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Comparison of Fall and Winter Food Habits for Sympatric Chukar and Gray Partridge in Hells Canyon of Idaho and Oregon

Abstract

Chukar and gray partridge are abundant and sympatric in Hells Canyon, Idaho and Oregon. We collected crops (birds collected during the hunting season) from both species to compare fall and winter food habits, which allowed for comparison of food selection, estimation of niche overlap, and identification of important food resources. We collected 143 chukar and 112 gray partridge crops during the 1999 and 2000 hunting seasons (late September through early January). We identified 21 items consumed by chukar and 16 items consumed by gray partridge. Both bird species consumed similar foods, with an 80% dietary overlap. Dominant food items for both species included prairie star root nodules and vegetative parts from various grasses and forbs. Food items differed between years, which may have reflected variation in weather and plant cycles. This is the first study of gray partridge from a non-agricultural environment, and the first rigorous comparison of food habits for sympatric chukar and gray partridge population in North America.

Introduction

Chukar (*Alectoris chukar*) and gray partridge (*Perdix perdix*) are highly successful exotic species in North America. To our knowledge, no other research has rigorously examined comparative ecology for sympatric populations of these species in North America. Interactions among sympatric *Alectoris* partridge and other partridge species were explored in Europe and Asia by Watson (1962). He hypothesized that competitive exclusion has eliminated competition among species across most of their original range, but they occurred together when two species had separate microhabitat requirements or breeding biology, or when hunting had kept populations below levels where competitive exclusion may be expressed. Like Watson (1962), we were interested in identifying possible niche partitioning and potential competition for certain food items. Monda and Ratti (1988), with similar objectives, reported that different species of duck broods had high levels of overlap in diet, but were segregated by microhabitat.

Other North American research on gray partridge food habits has been conducted in agricultural habitats (Hupp et al. 1988, Knight et al. 1979, Westerskov 1966), and in both agricultural and non-agricultural habitats for chukar (Knight et al. 1979, Weaver and Haskell 1967). This study was conducted in conjunction with a general assessment of chukar and gray partridge populations and habitat in Hells Canyon (Ratti and Giudice 2001). Although density estimates have not been conducted for chukar and gray partridge in Hells Canyon (Ratti et al. 1983), both species were abundant throughout our Hells Canyon study region. Over a 2-yr period, Ratti and Giudice (2001) reported observing >2 coveys/survey hour ($n=269$), with 54% chukar observations and 46% gray partridge observations. Excellent general reviews of chukar and gray partridge biology and ecology were presented by Christensen (1996) and Carroll (1993).

Our objectives were to 1) compare fall and winter food habits of chukar and gray partridge in Hells Canyon, 2) measure niche overlap and niche breadth, and 3) compare data from Hells Canyon with other studies. Our general research hypothesis was that sympatric chukar and gray partridge in Hells Canyon consume the same proportion of identical food items during fall and early winter.

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Study Area

The Hells Canyon Reach of the Snake River is situated in west-central Idaho and northeastern Oregon. Hells Canyon is the deepest (600-1700 m) and one of the most rugged river gorges in the continental United States. The topographical complexity of steep and broken slopes, often dominated by rock outcrops and talus, has produced a mosaic of vegetation types. Slopes are typically covered by a thin mantle of residual soil from weathered native basalt rock (Asherin and Claar 1976, Tisdale 1979, Bonneville Power Administration 1984, U.S. Department of Interior 1987, and U.S. Department of Agriculture 1994).

The Hells Canyon region is influenced by a rain shadow of the Cascade Mountains. Temperatures range from -5°C in January to 35°C in July. Average annual precipitation ranges from 380-500 mm (nearly 45% of annual precipitation occurs November through January).

Riparian, grassland, shrubland, and forest habitats exist in close proximity (Tisdale 1979). Grasslands are dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) cheatgrass (*Bromus tectorum*), and Idaho fescue (*Festuca idahoensis*) (Asherin and Claar 1976, Tisdale 1986). Shrub-steppe communities are also common and dominated by sagebrush (*Artemisia* spp.), bitterbrush (*Purshia tridentata*), hackberry (*Celtis reticulata*), serviceberry (*Amelanchier alnifolia*), and bittercherry (*Prunus emarginata*) (Tisdale and Hironaka 1981, Bonneville Power Administration 1984, Tisdale 1986, Franklin and Dyrness 1988). The predominant forest community is dominated by ponderosa pine (*Pinus ponderosa*), which typically occurs as a savanna with wheatgrass understory (Garrison et al. 1977, Johnson and Simon 1987).

Methods

Our study area extended from Weiser, Idaho, on the Snake River to Hells Canyon Dam, and included Idaho Power Company's 3-dam hydroelectric complex. The study area contained ~167 river km (i.e., rkm 397 to 565). We collected birds with a shotgun during habitat and population surveys (Ratti and Giudice 2001). We attempted one survey every 6.4 rkm between Weiser and Hells Canyon Dam. Surveys generally followed a circular pattern from the reservoir shoreline to the

nearest adjacent rim (~0.8 km laterally from the reservoir, and approximately perpendicular from the general river-flow direction), and back to the starting point. Deviations from this pattern were common due to terrain that could not be safely traversed. Elevation change during surveys was 300-350 m for most surveys. Birds were collected on the Idaho and Oregon sides of the river during fall-winter surveys in 1999 and 2000. All birds were collected during open hunting season in Idaho and Oregon. We used trained bird dogs (setters and retrievers) to assist with locating birds. Each survey consisted of ~4-6 hr of walking but they seldom exceeded 6 hr.

We examined food habits of birds collected in Hells Canyon by analysis of crop contents using standard methods (Korschgen 1980, Hupp et al. 1988). Crops were removed from birds on the day collected and frozen until dissection. Contents were later sorted, and volumes of each food item measured. Items that displaced <0.1 ml were recorded as trace amount (Hupp et al. 1988). Volumes were transformed to aggregate percentages (Martin et al. 1946) to minimize biases that occur when a single bird gorges on one food item (Swanson et al. 1974).

Food items were grouped into five classes similar to those used by Knight et al. (1979): vegetation (green grass shoots and other green foliage), roots (the bulbous stem base of grasses, root nodules, roots, and bulbs), seeds, berries, and insects. Classes were ranked within each crop sample, and differences in ranked classes analyzed. We used Mann-Whitney test statistics to compare species and years. Our sample size was inadequate for comparisons between month and location. Percent of total volume was also calculated for each item by species, month, and year to help depict differences.

We calculated two niche measures to quantify resource use and overlap. These measures included Levin's measure of niche breadth, calculated for each species as:

$$B = 1/\sum p_j^2$$

where p_j^2 is the fraction of items in the diet of an individual using resource j (Krebs 1989). Niche breadth describes diet variability, with a low value being a monophagous specialist, and a high value a generalist (Cody 1974). We also calculated the percentage overlap:

$$P_{jk} = \left[\sum_{i=1}^n (\min(p_{ij}, p_{ik})) \right] 100$$

where p_{ij} is the proportion that resource i represents of the total resources used by species j , and p_{ik} is the proportion that resource i is of the total resources used by species k (Krebs 1989). This index describes the amount of overlap between resource utilization curves of species (Cody 1974).

Results

We collected 255 crops from 54 chukar and 34 gray partridge in 1999, and 89 chukar and 78 gray partridge in 2000. We identified 30 food items (Table 1). Chukar consumed 21 items in 1999 and 19 items in 2000. Gray partridge consumed 16 items in 1999 and 13 items in 2000. Only 11 items individually accounted for >5% of the total vol-

ume for either species during both years: prairie star root nodules (*Lithophragma* sp.), vegetation (green grass and forbs), bulbous bluegrass stem-base (*Poa bulbosa*), sunflower seed (*Helianthus annuus*), Scotch thistle seed (*Onopordum acanthium*), hackberry (*Celtis reticulata*), cheatgrass seed (*Bromus tectorum*), fiddleneck seed (*Amsinckia* sp.), knotweed seed (*Polygonum* sp.), gromwell seed (*Lithosperma* sp.), and insects.

We were unable to test for differences for individual food items consumed (Table 1) because the data matrix contained too many zero values, creating unacceptable variation. Zero values were created by individual birds consuming large volumes of one or two food items, while the overall diet was varied. However, we tested volume differences among food categories (Tables 2 and 3).

TABLE 1. Food items from chukar and gray partridge in Hells Canyon. Food items not found indicated by (-). Plant names from Hitchcock et al. (1969).

Chukar Food item (seed unless specified)	1999		2000					
	Gray partridge Volume	Chukar %	Chukar Volume	Gray partridge %	Chukar Volume	Gray partridge %	Chukar Volume	Gray partridge %
Prairie star root nodules	57.4	27.0	15.1	27.7	38.2	15.4	15.2	13.1
Vegetation (grass and forbs)	30.8	14.5	9.5	17.4	90.2	36.4	43.0	37.0
Bulbous bluegrass stem-base	23.3	11.0	3.5	6.4	5.8	2.3	4.0	3.4
Sunflower	19.7	9.3	1.8	3.3	7.8	3.1	-	-
Scotch thistle	18.1	8.5	4.0	7.3	-	-	4.0	3.4
Hackberry	13.0	6.1	0.7	1.3	8.3	3.3	-	-
Black hawthorn berry	9.0	4.2	-	-	-	-	-	-
Cheatgrass	8.0	3.8	3.4	6.2	3.4	1.4	0.6	0.5
Unidentified insects	7.6	3.6	9.6	17.6	1.1	0.4	0.2	0.2
Unidentified roots	7.3	3.4	0.1	0.2	0.2	0.1	-	-
Fiddleneck	6.4	3.0	2.6	4.8	33.5	13.5	28.2	24.3
Filaree	4.5	2.1	1.3	2.4	-	-	0.1	0.1
Knotweed	0.1	0.1	0.9	1.7	22.8	9.2	7.4	6.4
Gromwell	-	-	-	-	11.7	4.7	12.3	10.6
Bulbous bluegrass	-	-	0.1	0.2	-	-	0.1	0.1
Tarweed sp.	-	-	-	-	1.0	0.4	-	-
Japanese brome	0.2	0.1	-	-	-	-	0.3	0.3
Medusahead	1.1	0.5	0.9	1.7	3.6	1.5	-	-
Arrowleaf balsamroot	-	-	-	-	1.5	0.6	0.7	0.6
Aster flowers	1.5	0.7	0.8	1.5	11.7	4.7	-	-
Lomatium	-	-	-	-	1.8	0.7	-	-
Bluebunch wheatgrass	-	-	-	-	3.9	1.6	-	-
Sand fringe pod	-	-	-	-	0.1	<0.1	-	-
Salsify	-	-	-	-	1.5	0.6	-	-
Onion bulb	1.0	0.5	-	-	-	-	-	-
Big sagebrush galls	0.2	0.1	-	-	-	-	-	-
Smooth sumac berry	0.1	0.1	-	-	-	-	-	-
Thistle	0.1	0.1	-	-	-	-	-	-
Bur ragweed	3.0	1.4	-	-	-	-	-	-
Hound's tongue	-	-	0.2	0.4	-	-	-	-

TABLE 2. Monthly percentages of food items consumed for chukar and gray partridge in 1999.

Item	October	November	December
Chukar			
Sample size	29	14	11
Vegetation	6	1	62
Seed	14	61	6
Root	65	36	<1
Insect	6	1	-
Berry	9	-	32
Gray partridge			
Sample size	15	12	7
Vegetation	17	3	100
Seed	28	39	-
Root	32	49	-
Insect	23	3	-
Berry	-	6	-

The total volume of foods consumed by chukar and gray partridge varied for both species between years ($P \leq 0.05$) for three of five food classes. Thus, data from the 2 yr were not pooled. Also, food categories were different between chukar and gray partridge, including vegetation ($P \leq 0.0001$), seeds ($P \leq 0.001$), and insects ($P \leq 0.0001$).

Diets of the two species were similar; niche overlap was estimated at 80% for both years. In 1999, Levin's measure of niche breadth was 5.2 for chukar and 4.3 for gray partridge; in 2000 niche

breadth was 7.5 for chukar and 6.3 for gray partridge.

Discussion

Chukar consumed 21 food items and gray partridge consumed 16 food items. Dominant food items for both species included prairie star root nodules, grass, and forbs. Although niche overlap was high (80%), we did detect consumption differences among food categories. However, these differences were not consistent among months and years. For example, gray partridge consumed more seeds in October 1999, but chukar consumed more seeds in November 1999 (Table 2).

Although chukar and gray partridge are important game birds in western states, there has been little research on these species. Consequently, few data are available to compare with our study results. Only one other North American study, conducted in Washington, compared chukar and gray partridge (Knight et al. 1979). However, that study contained only one year of data, was not from a totally non-agricultural environment, and sample size of crops for gray partridge was too small ($n=20$) for comparison with our study. In addition, our results were substantially different from those reported by Knight et al. (1979). For example, Knight et al. (1979) reported that seeds dominated chukar diet in all seasons. In our study, prairie star roots, vegetation, and bulbous blue-

TABLE 3. Monthly percentages of food items consumed for chukar and gray partridge in 2000.

Item	September	October	November	December	January
Chukar					
Sample size	21	38	24	2	3
Vegetation	36	33	70	100	35
Seed	37	36	25	-	65
Root	13	25	5	-	-
Insect	1	1	-	-	-
Berry	6	7	-	-	-
Gray partridge					
Sample size	20	32	14	0	12
Vegetation	12	50	78	-	100
Seed	59	38	18	-	-
Root	24	10	5	-	-
Insect	4	1	-	-	-
Berry	-	-	-	-	-

grass stem bases dominated our sample over a two-year period (Table 1). Some of these differences are likely due to geographic differences and food availability; others may be related to sample size.

Weaver and Haskell (1967) have the best previously published data on chukar food habits, but they had no gray partridge data. For chukar in Nevada, they reported a greater importance of cheatgrass in the diet. However, like our study, they found significant levels of fiddleneck seeds and prairie star roots.

To our knowledge, this is the first study to document prairie star roots as a food item for gray partridge. Our data suggest that prairie star was consumed less by gray partridge than by chukar, but overall, this plant species represents an important food item for these species in Hells Canyon.

From our observations both chukar and gray partridge consumed more vegetation in the form of green grass shoots as time passed from fall to winter (Tables 2 and 3). We suspect that this trend simply reflected availability. Late summer and early fall in Hells Canyon are extremely dry and green grass shoots are non-existent on most slopes. However, late fall and early winter precipitation often results in prolific emergence of green grass shoots, especially if temperatures were mild. We also noted that diet of our birds changed slightly during the second year; birds consumed more green vegetation and fiddleneck seeds, and reduced use of prairie star root nodules. Again, we suspect this change was related to availability. We have observed in many locations that birds scratch soil away from steep slopes to expose prairie star roots. During periods of cold after precipitation, frozen soils probably render most root nodules inaccessible to birds. However, temperature data for the local region did not support this hypothesis (Edelmann et al. 2001). An alternate explanation would simply be that prairie star was less abundant on the study area during the 1999-2000 winter, but we have no data on prairie star abundance.

We estimated an 80% overlap in food niche between the species for both years, and these data are consistent with comparisons among similar

species in Europe by Watson (1962). Although our niche overlap measurement reveals a similar diet by these species, our niche breadth data suggested a narrower range of food items consumed by gray partridge in both years. Knight et al. (1979) also noted that gray partridge had the least diverse diet of the four species compared in their study. Fewer dietary items used by gray partridge may be related to habitat use. In Hells Canyon, we know that gray partridge use a narrower range of habitat than sympatric chukar. At the population level observed during this study, we speculate that competition is low or non-existent between chukar and gray partridge. We have no data on food-resource availability, but we suspect most foods are abundant in Hells Canyon. In addition, the relatively even proportion of chukar and gray partridge and the relatively high population level (Ratti and Giudice 2001), fail to indicate competition at a level that has negatively affected survival and reproduction of either species. In a niche overlap study of American coot (*Fulica americana*) and Gadwalls (*Anas strepera*), high niche overlap was consistent with convergence on a super-abundant resource and suggested that food in their study was not limiting (McKnight and Hepp 1998).

Given the importance of relatively few plant species to both chukar and gray partridge, future research should document abundance and distribution of these plants, and management of livestock in Hells Canyon should consider potential impacts of grazing on these plant communities.

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