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Pre-laying nutrition of sage grouse hens in Oregon

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Abstract

Diet, dietary selection, and nutritional composition of the foods of sage grouse *(Centrocercus urophasianus)* hens were determined during the pre-laying period in southeastern Oregon in 1990 and 1991. We collected 42 female sage grouse during a 5-week period preceding incubation (4 March–8 April). Sagebrush (*Artemisia* spp.) was the most common among 21 foods consumed but forbs composed 18 to 50% of the diet by weight. Desert-parsley (*Lomatium* spp.), hawksbeard (*Crepis* spp.), long-leaf phlox (*Phlox longifolia* Nutt.), everlasting (*Antennaria* spp.), mountain-dandelion (*Agoseris* spp.), clover (*Trifolium* spp.), Pursh's milk-vetch (*Astragalus purshii* Dougl.), buckwheat (*Eriogonum* spp.), and obscure milk-vetch *(A. obscurus)* were the primary (≥1% of the diet by weight) forbs consumed. Forbs were used selectively over sagebrush in both low and big sagebrush cover types. All forbs were higher in crude protein and phosphorus and many were higher in calcium than sagebrush. Consumption of forbs increased nutrient content of the composite diet. Substantially fewer forbs were present in the diet in 1991 than in 1990, which coincided with reduced sage grouse productivity on the study area. These results suggest that consumption of forbs during the pre-laying period may effect reproductive success by improving nutritional status of hens.

Key Words: ***Centrocercus urophasianus*, diet, nutrition, Oregon, sage grouse**

Reduced productivity was associated with the population decline of sage grouse *(Centrocercus urophasianus)* in Oregon since the 1940's (Crawford and Lutz 1985). Poor productivity may be caused by inadequate nutrition of hens during the breeding season (Moss et al. 1975). Female red *(Lagopus lagopus scoticus)* and ruffed grouse *(Bonasa umbellus)* that obtain adequate nutrition in spring diets contribute more nutrients to eggs (Jenkins et al. 1965) and produce larger clutches and larger, more viable chicks compared with hens on less nutritious diets (Jenkins et al. 1963, Eastman and Jenkins 1970, Beckerton and Middleton 1982). Nitrogen (a measure of crude protein) and phosphorus were identified as nutrients that affected egg production of red grouse (Moss 1967). Waibel (1977) found dietary calcium and phosphorus important for breeding success and productivity of poultry. Little information is available on diets and nutrition of female sage grouse during the pre-laying period. Sagebrush (*Artemisia* spp.) contributed 89–100% of March and April diets (Rogers 1964, Wallestad 1975) of sage grouse in Montana and Colorado; the remainder of the diets were composed of forbs. However, diets of males and females were not separated in these studies and no information on reproductive stage of the birds, relative availability and nutrient content of foods, or dietary selection was provided.

A need for information about the diet and nutrition of sage grouse hens during the critical period preceding egg-laying prompted this study. Objectives of the study were to determine the diet (foods eaten, parts consumed, frequency of occurrence, and relative dry weight), dietary selection, and nutrient content of foods of pre-laying female sage grouse in Oregon.

Study Area

The study was conducted on lands administered by the U.S. Fish and Wildlife Service in eastern Lake County and by the Bureau of Land Management in western Harney County, Oregon. Elevations ranged from 1,200 to 2,450 m. Mean annual precipitation averaged 29 cm and maximum daily temperatures averaged approximately 23° C from March through September (U.S. Dep. Commerce 1991). Total annual precipitation was 27 cm for 1989 and 17 cm for 1990. Precipitation averaged 3 and 2 cm and temperatures averaged 3 and 1° C during the periods of data collection in 1990 and 1991, respectively.

The area consisted of flat sagebrush plains, interrupted by rolling hills, draws, and ridges, and was bounded by mountains on the west. Several lakebeds, springs, creeks, and meadows were distributed throughout the area. Two cover types were used by sage grouse hens during the pre-laying period: low sagebrush (*A. arbuscula* Nutt.) with bluebunch wheatgrass (*Agropyron spicatum* Scribn. & Smith) and Sandberg's bluegrass (*Poa sandbergii* Vasey), and big sagebrush (*A. tridentata* var. *wyomingensis* Nutt.) with Thurber's needlegrass (*Stipa thurberiana* Piper). Sagebrush cover exceeded 20% in both cover types, whereas grass cover was ≤10% (Barnett 1992). Common annual and perennial forbs in both cover types included desert-parsley (*Lomatium* spp.), milk-vetch (*Astragalus* spp.), phlox (*Phlox* spp.), clover (*Trifolium* spp.), lupine (*Lupinus* spp.), hawksbeard (*Crepis* spp.), and mountain-dandelion (*Agoseris* spp.). Plant nomenclature was taken from Hitchcock and Cronquist (1990).

During the past 10 years, stocking rates of livestock ranged from 0.13 to 0.18 AUMs/ha, and grazing occurred from April through December: rates were adjusted annually according to range conditions and forage availability. The study area was grazed in 1990, but not 1991. In 1990, utilization on key species averaged 44% on the Harney County portion of the study area (W.F. Taylor, Bur. of Land Manage., pers. commun.). Utilization data were not available for the Lake County portion of the area. Range condition of the Lake County portion was rated fair to poor (W.H. Pyle, U.S. Fish and Wildl. Serv., pers. commun.). Condition of the Harney County portion of the area was estimated 4% potential natural community, 28% late seral, 51% mid seral, and 14% early seral (W.F. Taylor, Bur. of Land Manage., pers. commun.).

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Table 1. Frequency of occurrence among crops and relative dry weight of foods consumed by pre-laying sage grouse hens in southeastern Oregon, March–April, 1990–91.

Food	Frequency of occurrence among crops			Relative dry weight		
	Big sagebrush 1990 (N = 7)	Low sagebrush 1990 (N = 13)	Low sagebrush 1991 (N = 22)	Big sagebrush 1990 (N = 7)	Low sagebrush 1990 (N = 13)	Low sagebrush 1991 (N = 22)
	(%)			(%)		
Sagebrush (*Artemisia* spp.)	100	92	100	55	50	82
Desert-parsley (*Lomatium* spp.)	86	92	68	7	16	8
Hawksbeard (*Crepis* spp.)	57	62	37	11	14	3
Long-leaf phlox (*Phlox longifolia* Nutt.)	86	92	55	12	4	2
Mountain-dandelion (*Agoseris* spp.)	28	69	11	2	4	1
Clover (*Trifolium* spp.)	0	31	18	0	4	1
Everlasting (*Antennaria* spp.)	43	69	41	8	3	2
Pursh's milk-vetch (*Astragalus purshii* Dougl.)	57	31	9	2	<1	<1
Buckwheat (*Eriogonum* spp.)	14	8	0	2	<1	0
Obscure milk-vetch (*Astragalus obscurus* Wats.)	0	31	5	0	2	<1
Buttercup (*Ranunculus* spp.)	0	8	0	0	<1	0
Other phlox (*Phlox* spp.)	14	15	18	<1	<1	<1
Blue-eyed mary (*Collinsia* spp.)	0	38	9	0	<1	<1
Bluebells (*Mertensia* spp.)	0	0	5	0	0	<1
Larkspur (*Delphinium* spp.)	0	0	5	0	0	<1
Rockcress (*Arabis* spp.)	14	0	0	<1	0	0
Other forbs	57	54	0	<1	<1	0
Grasses	57	69	5	<1	<1	<1
Ants	0	15	0	0	<1	0
Caterpillars	0	8	0	0	<1	0
Beetles	1	0	0	<1	0	0

The sage grouse population on the study area was characteristic of populations in much of the remaining range in Oregon with low densities and productivity (Crawford and Lutz 1985). During our study there were differences in productivity between years. Productivity surveys revealed 0.5 chicks/hen and average brood size of 2.7 in 1990 but only 0.2 chicks/hen and average brood size of 2.2 in 1991 (J.C. Lemos, Ore. Dep. of Fish and Wildl., pers. commun., and W.H. Pyle. U.S. Fish and Wildl. Serv., pers. commun.).

Methods

We shot 42 sage grouse hens during the 5-week period preceding incubation (4 March–8 April) in 1990 and 1991. Breeding chronology was determined from a concurrent radio-telemetry study of sage grouse hens on the study area. In 1990, 13 hens were collected from low sagebrush and 7 hens were obtained in big sagebrush stands. In 1991, all 22 hens were collected from low sagebrush stands despite expenditure of effort equal to 1990 in big sagebrush areas. We collected birds in the evening (from 2 hours before sunset to dusk) to increase likelihood of obtaining a full crop. Crop contents were removed and plant species and parts (leaves, flowers, stems, etc.) identified. Contents were placed in plastic bags and frozen.

Frequencies of foods were calculated for each cover type and year in 2 ways. First, overall frequency of occurrence was obtained by dividing the number of crops in which each food was present by the total number of crops examined. This method yielded information about frequencies of foods consumed among birds in the sample population. A second technique was employed to compare frequencies of foods within the crop contents of individual birds to frequencies of occurrence of those foods at foraging locations. This approach was used to describe dietary selection and was termed "frequencies within dietary samples." Frequency of food items within each crop was determined by spreading the contents in a single layer in a glass tray, overlaying a dot grid, and recording the food item directly below each of 100 dots. Crop contents were identified, separated, and dried at 50° C to constant weight. Relative percent dry weight (total weight of each food divided by total weight of all foods in all crops) was calculated for each cover type and year.

We evaluated vegetative characteristics at foraging sites and random locations. A foraging site was defined as a circle with a 10-m radius centered where a hen was first observed (J.W. Connelly, Ida. Dep. Fish and Game, pers. commun.). In addition, a random site was selected in the same cover type. Frequencies of plant species at foraging and random sites were estimated with the line-point method (Heady et al. 1959). Eight 15-m lines were randomly placed in the circle. For each line, the starting point was determined by a randomly selected distance and direction from the center of the site. Line orientation was determined by a randomly selected compass bearing. Lines that fell outside the circle were rejected and a new bearing was selected. Point samples were taken at 30-cm intervals along the line. Two of the 8 lines were randomly selected for determination of shrub cover, which was estimated with the line intercept method (Canfield 1941). Percent cover of grasses and forbs was estimated in 10 randomly placed 20 × 50-cm rectangular frames (Daubenmire 1959).

Samples of plants used by grouse were collected at foraging and random sites immediately after availability data were collected. If a plant was not found in the defined foraging or random site, plants closest to the site were collected. Because plant parts may differ in chemical content (Cook and Harris 1968), nutrient analyses were conducted only on the plant parts consumed by birds.

Plant samples were analyzed for crude protein, calcium, and phosphorus for all plants that composed ≥1% of the relative dry weight of the diet in either cover type or year. Preliminary analyses revealed no significant differences in availability (% cover) or in the nutrient content of sagebrush or forbs between foraging and random locations. Consequently, samples from foraging sites and random locations were pooled for further analyses. Samples were ground in a Wiley mill with a 20-mesh screen. Crude protein was

determined from analysis of samples for ammonium nitrogen and multiplication of ammonium values by 6.25. The Kjeldahl method (Association of Official Analytical Chemists 1980) was used to digest samples for crude protein and phosphorus analysis and determination for the nutrients was made colorimetrically on a Technicon Auto Analyzer. Calcium content was determined by ashing (Association of Official Analytical Chemists 1980). Nutrient content of the composite diet was calculated by combining nutrient analysis data with relative dry weight data (Reinecke and Owen 1980).

To evaluate food selection, frequency within dietary samples was compared with frequency data from foraging sites. Crops of 4 hens did not contain sufficient material for frequency analysis and were not used in food selection analysis. Frequencies were compared and ranked for each bird for those foods that composed ≥1% of the relative weight of the diet up to the limit of the number of variables (foods) that could be used (Johnson 1980). Differences between frequencies were then averaged among all birds and used as a measure of dietary selection with the program PREFER (Johnson 1980).

Vegetative characteristics (% cover of shrubs, grasses, forbs, and bare ground) were compared between years and cover types. Kruskal-Wallis tests were used for comparisons and, when significant differences were detected, the Least Significant Difference procedure was used to separate means (Snedecor and Cochran 1980). Tests were considered significant at the $P \leq 0.05$ level of probability.

Results

A total of 21 foods were consumed by female sage grouse during the pre-laying period, which included sagebrush, 16 forbs, 3 taxa of insects, and a trace of unidentifiable grasses (Table 1). Sagebrush occurred in all but 1 of the 42 crops examined. Forbs that were found in the highest frequencies included desert-parsley, hawksbeard, long-leaf phlox (*P. longifolia* Nutt.), mountain-dandelion, clover, everlasting (*Antennaria* spp.), and Pursh's milk-vetch (*A. purshii* Dougl.). Leaves were consumed from all plants. In addition, sage grouse hens consumed the buds of everlasting and obscure milk-vetch (*A. obscurus* Wats.) and the new flowers of desert-parsley and buttercup (*Ranunculus* spp.). Types of food eaten by hens were similar between cover types and years, but frequencies of forbs among crop samples were lower in 1991 than in 1990 (Table 1).

Sagebrush composed 50 (low sagebrush cover type in 1990) to 82% (low sagebrush cover type in 1991) of the diet by relative dry weight (Table 1). In 1990, forbs made up 45 to 50% of the diet but decreased to 18% in 1991. Grasses and insects collectively composed <1% of the weight of the diet. In addition to sagebrush, desert-parsley, hawksbeard, and long-leaf phlox supplied the bulk of the diet; 84 to 95% of the relative dry weight of the diet was made up of these 4 foods.

Results from the analysis of dietary selection revealed that within crops sagebrush was the most common food consumed (Table 2). These findings, which paralleled results from the analysis of frequencies among crops and from dry matter composition, also indicated greater amounts of sagebrush in the diet of pre-laying hens in 1991 than in 1990. Other frequently encountered foods

Table 2. Mean frequency of foods within dietary samples that composed ≥1% relative dry weight of the diet of pre-laying sage grouse hens, frequency of foods at foraging locations, and relative selection of foods, Oregon, March-April, 1990-91.

Cover type	Food	Mean frequency: Within dietary samples	Mean frequency: Occurrence at foraging sites	Relative order of selection[1]
		(%)	(%)	
Big sagebrush 1990 (N = 7)	Sagebrush	52.4	24.9	5
	Hawksbeard	12.0	0.1	1[a]
	Desert-parsley	10.4	1.0	4
	Long-leaf phlox	13.4	0.5	3[a]
	Pursh's milkvetch	1.6	0	2[a]
Low sagebrush 1990 (N = 11)	Sagebrush	38.4	27.0	8
	Desert-parsley	25.1	3.3	5[a]
	Hawksbeard	11.4	0.6	2[a]
	Mountain dandelion	11.7	0.1	1[a]
	Clover	4.3	1.0	4[a]
	Long-leaf phlox	2.4	1.0	7
	Obscure milk-vetch	3.0	0.3	3[a]
	Everlasting	1.0	0.4	6
Low sagebrush 1991 (N = 20)	Sagebrush	63.6	22.7	7
	Hawksbeard	8.8	0.2	1[a]
	Desert-parsley	14.4	1.5	6
	Long-leaf phlox	4.6	0.4	3[a]
	Everlasting	4.4	0.2	4[a]
	Mountain dandelion	3.1	0.1	2[a]
	Clover	0.1	0.2	5[a]

[1]Ranked numerically from most selected (1) to least selected.
[a] = used in a greater proportion that available ($P \leq 0.05$).

Table 3. Nutrient content of plant foods that composed ≥1% of the relative dry weight of the diet of pre-laying grouse hens in southeastern Oregon, March-April, 1990-91.

Food	N[1]	Crude protein $\bar{x}$	Crude protein SE	Calcium $\bar{x}$	Calcium SE	Phosphorus $\bar{x}$	Phosphorus SE
		(%)		(%)		(%)	
Low sagebrush leaves	66	14.2	0.47	0.41[2]	0.01	0.21	0.01
Big sagebrush leaves	14	15.9	0.43	0.70	0.02	0.25	0.01
Desert-parsley leaves	49	25.0	0.36	1.36	0.05	0.41	0.01
Desert-parsley flowers	12	25.7	0.72	0.35	0.02	0.62	0.04
Hawksbeard leaves	24	29.6	0.44	0.78	0.08	0.50	0.02
Long-leaf phlox leaves	16	25.6	0.98	0.98	0.04	0.47	0.02
Everlasting leaves and buds	14	16.7	0.56	0.52	0.02	0.36	0.01
Mountain-dandelion leaves	23	26.0	0.64	0.44	0.05	0.48	0.02
Clover leaves	5	36.7	1.49	0.69	0.16	0.47	0.05
Pursh's milk-vetch leaves	2	21.5	0.00	0.69	0.00	0.24	0.00
Obscure milk-vetch leaves and buds	3	26.0	2.09	0.52	0.00	0.26	0.04
Buckwheat leaves	2	16.9	1.62	0.78	0.02	0.30	0.03

[1]Number of sites from which plant samples were collected.
[2]Low sagebrush and big sagebrush were significantly different in calcium content ($P = 0.01$).

Table 4. Percent cover of vegetative classes in big sagebrush and low sagebrush stands used by pre-laying sage grouse hens in southeastern Oregon, March-April, 1990-91.

Cover type	N	Sagebrush		Grass		Forb		Bare ground	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
		----(%)----		----(%)----		----(%)----		----(%)----	
Big sagebrush 1990	14	23.0ab[1]	1.64	5.3b	0.83	2.5b	0.81	80.8a	1.68
Low sagebrush 1990	26	25.1a	1.97	10.3a	0.93	8.2a	1.00	58.3c	1.82
Low sagebrush 1991	44	18.8b	0.94	4.9b	0.47	3.1b	0.43	76.0b	1.06

[1]Within columns, means with the same letter were not significantly different at $P<0.05$.

within crops included hawksbeard, desert-parsley, mountain-dandelion, and long-leaf phlox. An evaluation of dietary selection revealed that forbs were preferentially selected ($P \leq 0.05$) over sagebrush by pre-laying hens. Hawksbeard, mountain-dandelion, and long-leaf phlox consistently had the highest selection values in most cover types and years (Table 2).

Nutrient analyses of those foods that composed $\geq 1\%$ of the diet by weight indicated that sagebrush was lowest in protein (14.2 to 15.9%) of all foods tested (Table 3). Protein content of forbs ranged from 16.7 (everlasting) to 36.7% (clover). Values for the forbs that contributed substantially to the diet or were among the most highly selected (desert-parsley, hawksbeard, mountain-dandelion, and long-leaf phlox) ranged from approximately 25 to 30% crude protein. Calcium content was highest in the leaves of desert-parsley (1.36%) and long-leaf phlox (0.98%). All other foods had values that ranged from 0.35 (desert-parsley flowers) to 0.78% (hawksbeard, long-leaf phlox, and buckwheat leaves). Phosphorous content was greatest in desert-parsley flowers (0.62%) and hawksbeard leaves (0.50%). Sagebrush leaves were lowest in phosphorus content of all plant foods tested. Nutrient content of the leaves of low and big sagebrush was similar except for calcium ($P = 0.01$), which was higher in big sagebrush (0.70%) than low sagebrush (0.41%).

Forbs were higher in nutrient content than sagebrush and consumption of forbs improved nutritional status of the hens. In 1990, nutrient content of the composite diet was 19.4% crude protein, 0.77% calcium, and 0.33% phosphorus for hens collected in big sagebrush cover type and 19.8% crude protein, 0.64% calcium, and 0.33% phosphorus for hens collected in low sagebrush cover type. In 1991 (hens collected from low sagebrush cover type only) nutrient content of the composite diet was 16.0% crude protein, 0.51% calcium, and 0.25% phosphorus. Nutrient content of the composite diet was higher than nutrient content for a diet composed solely of a sagebrush because of the consumption of forbs (Table 3).

We used the data obtained from vegetation sampling to test for changes in cover of the major vegetation classes on the study area. We compared cover types sampled in 1990 and found that forb and grass cover were greater and bare ground less in low sagebrush than big sagebrush. We also found that in low sagebrush cover type forb and grass cover declined and bare ground increased significantly ($P<0.05$) from 1990 to 1991 (Table 4). Consequently, fewer forbs were available on the study area in 1991.

Discussion

Our findings revealed that forbs constituted a substantially greater proportion of the pre-laying diet of sage grouse hens than previously reported. Previous research indicated that sagebrush composed 100% of the diet of sage grouse in February (Wallestad 1975), 97% in March (Wallestad 1975), 89–100% in April (Patterson 1952, Rogers 1964), and 80–86% in May (Patterson 1952, Rasmussen and Griner 1938). We found that forbs contributed approximately 20 to 50% to the diet of pre-laying hens. Forbs may not be available during the pre-laying period in all years or in all areas of sage grouse range due to snow cover. This discrepancy may also have resulted from lack of separation of the diets of males and females in other studies. Dietary differences between sexes of other grouse, including blue grouse *(Dendragapus obscurus)* and rock ptarmigan *(Lagopus mutus)*, during spring have been reported (King and Bendell 1982, Gardarsson and Moss 1969).

Four forbs, including hawksbeard, desert-parsley, long-leaf phlox, and mountain-dandelion, were taken in relatively high frequencies, collectively composed up to 38% of the dry weight of the diet, and were among the most highly selected foods. These foods contained at least 25% crude protein and several were high in calcium or phosphorus. No previous work addressed dietary selection in sage grouse hens during the reproductive period but selection for highly nutritious foods during the breeding season was documented for other grouse, including rock ptarmigan (Gardarsson and Moss 1969) and red grouse (Moss 1972).

The relationship between diet and productivity of female sage grouse is unknown but likely is similar to other species of grouse. Clutch size and weight and chick viability of captive ruffed grouse increased when dietary protein levels were raised incrementally from 8 to 20% (Beckerton and Middleton 1982). Likewise, clutch size and chick viability of captive willow ptarmigan *(L. lagopus)* were higher when diets of hens contained 20% crude protein compared with 15% protein (Hanssen et al. 1982).

Production of sage grouse, measured by chicks/hen and average brood size, decreased in 1991. This corresponded to a decrease in forbs eaten and decrease in nutrient content of the composite diet. Many factors contribute to successful reproduction, including predation, weather, and nutrition. Our study revealed that forbs are an important source of protein and other nutrients, and consumption of forbs increased nutritional status of the hens.

Differences in amounts of forbs consumed between 1990 and 1991 likely were related to decreased availability of forbs between the 2 years. This change in abundance of sage grouse foods perhaps was related to the 40% reduction from normal precipitation for the year preceding the 1991 sample. Differential use of low and big sagebrush stands, which was reflected in sample sizes of birds, may be related to the greater availability of forbs found in low sagebrush compared with big sagebrush, based on the sample from 1990.

The importance of sagebrush to sage grouse for food and cover can not be understated. Sagebrush is a major component of sage grouse diets throughout most of the year. However, forbs are more nutritious and are sought as forage when available. Historic overgrazing and fire suppression in many portions of the western range of sage grouse have resulted in increased sagebrush cover and decreased herbaceous understory (Kauffman 1990, Winward 1991). Because of the apparent importance of forbs to pre-laying female sage grouse, management activities should allow for restoration of

an array of early-season forbs within sagebrush stands.

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