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Ruffed Grouse (*Bonasa umbellus*) foraging in aspen stands during winter in northern Utah

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RUFFED GROUSE (*BONASA UMBELLUS*) FORAGING IN ASPEN STANDS DURING WINTER IN NORTHERN UTAH

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ABSTRACT.—Ruffed Grouse (*Bonasa umbellus*) population densities are lower in the Intermountain West than elsewhere in the species' range. Throughout much of its range, the Ruffed Grouse is closely associated with quaking aspen (*Populus tremuloides*), in part because aspen buds are an important winter food. Because population fluctuations of Ruffed Grouse have been associated with changes in aspen abundance or chemical composition, we studied winter foraging of the species in the Intermountain West where it has received little attention. Aspen buds were the most prominent forage in the bird's diet, although in contrast to other Ruffed Grouse food habits studies, reproductive buds were not eaten more than vegetative buds, and buds of other deciduous plants were also important (>20% of the diet). Excretion of high concentrations of ammonium nitrogen suggests that grouse in northern Utah are ingesting higher levels of secondary plant compounds than reported elsewhere. Our results show aspen is important in the winter ecology of Ruffed Grouse in northern Utah and suggest that continued loss of aspen may impact grouse populations.

Key words: Ruffed Grouse, Bonasa umbellus, *quaking aspen,* Populus tremuloides, *food habits, foraging, Utah, ammonium, secondary plant compounds, protein.*

The range of the Ruffed Grouse (*Bonasa umbellus*) covers the northern half of North America and extends south in the Appalachian, Rocky, and Pacific Coast Mountain ranges (Bump et al. 1947). While the species occurs in a wide variety of vegetation types across its range, highest densities are reported in areas dominated by quaking aspen (*Populus tremuloides*; hereafter referred to as aspen; Svoboda and Gullion 1972). In these areas Ruffed Grouse rely heavily on aspen buds as a winter forage. Consequently, aspen is considered a key food for Ruffed Grouse because it is abundant, can be harvested efficiently, and has adequate levels of nutrients (Svoboda and Gullion 1972). Changes in abundance, chemical composition, and grouse consumption of aspen buds have been correlated with population fluctuations of Ruffed Grouse (Jakubas and Gullion 1991).

Ruffed Grouse prefer staminate reproductive buds of quaking aspen over vegetative and pistillate buds and prefer certain aspen clones (Svoboda and Gullion 1972, Huempfner and Tester 1988). These foraging patterns can be explained in part by the large size, high levels of protein, and low levels of secondary plant compounds, especially coniferyl benzoate, of reproductive buds in preferred clones (Doerr et al. 1974, Jakubas and Gullion 1991).

Relationships between Ruffed Grouse and aspen have been extensively studied in Minnesota (e.g., Svoboda and Gullion 1972, Huempfner and Tester 1988) and Alberta (e.g., Doerr et al. 1974). Although Ruffed Grouse are associated strongly with aspen in the Intermountain West (Stauffer and Peterson 1985), little research has been conducted on their foraging in aspen stands during winter in this region. Despite the abundance of aspen, Ruffed Grouse densities are lower in the Intermountain West than in northern and eastern portions of the species' range (Stauffer 1989). In addition, grazing by wild and domestic herbivores and fire suppression, which favors succession toward conifer forest types, threaten the abundance of aspen in the Intermountain West (DeByle and Winokur 1985). Thus, an understanding of the relationship between Ruffed Grouse and aspen in the Intermountain West may help explain why densities are lower and could assist efforts to enhance populations. The objectives of our study were to determine the proportion of aspen buds in the winter diet of Ruffed Grouse in the Intermountain West, to describe Ruffed Grouse

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foraging patterns in aspen stands, and to compare levels of secondary plant compound ingestion between grouse in the Rocky Mountains and elsewhere, as reported in the literature.

METHODS

We conducted our study on the Wasatch-Cache National Forest, east of Logan, Utah. Dominant overstory species in the study area are apsen, *Pseudotsuga menziesii* (Douglas-fir), *Acer grandidentatum* (bigtooth maple), and *Sorbus scopulina* (mountain-ash). Understory shrubs are *Prunus virginiana* (chokecherry), *Salix* spp. (willow), *Rosa* sp. (rose), *Amelanchier alnifolia* (serviceberry), and *Physocarpus* sp. (ninebark). Patches of *Artemisia* sp. (sagebrush) and diverse herbaceous species are scattered throughout the area. Elevation of the study site is 1760–2360 m. Snowpack during the study was 50–120 cm.

Because Ruffed Grouse in our study area are rarely found during winter where aspen are not present (Stauffer and Peterson 1985), we used aerial photography to identify 21 aspen stands that were >0.5 km^2 and <2 km from a maintained roadway. Of these, 6 were chosen based on winter accessibility and confirmed presence of Ruffed Grouse. To sample each stand for foraging grouse and to collect aspen buds, we set up 900- to 1200-m-long transects perpendicular to land contours and marked them with colored flagging. Aspen was the dominant overstory species on all transects, but plant species common throughout the study area (listed above) were found on most transects. We searched for foraging grouse between 14 December 1995 and 28 February 1996 by slowly walking transects beginning 30 min before sunrise (once for each transect) or at sunset (2–3 times for each transect). Observers wore white clothing to camouflage their activities and minimize disruption of foraging grouse. When grouse were observed foraging, we recorded duration of observed foraging and marked trees in which birds foraged.

Vegetative and reproductive aspen buds were collected during March 1997 from the upper 1/3 of the tree canopy by removing a branch using a tree pruner on an expandable pole or by shooting with a shotgun. Buds were collected from mature aspen trees nearest every 200-m flag along each transect. If reproductive buds were not found on trees sampled systematically, buds were collected from the nearest aspen tree. Buds were held on dry ice in the field and frozen at –20°C until freeze-dried.

Ruffed Grouse intestinal feces were collected along transects from snow roosts or from foraging paths identified from grouse tracks in snow. We did not collect cecal droppings because their composition varies from that of intestinal droppings (Moss and Parkinson 1972) and they could not be collected with every fecal sample. Feces were analyzed to estimate food habits and nitrogen excretion patterns. Only feces <24 h old, based on flushing the bird or fresh sign in new snow or melting snow, were used for nitrogen analysis. All galliform feces collected were assumed to be from Ruffed Grouse. Although Blue Grouse (*Dendragapus obscurus*) inhabit the area, the species was not observed during the study and was unlikely to be found in the area because of preference for high-elevation conifer stands during winter (Stauffer and Peterson 1985).

Feces were freeze-dried and ground with a mortar and pestle. By mixing 1-g samples from each fecal collection, we made a composite of all feces collected from each aspen stand. Forage species composition was determined by microhistological analysis for each of 6 composite samples (Wildlife Habitat Lab, Washington State University, Pullman, WA). Because vegetative and reproductive buds of aspen can be distinguished through this analysis, a correction factor was established to account for differences in the amount of recognizable material between the 2 types of buds. The analysis indicated that both bud types had similar amounts of recognizable material per unit mass (1.1:1.0 for reproductive:vegetative), and thus proportions of these bud types in feces were assumed to represent relative proportions in the diet. Nitrogen content of feces and aspen buds (for samples with enough biomass for analysis) was determined in duplicate by the Kjeldahl technique and converted to crude protein by multiplying by 6.25 (Robbins 1993). Ammonium nitrogen in feces was assayed using only the distillation and titration steps of the Kjeldahl procedure.

RESULTS

Transects were walked once each at sunrise and 2–3 times each at sunset, resulting in 353 and 670 min of observation, respectively. We observed grouse foraging on 6 occasions on 4 different transects. Group sizes of 3, 2, and 1 were observed for a total of 9 birds. One of these birds foraged on both *Prunus virginiana* and aspen buds, another only on *P. virginiana*, and the remainder foraged entirely on aspen. We observed grouse foraging 7.52 ± 1.52 min ($\bar{x} \pm s_{\bar{x}}$; $n = 8$; one bird in a group of 3 was not fully visible while foraging). This is a minimum estimate of the duration of foraging bouts because 3 birds were foraging when first seen. The others were first seen flying into the trees in which they foraged. Foraging grouse were first observed 28 ± 4 min ($n = 6$) after official sunset. All foraging in aspen trees occurred in the upper 1/3 of the canopy, and birds moved higher into the canopy as they foraged, finishing in the uppermost branches. Birds foraged at a fast rate (25–45 bite motions/min) and rarely stopped foraging for >15 sec. Of 10 trees in which grouse were observed foraging, only 1 had reproductive buds; these were staminate buds. No grouse were observed foraging in the morning, although tracks indicated they foraged on shrubs at ground level in the morning.

Thirty-seven fecal samples were used for food habits analysis. Aspen buds were the predominant forage at 5 sites, averaging 41% of feces (Table 1). *Amelanchier alnifolia, Salix* spp., and *Acer grandidentatum* were consumed in lesser amounts on all sites, and *Shepherdia canadensis* (buffalo-berry) and *Prunus virginiana* occurred in feces at 1 site each. Aspen vegetative buds made up a larger percentage of the diet than reproductive buds on 5 sites. Ammonium averaged 40.2 ± 1.4% ($n = 24$) of nitrogen excreted in feces (Table 1). Vegetative and reproductive (male and female) buds of aspen averaged 6.7 ± 0.5% ($n = 12$) and 11.2 ± 0.4% ($n = 16$) crude protein, respectively.

DISCUSSION

Foraging behavior of Ruffed Grouse in Utah was similar to that of grouse in Minnesota and Alberta (Svoboda and Gullion 1972, Doerr et al. 1974, Huempfner and Tester 1988). Ruffed Grouse began foraging after sunset and often continued past the time sunlight was visible on the horizon. Arboreal foraging was more common in the evening than morning and was intense during evening as birds appeared to maximize intake rate to fill their crops before roosting for the night. Foraging patterns observed during this study differed from those reported previously (Doerr et al. 1974, Svoboda and Gullion 1972). Ruffed Grouse in Utah did not concentrate their foraging on reproductive buds, despite the higher nitrogen content and larger size of reproductive buds.

Crude protein of reproductive buds from random trees in Utah was similar to that of trees in Alberta (9.2–10.0%; Doerr et al. 1974) and Minnesota (9.3–13.9%; Jakubas and Gullion 1991, Guglielmo and Karasov 1995). Jakubas and Gullion (1991) argue that aspen buds should have ≥11% crude protein and

TABLE 1. Percent forage species composition of Ruffed Grouse feces collected December 1995–March 1996 on 6 study sites in northern Utah and the percentage of fecal nitrogen excreted as ammonium (NH_4) in feces collected within 24 h of excretion.

Study site	*Acer grandidentatum*	*Amelanchier alnifolia*	*Populus tremuloides* Reproductive	*Populus tremuloides* Vegetative	*Prunus virginiana*	*Salix* spp.	*Shepherdia canadensis*	NH_4%
Mill Hollow	22	25	3	30	0	20	0	—[a]
Creek Crossing	10	22	11	21	23	13	0	33
West Hodges Creek	7	21	39	22	0	12	0	30
Red Banks	8	21	21	29	0	22	0	34
Franklin Basin	22	22	18	26	0	12	0	44
Beaver Mountain	14	17	7	19	0	8	35	44
AVERAGE	13.8	21.3	16.5	24.5	3.8	14.5	5.8	40.2[b]
($s_{\bar{x}}$)	(2.8)	(1.1)	(5.3)	(1.8)	(3.8)	(2.2)	(5.8)	(1.4)

[a]Feces <24 h old were not found on this study site.
[b]Average and standard error for 24 separate samples.

≤1.8% coniferyl benzoate to be preferred by foraging Ruffed Grouse. Using only the protein criterion, 40% of trees with staminate buds sampled would be suitable for Ruffed Grouse foraging.

Foraging sign in the snow and analysis of material in grouse crops ($n = 5$) indicated that aspen and *Prunus virginiana* were predominant forages of Ruffed Grouse during winter in the Wellsville Mountains, southwest of Logan, Utah (Phillips 1967). Foraging sign also indicated grouse ate buds of *Salix* spp., *Amelanchier alnifolia,* and *Acer grandidentatum,* although these shrubs were not considered important (Phillips 1967). Grouse in our study consumed a similar array of species, although *P. virginiana* occurred in feces at only a single site, and *A. grandidentatum,* and *A. alnifolia* were consumed at most sites. Aspen may have been overrepresented relative to the diet of all Ruffed Grouse in the study area because feces were collected from areas in which aspen trees were part of the overstory. Because grouse were more likely to forage on understory plants during the day and in the canopy of aspen trees during evening, food habits analyses could be biased if daytime and nighttime feces were not collected in representative proportions. Of 29 fecal samples for which we recorded the type of collection (snow roost or grouse foraging path), 16 (55%) were from snow roosts. However, birds were flushed from 2 of these snow roosts in the afternoon, and thus some snow roosts contained feces from daytime foraging. Therefore, we do not feel our food habits data are strongly biased by unrepresentative proportions of feces produced from daytime feeding.

Excretion of ammonium nitrogen increases as a result of metabolic acidosis, which may arise from consumption of forages high in secondary plant compounds (Foley et al. 1995) or from starvation (DelGiudice et al. 1994). Because we saw no indication of malnourished grouse and starvation is rarely documented in grouse (Bergerud 1988), ammonium excretion may serve as an index to ingestion of secondary plant compounds (Foley et al. 1995). Such an index was preferred because analyses of common secondary plant compounds, such as phenolics or tannins, have not been useful in explaining Ruffed Grouse foraging behavior (Jakubas et al. 1989).

Ammonium was <7% of fecal nitrogen in grouse consuming pelleted diets with few secondary plant compounds (Jakubas et al. 1993, Hewitt and Kirkpatrick 1997) and was >10% in grouse consuming native forages or diets containing secondary plant compounds (Hewitt and Kirkpatrick 1997 and references therein). The highest reported ammonium excretion in grouse was 33–55% by Blue Grouse consuming conifer needles (Remington 1990). The high percentage of ammonium nitrogen excreted by Ruffed Grouse in Utah suggests they were ingesting high levels of secondary plant compounds. Although grouse on the West Hodges Creek study area had the lowest level of ammonium excretion and highest proportion of aspen reproductive buds in the diet (Table 1), there was no clear relationship between ammonium excretion and aspen level in the diet (regression analysis, $P > 0.25$). Ammonium concentrations reported in our study may be inflated because cecal feces, which often contain higher concentrations of nitrogen and lower concentrations of ammonium nitrogen (Moss and Parkinson 1972), were not collected. Correcting for cecal feces is unlikely to shift nitrogen excretion patterns dramatically because cecal feces are usually <15% of excreta dry matter (Moss and Parkinson 1972).

CONCLUSIONS

Aspen buds were the primary forage of Ruffed Grouse on our study sites. For this reason, and because Ruffed Grouse during winter in our area use aspen or aspen/conifer stands almost exclusively (Stauffer and Peterson 1985), we feel maintaining aspen in the ecosystem contributes to productive grouse populations, although inclusion of several browse species in Ruffed Grouse diets suggests that diverse communities of deciduous trees and shrubs are likely to provide the best habitat for foraging during winter. High levels of ammonium nitrogen excreted by Ruffed Grouse in the study area may indicate that grouse were consuming browse containing high levels of secondary plant compounds and that improvements in the winter diet may be possible. Whether different diets would influence grouse survival, production, or density is not known. However, further study of Ruffed Grouse foraging will advance our understanding of plant-herbivore interactions and provide new information regarding management options that can be implemented in the Intermountain West to enhance Ruffed Grouse populations.

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