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## Habitat Use Patterns of White-tailed Deer, Umatilla River, Oregon

### Abstract

Habitat use of white-tailed deer (*Odocoileus virginianus ochrourus*) along the Umatilla River in northeastern Oregon was investigated from January 1985 to July 1986. Twelve radiocollared deer were located 1148 times to determine habitat use. Plant communities used most in winter were dominated by Douglas hawthorn (*Crataegus douglasi*), ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), and black cottonwood (*Populus trichocarpa*). A model predicted that 50 percent, 75 percent, and 95 percent of use would occur within 44 m, 99 m, and 248 m of cover, respectively, which obscured 90 percent of a standing deer. The majority of relocations occurred more than 1600 m from main roads. Retention of existing mature ponderosa pine-Douglas fir and cottonwood-ponderosa pine communities, and restriction of access to these areas in winter will help maintain white-tails in this area.

### Introduction

White-tailed deer studies in the northern Rocky Mountains primarily represent areas of harsh winter weather, deep snowfall, and low temperatures (Mundinger 1981, Singer 1979, Pengelly 1961, Owens 1981). The winter weather patterns in the Umatilla River Basin are drier and warmer by comparison. Research in Oregon has been limited to the endangered Columbian white-tailed deer (Smith 1981, Suring and Vohs 1979). This study documents habitat use and forage use patterns for white-tailed deer in this area from January 1985 to July 1986. We also predict use relative to distance to effective hiding cover.

### Study Area

The study area (75,300 ha) encompassed the northwestern foothills of the Blue Mountains in northeast Oregon, primarily on the Umatilla Indian Reservation (UIR). Elevations ranged from 335 m along the Umatilla River near Pendleton to 1325 m near Tollgate, Oregon, in the northeastern corner of the study area. This region is influenced by Pacific air masses, with hot, dry summers and cool winters. Annual mean precipitation is 31.0 cm at Pendleton, with most occurring in November, December, and January. Temperatures during the study period closely followed the 30 year monthly values. Precipitation was 7.7 cm in Jan-Mar 1985

including 32 cm snowfall in February, and 15.0 cm January-March 1986, with 37 cm snowfall in December 1985, compared with 30-year means of 10.7 cm precipitation and 20 cm snowfall during January-March.

Plant communities described by Bodurtha (1987) and Bell (1988) are listed in Table 1, along with the combinations and structural types used in analysis of habitat use patterns by deer. Riparian communities were dominated by black cottonwood, white alder (*Alnus rhombifolia*), ponderosa pine, Douglas fir, and black locust (*Robinia pseudoacacia*). The common shrub species included common chokecherry (*Prunus virginianus*), blue elderberry (*Sambucus cerulea*), common snowberry (*Symphoricarpos albus*), rose (*Rosa nutkana*), and Himalayan blackberry (*Rubus discolor*).

Upland plant communities include seral stages of the bluebunch wheatgrass (*Agropyron spicatum*)-Sandberg's bluegrass (*Poa secunda*), and bluebunch wheatgrass-Idaho fescue (*Festuca idahoensis*) habitat types. Dominant grass species were cheatgrass (*Bromus tectorum*), ripgut brome (*B. rigidus*), rattlesnake brome (*B. brizaeformis*), medusa-head (*Taeniatherum asperum*), and Kentucky bluegrass (*P. pratensis*). The common forb species were western yarrow (*Achillea millefolium*), arrowleaf balsamroot (*Balsamorhiza sagittata*), mule's ear wyethia (*Wyethia amplexicaulis*), stork's bill (*Erodium cicutarium*), lupine (*Lupinus* spp.), and biscuitroot (*Lomatium* spp.).

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TABLE 1. Upland (Bodurtha 1987) and riparian plant community types and the associated pooled plant community and structural types used to analyze white-tailed deer winter habitat use in the Umatilla River Drainage, northeast Oregon.

Plant Community Types	Pooled Plant Community Types	Structural Types
	<i>Upland Plant Communities</i>	
Agriculture	Agriculture	Grass/Forb
<i>Agropyron spicatum-Bromus tectorum</i>	Perennial Grass Communities	Grass/Forb
<i>Agropyron spicatum-Festuca idahoensis</i>		
<i>Agropyron spicatum-Poa secunda</i>		
<i>Bromus rigidus-Taeniatherum asperum</i>	Annual Grass Communities	Grass/Forb
<i>Bromus tectorum-Bromus brizaeformis</i>		
<i>Taeniatherum asperum-Bromus tectorum-</i> <i>Bromus mollis</i>		
<i>Rosa nutkana/Poa pratensis</i>		
<i>Symphoricarpos albus/Poa pratensis</i>	<i>Symphoricarpos albus-Rosa nutkana-</i> <i>Rhus glabra</i>	Low shrub
<i>Rhus glabra/Bromus rigida</i>		
<i>Crataegus douglasii/Symphoricarpos albus</i>	<i>Crataegus douglasii/Symphoricarpos albus</i>	Tall Shrub
<i>Physocarpus malvaceus/Symphoricarpos</i> <i>albus/Carex geyeri</i>	<i>Physocarpus malvaceus/Symphoricarpos</i> <i>albus/Carex geyeri</i>	Tall Shrub
<i>Pinus ponderosa/Holodiscus discolor/</i> <i>Symphoricarpos albus</i>	<i>Pinus ponderosa-Pseudotsuga menziesii/</i> <i>Holodiscus discolor-Physocarpus malvaceus</i>	Mature/Shrub Mature
<i>Pinus ponderosa/Symphoricarpos albus/</i> <i>Carex geyeri</i>		
<i>Pseudotsuga menziesii/Physocarpus</i> <i>malvaceus</i>		
	<i>Riparian Plant Communities</i>	
<i>Populus trichocarpa/Symphoricarpos</i> <i>albus-Prunus virginianus</i>		Mature
<i>Pinus ponderosa/Crataegus douglasii-</i> <i>Prunus virginianus</i>		Mature

The major shrub-dominated communities generally occurred as narrow, irregular shaped patches, less than 10 ha (25 ac) in size, on north-to-east facing slopes, surrounded by grass dominated communities.

Bodurtha (1987) described 5 common forest communities: ponderosa pine / oceanspray (*Holodiscus discolor*), ponderosa pine / common snowberry, Douglas fir / ninebark, Douglas fir / common snowberry, and grand fir (*Abies grandis*) / twin-flower (*Linnaea borealis*).

Much of the lower elevations were planted to winter wheat, barley or peas. Grass and alfalfa hay were grown on small irrigated fields along the Umatilla River and McKay Creek. The study area is grazed by cattle, horses, and shecp.

## Methods

Deer were captured using Clover traps (Clover 1956), V-panel traps (Lightfoot and Maw 1963),

and a cannon net (Hawkins *et al.* 1968) and fitted with 164 mhz. radiocollars. Deer were relocated from the ground using a receiver and 2 element, H-shaped antenna using triangulation. The relocation error polygon (Heezen and Tester 1967) was reduced by visually observing each deer when establishing a location. When this was not possible without disturbing the animal, the deer was approached within approximately 50 m, as estimated by signal strength, topography and vegetation conditions, and monitored from a circular path at 90 degrees to the signal direction until a precise estimate of location was possible. Locations were recorded onto 1:15,840 black and white aerial photographs and transferred to 7.5 minute, USGS topographic maps.

Relocations were separated by at least one nocturnal period, to meet the assumption of behavioral independence (Dunn and Gipson 1977). Relocations were distributed from sunrise to sunset to

represent the diurnal behavior of each deer (Kammermeyer and Marchinton 1977). Deer were located in a predetermined sequence which was rearranged each time a round of relocations was completed to meet the assumption that the probability of detecting an animal in any part of its home range was proportional to the amount of time the animal spent in that area (Samuel *et al.* 1985). Relocations occurred during daylight hours.

At each relocation, topography, vegetation, and activity were recorded. Slope, aspect on slopes > 10 percent, slope position relative to the ridges and major drainages, and elevation were recorded from 7.5 minute USGS topographic maps. Activity was determined by visual observation or by monitoring the radio signal over a 1 minute interval (activity = irregular signal, inactivity = regular signal).

Hiding cover was defined as vegetation required to hide 90 percent of a standing deer at 30 m (Black *et al.* 1976). Distance to hiding cover was placed into 10 m classes using 1:15,840 black and white aerial photographs. A cumulative frequency distribution was generated for relocations in the 10 m classes up to 250 m. This cumulative distribution was fitted to a 2 parameter Weibull probability density function:

$$F(x) = 1 - \exp\{-[(x/B)^C]\}$$

where B = scale parameter and C = shape parameter (Bailey and Dell 1973). This function is a general-purpose function which depicts a range of unimodal shapes, including a reverse J-shape or a mound-shaped curve, which the road-density information was expected to approximate. A least-squares non-linear regression was used to fit the observed distribution to the above model (Helwig and Council 1979).

Winter deer locations were recorded by plant community type and structural classes (Table 1). Winter locations were defined as those occurring in November-March, after migratory deer moved from or to known summer ranges. Structural classes included low shrub, over 1 m height; tall shrub, 1-3 m height; sapling/pole, < 53 cm DBH; mature/forest, > 53 cm DBH. Summer vegetation analysis was limited to structural classes.

Availabilities of each plant community and structural class used in winter were determined from the relative area occupied within 3 sampling units: the sample population study area (SA), 95 percent harmonic mean home range (HM) of each deer (Dixon and Chapman 1980), and core area

(CA) within the harmonic mean home range (Samuel *et al.* 1985). The sample population study area boundary (43.6 km<sup>2</sup>) was defined to include all radio-collared deer and followed natural features which would limit deer movement, primarily large tracts of farmland. Sampling units were tested for differences in plant community availabilities using Quade's test (Conover 1980). Sampling units were treatments and plant communities were considered blocks. Only relocations lying within each sampling unit were used to determine deer use in each analysis. Plant communities, structural classes, and topographic components were delineated on 1:15,840 black and white aerial photographs, transferred to 1:24,000 USGS orthophoto quadrangles and area determined with a digital planimeter. The relative proportion of each parameter was determined within the sample unit. Availabilities for topographic components were measured only within the SA. Summer structural class availabilities were limited to HM because of the large range occupied by all deer during the summer. SA was 43.6 km<sup>2</sup>, included home ranges of all radio-collared deer and was bounded by natural features which would limit deer movement, such as elevation or large tracts of farmland.

The heterogeneity chi-square test was used to test for differences in use of structural types between individuals using the null hypothesis that individual deer did not differ. Availability and use was based on the HM home range estimates. Expected values based on each deer averaged over 5.0, the minimum recommended by Roscoe and Byars (1971) for use in heterogeneity chi-square tests.

Data for individual deer were then pooled within HM and CA for tests comparing use to availability. A chi-square goodness-of-fit tested the null hypothesis that proportion of habitat use by all deer was equal to the proportion of habitat available, within a particular sample unit using a family alpha < 0.10. Simultaneous confidence intervals of use for each habitat were constructed using a Bonferroni test statistic (Neu *et al.* 1974). No expected values were < 1 and no more than 20 percent were < 5 for all chi-square tests (Zar 1984).

Roads were classified into 2 categories. Main roads had paved or gravel surfaces over 1.5 lanes wide passable to vehicles most of the winter (Thomas 1979). Seasonal roads over 1.5 lanes wide were not maintained in the winter. The latter road category was a combination of secondary

and primitive road categories (Thomas 1979). The distance from relocations to each type of road was categorized into 400 m intervals up to 1600 m. Road densities (km/km<sup>2</sup>) were determined within HM home ranges. Deer with both summer and winter HM home ranges were used to test for differences in winter and summer road densities using a Wilcoxon signed ranks test (Zar 1984).

## Results

### Habitat Use

A total of 1,148 relocations was recorded from 12 individual deer. Of these locations 82 percent (n = 937) were used for winter and summer habitat use analysis, with 18 percent omitted because deer were disturbed. Summer relocations within HM totalled 466. Winter relocations totalled 471, 447, and 366 for SA, HM, and CA, respectively. Active behavior was recorded at 64 percent of the relocations during both summer and winter. Visual observations comprised 24 percent of summer and 42 percent of winter relocations.

Proportions of availability for community types were greater between sample units than proportions of use. Perennial grass availability decreased the most from the SA to the CA. Black cottonwood - ponderosa pine was absent from 3 HM home ranges, ponderosa pine - Douglas fir was absent from 2 HM home ranges, and ninebark - common snowberry was absent from 2 HM home ranges.

Winter use of plant community types differed significantly from availability within the 3 sampling units (Table 2). The agriculture type, perennial grass type, and annual grass type were used less than expected in all sampling units. Use of the Douglas hawthorne / common snowberry type and ponderosa pine - Douglas fir type was greater than expected. Black cottonwood - ponderosa pine was used greater than expected in SA and HM but was used in proportion to availability in CA. Availabilities of plant communities in winter were not different within the 3 sampling units ( $P > 0.25$ , Fig. 1).

### Structural Classes

The use of structural classes within summer and winter HM varied from month to month (Fig. 2). Mature forest was the only class used consistently while use of all other classes was variable. Sapling/pole, and mature/shrub structural classes constituted less than 1 acre of the winter study area,

and the low shrub structural class did not occur within the summer sample units.

TABLE 2. Goodness-of-fit chi-square test of use versus availability of plant community types by white-tailed deer during the winter of 1985-86 within the Umatilla River drainage, northeast Oregon. Availabilities are based on the relative area of each habitat within the sample population study area, 95% harmonic mean home range, and the core area. Simultaneous confidence intervals are based on a family alpha of 0.10. Plant community type names are PGC = Perennial Grass Community, AGC = Annual Grass Community, Syal-Ronu-Rhgl = *Symphoricarpos albus* - *Rosa nutkana* - *Rhus glabra*, Crdo/Syal = *Crataegus douglasii* / *Symphoricarpos albus*, Phma/Syal = *Physocarpus malvaceus* / *Symphoricarpos albus*, Pipo-Psme/Hodi = *Pinus ponderosa* - *Pseudotsuga menziesii* / *Holodiscus discolor*, Potr2/Syal-Prvi = *Populus trichocarpa* / *Symphoricarpos albus* - *Prunus virginianus*, Pipo/Crdo-Prvi = *Pinus ponderosa* / *Crataegus douglasii* - *Prunus virginianus*. Study area  $\chi^2 = 501.2$  ( $P < 0.0001$ ); home range  $\chi^2 = 556.0$  ( $P < 0.0001$ ); and core area  $\chi^2 = 260.7$  ( $P < 0.0001$ ).

Plant Community Type	Observed Proportion	Expected Proportion	Preference/Avoidance
<i>Study Area</i>			
Agriculture	0.05	0.23	-
PGC	0.07	0.21	-
AGC	0.13	0.27	-
Syal-Ronu-Rhgl	0.07	0.04	0
Crdo/Syal	0.19	0.05	+
Phma/Syal	0.07	0.05	0
Pipo-Psme/Hodi	0.25	0.11	+
Potr2/Syal-Prvi	0.04	0.02	0
Pipo/Crdo-Prvi	0.13	0.02	+
<i>Home Range</i>			
Agriculture	0.03	0.26	-
PGC	0.07	0.14	-
AGC	0.13	0.30	-
Ronu-Syal-Rhgl	0.08	0.04	0
Crdo/Syal	0.19	0.06	+
Phma/Syal	0.07	0.05	0
Pipo-Psme/Hodi	0.26	0.08	+
Potr2/Syal-Prvi	0.04	0.04	0
Pipo/Crdo-Prvi	0.13	0.03	+
<i>Core Area</i>			
Agriculture	0.04	0.20	-
PGC	0.06	0.11	-
AGC	0.13	0.29	-
Ronu-Syal-Rhgl	0.06	0.04	0
Crdo/Syal	0.20	0.06	+
Phma/Syal	0.08	0.05	0
Pipo-Psme/Hodi	0.24	0.12	+
Potr2/Syal-Prvi	0.05	0.07	0
Pipo/Crdo-Prvi	0.15	0.05	+

"-" = avoidance, "+" = preference, and "0" = no selection.

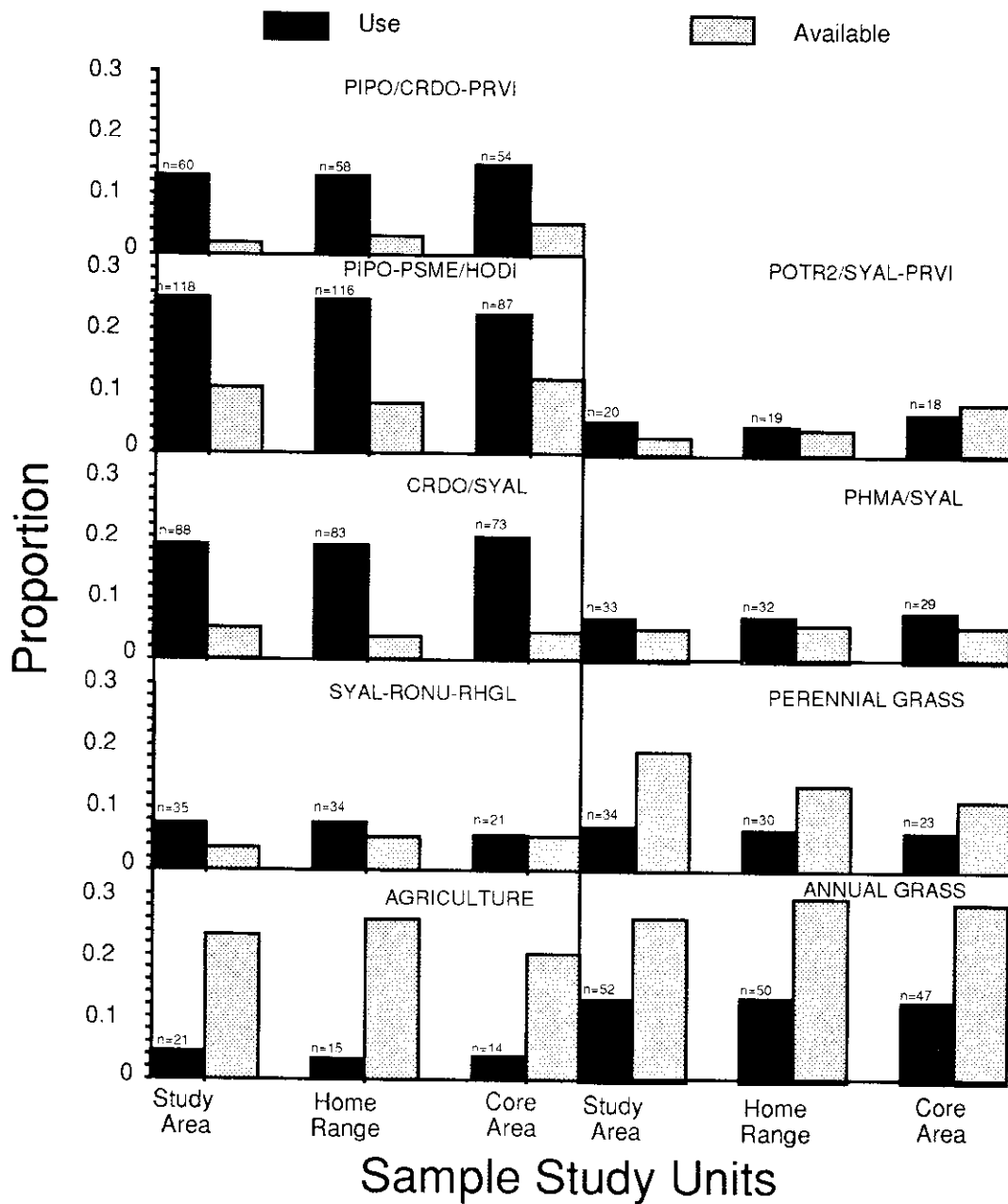


Figure 1. The proportion of use and availability of plant community types by white-tailed deer within 3 different sampling units during the winter 1985-86 along the Umatilla River, northeast Oregon. Sample sizes are 471, 447, and 366 for study area, home range, and core area, respectively. Plant community symbols are Syal-Ronu-Rhgl = *Symphoricarpos albus* - *Rhus glabra*, Crdo/Syal = *Crataegus douglasii* / *Symphoricarpos albus*, Phma/Syal = *Physocarpus malvaceus* / *Symphoricarpos albus*, Pipo-Psme/Hodi = *Pinus ponderosa* - *Pseudotsuga menziesii* / *Holodiscus discolor*, Potr2/Syal-Prvi = *Populus trichocarpa* / *Symphoricarpos albus* - *Prunus virginianus*, Pipo/Crdo-Prvi = *Pinus ponderosa* / *Crataegus douglasii* - *Prunus virginianus*.

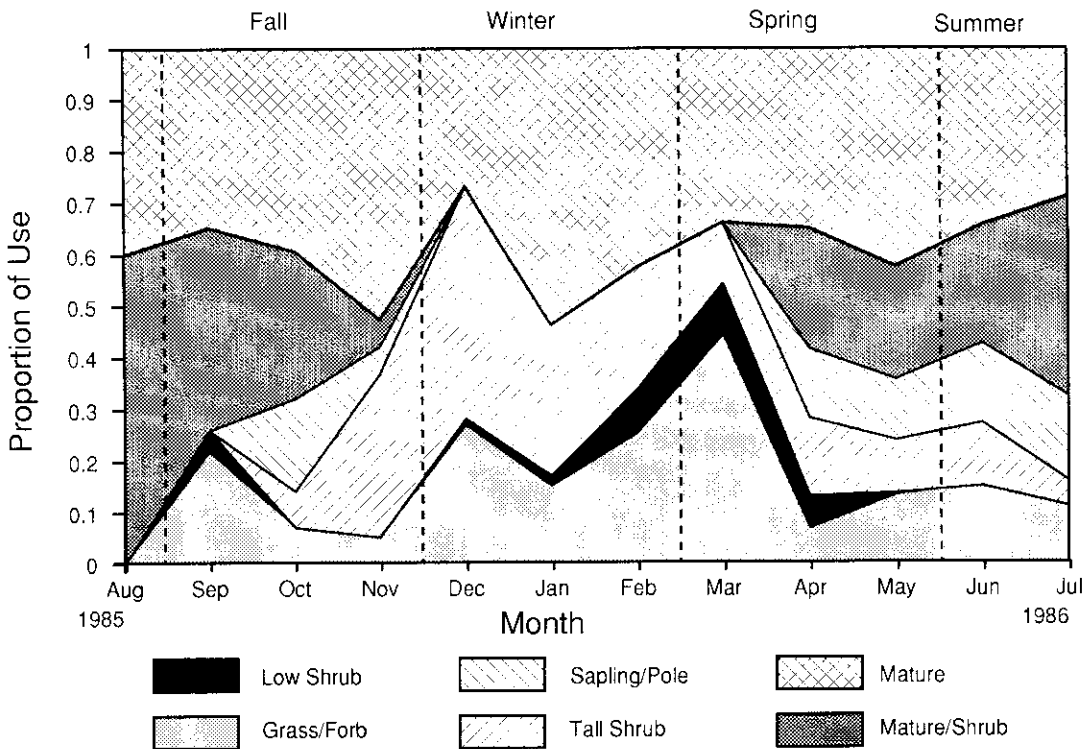


Figure 2. Cumulative proportion line graph of structural type use by white-tailed deer within the 95% harmonic mean home ranges during 1985-1986 ( $n = 937$ ). Dotted vertical lines identify the 3 months within each season, labeled at the top of the graph.

Use of 4 winter structural classes was not homogeneous between deer (Table 3). Two deer used the tall shrub class in a greater proportion than all other classes, while use of the mature class was greater for the remaining 7 deer. Use was different from availability for all deer ( $P < 0.0001$ ).

Deer use of structural classes in winter was different from availability when all locations were pooled within the SA, HM, and CA. Use of the grass/forb class was significantly less than availability in SA, HM, and CA. Use of the tall shrub class and mature class was greater than availability in SA, HM, and CA (Table 4).

Summer use relative to availability of structural classes was not homogeneous between deer ( $P < 0.0001$ ) but was different from availability for each deer ( $P < .02$ ) (Table 5). Grass/forb, tall shrub, and sapling/pole classes were not used by all deer, while mature/shrub and mature tree classes were used by all deer.

Summer use of structural classes was different than availability within home ranges and core areas

( $P < 0.0001$ ) when locations were pooled (Table 6). Grass/forb use was less than availability. Use of sapling/pole and mature classes was greater than availability. Mature/shrub use was less than availability within the CA.

#### Topography

Slope, slope position, aspect, and elevation classes were all used different from availability ( $P < 0.0001$ ) within the winter SA sample unit (Table 7).

The east aspect was used more than expected and 63 percent of this use occurred in tall shrub or mature types. The moister aspects including north, northwest, northeast, and east comprised 65 percent of all use. The south, southwest, and west aspects were used less than their availability. Most tall shrub use occurred on north, northwest, and northeast aspects.

Bottom slopes were used greater than expected, while the middle 1/3 and ridge slope positions were used less than expected. The lower 1/3 position received the greatest use but was not preferred.

TABLE 3. Heterogeneity chi-square test of use versus availability of structural types by individual white-tailed deer during the winter of 1985-86 within the Umatilla River drainage, northeast Oregon. Availabilities are based on the relative area of each structural type within the 95% harmonic mean home range. Expected values are listed directly below the observed values in parentheses. Overall  $\chi^2 = 620.11$  ( $P < 0.0001$ ,  $df = 24$ ) and heterogeneity  $\chi^2 = 156.96$  ( $P < 0.0001$ ,  $df = 21$ ).

Deer	Grass/Forb	Low Shrub	Tall Shrub	Mature Tree	Row $\chi^2$	$P$ ( $df = 3$ )
700	18 (48.507)	4 (1.932)	15 (5.451)	32 (13.110)	65.35	<0.0001
710	6 (34.200)	5 (2.600)	11 (4.850)	28 (8.350)	79.51	<0.0001
720	16 (37.128)	7 (2.142)	2 (4.080)	26 (7.650)	68.12	<0.0001
730	18 (44.736)	1 (5.312)	43 (11.392)	2 (2.560)	107.30	<0.0001
740	15 (33.352)	11 (2.596)	1 (0.968)	17 (7.084)	51.19	<0.0001
780	1 (19.282)	0 (0.124)	1 (2.170)	29 (9.424)	58.75	<0.0001
790	10 (30.700)	3 (1.550)	6 (4.400)	31 (13.350)	39.23	<0.0001
810	8 (31.992)	1 (1.118)	8 (5.203)	26 (4.687)	116.42	<0.0001
860	13 (30.645)	2 (0.900)	23 (11.700)	2 (1.755)	34.25	<0.0001

Eighty percent of the bottom slope use occurred in mature stands, while tall shrub and mature comprised 29 percent and 34 percent, respectively, of lower 1/3 use.

Use of the 11-30 percent and 31-50 percent slopes was greater than expected. The tall shrub and mature types dominated use within the 11-30 percent and 31-50 percent slope classes.

The lowest elevation class received almost half of the use. Almost half the use of the tall shrub and mature structural types, 49 percent and 53 percent, occurred in this class.

#### Distance to Hiding Cover

Distances to hiding cover ranged from 5 to 540 m ( $n = 139$ ) with only 5 locations recorded further than 250 m. The relative cumulative frequency distribution for distance from hiding cover pooled into 10 m classes fitted the 2 parameter Weibull ( $p > 0.95$ , Fig. 3). The Weibull model predicts 50 percent, 75 percent, and 95 percent of use will occur within 44 m, 99 m, and 248 m of hiding cover, respectively.

#### Roads

Road densities within the HM home ranges were variable between types of road and between

TABLE 4. Goodness-of-fit chi-square test of use versus availability of structural types by white-tailed deer during the winter of 1985-86 within the Umatilla River drainage, northeast Oregon. Availabilities are based on the relative area of each habitat within the sample population study area, 95% harmonic mean home range, and core area. Simultaneous confidence intervals are based on a family alpha of 0.10. Study area  $\chi^2 = 545.6$  ( $P < 0.0001$ ), home range  $\chi^2 = 439.4$  ( $P < 0.0001$ ), and core area  $\chi^2 = 252.6$  ( $P < 0.0001$ ) ( $df = 3$ ).

Structural Type	Observed Proportion	Expected Proportion	Preference/Avoidance <sup>1</sup>
<i>Study Area (n = 471)</i>			
Grass/Forb	0.25	0.71	-
Low Shrub	0.07	0.05	0
Tall Shrub	0.26	0.10	+
Mature Tree	0.42	0.14	+
<i>Home Range (n = 447)</i>			
Grass/Forb	0.24	0.69	-
Low Shrub	0.08	0.04	0
Tall Shrub	0.25	0.10	+
Mature Tree	0.43	0.17	+
<i>Core Area (n = 366)</i>			
Grass/Forb	0.23	0.62	-
Low Shrub	0.06	0.05	0
Tall Shrub	0.28	0.12	+
Mature Tree	0.43	0.22	+

<sup>1</sup> '-' = avoidance, '+' = preference, and '0' = no selection.

TABLE 5. Heterogeneity chi-square test of use versus availability of structural types by individual white-tailed deer during the summers of 1985-86 within the Umatilla River drainage, northeast Oregon. Availabilities are based on the relative area of each structural type within the 95% harmonic mean home range. Expected values are listed directly below the observed values in parentheses. Overall  $\chi^2 = 1492.1$  ( $P < 0.0001$ ,  $df = 28$ ) and heterogeneity  $\chi^2 = 1260.7$  ( $P < 0.0001$ ,  $df = 24$ ).

Deer	Grass/Forb	Tall Shrub	Sapling/Pole	Mature Shrub	Mature Tree	Row $\chi^2$	P (df = 4)
700 <sup>1</sup>	9 (48.43)	4 (7.80)	0 (1.37)	44 (1.50)	3 (0.90)	1133.7	<0.0001
700	20 (30.10)	10 (3.26)	0 (0.70)	3 (0.49)	2 (0.32)	39.9	<0.0001
710	0 (4.67)	0 (0.25)	1 (4.06)	13 (23.86)	27 (8.16)	55.7	<0.0001
720	3 (3.27)	0 (0.37)	30 (16.15)	7 (22.08)	5 (4.14)	24.5	<0.0001
730	1 (4.00)	1 (0.86)	30 (19.78)	4 (12.90)	8 (5.46)	14.9	<0.0043
780	0 (2.37)	4 (1.72)	24 (15.27)	8 (21.50)	7 (2.15)	29.8	<0.0001
790	1 (26.00)	3 (1.68)	0 (1.60)	9 (2.60)	27 (8.04)	87.1	<0.0001
810	0 (1.85)	6 (3.96)	1 (1.35)	7 (25.20)	31 (12.69)	45.5	<0.0001
860 <sup>1</sup>	1 (29.16)	1 (2.67)	4 (3.81)	28 (21.71)	47 (23.65)	53.1	<0.0001
860	2 (4.74)	0 (1.70)	1 (2.27)	9 (12.10)	20 (11.20)	11.7	<0.0197

TABLE 6. Goodness-of-fit chi-square test of use versus availability of structural types by white-tailed deer during the summers of 1985-86 within the Umatilla River drainage, northeast Oregon. Availabilities are based on the relative area of each habitat within the 95% harmonic mean home range and core area. Simultaneous confidence intervals are based on a family alpha of 0.10. Study area  $\chi^2 = 331.9$  and core area  $\chi^2 = 280.6$  ( $P < 0.0001$ ,  $df = 4$ ).

Structural Type	Observed Proportion	Expected Proportion	Preference/Avoidance <sup>1</sup>
<i>Home Range (n = 466)</i>			
Grass/Forb	0.08	0.43	-
Tall Shrub	0.06	0.05	0
Sapling/Pole	0.20	0.14	+
Mature/Shrub	0.28	0.23	0
Mature	0.38	0.14	+
<i>Core Area (n = 321)</i>			
Grass/Forb	0.05	0.36	-
Tall Shrub	0.04	0.06	0
Sapling/Pole	0.25	0.11	+
Mature/Shrub	0.22	0.30	-
Mature	0.43	0.17	+

<sup>1</sup>- = avoidance, '+' = preference, and '0' = no selection.

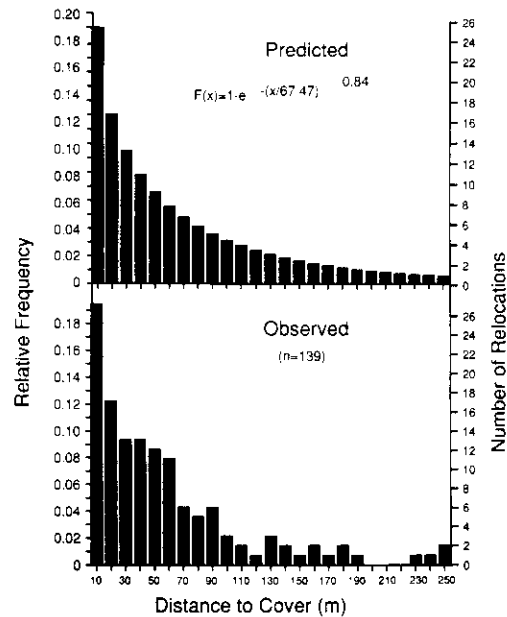


Figure 3. Predicted and observed probability distribution of white-tailed deer relocations as a function of the distance from hiding cover during the winter of 1985-86 in northeast Oregon. Predicted values are based on the fit of observed data to a 2 parameter Weibull distribution.

TABLE 7. Goodness-of-fit chi-square test of use versus availability of aspect, slope position, slope, and elevation by white-tailed deer during the winter of 1985-86 within the Umatilla River drainage, northeast Oregon. Simultaneous confidence intervals are based on a family alpha of 0.10. Availabilities are based on the relative area for each habitat within the sample population study area, inclusive of all winter home ranges. Aspect  $\chi^2 = 131.7$  ( $p < 0.0001$ ,  $df = 7$ ); slope position  $\chi^2 = 164.5$  ( $p < 0.0001$ ,  $df = 4$ ); slope  $\chi^2 = 176.1$  ( $p < 0.0001$ ,  $df = 3$ ); and elevation  $\chi^2 = 100.6$  ( $p < 0.0001$ ,  $df = 3$ ).

Class	Observed Proportion	Expected Proportion	Preference/Avoidance <sup>1</sup>
<i>Aspect</i> ( $n = 361$ ) <sup>2</sup>			
North	0.15	0.11	0
Northeast	0.11	0.09	0
East	0.17	0.10	+
Southeast	0.09	0.11	0
South	0.04	0.09	-
Southwest	0.04	0.10	-
West	0.18	0.24	-
Northwest	0.23	0.18	0
<i>Slope Position</i> ( $n = 471$ )			
Ridge	0.05	0.16	-
Upper 1/3	0.21	0.24	0
Middle 1/3	0.17	0.24	-
Lower 1/3	0.30	0.24	0
Bottom	0.26	0.11	+
<i>Slope</i> ( $n = 471$ )			
0-10%	0.24	0.25	0
11%-30%	0.36	0.24	+
31%-50%	0.35	0.21	+
>51%	0.05	0.30	-
<i>Elevation</i> ( $n = 471$ )			
500m-610m	0.44	0.26	+
611m-730m	0.27	0.25	0
731m-850m	0.11	0.26	-
851m-975m	0.17	0.22	0

<sup>1</sup>- = avoidance, '+' = preference, and '0' = no selection  
<sup>2</sup>Only locations with slope >10% were analyzed for use of aspect.

TABLE 8. Road densities (km/km<sup>2</sup>), year-round and seasonal, within white-tailed deer summer and winter 95% harmonic mean home ranges in northeast Oregon.

Deer	Main Roads		Seasonal Roads <sup>1</sup>	
	Summer	Winter	Summer	Winter
700	0.00	0.30	0.38	0.18
710	0.00	0.00	2.71	0.63
720	0.35	0.00	3.39	0.72
730	0.00	0.58	3.66	0.00
780	1.60	0.69	4.01	0.10
790	0.00	0.13	1.38	0.65
810	0.00	0.00	2.49	0.39
860	0.00	0.02	4.07	0.00
$\bar{x}$	0.24	0.22	2.76	0.33

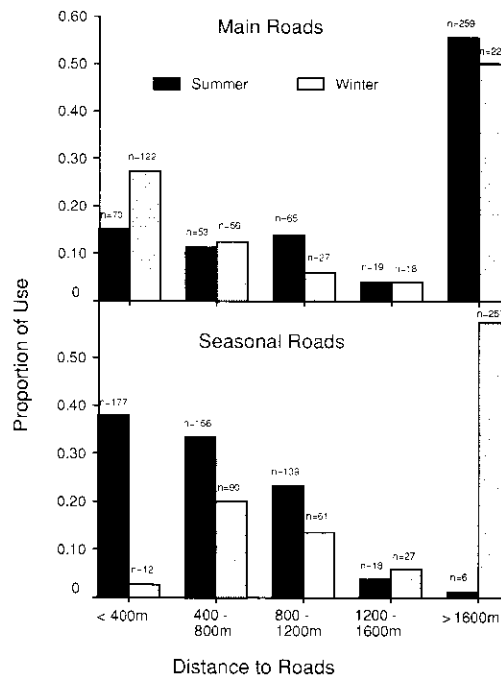


Figure 4. The proportion of use and distance (m) to main and seasonal roads within summer and winter home ranges of white-tailed deer in northeast Oregon from 1985-1986. Distances to roads have been grouped into 5 400-m classes with sample size displayed on top of each bar.

summer and winter (Table 8). Mean main road densities were 0.24 and 0.22 km/km<sup>2</sup> for summer and winter, respectively, and were not different ( $T = -0.10$ ,  $P = 0.54$ ). Seasonal road densities differed between summer and winter ( $T = 2.52$ ,  $P = 0.0006$ ) with mean densities of 2.76 and 0.33 km/km<sup>2</sup>, respectively. Seasonal road densities were positively correlated to the amount of non-forested habitat within summer home ranges (Spearman's  $r = -0.6848$ ,  $p < 0.025$ ), although this relationship was not true for summer main road or either winter road densities.

Distance to roads exhibited similar results to road densities. The majority of use in both summer and winter occurred more than 1600 m from main roads while this only held true for seasonal roads in the winter (Fig. 4). Ninety-five percent of all summer use was located within 1200 m of seasonal roads.

## Discussion

The method used for determining available habitat may affect conclusions on habitat selection (Johnson 1980, Porter and Church 1987). Tests of use and availability for all 3 winter sample units were very similar, both for plant communities and structural classes. The consistency between tests for both winter and summer suggested that all 3 methods for determining habitat availability were reasonable.

In winter white-tailed deer preferred mature forest structural types on moist sites with northerly aspects at low elevations which provided hiding cover due to the well-developed shrub understories. These findings were comparable to other studies in the northwest (Owens 1981, Keay and Peek 1980, Singer 1979, Mundinger 1981). Deer preferred tall shrub-dominated riparian zones, suggesting that in areas where conifer cover is scarce and winters are relatively mild, riparian shrub communities may be important to wintering deer.

All summer ranges contained an interspersed of plant communities and associated structural classes. All but one deer occupied sites dominated by ponderosa pine, Douglas fir, Engelman spruce, and grand fir, although no old-growth forests were found in or near the summer home ranges. The low shrub structural class was not found in measurable quantities within summer home ranges while sapling/pole and mature/shrub occurred in sizable quantities. The latter classes were generally the product of multiple-entry logging. Recent fires did not influence the majority of land occupied by white-tailed deer in the summer.

The variable use pattern by individuals suggests that vegetation structure was not an important environmental cue for summering white-tailed deer. Many studies on white-tailed deer have concluded deer select summer habitats based on the availability of preferred forage within or near cover (Kohn and Mooty 1971, Suring and Vohs 1979, Smith 1981, Murphy *et al.* 1985). Abundance and diversity of forbs in and near cover may also be important in determining summer habitat use in northeast Oregon.

Grass/forb communities were abundant and avoided in winter and summer, similar to other northwest studies (Keay and Peek 1980, Smith 1981). Deer using these communities were generally within relatively short distances of hiding cover. Kramer (1971) and Keay and Peek (1980) found use of open grassland habitats greater than

expected in winter, when adjacent to suitable security cover. Agricultural lands provided the first new green forage available to deer in spring, and we observed heavy use of agricultural fields adjacent to hiding cover along the rim of steep canyons during early morning and late evening for a 1 to 2 week period prior to spring migrations.

The probability distribution developed for distance from hiding cover predicted use to increase almost exponentially as the distance decreases. The availability of the grass/forb and low shrub communities may be substantially overestimated given the relatively small area occupied by communities with value as hiding cover and the distribution of use away from hiding cover.

Summer main road densities averaging 0.24 km/km<sup>2</sup> reduced deer habitat effectiveness over 5 percent, while the mean seasonal road density of 2.76 km/km<sup>2</sup> reduced deer habitat effectiveness approximately 62 percent (Thomas 1979). Main road densities probably had little influence on summer home range locations. The relatively high seasonal road densities found in summer home ranges may be tolerated because of the high amount of hiding cover present.

Avoidance of main roads within winter home ranges was apparently due to the large amount of open habitat in the winter ranges. Avoidance of seasonal roads was not so obvious because they were closed in winter. Snowmobiles were generally used on existing roads and could affect white-tailed deer movements and area of use (Dorrance *et al.* 1975). All-terrain-vehicles were observed during early spring within the winter range. Nixon *et al.* (1988) found white-tailed deer use of forested tracts in Illinois was related to the amount of forest habitat in a refuge unavailable to hunting and off-road vehicles. In contrast, Drolet (1976) found white-tailed deer use greater along roads through clearcuts during May due possibly to reduced energy costs for travel, and lack of vehicle use at that time. Road densities in this study were probably not great enough to affect location of home ranges or use of habitats. More research would be required to establish the relationship of road densities to the use of winter and summer habitats.

Maintenance or increases in the amount of conifer cover along valley bottoms would benefit white-tailed deer. Patches of hawthorne in draws and adjacent to agricultural fields should be maintained.

Communities dominated by ninebark could be burned to improve forage values (Keay and Peck 1980) and as a precursor to other silvicultural practices which would promote their succession to conifers.

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