trifolium sp.</u>	-----	Clover ✓
<u>Erigeron sp.</u>	-----	Daisy
<u>Rumex sp.</u>	-----	Dock ✓
<u>Poa pratensis</u>	-----	Blue grass ✓
<u>Phleum alpinum</u>	-----	Mountain timothy ✓
<u>Stipa sp.</u>	-----	Needle grass ✓
<u>Agrostis sp.</u>	-----	Red top ✓
<u>Sitanion sp.</u>	-----	sitanion
<u>Carex sp.</u>	-----	Wire grass ✓
<u>Eriogonum sp.</u>	-----	Indian tobacco ✓
<u>Orthocarpus sp.</u>	-----	Orthocarpus
<u>Pentstemon sp.</u>	-----	Beards tongue
<u>Fragaria sp.</u>	-----	Strawberry
<u>Potentilla sp.</u>	-----	Cinquefoil

When feeding, the sage grouse generally take the tops from the plants in a grazing manner. The following quotations, taken from field notes made during this study, will indicate some of the plants eaten by the sage grouse, and the manner in which they were grazed.

At 8:00 p.m. on June 23, 1936, 20 sage grouse were observed feeding in a meadow and along the highway in Strawberry Valley. The birds were seen to take the heads from dandelions and yarrow. They were also seen feeding on some grasses and careces. They remained feeding in the meadow until about 8:30.

On July 31, 1936, a hen and her brood of six chicks were feeding in the yard at the highway camp. These birds appeared to be feeding heavily upon Poa pratensis, and Polygonum douglasii, and, to a lesser extent, upon Erigeron sp. and Taraxacum officinales.

All of the material collected for this food habit study has been obtained from the sagebrush and natural range lands. This may not give the complete and correct picture of the food habits of these birds, as the sage grouse not only inhabit the open range lands, but large flocks

are found in the dry wheat and alfalfa farm areas of northern Utah and southern Idaho. At present, there does not seem to be any reliable information concerning the food habits of the sage grouse in these cultivated areas. There is not total agreement on the question as to whether or not sage grouse eat ripened grain. From the anatomical standpoint it is rather doubtful that the sage grouse eat hard and dry grains, as



gives the following information:

Animals obtain water from four sources, which may be labeled for purposes of game management:

1. Drinking water. This means surface water in the ordinary sense of pools, springs, brooks, etc. As nearly as is possible, the sage grouse is included in this category. **Plate 18. Sage grouse feeding in an open meadow area near the Strawberry River. Note the sagebrush and willows in the background**

2. Dew water. Many birds drink dew drops, or water condensed from fogs, when it collects on vegetation.

3. Humulence. This means water contained in plant foods of high moisture content, such as fruits, berries, green leaves, sprouts, flowers, and interior pulp of fleshy plants like cacti. It also includes water contained in animal food of high moisture content, such as insects and insect eggs.

4. Metabolic water. Some species (including many rodents and insects) are now known to possess the ability to convert the carbohydrates eaten as food, or as reserve body fats, into water. Such internally manufactured water is called metabolic water.

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WATER REQUIREMENTS

Concerning water and water requirements of animals, Leopold (9) gives the following information:

Animals obtain water from four sources, which may be labeled for purposes of game management:

1. Drinking water. This means surface water in the ordinary sense of pools, springs, brooks, etc. As nearly as is known, all game animals utilize drinking water when it is available, whether or not they are dependent on it. Snow is included in this category.
2. Dew water. Many birds drink dew drops, or water condensed from fogs, when it collects on vegetation.
3. Succulence. This means water contained in plant foods of high moisture content, such as fruits, berries, green leaves, sprouts, flowers, and interior pulp of fleshy plants like cacti. It also includes water contained in animal food of high moisture content, such as insects and insect eggs.
4. Metabolic water. Some species (including many rodents and insects) are now known to possess the ability to convert the carbohydrates eaten as food, or as reserve body fats, into water. Such internally manufactured water is called metabolic water.

The presence or absence of a drinking water supply (according to Leopold's classification) is not a reliable criterion in determining a suitable sage grouse range. It is true, however, that water in some form or another is necessary to supply the physiological demands of the species.

Sage grouse will drink water when it is available. The following quotation from field notes emphasizes this point: "Between 6:00 and 6:35 a.m. on May 10, 1936, I saw 17 sage grouse (11 females and 6 males) stop feeding and walk a short distance to water, where they drank and then continued to feed. Again on the same day at about 6:45 I saw two female birds drinking at a small pond along the road." The water used by sage grouse need not be from fresh springs or streams, but can be obtained from stagnant ponds, succulence, or dew water. In an area where dew and succulent vegetation may be had during the summer and fall, it is not necessary to have a supply of fresh running water.

The following information, from a memorandum prepared by Professor A. D. Smith concerning the sage grouse near Holbrook, Oneida County, Idaho, gives an instance where sage grouse were able to raise their broods in an area where drinking water was scarce:

There is very little water in the whole valley. It only occurred naturally in one or two areas, and the sage grouse completed their nesting and brooding activity without access to it, as evidenced by the large numbers present and the very small numbers that have visited the little springs that were there. The evidence is definite that many of the grouse were entirely independent of a permanent water supply. It is, however, thought that during the late season these birds desired water, since they could generally be found in greater numbers in the vicinity of available water.

In the Strawberry Valley water is abundant over the entire range. This fact makes it hard to determine the amount and kinds of water necessary to meet the physiological demands of the sage grouse. Rain

falls quite regularly during the last of June, July, and in the forepart of August, thus providing an ample supply of water during the summer season. This abundance of water during the growing season insures a good crop of succulent plants. This source of water, coupled with the many springs, creeks, seeps, the river, and the lake, gives an adequate water supply at all times.

In contrast with the excellent conditions found in Strawberry, the sage grouse on the Parker Mountain range apparently have a much more difficult time in obtaining water. On this range the only source of drinking water is that obtainable from stock watering holes, and the few springs that have been developed under the direction of the U. S. Division of Grazing. Plant growth on this range has been so depleted that there are few plants that would offer succulence to the sage grouse or any other game species. Even the sagebrush has been so depleted that it offers little in the way of food or protection. Sage grouse on the Parker Mountain range may be regularly found inhabiting the areas near the water holes and springs. Nearly every morning and evening while the author was studying conditions on this range, the sage grouse were seen coming in to water at the artificially developed water holes. In addition to watering, the grouse were seen feeding on some of the more succulent plants growing near the water's edge. Rarely were the sage grouse on the Parker Mountain range seen on areas more than a mile from these water supply areas.

Ranger Peterson, of the Caribou National Forest at Soda Springs, Idaho, stated that there had been an increase in the number of sage grouse in Dry Valley following the development of some water holes for livestock by the U. S. Forest Service. Prior to this development there was little water available.

The kind and the amount of water and its distribution over the range may be one of the factors that will limit the natural spread of this fine game bird.

MORTALITY FACTORS

Nesting Mortality. A tabulation of nesting mortality is shown in table 14. There are 3 distinct classes of nesting failure, namely, destruction, desertion, and infertility. These 3 types of failures accounted for a total of 64 nests, or 40.03 percent of the nests observed.

Table 14. Probable causes of nesting destruction and desertion

Causes of mortality	Number of nests deserted	Number of nests destroyed
Carnivore	0	23
Stook	5	2
Man	15	2
Unknown	1	7
Ravens	0	7
Infertility	2	0
Total	23	41

Figure 11 shows the factors responsible for nesting mortality and the number of nests that contributed to each other.

Nest destruction is the greatest of the 3 factors, as 41, or 25.46 percent of all nests, were destroyed. As indicated by signs at the nests, these nests were destroyed by the following:

1. Carnivores (coyotes, skunks, and weasels), 23 nests.
2. Raven, 7 nests.
3. Unknown causes, 7 nests.

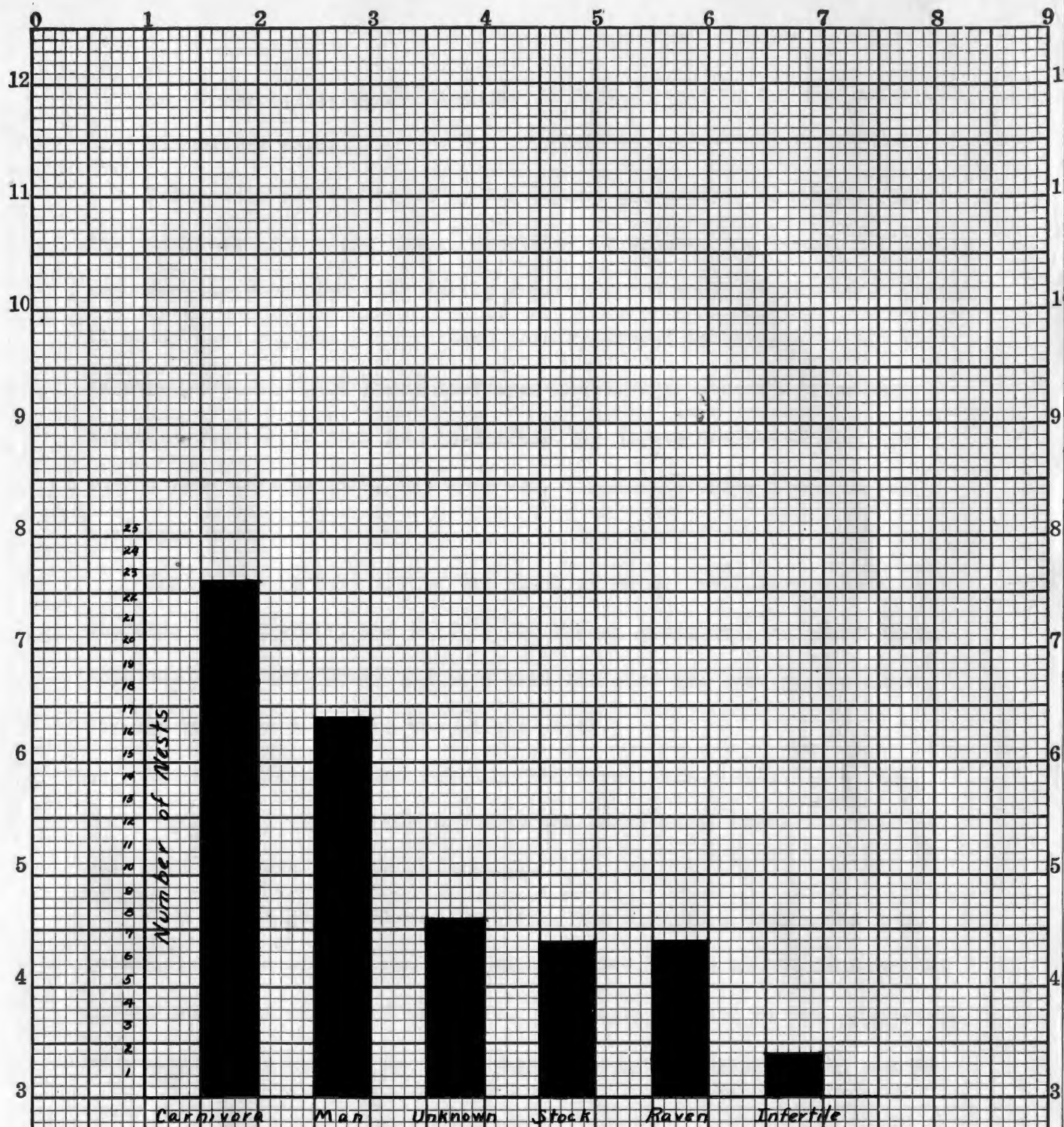


Fig. 11. Nesting mortality, according to type.

4. Domestic livestock, 2 nests.

5. Man, 2 nests.

Nests that are destroyed by the coyote can usually be identified by the condition of the egg shells remaining in or near the nest. The shells are completely crushed and usually a part of the shell is missing. Plate 11 shows some egg shells that have been destroyed in various ways. In an attempt to check on these destroyed nests, eggs were fed to a penned coyote. The shells that remained after the coyote had eaten the eggs varied from time to time, but were very similar to those found in the destroyed nests.

Egg shells left by either the skunk or weasel will have a hole in the side of the shell, and part of the broken shell will be pushed back into the egg. This would indicate that the nose had been pushed into the egg in order to secure the edible parts.

The eggs destroyed and eaten by the raven show a hole and a few small peck holes on the side opposite the large hole, where the bill had been used in breaking through the egg.

When a nest was destroyed by stock, the eggs were crushed on the ground, and none of them would be eaten. Also, there may be foot prints on the ground in or around the nest. Generally not all of the eggs would be broken, as is usually the case when the eggs are destroyed by a predatory animal.

In a number of cases it was impossible to determine just which one of the 3 listed carnivores was responsible for the nest destruction, therefore, their grouping under the general heading of carnivores.

In other cases definite evidence was missing which would indicate the responsible predator, necessitating that they be classified as unknowns.

Of the 2 destructions contributed to man, one was a case of poaching and the other an accident incurred during this study.

In the case of the 2 nests destroyed by livestock one is attributed to sheep and the other to cattle, as they were the only class of stock using the area where the destruction occurred.

Of the 161 nests studied 23, or 14.28 percent, of them were deserted. Nearly all of these nests were deserted during the early part of the nesting season and usually contained incomplete clutches or clutches in which incubation had just begun.

The following factors were listed as the causes of desertion:

1. Man, 15 nests.
2. Livestock, 5 nests
3. Infertile clutches, 2 nests.
4. Unknown causes, 1 nest.

Eleven of the deserted nests which were attributed to man were incurred during the first 2 weeks of the nesting study. The other 4 occurred later in the nesting season and are not directly attributed to the nesting survey.

The livestock which accounted for the 5 desertions were both sheep and cattle. In all cases the stock either knocked eggs from the nest or bedded down too near the nest.

In 2 instances the female remained on her eggs for over 30 days before deserting the nest. All of the eggs in these 2 clutches proved to be infertile when opened. Infertile eggs (1 or 2) were also found in some of the nests that were hatched.

The possibility of a sixth nesting mortality factor, that of cold, wet weather during the incubation period, has been reported. Mr. Bruce,

a forest ranger at Montpelier, Idaho, is of the opinion that the cold, wet, windy days in May are one of the limiting factors of the sage grouse numbers in Elk Valley on the Caribou National Forest in Idaho, as many nests have been found abandoned following a period of cold, wet days.

The combined mortality factors accounted for 334 of the 953 eggs that were observed during the 2-year study and on which we have a complete check. Therefore, the nesting mortality when considered from the standpoint of the number of eggs destroyed is 35.04 percent instead of the 39.10 on the basis of the total number of nests destroyed.

Predations and Accidents. The losses of birds may be accounted for by the following mortality factors: (1) predations, (2) accidents, (3) poaching, (4) weather changes, and (5) diseases and parasites.

Like most other species of wildlife, the sage grouse are subject to predation by several predatory species. The principal natural enemies of these birds, as noted in this study, are: coyote, weasel, golden eagle, and some of the hawks.

At the present time there is little definite proof, such as stomach analyses, study of droppings, or direct observations of kills, that any of these animals are responsible for a great amount of predation upon the sage grouse. There is, however, evidence that points towards these species as preying upon the grouse.

Remains of dead birds usually had tell-tale evidence of what caused the losses. It is generally possible to tell by the condition of the remaining carcass whether the responsible predator was a coyote, weasel, or hawk.

A coyote generally consumes all but the entrails, wingtips, and feet of the kills that it makes. However, at times the entire bird may be eaten, or again just a portion of it. This type of kill may be

distinguished from a hawk kill, in that the hawk, and perhaps the eagle, consumes very little bone, usually leaving the skeleton intact, but strips off the flesh. Both the coyote and the hawk generally leave the intestines and gizzard. In the weasel kills, very little flesh is taken, and that usually from around the head, neck, and back. In one instance, a dead sage grouse with only a small portion of the neck eaten was found lying over a weasel hole in the snow. Some remains of sage grouse were observed in coyote droppings, and evidence of sage grouse chicks were found in one of a series examined. Skunks and mink were present in the area, but no direct evidence of predation was noted by either of these.

Just which species of hawks kill the sage grouse has not been determined. The following hawks are found in the study area: the Goshawk, Cooper's hawk, red-tailed hawk, American roughlegged hawk, ferruginous roughlegged hawk, marsh hawk, and the Swainson's hawk. By common report, the Goshawk was responsible for numerous losses.

In addition the golden eagle is known to take sage grouse. A golden eagle taking a sage grouse was seen on May 12, 1936. Quoting from field notes: "At 10:30 a.m. this morning I flushed six sage cocks, and while watching them through my binoculars I saw a golden eagle swoop in from the side and hit one of the birds with its feet, knocking it to the ground. It then flew down, picked up the bird, and flew off with it."

A large part of the predation upon the sage grouse in the Strawberry Valley takes place in the late summer, fall, and winter after the rodents, which no doubt act as buffer species, have hibernated. This is evidenced by the increased number of fresh kills that are found following the holing-up of the ground squirrels (Citellus armatus). During the summer of 1937 no fresh kills were located between May 23 and July 20 (table 15).

Table 15. Predations and their relation to vegetative types

Date	Number of kills	Age group	Predator	Location of kill as to vegetation
5-22-37	1	Adult	Coyote	
5-23-37	1	"	"	
7-20-37	1	"	"	Artemisia cana
7-27-37	2	"	Hawks	
8-8-37	1	Juvenile	Skunk or weasel	A. tridentata, sparse
8-26-37	6	"	Coyote	Edge of A. cana & meadow
8-27-37	1	"	"	" " " " " "
9-23-37	5	"	"	" " " " " "
9-23-37	3	Adults	"	" " " " " "
9-23-37	1	Juvenile	Hawk	" " " " " "
9-23-37	1	"	?	" " " " " "
9-24-37	4	"	Hawks	" " " " " "
9-24-37	1	Adult	"	" " " " " "
9-26-37	1	Juvenile	"	" " " " " "
10-17-37	2	Adults	"	" " " " " "
10-17-37	2	Juveniles	Weasel or skunk	A. tridentata
10-17-37	2	"	Coyote	Edge of A. cana & meadow

This, however, does not mean that there was no predation on the adult birds at this time. Most of the nesting predation occurred during this period. From July 20 to August 8, 1937, there were only 4 dead birds located. At about this time the greater part of the ground squirrels had begun to hibernate, as is illustrated in figure 12. After August 10 the number of kills by predators increased considerably. Table 15 gives the date (for 1937) of the number killed, the responsible predator, and an indication of the vegetative type. Most of these birds were killed along the edges between Artemisia cana and the open meadows. This would tend to indicate that, especially in the case of coyote predations, the birds are killed either as they move out of the sagebrush areas into the meadows to feed, or later in the evening as they moved back from the meadows into the sagebrush after feeding and before going to roost. Birds killed both by hawks and coyotes may have been killed in the open meadows while feeding and then carried to the sagebrush borders to be eaten.

Table 16. Number of predations and accidents found in relation to man-days spent in the field by months

		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Man-days spent in the field		34	21	31	48	12	6	0	9	21	16
Predatory kills	Winged	0	0	2	0	8	2	0	0	0	0
	Ground	2	0	1	8	8	3	0	0	0	0
Accidents		4	2	13	2	0	0	0	0	0	0

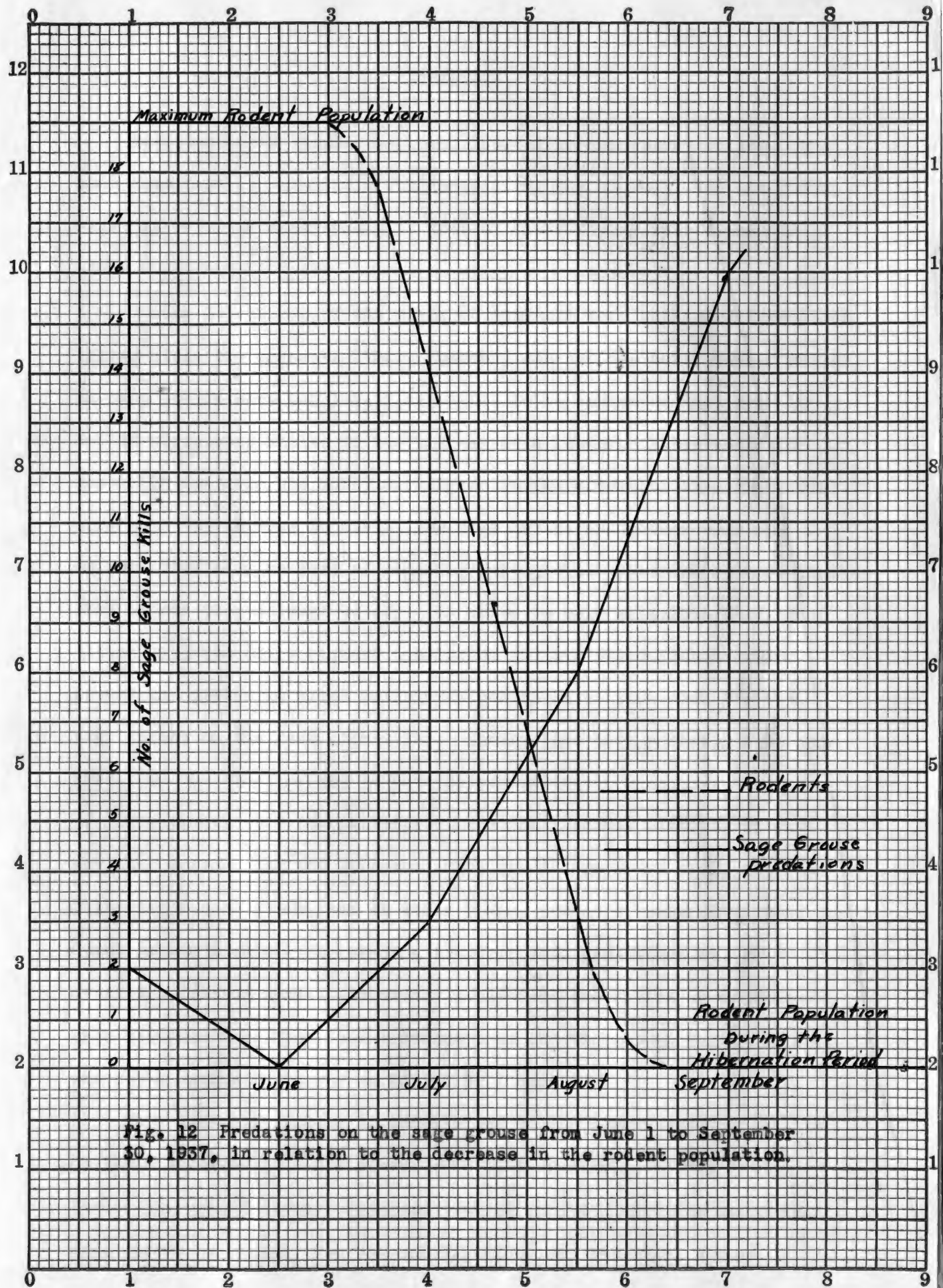


Fig. 12 Predations on the sage grouse from June 1 to September 30, 1937, in relation to the decrease in the rodent population.

ACCIDENTS

Accidents of 2 kinds have been observed in Strawberry Valley. The most important is automobile accidents along the highway, and the other, which is of minor importance, is that of birds flying into fences or other stationary objects.

During the course of the study 55 stomachs were collected from birds killed along the highway. This, however, was not the total number killed, as many others were completely crushed. It is estimated that from 100 to 125 birds were killed on the highway each summer. These accidents generally occur in the early morning or in the afternoon when the birds come onto the highway to dust. The sage grouse are rather tame and seem to have little or no fear of a moving automobile. Fast moving cars strike them before they attempt to fly. In order to help alleviate this condition the Utah State Highway Commission and the State Fish and Game Department posted 10 signs asking the motorists to slow down for the sage grouse on the road (plate 19). These signs have probably done some good, but the exact effect is hard to determine.

The number of birds killed on the highway varies with the time of day, the season, and the climate. More grouse are found along the road following a rain storm than at other times, probably because the road dries faster than the surrounding country, thus presenting the only available dusting areas. Generally more birds are killed in mid-summer when the hens take their young broods onto the highway to dust. In some cases the entire brood may be killed by 1 car.

This mortality factor is not limited to the Strawberry Valley, but has been observed in other areas. Mr. W. H. Marshall, of the United States Biological Survey, reported that on July 28, 1937, he saw 5 dead sage grouse on highway 89, between Big Piney and Kemmerer, Wyoming.

This mortality factor may appear high in comparison with the other factors, mainly because it is much more evident and is restricted to a very narrow strip in which practically all of the dead birds will be seen; while in the case of predation, only a small percentage of the dead birds are ever found.

Poaching still persists and shall probably always exist in some areas. Little can be done to prevent this, but it should be kept in mind that any bird that is killed in this manner, and any

At the present time the loss of birds during severe wintering the snow and dis- very possible that may account for, is food shortage direct information



Plate 19. Sign used to help modify the accident mortality conditions in Strawberry Valley

In addition to the summer's sudden change in the climatic conditions may kill some of the smaller chicks. A severe hailstorm may also kill not only the chicks but also the adult birds. There is a report of such a storm in Strawberry Valley. Mrs. George Hansen reported that during the winter of 1934

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Poaching still persists and shall probably always exist in some areas. Little can be said in regard to poaching, as its effects cannot be measured with any degree of accuracy, because it is done in an underhanded manner, and any evidence of its having been done is usually destroyed.

WEATHER

At the present time there is not much that can be said regarding the losses of birds due to weather conditions. It is possible that during severe winter storms some of the sage grouse may become caught under the snow and die. During periods of extremely cold weather it is also very possible that some of the birds may freeze. Another factor that may account for, or cause, losses of birds during a winter of heavy snows is food shortage and resultant starvation. The possible reasons that no direct information regarding these probable losses has been collected may be because: there have been so few observations made during the winter months; the dead birds are probably eaten by other animals; and each new snow covers up the evidence that was present before the snow fall.

In addition to the winter losses it is possible that during the summer a sudden change in the climatic conditions may kill some of the smaller chicks. A severe hailstorm may also kill not only the chicks but also the adult birds. There is 1 report of such a storm in Strawberry Valley. Mrs. George Madsen reported that during the summer of 1934

they had a severe hailstorm in the valley and that following the storm several dead sage grouse were found near their camp. This and other factors are hard to evaluate as there is so little information regarding them available at the present time.

Parasites and Disease. A tapeworm, Raillietina centroceri Skj. (13), is very frequently found in the sage grouse. This tapeworm is found in and near the central part of the small intestine. This parasite is most common during the spring and summer months. During the mating season it is not at all uncommon to find several proglotids in the droppings of the sage grouse. This has been especially noticeable on the strutting grounds.

Usually there are only a few tapeworms found in each individual, but there have been a few cases when the number has approached 100. In 1 instance 78 tapeworms were taken from 1 bird. At such times they are abundant enough to obstruct the intestine. The filling of the digestive canal by large numbers of these tapeworms might block the passage of fecal material and thus result in death. This tapeworm was the only endoparasite which was found during this investigation. Lice (of the order Malophaga) were frequently found on the birds.

Felix Simon (13), of the University of Wyoming, is now preparing a list of the parasites of the sage grouse.

There has been considerable discussion concerning the effects that rodent poisoning campaigns have had on the sage grouse. A number of times dead sage grouse have been reported on the areas where such control work has been undertaken. Dead sage grouse have also been reported near the carcass of a poisoned horse used for coyote control (16).

The problem of the effect of poison grain has been given careful consideration by the United States Biological Survey, resulting in the

publication of leaflet Bi-1028 (3), showing from experiments that galinaceous birds have a relative immunity to strychnine poisoning and are not likely to be harmed by strychnine when it is used in the proportions recommended by the biological survey for rodent control.

The following discussion is a summary of a memorandum prepared by Dr. D. I. Rasmussen for the United States Biological Survey: In 1936 an experiment was undertaken in the hope that additional light might be thrown on this problem. Three acres (2 of which had controls), making a total of 8.9 acres, were established, and the standard United States Biological Survey bait (poisoned oats) for the control of ground squirrels, purchased from the county agent, was distributed at the entrance of the burrows of all ground squirrels. These plots were in areas of heavy sage grouse population (hens with broods). Observations were made for approximately 30 days, during which time the number of dead squirrels and other animals was tabulated; however, no definite results were obtained. Tables 17 and 18 are tabulations of the results of these counts.

Table 17. Record of experimental poison plots

Area	Dead ground squirrels first day	All subsequent days	Total
Area A (2.5 acres)	4	43	47
control			
Area A' (2.5 acres)	0	0	0

Following this experiment, on July 18, 1936, 3 young sage grouse were placed in specially constructed holding pens. Care was taken to make sure that an abundance of suitable foods was available at all times. A number of ground squirrels were shot and left on the ground for 2 days. These squirrel carcasses were then placed on the wire top of the holding pen, allowing the fly larvae to fall into the pen where they would be

Table 18. Record of experimental poison plots and dead animals. (Each animal counted but once)

Area established	Date July, 1936	4	5	6	(2) 7	8	9	10	11	12	13	14	15	16	17	(7) Total
B (2.8 acres) July 3, 1936, 4 p.m.	Ground Squirrels	176	49	(1)	12	(1)	(3)	0	0	0	0	0	0	0	(5) 3	240
	Others	0	1BB		1CB		0	0	0	0	0	0	0	0	(6) 1SG	1BB 1CB 1SG
B' (2.8 acres) July 3, 1936, 5 p.m.	Ground Squirrels	0	0		0			0	0	0	0	0	0	0	0	0
	Others	0	0		0			0	0	0	0	0	0	0	0	0
C (3.6 acres) July 3, 1936, 7 p.m.	Ground Squirrels	243	47	(1)	29	(1)	(3)	0	0	0	0	0	0	0	0	319
	Others	2P	1BB	2P 1CB		8BB 1CB (4)	0	0	0	0	0	1BB	0	0	0	10BB 2CB 4P

BB = Brewer Blackbird

(1) Visited but made no exact counts.

CB = Cowbird

(2) Notes say very small amount of grain remaining, somewhat damaged by showers.

P = Peromyscus mice

(3) Visited, but could not make accurate count on rodents because of severe rain storms on dead animals. Very few if any were newly dead.

SG = Sage Grouse

(4) Possibility that these blackbirds died from causes other than eating treated grain.

(5) These three dead squirrels were all small, immature individuals found at the mouth of a single burrow.

(6) Evidence that this adult sage grouse was killed by a winged predator.

(7) These figures are no doubt higher than the original population of the area, because of an influx of animals during the period of the experiment. Also, animals dead along borders of the plots were tabulated.

available to the grouse. On July 22, one of the birds developed a type of paralysis similar to that associated with botulism poisoning. On the morning of July 24 this bird was dead. The bird was sent to Dr. O. G. Larson of the Veterinary Department of the Utah State Agricultural College to test the possibility of its having the botulina organism in its body. However, the organism was not found. Fly larvae were allowed to develop in the bird, and it was then placed on the wire top of a holding pen containing 2 young white leghorn roosters. They ate the larvae and both of them died, each developing a type of paralysis similar to that associated with botulism. Number 1 died on August 2, and number 2 on August 9. On August 4 the experiment was repeated, allowing fly larvae to develop in rooster number 1, which was fed on by a third rooster, which developed a paralysis similar to that found in the other birds. The experiment was terminated on August 18, and the affected bird later recovered.

On September 16 another sage grouse, afflicted with a similar type of paralysis, was found, captured, and sent to the college. A careful post mortem was conducted and bacteriological cultures made by Dr. Larson; however, the examination gave no definite proof of bacterial infection.

These experiments and field data tend to indicate that the sage grouse are susceptible to a poisoning condition similar to that found in ducks afflicted with botulism. The toxin can probably be produced in the field in decaying animal material, and then be picked up by the sage grouse's feeding on the fly larvae. It is possible that this may help to explain the condition that now exists in this region when dead sage grouse are observed after rodent and predatory poisoning operations have taken place. There is a need for further studies on this matter.

It is these fertile grass meadows and riparian sagebrush and grasslands that are important in forming a desirable summer habitat for the sage grouse.

RANGE AND HABITAT FACTORS

There are many wildlife species that have an inflexibility in their demands for a habitat with certain combinations of factors, such as type of cover, food, climate, and water.

The sage grouse is one of these species that is adapted to certain habitat conditions and is found inhabiting only the sagebrush areas of the Western States. It is truly the bird of the sagebrush areas and spends its entire life in that habitat. In reviewing literature, and in interviews with old residents, it is found that sage hens were usually abundant where sagebrush and grass were present.

Native Range. A good picture of the habitat of the sage grouse in the days of its maximum numbers may be gained from the following excerpts (17):

One of the most distinctive range types, making up the native range of the sage grouse was the sagebrush-grass consociation, which extended from eastern Wyoming to southern British Columbia, southeastern California, and northern Arizona, and is the third largest range type, covering 90 million acres. With the exception of the true grass areas, the sagebrush-grass ranges are potentially the most productive of the range types.

A significant feature of the virgin sagebrush type was the abundance of palatable grasses and weeds which grew under and between the shrubs. The most important of these plants were the wheatgrasses, blue bunch fescue, needlegrasses, wild rye, Indian ricegrass, wild geranium, balsamroot, yarrow, and many other less important forage plants. This cover of grasses and weeds beneath the sagebrush varied in density of soil and moisture conditions, from a thin stand such as that found in the Snake River plains of Idaho to a fairly thick sod in the mountains along the foothills in Montana.

Associated with this sagebrush-grass type there were found interspersions of meadow and grasslands. Most of these small meadow and grassland areas were to be found at moderately high elevations or on the benchlands in the mountain ranges of the West, often associated near woodlands. It is these fertile damp meadows and bordering sagebrush and grasslands that are important in forming a desirable summer habitat for the sage grouse.

During the early spring, summer, and fall the sage grouse become residents of these sagebrush-grass and meadow lands and here carry on mating and nesting activities. The primary importance of these meadow and sagebrush areas is that they furnish many of the more palatable plants that constitute the summer diet of the sage grouse and provide the most suitable nesting cover.

The following notes and quotations, concerning early range conditions in Utah and Idaho, were procured from books obtained at the Church of Jesus Christ of Latter-Day Saints, Historical Office, in Salt Lake City, Utah. They are now compiled into "Historical Notes on Utah and Adjacent Western States", Section II, U.S.D.A. Forest Service, Ogden, Utah.

In 1859 Cache Valley was described as "a fertile valley which, however, at that time was a country of sagebrush and wild grasses."

In 1889 "The country in and around the Boulder Mountains has been utilized for herding sheep and cattle, the grass and water being plentiful."

In the Deseret News of April 2, 1886, was published in part the following:

Stock raising is the chief pursuit of the people of Escalante; the mountains on the west and north of the place furnish an excellent range for their cattle, horses, and sheep, while the extensive desert on the east, extending to the Colorado River is one of the best winter ranges that could be desired.

Never had their eyes beheld a more eligible site on which to make a home. The season was early June, 1850, and the scorching rays of the sun had not yet parched the landscape. Acres of waving grass studded with bright-colored flowers, beautified the broad expanse from the lake to the snow line on the mountains, and loaded the pure air with their fragrance and bloom. (Speaking of Springville, Utah.)

Under date of January 18, 1875, E. W. Johnson wrote from Johnson, Utah, to the Deseret News, as follows: "Our stock is doing splendid,

there being thousands of acres of splendid range and considerable green grass starting among the sagebrush which is uncommon for this time of the year."

Under date of Tuesday, February 3, 1885, Thomas E. Passet wrote the following in part for the Deseret News, concerning the valley around Rexburg, Idaho:

Many streams that flow through the valley being lined with a heavy growth of timber in several places for miles on each side. And a thrifty growth of grass intermixed herewith, furnishing not only excellent pasturage for our stock but good shelter for them during the more inclement seasons of the year. They have principally wintered out so far and look fully as well as those kept up and fed. It is estimated that from three hundred thousand to five hundred thousand acres of land in this vicinity can be made available for farming for which there is abundance of water easy of access. There is also about the same amount of grazing land adjoining, consisting of gently rising hills extending towards the mountains for a distance from twelve to twenty miles, covered with a heavy growth of grass from seven to eighteen inches high. Thus we have one of the finest summer ranges in the West.

Such accounts as these vividly picture the environment that the sage grouse had in the early days when the settlers first came into the West.

Settlement and Range Destruction. As man moved westward and settled, the range and wildlife resources began to diminish, until at the present time much of the range has been depleted and the great flocks of sage grouse, so often referred to, have likewise decreased to a mere fragment of their former numbers. This marked decrease may probably be attributed to the following factors:

1. Destruction of the forage and depletion of available water by overgrazing.
2. Destruction of forage by burning practices.
3. Settlement on and cultivation of original sage grouse range.

In 1847 the pioneers and early settlers began to move into the great expanses of land west of the Rocky Mountains. This virgin range land was so great and new that it offered them the idea of an unlimited resource, one that would always be present, and it was treated as such.

Overgrazing. With the coming of the pioneers came the livestock, which were later to destroy many acres of valuable grazing land. The real depletion of the range forage became of importance during the boom of the eighties. During the 20-year period between 1890 and 1910 the vigor of the range was severely injured due to the repeated close cropping. The conflict between large and small operators and between sheep and cattle units intensified the use of the range until depletion was everywhere present and common. Then came the increase in animal numbers during the war years, with the result that both the stockmen and the range faced ruin. This depletion of the range forage was due to: (1) too early and too late grazing, with the result that only a small, if any, seed crop was produced; (2) overstocking and combined close cropping, which weakened the plant vigor; (3) year-long use, destroying nearly all palatable forage plants (17).

Today in the sagebrush areas, because of the misuse which the land has experienced, the sagebrush has increased; however, the palatable perennial grasses and weeds have decreased and have almost disappeared. In fact, in some areas they are now practically absent. The poorer plants have become more abundant on the deteriorated sites, and eventually in some areas they have gained possession of the range. Over part of the sagebrush grass area practically the only feed for livestock today is the very inferior sagebrush itself.

It is this tremendous loss of forage grasses and weeds that has brought about the present low-grazing capacity. It is estimated that

the grazing capacity in different parts of the sagebrush type is 60 to 90 percent less than it was in the early pioneer days. The virtual wrecking through misuse of this valuable resource can be traced to the apparent indifference of those controlling the use of the land (17).

Overgrazing, with the resultant impairment of the ground cover and accelerated erosion, is responsible for the present inadequate water supply. Many spring and water holes have dried up and are no longer of use to wildlife or stock. Because of overgrazing and subsequent misuse of the range lands gullies have formed which have drained large areas, resulting in a general lowering of the water table. Some of these gullies are 60 to 100 feet deep and 200 or 300 feet wide. Not only have they affected the drinking water of both human and animal life, but they have taken a good deal of the water away from plants which would be of use as food and cover for wildlife and livestock (4).

Burning. The practice of promiscuous burning also played a part in the process of depleting the western ranges. It was the opinion of the early stockmen that when the range began to show signs of decrease in its carrying capacity, it should be burned over, resulting in a substantial forage increase. This idea is still held today by some groups of stockmen. From experimental research it has been found that there is usually an increase in the volume of forage and a longer period of succulence for the first year, and to a lesser extent the second year, as a result of burning the sagebrush ranges (11).

According to Pickford (11):

Observations on areas which have been subjected both to promiscuous burning and to heavy grazing show that a combination of these factors has seriously reduced the total density of the plant cover, and has depleted the stand of perennial grasses nearly 85 per cent; the sagebrush cover likewise has been reduced 80 per cent. Annual grasses and poor perennial and

annual weeds are predominating the areas. These changes in the plant cover due to fire and grazing have caused a reduction of over 50 per cent in the grazing capacity of the spring-fall ranges.

Sage grouse on the winter ranges undoubtedly suffer the most from burning practices, for when the sagebrush is burned off it offers little food or cover for the birds, even in mild winters.

Settlement. Settlement of the western lands began to take place when the first pioneers came to the West. As this settlement increased, there were several boom years in which exceptional crops were produced, and for which high prices were paid. The belief that cultivation resulted in increased rainfall and the exceptional prices which were paid for cereal crops in the early days encouraged new settlers to come into the West and turn grazing lands into submarginal farms, which after a few good years began to decrease in yield and which were finally deserted. Today many areas in the semi-arid West are dotted with old deserted shacks and barns (17).

In the mountain regions most of the settling and subsequent cultivation took place on the spring-fall ranges which were inadequate even at that time. Livestock and game were pushed up to the summer ranges on one hand and out to the desert winter ranges on the other, resulting in overgrazing and subsequent depletion of the range. Surely it would have been better for all concerned if these sub-marginal farms had been left in their natural state, to be properly used by livestock and wildlife.

Results of Misuse. All of these factors are believed to have played an important part in reducing the numbers of the sage grouse throughout their range. These practices are now being changed through education and new land use programs of the Forest Service, Soil Conservation Service,

the Division of Grazing, and other governmental agencies. There will have to be changes in land use if it is hoped to increase the numbers of the sage grouse.

These vast changes in the natural vegetation because of overgrazing, burning, and settlement on submarginal areas have greatly altered the natural environment of many of the species of native wildlife. Among those species that have been affected most is the sage grouse. To the sage grouse the range depletion meant the removal of many of the succulent grasses and forbs which were used in their spring and summer food supply. It has also disturbed and ruined many of the better nesting areas and winter ranges.

SUGGESTED MANAGEMENT

The first and probably most important step in planning for an increase in the sage grouse numbers is to establish a proper system of range management on areas where the sage grouse are now present. This range management system must include the following points: (1) proper stocking; (2) correct season of use, and proper entry dates; (3) control of burning; and (4) water developments, where they are necessary.

If all of the sage grouse ranges were similar to the Strawberry Valley, there would be little need to make such an extensive management plan for the restoration of the range and the sage grouse; but even here it is not certain what factors are limiting the numbers of the sage grouse.

During the course of the 2-year study the author made a study of range conditions in parts of Utah and Idaho. In August 1937 a 10-day stay was made on the Parker Mountain and Forshay Range in Piute and Garfield Counties, Utah. This area is part of the public domain and

has been subjected to unrestricted use for many years. Originally this area supported several thousand sage grouse; however, during the 10 days that were spent in the area a total of 97 sage grouse is all that were seen.

The history of this range area reveals that in its natural state it was capable of supporting several thousand sheep during the summer months and, in addition, had a fairly good cover of range plants that were used by deer and other game species. However, instead of properly stocking and grazing this area between 20,000 and 25,000 head of sheep and 1,000 head of cattle grazed the area from 6 to 9 months. The results were that the entire range was heavily overstocked and overgrazed, even to the extent that most of the sagebrush has been reduced in size, until it is now seldom over 12 inches high (plates 20 and 21). This destruction of the sagebrush and forage plants is undoubtedly a limiting factor to the sage grouse numbers. The destruction of the sagebrush has meant the destruction of suitable nesting areas in the summer and feeding areas in the winter. In addition the more succulent understory plants have become nearly eliminated, as only a few were found, and these were around the water holes (plates 22 and 23). On the entire range only 63 species of plants, including all of the browse, woodland, and coniferous species were listed by the author. (Over 200 plants were observed on the Strawberry area.) Plates 24, 25, and 26 of areas in Strawberry Valley show a decided contrast to the Forshay area.

This destruction of the range under free rule continued until the Taylor Grazing Act went into effect. At the present time under the direction of the Division of Grazing only 5,000 head of sheep and 100 head of cattle are grazing this range. According to the local sheepherders,



Plate 20. The type of sagebrush found on the Forshay Range, Utah



Plate 21. Sagebrush on the Forshay Range. Note the absence of an understory cover



Plate 22. Sheep at the artificially developed water holes on the Forshay Range



Plate 23. An artificially developed water hole on the Forshay Range. Note the scarcity of vegetation



Plate 24. Cattle grazing in the Strawberry Valley. Courtesy of Dr. L. A. Stoddart



Plate 25. A view of one of the meadows in Strawberry Valley



Plate 26. In the foreground is Artemisia cana (water sage) and in the background in Artemisia tridentata. This is a general view of part of Strawberry Valley

this range is already showing some improvements. The Taylor Grazing people have reduced the number of animals using the area, set proper opening and closing dates, and are developing water holes. (All of the sage grouse that were seen on this area in 1937 were seen in the evening around these water holes.) Under this present system of improved management it is hoped that the vegetation of the area will improve, and along with this increase in vegetation it is felt that the sage grouse will probably increase.

In general it is believed that the areas where sage grouse are most abundant are ranges that are in good condition and are under the best systems of use. Under present conditions it appears that interest has been taken in our range conditions and that with the aid of the several government agencies it will be possible to again restore our ranges and our animal numbers.

It may be desirable to restock with sage grouse certain areas from which they have been exterminated, if the range conditions have been improved and are capable of supporting the birds.

The state of New Mexico, through the efforts of Mr. J. Stokley Ligon, New Mexico's game specialist, has attempted to re-introduce the sage hen into the state.

In 1933 New Mexico entered into a cooperative agreement with Wyoming, whereby the 2 states made exchanges of native species desired by the other. In this exchange New Mexico received sage grouse for planting into Taos, Rio Arriba, Dandoval, and San Juan Counties, where they originally occurred, but became extinct in 1906. In the fall of 1933 Mr. Ligon went to Wyoming and trapped 40 adult sage grouse which were all released in the Tres Piedras area. In 1934 Mr. Ligon returned to Wyoming

and brought back a total of 135 birds on 3 different trips. No birds were obtained in 1935 due to the drought conditions; however, in 1936 he obtained 70 birds, which were released at Taos Junction. There is no absolute check on these sage hens as to how they have fared, but they are known to have survived and in some instances to have raised young. This is probably the first real attempt that has been made at restocking areas with sage grouse. Transplanting of sage grouse to areas formerly inhabited by them should not be done until a thorough biological examination of the area shows that it is capable of again supporting the birds.

A program of artificial propagation for increasing the number of sage grouse in their present range is open to serious question, not only because of the difficulty of raising the birds, but also because there is still doubt concerning the factors truly responsible for the decrease.

Refuges. Two major reservations or refuges established and administered by the United States Biological Survey for this species and the antelope are the Charles Sheldon Refuge in northwestern Nevada and the Hart Mountain Refuge in southern Oregon (12).

The Strawberry Valley Federal Refuge in northern Utah, which was established as a native bird refuge, offers protection to the sage grouse, as well as waterfowl and other birds. All that has been done towards developing this refuge was to establish the area and post it. At the present time there is need of further development and management if the present habitat conditions are to be maintained. This refuge has great possibilities as a sage grouse and waterfowl area, as it will be comparatively easy to improve the habitat conditions by proper management. The principal need is to establish a proper grazing system (or in some cases to exclude grazing) that will not destroy, but will protect the nesting and feeding covers.

It may be necessary in some of our western states to establish refuges wherein the sage grouse will be given complete protection and will have the assistance of game specialists in providing a more suitable habitat.

Predator Control. At the present time, from what meager evidence is available, it is impossible to determine how many of the faunal associates of the sage grouse are their actual enemies. Until further research and study is made regarding this biotic relationship, no large-scale control projects should be undertaken against those species that, due to popular opinion, are now being condemned. All control activities should be confined to those animals that are caught in actual depredations. Control measures can also be taken against the coyote and the goshawk, as they are known to be detrimental to many species of game, and also to livestock in the case of the coyote.

Modifications to Prevent Accidents. In Strawberry Valley and other areas where a considerable number of sage grouse are killed on the highway each summer it may be necessary to modify the condition. This situation might be remedied by providing suitable dusting areas, or by oiling the highway, in order that it would not be available as a dusting area. In Strawberry Valley an attempt was made to alleviate this condition. Through the cooperation of the State Highway Commission and the State Fish and Game Department signs have been posted asking the motorist to slow down for sage grouse crossing the highway.

Education. Much can be done for all game by educating the people as to its habits and values. The land owners and land users should be instructed in the methods of proper range management and the part that range management plays in wildlife conservation. Steps have been taken by the various governmental agencies in educating the people to proper land uses and conservation.

Through proper contact and leadership on the part of the state conservation departments and the local wildlife federations it may be possible to continue to reduce the amount of poaching on the sage grouse. The people must be shown, through an honest and true picture, the present conditions of the sage grouse and the range that they inhabit, and what must be done if an increase in their numbers is desired.

SUMMARY

1. Most of the information contained in this paper was obtained from the study made in Strawberry Valley.

The sage grouse, the largest native American grouse, is an inhabitant of the arid or semi-arid sagebrush areas of the western United States. It was first discovered by Lewis and Clark around the headwaters of the Columbia and Missouri rivers.

2. Sage grouse were formerly the most important native game bird in the intermountain region but are now hunted as legal game in only a small part of their range.

3. Strutting of the males appears to be a means of attracting attention during the mating season.

4. Sage grouse are promiscuous in their mating habit.

5. The sage grouse are ground nesting birds, and the entire process of nesting and care of the young is accomplished by the females.

6. The time of nesting extends from the middle of April to the middle of July, the later dates occurring at the higher elevations.

7. A study of 161 nests during 1936 and 1937 showed an average clutch of 6.82 eggs--24.6 percent of the nests contained 6 eggs, 32.6 percent contained 7 eggs, 28.5 percent contained 8 eggs, and no nest contained over 9 eggs.

8. The average brood size at hatching was 6.73.
9. The sage grouse raise only 1 brood a year, but they may re-nest in case of nest destruction or desertion.
10. The daily routine of the sage grouse includes roosting, dusting, resting, watering, and feeding.
11. Sage grouse feed during the early morning and evening hours and rest and dust during midday.
12. The young sage grouse learn to fly at an early age.
13. Sage grouse gather in large flocks in the fall.
14. Sage grouse make a seasonal migration from the valleys and benchlands to the ridge tops or out to the edges of the plateaus during the winter, prompted by snow conditions.
15. An analysis of 61 sage grouse stomachs showed that adult sage grouse and young grouse over 2 months of age eat approximately 95 percent plant material during the summer season.
16. Plants of the family Compositae make up the bulk of the vegetable material eaten, and sagebrush, Artemisia, is the most important single food of the sage grouse.
17. The diet of the young birds less than 3 months old is 40 to 50 percent insects, principally ants and beetles.
18. Young grouse eat a greater variety of plants than do the adults; they also eat more insects than do the adults.
19. The winter diet is nearly 100 percent sagebrush.
20. Drinking water is not a limiting factor in the sage grouse range, but it may do much towards making a more desirable range.
21. The kinds of cover used by the sage grouse are: nesting, resting, roosting, feeding, and dusting.
22. A direct correlation between nesting types and degree of nesting success was found.

23. The presence of grasses and weeds interspersed with the sagebrush made a more successful nesting type than sagebrush of equal density without the understory.

24. The highest nesting density was found in dense second growth of sagebrush. Twenty-three nests were found on 160 acres.

25. Of the nests observed 59.07 percent hatched successfully, 26.02 percent were destroyed by natural enemies, and 14.28 percent were deserted. The main cause of desertion was believed to be due to man's activity, a major part of which was due to the study.

26. The principal natural enemies of the sage grouse in Strawberry Valley are: coyotes, weasels, hawks, and golden eagles.

27. There appears to be a correlation in the amount of predation on the sage grouse and the ground squirrel populations.

28. It is possible that a disease similar to botulism in ducks may be found in the sage grouse following rodent control operations.

29. Tape worms and lice are common to the sage grouse.

30. Improper land usage of both range and cultivated lands has reduced the amount of suitable sage grouse range and has possibly caused a reduction in the sage grouse numbers. Over-hunting and predation are also factors contributing to decrease in sage grouse numbers.

31. The probable key to the restoration of the sage grouse lies in range management.

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