BNWL-1931

Special Distribution
in Category UC-70

Diets of Black-Tailed Hares on the Hanford Reservation

April 1975

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Ecosystems Department**

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FIGURE 1. Big Sagebrush (*Artemisia tridentata*) Plant Community Common to the B-C Cribs Area

FIGURE 2. Bitterbrush (*Pursha tridentata*) Plant Community Common to the Wye-Barricade Area

EXECUTIVE SUMMARY

A fecal pellet analyses showed that black-tailed hares (jackrabbits) were selective in plants chosen as food. The most abundant herbaceous plant, cheatgrass, was not found in the pellets. Sagebrush and bitterbrush, woody plants, were not an important part of the hares' diet. Forbs, rabbitbrush and certain grass species were preferred foods.

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DIETS OF BLACK-TAILED HARES ON THE HANFORD RESERVATION

INTRODUCTION

The purpose of this investigation was to examine the fecal pellets dropped by black-tailed hares (Lepus californicus), as a means to determine the kinds of plants eaten.

Two widely separated and different plant communities were selected as study areas. One dominated by big sagebrush (Artemisia tridentata) was located adjacent to the B-C Cribs Controlled area and the other dominated by bitterbrush (Pursha tridentata) was located in the vicinity of the Wye-Barricade (Figure 1).

Although cheatgrass, Bromus tectorum, is the most abundant herbaceous plant observed in the field, it did not appear in the fecal pellets examined. The plant species most often associated with fecal pellets were yarrow, Achillea millifolium; turpentine cymopterus, Cymopterus terebinthinus; and Erigeron sp. All are relatively scarce in the hare's habitat. The shrub species most often represented in fecal pellets was rabbitbrush, Chrysothamnus nauseosus, which was common in habitat.

Study Sites for Black-Tailed Hare Diet Analyses on the ERDA-Hanford Reservation.

METHODS

The experimental design for collecting fecal pellets of hares consisted of two replicated sites located at random in each of two habitat types within the B-C Cribs Control zone and near the Wye-Barricade. Within each replicate two parallel transects (1 m x 50 m) were spaced 60 meters apart. Each transect was subdivided into two lengths—1 to 25 meters and 25 to 50 meters. All pellets were collected from the two subdivisions of each transect and designated as two samples. This procedure was repeated for all transects, making a total of four samples for each replicate. The number of pellets in the samples by classes ranged from 20 to 1026. A total of 6712 pellets was analyzed in the B-C Cribs Controlled zone and 2871 in the Wye-Barricade site.

The experimental design for plant habitat comparisons was a nested factorial design and all tests, including analysis of variance, follow Snedecor and Cochran (1967). For multiple comparisons, a Bonferroni t-test was used as outlined by Miller (1966).

FECAL PELLET ANALYSES

Fecal pellets were plucked from the ground by hand and categorized into four general age classes: (1) recent pellets, less than 1 year old and green in color; (2) brown pellets, more than 1 year old; (3) gray-brown pellets, eroded in size and shape, several years old; and (4) a general category consisting of mixtures of classes 2 and 3. Additional fecal pellets were collected and categorized as radioactive. Pellets were dried at 70°C for 48 hours and ground in a Wiley mill (1 mm screen) to make a homogeneous sample. All sampling was conducted during April 1974.

Five slides were prepared for each of the four samples by classes after the contents had been washed over a 0.1 mm screen (Sparks and Malechek, 1968). Slides were prepared with Hertwig's solution and Hoyer's solution (Baumgartner and Martin, 1939; Hansen and Flinders, 1969) and dried for approximately 72 hours at 60°C.

Identification of plant fragments was made by microscopic examination of fecal material on the basis of structural modifications of epidermal cells when compared to reference plant material prepared from specimens identified and collected from the study areas. Twenty microscope fields were examined on each slide and all recognizable fragments recorded. Frequency of occurrence was determined by dividing the number of microscope views in which a given species occurred by the total number of views $\times 100$ (Curtis and McIntosh, 1950). This value of frequency of a given species was divided by the total of the frequency values for all species and expressed as percent frequency.

HABITAT ANALYSES

Vegetational analyses were made of species composition, canopy-cover provided by each species, and frequency of occurrence. Two replicated sites were examined adjacent to the B-C Cribs Controlled zone, and also in the Wye-Barricade area. The area adjacent to the B-C Cribs Controlled zone was utilized only for vegetational analyses. Each replicate adjacent to the B-C Cribs Controlled zone consisted of four parallel line transects each 50 m long and 30 m apart while vegetational measurements were on the same two pellet transects for each transect in the Wye-Barricade habitat. The canopy-cover method of vegetational analysis developed by Daubenmire (1959) was used for herbaceous taxa. Canopy-cover was estimated using the following cover-class categories: class 1 (1-5%), class 2 (6-15%), class 3 (16-25%), class 4 (26-50%), class 5 (51-75%), and class 6 (76-100%), by ocularly examining fifty (2×5 dm, 0.1 m^2) plots systematically spaced at 1 meter intervals along each 50 m line transect. For summarization of the canopy-cover for each line transect, an average was obtained by summing the median percent value for each size class for each 2×5 dm plot and dividing by 50. Frequency of occurrence of a given species was divided by the total of the frequency values for all species and expressed as percent frequency for habitat analyses. All field sampling of the vegetation was conducted during April 1974.

The density of shrubs was determined by counting all shrubs rooted within a 10×50 m plot centrally located in each replicated study site.

Each shrub was measured for long and short diameter and for height above ground.

SIMILARITY AND PREFERENCE INDICES

Similarity indices were determined by using Kulczynski's mathematic expression for similarity (Oosting, 1956):

$$SI = \frac{2w}{a + b} (100),$$

where w = the lowest amount of an item shared by two categories, and $a + b$ = the total amount of an item shared by these two categories. Similarity indices were calculated for pellet and for habitat analyses to determine the degree of association.

Preference indices were calculated by dividing the percent frequency in the diet by percent frequency in the habitat (Krueger, 1972). Data collected in the field as frequency of occurrence (Hyder et al., 1965) was converted to percent frequency by species at a base of 100 or as a percentage of the total frequency of all species. The objective of this procedure is to put both the plants in the feces and plants in the field in the same relative proportions. Frequency of occurrence may be different for two areas, but the relative proportions from which the animal is selecting may be the same. Putting it on this basis, relative preference indices may be determined. As used here, the preference indices are regarded only as a guide to food preferences rather than absolute values.

RESULTS

HABITAT ANALYSES

Shrubs are important to black-tailed hares. They provide protection from predators and shelter from adverse weather conditions. Shrub cover (length x width x density) averaged 34 and 44% adjacent to the B-C Cribs Controlled area and Wye-Barricade habitats, respectively (Table 1).

TABLE 1. Canopy cover (%) provided by shrubs at B-C Cribs and Wye-Barricade habitats.

Plant Species	B-C Cribs			Wye-Barricade		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
<u>Artemisia</u>	32	35	34	6	12	9
<u>Chrysothamnus</u>	0	1	1	6	3	5
<u>Purshia</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>34</u>	<u>25</u>	<u>30</u>
Total	32	36	35	46	40	44

Thus, a significant difference ($P \leq 0.01$) in shrub cover occurred between these two habitats (Table 2). This is primarily due to the occurrence of bitterbrush at the Wye-Barricade site. However, the canopy area provided by individual sagebrush plants was lower ($P \leq 0.01$) at the B-C Cribs site compared to sagebrush within the Wye-Barricade habitat. The average number of shrubs in the B-C Cribs habitat was 188/500 m² as compared to 90/500 m² in the Wye-Barricade habitat (Table 3). The more

TABLE 3. Density of shrubs (numbers per 500 m²) at the B-C Cribs and Wye-Barricade habitats.

Plant Species	B-C Cribs			Wye-Barricade		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
<u>Artemisia</u>	113	259	186	20	23	22
<u>Chrysothamnus</u>	0	4	2	22	11	17
<u>Purshia</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>67</u>	<u>35</u>	<u>51</u>
Total	113	263	188	109	69	90

TABLE 2. Summary of canopy area (length x width, cm²) for shrubs located at B-C Cribs and Wye-Barricade habitats.

Plant Species	Rep 1			C.V. ^{1/}	Rep 2			Rep 1 + Rep 2			C.V.
	n	$\bar{X} \pm SE$			n	$\bar{X} \pm SE$		n	$\bar{X} \pm SE$		
B-C Cribs											
All shrubs	113	14187 $\pm$ 962	0.72	263	6732 $\pm$ 353	0.85	376	8973 $\pm$ 418	0.90		
<u>A. tridentata</u>	113	14187 $\pm$ 962	0.72	259	6723 $\pm$ 357	0.85	372	8991 $\pm$ 422	0.91		
<u>C. viscidiflorus</u>	-	-	-	4	7285 $\pm$ 2335	0.64	4	7285 $\pm$ 2335	0.64		
Wye-Barricade											
All shrubs	109	21778 $\pm$ 1815	0.87	69	21177 $\pm$ 2634	0.84	178	23453 $\pm$ 1513	0.86		
<u>A. tridentata</u>	20	15496 $\pm$ 2681	0.77	23	25786 $\pm$ 6030	1.12	43	21000 $\pm$ 3511	1.10		
<u>P. tridentata</u>	67	25740 $\pm$ 2625	0.83	35	35034 $\pm$ 4449	0.75	102	28930 $\pm$ 2332	0.81		
<u>C. nauseosus</u>	13	15270 $\pm$ 3028	0.81	10	11872 $\pm$ 3012	0.80	23	15182 $\pm$ 2477	0.78		
<u>C. viscidiflorus</u>	9	12091 $\pm$ 2851	0.71	1	13090 $\pm$ -	-	10	11305 $\pm$ 2669	0.75		

Statistical Treatment

Treatment	Significance	
B-C Cribs (all shrubs) vs. Wye-barricade (all shrubs)	P ≤ .01	S
Replicates within habitats.	P ≤ .001	S
B-C Cribs (<u>A. tridentata</u>) vs. Wye-barricade (<u>A. tridentata</u>)	P ≤ .01	S
Replicates within habitats.	P ≤ .001	S

^{1/} Sample size, mean ± standard error of the mean and coefficient of variation.

dense stand of shrubs did not increase ground cover at the B-C Cribs habitat. Bitterbrush has a different growth form than sagebrush, providing more cover per shrub. Heights of sagebrush and bitterbrush were similar at both sites, averaging 85-88 cm (Table 4). Rabbitbrush was

TABLE 4. Average height (cm) and length x width (cm²) of shrubs at the B-C Cribs and Wye-Barricade habitats.

Plant Species	B-C Cribs		Wye-Barricade	
	Ht.	L x W	Ht.	L x W
<u>Artemisia</u>	85	8991	87	21000
<u>Chrysothamnus</u>	51	7285	58	14007
<u>Purshia</u>	--	--	88	28930
All shrubs	85	8973	83	23483

much shorter in stature, ranging between 51 and 58 cm. There were statistically significant differences ($P \geq 0.05$) in shrub heights between sites (Table 5).

The total cover provided by herbaceous species was approximately 20% higher in the Wye-Barricade habitat than that associated adjacent to the B-C Cribs Controlled area (Table 6). The difference was significant at the $P \leq 0.01$ level (Table 7).

When excluding the cheatgrass from the total cover, both sites had approximately the same ($P > 0.05$) amount of cover (Table 8). Cheatgrass made up 35 and 15% ($P \leq 0.01$) of the total cover on the Wye-Barricade and B-C Cribs habitat, respectively (Table 9).

The coefficient of variation is commonly used as a measure of variability. Excessive variability is sometimes present even though the standard errors of the mean may be small. The coefficient of variation (C.V.) is a useful measurement for comparing variability when the measurements are in different units. Since coefficients of variation are expressed as proportions or percentages and are divorced from units, they can be compared directly.

TABLE 5. Summary of shrub heights (cm) at the B-C Cribs and Wye-Barricade habitats with statistical treatment.

Plant Species	Rep 1		1/ C.V.		Rep 2		Rep 1 + Rep 2		C.V.
	n	$\bar{X} \pm SE$	n	$\bar{X} \pm SE$	n	$\bar{X} \pm SE$	n	$\bar{X} \pm SE$	
B-C Cribs Overstory									
A11 shrubs	113	102 ± 3			263	78 ± 2	376	85 ± 1	.33
A. tridentata	113	102 ± 3		.28	259	78 ± 2	372	85 ± 1	.33
C. viscidiflorus	-	-		.28	4	51 ± 5	4	51 ± 5	.20
Wye-Barricade Overstory									
A11 shrubs	102	78 ± 3		.35	69	90 ± 4	178	83 ± 2	.35
A. tridentata	20	78 ± 7		.38	23	95 ± 7	43	87 ± 5	.38
P. tridentata	67	83 ± 3		.32	35	98 ± 3	102	88 ± 3	.28
C. nauseosus	13	62 ± 6		.34	10	57 ± 5	23	58 ± 4	.31
C. viscidiflorus	9	61 ± 9		.43	1	40 ± -	10	59 ± 8	.43

Statistical Treatment

Treatment	Significance
B-C Cribs (all shrubs) vs. Wye-Barricade (all shrubs)	P > .05 NS
Replicates within habitats	P < .001 S
B-C Cribs (A. tridentata) vs. Wye-Barricade (A. tridentata)	P > .05 NS
Replicates within habitats.	P < .001 S

1/ Sample size, mean $\pm$ standard error of the mean and coefficient of variation.

TABLE 6. Cover of herbaceous plants by species at the B-C Cribs and Wye-Barricade habitats, expressed as percentage of ground cover.

Plant Species	B-C Cribs			Wye-Barricade		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
	-----Percent-----			-----Percent-----		
Grasses						
<u>B. tectorum</u>	45	34	40	61	69	65
<u>F. octoflora</u>	6	17	11	<1	0	<1
<u>P. sandbergii</u>	7	2	5	11	8	10
<u>S. comata</u>	-	-	-	0	<1	<1
Total	58	53	56	72	77	75
Forbs						
<u>D. pinnata</u>	25	19	22	<1	<1	<1
<u>M. gracilis</u>	8	10	9	6	3	5
<u>C. circumscissa</u>	4	6	5	<1	<1	<1
<u>C. pterocarya</u>	2	1	1	<1	<1	<1
<u>P. linearis</u>	<1	1	<1	<1	0	<1
<u>D. verna</u>	-	-	-	8	6	7
<u>H. umbellatum</u>	-	-	-	10	2	7
<u>A. lycopoides</u>	<1	0	<1	<1	<1	<1
<u>Astragalus</u>	0	1	<1	-	-	-
<u>B. careyana</u>	<1	<1	<1	-	-	-
<u>B. douglasii</u>	0	<1	<1	-	-	-
<u>C. pallida</u>	0	<1	<1	-	-	-
<u>C. terebinthinus</u>	<1	1	<1	-	-	-
<u>C. macrocarpus</u>	0	<1	<1	-	-	-
<u>E. asperum</u>	1	0	<1	-	-	-
<u>Eriogonum</u>	<1	<1	<1	2	8	5
<u>S. kali</u>	<1	<1	<1	<1	<1	<1
<u>S. altissimum</u>	0	<1	<1			
<u>M. albicaulis</u>	0	<1	<1			
<u>Lomatium</u>	-	-	-	0	<1	<1
<u>Unknowns</u>	<1	0	<1	<1	<1	<1
<u>P. longifolia</u>	<1	4	2	-	-	-
Total	42	47	44	28	23	25

TABLE 7. Total understory cover (%) at the B-C Cribs and Wye-Barricade habitats with statistical significance.

Transect	Rep 1			Rep 2		
	n	$\bar{X} \pm SE$	C.V. ^{1/}	n	$\bar{X} \pm SE$	C.V.
B-C Cribs Understory						
1	50	33.2 $\pm$ 3.0	.65	50	33.7 $\pm$ 2.4	.50
2	50	36.0 $\pm$ 3.1	.61	50	29.6 $\pm$ 2.5	.60
3	50	47.6 $\pm$ 3.5	.53	50	35.3 $\pm$ 2.5	.50
4	50	38.8 $\pm$ 2.8	.50	50	35.2 $\pm$ 3.4	.68
	200	38.9 $\pm$ 1.6	.58	200	33.4 $\pm$ 1.4	.58
Rep 1 + 2				400	36.2 $\pm$ 1.1	.59
Wye-Barricade Understory						
1	50	51.1 $\pm$ 4.6	.63	50	52.8 $\pm$ 4.7	.62
2	50	63.8 $\pm$ 3.9	.43	50	50.3 $\pm$ 4.6	.65
	100	57.8 $\pm$ 3.1	.53	100	51.5 $\pm$ 3.3	.63
Rep 1 + Rep 2				200	54.7 $\pm$ 2.2	.58

Statistical Treatment

Treatment	Significance
B-C Cribs site vs. Wye-Barricade Site	P $\leq$.01 S
Replicates within habitats	P = .23 NS
Transects within replicates	P $\leq$.001 S

^{1/} Sample size, mean $\pm$ standard error of the mean and coefficient of variation.

TABLE 8. Total cover (%) excluding cheatgrass of the understory at the B-C Cribs and Wye-Barricade habitats with statistical treatment.

Transect	Rep 1			Rep 2		
	n	$\bar{X} \pm SE$	C.V. ^{1/}	n	$\bar{X} \pm SE$	C.V.
B-C Cribs Understory						
1	50	20.2 $\pm$ 1.9	0.64	50	23.4 $\pm$ 2.1	0.64
2	50	20.3 $\pm$ 2.2	0.75	50	20.5 $\pm$ 1.6	0.53
3	50	21.6 $\pm$ 2.1	0.69	50	22.7 $\pm$ 1.9	0.59
4	50	22.1 $\pm$ 1.6	0.53	50	15.8 $\pm$ 2.1	0.96
	<u>200</u>	<u>21.1 $\pm$ 0.9</u>	<u>0.65</u>	<u>200</u>	<u>20.6 $\pm$ 1.0</u>	<u>0.68</u>
	Rep 1 + Rep 2			400	20.9 $\pm$ 0.7	0.66
Wye-Barricade Understory						
1	50	16.2 $\pm$ 2.1	0.91	50	16.5 $\pm$ 2.5	1.05
2	50	28.6 $\pm$ 3.1	0.77	50	17.9 $\pm$ 3.2	1.26
	<u>100</u>	<u>22.4 $\pm$ 2.0</u>	<u>0.88</u>	<u>100</u>	<u>17.2 $\pm$ 2.0</u>	<u>1.17</u>
	Rep 1 + Rep 2			200	19.8 $\pm$ 1.4	1.00
Statistical Treatment						
	<u>Treatment</u>			<u>Significance</u>		
	B-C Cribs site vs. Wye-Barricade site			P $\geq$.05	NS	
	Replicates within habitats.			P = .19	NS	
	Transects within replicates			P < .001	S	

^{1/} Sample size, mean $\pm$ standard error of the mean and coefficient of variation.

TABLE 9. Cheatgrass cover (%) at the B-C Cribs and Wye-Barricade habitats with statistical treatment.

Transect	Rep 1			C.V. ^{1/}	Rep 2		
	n	X ± SE			n	X ± SE	C.V.
B-C Cribs Understory							
1	50	13.0 ± 2.1	1.12	50	10.2 ± 1.4	0.99	
2	50	15.6 ± 2.3	1.07	50	9.1 ± 1.7	1.30	
3	50	25.9 ± 2.2	0.87	50	12.6 ± 1.9	1.08	
4	50	16.7 ± 2.3	0.98	50	19.4 ± 3.0	1.08	
	<u>200</u>	<u>17.8 ± 1.3</u>	<u>1.03</u>	<u>200</u>	<u>12.8 ± 1.1</u>	<u>1.10</u>	
Rep 1 + Rep 2				400	15.3 ± 0.9	1.11	
Wye-Barricade Understory							
1	50	35.7 ± 4.1	0.80	50	36.3 ± 4.9	0.94	
2	50	35.1 ± 4.2	0.85	50	32.4 ± 4.3	0.94	
	<u>100</u>	<u>35.4 ± 2.9</u>	<u>0.82</u>	<u>100</u>	<u>34.3 ± 3.2</u>	<u>0.93</u>	
Rep 1 + Rep 2				200	34.9 ± 2.2	0.89	
Statistical Treatment							
<u>Treatment</u>				<u>Significance</u>			
B-C Cribs site vs. Wye-Barricade site				P ≤ .01	S		
Replicates within habitats.				P = .50	NS		
Transects within replicates				P = .01	S		

^{1/}Sample size, mean $\pm$ standard error of the mean and coefficient of variation.

The variation associated with the understory parameters measured ranged from 0.58 to 1.11 on both sites, while the shrub parameters measured had a range from 0.28 to 1.10 (Table 10). Bitterbrush and

TABLE 10. Coefficient of variations (C.V.) of various parameters measured at the B-C Cribs and Wye-Barricade habitats.

Measurement	B-C Cribs	Wye-Barricade
Total understory cover	.59	.58
Cheatgrass (<u>B. tectorum</u>)	1.11	.89
Total cover excluding cheatgrass	.66	1.00
Total overstory (shrub) cover (L x W)	.90	.86
Sagebrush (<u>A. tridentata</u>)	.91	1.10
Bitterbrush (<u>P. tridentata</u>)	-	.81
Rabbitbrush (<u>C. nauseosus</u>)	-	.78
Rabbitbrush (<u>C. viscidiflorus</u>)	.64	.75
Total shrub height	.33	.35
Sagebrush (<u>A. tridentata</u>)	.33	.38
Bitterbrush (<u>P. tridentata</u>)	-	.28
Rabbitbrush (<u>C. nauseosus</u>)	-	.31
Rabbitbrush (<u>C. viscidiflorus</u>)	.20	.43

rabbitbrush were less variable in canopy cover than sagebrush on both sites. For all parameters measured, heights of shrubs were the least variable for all species. The coefficient of variation ranged between 0.20 to 0.43 on the two habitats.

Frequency of occurrence as outlined by Hyder et al. (1965) was converted to percent frequency and is shown in Table 11 for plants occurring within both habitats. Grasses contributed 41 and 37% of the total species, while forbs contributed 51 and 56% on the B-C Cribs and Wye-Barricade sites, respectively. A preliminary list of common plants occurring within the habitats is presented in Appendix, Table A-1.

TABLE 11. Percent of botanical composition of plant species calculated from frequency occurrence at the B-C Cribbs and Wye-Barricade habitats.

Plant Species	B-C Cribbs			Wye-Barricade		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
	-----Percent-----			-----Percent-----		
Grasses						
<u>B. tectorum</u>	21	20	20	25	28	26
<u>F. octoflora</u>	15	18	17	<1	0	<1
<u>P. sandbergii</u>	7	3	5	10	10	10
<u>S. comata</u>	-	-	-	0	<1	<1
Total	43	41	41	35	38	36
Forbs						
<u>D. pinnata</u>	19	17	18	<1	2	1
<u>M. gracilis</u>	16	12	14	14	12	13
<u>C. circumscissa</u>	11	10	10	5	3	4
<u>C. pterocarya</u>	3	2	3	1	3	2
<u>P. linearis</u>	<1	3	1	<1	0	<1
<u>D. verna</u>	-	-	-	18	21	19
<u>H. umbellatum</u>	-	-	-	11	4	8
<u>A. lycopsoides</u>	<1	0	<1	<1	<1	<1
<u>Astragalus</u>	0	1	<1	-	-	-
<u>B. careyana</u>	<1	<1	<1	-	-	-
<u>B. douglasii</u>	0	<1	<1	-	-	-
<u>C. pallida</u>	0	<1	<1	-	-	-
<u>C. terebinthinus</u>	<1	<1	<1	-	-	-
<u>C. macrocarpus</u>	0	<1	<1	-	-	-
<u>E. asperum</u>	1	0	<1	-	-	-
<u>Eriogonum</u>	<1	1	<1	3	6	4
<u>S. kali</u>	<1	1	<1	<1	<1	<1
<u>S. altissimum</u>	0	<1	<1	-	-	-
<u>M. albicaulis</u>	0	<1	<1	-	-	-
<u>Lomatium</u>	-	-	-	0	<1	<1
<u>O. pallida</u>	<1	<1	<1	-	-	-
Unknowns	<1	0	<1	2	3	2
Total	52	49	51	56	56	56
Shrubs						
<u>P. tridentata</u>	-	-	-	7	5	6
<u>A. tridentata</u>	5	9	8	2	1	1
<u>C. nauseosus</u>	0	0	0	<1	<1	<1
<u>C. viscidiflorus</u>	<1	0	<1	<1	<1	<1
<u>P. longifolia</u>	<1	1	<1	-	-	-
Total	5	10	8	9	6	7

FECAL PELLET ANALYSES

Recent Pellets

Nine plant species were identified in recent pellets at the B-C Cribs Control zone as compared to 11 species at the Wye-Barricade (Table 12). Yarrow, Achillea millifolium, was the most often encountered species, comprising 29 and 21% of the identifiable plant fragments in the B-C Cribs Control zone and Wye-Barricade samples, respectively. The plant species identified in pellets from the B-C Cribs sites listed in decreasing order of abundance are: yarrow > turpentine cymopterus > tumble mustard > erigeron > needle-and-thread > matted cryptantha > rabbitbrush > sagebrush. The important species of the Wye-Barricade site listed in decreasing order of abundance are: yarrow > turpentine cymopterus > erigeron > needle-and-thread > rabbitbrush > Sandberg bluegrass > scurf pea. Forbs provided the mainstay of the hare diet. Eighty-one percent of identified plant parts at the B-C Cribs were forbs as compared to 69% at the Wye-Barricade (Figure 2).

When a plant species is scarce in the field but shows up frequently in fecal pellets, it is assumed that this particular plant is actively sought by the foraging animal. The data listed in Table 13 show that yarrow is a preferred forage, as well as turpentine cymopterus, needle-and-thread, erigeron, and tumble mustard. On the other hand, cheatgrass, abundant in both study sites, did not appear in the fecal pellets at all, thereby indicating that hares selectively avoided cheatgrass. Russian thistle, Salsola kali, was sparsely represented in both study areas and did not appear in the pellet analyses. A list of plants identified in fecal pellets is presented in Appendix, Table A-2.

Indices of similarity between diets and habitats are comparisons that show a relationship between food items and the same items observed in the habitat. A similarity index of 100 indicates that hares are foraging upon plants in the same proportion as they actually occur in the field. A small index number indicates that the hare's diet preference is less compatible with the vegetation in the field. Sandberg bluegrass, matted cryptantha, and sagebrush had high similarities while other species in the diet showed low similarity indices (Table 14).

TABLE 12. Plant species identified in recent hare pellets collected at B-C Cribs and Wye-Barricade habitats with percent frequency.

Plant Species	B-C Cribs	Wye-Barricade
<u>Grasses</u>		
<u>Stipa comata</u>	11	11
<u>Poa sandbergii</u>	0	10
<u>Forbs</u>		
<u>Achillea millifolium</u>	29	21
<u>Cymopterus terebinthinus</u>	17	19
<u>Sisymbrium altissimum</u>	14	7
<u>Erigeron sp.</u>	13	16
<u>Balsamorhiza careyana</u>	0	<1
<u>Psoralea lanceolata</u>	1	4
<u>Cryptantha circumscissa</u>	6	<1
<u>C. pterocarya</u>	0	<1
<u>Unknown</u>	1	1
<u>Shrubs</u>		
<u>Chrysothamnus nauseosus</u>	4	10
<u>Artemisia tridentata</u>	4	0

Figure 2. Composition by percent frequency of grasses, forbs, and shrubs in diets of black-tailed hares and within Wye-barricade and B-C Cribs habitats.

TABLE 13. Preference indices for the most important plants found in the diet of the black-tailed hare from recent and all pellets combined at the B-C Cribs and Wye-Barricade habitats.

Plant Taxa	B-C Cribs		Wye-Barricade	
	Recent	All Pellets	Recent	All Pellets
<u>Grasses</u>				
<u>S. comata</u>	110.0	140.0	110.0	130.0
<u>P. sandbergii</u>	-	<0.1	1.0	0.8
<u>Forbs</u>				
<u>A. millifolium</u>	290.0	270.0	210.0	220.0
<u>C. terebinthinus</u>	170.0	160.0	190.0	180.0
<u>Erigeron</u> sp.	130.0	140.0	160.0	170.0
<u>S. altissimum</u>	140.0	130.0	70.0	70.0
<u>C. circumscissa</u>	0.6	0.4	<0.1	0.2
<u>P. lanceolata</u>	10.0	1.0	40.0	40.0
<u>B. careyana</u>	-	-	<0.1	1.0
<u>C. pterocarya</u>	-	-	<0.1	<0.1
<u>D. verna</u>	-	<0.1	-	-
<u>Shrubs</u>				
<u>A. tridentata</u>	0.5	0.5	-	-
<u>C. nauseosus</u>	40.0	50.0	100.0	90.0

TABLE 14. Kulczynski's index of similarity (SI) comparing plant frequency found in recent pellets with plant frequency at the B-C Cribs and Wye-Barricade habitats.

Plant Taxa	B-C Cribs % SI	Wye-Barricade % SI
Grasses		
<u>P. sandbergii</u>	-	100.0
<u>S. comata</u>	0.2	0.2
Forbs		
<u>C. circumscissa</u>	75.0	0.5
<u>C. pterocarya</u>	-	1.0
<u>B. careyana</u>	-	*
<u>C. terebinthinus</u>	0.1	0.1
<u>S. altissimum</u>	0.1	0.3
<u>Erigeron sp.</u>	0.1	0.1
<u>A. millifolium</u>	0.1	0.1
<u>P. lanceolata</u>	1.9	0.5
Shrubs		
<u>A. tridentata</u>	66.6	-
<u>C. nauseosus</u>	0.5	0.2

*Present in trace amounts.

Comparison of the mean indices of Kulczynski's index of similarity for new, old, and aged pellets collected at the B-C Cribs Control site showed similarities ranging from 83 to 92% (Table 15). Within the Wye-Barricade habitat, the similarity between new and old-aged pellets was 78%. The mean index of similarity when comparing the two sites was 36%. This indicates that the two sites were not similar in species composition. The average index of similarity between new pellets of both sites was 49%. This suggests that there are some differences in hare diets between the two habitats.

Combined Pellet Classes

The average percent frequency of plant species occurring in recent, old, aged, and old-aged pellets were similar. Grasses were most variable, having an average frequency of 16% and ranging between 11 and 22% of the total (Table 16). Forbs were less variable among the different age groups of pellets having an average of 73% and ranging between 67 and 80%. Shrubs were the least variable among the different classes of pellets, averaging about 9%. All major and important food items were present in approximately the same percent frequency for all groups of pellets (Tables 17 and 18). The less important species, making up less than 5% of the total frequency, varied among the classes. This may be due to the hare's seeking out these plants one year but not the next, or to seasonal changes in plant abundance. These results indicate that the black-tailed hare has selected the major plant species in approximately the same proportion in all age classes of pellets over a period of years.

A comparison of all pellet classes within the B-C Cribs and Wye-Barricade habitats shows grasses to comprise 14 and 21% of the diet, while forbs made up 74 and 70% in the respective habitats (Table 19). Occurrence of shrub parts in the pellets was approximately the same at both sites and made up 9% of the composition. Comparison of both habitats shows a significant difference in amounts of Sandberg bluegrass. Sandberg bluegrass made up approximately 8% of the diet in the Wye-Barricade habitat and was presently only in trace amounts in pellets from the B-C Cribs habitat. Although sagebrush did not occur in the

TABLE 15. Mean ($\bar{X}$) and standard errors (SE) of Kulczynski's index of similarity (%) comparing the diets and feeding habits of black-tailed hares and age class of pellets.

Comparisons	$\bar{X} \pm SE$
B-C Cribs habitat	
Recent pellets vs. old pellets	84 $\pm$ 8
Recent pellets vs. aged pellets	83 $\pm$ 3
Old pellets vs. aged pellets	92 $\pm$ 1
Recent pellets vs. old + aged pellets	83 $\pm$ 3
Wye-Barricade habitat	
Recent pellets vs. old + aged pellets	78 $\pm$ 1
B-C Cribs habitat vs. Wye-Barricade habitat	36 $\pm$ 1
Recent pellets (B-C Cribs habitat) vs. recent pellets (Wye-barricade habitat)	49 $\pm$ 1

TABLE 16. Average percent frequency of plant fragments occurring in recent, old, aged, and old-aged black-tailed hare pellets within the B-C Cribs (B) and Wye-Barricade (W) habitats.

Plant Taxa	Recent		Old	Aged	Old + Aged	
	B	W	B	B	B	W
Grasses						
<u>S. comata</u>	11	11	12	19	15	14
<u>P. sandbergii</u>	-	10	<1	-	<1	5
Total	11	22	12	19	15	19
Forbs						
<u>A. millifolium</u>	29	21	26	27	26	23
<u>C. terebinthinus</u>	17	19	16	16	16	18
<u>Erigeron sp.</u>	13	16	15	13	14	18
<u>S. altissimum</u>	14	7	13	12	12	7
<u>C. circumscissa</u>	6	<1	7	<1	4	3
<u>P. lanceolata</u>	1	4	<1	-	<1	3
<u>B. careyana</u>	-	<1	-	-	-	-
<u>C. pterocarya</u>	-	<1	-	-	-	<1
<u>D. verna</u>	-	-	<1	-	<1	-
Total	80	67	77	69	72	72
Shrubs						
<u>A. tridentata</u>	4	-	5	3	4	-
<u>C. nauseosus</u>	4	10	5	6	5	9
Total	8	10	10	9	9	9
Unknowns	1	1	<1	<1	<1	<1

TABLE 17. Percent frequency of plant species occurring in recent, old, and aged black-tailed hare pellets at the B-C Cribs habitat.

Plant Taxa	Recent			Old			Aged		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
Grasses									
<u>S. comata</u>	4	17	11	13	11	12	22	17	19
<u>P. sandbergii</u>	-	-	-	1	0	<1	-	-	-
<u>Total</u>	<u>4</u>	<u>17</u>	<u>11</u>	<u>14</u>	<u>11</u>	<u>12</u>	<u>22</u>	<u>17</u>	<u>19</u>
Forbs									
<u>A. millifolium</u>	28	30	29	24	28	26	26	28	27
<u>C. terebinthus</u>	15	18	17	17	16	16	16	16	16
<u>Erigeron sp.</u>	13	14	13	16	13	15	14	13	13
<u>S. altissimum</u>	19	10	14	10	16	13	14	11	12
<u>C. circumscissa</u>	7	4	6	9	4	7	1	1	1
<u>P. lanceolata</u>	2	0	1	<1	1	<1	-	-	-
<u>D. verna</u>	-	-	-	<1	0	<1	-	-	-
<u>Total</u>	<u>84</u>	<u>76</u>	<u>80</u>	<u>76</u>	<u>78</u>	<u>77</u>	<u>71</u>	<u>69</u>	<u>69</u>
Shrubs									
<u>A. tridentata</u>	3	4	4	5	3	5	2	5	3
<u>C. nauseosus</u>	7	2	4	3	6	5	5	8	6
<u>Total</u>	<u>7</u>	<u>6</u>	<u>8</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>7</u>	<u>13</u>	<u>9</u>
Unknowns	2	1	1	<1	<1	<1	<1	1	<1

TABLE 18. Percent frequency of plant species occurring in recent, old, and aged black-tailed hare pellets in the Wye-Barricade habitat.

Plant Taxa	Recent			Old + Aged		
	Rep 1	Rep 2	Avg.	Rep 1	Rep 2	Avg.
Grasses						
<u>S. comata</u>	6	17	11	13	14	14
<u>P. sandbergii</u>	11	10	10	6	4	5
<u>Total</u>	<u>17</u>	<u>27</u>	<u>21</u>	<u>19</u>	<u>18</u>	<u>19</u>
Forbs						
<u>A. millifolium</u>	24	18	21	22	24	23
<u>C. terebinthus</u>	24	13	19	18	18	18
<u>Erigeron sp.</u>	17	15	16	18	18	18
<u>S. altissimum</u>	3	11	7	5	8	7
<u>C. circumscissa</u>	<1	0	<1	4	2	3
<u>P. lanceolata</u>	4	4	4	3	3	3
<u>B. careyana</u>	<1	0	<1	-	-	-
<u>C. pterocarya</u>	1	0	<1	<1	0	<1
<u>Total</u>	<u>73</u>	<u>61</u>	<u>68</u>	<u>70</u>	<u>73</u>	<u>72</u>
Shrubs						
<u>A. tridentata</u>	-	-	-	-	-	-
<u>C. nauseosus</u>	7	11	10	11	8	9
<u>Total</u>	<u>7</u>	<u>11</u>	<u>10</u>	<u>11</u>	<u>8</u>	<u>9</u>
Unknowns	1	1	1	<1	<1	<1

TABLE 19. Average percent frequency of plant fragments occurring in all classes of pellets collected from the B-C Cribs and Wye-Barricade habitats.

Plant Taxa	B-C Cribs	Wye-Barricade	Average
	%	%	%
Grasses			
<u>S. comata</u>	14	13	13
<u>P. sandbergii</u>	<1	8	4
<u>Total</u>	<u>14</u>	<u>21</u>	<u>17</u>
Forbs			
<u>A. millifolium</u>	27	22	25
<u>C. terebinthinus</u>	16	18	17
<u>Erigeron sp.</u>	14	17	15
<u>S. altissimum</u>	13	7	10
<u>C. circumscissa</u>	4	2	3
<u>P. lanceolata</u>	<1	4	2
<u>B. careyana</u>	-	<1	<1
<u>C. pterocarya</u>	-	<1	<1
<u>D. verna</u>	<1	-	<1
<u>Total</u>	<u>74</u>	<u>70</u>	<u>72</u>
Shrubs			
<u>A. tridentata</u>	4	-	2
<u>C. nauseosus</u>	5	9	7
<u>Total</u>	<u>9</u>	<u>9</u>	<u>9</u>
Unknowns	<1	<1	<1

pellets collected from the Wye-Barricade site, it made up 4% of the dietary composition of pellets from the B-C Cribs site.

The average dietary composition at both sites consisted of 17% grasses, 72% forbs, and 9% shrubs (Table 19).

Plant Parts in Radioactive and Non-Radioactive Pellets

In an investigation at the B-C Cribs Controlled area, pellets were segregated into new pellets, old pellets, and radioactive pellets* (all old) (Table 20). Fourteen plant species were identified in these pellets. Three of these were grasses, eight were forbs, and three shrubs (Table 20). Five species were sparingly represented, i.e., <1% of identifiable plant parts. These were squirreltail, balsamroot, blazing star, scurf pea, and big sagebrush. Ninety-two percent of the identifiable plant parts were contributed by the remaining nine species. The most important plants were turpentine cymopterus, erigeron, rabbitbrush, Sandberg bluegrass, and common yarrow. Only eight species of plants were identified in the radioactive pellets, but the number of pellets examined was limited.

Radioactive pellets were at least 10 years old because trenches which were burrowed into by native animals and exposing the salts to the hares were filled and sealed with asphalt in 1964 (O'Farrell and Gilbert, 1975; Maxfield, 1974). The dispersal of radionuclides in fecal pellets is believed to have resulted from hares consuming radioactive salts. The data indicate that hares relied upon the same plants for forage 10 years ago as they do at the present time.

*Determined by hand-held survey meter.

TABLE 20. Plant species and composition (%) in the pellets of black-tailed hares collected within the B-C Cribbs Controlled zone

Plant Species	New ¹	Old ²	Radioactive ³	Avg. ⁴
Grasses				
<u>Poa sandbergii</u>	12	15	2	11
<u>Sitanion hystrix</u>	<1	<1		<1
<u>Stipa comata</u>			9	2
Forbs				
<u>Achillea millifolium</u>	5	17	12	11
<u>Balsamorhiza careyana</u>	2			<1
<u>Cryptantha circumscissa</u>	11	<1		5
<u>Cymopterus terebinthinus</u>	22	19	16	20
<u>Erigeron species</u>	15	31	13	20
<u>Mentzelia laevicaulis</u>	<1			<1
<u>Psoralea lanceolata</u>	<1	<1		<1
<u>Sisymbrium altissimum</u>	<1	<1	14	3
Shrubs				
<u>Artemisia tridentata</u>	2		2	1
<u>Chrysothamnus nauseosus</u>	13	13	21	15
<u>Grayia spinosa</u>	13			5
Unknown			12	3

¹N = 16 pellets

²N = 14 pellets

³N = 9 pellets

⁴N = 39 pellets

DISCUSSION

Plant selectivity by the black-tailed hare has been reported by several investigators. Selectivity is influenced by phenological stages of plant development within growing seasons (Hayden, 1966; Sparks, 1968; Hansen and Flinders, 1969; Flinders, 1971; and Flinders and Hansen, 1972). Hayden (1966) and Sparks (1968) showed that grasses were the important food items during early spring and summer, with forbs important during the summer, while shrubs were more important in winter. Hares exhibited a preference for green vegetation at all four seasons of the year. It has been suggested by Hayden (1966) and Sparks (1968) that green, succulent plants are preferred by hares to help maintain internal water balance. Selectivity may also be influenced by the amount of available energy stored in certain plants (Church et al., 1972).

It is important to point out that cheatgrass (Bromus tectorum) and Russian thistle (Salsola kali) were not identified in the pellets of the black-tailed hare on the Hanford Reservation. When these two plant species do occur in hare pellets, they are generally found in only trace amounts (Sparks, 1968; Hansen and Flinders, 1969; Flinders and Hansen, 1972).

Stewart and Hull (1969) state that hares strongly influence the development and maintenance of cheatgrass cover. Hares feeding heavily on perennial grasses prevented them from invading cheatgrass communities and sometimes even destroyed reseeded grass without eating cheatgrass. On areas that purposefully excluded hares, perennial grasses increased as rapidly as cheatgrass, but these disappeared when grazed by hares and cattle. Hares sometimes girdle main stems of sagebrush and rabbit-brush, which may destroy the plant. Seeds may be transported internally by the hare from area to area, and germination of seeds with durable seed coats may be enhanced after passing through the digestive tract, thus contributing to dispersal and invasion of certain plant species.

Hansen and Flinders (1969) state that on rangelands deteriorated by livestock grazing, hares exerted forces favoring plant succession toward the climax stage. However, when ranges have deteriorated to a point where forbs ("weedy species") are abundant, then the influence by hares would be toward further deterioration.

Forage consumption by hares averaged 105 g/day but reached values as high as 260 g/day in Curlew Valley, Utah, which is similar to the sagebrush habitats on the Hanford Reservation (Currie and Goodwin, 1966). Controlled feeding tests using mixtures of alfalfa and rolled barley showed that black-tailed hares consumed on the average 104 ± 4.5 g/day (Hansen and Flinders, 1969).

Hares that are deprived of salt develop a craving and may resort to licking dirt or other mineral elements (Hansen and Flinders, 1969; and Siegmund, 1969). Pellets collected at Hanford contained fair amounts of soil, suggesting a salt deficiency in the diet.

Natural control of hare populations depends upon the food supply, predation, and disease. Predators of the hare on the Hanford Reservation include the coyote, golden eagle, great-horned owl, and hawks.

In waste burial zones, man-induced population control of hares may include one or several possibilities: (1) poisoning, (2) trapping, (3) shooting, (4) exclusion, and (5) habitat modification (Vallentine, 1974). Trapping, shooting, and exclusion by fencing may be useful in small areas. Poisoning would only be recommended in extreme cases. Habitat modification may be the most useful long-term control of hares in waste burial zones. Such modifications may change plant species composition to eliminate essential food and cover. Plants that are not consumed by the hare may be considered for the habitat modification. Shrub cover may be removed, since black-tailed hares do not prefer the more open areas (Flinders, 1971; Flinders and Hansen, 1973). However, the welfare of other animals needs to be considered before making such modifications of the habitat.

SUMMARY

Sixteen species of plants were identified in the fecal pellets of the black-tailed hare in two habitats—sagebrush-bitterbrush/Sandberg bluegrass and sagebrush/Sandberg bluegrass. Microscopic analysis of plant fragments indicated that yarrow (Achillea millifolium) was the most common food in the diet, making up 25% of the overall diet. Other plants in the diet listed in order of importance were turpentine cymopterus, erigeron sp., needle-and-thread, and tumble mustard. These five species made up approximately 80% of the total diet. Forbs were more important than grasses, and grasses were more important than shrubs. Cheatgrass, the dominant herbaceous species, and Russian thistle, a common forb, did not occur in fecal pellets. The most important plants found in radioactive pellets were turpentine cymopterus, erigeron, rabbitbrush, Sandberg bluegrass, and common yarrow. These five species make up 77% of the total diet. Eight species of plants were identified in the radioactive pellets, but the number of pellets examined was limited.

REFERENCES

- Baumgartner, L. L., and A. C. Martin. 1939. Plant histology as an aid in squirrel food habit studies. J. Wildl. Manage. 3:266-268.
- Church, D. C. 1972. Digestive Physiology and Nutrition, Vol. 3. Oregon State University, Corvallis, Oregon. 349 pp.
- Currie, P. O. and D. L. Goodwin. 1966. Consumption of forage by black-tailed jacks on salt-desert ranges of Utah. J. Wildl. Manage. 30:304-311.
- Curtis, J. T. and R. P. McIntosh. 1950. The inter-relations of certain analytic and synthetic phytosociological characters. Ecology 31: 434-455.
- Daubenmire, R. F. 1959. A canopy-coverage method of vegetation analysis. Northwest Sci. 33:43-64.
- Flinders, J. T. 1971. Diets and Feeding Habits of Jackrabbits Within a Shortgrass Ecosystem. Ph.D. Thesis, Colorado State University. 75 pp.
- Flinders, J. T. and R. M. Hansen. 1972. Diets and Habits of Jackrabbits in Northeastern Colorado. Range Sci. Dept., Ser. 1. 29 pp.
- Hansen, R. M. and J. T. Flinders. 1969. Food Habits of North American Hares. Colo. State Univ., Range Sci. Dept., Sci. Ser. 1. 17 pp.
- Hayden, P. 1966. Food habits of black-tailed jackrabbits in southern Nevada. J. Mammal. 47:42-46.
- Hyder, D. N., R. E. Bement, E. E. Remmenga, and C. Terwilliger, Jr. 1965. Frequency sampling of blue grama range. J. Range Manage. 18:90-94.
- Krueger, W. C. 1972. Evaluating animal forage preference. J. Range Manage. 25:471-475.
- Maxfield, H. L. 1974. Preliminary Safety Analysis of Alternate Proposals for B-C Cribs Controlled Area Action, ARH-3088, Atlantic Richfield Hanford Company, Richland, WA.
- Miller, R. G., Jr. 1966. Simultaneous Statistical Influence. McGraw-Hill Book Co. 272 pp.
- O'Farrell, T. P. and R. O. Gilbert. 1975. Transport of radioactive materials by jackrabbits on the Hanford Reservation. Health Phys. 29:9-15.

- Oosting, H. J. 1956. The Study of Plant Communities. W. H. Freeman and Co., San Francisco, CA. 440 pp.
- Siegmund, O. H. 1967. The Merck Veterinary Manual. Merck and Co., Inc. Rahway, NJ. 1685 pp.
- Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods. Iowa State Univ. Press, Ames. 593 pp.
- Sparks, D. R. 1968. Diets of black-tailed jackrabbits on sandhill rangelands in Colorado. J. Range Manage. 21:203-208.
- Sparks, D. R. and J. C. Malechek. 1968. Estimating percentage dry weights in diets using a microscopic technique. J. Range Manage. 21:264-265.
- Stewart, G. and A. C. Hull. 1949. Cheatgrass, Bromus tectorum L.—an ecological intruder in southern Idaho. Ecology 30:58-74.
- Vallentine, J. F. 1974. Range Developments and Improvements. Brigham Young Univ. Press, Provo, UT. 516 pp.

APPENDIX A

TABLE A-1. List of plant species from the B-C
Cribs and Wye-Barricade habitat.

<u>Common Name</u>	<u>Scientific Name</u>
GRAMINEAE - Grass Family	
Annual Grasses	
Cheatgrass	<u>Bromus tectorum</u>
Sixweek Fescue	<u>Festuca octoflora</u>
Perennial Grasses	
Thick-spike Wheatgrass	<u>Agropyron dasytachyum</u>
Squirrel Tail	<u>Sitanion hystrix</u>
Sandberg's Bluegrass	<u>Poa sandbergii</u>
Indian Ricegrass	<u>Oryzopsis hymenoides</u>
Needle-and-thread Grass	<u>Stipa comata</u>
Bluegrass	<u>Poa canbyi</u>
Bluebunch Wheatgrass	<u>Agropyron spicatum</u>
LILIACEAE - Lily Family	
Douglas Brodiaea	<u>Brodiaea douglasii</u>
Star Tulip	<u>Calochortus macrocarpus</u>
SANTALACEAE - Sandalwood Family	
Comandra	<u>Comandra pallida</u>
POLYGONACEAE - Buckwheat Family	
Buckwheat	<u>Eriogonum sp.</u>
CHENOPODIACEAE - Goosefoot Family	
Russian Thistle	<u>Salsola kali</u>
Hopsage	<u>Grayia spinosa</u>
CRUCIFERAE - Mustard Family	
Tansy Mustard	<u>Descurainia pinnata</u>
Western Wallflower	<u>Erysimum asperum</u>
Tumble Mustard	<u>Sisymbrium altissimum</u>
Draba	<u>Draba verna</u>
ROSACEAE - Rose Family	
Bitterbrush	<u>Purshia tridentata</u>
LEGUMINOSAE - Pea Family	
Locoweed	<u>Astragalus sp.</u>
Spurred Lupine	<u>Lupinus sp.</u>
Scurf-pea	<u>Psoralea lanceolata</u>
GERANIACEAE - Geranium Family	
Storks-bill	<u>Erodium cicutarium</u>
LOASACEAE - Loasa Family	
White Stem Mentzelia	<u>Mentzelia albicaulis</u>

<u>Common Name</u>	<u>Scientific Name</u>
ONAGRACEAE - Evening Primrose Family	
Evening Primrose	<u>Oenothera pallida</u>
UMBELLIFERAE - Parsley Family	
Turpentine Cymopterus	<u>Cymopterus terebinthinus</u>
POLEMONIACEAE - Phlox Family	
Long-leaved Phlox	<u>Phlox longifolia</u>
Microsteris	<u>Microsteris gracilis</u>
HYDROPHYLLACEAE - Waterleaf Family	
Narrow-leaved Phacelis	<u>Phacelis linearis</u>
BORAGINACEAE - Borage Family	
Fiddleneck	<u>Amsinckia lycopsoides</u>
Matted Cryptantha	<u>Cryptantha circumscissa</u>
Wing-nut Cryptantha	<u>Cryptantha pterocarya</u>
SCROPHULARIACEAE - Figwort Family	
Sharp-leaved Penstemon	<u>Penstemon acuminatus</u>
COMPOSITAE - Sunflower Family	
Big Sagebrush	<u>Artemisia tridentata</u>
Rabbitbrush	<u>Chrysothamnus nauseosus</u>
Rabbitbrush	<u>Chrysothamnus viscidiflorus</u>
Bursage	<u>Franseria acanthicarpa</u>
Balsamroot	<u>Balsamorhiza careyana</u>
Yarrow	<u>Achillea millefolium</u>
Aster species	<u>Aster sp.</u>
Erigeron species	<u>Erigeron sp.</u>

TABLE A-2. Plant species identified in fecal pellets
of black-tailed hares.

<u>Common Name</u>	<u>Scientific Name</u>
Shrubs	
Big sagebrush	<u>Artemisia tridentata</u>
Rabbitbrush	<u>Chrysothamnus nauseosus</u>
Spiny hopsage	<u>Grayia spinosa</u>
Perennial Grasses	
Squirreltail	<u>Sitanion hystrix</u>
Sandberg bluegrass	<u>Poa secunda</u>
Needle-and-thread	<u>Stipa comata</u>
Perennial forbs	
Erigeron	<u>Erigeron spp.</u>
Scurf pea	<u>Psoralea lanceolata</u>
Balsamroot	<u>Balsamorhiza careyana</u>
Yarrow	<u>Achillea lanulosa</u>
Turpentine Cymopterus	<u>Cymopterus terebinthinus</u>
Annual forbs	
Tumble mustard	<u>Sisymbrium altissimum</u>
Spring draba	<u>Draba verna</u>
Blazing star	<u>Mentzelia sp.</u>
Matted cryptantha	<u>Cryptantha circumscissa</u>
Wing-nut cryptantha	<u>Cryptantha pterocarya</u>

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