HABITAT USE BY COLUMBIAN WHITE-TAILED DEER[1]

LOWELL H. SURING, Cooperative Wildlife Research Unit, Oregon State University, Corvallis, OR 97331[2]
PAUL A. VOHS, JR., Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331[3]

Abstract: Columbian white-tailed deer (*Odocoileus virginianus leucurus*) were studied to provide information for management of habitat essential to this endangered subspecies. Vegetation was assigned to major community groupings of rush, thistle, grass, horsetail, and forest. Coverage of 85% of the 790-ha study area provided information concerning utilization of the plant communities by these animals that have adopted a diurnal activity pattern. Communities providing both cover and forage were more heavily utilized than were communities providing cover or forage alone. Communities providing forage alone were used most near adjacent cover. Canada thistle (*Cirsium arvense*) provided cover in summer and allowed deer to utilize previously unused areas. Browse was not used. Green forage was available throughout the year. Restricting visitors to periphery roads allows continuance of the diurnal activity pattern of the deer and aids public enjoyment. Establishment of patches of permanent woody cover where absent would aid in dispersion of the population throughout the refuge.

J. WILDL. MANAGE. 43(3):610–619

This study provided information on habitat use by an endangered ungulate. Published information concerning the Columbian white-tailed deer documents only its discovery (Douglas 1829; Thwaites 1905, vol. 4:209–210; Douglas 1914) and subsequent decrease in numbers (Jewett 1914, Bailey 1936). Douglas (1829) reported white-tailed deer along the lower Columbia River and along the Cowlitz and Willamette rivers in Washington and Oregon, respectively (Fig. 1), and provided the original description of the subspecies.

Brushy lands in river valleys and surrounding low foothills from the south end of Puget Sound in Washington to Roseburg, Oregon, were the historical habitat and range of the subspecies (Bailey 1936:91, Cowan 1936). The population was extirpated from most if its range by 1900 (Jewett 1914, Bailey 1936) during clearing and agricultural development of river valleys (Crews 1939:2). Jewett listed a small concentration of white-tailed deer near Roseburg in 1934 (Cowan 1936:203). Scheffer (1940) reported 500–700 white-tailed deer along the shores of the lower Columbia River and on islands near Cathlamet, Washington and Westport, Oregon. A more recent estimate places the numbers from 250 to 300 along the lower Columbia River (Office of Endangered Species and International Activities 1973:266). Suring (1974) estimated between 200 and 230 deer on the Washington shore in 1973. The survival of the Columbian white-tailed deer in this area prior to 1940 and to the present implies that favorable habitat conditions exist. Description of the habitat utilization by the deer on the newly created Columbian White-tailed Deer National Wildlife Refuge (CWDNWR) was considered essential to provide a basis for management of this remnant population and possible reestablishment of this subspecies on portions of its former range.

[1] Study supported by the U.S. Fish and Wildlife Service, Division of Refuges and the Oregon Cooperative Wildlife Research Unit: Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Oregon State University, and the Wildlife Management Institute cooperating. Technical paper 4406, Oregon Agricultural Experiment Station, Corvallis, OR 97331.

[2] Present address: U.S. Fish and Wildlife Service, Ecological Services, 3530 Pan American Highway, Albuquerque, NM 87107.

[3] Present address: Cooperative Wildlife Research Unit, Oklahoma State University, Stillwater, OK 74074.

We acknowledge D. A. Fisher, former manager, CWDNWR, and the personnel of the Willapa National Wildlife Refuge who gave assistance throughout the study. Funding was provided by the U.S. Fish and Wildlife Service, Bureau of Refuges, through the Oregon Cooperative Wildlife Research Unit. T. A. Gavin, R. L. Linder, E. C. Meslow, J. A. Bissonette, and F. L. Knopf provided helpful comments on the manuscript.

STUDY AREA

The study area was that portion (790 ha) of the CWDNWR on the Washington shore of the Columbia River (Fig. 2). Annual precipitation averaged 254 cm and varied from a monthly average of 43 cm for November–January to 3 cm in July. Average temperatures ranged from 1.7 C in winter to 18.5 C in summer. The mild, wet climate promoted continued growth of forage throughout the year.

The land is a uniformly flat flood plain approximately 15 m above mean sea level and is bordered by steep hills and the river. Soils are primarily Clatsop silty clay loam. Cultivated grasses are productive only where soils are properly drained. Levees protect the refuge from flooding during periods of high tide. A network of ditches and sloughs provide drainage. Flood gates prevent tidal influx, and pumps augment gravity flows.

Nearly 70% of the refuge has been cleared and seeded to permanent pasture. Stands of Canada thistle or common rush (*Juncus effusus*) have invaded much of the pasture land. Small woodlots are interspersed with pasture land in the western ⅔ of the study area. Until recently, 739 ha on the refuge were used for intensive beef cattle and hay production. An additional 51 ha supported a dairy operation. Historically, the area has been used to support dairy operations,

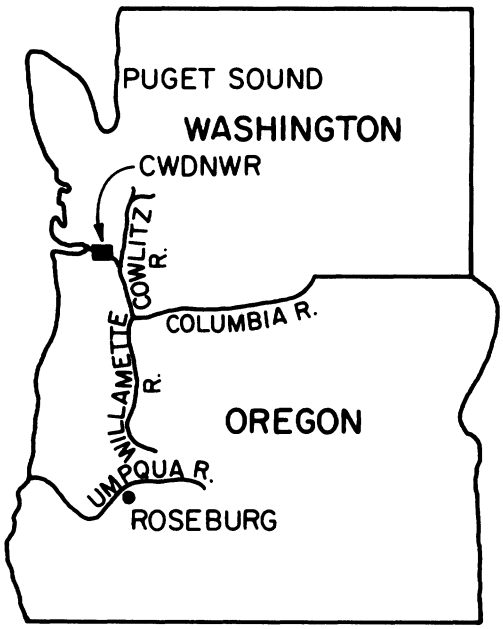

Fig. 1. Geographic locations relative to the current and former distribution of the Columbian white-tailed deer.

but the recent trend is toward beef production. Deer have continued to exist in relatively high densities in association with grazing practices carried on by private landowners. Intensification of clearing of remaining woodlands was evident at the time of refuge establishment. The mixture of small woodlots, additional cover provided by Canada thistle and common rush on poorly maintained and undeveloped pastures, and rainfall made the area acceptable to this remnant population. The deer did not compete directly with man for intensively cultivated crops and thus were tolerated by landowners.

METHODS

Major vegetation types were delineated using aerial photographs and ground reconnaissance. Vegetation within each type was quantified by assigning species encountered along randomly located

Fig. 2. Washington mainland portion of the Columbian White-tailed Deer National Wildlife Refuge (enclosed by outer observation route).

transects a prominence value of 1 to 5 (Anderson and Poulton 1958) and a cover percentage value (Daubenmire 1959). Average height of tree and shrub species was also estimated.

Differences in visibility within and between communities were measured using a density board (de Vos and Mosby 1971:142). The percentage of the board visible at 30 m was recorded for nonforest communities. The board was placed 10 m into woodlots from the edge in forest communities, and observations were made from a point 20 m outside of the woodlot. Observations were made biweekly in at least 2 stands of each community. Percentages of visibility by season were determined by averaging the observations made during each season. Woodland cover and its rate of removal were determined by comparing aerial photographs taken in 1939, 1953, 1961, 1965, 1967, and 1972.

Relative use of habitats by deer was determined by observations made during early morning and late evening daylight hours. These deer had adapted to diurnal activity in apparent response to protection, and the timing of observations was selected to correspond to the periods when maximal numbers were visible. Observations began in July 1972, and were made from a vehicle, with 7 × 50 binoculars or a 20× spotting scope, along the periphery of the study area. A 2nd observation route traversing the center of the area was added in October 1972. Observations continued through June 1973. Over 85% of the study area could be observed directly from the observation routes (Fig. 2). The deer were conditioned to our activity and showed no avoidance behavior as long as the observer remained inside the vehicle.

Activity of deer observed was classified as either resting, feeding, movement, or social. A Habitat Use Index (HUI) was computed for each community by dividing the number of observations of deer per hectare in the community by the percentage of visibility for the community. The HUI was used to reduce bias result-

Table 1. Descriptions of plant communities on the Washington mainland, Columbian White-tailed Deer National Wildlife Refuge.

Plant communities	Area		Dominant species and differences between subgroupings
	Ha	%	
Rush communities			
Hydric rush	36	5	Common rush–buttercup (*Ranunculus repens*). Low, wet sites.
Mesic rush	11	1	Common rush–buttercup–grass. Wet sites–sparse rush stands.
Sparse rush[a]	41	5	Common rush–marsh foxtail (*Alopecurus geniculatus*). Wet sites–very sparse rush stands.
Thistle communities			
Dense thistle	45	6	Canada thistle–reed canary grass (*Phalaris arundinacea*)–velvet grass (*Holcus lanatus*). Not developed beyond clearing.
Sparse thistle[a]	114	15	Canada thistle–alta fescue (*Festuca elatior arundinacea*)–rye grass (*Lolium* spp.)–velvet grass. Overgrazed pasture.
Grass communities			
Reed canary grass[a]	35	4	Reed canary grass. Very dense grass stands.
Improved pasture[a]	308	39	Alta fescue–velvet grass–white clover (*Trifolium repens*)–rye grass. Level, well-drained fields.
Horsetail community			
Horsetail	3	tr	Northwest horsetail (*Equisetum maximum*). Dense stand–low, wet site.
Forest communities			
Dogwood	8	1	Red-osier dogwood (*Cornus stolonifera*)–Salmon berry (*Rubus spectabilis*). Dense stands-limited tree canopy.
Closed canopy forest	22	3	Western redcedar (*Thuja plicata*)–alder (*Alnus rubra*)–Sitka spruce (*Picea sitchensis*). Continuous canopy–sparse ground vegetation.
Open canopy forest	91	12	Western redcedar–red alder–Sitka spruce. Noncontinuous tree canopy–grass-shrub understory.
Park forest	10	1	Sitka spruce. Noncontinuous tree canopy–grass understory.
Drainage ditches and sloughs	66	8	
Totals	790	100	

[a] These communities had been seeded with grass-seed mixtures.

Table 2. Average Habitat Use Index values for plant communities on the Columbian White-tailed Deer National Wildlife Refuge from July 1972 through June 1973.

Plant community	Habitat use index
Park forest	100
Open canopy forest	70
Sparse rush	60
Dense thistle	50
Sparse thistle	50
Mesic rush	37
Improved pasture	27
Reed canary grass	22
Closed canopy forest	16
Hydric rush	15
Horsetail	10
Dogwood	tr

ing from unequal size of the plant communities, seasonal differences in areas of visibility within communities, and differences in areas of visibility between communities.

Differences in mean HUI values between habitats were tested with the Student's *t*-test. The percentage of observations on specific portions of the study area was compared with the percentage of woody cover on each area using the chi-square contingency test to evaluate the hypothesis of random distribution of deer on the study area. The level of significance used for both techniques was 0.05.

RESULTS

Vegetation on the study area prior to diking and clearing was probably forested swamps as described by Franklin and Dyrness (1969:54–55). Clearing, draining, and cultivation have continued since original diking in the early 1900's, and only indistinct remnants of the forested swamps remain. The 70% forest cover present in 1939 was reduced to 36% in 1961 and to 17% by 1972. Pastures seeded to domestic forage species increased in direct proportion to the cover removed.

Table 3. Activities of white-tailed deer observed in each plant community expressed as a percentage of total observations made in each community on the Columbian White-tailed Deer National Wildlife Refuge.

Plant community	Activity			
	Feeding[a]	Resting[b]	Movement[c]	Social[d]
Hydric rush	70	9	19	2
Mesic rush	81	9	10	0
Sparse rush	88	7	3	2
Dense thistle	65	15	20	tr
Sparse thistle	82	10	7	1
Reed canary grass	83	11	6	0
Improved pasture	82	12	5	1
Horsetail	87	3	10	0
Dogwood	20	20	60	0
Closed canopy forest	68	12	20	0
Open canopy forest	60	18	22	tr
Park forest	64	22	12	1

[a] Feeding included grazing, browsing, and nursing activities.
[b] Resting included lying, standing, and grooming activities.
[c] Movement included walking and running activities.
[d] Social included agonistic, mating, and playing behavior.

Vegetation was grouped into 5 plant communities: rush, thistle, grass, horsetail, and forest (Table 1). The rush community was subdivided into 3, the thistle community into 2, grass into 2, and forest into 4 subgroups. Differences in species composition and growth form were criteria for subdivision.

Relative Use of Habitats

Similar patterns of habitat use were observed for all sex and age classes; hence the data were combined. A total of 18,707 observations of deer was recorded during 213 morning and evening observation periods averaging 2.5 hours in length.

Seasonal use in the 3 rush communities was variable with an increase noted in the mesic rush and a decrease in sparse rush through the year (Fig. 3). However, the sparse rush community exhibited the highest overall use by deer among the 3 rush communities. Within the rush communities, deer fed more in sparse rush and less in mesic rush and hydric rush

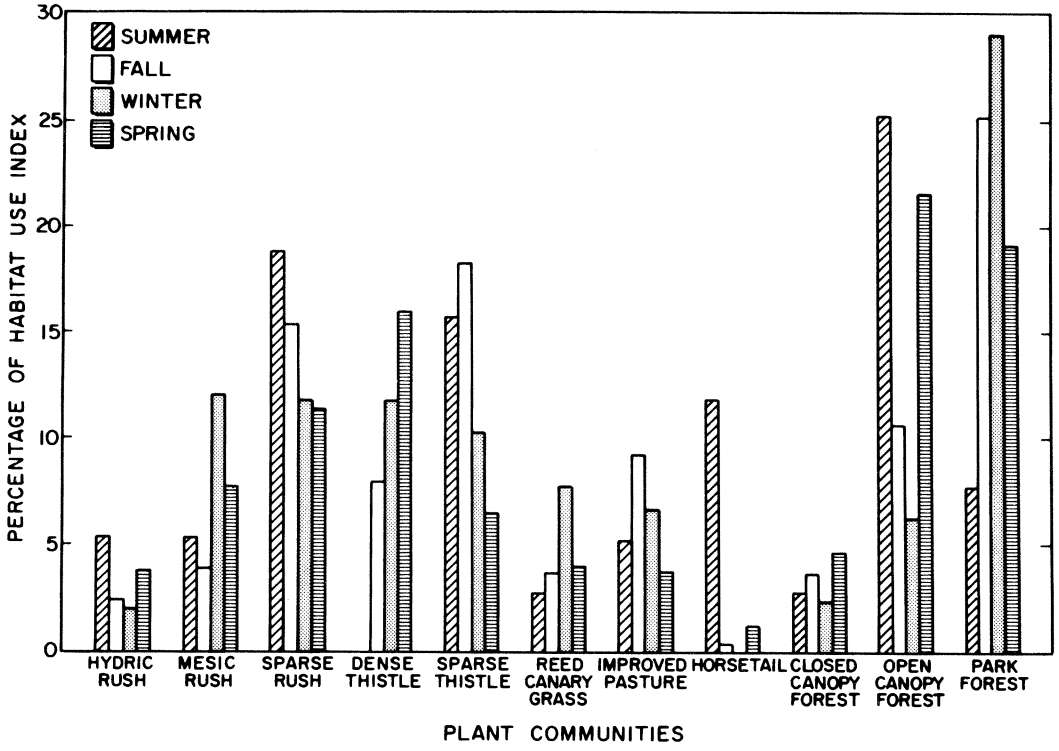

Fig. 3. Relative use of habitats by white-tailed deer on the Washington mainland, Columbian White-tailed Deer National Wildlife Refuge. Sufficient observations of deer to calculate HUI values for dense thistle were not made until the 2nd observation route was established in the fall.

(Table 3). Conversely, resting and moving deer made up a larger portion of the observations in hydric rush than in mesic rush or sparse rush. Hydric rush had a taller growth form.

Deer exhibited similar annual preference for dense and sparse thistle communities. Utilization of the sparse thistle community decreased throughout the year while use of vegetation within the dense thistle community increased from fall to spring (Fig. 3). Of the time spent in each habitat, deer were observed foraging more frequently in the sparse thistle as compared with dense thistle (Table 3). Sightings of resting and moving deer comprised a larger percentage of total observations in dense thistle than in sparse thistle, however, and indicate the value of thistle in providing cover for deer when they are not actively feeding.

Habitat use values for reed canary grass (*Phalaris arundinaceae*) and improved pasture communities (Table 2) were relatively low throughout the year (Fig. 3). Activity patterns on the 2 grass communities were similar (Table 3); feeding was the most prominent activity. The horsetail community exhibited the minimum habitat use value for nonforest communities (Table 2). Relative use of vegetation in this community was greatest in summer (Fig. 3) when grazing was the most prominent activity (Table 3).

Park forest and open canopy forest had the highest HUI values (100 and 70, re-

spectively) of all communities (Table 2). In contrast, HUI values for closed canopy forest and dogwood communities were 16 and trace, respectively. Summer use of open canopy forest was greater than park forest; fall and winter use was greater in park forest than open canopy forest. Use of both open canopy and park communities exceeded use in all other communities in spring.

Feeding activities of the deer on the study area were 99% grazing, 1% browsing, and a trace nursing. With the exception of dense thistle, the lowest percentage of feeding deer was observed in forest communities (Table 3). Higher percentages of deer were observed resting and moving in the forest than in the nonforest communities. Thus, even though the highest habitat use was made in 2 of the forest communities, browsing was rare.

Mean use values of sparse rush, sparse thistle, and improved pasture sites with bordering woodlots were compared to mean use values of similar sites not adjacent to woodlots. Use of sites with adjacent cover was higher ($P < 0.05$) during all seasons of the year. The west and center sections of the refuge consisted of pasture lands interspersed with cover (Fig. 2). Little cover in the form of shrubs and trees was interspersed with the pastures on the eastern ⅓ of the refuge. The percentage of observations of deer on the western and center sections was higher than the expected percentage, and the percentage of observations on the eastern section was lower than expected ($P < 0.0005$).

Large numbers of cattle on the refuge during 10 months of the year provided almost continual contact between cattle and deer, and affected the activities of the deer. Deer actively avoided close associations with cattle, and only 7% of the observations of feeding deer were within 30 m of grazing cattle. Harassment of deer by cattle was not observed, but observations indicated that deer preferred to utilize areas without cattle or where cattle densities were low.

DISCUSSION

Columbian white-tailed deer on the refuge exhibited differential utilization of plant communities on a seasonal basis. Changing availability of forage and vegetative cover within each community was related to utilization by deer. Plant communities most often used by deer were those providing both forage and cover. Presence of vegetation over 70 cm high in the vicinity of forage species attracted deer. Deer showed preference for the park forest community, especially in fall, winter, and spring. Cover was provided by widely distributed shrubs and the trunks of large trees. The reduction in heat loss that occurs under tree canopy (Ozoga and Gysel 1972) may have attracted the animals to this community during these times of the year. Deer preferred open canopy forest in the spring and summer when use of park forest decreased.

Sparse rush, sparse thistle, and dense thistle showed relatively high use by deer. The sparse rush and sparse thistle exhibited similar growth form and similar patterns of utilization by deer. Both were "open," provided forage, and had either scattered rush or thistle that provided cover. Fewer observations of feeding deer were made in the dense thistle than in the sparse rush or sparse thistle, but observations of resting and moving deer increased in dense thistle. Additional cover provided by the dense stands of thistle may have made this community more favorable for resting than other nonforest communities. Use of mesic rush

was moderate and corresponded to increased density of common rush and decreased availability of forage species when compared to sparse rush.

Utilization of improved pasture was relatively low even though this type covered nearly 40% of the study area. Forage was available throughout the year but cover was absent. Deer use was higher on improved pasture stands immediately adjacent to forest communities. Home ranges of individually identified deer included forest communities even though the deer foraged in adjacent pastures (Suring 1974). These deer openly fed on maintained pastures but only within 250 m of woodlands. Utilization by deer of the reed canary grass community decreased in late summer and fall even though the rank growth of grass provided cover. Palatability may have been reduced during these seasons.

Closed canopy forest, hydric rush, and dogwood communities provided deer with cover but the vegetative structure reduced forage, and use by deer was low. Shade provided by the closed canopy forest made this community attractive to cattle for bedding during summer. The resultant trampling of vegetation and the low light intensities limited growth of forage species. The horsetail community received low use except in late spring and early summer following growth of forbs that provided cover.

Observations by Kramer (1973) that white-tailed deer avoided close association with cattle were applicable to the Columbian white-tailed deer. The physical presence of cattle appeared to displace deer. Selection of feeding sites by deer was not related to the previous presence or absence of cattle.

In some areas, white-tailed deer consume grasses and forbs during spring and summer, and change to browse in winter (Martinka 1968, Coblentz 1970, McCaffrey et al. 1974, Wetzel et al. 1975) or remain on a diet composed mainly of grasses and forbs throughout the year (Coblentz 1970, Nixon et al. 1970). Grasses and forbs in the green stage are more digestible and contain more protein than browse contains (Segelquist et al. 1972, Short 1975). Mature grasses and forbs have reduced digestibility and protein content (Blair et al. 1977) and may become unavailable to deer in winter when snow covers the ground (Coblentz 1970, Wetzel et al. 1975). However, grass that remains green throughout the winter is as digestible as that growing during spring and summer (Short 1975).

Short, actively growing grasses and forbs were available on the refuge throughout the year. Green herbage was made available on the rufuge through stimulation of plant growth by grazing of cattle, cutting of hay, and removal of green vegetation for cattle feed. The mild climate along the lower Columbia River assured the availability of grasses and forbs, and the Columbian white-tailed deer utilized green herbage throughout the year. Coblentz (1970:539) indicated that white-tailed deer utilized browse during winter out of necessity and not because of preference. The Columbian white-tailed deer had an opportunity to browse but chose to graze instead. The availability of grasses and forbs for food during winter is believed important in maintaining the population on the refuge.

MANAGEMENT RECOMMENDATIONS

Dispersion of Columbian white-tailed deer on the refuge was related to availability of cover and immediate presence of cattle. Thus, we believe that management of vegetative cover and grazing of

cattle can be used to manipulate the density and dispersion of the deer population. Although deer preferred forest communities for cover, they utilized new growth of tall forbs, including Canada thistle and common rush, as cover in spring and summer. Seasonal growth of tall forbs was followed by expanded use of the refuge by deer. Allowing thistle (classified as noxious weed) to grow on the refuge would provide immediate cover for deer in areas where permanent cover is lacking. Improvement of existing forest communities and the addition of new woody cover would eventually provide for the cover requirements for deer in all areas of the refuge. Fencing to exclude cattle from a portion of currently existing woodlots would enhance their use by deer. Establishment of fenced plantings of native tree species in areas where woody cover is desired but not present is recommended to improve dispersion of woody cover on the eastern portion of the refuge. Grazing by cattle and/or removal of vegetation from improved pastures by machinery should continue as is necessary to maintain short, actively growing forage for deer. Grazing by cattle should be manipulated to insure provision of sufficient forage of high quality in fall to allow deer to build fat reserves for winter. Exclusion of cattle from ½ of existing woodlots is recommended to provide understory development preferred by deer during winter and in the fawning period.

Management activities that constitute major changes in vegetation management should be subjected to careful evaluation to determine the response by deer prior to widespread application. Additional habitat conversions from woodlands to pasture could deprive the population of essential cover. Large-scale establishment of woodlands or drastic changes in grazing practices could diminish needed forage.

LITERATURE CITED

ANDERSON, E. W., AND C. E. POULTON. 1958. Collections of ecological data for soil-site correlation in Oregon. Soil Conservation Service and Oregon State College. 17pp.

BAILEY, V. 1936. The mammals and life zones of Oregon. North Am. Fauna 55. 416pp.

BLAIR, R. M., H. L. SHORT, AND E. A. EPPS, JR. 1977. Seasonal nutrient yield and digestibility of deer forage from a young pine plantation. J. Wildl. Manage. 41:667–676.

COBLENTZ, B. E. 1970. Food habits of George Reserve deer. J. Wildl. Manage. 34:535–540.

COWAN, I. MCT. 1936. Distribution and variation in deer (Genus *Odocoileus*) of the Pacific coastal region of North America. Calif. Fish and Game 22:155–246.

CREWS, A. K. 1939. A study of the Oregon white-tailed deer, *Odocoileus virginianus leucurus* (Douglas). M.S. Thesis. Oregon State Coll., Corvallis. 46pp.

DAUBENMIRE, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43–65.

DE VOS, A., AND H. S. MOSBY. 1971. Habitat analysis and evaluation. Pages 135-172 *in* R. H. Giles, ed. Wildlife management techniques. 3rd ed., The Wildlife Society, Washington, D.C.

DOUGLAS, D. 1829. Observations on two undescribed species of North American mammalia (*Cervus leucurus et Ovis californianus*). Zool. J. 4:330–332.

———. 1914. Journal kept by David Douglas during his travels in North America, 1823–1827. W. Wesley and Son, London. 364pp.

FRANKLIN, J. F., AND C. T. DYRNESS. 1969. Vegetation of Oregon and Washington. U.S. Dep. Agric. For. Serv. Res. Pap. PNW-80. 216pp.

JEWETT, S. G. 1914. The white-tailed deer and other deer in Oregon. Oreg. Sportsman 2(8): 5–9.

KRAMER, A. 1973. Interspecific behavior and dispersion of two sympatric deer species. J. Wildl. Manage. 37:288–300.

MARTINKA, C. J. 1968. Habitat relationships of white-tailed and mule deer in northern Montana. J. Wildl. Manage. 32:558–565.

MCCAFFERY, K. R., J. TRANETZKI, AND J. PIECHURA, JR. 1974. Summer foods of deer in northern Wisconsin. J. Wildl. Manage. 38:215–219.

NIXON, C. M., M. W. MCCLAIN, AND K. R. RUSSELL. 1970. Deer food habits and range characteristics in Ohio. J. Wildl. Manage. 34:870–886.

OFFICE OF ENDANGERED SPECIES AND INTERNA-

TIONAL ACTIVITIES. 1973. Threatened wildlife of the United States. Bur. Sport Fish. Wildl. Resour. Publ. 114. 289pp.

OZOGA, J. J., AND L. W. GYSEL. 1972. Response of white-tailed deer to winter weather. J. Wildl. Manage. 36:892–896.

SCHEFFER, V. B. 1940. A newly located herd of Pacific white-tailed deer. J. Mammal. 21:271–282.

SEGELQUIST, C. A., H. L. SHORT, F. D. WARD, AND R. G. LEONARD. 1972. Quality of some winter deer forages in the Arkansas Ozarks. J. Wildl. Manage. 36:174–177.

SHORT, H. L. 1975. Nutrition of southern deer in different seasons. J. Wildl. Manage. 39:321–329.

SURING, L. H. 1974. Habitat use and activity patterns of the Columbian white-tailed deer along the lower Columbia River. M.S. Thesis. Oregon State Univ., Corvallis. 59pp.

THWAITES, R. G., ED. 1905. Original journals of the Lewis and Clark expedition, 1804–1806. Vol. 4. Dodd, Mead, and Company, New York. 363pp.

WETZEL, J. F., J. R. WAMBAUGH, AND J. M. PEEK. 1975. Appraisal of white-tailed deer winter habitats in northeastern Minnesota. J. Wildl. Manage. 39:59–66.

Received 28 March 1977.
Accepted 17 November 1978.