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Winter habitat use migration and spring and summer use of clearcuts by white-tailed deer in the Priest Lake watershed of northern Idaho

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WINTER HABITAT USE, MIGRATION, AND SPRING AND SUMMER USE OF CLEARCUTS BY WHITE-TAILED DEER IN THE PRIEST LAKE WATERSHED OF NORTHERN IDAHO

By

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Frontispiece. Selkirk Mountain Range overlooking Reeder Bay, Priest Lake, Idaho.

ABSTRACT

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Winter habitat use, migration, and spring and summer use of clearcuts by white-tailed deer in the Priest Lake watershed of northern Idaho. (143 pp.)

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Winter habitat selection patterns of white-tailed deer (Odocoileus virginianus) in the Priest Lake watershed of northern Idaho were studied during the winters of 1990-91 and 1991-92. Twenty-five radio-collared deer were monitored on 4 geographically distinct winter ranges within the watershed. White-tailed deer displayed a strong preference for low elevation ($\leq$ 820 m), densely forested sites with mean tree ages ranging from 65 to 91 years. All study animals avoided non-forested sites and selected stands of mature timber with overstory canopy coverages exceeding 80%. Preferred winter habitats of whitetails in the Priest Lake watershed were predominated by Douglas-fir (Pseudotsuga menziesii) and grand fir (Abies grandis) overstory trees with an admixture of lodgepole pine (Pinus contorta), western red cedar (Thuja plicata), and western hemlock (Tsuga heterophylla). Understory plant communities were depauperate and characterized by shade tolerant species on all winter ranges. Twenty-four of the 25 study animals were migratory. Spring dispersals peaked in mid-March following a period of increasing temperatures and reduced snow depths. Spring migrations ranged from 6.8 to 59.1 km ($\bar{X}$ = 27.3 km, S.D. = 16.4). All migrating animals moved northward to higher elevations.

Fourteen clearcut sites were used to evaluate spring and summer use of low elevation clearcuts by white-tailed deer in the Priest Lake watershed. Pellet-group densities were used as an index of deer use. White-tailed deer use of clearcuts adjacent to winter ranges declined significantly from spring to summer. I believe spring dispersal of deer to higher elevation summer ranges is responsible for this decrease in use. The structure and composition of seral plant communities was highly variable between units and no correlation between pellet-group densities and unit size or age was found.

These habitat use patterns were observed during mild winter conditions. Greater use of mature and old growth forest is predicted during a normal or severe winter. I recommend maintenance of old growth and mature forest on white-tailed deer winter ranges adjacent to Priest River and Priest Lake. Group selection cuts and strip clearcuts within winter ranges should be discouraged to avoid fragmentation of existing winter habitats.

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CHAPTER I: INTRODUCTION

White-tailed deer are an integral part of North America's wildlife heritage and are an important wildlife resource in many areas. The subspecies O.v. ochrourus is found in Idaho. This subspecies occurs predominately north of the Salmon River, with the mountainous panhandle region of the state harboring the largest populations (Rybarczyk 1991). White-tailed deer are the most abundant ungulate species in many parts of northern Idaho and are enjoyed by a wide diversity of outdoor enthusiasts. It is estimated that in 1989 alone direct expenditures by Idaho white-tailed deer hunters exceeded $7.7 million; in terms of both money spent and participation, benefits from non-consumptive users are believed to be equally significant (Horvarth 1974, Rybarczyk 1991).

Although white-tailed deer have been studied throughout their range, relatively little is known about their responses to the forest management practices currently used in northern Idaho. This portion of the state is dominated by dense coniferous forest and is actively managed for timber production. Timber harvest operations have wide ranging effects on deer habitat. Overstory removal can stimulate the growth of many understory plant species by reducing the competition for sunlight and nutrients, and various logging treatments have been recommended to increase browse production and provide vegetative diversity (Pengelly 1963, Patton and McGinnes 1964, Verme 1965, Irwin and Peek 1979). However, in many areas timber harvest can have adverse effects on deer habitat. In regions with heavy snowfall, snow depths in harvested units can preclude deer from using these areas even when woody browse is available above the snow (Mundinger 1981, Owens 1981, Crawford 1984). Winter ranges which provide adequate shelter are vital to the survival of white-tailed deer in northern climates and winter range quality can be a principle limiting factor for many deer herds (Olson 1938, Pengelly 1963, Drolet 1976, Peek 1984, Rybarczyk 1991). Dense coniferous stands of mature timber intercept and provide a substrate for sublimation of snow, reduce wind chill, and provide a narrower temperature range than do younger, more open stands (Verme 1965; Ozoga 1968; Pengelly 1972; Telfer 1970, 1974; Crawford 1984). Telfer (1974) found large clearcuts were harmful to wintering whitetails in boreal forests; in the Upper Swan River Valley of northwestern Montana, Hildebrand (1971) reported the loss of large portions of winter range due to logging. White-tailed deer displaced from disrupted wintering areas may also increase competition on adjacent ranges and enhance the possibility of habitat degradation (Hildebrand 1971, Crawford 1984). Road construction associated with timber operations can also reduce the effective area of suitable habitat and increase human disturbance and hunting pressure (Pengelly 1963, Dorrance et al. 1975, Eckstein et al. 1979).

Areas that receive heavy deer use in this area contain valuable timber resources and the need for coordination between forest and wildlife managers is critical (Peek 1984). Silvicultural methods that create an interspersion of forage and cover often provide the best compromise, and various management strategies based on this theme have been proposed (Gill 1957b, Pengelly 1963, Telfer 1974).

The habitat management guidelines compiled by Jageman (1984) are the most comprehensive for north Idaho white-tailed deer and are widely used. These guidelines are based on research findings from the University of Idaho's Hatter Creek enclosure (Roberts 1956, Shaw 1962, Gladfelter 1966, Howard 1969, Owens 1981), as well as studies by Pengelly (1963) in the Coeur d' Alene National Forest; Keay and Peek (1980) in the Upper Selway, Idaho; Mundinger (1980) in northwestern Montana; and others outside of the region. Although these guidelines are useful in developing management strategies, site-specific studies are imperative to effectively incorporate white-tailed deer management with forest management in northern Idaho. Vegetation displays wide geographic variation in its response to cutting and manipulation, and habitat requirements of white-tailed deer vary substantially across their range (Janke 1977, Slott 1980, Crawford 1984, Berner 1985).

The Idaho Department of Fish and Game (IDFG) realized the need to test and augment existing management guidelines, and in 1987 a management-oriented investigation of white-tailed deer ecology in north Idaho was initiated. This research project provided valuable information on white-tailed deer food habits, migrational movements, and seasonal habitat use (Pauley 1990). Pauley (1990) found mid-winter habitat was narrowly defined in the Priest River Drainage of northern Idaho. As snow depths increased, wintering whitetails sought out climax stands of conifer forest with closed canopies and depauperate understories. Pole timber accounted for only 7% of total mid-winter use and non-forested habitats were avoided by all study animals during this period. From late winter into spring, selection progressively shifted from older, closed-canopied stands to younger stands with lush understories, riparian areas, and non-forested habitats. Clearcuts were often used by white-tailed deer during the snow-free period and were found to be an integral part of summer home ranges.

NEED AND OBJECTIVES:

Pauley (1990) provided valuable insight into the ecology of north Idaho white-tailed deer. Old growth is very restricted in northern Idaho, however, and does not provide mid-winter habitat for all deer. Additional research was required to further evaluate winter habitat selection. Our understanding of white-tailed deer use of clearcuts also needed to be expanded, especially the spatial and temporal aspects of clearcut use by deer in the Priest Lake region. Such information will allow IDFG and the U.S. Forest Service to further test and validate their current habitat management guidelines for whitetails in north Idaho. My project was designed to expand upon the findings of Pauley (1990) and focused on the following objectives:

1) To identify and describe winter range habitats, and document the timing and extent of migrational movements.

2) To evaluate logistic regression models developed by Pauley (1990) for predicting white-tailed deer use of forest structural types based on snow depths.

3) To describe the structural and vegetative characteristics of various clearcuts and investigate white-tailed deer use of these areas during the spring and summer months.

4) To further validate and augment existing management guidelines.

STUDY AREA:

Priest Lake is located in Bonner County in the northwestern corner of the Idaho Panhandle. This 10,526 ha lake is drained by the Priest River which flows south through a broad valley before reaching its confluence with the Pend d' Orielle River 71 km downstream.

My study area extended from the upper Priest River valley to the northern end of Priest Lake, and was bounded by the Washington state line on the west and the Selkirk Mountain Range on the east (Fig. 1). Elevations range from 700 m in the valley to 2100 m in the mountains. The majority of research occurred in the southern and central portions of the study area. The winter ranges selected and the migratory movements of the study animals were the defining factors in delineating the study area boundaries.

The vast majority of land within the study area is public land administered by the U.S. Forest Service and the Idaho Department of Lands. Small residential areas are scattered throughout the valley and numerous private holdings occur at lower elevations adjacent to Priest Lake. Permanent residences and vacation homes are scattered around the lake, and lakeshore properties are increasingly being developed.

The Shedroof Divide and Selkirk Mountain Range border the lake and it's associated drainage. These features were created by thrust-faulted granitic and metasedimentary

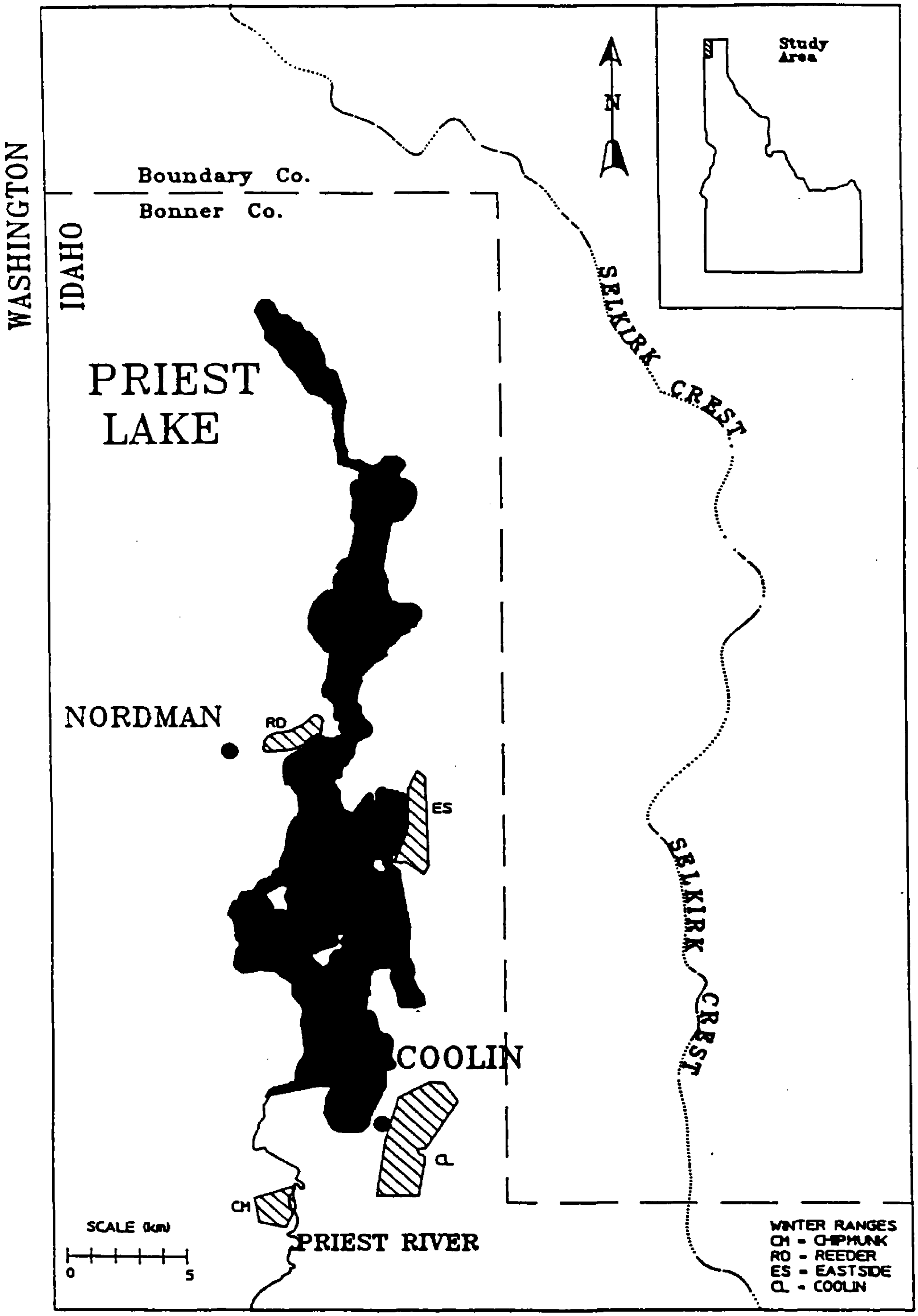


Figure 1. Delineation of study area, Priest Lake, Idaho.

formations, and continental and alpine glaciers sculpted the landscape creating u-shaped valleys and numerous mountain lakes (Weisel 1982). Soils in the drainage are primarily derived from granite, gneiss, and schist with a mantle of volcanic ash and loess (Weisel 1982). Glacial till predominates on foot slopes and in the valley floor.

The climate is strongly influenced by the prevailing westerly airflow of the upper atmosphere. This airflow carries moisture-laden air masses in from the northern Pacific Ocean and creates an "inland maritime" climatic regime (Finklin 1983). Approximately 60% of the annual precipitation occurs from November through March (Finklin 1983). Average annual snowfall ranges from 225 cm in the Priest River valley to over 760 cm at elevations above 1600 m. Snow cover is typically present from late November through late March and averages a maximum seasonal depth of 75 cm. At higher elevations snowpack may persist into June. Average winter temperatures range from -8^{0} to 2^{0} C, with January typically being the coldest month. With increasing spring temperatures come periods of prolonged gentle rain and relatively high humidity. Summers are typically very dry, and July and August, the only distinct summer months, are characteristically warm and sunny (Finklin 1983). Summer temperatures range from an average low of 6^{0} C to an average high of 28^{0} C.

This area is characterized by dense, coniferous forest, with the western hemlock and western red cedar habitat type series dominating mid to lower elevations (Cooper et al. 1987). At higher elevations (>1500 m) the subalpine fir (Abies lasiocarpa) and Engelmann spruce (Picea engelmannii) series predominate. Topographic climaxes of Douglas-fir occur throughout the study area on warm, xeric south-southwest aspects at mid to low elevation. Other commonly occurring overstory species are grand fir, lodgepole pine, western larch (Larix occidentalis), and western white pine (Pinus monticola).

Forest communities are characterized by understory species with an affinity for mesic conditions. Queen cup beadlily (Clintonia uniflora), wild sarsaparilla (Aralia nudicaulis), bunchberry dogwood (Cornus canadensis), round-leaved violet (Viola orbiculata), and starry Solomon seal (Smilacina stellata) are commonly occurring forbs. On moist sites, pachistima (Pachistima myrsinites), blue huckleberry (Vaccinium globulare), dwarf huckleberry (V. caespitosum), common snowberry (Symphoricarpos albus), Oregon grape (Berberis repens), serviceberry (Amelanchier alnifolia), and twinflower (Linnaea borealis) are the predominate shrubs, while drier southern and western aspects often support ninebark (Physocarpos malvaceus) and ocean-spray (Holodiscus discolor). Elk sedge (Carex geyeri) and pinegrass (Calamagrostis rubescens) are 2 of the most frequently occurring graminoids. Although young and open-canopied forested stands often support lush understories, depauperate understory communities are commonly encountered in older, closed-canopied stands.

Historically, wildfires played an integral role in shaping forest ecosystems in the Priest Lake area and created a mosaic of forest communities across the landscape (Arno 1980, Cooper et al. 1987). Periodic wildfires allowed the regeneration of shade-intolerant tree and shrub species in a region dominated by western hemlock and red cedar forests (Arno and Davis 1980). The most significant fires affecting the area in recent times occurred in 1967. The Trapper Peak fire burned 5,000 ha in the northern section of the watershed and the 22,663 ha Sundance fire burned southwest of Priest Lake and into the Pack River drainage (unpubl. U.S.F.S. fire records, Priest Lake Ranger District). Effective fire suppression in the last 60 years has increasingly reduced the influence of wildfire on the Priest Lake landscape (Zager 1980).

Timber production and harvest is the primary land-use practice in northern Idaho and presently has the greatest influence on white-tailed deer habitat within the Priest Lake region (Young 1978, Pauley 1990). Timber is harvested on federal, state, and private holdings throughout the study area. Recreation is also a major land-use practice in the region. Snowmobiling and cross-country skiing are popular winter sports and extensive trail systems are maintained.

During the fall months the area is favored by sportsmen, with the white-tailed deer being the most sought after species (Rybarczyk 1991). Water sports, camping, backpacking, berry picking, and fire-wood cutting are common spring and summer activities.

REFERENCES CITED

Arno, S. F. 1980. Forest fire history in the northern Rockies. J. For. 78:460-465.

Arno, S. F., and D. H. Davis. 1980. Fire history of western redcedar/hemlock forests in northern Idaho. Proc. fire history workshop; U.S.D.A. For. Serv. Gen. Tech. Rep. RM-81.

Berner, K. L. 1985. Winter and spring habitat selection by white-tailed deer in a western Montana second-growth forest. M.S. Thesis, Univ. Montana, Missoula. 98pp.

Crawford, H. S. 1984. Habitat management. Pages 629-646 in L. K. Halls, ed., White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa. 870pp.

Cooper, S. V., K. E. Neiman, R. S. Steele, and D. W. Roberts. 1987. Forest habitat types of northern Idaho: a second approximation. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-236. 135pp.

Dorrance, M. J., T. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39:563-569.

Drolet, C. A. 1976. Distribution and movements of white-tailed deer in southern New Brunswick in relation to environmental factors. Can. Field Natur. 90:123-136.

Eckstein, R. G., T. F. O'Brien, O. J. Rongstad, and J. G. Bollinger. 1979. Snowmobile effects on movements of white-tailed deer: A case study. Environmental Conservation (Spring 1979):45-51.

Finklin, A. L. 1983. Climate of Priest River Experimental Forest, northern Idaho. U.S.D.A. For. Serv. Gen. Tech. Rep. RM-159. 53pp.

Gill, J. D. 1957. Review of deer yard management 1956. Game Div. Bull. 5.: Maine Department of Inland Fish and Game, Augusta. 61pp.

Gladfelter, H. L. 1966. Nocturnal behavior of the white-tailed deer in the Hatter Creek Enclosure. M.S. Thesis, Univ. of Idaho, Moscow.

Hildebrand, P. R. 1971. Biology of white-tailed deer on winter ranges in the Swan Valley, Montana. M.S. Thesis, Univ. of Montana, Missoula. 91pp.

Horvarth, J. C. 1974. Southeastern executive summary: economic survey of wildlife recreation. Env. Res. Group, Georgia St. Univ., Atlanta. 68pp.

Howard, V. W. 1969. Behavior of white-tailed deer within three northern Idaho plant associations. Ph.D. Diss., Univ. of Idaho, Moscow. 71pp.

Irwin, L. L., and J. M. Peek. 1979. Shrub production and biomass trends following five logging treatments within the cedar-hemlock zone of northern Idaho. For. Sci. 25:415-426.

Jageman, H. 1984. White-tailed deer habitat management guidelines. For., Wild., and Range Exp. Stn. Bull. No. 37. Univ. of Idaho, Moscow. 14pp.

Janke, D. 1977. White-tailed deer population characteristics, movements, and winter site selection in western Montana. M.S. Thesis, Univ. of Montana, Missoula. 92pp.

Keay, J. A., and J. M. Peek. 1980. Relationship between fires and winter habitat of deer in Idaho. J. Wildl. Manage. 40:372-380.

Mundinger, J.G. 1980. Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana. Pages 8-92 in Montana Deer Studies. Job Prog. Rep. W-120-R, Montana Dep. Fish, Wildlife, and Parks, Helena, MT.

______. 1981. Impacts of timber harvest on white-tailed deer in the coniferous forests of northwestern Montana. NW Section Wildl. Soc. Annu. Meeting. 15pp.

Olson, O. 1938. Winter range as a limiting factor in big game management. Univ. Idaho Bull. 33(22):20-22.

Owens, T. E. 1981. Movement patterns and determinants of habitat use of white-tailed deer in northern Idaho. M. S. Thesis, Univ. of Idaho, Moscow. 80pp.

Ozoga, J. J. 1968. Variations in microclimate in a conifer swamp deer yard in northern Michigan. J. Wildl. Manage. 32:574-585.

Patton, D. R., and B. S. McGinnes. 1964. Deer browse relative to age and intensity of timber harvest. J. Wildl. Manage. 28:458-463.

Pauley, G. R. 1990. Habitat use, food habits, home range, and seasonal migration of white-tailed deer in the Priest River drainage, north Idaho. M.S. Thesis. Univ. of Idaho, Moscow. 153pp.

Peek, J. M. 1984. Northern Rocky Mountains. Pages 497-504 in L. K. Halls, ed., White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa. 870pp.

Pengelly, W. L. 1963. Timberlands and deer use in the northern Rockies. J. For. 61:734-746.

______. 1972. Clearcutting: detrimental aspects for wildlife resources. J. Soil and Water Conserv. 27:225-258.

Roberts, H. B. 1956. Food habits and productivity of white-tailed deer in the Hatter Creek enclosure. M.S. Thesis, Univ. of Idaho, Moscow. 57pp.

Rybarczyk, B. 1991. White-tailed deer management plan, 1991-1995. Idaho Dept. of Fish and Game. 39pp.

Shaw, H. G. 1962. Seasonal habitat use by white-tailed deer in the Hatter Creek enclosure. M.S. Thesis, Univ. of Idaho, Moscow.

Slott, B. J. 1980. White-tailed deer movements, survival, and population characteristics in the Clearwater drainage, Montana. M.S. Thesis, Univ. Montana, Missoula. 62pp.

Telfer, E. S. 1970. Winter habitat selection by moose and white-tailed deer. J. Wildl. Manage. 344:553-559.

______. 1974. Logging as a factor in wildlife ecology in the boreal forest. For. Chron. 50:1-5.

Verme, L. J. 1965. Swamp conifer deer yards in northern Michigan. J. For. 63:523-529.

Weisel, C. J. 1982. Soil survey of the Bonner County area, Idaho. U.S.D.A., Soil Conserv. Serv. 201pp.

Young, D. D. 1978. Black bear habitat use at Priest Lake, Idaho. M.S. Thesis. Univ. of Montana, Missoula. 66pp.

Zager, P. E. 1980. The influence of logging and wildfire on grizzly bear habitat in northwestern Montana. Ph.D. Diss., Univ. of Montana, Missoula. 131pp.

CHAPTER II: WINTER HABITAT SELECTION

INTRODUCTION

A wide array of studies have been conducted on white-tailed deer ecology in Idaho (Thilenius 1960, Gladfelter 1966, Howard 1969, Nyquist 1972). However, few investigations have addressed the winter habitat preferences of these deer. In northern Idaho, the findings of Pengelly (1961), Owens (1981), and Pauley (1990) are most notable.

Pengelly (1961) documented white-tailed deer distributions, winter range conditions, and population trends in the Coeur d' Alene National Forest and southeast portion of the Kaniksu National Forest. This area receives relatively high levels of precipitation and winters are characterized by heavy snow accumulations. White-tailed deer within this study area were migratory and with the onset of winter moved to low elevation winter ranges in the valley bottoms. Winter severity was believed to determine the timing and extent of these movements. During the winter period, whitetails concentrated in forested stands with overstory canopy coverages of at least 50%. Deer were frequently observed on southern slopes during mild winters. However, creek and river bottoms were preferred during severe winters, and whitetails were periodically found resting under dense hemlock stands where snow depths were noticeably reduced. Valley bottoms constituted an estimated

1% of the study area but were important winter habitat to white-tailed deer in the region. Low brush fields received only minimal use during the winter months.

Wintering white-tailed deer restricted their movements to densely forested sites with depauperate shrub understories in the Palouse Range of northern Idaho (Owens 1981). Critical winter habitat consisted of dense stands of grand fir and red cedar with Douglas-fir, lodgepole pine, and grand fir components. This portion of the state is drier than the northern region, and is characterized by more xeric sylvan environments. Forested stands 30-50 years in age with a mean dbh of 15 cm and canopy coverages of 88% provided adequate shelter to wintering white-tailed deer (Owens 1981).

Pauley (1990) provided some of the most valuable insight into the winter habitat selection patterns of white-tailed deer in northern Idaho. His research documented not only seasonal changes in habitat use, but also shifts in habitat use during the early, mid, and late winter periods in the Priest River drainage. White-tailed deer habitat use focused almost exclusively around intermediate stages of forest succession during the early and late winter periods. Stands of pole timber (12 - 22 cm dbh) were used more than expected and accounted for 59% of deer use in the early period and 56% during the late period. Whitetails selected densely stocked stands of Douglas-fir and lodgepole pine overstory trees with canopy coverages averaging 74%. Habitat selection shifted significantly during the mid-winter period; study animals displayed a strong preference for old growth stands and avoided pole timber. During the mid-winter period white-tailed deer selected climax stands of coniferous forest with canopy coverages averaging 87%. Whitetails selected habitats with gradual slopes (<5%) at low elevations (759-778 m) and displayed avoidance of non-forested sites during all winter periods. Mid-winter habitats contained a major component of old growth western red cedar and western hemlock which was vital to white-tailed deer during periods of high snow accumulation (Fig. 2).

Existing studies provide limited insight into the winter habitat requirements of white-tailed deer in northern Idaho and managers are often required to extrapolate information from studies conducted outside of the region. However, habitat preferences of whitetails can vary substantially over a relatively small geographic area (Janke 1977, Slott 1980, Berner 1985), and site specific studies are imperative to effectively manage this species. A crucial need exists to further define the winter habitat selection patterns of white-tailed deer in the Priest Lake watershed. Old growth forest is not available to all deer in this region and additional winter habitats need to be identified. By further defining the winter habitat requirements of white-

Figure 2. Old growth stand of western hemlock (Tsuga heterophylla) and western red cedar (Thuja plicata) on the Chipmunk winter range, Priest Lake, Idaho.

tailed deer in this area, critical winter habitats can be identified and suitably managed to ensure the future welfare of this species. These areas can then be protected from human encroachment which has resulted in the loss of critical winter habitat in this region (Meske 1972, Crawford 1984). My objectives were to:

1) Define winter habitat use by white-tailed deer on the winter range studied by Pauley (1990), and on other winter ranges throughout the Priest Lake Drainage.

2) Document the timing and extent of spring migration by white-tailed deer within the Priest Lake Drainage.

3) Determine winter range fidelity of white-tailed deer within the Priest Lake Drainage.

4) Augment the IDFG database on white-tailed deer mortality within the Priest Lake Drainage.

METHODS

Animal Capture: I used ground surveys to locate white-tailed deer winter ranges within the Priest Lake watershed during the winters of 1990-91 and 1991-92. Winter ranges were defined as high use areas with an abundance of deer tracks and trail systems. I selected four geographically independent winter ranges for this study. These sites were identified as the Chipmunk (CM), Eastside (ES), Coolin (CL), and Reeder (RD) winter ranges (Fig. 1). The CM range was the winter range described by Pauley (1990) and was selected to allow temporal comparison of winter habitat use between the 2 studies. On each range, I used collapsible "Clover" traps (Clover 1956) baited with alfalfa hay to capture white-tailed deer. Trapped deer were handled without immobilizing drugs and were aged by tooth development and wear (Severinghaus 1949b). Study animals were ear-tagged with plastic roto-tags and equipped with "mortality-sensing" radio transmitters. I collared fawns with modified adult collars following the methods of Craighead et al. (1969).

<u>Animal Monitoring</u>: I used a portable receiver and H-antenna to locate radio-collared study animals from the ground, with relocations of individual deer spaced a minimum of 3 days apart to allow for "biological" independence (Dunn and Gibson 1977, Swihard and Slade 1985a). In homogeneous habitats, I used close triangulation (<300 m) to relocate study animals. In-field plotting of azimuths on USGS topographical maps (scale 1:24,000) with mylar overlays was used to ensure the accuracy of all triangulations. I used 180 degree circling in close

proximity to the study animal in heterogeneous habitats or in situations where on-site evaluation of plotted azimuths revealed chronic signal reflection (Pauley 1990). I maintained a homing distance of at least 100 m to prevent the alteration of normal movement patterns and behavior (Michael 1965). I monitored study animals during both diurnal and crepuscular periods. Initially, nocturnal radio-tracking was also attempted. Rugged terrain precluded the nighttime monitoring of many of my study animals however, and when successful, nocturnal tracking efforts revealed that study animals remained within similar habitats during all temporal periods. All relocations were classified according to their level of accuracy (Unsworth et al. 1989), and location time and current weather conditions were recorded. Radio locations were plotted on topographical maps (scale 1:24,000) and were confirmed with 1:15,840 color aerial photographs. Each position was determined to the nearest 100 m using Universal Transverse Mercator meridians and designated by X, Y coordinates. I monitored white-tailed deer trapped on the RB winter range from 18 January 1991 to 5 February 1993. Deer trapped on the CL and ES ranges were monitored from 1 November 1991 to 5 February 1993, and CM study animals were monitored from 4 January 1992 to 5 February 1993.

Habitat Use: I determined habitat use from habitat variables measured at study animal relocations during the summer months. The following measures of vegetation structure and composition were taken: forest stand structure definitions followed U.S.F.S. criteria and was classified as old growth (>30% canopy cover, $\geq$ 160 years old, and $\geq$ 37 trees/ha $\geq$ 50 cm diameter at breast height (dbh)); mature (>30% canopy cover with the density of trees $\geq$ 23 cm dbh exceeding the density of trees 12 cm to 22 cm dbh); pole (>30% canopy cover with the density of trees 12 cm to 22 cm dbh exceeding the density of trees $\geq$ 23 cm dbh); or sapling (>30% canopy cover and <10% of the trees $\geq$ 12 cm dbh). At each plot, I recorded the density of old growth ($\geq$ 50 cm dbh), mature (23-49 cm dbh), pole (12-22 cm dbh), and sapling (5-11 cm dbh) trees with the point center quarter method (Cottam and Curtis 1956). I measured basal area with a 20 BAF prism and determined canopy cover with a spherical densiometer (Lemmon 1957, Strickler 1959). The height of the overstory canopy was measured with a clinometer. I determined stand age from tree cores taken with an increment borer. The canopy cover of understory species was determined with a 30 m line point transect (Levy and Madden 1933). The transect was oriented in a north/south direction and plant intercepts were recorded at 30 cm intervals (100 total). Plant nomenclature followed Hitchcock and Cronquist (1973) and each location was habitat typed using the methods of Cooper et al. (1987). I measured hiding cover at heights of 0.0-0.5 m, 0.5-1.0 m, and 1.0-1.5 m (Griffith and Youtie 1988). The following physiographic measures were also taken for each site: slope was measured with a clinometer, and the topographic position (ridgetop, slope, bench, or bottom) and horizontal configuration (convex, level, concave, or undulating) of the site were determined. Aspect and elevation were obtained from topographic maps.

I used Analysis of Variance to assess deer habitat use between winter ranges, years, and the early (18 Nov. - 8 Jan.), mid (9 Jan. - 2 Mar.), and late (3 Mar. - 2 Apr.) winter periods delineated by Pauley (1990). I made Pairwise comparisons with a modified Least Significant Difference test in which observed significance levels were adjusted to compensate for multiple comparisons. Data on deer habitat use during the 3 winter periods, during the same year, were only available for the Cl and ES winter ranges. I used the following variables in my analysis: elevation; slope; aspect; cover of Oregon grape and pachistima; forest stand age; overstory canopy cover; tree basal area; and sapling, pole, and mature tree densities. Due to low densities of old growth trees on the CM, CL, and RD winter ranges, I did not use this variable in my analysis. On each of these winter ranges, old growth tree ($\geq$ 50 cm dbh) densities were less than 15 trees per hectare. I transformed non-normally distributed variables with arcsine (canopy cover and slope) or logarithmic (sapling, pole, and mature tree densities) transformations.

I used the methods of Neu et al. (1974) to compare availability and use of habitat categories. Availability was defined by a composite, minimum convex polygon encompassing all winter relocations. Polygons defining availability were independently calculated for each winter range studied. The following habitat categories were used in analysis: elevation (730-819, 820-909, 910-1000 m), slope (0-5,6-15, 16-25, >25 %), forest canopy cover (<65, 65-80, >80 %), forest structure (non-forested, pole, mature, old growth), and cover type (mesic-ABGR/THPL/TSHE, xeric-PICO/PIPO/PSME). Habitat categories were delineated on 1:15,840 color aerial photographs and were transferred to mylar overlays on 1:15,840 topographic maps. A digital planimeter was used to determine the total hectares of each habitat category. I used the total area of each habitat category to determine its availability within the minimum convex polygon defining each winter range. A chi-square-goodness-of-fit test was used to test the null hypothesis that deer used each habitat category in exact proportion to its occurrence within the study area. All expected values within the contingency table exceeded 5.0 and the Yates correction for continuity was applied when only 2 categories were tested. In cases where the X^2 test rejected the null hypothesis, I used Bonferroni normal statistics to construct confidence intervals about the observed proportions.

Confidence intervals were checked for overlap with the availability proportion of the corresponding habitat to determine the avoidance, preference, or neutral use of each habitat (White and Garrott 1990). A family alpha of 0.05 was used to calculate confidence intervals.

Home Range Estimation: I used Program HOME RANGE (Ackerman et al. 1989) to estimate winter home ranges and to evaluate winter range fidelity. Winter home range estimates were calculated only when the number of relocations for a single animal equalled or exceeded 20. Statistical independence of successsive radio locations was tested with the t^2/r^2 statistic at an alpha level of 0.25 (Swihart and Slade 1985b, 1986). I used three techniques in calculating home range estimates: the minimum convex polygon, the bivariate normal ellipse, and the weighted bivariate normal ellipse. The Cramer-von Mises goodness-of-fit test was used in determining if bivariate distributions were appropriate for the home range estimates used. All of my study animal relocations were tested for bivariate uniformity (minimum convex polygon), bivariate normality (bivariate normal ellipse), and weighted bivariate normality (weighted bivariate normal ellipse).

Migrational Movements and Winter Range Fidelity: Study animals which established summer home ranges outside the boundaries of their winter ranges were classified as migratory. Deer were considered to have initiated spring migration when they were first located $\geq$1 km outside of the boundaries of their respective winter ranges. Animals were relocated at 3 day intervals during migration. Spring migration was considered complete when the consecutive relocations of a study animal indicated it had established a summer home range. Once an animal established a summer home range, it was relocated once each week for the duration of the summer. I used summer relocations solely to obtain a rough estimate of summer home ranges so the extent of spring migrations could be determined. Summer home ranges were defined by minimum convex polygons, with each home range containing a minimum of 10 relocations. The extent of spring migration was determined from the linear distance between the most distal points in the summer and winter home ranges of each study animal. I examined elevational differences between winter and summer home ranges with t - tests ($P \leq 0.05$). To document the initiation of fall migration, study animals were once again tracked at 3 day intervals beginning 1 October 1992. This tracking schedule continued until the completion of field work on 5 February 1993. Fall migration was determined to be complete when an animal was relocated within the winter range it used the previous year, or when consecutive relocations indicated that animal was establishing a winter home range.

Deer were considered to display winter range fidelity when winter relocations from consecutive years occurred within the same winter range. An animal was considered to display strong fidelity when it was relocated within the boundaries of the minimum convex polygon defining its previous years winter home range.

Effects of snow accumulation on habitat use: I used an independent data set to test the logistic regression models Pauley (1990) developed to predict winter habitat use. Pauley measured snow depth and sinking depth in mature timber, pole timber, and low shrub (< 1m) clearcuts. The relationship of these snow characteristics to the observed use of forest stand types by radio-collared whitetails was analyzed with logistic regression. Pauley (1990) found sinking depth measures to be highly variable and a poor predictor of stand use by deer. Snow depth measures were easier to replicate, were less variable, and provided the best fit in the final models. The probability of a white-tailed deer using pole, mature, or old growth timber was predicted by the following logistic functions (Pauley 1990):

$$P \text{ (Pole Timber Use)} = 1 / 1 + e^{(g1)} + e^{(g2)}$$

$$P \text{ (Mature Timber)} = e^{(g2)} / 1 + e^{(g1)} + e^{(g2)}$$

$$P \text{ (Old Growth Use)} = e^{(g1)} / 1 + e^{(g1)} + e^{(g2)}$$

where e = the base of the natural logarithm and,

x = the snow depth (cm) in clearcuts, and,

$g1 = 0.1244\ (x) - 4.4608$ $g2 = 0.0394\ (x) - 0.9001$

or where the snow depth in pole timber = x, and,

$g1 = 0.1832\ (x) - 4.8394$ $g2 = 0.0623\ (x) - 1.1135$

or where the snow depth in mature timber = x, and,

$g1 = 0.2307\ (x) - 4.5215$ $g2 = 0.0842\ (x) - 1.1660$

These models predicted an increase in the use of progressively older stands by white-tailed deer as snow depths increased. The predicted use of pole timber by white-tailed deer declined almost linearly with snow depth, while mature timber use gradually increased until snow depths reached 30 cm. After snow depths exceeded 30 cm, the use of mature stands increasingly declined. White-tailed deer use of old growth stands was predicted to increase gradually until snow depths exceeded 20 cm, at which time use rapidly increased.

I placed a series of transects in old growth forest, mature timber, pole timber, and low shrub clearcut stand types to obtain snow measures representative of actual deer locations while avoiding disturbance of the study animals. All transects were located on level terrain within, or adjacent to, the CM winter range. I recorded snow depths at

1 m intervals along 2, 10 m transects within each stand type during the 1991-92 winter. Readings were taken on a weekly basis beginning with the first snow accumulation in November 1992 and ending with snowmelt in March 1992. Snow depths were only considered to be representative of deer locations within the CM and CL winter ranges. A total of 161 deer locations were used in testing the models.

Pauley (1990) developed 3 versions of his models whereby snow depths measured in clearcuts, pole timber, or mature timber served as the explanatory variable. In the current study however, a wide range of within sample variation was found between snow sampling sites. Coefficients of variation revealed that snow depths measured in clearcuts were more precise than those measured in pole timber or mature timber. Therefore, only those models incorporating snow depths measured in clearcuts were tested.

I used chi-square to test the null hypothesis that observed use of stand types by white-tailed deer did not differ significantly from model predictions. A test of fit was not conducted for these models due to the low number of observations in pole timber and old growth timber for each snow depth class. Tests with few observations at each value of the explanatory variable (x) are uninformative and can be misleading (Loftsgarden and Andrews 1992).

RESULTS

Animal Capture: I captured 20 white-tailed deer on the RD winter range from 18 January to 20 February, 1991. Five males and 5 females were fitted with radio collars (Table 1). I monitored these animals from 18 January 1991 through 1 April 1991. Eight of these animals were lost to various causes and only 2 adult females were relocated on the RD range in December of 1991 (Table 2).

Only adult females were monitored during the 1991-1992 winter field season. During the winter of 1990-91, a sample of white-tailed deer were instrumented on the Eastside of Priest Lake as part of a separate IDFG investigation. Of these deer, 7 females trapped on the CL winter range, and 8 females trapped on the ES winter range were incorporated into my study. I also included 8 females trapped on the CM winter range during January of 1992 into my sample. Twenty-five white-tailed deer were monitored on winter ranges at Priest Lake during the 1991-92 winter field season (Table 2).

Habitat Selection: I used 341 deer locations in defining winter habitat use in the Priest Lake watershed. The spatial and temporal composition of the sample was as follows: RD (48 locations from 18 January 1991 to 1 April 1991; 23 locations from 28 December 1991 to 1 April 1992),

Table 1. Capture data of white-tailed deer monitored on winter ranges in the Priest Lake watershed of north Idaho.

I.D. #	SEX	CAPTURE AGE	CAPTURE LOCATION	DATE
01 RD 91	M	Adult	Reeder Bay	01/18/91
02 RD 91	F	Yearling	Reeder Bay	01/18/91
03 RD 91	M	Yearling	Reeder Bay	01/18/91
04 RD 91	M	Adult	Reeder Bay	01/23/91
05 RD 91	F	Yearling	Reeder Bay	01/23/91
06 RD 91	F	Adult	Reeder Bay	01/23/91
07 RD 91	M	Yearling	Reeder Bay	01/24/91
08 RD 91	F	Yearling	Reeder Bay	01/25/91
09 RD 91	F	Fawn	Reeder Bay	01/30/91
10 RD 91	F	Yearling	Reeder Bay	01/31/91
01 CM 92	F	Adult	Chipmunk	01/04/92
02 CM 92	F	Adult	Chipmunk	01/05/92
03 CM 92	F	Adult	Chipmunk	01/15/92
04 CM 92	F	Adult	Chipmunk	01/15/92
05 CM 92	F	Yearling	Chipmunk	01/25/92
06 CM 92	F	Adult	Chipmunk	01/26/92
07 CM 92	F	Adult	Chipmunk	01/29/92
08 CM 92	F	Yearling	Chipmunk	02/01/92
09 CM 92	F	Adult	Chipmunk	02/03/92
01 ES 91	F	Adult	Eastside	01/04/91
02 ES 91	F	Adult	Eastside	01/28/91
03 ES 91	F	Adult	Eastside	02/04/91
04 ES 91	F	Adult	Eastside	12/27/90
05 ES 91	F	Fawn	Eastside	02/07/91
06 ES 91	F	Fawn	Eastside	12/27/90
07 ES 91	F	Yearling	Eastside	01/28/91
08 ES 91	F	Yearling	Eastside	01/28/91
01 CL 91	F	Fawn	Coolin	02/07/91
02 CL 91	F	Adult	Coolin	01/18/90
03 CL 91	F	Fawn	Coolin	02/11/91
04 CL 91	F	Adult	Coolin	03/27/90
05 CL 91	F	Adult	Coolin	02/13/91
06 CL 91	F	Fawn	Coolin	02/13/91
07 CL 91	F	Yearling	Coolin	01/31/91

Table 2. Attrition of white-tailed deer monitored in the Priest Lake Watershed during the period 18 January 1991 through 1 February 1993.

I.D. #	SEX	STATUS	DATE	COLLAR TIME
01 RD 91	M	Dead: cougar kill	03/05/91	42 Days
02 RD 91	F	Alive	02/01/93	743 Days
03 RD 91	M	Dead: cougar kill	01/26/91	08 Days
04 RD 91	M	Dead: cougar kill	02/08/91	14 Days
05 RD 91	F	Lost signal	03/19/91	56 Days
06 RD 91	F	Lost signal	03/19/91	56 Days
07 RD 91	M	Dead: legal kill	11/22/91	302 Days
08 RD 91	F	Dead: cause unknown	06/18/91	144 Days
09 RD 91	F	Dead: legal kill	11/02/92	278 Days
10 RD 91	F	Alive	02/01/93	730 Days
01 CM 92	F	Alive	02/01/93	392 Days
02 CM 92	F	Dead: cause unknown	11/28/92	328 Days
03 CM 92	F	Alive	02/01/93	381 Days
04 CM 92	F	Alive	02/01/93	381 Days
05 CM 92	F	Dead: trapped in ice	01/18/93	358 Days
06 CM 92	F	Alive	02/01/93	370 Days
07 CM 92	F	Dead: cause unknown	04/15/92	78 Days
08 CM 92	F	Alive	02/01/93	364 Days
09 CM 92	F	Alive	02/01/93	362 Days
01 ES 91	F	Dead: cause unknown	05/15/92	466 Days
02 ES 91	F	Alive	02/01/93	733 Days
03 ES 91	F	Alive	02/01/93	726 Days
04 ES 91	F	Alive	02/01/93	765 Days
05 ES 91	F	Alive	02/01/93	723 Days
06 ES 91	F	Lost signal	10/23/92	665 Days
07 ES 91	F	Dead: cause unknown	08/14/92	565 Days
08 ES 91	F	Alive	02/01/93	733 Days
01 CL 91	F	Dead: cause unknown	12/24/92	686 Days
02 CL 91	F	Alive	02/01/93	1108 Days
03 CL 91	F	Alive	02/01/93	719 Days
04 CL 91	F	Dead: cause unknown	06/19/92	814 Days
05 CL 91	F	Alive	02/01/93	717 Days
06 CL 91	F	Alive	02/01/93	717 Days
07 CL 91	F	Alive	02/01/93	730 Days

CL (87 locations from 4 December 1991 to 1 April 1992), ES (103 locations from 23 December 1991 to 1 April 1992), CM (80 locations from 13 January 1992 to 1 April 1992). On the RD winter range, I found no significant difference in habitat use between the winters of 1990-91 and 1991-92 ($P>0.01$). Therefore, deer locations from both winters were combined for further analysis.

The mean elevations of the winter ranges varied from 766m to 799m, with the ES site being significantly higher in elevation ($P<0.01$) than the other sites (Table 3). Both the ES and RD ranges were dominated by sloping terrain, while 78% of the CL range was level (slope <5%). The CM range was intermediate, with 58% of the terrain classified as level. On all winter ranges, sloping terrain was predominately on south and west aspects. Forested stands of pole and mature grand fir, western red cedar, and western hemlock characterized both the CL and RD winter ranges. The CM and ES sites supported a larger component of dry-site tree species with pole and mature stands of ponderosa pine, lodgepole pine, and Douglas-fir predominating (Table 4).

White-tailed deer habitat use was evaluated for each winter range independently because of disparities in topography and forest structure between ranges. On all winter ranges, white-tailed deer habitat use was not significantly different between the early, mid, and late winter periods delineated by Pauley (1990) ($P>0.01$).

Table 3. Elevation and forest stand structure measured at deer locations on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin).

	Winter Range									
	Chipmunk (n=80)		Eastside (n=103)		Coolin (n=87)		Reeder (n=71)		Composite (n=341)	
	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Elevation (m)	777	1.3	820	2.4	773	3.8	791	0.7	791	1.0
Forest Canopy Height (m)	26	0.4	30	0.4	24	0.8	26	0.3	26	0.3
Forest Canopy Cover (%)	85	0.6	88	0.4	82	1.9	86	1.2	85	0.6
Tree Basal Area (m^2/ha)	34	1.3	47	1.3	36	1.8	41	1.7	40	0.8
Tree Density (stems/ha)										
Sapling	80	35.4	103	37.1	87	41.7	991	98.8	510	29.7
Pole	503	48.1	343	22.9	320	22.9	859	106.3	475	28.1
Mature	485	103.0	390	23.8	400	25.3	383	22.4	413	26.6
Old growth	14	6.4	49	7.0	13	3.3	2	0.1	30	3.1
Mean Diameter dbh (cm)										
Sapling	9	0.1	9	0.1	8	0.1	8	0.1	8	0.1
Pole	19	1.7	18	0.2	18	0.2	18	0.2	18	0.4
Mature	30	0.4	33	0.4	32	0.4	32	0.5	32	0.2
Old growth	67	1.3	67	1.2	63	1.1	69	2.2	67	0.7
Hiding Cover (%)										
0.0 - 0.5m	91	1.3	66	2.2	78	2.0	67	2.7	75	1.2
0.5 - 1.0m	74	2.6	42	2.8	60	3.0	50	3.1	56	1.6
1.0 - 1.5m	71	2.6	36	2.6	58	3.1	44	3.1	52	1.6

Table 4. Proportion of observed and expected use of habitat categories by white-tailed deer on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin). PICO = Pinus contorta, PSME = Pseudotsuga menzisii, THPL = Thuja plicata, TSHE = Tsuga heterophylla.

	Winter Range							
	Chipmunk		Eastside		Coolin		Reeder	
	observed	expected	observed	expected	observed	expected	observed	expected
Elevation (m)								
730 - 819	0.85	0.64	0.58	0.33	0.95	0.94	0.86	0.63
820 - 909	0.14	0.20	0.34	0.43	0.05	0.06	0.14	0.37
910 - 1000	0.01	0.16	0.08	0.24	----	----	----	----
Slope (%)								
0 - 5	0.77	0.58	0.42	0.06	0.90	0.78	0.41	0.13
6 - 15	0.06	0.19	0.28	0.21	0.04	0.14	0.39	0.48
16 - 25	0.09	0.12	0.30	0.50	0.06	0.08	0.16	0.22
> 25	0.08	0.11	0.00	0.23	----	-----	0.04	0.17
* **Aspect**								
North/East	0.06	0.18	0.29	0.06	0.11	0.13	0.74	0.06
South/West	0.94	0.82	0.71	0.94	0.89	0.87	0.26	0.94
Forest Canopy Cover (%)								
< 65	0.00	0.09	0.00	0.10	0.07	0.22	0.04	0.29
65 - 80	0.21	0.25	0.03	0.26	0.16	0.10	0.17	0.17
> 80	0.79	0.66	0.97	0.64	0.77	0.68	0.79	0.54
Forest Stand Structure								
Non - Forested	0.00	0.08	0.00	0.05	0.03	0.19	0.00	0.14
Pole	0.26	0.43	0.17	0.31	0.15	0.27	0.20	0.41
Mature	0.71	0.43	0.61	0.58	0.82	0.54	0.80	0.45
Old Growth	0.03	0.06	0.22	0.06	----	-----	----	-----
Cover Type								
THPL/TSHE	0.55	0.42	0.56	0.47	0.86	0.84	0.89	0.71
PICO/PSME	0.45	0.58	0.44	0.53	0.10	0.16	0.11	0.29

* Determined for terrain with >5% slope.

Therefore, I combined data for all winter periods and the findings presented represent habitat use patterns displayed by whitetails during a single winter period.

White-tailed deer displayed a strong preference for densely forested sites with mean tree ages ranging from 65 to 91 years (Table 5). Univariate habitat analysis revealed that gently sloping terrain below 820 m was preferred by wintering deer (Table 5). Disproportionate use of level terrain was found throughout the Priest Lake watershed, with whitetails selecting sites with slopes <5% on all winter ranges. Level terrain comprised only 6.2% of the ES range and 13.0% of the RD range, but was selected by deer on both sites. Of all winter locations, 38% occurred on slopes >5%, but only 12% occurred on slopes >25%. All aspects were used in proportion to their availability on the CM and CL ranges. However, on the ES and RD ranges, south and west aspects were avoided and north and east aspects were selected.

On all winter ranges, whitetails displayed strong avoidance of non-forested sites and selected predominately mature stands of coniferous forest with canopy coverages exceeding 80% (Table 5, Fig. 3). Stands of old growth forest were not present on either the CL or RD ranges (Table 4). Small stands of old growth were present on both the CM and ES ranges. Whitetails wintering on the CM range used old growth in proportion to its availability, while ES deer displayed strong selection for this stand type (Table 5).

Table 5. Selection of habitat categories by white-tailed deer on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin). Confidence intervals were not estimable in cases where no use occurred. Prefer = +, neutral = 0, avoid = -.

	Winter Range							
	Chipmunk		Eastside		Coolin		Reeder	
	Confidence Interval	Habitat Use	Confidence Interval	Habitat Use	Confidence Interval	Habitat Use	Confidence Interval	Habitat Use
Elevation (m)								
730 - 819	0.754 - 0.946	+	0.466 - 0.699	+	chi-square not significant		0.760 - 0.958	+
820 - 909	0.045 - 0.230	o	0.228 - 0.452	o			0.048 - 0.233	-
910 - 1000	-0.016 - 0.041	-	0.014 - 0.141	-			not available	
Slope (%)								
0 - 5	0.658 - 0.892	+	0.296 - 0.538	+	0.818 - 0.975	+	0.263 - 0.554	+
6 - 15	-0.005 - 0.130	-	0.171 - 0.392	o	-0.008 - 0.100	-	0.249 - 0.539	o
16 - 25	0.009 - 0.166	o	0.188 - 0.414	-	-0.002 - 0.117	-	0.048 - 0.262	o
> 25	0.001 - 0.149	o	not estimable		not available		-0.017 - 0.102	-
* **Aspect**								
North/East	chi-square not significant		0.157 - 0.423	+	chi-square not significant		0.588 - 0.892	+
South/West			0.577 - 0.843	-			0.108 - 0.412	-
Forest Canopy Cover (%)								
< 65	not estimable		not estimable		0.004 - 0.134	-	-0.015 - 0.010	-
65 - 80	0.103 - 0.322	o	-0.011 - 0.069	-	0.066 - 0.255	o	0.062 - 0.276	o
> 80	0.678 - 0.897	+	0.931 - 1.000	+	0.662 - 0.878	+	0.672 - 0.905	+
Forest Structure								
Non-Forested	not estimable		not estimable		-0.009 - 0.078	-	not estimable	
Pole timber	0.140 - 0.385	-	0.074 - 0.256	-	0.058 - 0.241	-	0.084 - 0.311	-
Mature	0.586 - 0.839	+	0.492 - 0.732	o	0.716 - 0.916	+	0.689 - 0.916	+
Old Growth	-0.019 - 0.069	o	0.121 - 0.326	+	not available		not available	
Cover Type								
THPL/TSHE	0.425 - 0.675	+	chi-square not significant		chi-square not significant		0.803 - 0.971	+
PICO/PSME	0.325 - 0.575	o					0.029 - 0.197	-

* Determined for terrain with >5% slope.

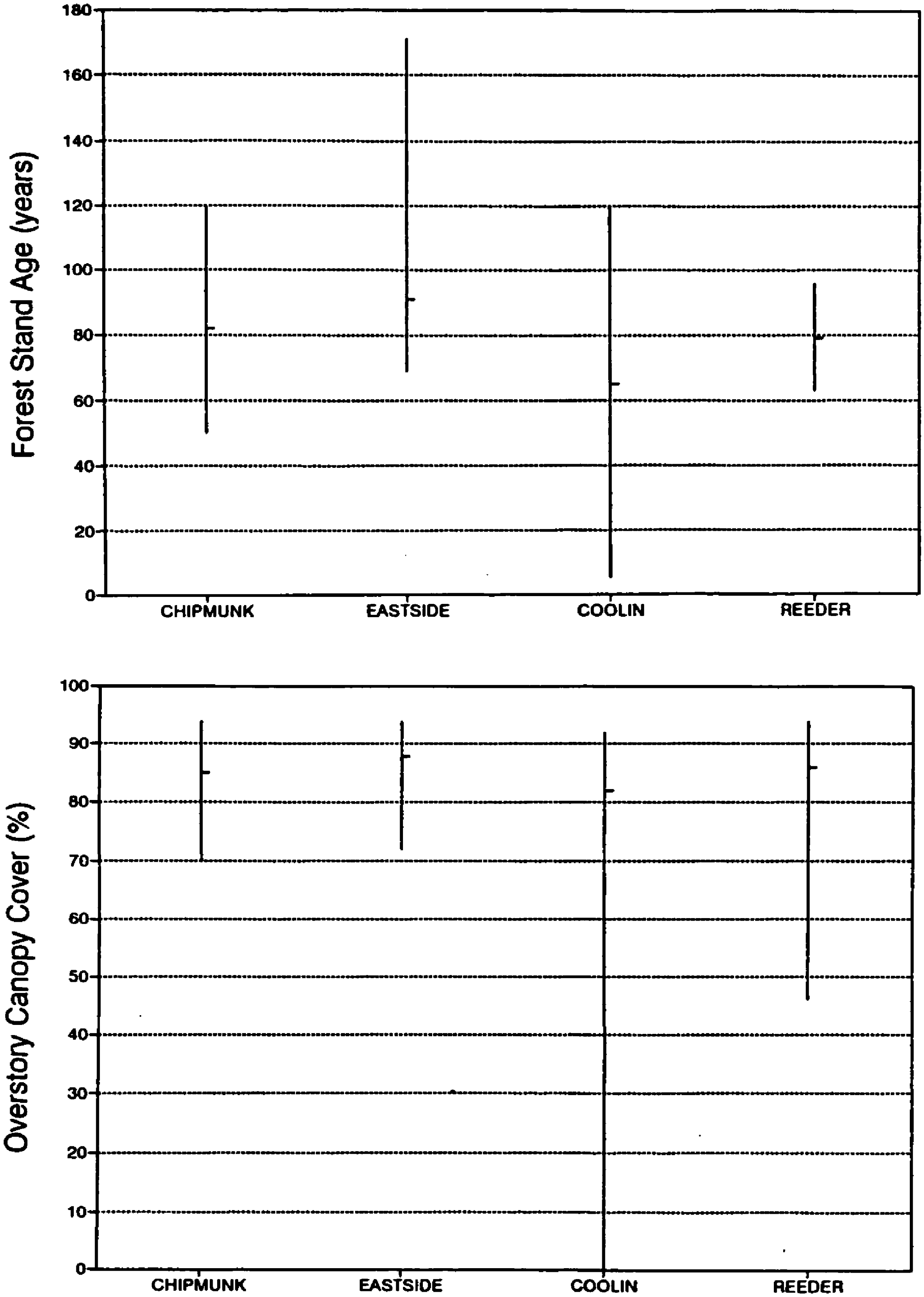


Figure 3. Mean and range of forest stand age and overstory canopy cover recorded at deer locations on 4 winter ranges in the Priest Lake watershed during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin).

Mature forest stands received the highest proportion of use on all winter ranges (Fig. 4) and were selected by whitetails on the CM, RD, and CL ranges (Table 5). Pole timber was avoided on all sites (Table 5). Non-forested areas were present in, and adjacent to, all winter ranges. However, no use of non-forested sites was recorded for the CM, ES, and RD ranges (Fig. 4), and on the CL winter range, strong avoidance of non-forested areas by whitetails was found. Preferred winter habitats of white-tailed deer in the Priest Lake drainage were predominated by a Douglas-fir and grand fir overstory with an admixture of lodgepole pine, western red cedar, and western hemlock (Table 6). At winter locations of study animals, Douglas-fir accounted for the largest percent composition of pole (30%), mature (37%), and old growth (51%) trees. Grand fir comprised the largest percentage of saplings (38%), with Douglas-fir and western hemlock each accounting for 22% of sapling species composition. Fifty-six percent of deer locations occurred in the western hemlock habitat series, 19% in the western hemlock\queencup beadlily habitat type, and 37% in the western hemlock\wild ginger habitat type (Table 7). Availability of habitat types within the study area was not determined, therefore selection of the various habitat types was not assessed. However, 85% of the Kaniksu National Forest is classified within the western hemlock series (U.S.F.S records) and I do not believe deer were selecting

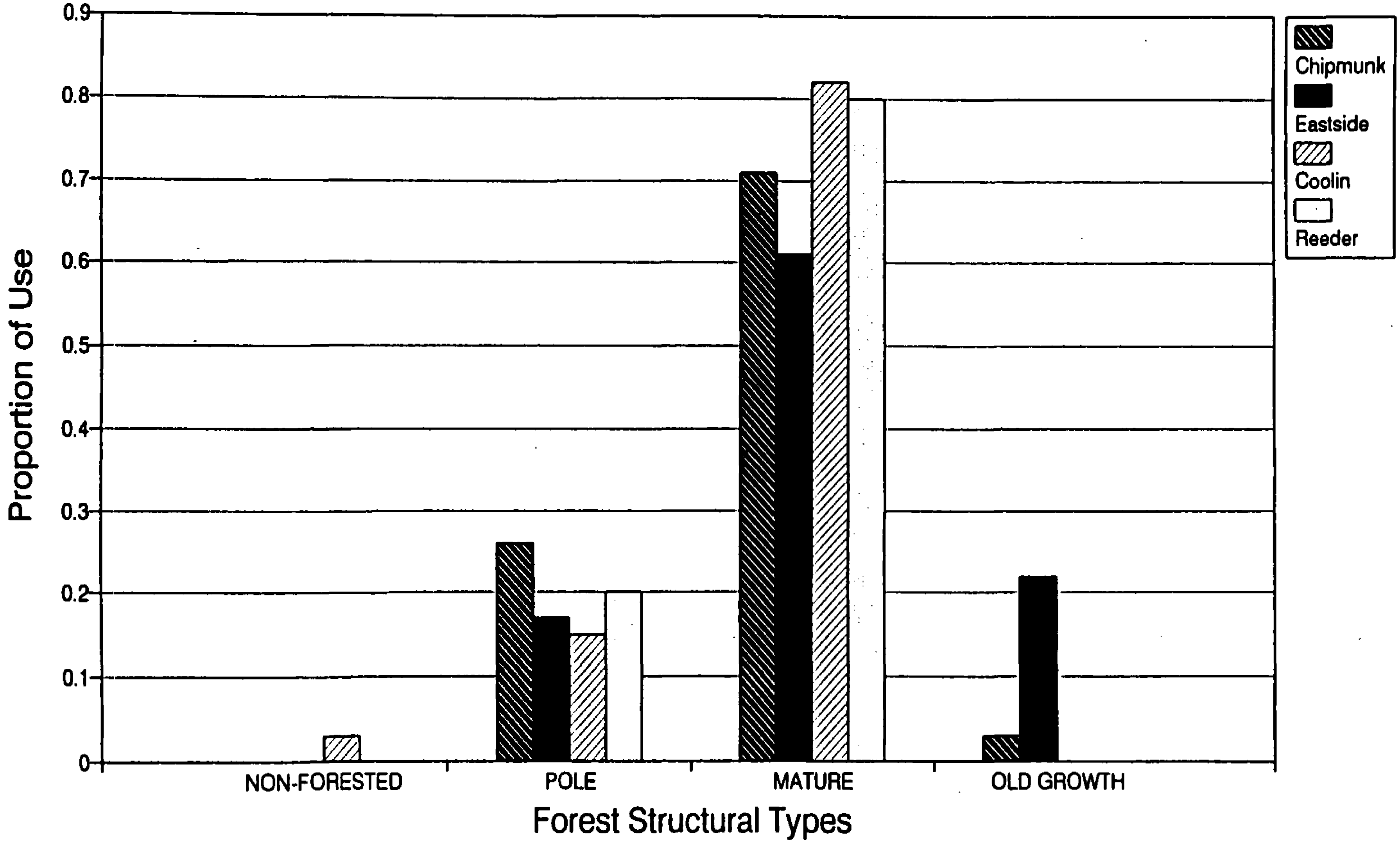


Figure 4. Use of forest structural types by white-tailed deer on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin).

Table 6. Percent composition of overstory tree species measured at winter locations of radio-collared white-tailed deer on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Coolin, Eastside). Species below 1.0% composition are not presented.

Tree Species	Winter Range				
	Chipmunk	Coolin	Eastside	Reeder	Composite
SAPLINGS	(n=239)	(n=318)	(n=387)	(n=243)	(n=1,188)
Abies grandis	30.0	49.0	38.0	32.0	38.0
Larix occidentalis	01.0	01.0	01.0	00.0	01.0
Pinus contorta	01.0	01.0	01.0	03.0	03.0
Pseudotsuga menziesii	41.0	06.0	33.0	06.0	22.0
Thuja plicata	06.0	11.0	04.0	43.0	14.0
Tsuga heterophylla	10.0	32.0	23.0	18.0	22.0
POLE	(n=287)	(n=300)	(n=355)	(n=240)	(n=1,182)
Abies grandis	20.0	45.0	26.0	21.0	28.0
Larix occidentalis	02.0	03.0	02.0	16.0	05.0
Pinus contorta	35.0	05.0	07.0	04.0	13.0
Pseudotsuga menziesii	36.0	19.0	46.0	11.0	30.0
Thuja plicata	00.0	08.0	09.0	34.0	11.0
Tsuga heterophylla	07.0	20.0	10.0	14.0	13.0
MATURE	(n=278)	(n=311)	(n=368)	(n=253)	(n=1,210)
Abies grandis	18.0	38.0	24.0	19.0	25.0
Larix occidentalis	02.0	05.0	03.0	20.0	07.0
Pinus contorta	38.0	02.0	06.0	02.0	12.0
Pseudotsuga menziesii	34.0	26.0	51.0	36.0	37.0
Thuga plicata	03.0	13.0	05.0	14.0	10.0
Tsuga heterophylla	05.0	16.0	07.0	09.0	09.0
OLD GROWTH	(n=20)		(n=108)		
Abies grandis	15.0	----	01.0	----	----
Larix occidentalis	30.0	----	03.0	----	----
Pseudotsuga menziesii	45.0	----	52.0	----	----
Thuga plicata	05.0	----	40.0	----	----
Tsuga heterophylla	05.0	----	04.0	----	----

Table 7. Winter use of forest habitat types by white-tailed deer in the Priest Lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Coolin, Eastside). Expressed as the proportion of radio locations for each winter range and for the composite of all ranges.

	Winter Range				
	Chipmunk (n=80)	Eastside (n=103)	Coolin (n=87)	Reeder (n=71)	Composite (n=341)
<u>Habitat Type</u>					
ABGR/CLUN	0.08	0.01	----	----	0.02
ABGR/ASCA	----	0.01	0.01	----	0.01
ABGR/LIBO	----	0.05	----	----	0.01
ABGR/PHMA	----	0.07	0.02	----	0.02
ABLA/CLUN	0.03	0.02	----	----	0.01
PSME/PHMA	0.11	0.18	0.01	0.07	0.09
PSME/SYAL	0.02	----	----	0.01	0.01
THPL/ASCA	----	----	0.02	0.10	0.02
THPL/CLUN	0.03	----	----	0.12	0.02
THPL/GYDR	----	----	----	0.06	0.01
TSHE/ASCA	0.34	0.37	0.81	0.27	0.37
TSHE/CLUN	0.39	0.29	0.13	0.37	0.19

this series in preference to others.

Winter range understory communities were depauperate and characterized by shade intolerant species. Of the 4 study sites, the CM range supported the richest understory community. The highest coverages of 14 of the 21 dominant understory species were recorded on this winter range (Table 8). Pachistima had the highest coverage of any understory species on the CM range, averaging 16.4%. Although pachistima dominated this site, coverages of this shrub on the other ranges averaged less than 1%. Ocean spray (Holodiscus discolor) and ninebark (Physocarpus malvaceus) were the dominant shrub species on the ES range, with coverages of 1.9% and 1.5%, respectively. These shrub species typically dominated the dry, south and west exposures of the ES and RD ranges. The mesic soil and predominately level terrain of the CL winter range was reflected by its depauperate shrub community. Wild rose (Rosa spp.) was the predominant shrub on this site, with a coverage of 1.2%. Across all winter ranges, the subshrubs Oregon grape (Berberis repens) and twinflower (Linnaea borealis) provided the most consistent understory coverages (Table 8). Coverages of Oregon grape ranged from 1.0% to 3.1%, while twinflower coverages ranged from 2.5% to 9.8%. Queencup beadlily (Clintonia uniflora) and prince's pine (Chimaphila umbellata) were the most dominant forb species. I found the highest coverages of these species on level,

Table 8. Canopy cover (%) of understory plant species measured at locations of white-tailed deer on 4 winter ranges in the Priest lake watershed of northern Idaho during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Coolin, Eastside). T = trace (mean canopy cover <0.1%).

Understory species	Winter Ranges									
	Chipmunk (n=80)		Eastside (n=103)		Coolin (n=87)		Reeder (n=71)		Composite (n=341)	
	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
SHRUBS										
Acer glabrum	0.9	0.4	0.4	0.1	---	---	0.4	0.2	0.4	0.1
Amelanchier alnifolia	2.7	0.3	0.3	0.1	0.3	0.1	1.0	0.3	1.0	0.1
Holodiscus discolor	0.6	0.3	1.9	0.4	T	0.04	1.7	0.6	1.1	0.2
Pachistima myrsinites	16.4	1.7	T	0.01	0.3	0.1	T	0.04	4.0	0.6
Physocarpus malvaceus	1.1	0.4	1.5	0.3	T	0.03	0.9	0.4	0.9	0.2
Rosa spp.	2.1	0.2	1.3	0.1	1.2	0.1	1.5	0.3	1.5	0.1
Spiraea betulifolia	0.3	0.1	0.6	0.1	0.5	0.1	T	0.02	0.4	0.01
Symphoricarpos albus	3.1	0.5	0.4	0.1	0.7	0.1	2.3	0.6	1.5	0.2
Vaccinium spp.	1.8	0.3	0.8	0.2	0.6	0.1	0.2	0.1	0.9	0.1
SUBSHRUBS										
Berberis repens	3.1	0.4	1.0	0.1	2.8	0.3	2.2	0.4	2.2	0.2
Linnaea borealis	9.8	0.9	2.6	0.4	6.4	0.5	2.5	0.6	5.2	0.3
FORBS										
Aralia nudicaulis	1.7	0.4	1.8	0.3	1.0	0.2	0.8	0.2	1.6	0.2
Asarum caudatum	T	0.03	T	0.02	---	---	0.2	0.1	T	0.2
Chimaphila umbellata	5.1	0.7	0.3	0.1	2.3	0.3	0.7	0.2	2.0	0.2
Clintonia uniflora	4.6	0.6	0.6	0.1	1.7	0.2	1.4	0.3	2.0	0.2
Cornus canadensis	3.2	0.6	T	0.01	0.5	0.1	0.3	0.1	1.0	0.2
Fragaria spp.	1.1	0.2	0.7	0.1	0.4	0.1	1.0	0.3	0.8	0.1
Galium triflorum	0.2	0.1	0.3	0.1	0.4	0.1	0.2	0.1	0.2	0.01
Osmorhiza chilensis	0.1	0.1	T	0.01	T	0.03	0.2	0.1	T	0.02
Smilacina racemosa	0.3	0.1	0.2	0.1	T	0.03	0.2	0.1	0.1	0.01
Smilacina stellata	2.7	0.3	0.5	0.1	0.2	0.1	1.1	0.2	1.0	0.1

mesic sites within the CM and CL ranges.

Winter Home Range Estimates: For 9 of the 10 data sets, values of the t^2/r^2 statistic were significantly smaller than the null value of 2 and indicated serial correlation of deer locations (Table 9). However, I believe the 3 day time lag between animal relocations was adequate to insure "biological independence" of animal locations. Low t^2/r^2 values are believed to be an artifact of the repetitive winter activity patterns of the study animals (Swihart and Slade 1985).

I calculated home range estimates for 10 of the 25 study animals monitored during the winter of 1991-92 (Table 9). Estimates were not calculated for the remaining animals due to inadequate sample sizes (n<20). Home range sizes were calculated for 2 of the deer wintering on the CM range, 5 wintering on the CL range, and 3 wintering on the ES range. All of these animals were adult females. The minimum convex polygon technique yielded the smallest home range estimates, with home range size averaging 53 ha (S.D. = 23.78). Bivariate ellipse estimates were greatest, averaging 114.5 ha (S.D. = 63.33), while weighted bivariate ellipse estimates averaged 79.3 ha (S.D. = 53.41).

Results of the Cramer-von Mises goodness-of-fit test indicated that utilization distributions of 6 of the 10 deer differed from bivariate normal and weighted bivariate normal

Table 9. Homerange estimates of radio-collared white-tailed deer monitored in the Priest Lake watershed of northern Idaho during the winter of 1991-1992.

DEER	N	T^2/R^2	BIVARIATE ELLIPSE	WEIGHTED BIVARIATE ELLIPSE	MINIMUM CONVEX POLYGON
1CM92	20	1.30 ± 0.32	210 ha *	160 ha *	86 ha *
3CM92	20	1.65 ± 0.35	220 ha *	180 ha *	92 ha *
1CL92	21	1.67 ± 0.31	87 ha *	49 ha *	45 ha *
2CL92	21	1.59 ± 0.32	129 ha *	63 ha	55 ha *
3CL92	22	1.72 ± 0.31	137 ha	92 ha	64 ha *
4CL92	23	2.34 ± 0.31	30 ha	22 ha	16 ha *
5CL92	21	1.76 ± 0.31	127 ha	89 ha *	59 ha *
4ES92	20	0.90 ± 0.39	47 ha *	23 ha	27 ha
5ES92	22	1.30 ± 0.33	78 ha *	48 ha *	41 ha *
8ES92	20	0.59 ± 0.38	80 ha	67 ha *	45 ha *

* Cramer-Von Mises statistic indicates data are inappropriate for homerange estimate technique (0.10 alpha level).

distributions (Tables 9, 10). Nine differed from a bivariate uniform distribution.

Migrational Movements and Winter Range Fidelity: Twenty-four of the 25 study animals were migratory. Spring dispersals from winter ranges began in late February and continued into early May (Table 11). Dispersals peaked in mid-March following a period of increasing temperatures and reduced snow depths (Fig. 5). Animals wintering on the CL range were the last to disperse, initiating spring migration after all CM and ES animals had migrated.

All spring migrations were in a north to northwest direction within the Priest Lake watershed (Figs. 6 & 7). All migrations were to higher elevations. The average distance between the distal summer and winter locations of CM deer was 13.6 km (S.D. = 5.8). These animals displayed the shortest migration distance and remained below 1,000 m in elevation throughout the time they were monitored. All CM deer remained on the eastside of the drainage throughout the study period (Fig. 6). ES whitetails traveled an average of 30.7 km (S.D. = 8.4) and migrated to the upper reaches of the Priest Lake watershed (Fig. 7). Five of the 8 ES whitetails summered near the northern end of Upper Priest Lake. Of the remaining 3 deer, 1 died 0.5 km east of the Upper Lake during late spring, and 2 crossed into British Columbia. Although the CL winter range was located

Table 10. Suitability of home range estimates used in analysis and Cramer-von Mises statistics used in testing bivariate distributions of deer relocations. Alpha levels were set at 0.10 for all tests.

DEER I.D.	BIVARIATE NORMALITY	CRITICAL VALUE	WIEGHTED BIVARIATE NORMALITY	CRITICAL VALUE	BIVARIATE UNIFORMITY	CRITICAL VALUE
1CM92	$W^2 = 0.199$	0.175 *	$W^2 = 0.324$	0.171 *	$W^2 = 0.251$	0.176 *
3CM92	$W^2 = 0.303$	0.176 *	$W^2 = 0.360$	0.171 *	$W^2 = 0.221$	0.176 *
1CL92	$W^2 = 0.292$	0.176 *	$W^2 = 0.242$	0.171 *	$W^2 = 0.309$	0.176 *
2CL92	$W^2 = 0.274$	0.176 *	$W^2 = 0.125$	0.171	$W^2 = 0.315$	0.176 *
3CL92	$W^2 = 0.130$	0.176	$W^2 = 0.160$	0.171	$W^2 = 0.322$	0.176 *
4CL92	$W^2 = 0.113$	0.176	$W^2 = 0.140$	0.171	$W^2 = 0.222$	0.176 *
5CL92	$W^2 = 0.175$	0.176	$W^2 = 0.225$	0.171 *	$W^2 = 0.238$	0.176 *
4ES92	$W^2 = 0.302$	0.176 *	$W^2 = 0.167$	0.171	$W^2 = 0.110$	0.176
5ES92	$W^2 = 0.235$	0.176 *	$W^2 = 0.174$	0.171 *	$W^2 = 0.713$	0.176 *
8ES92	$W^2 = 0.144$	0.176	$W^2 = 0.176$	0.171 *	$W^2 = 0.115$	0.176 *

* Relocations do not conform to assumed bivariate distribution of home range estimation technique.

Table 11. Timing and extent of migratory movements by white-tailed deer monitored on 4 winter ranges in the Priest Lake watershed of northern Idaho during the winter of 1991-92. Distance traveled is expressed as the linear distance between the most distal summer and winter locations of each animal.

Deer I.D.	[1]Date of Dispersal	Distance Traveled (km)	[2]Date of Return
<u>Chipmunk Range</u>			
1CM	03/10/92	27.04	12/16/92
* 2CM	03/10/92	6.76	--------
3CM	03/08/92	12.39	12/21/92
4CM	02/28/92	16.41	12/22/92
5CM	03/12/92	11.91	12/14/92
6CM	03/12/92	11.59	12/15/92
* 7CM	03/16/92	13.52	--------
8CM	04/01/92	8.21	12/15/92
9CM	02/28/92	14.16	12/21/92
<u>Eastside Range</u>			
* 1ES	03/10/92	23.01	--------
2ES	03/06/92	27.68	12/21/92
3ES	03/06/92	23.98	12/22/92
4ES	04/23/92	29.45	12/14/92
5ES	03/13/92	42.81	12/08/92
6ES	03/06/92	22.85	11/18/92
* 7ES	03/18/92	43.61	--------
8ES	04/23/92	31.86	12/16/92
<u>Coolin Range</u>			
1CL	05/04/92	19.63	10/19/92
2CL	04/30/92	38.95	12/16/92
+ 3CL	--------	3.23	--------
* 4CL	04/27/92	53.43	--------
5CL	05/04/92	57.61	12/14/92
6CL	04/28/92	49.24	11/30/92
7CL	04/23/92	59.06	12/14/92
<u>Reeder Range</u>			
* 9RD	05/04/92	9.07	--------

1 Animal first located 1 ≥ km outside the boundaries of its respective winter range.
2 Animal first located within the boundaries of its previous years winter range.
* Animal died prior to or during fall migration.
+ Resident animal with overlapping winter and summer home ranges.

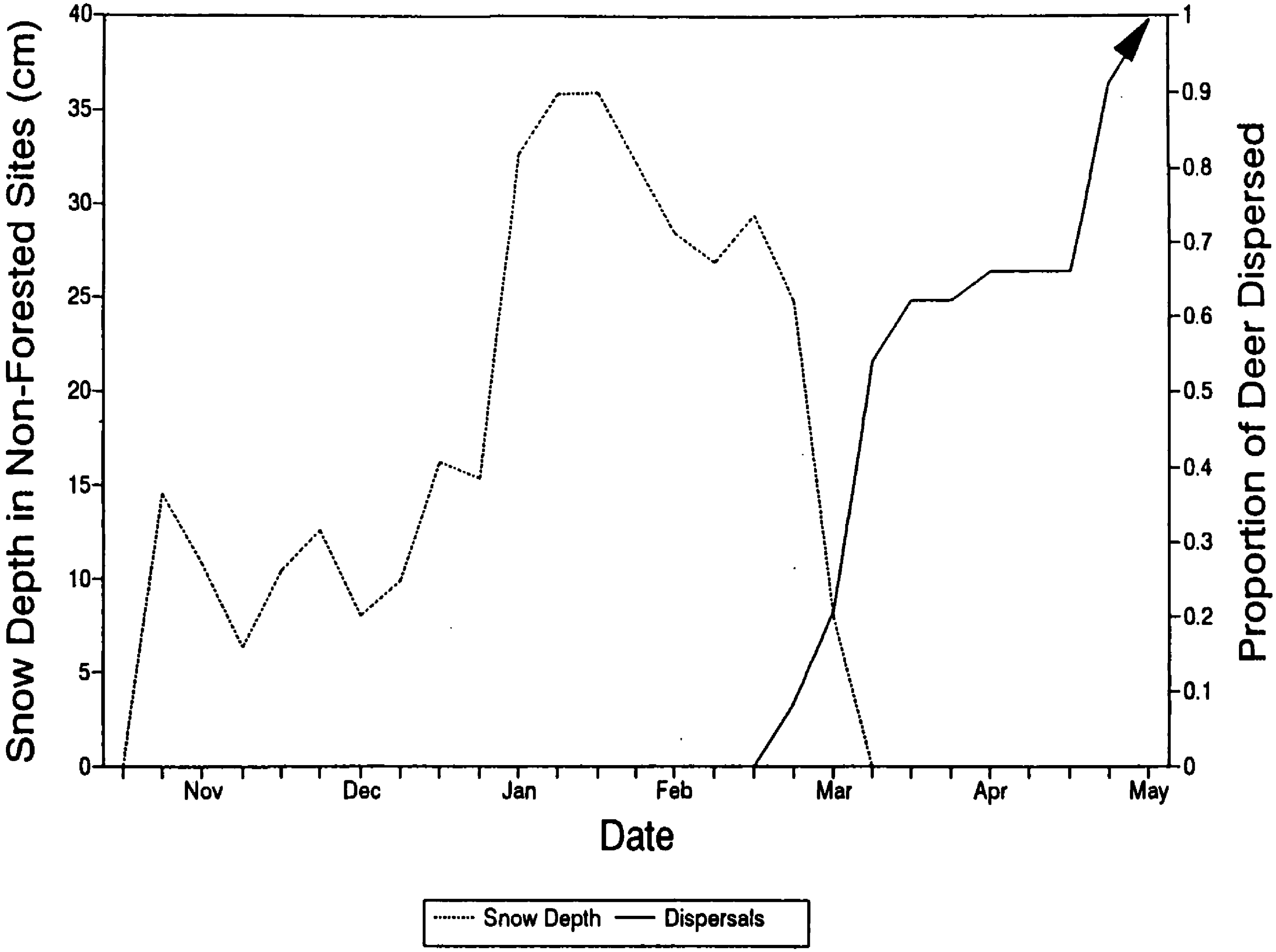


Figure 5. Relationship of snow depth and dispersal of white-tailed deer (n = 24) from winter ranges in the Priest Lake watershed during the spring of 1992. Snow depths measured in non-forested sites within the Chipmunk winter range.

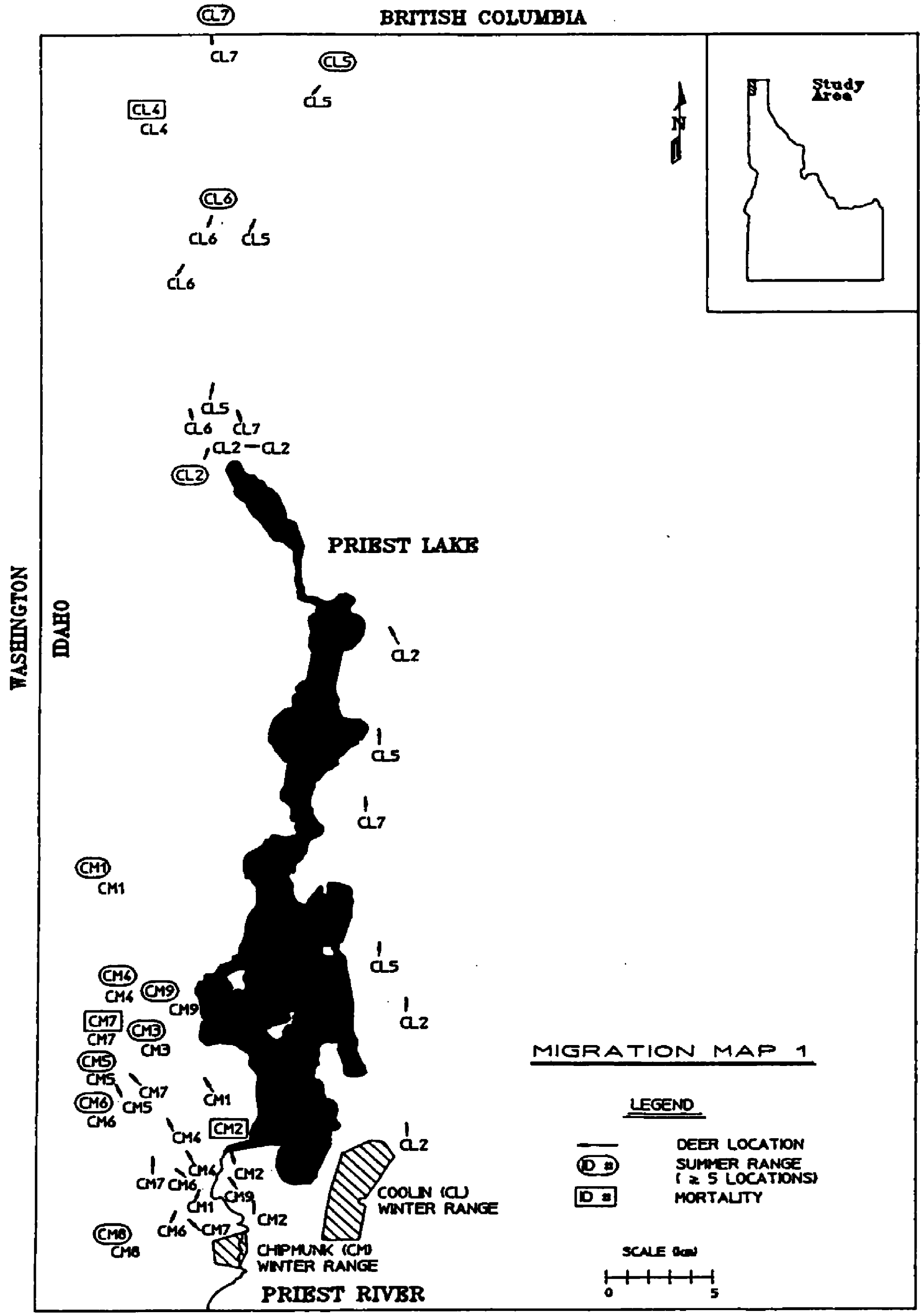


Figure 6. Spring and summer movements of white-tailed deer which dispersed from the Coolin (CL) and Chipmunk (CM) winter ranges during 1992. Arrows indicate the estimated direction of travel.

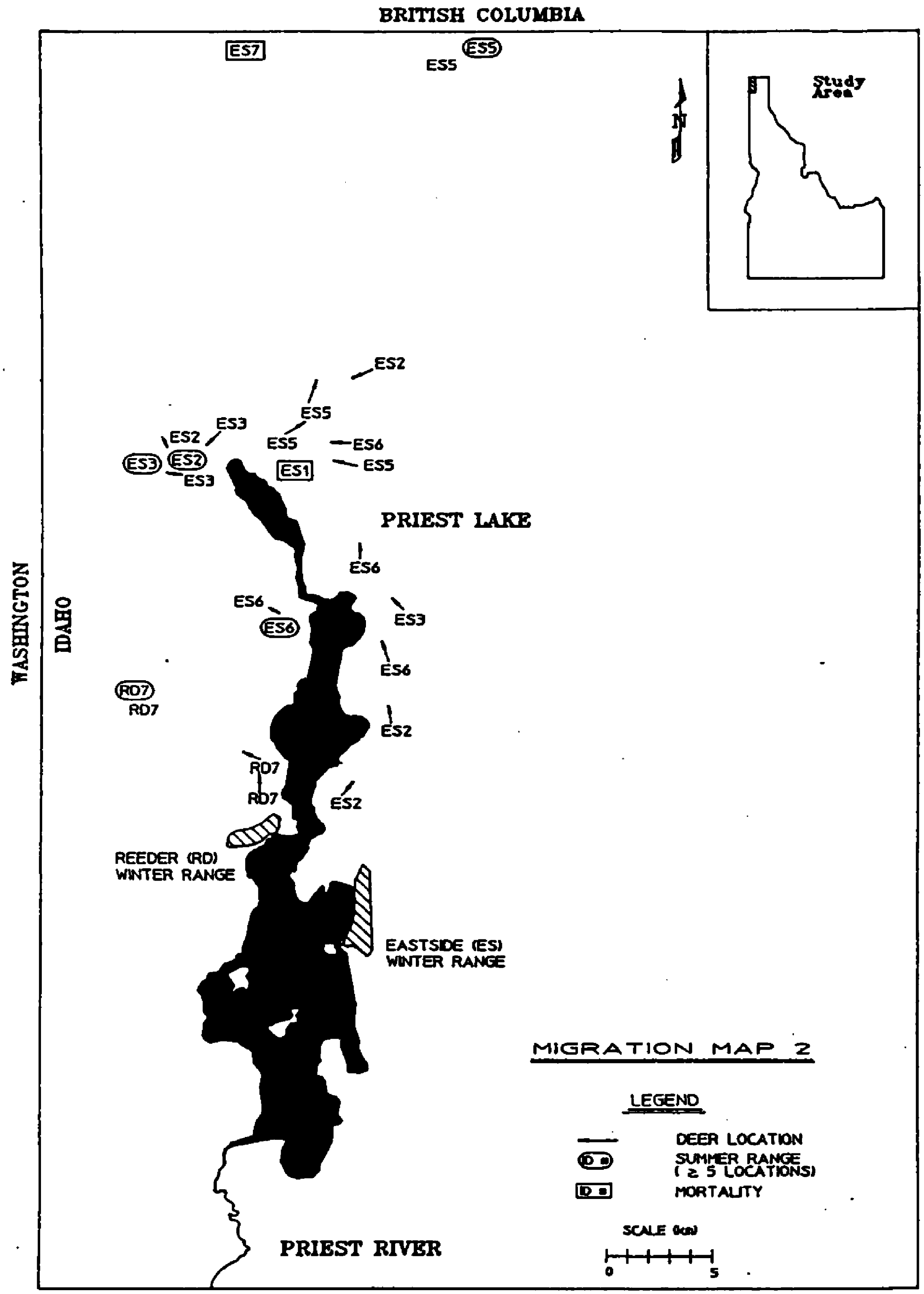


Figure 7. Spring and summer movements of white-tailed deer which dispersed from the Eastside (ES) and Reeder (RD) winter ranges during 1992. Arrows indicate the estimated direction of travel.

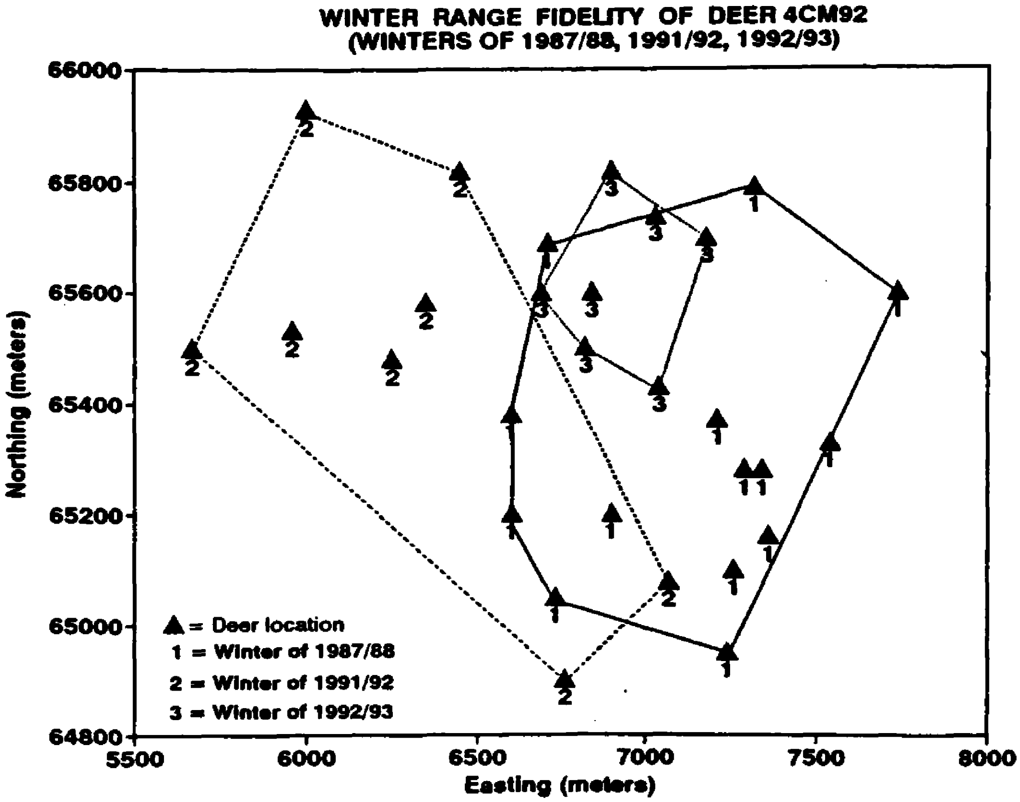
less than 4 km northeast of the CM range, whitetails wintering on the CL range dispersed significantly further than CM deer ($P<0.001$)(Fig. 6). CL animals dispersed an average of 40.2 km (S.D. = 21.2) and the longest dispersal distance was recorded from this winter range (59.1 km). Migratory movements of CL whitetails were similar to those of ES deer. All migratory CL deer moved north of Upper Priest Lake and 1 animal crossed into British Columbia. Of the 2 surviving RD whitetails, only 1 was relocated during spring migration. This animal was located 9.1 km northwest of the RD winter range during late May but could not be relocated throughout the remainder of the spring and summer months.

Six of the 24 migratory white-tailed deer died prior to or during fall migration (Table 11). During the winter of 1992-93, all 18 remaining study animals displayed fidelity to their previous year's winter range. Seventeen of these study animals showed strong fidelity, and wintered within the boundaries of the minimum convex polygon defining their 1991-92 winter home range. The first study animal arrived on its winter range on 19 October 1992, and by 22 December all study animals had returned to their winter ranges (Table 11).

Deer 4CM92 was one of the original study animals used in the habitat study conducted by Pauley (1990) during the winter of 1987-88. During the winter of 1991-92, this animal was recaptured on the Chipmunk winter range where it was first trapped and monitored in 1987. After being refitted with a new transmitter, this animal was monitored during the winter of 1991-92 (n=8 locations) and 1992-93 (n=7 locations). During the winters of 1987-88, 1991-92, and 1992-93, this deer displayed strong fidelity to the CM winter range (Fig. 8). Strong fidelity also was shown by deer 2RD91 which was monitored during the winters of 1990-91, 1991-92, and 1992-93 (Fig. 8). This deer was trapped as a yearling on the RD winter range on 18 January 1991, but dispersed across the frozen lake 3 days later and wintered on the ES range for the remainder of the study.

Although many of the study animals wintering on the CM range summered in the same watershed as Pauley's study animals (Pauley pers. comm), my data were insufficient to determine summer range fidelity.

Effects of snow accumulation on habitat use: Nineteen weekly snow measurements were taken in each of the 4 structural stand types during the winter of 1991-92. The first measurable snow accumulation was recorded on 5 November 1991 and continuous snow cover was present until 11 March 1992. Periodic thaws occurred throughout the winter period (Fig. 9). A well defined gradient in snow depth was found between stand types, with maximum depths recorded in non-forested sites (Fig. 10). The greatest disparity in



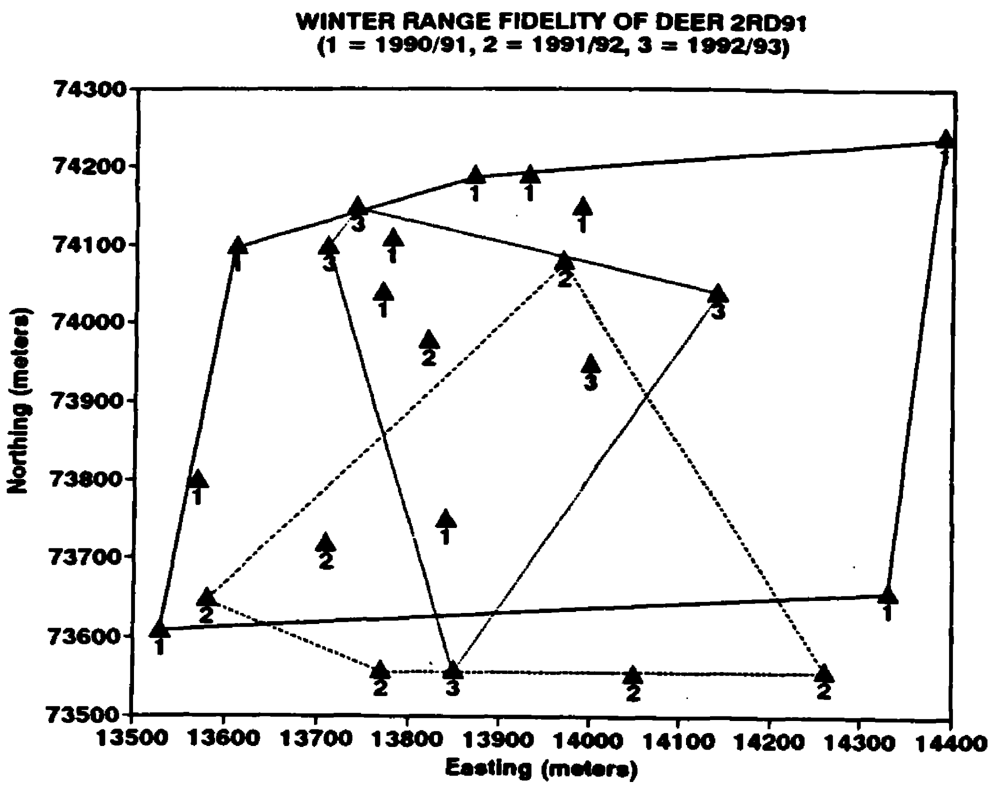


Figure 8. Winter range fidelity of 2 white-tailed deer monitored in the Priest Lake watershed of northern Idaho.

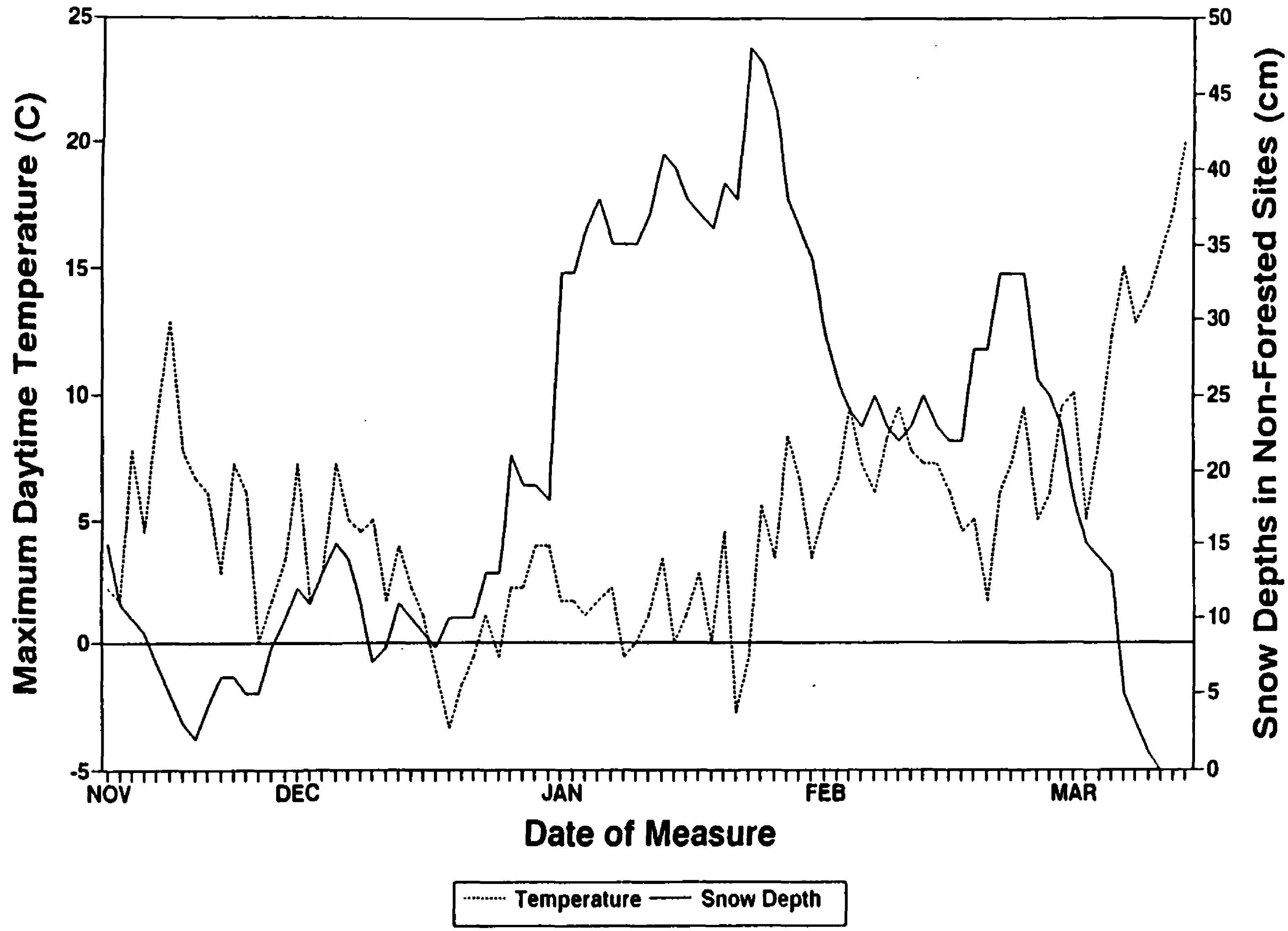


Figure 9. Snow depths (cm) and maximum daytime temperatures (^{0}C) measured at the Priest Lake Ranger Station during the period 5 November 1991 to 15 March 1992.

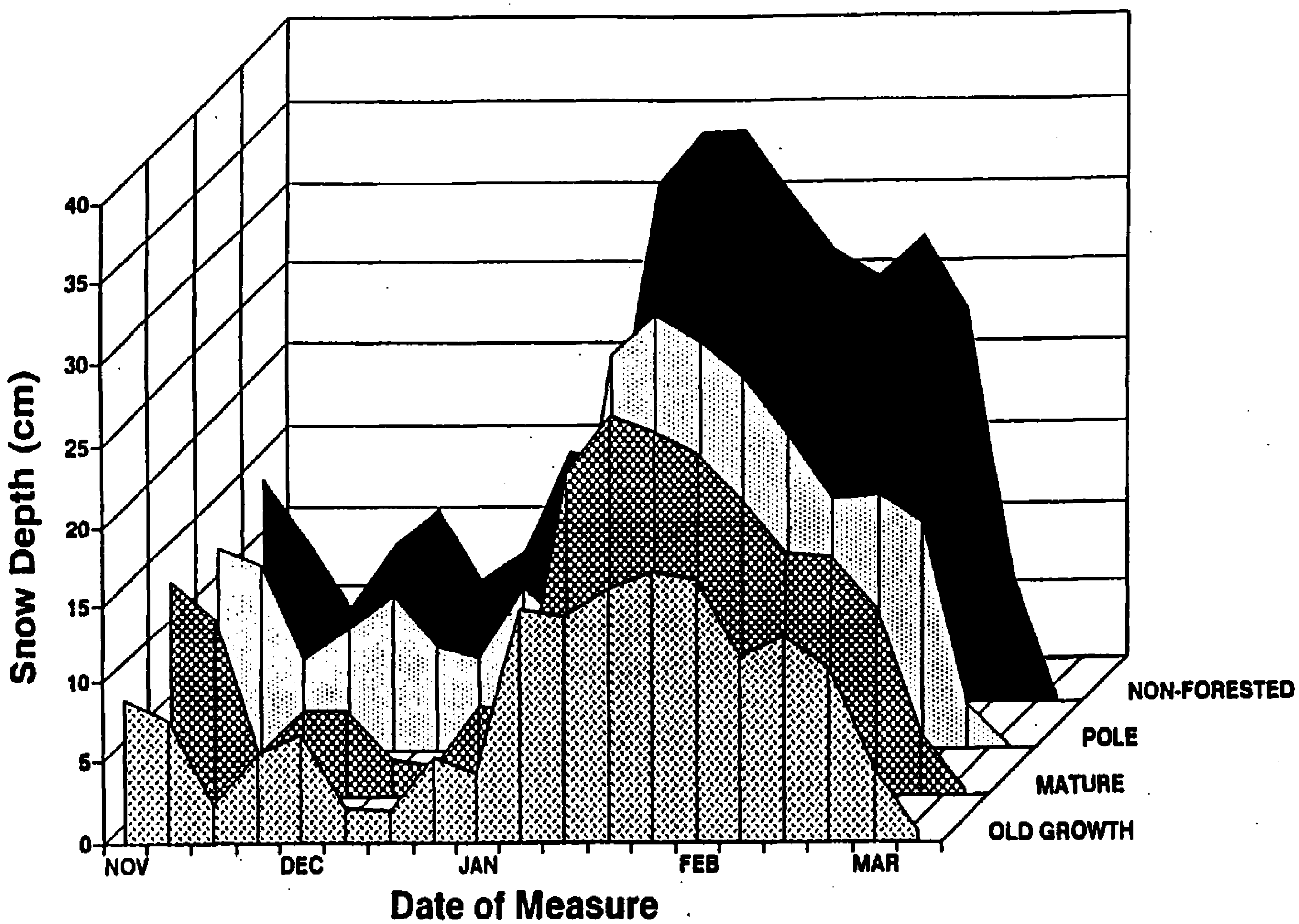


Figure 10. Weekly snow depths measured in old growth, mature, pole and clearcut stand types on the Chipmunk and Coolin winter ranges during the period 22 November 1991 to 23 March 1992.

snow depths was found between the non-forested and old growth sites. The maximum snow depth recorded in non-forested sites was 36.0 cm (S.D. = 11.3) and the maximum depth in old growth stands was 16.5 cm (S.D. = 5.5). However, the rate of snowmelt was inversely related to stand structure and old growth sites were snow-free within 3 days of non-forested sites (Fig. 10). Model predictions were found to significantly under-estimate white-tailed deer use of mature timber on the CM and CL winter ranges (χ^2 = 91.6, d.f. = 1, p < 0.001) (Figs. 11 & 12). Logistic regression models predicted the proportion of mature timber use by white-tailed deer to range from 0.35 to 0.47, based on the observed snow depths. Actual use of mature timber varied from 0.71 to 0.89 (Table 12). Models appeared to over-estimate the proportion of deer use in pole and old growth timber (Table 12, Fig. 12). However, old growth forest was not available on the Cl winter range and prevented a valid test of this model. The number of observations in pole timber (n=34) was not considered adequate to provide reliable results (Loftsgarden and Andrews 1992).

DISCUSSION

Sampling: Winter ranges examined were considered to be representative of winter range habitats within the Priest

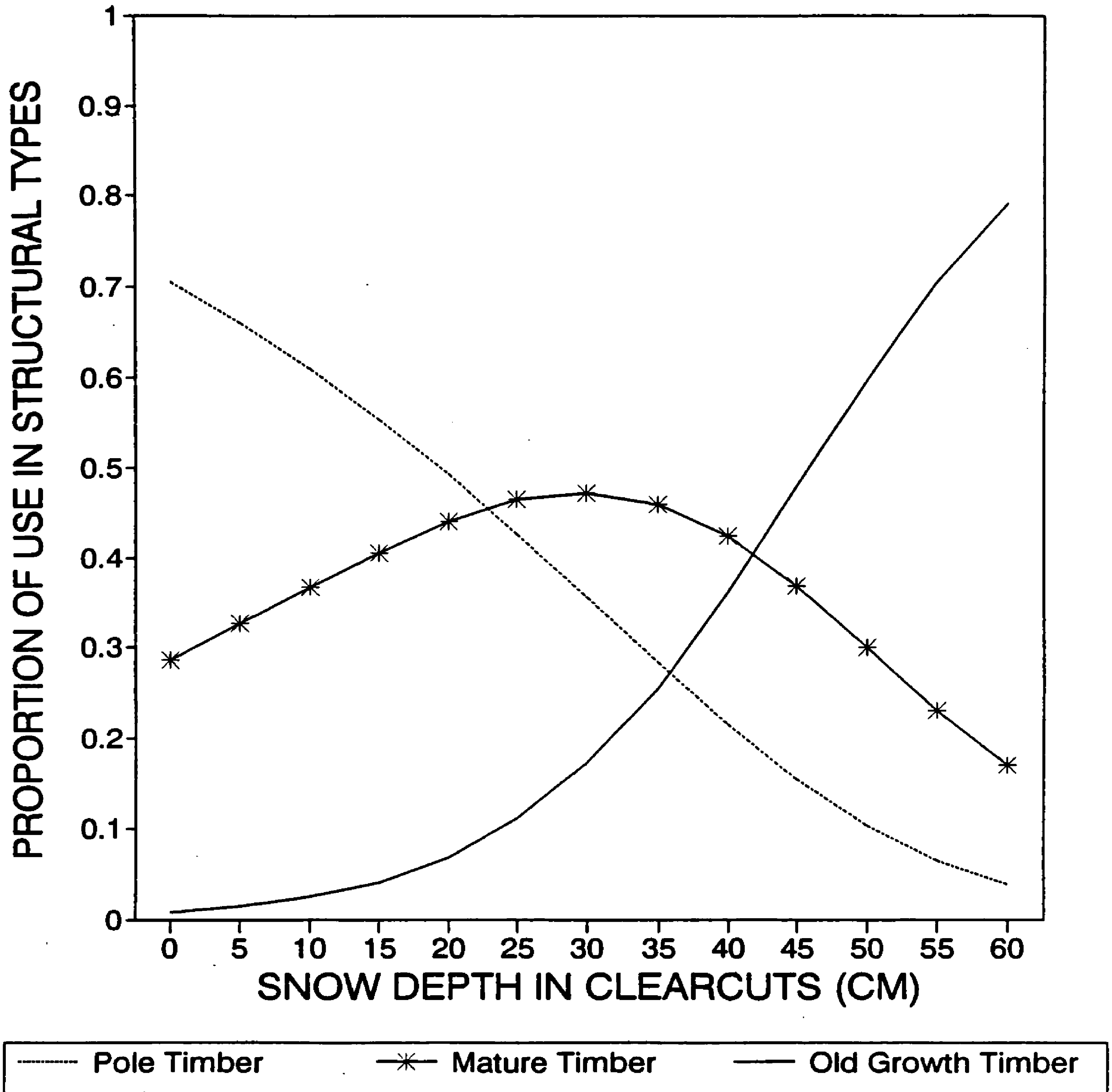
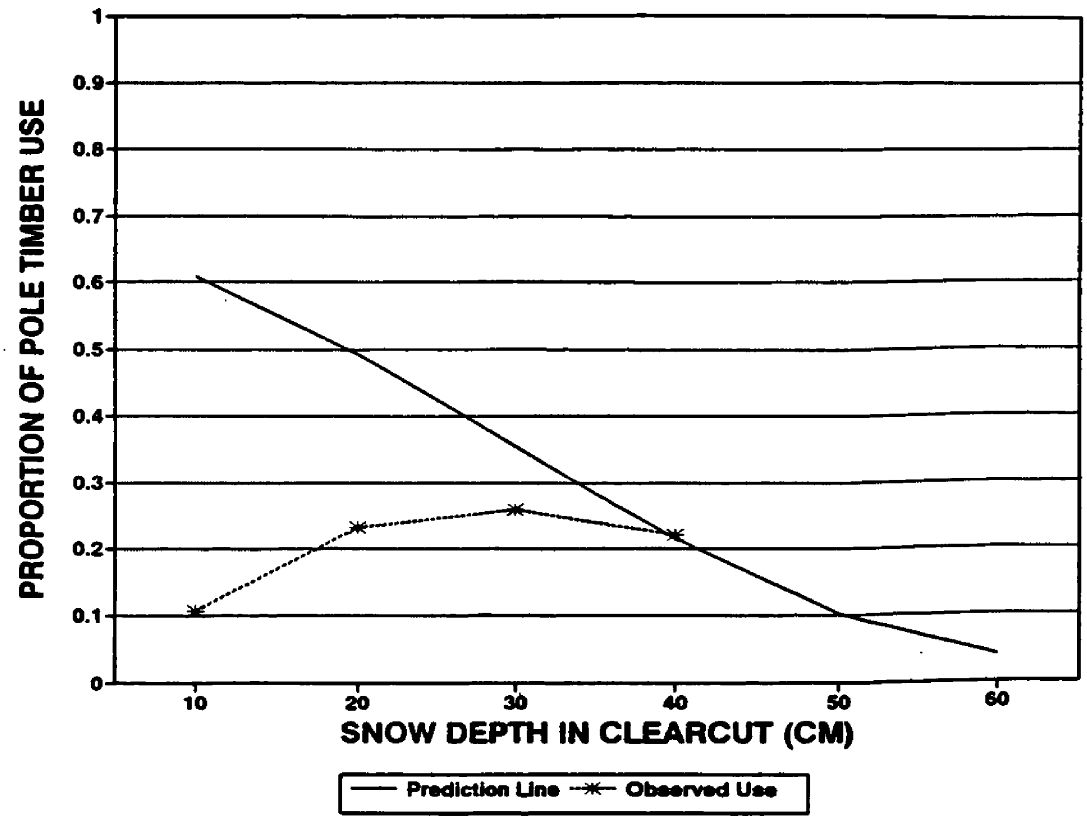


Figure 11. predicted use of pole, mature, and old growth timber by white-tailed deer during periods of increasing snow accumulations (Pauley 1990).



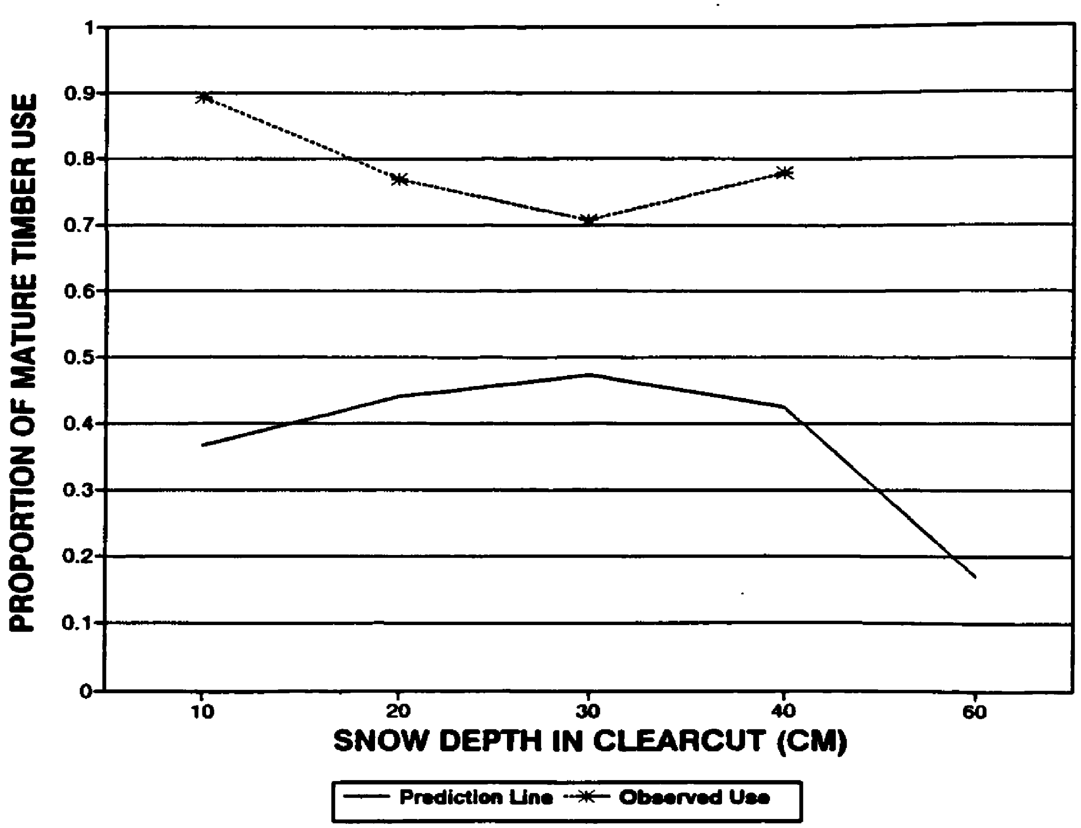


Figure 12. Observed and predicted use of pole and mature timber by white-tailed deer in the Priest Lake watershed of northern Idaho during the winter of 1991-92. Predictions based on the models developed by Pauley (1990).

Table 12. Proportion of observed and predicted use of forest structural types by white-tailed deer on the CM and CL winter ranges during periods of increasing snow accumulation (winter of 1991-1992). Predicted values were determined with logistic regression models developed by Pauley (1990).

SNOW DEPTH			POLE			MATURE			OLD GROWTH *		
Range	Midpoint	N	Obs.	N	Predicted	Obs.	N	Predicted	Obs.	N	Predicted
0-15	7.5	37	0.11	4	0.64	0.89	33	0.35	0.00	0	0.02
16-25	20.5	39	0.23	9	0.49	0.77	30	0.44	0.00	0	0.07
26-35	30.5	58	0.26	15	0.35	0.71	41	0.47	0.03	2	0.18
36-45	40.5	27	0.22	6	0.21	0.78	21	0.43	0.00	0	0.37

* Not available on CL winter range.

Lake watershed. The winter range boundaries delineated in Fig. 1 were defined by the movements of the radio-marked animals in each area. Trap placement and the sample of animals selected ultimately determined these boundaries. Winter ranges were defined as discrete areas and study animals from different wintering areas were not found to interact during the winter period. However, the study sites essentially represent points along the gradient of winter range habitats present within the Priest Lake drainage. Winter range habitat within the watershed does not occur in such discrete units and I believe the CM, CL, ES, and RD ranges are fragments of what was once a contiguous section of winter range habitat. Habitat losses and modifications resulting from human encroachment have created the present mosaic.

The study sites I sampled represented the spectrum of topography on winter ranges at Priest Lake. The CL range was typical of level, low elevation terrain, while the ES range was predominately mountainous terrain with slopes in excess of 15% commonly encountered. Both the CM and RD sites were characterized by low elevation mountainous terrain interspersed with level sites. I selected the CM range to allow for direct comparison with the findings of Pauley (1990). My trap placements on this range emulated those of Pauley, and one of his original study animals was recaptured and incorporated into the CM study sample.

Although the study sample was dominated by adult females, I believe my results accurately reflected winter habitat use by both sexes of white-tailed deer in the Priest Lake drainage. Pauley (1990) found that male white-tailed deer in the Priest River drainage occupied larger home ranges than female deer, but found no difference in winter habitat use between the sexes. Likewise, no differences in habitat use were found between the 4 male and 6 female white-tailed deer monitored on the RD range during the winter of 1990-91. Some researchers have reported disparities in winter habitat selection between the sexes of white-tailed deer however. In New Hampshire, Laramie and White (1964) found adult bucks were most commonly found at the periphery of wintering areas, and on the George Reserve in Michigan, McCullough (1979) observed spatial segregation of the sexes throughout the winter months. In west-central Montana, Brockmann (1988) also found disparities in winter habitat selection between the sexes of white-tailed deer. Males preferred sites adjacent to those areas where most females concentrated. Females used lower elevations and steeper terrain than did males. No difference in the overstory canopy pattern or canopy coverage of areas used by the sexes of white-tailed deer was found by Brockmann (1988) however. Both sexes avoided nonforested sites and preferred "unlogged" second growth stands of forest (cuts > 50 years old) (Brockmann 1988). Differential habitat use between the sexes was negligible in my study.

Winter Severity: In the Northern Rocky Mountains, winter habitat selection by white-tailed deer is strongly influenced by winter weather patterns, and during severe winters there appears to be a critical need for closed canopy, mature forests that can provide adequate shelter (Peek 1984). This supposition is strongly supported by the findings of Pauley (1990) and numerous other studies in the Northern Rockies. In association with shifts in winter severity, Pauley observed well defined shifts in habitat use during the early, mid, and late winter periods. Whitetails typically used early and intermediate stages of forest succession on the valley floor when weather conditions were moderate during early and late winter. However, with increasing winter severity during mid-winter, deer moved into old growth and mature forested stands in the river bottom where overstory canopy coverages averaged 87%. A similar pattern of habitat use associated with severe winter conditions was recorded in northwestern Montana. Along the North Fork of the Flathead River, Jenkins (1985) documented significant changes in winter habitat use by white-tailed deer in association with changes in winter conditions over a 2-year period. During 1982, the first year of his study, severe winter conditions were encountered and the total snowfall recorded was approximately 150% of the previous 10 year mean. The second year of the study, 1983, was exceptionally mild with total snowfall estimated at only 67% of the previous 10 year mean. Throughout the severe winter, heavy use of dense coniferous forest occurred, but during the mild winter of 1983, a greater diversity of habitats was used by white-tailed deer and an increase in the use of more open-canopied stands with moderate understories was documented.

White-tailed deer are not generally considered to exhibit traditional yarding behavior in the Northern Rocky Mountains. However, during the atypically severe winter of 1978-79, Owens (1981) reported classical yarding behavior in white-tailed deer on the Palouse Range in north-central Idaho. Study animals restricted their movements to advanced seral stages of the cedar/hemlock zone throughout the winter. Densely forested stands with closed canopies and minimal forage availability were used almost exclusively.

No significant shifts in winter habitat selection by white-tailed deer occurred during my study and similar habitat selection patterns were observed throughout all winter periods. I believe these homologous patterns of habitat use are a direct reflection of the weather conditions encountered throughout the winter monitoring period. Between 1931 and 1980, average snow accumulation in the upper Priest River drainage averaged 75 cm and the duration of continuous snow cover extended from December 5 to March 30 (Finklin 1983). Although Pauley (1990) experienced relatively mild winter conditions during the winter of 1987-88, well defined shifts in early, mid, and late winter severity were recorded. During the winter of 1991-92, when the majority of deer were monitored during my study, exceptionally mild conditions were encountered and no shifts in winter severity occurred. Total snow accumulation in non-forested sites on the CM range was only 35.95 cm and by 11 March 1992, all winter ranges were snow free. Pauley (1990) reported a maximum snow accumulation of 57 cm in non-forested sites within the CM range during his study. The consistently mild conditions and abnormally low snow accumulations I encountered strongly influenced winter habitat selection patterns of Priest Lake white-tailed deer. During all winter periods, whitetails consistently selected mature stands of coniferous forest on the valley floor and adjacent slopes.

Although not statistically significant, a small degree of differential habitat use was observed. During the infrequent periods of clear, sunny weather, study animals often moved to sparsely canopied, south and west facing slopes. Conversely on the CM and ES ranges, the infrequent periods of severe winter weather were marked by deer movements to old growth forest adjacent to Priest Lake and Priest River.

Snow depth appeared to be the primary factor influencing winter habitat selection by Priest Lake white-tailed deer as revealed by my comparisons with the findings of Pauley (1990) (Fig. 13). The mid-winter period delineated by Pauley (1990) was characterized not only by strong selection of old growth forest by wintering whitetails, but also by snow depths consistently in excess of 40 cm in non-forested sites. In my study, snow depths typically remained below 30 cm in non-forested sites and strong selection of old growth forest by CM whitetails was not observed (Fig. 14). In addition, snow levels gradually accumulated during the winter of 1987-88 until a maximum accumulation of 57 cm was reached. During the winter of 1991-92 however, snow cover rapidly reached depths of 15 cm by early November and remained between 10 - 30 cm throughout the majority of the winter.

The logistic regression models developed by Pauley (1990) clearly illustrate the relationship of snow depth to white-tailed deer habitat selection at Priest Lake. Although model predictions under-estimated deer use of mature forest (Fig. 12), overall patterns of winter habitat use support the basic premise of the models. Model predictions indicate peak use of mature timber by white-tailed deer occurs at snow depths of 25 - 35 cm. Snow depths typically ranged from 10 - 30 cm throughout the winter of 1990-91 (Fig. 13) and on all winter ranges deer displayed strong selection of mature forest. Pauley

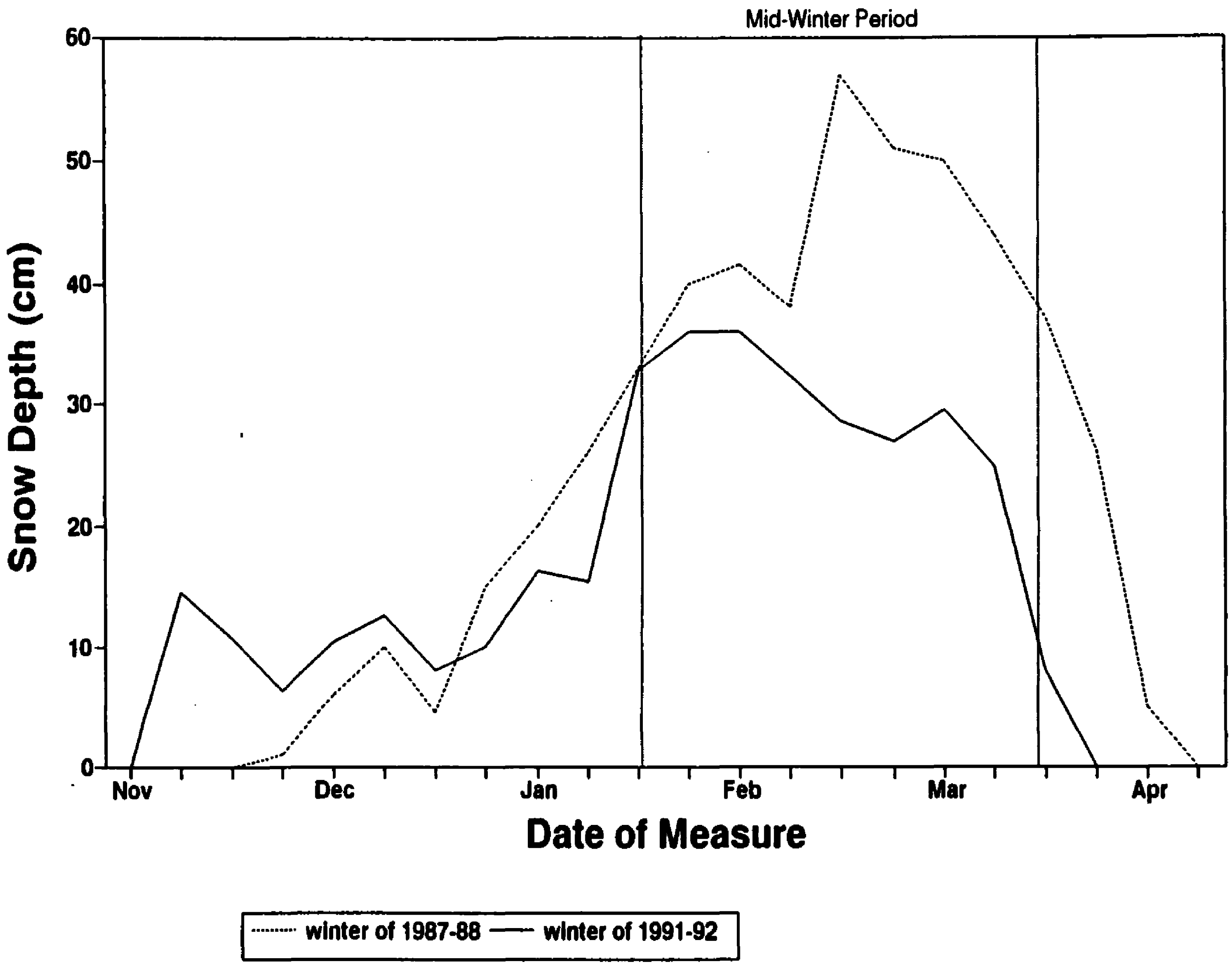
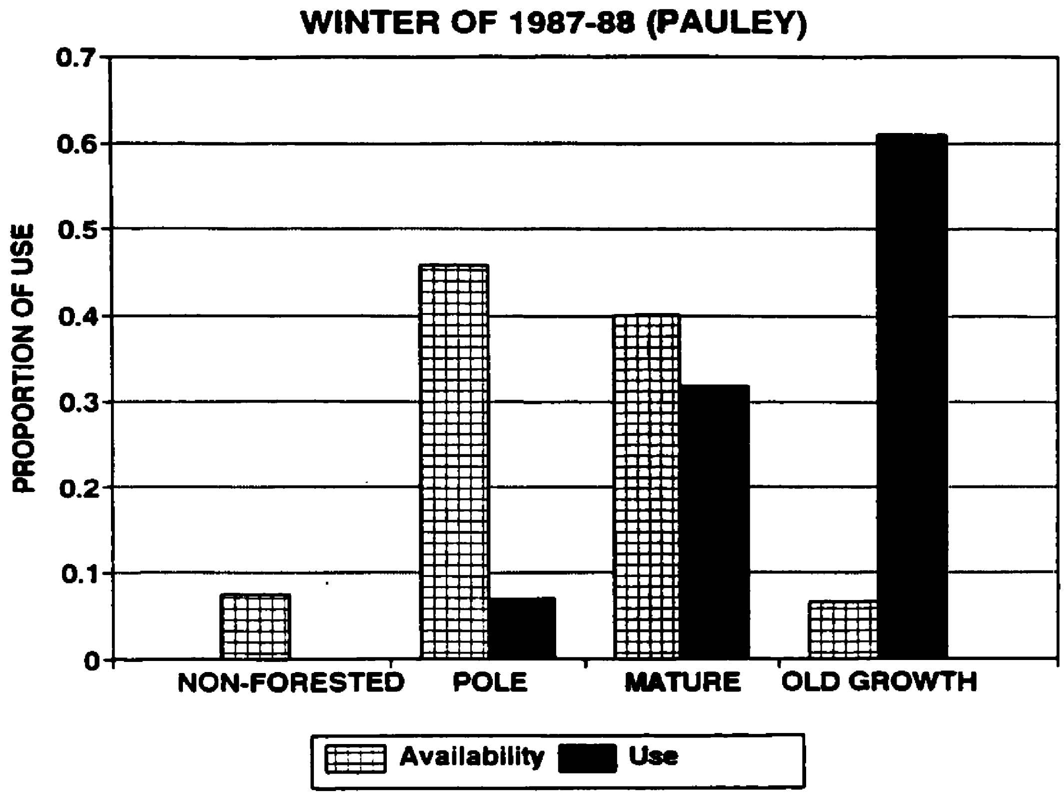


Figure 13. Comparison of snow depths measured in non-forested sites on the Chipmunk winter range during the winters of 1987-88 (Pauley 1990) and 1991-92. The mid-winter period (9 January - 2 March) is presented as defined by Pauley (1990).



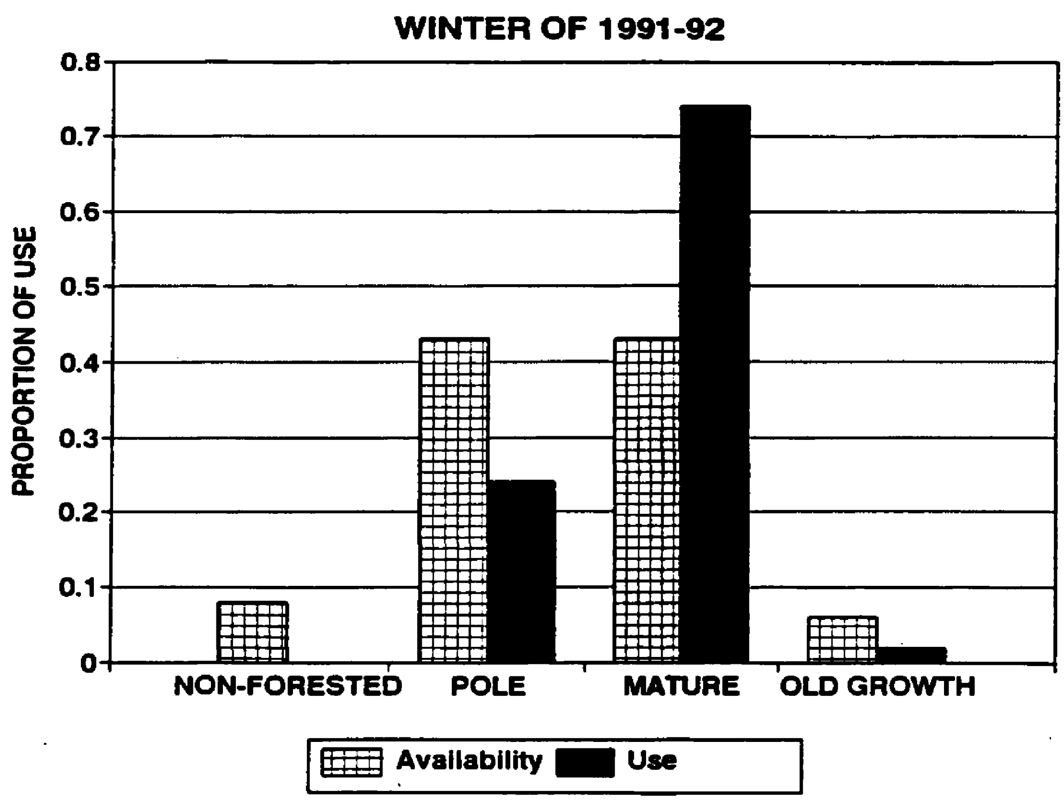


Figure 14. Comparison of white-tailed deer use of forest structural types on the Chipmunk (CM) winter range during the mid-winter period (9 January - 2 March) of 1987-88 (Pauley) and 1991-92.

predicted old growth would rapidly increase once snow depths exceed 30 cm and almost exclusive use of this stand type was predicted to occur at depths of 50 - 60 cm. Snow depths rarely exceeded 30 cm on the CM winter range during the winter of 1991-92, where the snow transects were located, and the maximum snow depth recorded for this site was only 36 cm. Correspondingly, only a small degree of old growth use by wintering whitetails was documented on the CM range (Fig. 14).

Numerous studies have reported critical snow depths and their influence on white-tailed deer habitat selection. In Montana, Jenkins (1985) found whitetails selected forest cover primarily for its reduced snow depths. The majority of deer in his study selected sites with snow accumulations below 40 cm and 50 - 60 cm of snow was reported as the maximum depth tolerated. In southwestern British Columbia, Smith (1977) observed that deer occupied shrub zones of open-canopied or unforested habitats when snow depths in the open remained below 30 - 40 cm. However, during winters when snow depths exceeded this level, deer moved into dense, heavily canopied forests. Many studies have reported snow depths in excess of 39 cm as being critically restrictive to deer movement (Norberg 1957, Hepburn 1959, Day 1963, Kelsall and Prescott 1971). In the absence of a supporting crust, deer may be forced to plow or bound through deep snow and the energy output required to forage can exceed the energy supplied by the food ingested (Kelsall 1969). Deep snow cover can also severely reduce forage availability.

Strong crusts which are capable of supporting the weight of a white-tailed deer can be a distinct asset by negating some of the restrictions imposed by heavy snow accumulations (Verme and Ozoga 1971). Jenkins (1985) observed that hard crusts allowed deer to disperse into open habitats such as clearcuts and river areas and made additional food resources available to them. However, Verme (1965) observed that although hard crusts allowed easier access to some areas, weak crusts broke repeatedly and caused injury and excessive tiring. Crusting conditions can also increase a deer's vulnerability to predation. Twice during the 1990-91 winter, backtracking revealed that mountain lions (Felix concolor) had traveled across the top of the snow and had killed study animals which were cratering through the crusted surface. Deer are able to exploit not only decreased snow depths, but also more stable snow conditions by moving into heavy coniferous cover (Verme 1965, Ozoga 1968, Bloom 1978, Nelson and Mech 1981).

The influence of cold temperatures and high winds on winter habitat selection by white-tailed deer is highly variable. Numerous researchers have reported an increase in the use of coniferous shelter during periods of extreme air or wind chill (Behrend 1966, Ozoga and Gysel 1972, Rongstad and Tester 1969, Moen 1976), and Verme and Ozoga (1971) observed that, despite the presence of snow cover in late December, deer in Michigan's Upper Peninsula did not concentrate in yarding areas until the arrival of very cold, windy weather in early January. Other researchers have documented deer use of open environments during extreme cold weather, however (Kramer 1971, Kucera 1976) and weight losses in captive deer have been shown to be independent of cover characteristics (Robinson 1960). The thermal characteristics of different forest structural types were not measured during my study. However, throughout the winter of 1991-92 air and wind chills appeared moderate, and I believe these were less definitive than snow cover in determining winter activity patterns of white-tailed deer.

Habitat Use: All winter ranges were located at low elevations on relatively level terrain adjacent to Priest Lake and Priest River. Many other studies in the Northern Rocky Mountains have documented similar use of low elevation winter ranges along lakes, valley bottoms, and riverine habitats (Pengelly 1961, 1963; Hildebrand 1971, Berner 1985, Mundinger 1980, Slott 1980, Woods 1984, Hicks 1990). In southeastern Montana, riverine habitats typically support greater densities of whitetails than adjacent prairies (Dusek et al. 1989) and Swenson et al. (1983) estimated that nearly half of all white-tailed deer there winter in riparian habitat along streams. In addition, damming of the

Clearwater and Kootenai rivers in Montana and Idaho was found to result in the loss of over 8,700 ha of winter range, and thousands of white-tailed deer were subsequently displaced (Peek 1984).

Whitetails displayed a strong preference for level or gently sloping terrain throughout my study area. Level terrain provides an advantage to wintering animals by lowering the level of energy expenditure required for movement (Moen 1976, Parker et al. 1984) and selection of level terrain by wintering whitetails has been well documented (Pengelly 1961, Telfer 1970, Boer 1978, Seeley 1985). In the Priest River valley, Pauley (1990) found whitetails selected gentle slopes (0 - 25%), avoided steep slopes (51% +) and used intermediate slopes (26 - 50%) in proportion to their availability.

All aspects were used in proportion to their availability on the CM and CL ranges. On the ES and RD ranges however, south and west aspects were avoided and north and east aspects were selected. Pauley (1990) found south and west aspects were selected during all winter periods on the CM range but accounted for only 15% of winter use. My findings indicate that south and west aspects were used in proportion to their availability on the CM and CL ranges, and were avoided on the ES and RD ranges. I frequently observed whitetails using these aspects during warm, sunny conditions, however. During these infrequent periods, whitetails used sparsely forested south and west slopes dominated by large, scattered conifers. Snow depths on these slopes were noticeably reduced following a period of warm temperatures and sunshine, and deer were often observed bedding and feeding on these exposed sites. Similar use of southerly aspects characterized by patchy canopies has been reported by other researchers (Drolet 1976, Janke 1977, Singer 1979, Slott 1980, Woods 1984). It is generally speculated that this arrangement offers both shelter and adjacent openings with abundant forage. The selection of north and east aspects on the ES and RD ranges is believed to reflect the use of these areas as bedding sites. On both the ES and RD ranges, high concentrations of deer beds were commonly encountered on gradually sloping benches on north and east aspects. These mesic sites were typically dominated by western red cedar and western hemlock and appeared to be common loitering areas.

The structure and composition of coniferous stands used by white-tailed deer during this study were intermediate to the parameters reported by Pauley (1990), and once again reflect the weather patterns encountered. Pauley (1990) observed almost exclusive use of pole and mature stands of Douglas-fir and lodgepole pine during early and late winter. These xeric sites were on the valley floor above the river and on adjacent, south slopes. With increased winter severity in mid-winter, deer moved to mesic sites in the river bottom dominated by mature and old growth stands of western red cedar and western hemlock. Mature stands dominated by Douglas-fir and grand fir were consistently selected by wintering whitetails throughout the winter of 1991-92. At Priest Lake, 56% of all deer locations were classified within the western hemlock habitat series. The habitat series of a site is not always indicative of the overstory cover type, however. Although western hemlock regeneration was prevalent throughout the study area, Douglas-fir was the prevalent overstory species on all winter ranges studied.

Whitetails selected winter habitats with depauperate understories throughout the Priest Lake drainage. These sparse understories were reflective of the mature forested stands used throughout the winter. White-tailed deer selection of winter ranges with dense coniferous cover and little available forage has been widely documented (Verme 1965, Ozoga 1968, Krefting and Phillips 1970, Ozoga and Gysel 1972, Owens 1981, Woods 1984, Jenkins 1985, Pauley 1990).

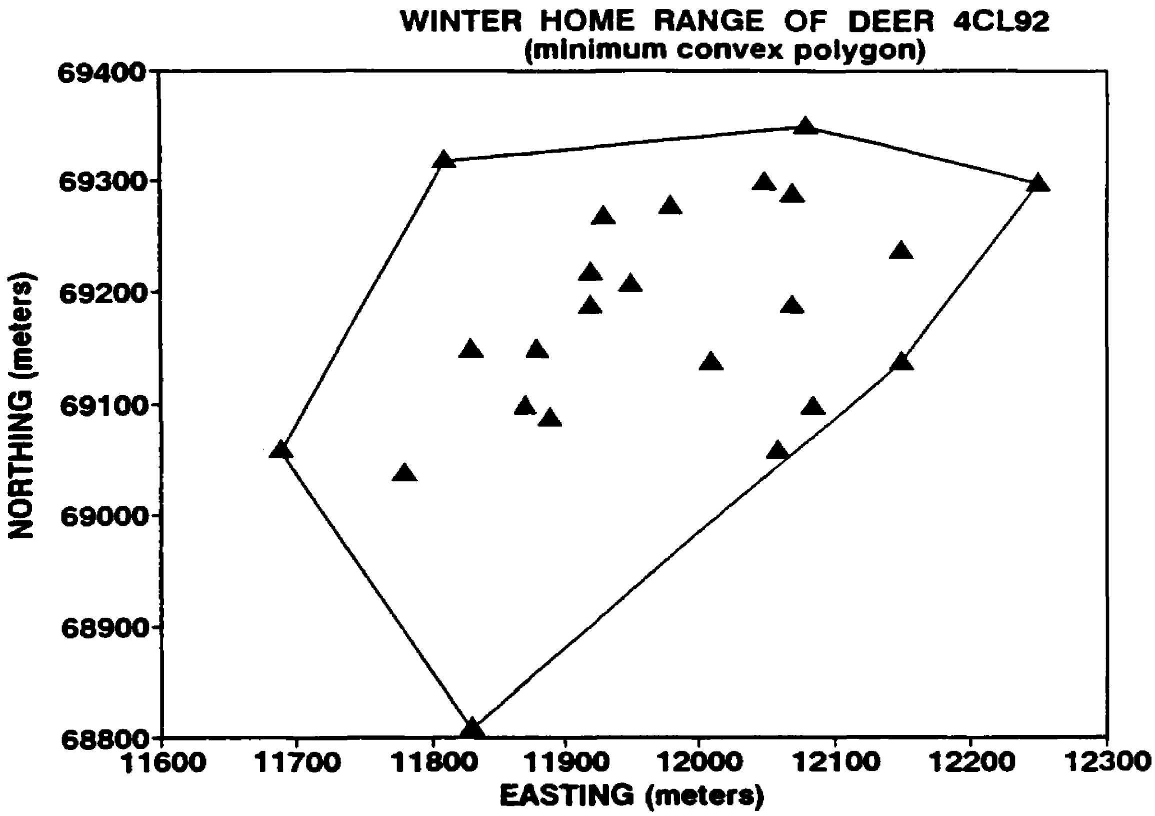
During mid-winter, Pauley (1990) recorded shrub coverages averaging only 6% and found that forage was largely unavailable to deer in all habitats due to burial by snow. Deer selected habitats with relatively abundant forage when snow depths were less constraining during early and late winter. During the winter of 1991-92, deer forage in young and intermediate forest seral stages was largely unavailable due to the snow accumulations. Shrub cover was abundant on south and west aspects throughout the drainage, but steep slopes and high snow accumulations deterred deer from using these sites.

Although clearcuts were adjacent to the CM and CL ranges, these sites were avoided throughout the winter. Shrub response was typically poor in these cuts, and little forage was available above the snow. Snow depths in the mature forest selected by wintering deer remained below 20 cm throughout the winter, and the sparse shrub cover of these sites was available throughout the winter. Microhistological analysis of fecal material has shown that conifers and evergreen shrubs are most common in the winter diet of white-tailed deer in the Priest Lake Drainage (Pauley 1990). Douglas-fir and western red cedar seedlings and saplings, and the evergreen shrubs pachistima and Oregon grape are an important food resource during the winter. Oregon grape, Douglas-fir, and western red cedar regeneration were common on all winter ranges. However, measurable coverages of pachistima ($\geq$ 0.5%) occurred only on the CM range where it dominated the understory with coverages averaging 16.4%. Fecal analysis has indicated that arboreal lichens constitute only a minor component of the winter diet of white-tailed deer in the Priest Lake Drainage (Pauley 1990). However, arboreal lichens

(Alectoria spp.) were believed to be an important food resource. These lichens were common in forested areas throughout the Priest Lake area and deer were frequently observed feeding on them. In western Montana, Mundinger (1984) and Hicks (1990) recorded similar use of arboreal lichens by whitetails during the winter. When rooted forage is buried by snowcover, deer may consume large amounts of litterfall, and lichens can be a critical source of energy (Rochelle 1980, Hicks 1990).

Home Range Estimates: I believe the rejection of the independence hypothesis was an artifact of the winter activity patterns of the study animals and did not reflect serially correlated locations. Shifts in activity centers and "traplining" have both been found to artificially decrease the t^2/r^2 statistic (Swihart and Slade 1985, Pauly 1990), and although no shifts in activity centers were detected (Fig. 15), "traplining" may have occurred. In "traplining", an animal travels along well-defined paths in a temporally predictable manner and movements appear to be serially correlated even when the time period between observations is adequate to allow for "biological independence" (Manning 1956, Swihart and Slade 1985).

Winter home range estimates were strongly influenced by the weather patterns encountered during the study period and all comparable winter home range estimates were smaller than



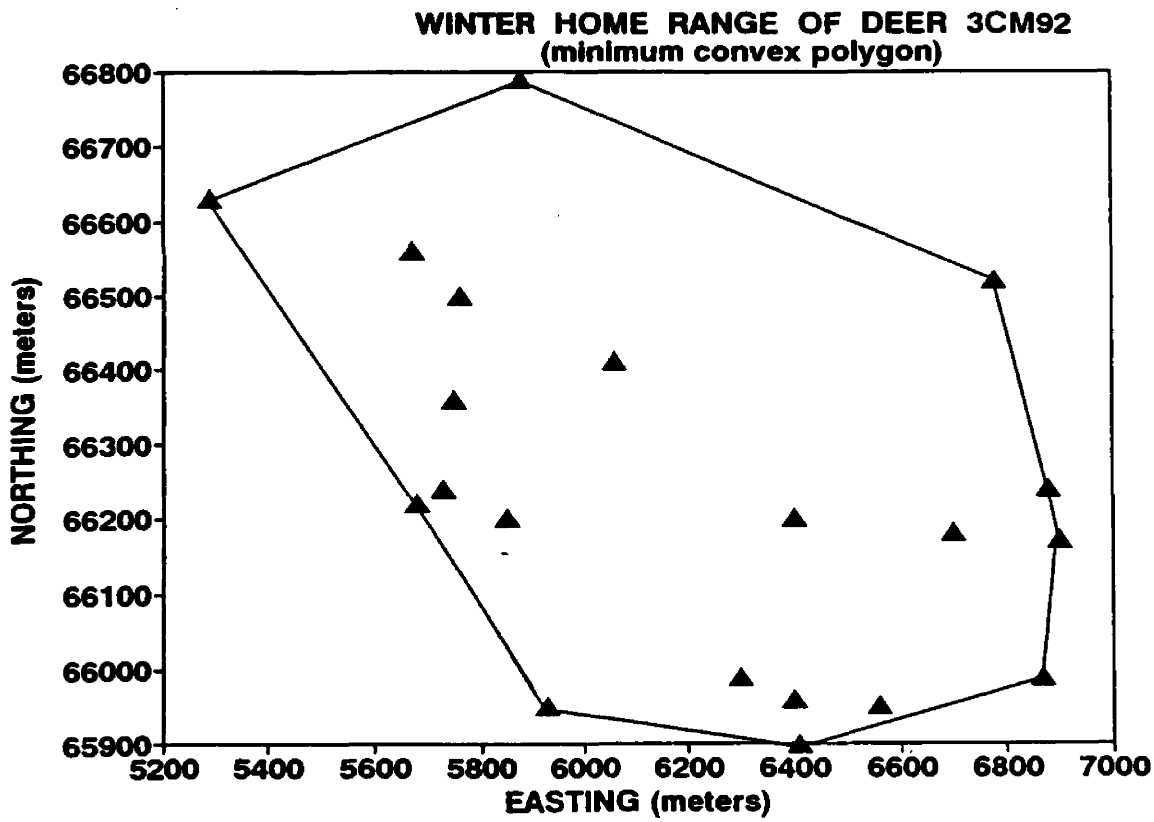


Figure 15. Distribution of radio locations within the winter home ranges of 2 white-tailed deer monitored in the Priest Lake watershed during the winter of 1991-92.

those reported by Pauley (1990). This is believed to be a direct result of the significant differences in winter severity which occurred between the two studies. The consistently mild winter conditions encountered during my study resulted in uniform habitat use patterns and relatively uniform distributions of relocations within the individual winter home ranges of the study animals (Fig. 15). Conversely, Pauley (1990) encountered distinct changes in winter severity which resulted in distinct intraseasonal shifts in white-tailed deer habitat use. These shifts were manifested as multiple centers of activity within the individual winter home ranges of the study animals and resulted in larger winter home range estimates.

Spring Migration and Winter Range Fidelity: Seasonal shifts in the activity patterns of white-tailed deer have been documented throughout its range. In the mountains of North Carolina, whitetails have been observed moving to lower elevations in early spring to take advantage of more succulent vegetation, and in the Florida Everglades, deer often move southward with receding water levels during dry years (Marchinton and Hirth 1984). In addition, Welch (1960) found that in the Chiricahua Mountains of Arizonia, Coues white-tailed deer (O. v. couesi) moved seasonally in response to changes in food, water, and cover availability. However, pronounced migrational movements between summer and winter ranges by white-tailed deer typically occur only in regions where there are strong seasonal differences in weather (Marchinton and Hirth 1984, Root et al. 1990). In the northern latitudes, these seasonal differences are manifested not only by seasonal changes in energetic demands by white-tailed deer, but also by changes in forage quality and quantity. Migration allows deer to maximize the seasonal availability of forage while avoiding deep snow during winter (Marchinton and Hirth 1984). Snow cover restricts movement and cold temperatures greatly increase energetic demands during winter (Kelsall 1969, Walmo and Gill 1971, Parker et al. 1984, Torbit et al. 1985). In addition, the nutritional quality of forage declines due to plant senescence (Wallmo et al. 1977). With the release from restricted food supplies in the spring, deer migrate to summer ranges to exploit new forage resources (Severinghaus and Cheatum 1956).

The spring dispersal of white-tailed deer from wintering areas in the Priest Lake Drainage was believed to be triggered by the occurrence of spring green-up. In Michigan, Verme (1973) observed that as soon as weather and snowpack conditions permit, whitetails leave their winter yards. However, Garrott et al. (1987) hypothesized that deer must reduce or reverse the negative energy balance incurred during winter, and improve their physiological condition prior to initiating spring migration. Whitetails must ingest high quality forage to improve their physiological condition prior to migrating, and spring green-up provides them this opportunity. Clearcuts and natural openings at low elevations are among the first areas to become snow-free and support actively growing, nutritious forage. Based on Garrott's supposition, deer use of these open-canopied sites adjacent to winter ranges should peak just prior to spring migration. My observations support this theory. No use of non-forested sites was documented during the winter, but following snowmelt in late winter, deer were frequently observed foraging in clearcuts adjacent to wintering areas. In addition, pellet-group densities in clearcuts adjacent to winter ranges were significantly higher during the spring than during the summer (Chapter 3). Pauley (1990) reported similar migratory patterns during the winter of 1987-88. From winter into spring, deer made a decided shift to openings and did not initiate migration until after most areas were snow-free. In a few instances, migrating deer moved from snow-free regions to areas where snow cover was present. However, snow depths in these localities did not appear to be restrictive (< 20 cm) and deer may have been exploiting succulent forage in snow-free microsites.

Garrott et al. (1987) also suggested that annual variation in the timing of spring migration is likewise associated with the physiological condition of deer. Deer in relatively good condition would be expected to overcome the negative energy balance experienced during winter before animals in poorer condition. Correspondingly, deer in good condition would migrate before those in poorer condition. This is believed to explain the variation in dispersals recorded during the winter of 1991-92. As shown in Table 13, dispersals began in late February and continued into early May.

Pauley's study animals were trapped and wintered on the CM range and displayed migrational movements similar to those recorded for my CM study animals. Migrational movements from the CM winter range averaged 14.5 km (S.D. = 6.1) as compared to an average distance of 20.4 km (S.D. = 12.1) reported by Pauley. Many of the CM study animals also summered in the same drainages as those used by Pauley's study animals (Pauley, pers. commun.). Deer wintering on the CL and ES ranges displayed markedly longer migrational movements than deer wintering on the CM range. This disparity in migrational distance was most pronounced between the CM and CL ranges (Fig. 6). The CL winter range is located approximately 5 km northeast of the CM range (Fig. 1) and yet migrational movements from this range averaged 44.9 km (S.D. = 16.2). Deer on the ES range migrated an average of 29.8 km (S.D. = 7.2).

The migrational movements recorded during this study are among the longest recorded for the Northern Rockies. In

Idaho, migrational distances for white-tailed deer have been reported as averaging from 11 km (Owens 1981) to 39 km (Baumeister 1992). In northwestern Montana, migrations by white-tailed deer have ranged from 5 to 72 km in the Swan River Valley (Leach 1982, Mundinger 1984) and 23 to 31 km in the Flathead and Kootenai National Forests (Dusek 1989, Dusek and Morgan 1991). In the North Fork of the Flathead River, in northwestern Montana, migrations averaged 12 km (Rachael 1992). Whitetails migrated an average of 20 km in the Umatilla River Drainage of northeastern Oregon (Bell 1988).

The use of traditional wintering areas by white-tailed deer at Priest Lake reflects the matriarchal social structure of this species (Marchinton and Hirth 1984). While females tend to remain isolated with their fawns during the summer months, they often associate with their previous years offspring during the autumn and winter. Family groups comprised of adult females, their fawns, and female yearlings often form during this period (Marchinton and Hirth 1984). These groups typically represent an extended family group and winter home ranges and migratory patterns of yearling females tend to be similar to their mothers (Staines 1974, Hirth 1977, Marchinton and Hirth 1984).

Due to the dynamic character of forested stands, individual differences between deer, and the stochastic nature of winter severity, some shifting of winter range boundaries is expected (Mattfeld et al. 1977). The initial establishment of winter home ranges by yearling bucks will also affect the dimensions of winter ranges. In the absence of severe habitat alteration, large scale shifts in winter range boundaries are not expected to occur in the Priest Lake drainage. Winter range habitat suitable for white-tailed deer is limited in this drainage and snow depths at higher elevations greatly restrict deer movements. However, changes in winter severity over time are predicted to create small scale changes in winter range boundaries (Pauley 1990).

REFERENCES CITED

Ackerman, B. B., F. A. Leban, M. D. Samuel, and E. O. Garton. 1989. User's manual for program Home Range. 2nd ed. For. Wildl. and Range Exp. Sta. Tech. Rep. 15. Univ. of Idaho, Moscow. 80pp.

Baumeister, T. R. 1992. Ecology of white-tailed deer on summer-fall range in northcentral Idaho. M.S. Thesis, Montana State Univ., Bozeman, Montana. 78pp.

Behrend, D. F. 1966. Behavior of white-tailed deer in an Adirondack forest. Ph.D. Thesis, State Univ. New York, Syracuse. 206pp.

Bell, J. H. 1988. Habitat use, movements, and home range of white-tailed deer in the Umatilla River drainage, northeast Oregon. M.S. Thesis, Univ. of Idaho, Moscow. 108pp.

Berner, K. L. 1985. Winter and spring habitat selection by white-tailed deer in a western Montana second-growth forest. M.S. Thesis, Univ. Montana, Missoula. 98pp.

Bloom, A. M. 1978. Sitka black-tailed deer winter range in the Kadashan Bay area, southeast Alaska. J. Wildl. Manage. 42:108-112.

Boer, A. 1978. Management of deer wintering areas in New Brunswick. Wildl. Soc. Bull. 6:200-205.

Brockman, S. P. 1988. Winter habitat selection by the sexes of white-tailed deer. M.S. Thesis, Univ. Montana, Missoula. 102 pp.

Clover, M. R. 1956. Single-gate deer trap. Calif. Fish and Game. 40:367-373.

Cooper, S. V., K. E. Neiman, R. S. Steele, and D. W. Roberts. 1987. Forest habitat types of northern Idaho: a second approximation. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-236. 135pp.

Cottom, G., and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecol. 37:451-460.

Craghead, J. J., M. G. Hornocker, M. W. Shoesmith, and R. I. Ellis. 1969. A marking technique for elk. J. Wildl. Manage. 33:906-909.

Crawford, H. S. 1984. Habitat management. Pages 629-646 in L. K. Halls, ed., white-tailed deer: ecology and management. Stockpole Books, Harrisburg, Pa. 870pp.

Day, B. W., Jr. 1963. Winter behavior of white-tailed deer in north-central Maine. M.S. Thesis. Univ. Maine, Orono. 151pp.

Drolet, C. A. 1976. Distribution and movements of white-tailed deer in southern New Brunswick in relation to environmental factors. Can. Field-Nat. 90:123-136.

Dunn, J. E., and P. S. Gipson. 1977. Analysis of radio-telemetry data in studies of home range. Biometrics. 33:35-101.

Dusek, G. L. 1989. Population ecology of white-tailed deer in northwestern Montana. Job Prog. Rep., Fed. Aid Proj. W-100-R-4. Mont. Dept. Fish, Wildl. and Parks, Helena. 46pp.

______, R. J. Mackie, J. D. Herriges, Jr., and B. B. Compton. 1989. Population ecology of white-tailed deer along the lower Yellowstone River. Wildl. Monogr. 104. 68pp.

______, and J. T. Morgan. 1991. Population ecology of white-tailed deer in northwestern Montana. Job Prog. Rep., Fed. Aid Proj. W-100-R-4. Mont. Dept. Fish, Wildl. and Parks, Helena. 46pp.

Finklin, A. L. 1983. Climate of Priest River Experimental Forest, northern Idaho. U.S.D.A. For. Serv. Gen. Tech. Rep. RM-159. 53pp.

Garrott, R. A., G. C. White, R. M. Bartmann, L. H. Carpenter, and A. W. Alldredge. 1987. Movements of female mule deer in northwest Colorado. J. Wildl. Manage. 51:634-643.

Gladfelter, H. L. 1966. Nocturnal behavior of the white-tailed deer in the Hatter Creek Enclosure. M.S. Thesis, Univ. of Idaho, Moscow.

Griffith, B., and B. A. Youtie. 1988. Two devices for estimating foliage density and deer hiding cover. Wild. Soc. Bull. 16:206-209.

Hepburn, N. W. 1959. Effects of snow cover on mobility and local distribution of deer in Alonquin Park. M.S. Thesis. Univ. of Toronto, Toronto, Ontario. 55pp.

Hicks, L. L. 1990. Habitat use by white-tailed deer in relation to winter range silvicultural treatments in the Thompson River drainage, northwestern Montana. Ph.D. Diss., Univ. of Montana, Missoula. 79pp.

Hildebrand, P. R. 1971. Biology of white-tailed deer on winter ranges in the Swan Valley, Montana. M.S. Thesis, Univ. of Montana, Missoula. 91pp.

Hirth, D. H. 1977. Social behavior of white-tailed deer in relation to habitat. Wildl. Monogr. 53. 55pp.

Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. of Washington Press, Seattle. 730pp.

Hosmer, D. W., Lemeshow, S. 1989. Applied logistic regression. John Wiley and Sons, N.Y. 307pp.

Howard, V. W. 1969. Behavior of white-tailed deer within three northern Idaho plant associations. Ph.D. Diss., Univ. of Idaho, Moscow.

Janke, D. 1977. White-tailed deer population characteristics, movements, and winter site selection in western Montana. M.S. Thesis, Univ. of Montana, Missoula. 92pp.

Jenkins, K. J. 1985. Winter habitat and niche relationships of sympatric cervids along the North Fork of the Flathead River, Montana. Ph.D. Thesis, Univ. of Montana, Missoula. 141pp.

Kelsall, J. P. 1969. Structural adaptations of moose and deer for snow. J. Mammal. 50:302-310.

______, and W. Prescott. 1971. Moose and deer behavior in snow in Fundy National Park, New Brunswick. Can. Wildl. Serv. Rep. Ser. No. 15.

Kramer, A. 1971. Notes on the winter ecology of the mule and white-tailed deer in the Cypress Hills, Alberta. Can. Field Nat. 85:141-145.

Krefting, L. W. and R. S. Phillips. 1970. Improving deer habitat in upper Michigan by cutting mixed-conifer swamps. J. For. 68:701-704.

Kucera, E. 1976. Effects of winter conditions on the white-tailed deer of Delta Marsh, Manitoba. Can. J. Zool. 54:1307-1313.

Laramie, H. A., Jr. and D. L. White. 1964. Some observations concerning hunting pressure and harvest on white-tailed deer. New Hampshire Fish and Game Dept. Tech. Circ. 20.

Leach, R. H. 1982. Summer range ecology of white-tailed deer in the coniferous forests of northwestern Montana. M.S. Thesis, Univ. Montana, Missoula. 80pp.

Lemmon, P. E. 1957. A new instrument for measuring forest overstory density. J. For. 55:667-669.

Levy, E. B., and E. A. Madden. 1933. The point method for pasture analysis. N. Z. J. Agric. 46:267-279.

Loftsgarden, D. O., and P. A. Andrews. 1992. Constructing and testing logistic regression models for binary data: applications to the national fire danger rating system. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-286. 36pp.

Manning, A. 1956. Some aspects of the foraging behavior of bumblebees. Behavior 9:164-201.

Marchinton, R. L. and D. H. Hirth. 1984. Behavior. pages 129-167 in L. K. Halls, ed. White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa. 870pp.

Mattfeld, G. F., R. W. Sage, R. D. Masters, and M. J. Tracy. 1977. Deer movement patterns in the Adirondacks-a progress report. Trans. Northeast Deer Study Group 11:157-167.

McCullough, D. R. 1979. The George Reserve deer herd: population ecology of a K-selected species. Univ. Michigan Press, Ann Arbor. 271pp.

Meske, T. A. 1972. Big game habitat improvement studies in the Dworshak Reservoir area. Contract completion rep. IDFG, Boise. 31pp.

Michael, E. D. 1965. Movements of white-tailed deer on the Welder Wildlife Refuge. J. Wildl. Manage. 29:44-52.

Moen, A. N. 1976. Energy conservation by white-tailed deer in the winter. Ecol. 57:192-198.

Mundinger, J.G. 1980. Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana. Pages 8-92 in Montana Deer Studies. Job Prog. Rep. W-120-R, Montana Dep. Fish, Wildlife, and Parks. Helena, MT.

______, 1984. Biology of the white-tailed deer in the coniferous forest of northwestern Montana. Pages. 275-284 in W. R. Meehan, T. R. Merrell, Jr., and T. A. Handley, eds. Proc. Fish and Wildlife Relationships in Old Growth Forests. Sym. Am. Inst. Fish Res. Biol.

Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

Norberg, E. R. 1957. White-tailed deer movements and foraging on the Cedar Creek Forest, Minnesota. M.S. Thesis, Univ. of Minnesota, St. Paul. 77pp.

Nyquist, M. O. 1972. Deer and elk utilization of successional forest stages in northern Idaho. Ph.D. Diss., Washington State University, Pullman.

Owens, T. E. 1981. Movement patterns and determinants of habitat use of white-tailed deer in northern Idaho. M.S. Thesis, Univ. of Idaho, Moscow. 80pp.

Ozoga, J. J. 1968. Variations in microclimate in a conifer swamp deer yard in northern Michigan. J. Wildl. Manage. 32:574-585.

Ozoga, J. J., and L. W. Gysel. 1972. Response of white-tailed deer to winter weather. J. Wildl. Manage. 36:892-896.

Parker, K. L., C. T. Robbins, and T. A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. J. Wildl. Manage. 48:474-488.

Pauley, G. R. 1990. Habitat use, food habits, home range, and seasonal migration of white-tailed deer in the Priest River drainage, north Idaho. M.S. Thesis, Univ. of Idaho, Moscow. 153pp.

Peek, J. M. 1984. Northern Rocky Mountains. Pages 497-504 in L. K. Halls, ed., White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa. 870pp.

Pengelly, W. L. 1961. Factors influencing production of white-tailed deer on the Coeur d'Alene National Forest, Idaho. U.S.D.A. For. Serv. 190pp.

______, 1963. Timberlands and deer use in the northern Rockies. J. For. 61:734-746.

Rachael, J. S. 1992. Mortality and seasonal distribution of white-tailed deer in an area recently recolonized by wolves. M.S. Thesis, Univ. of Montana, Missoula. 132pp.

Robinson, W. L. 1960. Test of shelter requirements of penned white-tailed deer. J. Wildl. Manage. 24:364-371pp.

Rochelle, J. A. 1980. The role of mature conifer forests in the winter nutrition of black-tailed deer. Ph.D. Thesis, Univ. British Columbia, Vancouver. 285pp.

Rongstad, O. J., and J. R. Tester. 1969. Movements and habitat use of white-tailed deer in Minnesota. J. Wildl. Manage. 33:366-379.

Root, B. G., E. K. Fritzell, and N. F. Giesmann. 1990. Migrations by white-tailed deer in northeastern Missouri. Prairie Nat. 22:185-190.

Seeley, C. R. 1985. Effects of timber harvesting on deer winter ranges and deer use near Missoula, Montana. M.S. Thesis, Washington State. Univ., Pullman. 74pp.

Severinghaus, C. A. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Manage. 13(2):195-216.

______, and E. L. Cheatum. 1956. Life and times of the white-tailed deer. pages. 52-186 in W. P. Taylor, ed. The deer of North America. Stackpole Books, Harrisburg, Pa.

Singer, F. J. 1979. Habitat partitioning and wildlife relationships of cervids in Glacier National Park, Montana. J. Wildl. Manage. 43:437-444.

Slott, B. J. 1980. White-tailed deer movements, survival, and population characteristics in the Clearwater River drainage, Montana. M.S. Thesis, Univ. of Montana, Missoula. 62pp.

Smith, C. A. 1977. The habitat use patterns and associated movements of white-tailed deer in southeastern British Columbia. M.S. Thesis. Univ. of British Columbia, Vancouver. 139pp.

Staines, B. W. 1974. A review of factors affecting deer dispersion and their relevance to management. Mammal Rev. 4:79-91.

Strickler, G. S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. Pacific Northwest For. and Range Exp. Stn. Res. Note No. 180. 5pp.

Swenson, J. E., S. J. Knapp, and H. J. Wentland. 1983. Winter distribution and habitat use by mule deer and white-tailed deer in southeastern Montana. Prairie Nat. 15:97-112.

Swihard, R. K., and N. A. Slade. 1985. Influence of sampling interval on estimates of home-range size. J. Wildl. Manage. 49:1019-258.

______, and ______. 1985b. Testing for independence of observations in animal movements. Ecol. 66:1176-1184.

______, and ______. 1986. The importance of statistical power when testing for independence in animal movements. Ecol. 67:225-258.

Telfer, E. S. 1970. Winter habitat selection by moose and white-tailed deer. J. Wildl. Manage. 344:553-559.

Thilenius, J. F. 1960. Forest utilization by cattle and white-tailed deer on a northern Idaho forest range. M.S. Thesis, Univ. of Idaho, Moscow.

Torbit, S. C., L. H. Carpenter, D. M. Swift, and A. W. Alldredge. 1985. Differential loss of fat and protein by mule deer during winter. J. Wildl. Manage. 49:80-85.

Unsworth, J. W., J. J. Beecham, and L. R. Irby. 1989. Female black bear habitat use in west-central Idaho. J. Wildl. Manage. 53:668-673.

Verme, L. J. 1965. Swamp conifer deer yards in northern Michigan. J. For. 63:523-529.

______. 1973. Movements of white-tailed deer in upper Michigan. J. Wildl. Manage. 37:545-552.

______, and J. J. Ozoga. 1971. Influence of winter weather on white-tailed deer in upper Michigan. Pages 1-14 _in_ A. O. Haugen, ed. Proc. snow and ice in relation to wildlife and recreation symposium. Iowa State Univ., Ames, IA.

Wallmo, O. C., and R. B. Gill. 1971. Snow, winter distribution, and population dynamics of mule deer in the central Rocky Mountains. Pages 1-15 in A. O. Haugen, ed. Proc. snow and ice in relation to wildlife and recreation symposium, Iowa State Univ., Ames, IA.

______, L. H. Carpenter, W. L. Regelin, R. B. Gill, and D. L. Baker. 1977. Evaluation of deer habitat on a nutritional basis. J. Range Mange. 30:122-127.

Welch, J. M. 1960. A study of seasonal movements of white-tailed deer (Odocoileus virginianus couesi) in the Cave Creek Basin of the Chiricahua Mountains. M. S. Thesis. Univ. of Arizona, Tucson. 79pp.

White, G. C., and R. A. Garrott. 1986. Effects of biotelemetry triangulation error on detecting habitat selection. J. Wildl. Manage. 50:509-513.

Woods, G. P. 1984. Habitat selection of white-tailed deer in the Pend d'Oreille Valley, British Columbia. M.S. Thesis, Univ. Idaho, Moscow. 361pp.

CHAPTER III: DEER USE OF CUTTING UNITS

INTRODUCTION

While numerous authors have recommended timber harvest as a means of increasing forage production for deer, clearcutting has been found to reduce thermal cover on winter ranges in the northern Rockies (Hildebrand 1971, Pengelly 1961, Telfer 1974, Woods 1984, Berner 1985, Pauley 1990). Mueggler (1965) found tree canopy and shrub cover to be negatively correlated within the cedar-hemlock zone of northern Idaho and crown coverages of willow (*Salix parviflorus*) and thimbleberry (*Rubus parviflorus*) were over 10 times greater in areas with overstory canopies < 25% than in sites with overstory canopies of 40 - 80%. Irwin and Peek (1979) reported similar findings. Clearcuts produced more shrub biomass and twigs per unit area than other timber harvest practices within the cedar-hemlock zone, with maximum shrub biomass occurring 10 to 14 years post-disturbance. At maximum development, clearcut-logged areas produced an average shrub biomass of 7,300 kg/ha (Irwin and Peek 1979).

Post-harvest vegetation response, however, is highly variable. The composition of post-logging seral stages varies with latitude, slope, aspect, soil composition, and various other site factors (Mueggler 1965, Nyquist 1973, Laursen 1984). Harvest techniques and slash treatments also strongly influence the post-logging successional plant community, and some harvest techniques can hinder forage production (Mclean 1969, Wright 1972, Telfer 1974, Miller 1977, Zager 1980).

Forage production is not the sole factor influencing deer use of clearcuts, however. Many temporal and spatial factors must also be considered. White-tailed deer habitat selection patterns change seasonally and clearcut use is highly transient (Hildebrand 1971, Berner 1985). In the Priest Lake watershed, Pauley (1990) documented limited seasonal use of clearcuts by white-tailed deer. From late winter into spring (3 Apr - 25 May), white-tailed deer habitat use progressively shifted from older, closed-canopied stands to early successional stages and riparian areas. During the spring, 5% of diurnal and crepuscular deer locations were in low shrub (<1 m) clearcuts and 7% were in high shrub (≥1 m) clearcuts. Use of clearcuts peaked during the summer (26 May - 28 Aug) with 13% use in low shrub cuts and 18% use in high shrub cuts. Whitetail selection of clearcuts declined during the fall (29 Aug - 17 Nov) with 10% use recorded. No use of clearcuts was documented during the winter period (18 Nov - 2 Apr).

Seasonal use of clearcuts is further accentuated by migrational movements. Deer use of individual clearcuts change in association with shifts in white-tailed deer distribution. Clearcuts located along migratory routes are expected to receive higher levels of use than distantly removed units.

It is often difficult to determine the response of deer to silvicultural practices with this mosaic of interacting factors. Silvicultural techniques can be used to increase forage availability when the need exists. However, a thorough knowledge of white-tailed deer habitat use within specific regions is required. Such information is a vital precursor to designing effective management strategies aimed at enhancing forage resources through the use of silvicultural techniques.

My study was designed to augment the findings of Pauley (1990) and evaluated the spring and summer use of low elevation clearcuts by white-tailed deer in the Priest Lake watershed. Limited time and other contingencies made it impossible to study all aspects of clearcut logging which influence deer use. My investigation focused primarily on the relationship of deer use to spatial and temporal factors. In evaluating clearcut use by white-tailed deer in the Priest Lake watershed, the following objectives were defined:

1) Compare deer use of clearcuts to deer use of the forested areas surrounding the clearcuts.

2) Compare deer use of clearcuts during the spring to use during the summer.

3) Examine the influence of clearcut size on deer use.

4) Examine the influence of clearcut age on deer use.

5) Compare deer use of clearcuts which were broadcast burned to those in which the residual slash was dozer piled prior to burning.

METHODS

Sampling: The U.S.F.S. Timber Stand Management Record System was initially used in selecting units. This database was queried to obtain a list of all clearcuts on the Kaniksu National Forest which were adjacent to white-tailed deer winter range and which had a slope of less than 35%. The year of harvest, year and type of site preparation, aspect, elevation, and pre-harvest habitat type were recorded for each unit. An attempt was made to locate all units within the *Tsuga heterophylla* / *Clintonia uniflora* (TSHE/CLUN) habitat type, however an adequate sample size was not obtainable so units within the *Tsuga heterophylla* / *Asarum caudatum* (TSHE/ASCA) habitat type were also included. A habitat type is defined as an area which supports, within recent time supported, and presumably is still capable of supporting, one plant association (Daubenmire 1968). The habitat type reflects the potential of a site, and successional patterns following a particular disturbance should be similar in areas of the same habitat type.

I selected 14 units to evaluate white-tailed deer use of clearcuts in the Priest Lake watershed (Table 13). Units varied in age from 1 to 25 years, post site-treatment, and were located on relatively level terrain (slope $\leq$ 10%) below 1,000 m in elevation.

Units were located on a District compartment map to evaluate surrounding areas. A stereoscope and aerial photos were used to examine topography. Information on the vegetative composition and structure of surrounding units was obtained from Forest Service stand exams. Once a unit was selected, I walked through the unit and its surrounding timber to confirm previously gathered information on the site. This was the final criterion in the selection process.

I measured white-tailed deer pellet-group densities to assess deer use of clearcut-logged areas during the spring and summer months. Permanent 0.001 ha circular plots were placed at 25 m intervals along transect lines radiating from the center of each unit and extending 150 m into the surrounding timber. I determined plot size and spacing

Table 13. Description of sample used to evaluate white-tailed deer use of clearcuts in the Priest Lake watershed during the spring (1 Apr - 15 Jun) and summer (16 Jun - 1 Sept), 1992.

UNIT NUMBER	SIZE (ha)	*AGE (yrs)	SITE TREATMENT	SLOPE (%)	ASPECT	ELEVATION (m)
1	4.0	5	Broadcast Burn	5	--	762
2	5.3	8	Broadcast Burn	5	--	762
3	8.9	3	Broadcast Burn	0	--	793
4	4.5	9	Dozer Pile	5	--	762
5	3.2	1	Broadcast Burn	10	S	762
6	14.6	18	Dozer Pile	8	--	762
7	3.2	10	Dozer Pile	5	--	732
8	6.5	17	Dozer Pile	10	SW	854
9	9.3	13	Dozer Pile	10	W	976
10	10.5	5	Dozer Pile	10	S	732
11	8.9	25	Broadcast Burn	0	--	732
12	6.5	8	Broadcast Burn	5	--	762
13	5.3	3	Broadcast Burn	5	--	793
14	5.7	2	Dozer Pile	10	SE	793

* Years since site treatment.

based on the number of units sampled and the associated logistics. Random placement of the first plot of each transect was followed by systematic placement of the remainder of the transect's plots. To insure the adequate sampling of each clearcut, I conducted preliminary surveys on temporary plots to estimate the mean density, variance, and distribution of pellet-groups in each unit. A sample size formula was then used to calculate the number of plots to be placed in each unit (Rustagi 1983). The maximum acceptable difference (error) between the sample and unknown population mean was $E = 0.25$. The confidence level used was 0.90. Plots were cleared of all pellet-groups immediately following snowmelt in March of 1992. I made spring counts during mid-June, at which time plots were again cleared. Summer counts were conducted in August. I used the following interpretational standards to minimize counting errors associated with defining pellet-groups and to determine which groups on the plot periphery should be counted:

A) Associated groups of pellets which were similar in size, shape, and color were counted as a single pellet-group.

B) Adjacent pellet-groups of similar appearance were counted separately unless connected by scattered pellets.

C) Individual pellets scattered throughout the plot were consolidated to form a pellet-group if a minimum of 20 pellets of similar morphology were found.

D) A pellet-group on the periphery of the plot was counted if any part of that group fell within the plot boundaries.

Each plot was surveyed by 2 investigators to reduce counting errors. Each investigator searched half of the plot and then cross-checked the remaining half. Pellet-group counts were determined by consensus.

I determined the canopy cover, height, and percent composition of understory vegetation in each unit and its surrounding forest with randomly placed 15 m line point transects. Transects were placed within each unit and extended 150 m into the surrounding forest. Hits were recorded at 30 cm intervals along each transect. Plant nomenclature followed Hitchcock and Cronquist (1973). The techniques outlined in Chapter II were used in determining the structure and composition of overstory vegetation in and adjacent to the cutting units.

Analysis: Pellet-group densities were expressed as the density of pellet-groups per plot. I used an Independent-T test to compare deer use of clearcuts and their adjacent forest, and a Paired-T test to compare deer use of clearcuts during the spring against deer use of these areas during the summer. I defined the spring and summer seasons by the timespan between pellet-group surveys. Plots were cleared of all pellet-groups immediately following snowmelt in 1992 to insure accurate spring counts. Spring counts were made during mid-June, at which time plots were again cleared. Summer counts were carried out in early September. The spring period reflected pellet-group deposition from 1 April to 15 June and the summer period reflected deposition from 16 June to 1 September, 1992. I classed unit site treatments as either broadcast (BC) or dozer piled (DP) and tested differences with an Independent-T test. BC units were defined as those sites in which residual woody material was left dispersed throughout the unit following timber harvest and fire was broadcast throughout the unit to dispose of it. In DP units, tractors were used to consolidate residual woody material into piles which were then burned.

I further evaluated deer use of clearcut areas with simple regression analysis to detect associations between pellet-group densities and clearcut size, age, shrub height, shrub cover, and forb cover. Unit size was determined from U.S.F.S timber sale records. The age of each unit was defined as the time between the site treatment of each respective unit and the initiation of pellet-group sampling in the spring of 1992.

RESULTS

No significant difference in pellet-group densities between clearcuts and their adjacent forest was found during either the spring (t=0.23, D.F.=26, P=0.822) or summer (t=1.24, D.F.=19, P=0.23). Pellet-group densities measured within clearcuts and their adjacent forest were therefore pooled for further analysis (Table 14).

Spring use of clearcuts by white-tailed deer was significantly higher than summer use in all clearcuts sampled (t=2.16, D.F.=13, P<0.01) (Fig. 16). Pellet-group densities during the spring averaged 0.76 groups per plot (S.D.=0.58) while summer densities averaged 0.25 groups per plot (S.D.=1.8).

There was no significant difference between pellet-group densities in clearcuts which were broadcast burned (BC) and those in which the residual slash was dozer piled (DP) prior to burning (spring (t=1.06, D.F.=12, P=0.31); summer (t=0.56, D.F.=12, P=0.59)). Mean pellet-group densities were slightly higher in broadcast burned units during the spring, however (BC=0.92, DP=0.60).

Units selected ranged in size from 4.05 to 14.57 ha (Table 13). Regression analysis revealed no significant associations between pellet-group densities and unit size (Fig. 17). For spring r= -0.42 (P=0.13) and for summer r= -0.14 (P=0.64).

Table 14. Pellet counts recorded in 14 clearcuts and their adjacent forest within the Priest Lake watershed of northern Idaho during the spring (1 April - 15 June) and summer (16 June - 1 September), 1992. Counts are expressed as the number of pellet-groups per plot.

		CLEARCUT			FOREST		
UNIT NUMBER	SAMPLE SIZE	SPRING COUNT	SUMMER COUNT	TOTAL COUNT	SPRING COUNT	SUMMER COUNT	TOTAL COUNT
1	49	0.64	0.16	0.80	1.50	0.33	1.83
2	49	0.16	0.12	0.28	0.58	0.38	0.96
3	51	0.22	0.11	0.33	0.25	0.13	0.38
4	49	0.40	0.40	0.80	0.92	0.29	1.21
5	49	1.52	0.64	2.16	1.88	0.38	2.25
6	55	0.45	0.16	0.61	0.25	0.13	0.38
7	49	0.68	0.20	0.88	2.83	0.50	3.33
8	51	0.19	0.04	0.23	0.04	0.04	0.08
9	53	0.17	0.03	0.20	0.00	0.00	0.00
10	53	0.86	1.03	1.89	0.50	0.04	0.54
11	51	2.44	0.85	3.29	0.92	0.04	0.96
12	49	1.20	0.44	1.64	0.21	0.17	0.38
13	49	0.52	0.04	0.56	0.83	0.17	1.00
14	49	0.72	0.12	0.84	0.33	0.08	0.42

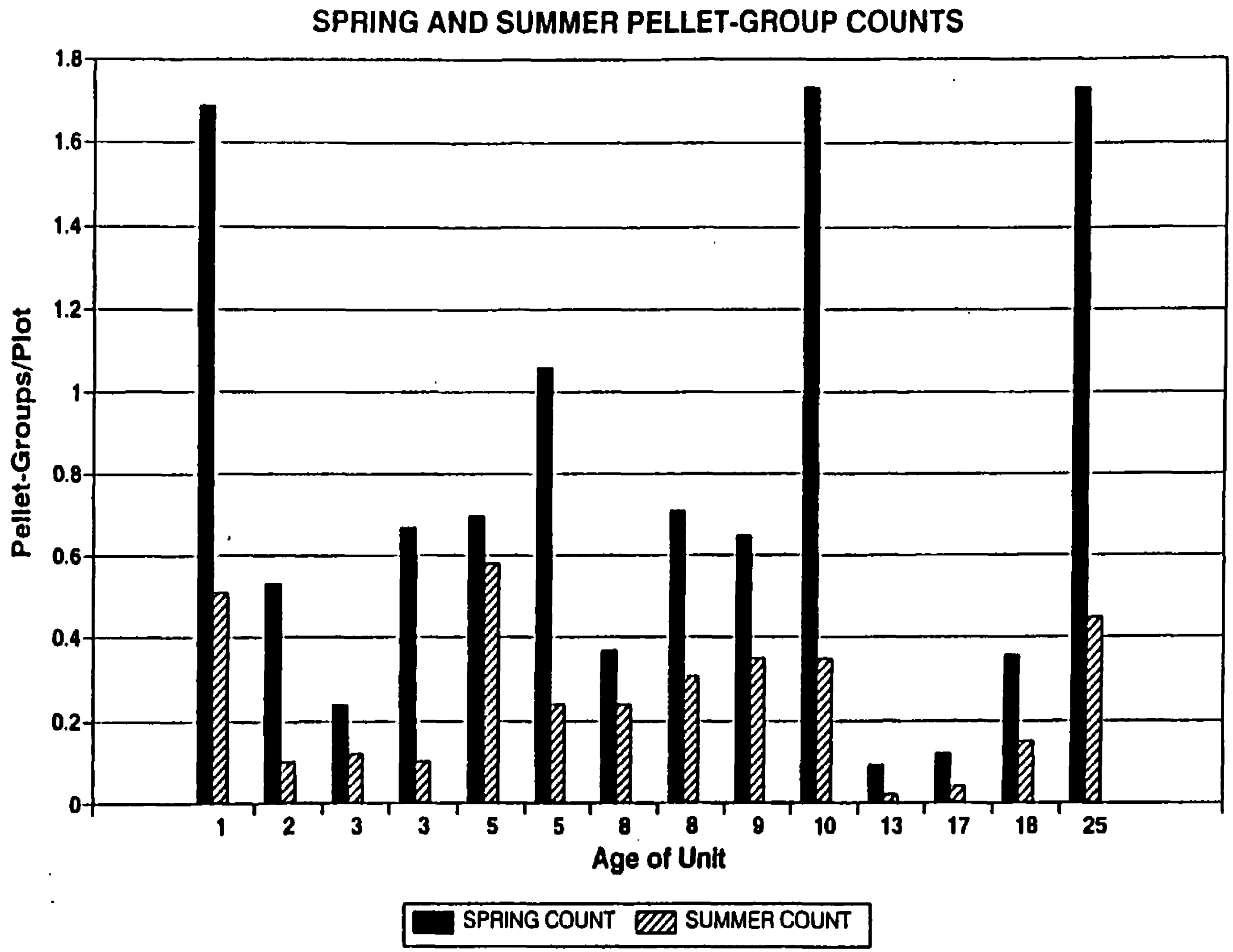
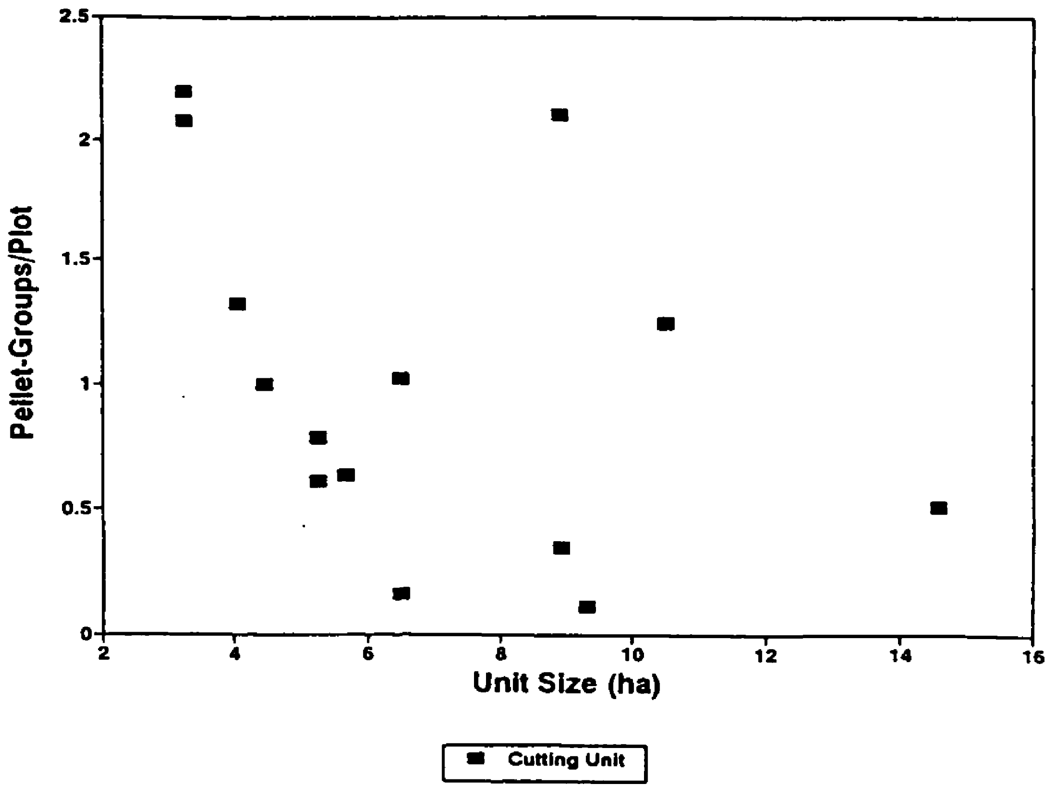


Figure 16. Comparison of spring (1 April - 15 June) and summer (16 June - 1 September) pellet-group densities recorded in clearcuts within the Priest Lake watershed of northern Idaho during 1992.



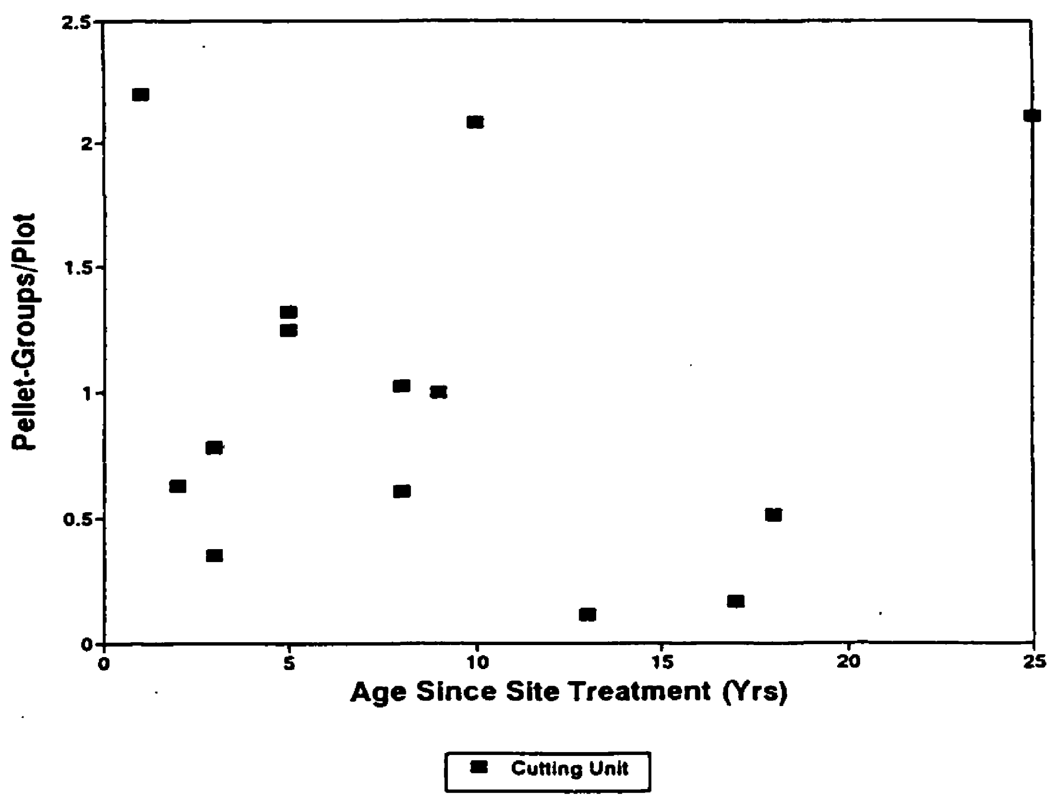


Figure 17. Relationship of clearcut size and age to pellet-group densities measured in the Priest Lake watershed of northern Idaho. Densities represent combined spring and summer pellet-group counts.

The study sample represented an array of age classes with units ranging from 1 to 25 years since post-harvest site treatment (Table 13). I did not detect any associations between pellet-group densities and unit age ($r=0.03$, $P=0.92$ (spring); $r= -0.07$, $P=0.82$ (summer)) (Fig. 17). The r values for comparisons between unit age and pellet-group densities were 0.03 for spring ($P=0.92$) and -0.07 for summer ($P=0.82$).

No relationship between pellet-group densities and understory structure was found. Shrub cover: $r=0.09$, $P=0.76$ for spring, $r= -0.13$, $P=0.67$ for summer; forb cover: $r=0.33$, $P=0.25$ for spring, $r=0.38$, $P=0.18$ for summer. Revegetation of clearcuts appeared to be influenced by highly variable site factors such as burn intensity and no temporal pattern of succession was evident within the sample (Table 15, Fig. 18). The greatest disparity in understory response was between units #8 and #5. Unit #8 was among the oldest clearcuts sampled, with a post site-treatment age of 17, and contained one of the most depauperate understory communities of the sample (Fig. 18). The understory coverage of this unit was only 29% and was dominated by wild strawberry (<u>Fragaria</u> spp., 10.4%) and common yarrow (<u>Achillea millefolium</u>, 28%). The total shrub cover of this unit was only 3.8% (Table 15). Conversely, Unit #5, the youngest unit with a post site-treatment age of 1 year, supported a relatively vigorous and diverse understory community (Fig.

Table 15. Vegetative structure of clearcuts sampled in the Priest Lake watershed of northern Idaho.

	UNIT NUMBER													
	1		2		3		4		5		6		7	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Overstory Structure														
Tree Den. (stems/ha)	264	155	1758	1115	1431	571	1238	668	860	728	1401	758	7576	6772
Mean Tree Height (m)	0.8	0.4	1.0	0.4	0.8	0.3	1.1	0.7	0.3	0.1	1.6	0.5	1.4	0.7
Mean Tree Age (yrs)	3.7	1.2	5.9	1.7	3.7	0.5	5.4	3.2	1.0	0.0	8.4	1.5	5.9	2.8
Canopy Cover (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Understory Structure														
Shrub Cover (%)	23.8	14.8	2.8	2.9	5.0	6.4	3.4	2.2	6.2	6.4	13.6	13.3	5.6	8.3
Shrub Height (cm)	36.5	15.7	32.4	26.2	44.4	16.6	45.0	36.7	13.8	7.1	114.4	60.3	16.3	5.1
Subshrub Cover (%)	0.8	1.41	34.6	109.6	3.8	4.9	28.0	71.4	16.8	39.9	16.0	37.5	33.4	86.2
Herbaceous Cover (%)	22.6	30.6	5.4	7.4	7.6	8.4	11.4	1.4	18.0	14.9	11.8	7.3	5.2	5.1
Graminoid Cover (%)	10.8	4.8	8.4	3.3	3.2	3.3	7.2	2.2	13.4	4.0	18.0	5.5	8.8	2.5
Understory Cover (%)	58.0	22.2	51.2	44.8	19.6	6.8	50.0	32.7	54.4	22.8	59.4	23.2	53.0	39.7

Table 15. Continued.

	UNIT NUMBER													
	8		9		10		11		12		13		14	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Overstory Structure														
Tree Den. (stems/ha)	897	338	1805	1169	697	457	1410	672	1024	582	799	406	4695	3388
Mean Tree Height (m)	1.6	0.7	1.9	0.7	1.1	0.7	9.5	2.6	1.1	0.5	0.6	0.2	0.6	0.3
Mean Tree Age (yrs)	9.0	3.4	8.0	1.4	3.8	1.0	12.6	8.4	5.4	2.2	3.4	0.6	2.4	0.6
Canopy Cover (%)	0.0	0.0	21.0	13.3	0.0	0.0	50.2	23.8	0.0	0.0	0.0	0.0	0.0	0.0
Understory Structure														
Shrub Cover (%)	3.8	3.9	9.2	7.9	2.4	4.4	5.2	5.4	7.6	5.5	5.2	11.8	0.8	0.0
Shrub Height (cm)	82.9	69.4	59.0	39.2	26.2	11.2	24.5	22.1	58.6	44.4	13.1	4.2	20.0	14.1
Subshrub Cover (%)	2.4	7.1	1.4	0.0	1.0	0.7	5.4	12.0	20.8	48.8	4.8	2.8	0.8	0.0
Herbaceous Cover (%)	15.4	20.9	18.8	16.2	25.6	10.9	25.6	13.7	13.6	8.5	17.4	10.5	25.2	15.7
Graminoid Cover (%)	7.4	3.0	4.2	4.0	17.4	6.0	11.4	11.0	7.8	3.1	13.4	4.0	0.2	0.5
Understory Cover (%)	29.0	16.0	33.6	13.4	46.4	19.3	47.6	12.0	49.8	19.8	40.8	9.5	27.0	16.2

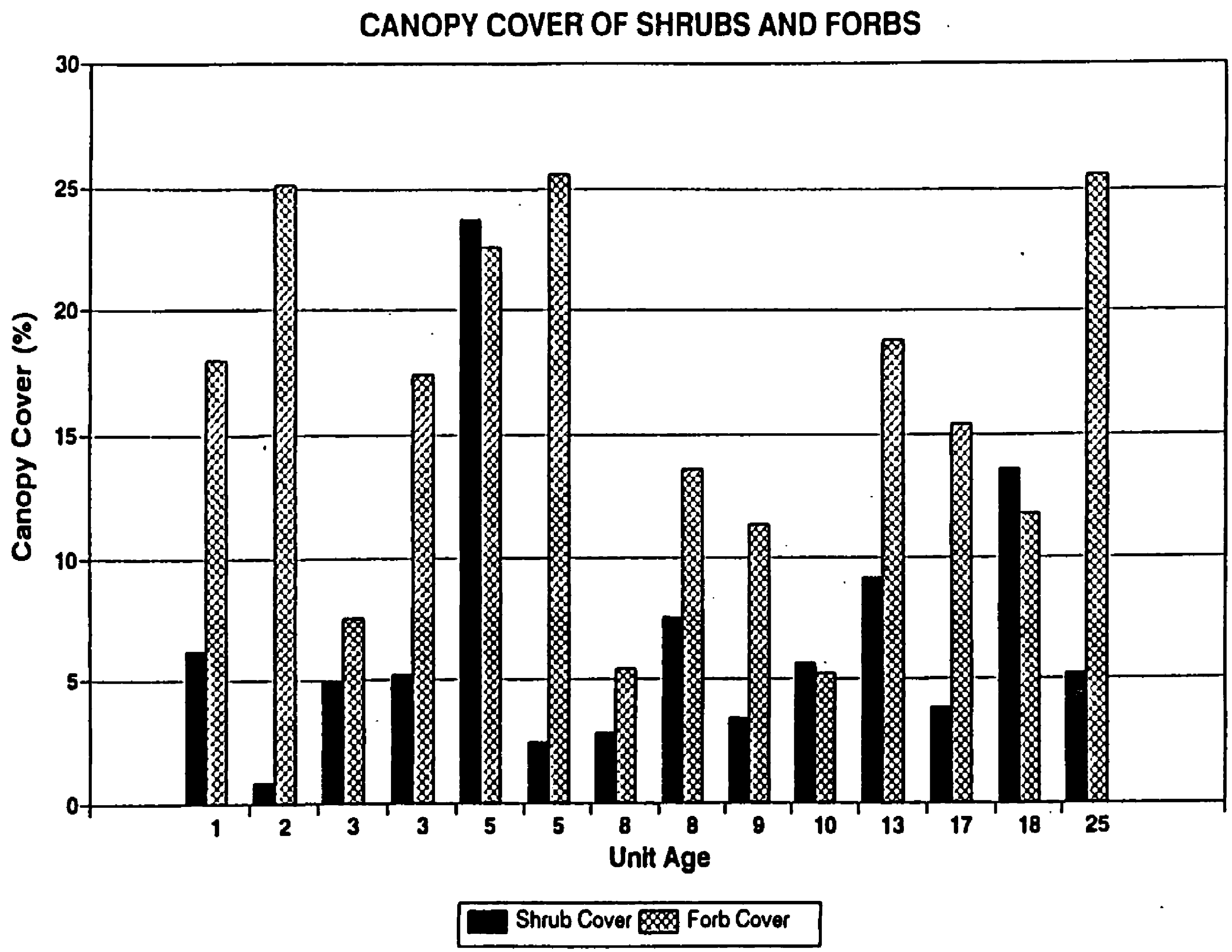


Figure 18. Canopy cover of forbs and shrubs recorded in a sample of 14 clearcuts within the Priest Lake watershed of northern Idaho. The cover of subshrub species is not included.

18). The 3rd greatest understory coverage (54.4%) was recorded in this clearcut and shrub coverage averaged 6.2%.

Pachistima was the most prevalent shrub species encountered and occurred in 13 of the 14 units. Coverages of this shrub ranged from 0.80% to 2.40%. Wild strawberry and twinflower (Linnaea borealis) were also commonly encountered and occurred in 12 of the 14 clearcuts.

DISCUSSION

Sampling: The units selected represented low elevation (<1000 m) clearcuts adjacent to white-tailed deer winter range within the Priest Lake watershed. Sampling was restricted to level sites (slope < 10%) in an effort to reduce variation associated with differences in slope and aspect between units. Aspect has been found to strongly influence the composition and structure of understory communities (Mueggler 1965, Nyquist 1973), and variations in aspect between units may mask the effect of other site factors on deer use.

Pellet-group densities were used solely as a relative index of use. No attempt was made to estimate the density of animals using each unit. Such estimates of animal abundance require the assumption of a known defecation rate. Defecation rates have been found to vary between the sexes and between different age groups (Neff 1968, Ryel 1971, Rogers 1987). Variations in winter severity can also alter feeding habits, leading to fluctuating deposition rates (Fuller 1991). I believe my pellet-group surveys were exclusively reflective of white-tailed deer use. Mule deer (Odocoileus hemionus) winter at higher elevations than white-tailed deer in the Priest Lake watershed.

Vegetation Response: Understory structure and composition were highly variable between units, and appeared strongly influenced by both the physiographic features of the areas cut and the post-harvest site treatments. I believe the sparse shrub cover observed within my study sites was a direct reflection of my sampling scheme. Strong shrub response is typically observed on south facing slopes in north Idaho (Pengelly 1961) and Pauley (1990) noted that clearcuts on level sites within the Priest River drainage were characterized by scant shrub cover. The low elevation clearcuts I sampled also appeared moister than adjacent south and west facing slopes, and may have been located in frost pockets.

Affinities to specific aspects may also explain the low frequencies, or absence, of some shrub species within the clearcuts sampled. Ninebark and ocean spray are commonly encountered on dry south and west aspects throughout the study area. However, neither of these species occurred within the units studied. Conversely, pachistima which is not associated with specific aspects (Mueggler 1965, Nyquist 1973) was the most prevalent shrub encountered. In evaluating seral shrub communities in the cedar-hemlock zone of northern Idaho, Mueggler (1965) found many shrub and herb species to be significantly associated with north and south aspects. Sitka alder (Alnus sinuata) and huckleberry (Vaccinium spp.) were positively associated with northern exposures while mountain maple (Acer glabrum), serviceberry, redstem ceanothus, shinyleaf ceanothus, ocean spray, and ninebark were positively associated with southern exposures. In the western hemlock/pachistima habitat type of northern Idaho, Nyquist (1973) also found ninebark, snowberry, and redstem and shinyleaf ceanothus to be associated with southerly aspects.

Post-harvest site treatments are often employed in even-aged management to encourage the establishment and growth of tree seedlings (Collins and White 1981). Prescribed fire is widely used to dispose of residual woody material which may act as a physical barrier to seedlings and pose a potential fire hazard. Although no significant differences in deer use was found between broadcast burned sites and dozer-piled sites, post-harvest site treatments can greatly influence seral plant communities. The extreme temperatures created by burning slash piles can kill rhizomes and rootcrowns (Zager 1980), and Vogl and Ryder (1969) found that some shrub species declined in areas where the burning of slash piles occurred. In addition, soil disturbance caused by scarification and the piling of slash with bulldozers can physically destroy the underground reproductive structures of many shrub species (Zager 1980).

Temporal and Spatial Relations: The patterns of clearcut use strongly reflected the seasonal distributions of white-tailed deer within the Priest Lake watershed. Whitetails in the Priest Lake region display marked migrational patterns. Movements appear to be closely associated with spring snowmelt and the resulting shifts in forage availability (Chapter 2). I believe these migrational movements are the single most important variable influencing regional clearcut use by Priest Lake white-tailed deer.

Whitetails concentrate on low elevation winter ranges and display strong avoidance of non-forested sites during the winter. Snow depths are greatest on these winter ranges during this period and senescent plants are buried under snowcover. With the advent of warm weather and reduced snow depths, deer become more active and non-forested sites receive increasing levels of use. As spring temperatures increase, the high snow accumulations of non-forested sites is offset by their accelerated rate of snowmelt. These sites receive maximum radiation loads and the lack of windbreaks increases windflow and evaporation. Non-forested areas are typically the first to become free of snow cover and can serve as foraging sites.

White-tailed deer energy reserves are depleted in early spring and many females are in the later stages of pregnancy. A pregnant doe may have small or nonexistent fat reserves after a severe winter, and ample nutrition during this period may be a significant factor in fawn survival (Verme and Ulrey 1984). Non-forested sites can provide a source of actively growing, nutritious forage during a period when the nutritional demands of deer are exceedingly high (Garrott et al. 1987). Spring green-up in non-forested sites provides deer the first opportunity to reverse the negative energy balance incurred during winter and prepares them for migration to high elevation summer ranges.

Low elevation clearcut use peaked during the spring but dropped significantly with the advent of summer. This significant reduction between spring and summer pellet-group counts clearly demonstrates a shift in site-specific use of clearcuts by white-tailed deer. Telemetry further revealed that the majority of deer began migrating to high elevation summer ranges shortly after snowmelt. This large-scale movement from winter ranges created a decided shift in deer densities and the use of non-forested sites adjacent to wintering areas markedly declined.

My subjective observations of whitetails on low elevation winter ranges during spring and summer also support these findings. White-tailed deer sightings dropped off markedly from spring into summer. During the spring, deer were frequently observed feeding in low elevation clearcuts and along skid trails on which white clover (*Trifolium repens*) had been seeded. Deer were seldom observed using these areas during the summer.

My results suggest that clearcut use by whitetails in the Priest Lake watershed is strongly influenced by season and the location of the units. The location of clearcuts appears to be directly related to the degree of use they receive. In my study, the difference in elevation and proximity to winter range habitat between units was kept to a minimum. However, these disparities may explain the low pellet-group densities recorded in some units. Unit #9 was the highest elevation unit sampled (976 m) and was the farthest from known winter range habitat. This unit supported a diverse understory community containing several preferred forage species (Pauley 1990). The highest coverages of wild strawberry (11.2%), scouler willow (*Salix scouleriana*) (4.0%), and pachistima (2.4%) occurred in this clearcut, and yet it contained the lowest pellet-group densities of all units sampled. Although this unit contained numerous forage species, its location may have precluded its use.

Telemetry data reveal that deer are not uniformly distributed throughout the watershed and seasonal shifts in habitat use occur (Pauley 1990). Clearcuts located on white-tailed deer summer range receive little if any use during early spring because these areas are typically buried under heavy snowcover and are inaccessible. However, from late spring into summer these sites are expected to receive an increasing level of use. With the advent of summer, these higher elevation sites are released from winter dormancy and provide forage for deer migrating from low elevation winter ranges. Pauley (1990) reported that use of clearcuts peaked during the summer months and steadily declined thereafter. I predict a sharp reduction in the use of high elevation clearcuts as fall migration begins. Deer begin moving to lower elevations and the use of forested habitats progressively increases during this period (Pauley 1990).

CONCLUSION: Many site-specific factors must be considered when attempting to predict the forage value of clearcuts. Post-harvest vegetation response can be highly variable and, during this study, was not related to levels of deer use. Seral community composition varies with physical site-factors such as slope, aspect, and soil structure, and is markedly influenced by different site treatments (Mueggler 1965, Nyquist 1973). Some site treatments are beneficial and encourage the growth of deer forage while others have been found to be detrimental.

Temporal and spatial relations strongly influence deer use of clearcuts in the Priest Lake watershed. Many units receive only seasonal deer use and clearcut location can be a critical factor. The avoidance of non-forested sites during winter is well documented and units placed within winter ranges may be at the expense of thermal cover. However, clearcuts adjacent to winter ranges and along migratory routes are expected to receive heavy use during spring and can provide a readily available forage resource to winter-stressed whitetails. The use of clearcuts on summer range is predicted to increase from spring to summer and is expected to decrease in the fall as deer disperse to wintering areas.

REFERENCES CITED

Berner, K. L. 1985. Winter and spring habitat selection by white-tailed deer in a western Montana second-growth forest. M.S. Thesis, Univ. Montana, Missoula. 98pp.

Collins, B. M., and F. M. White. 1981. Elementary forestry. Reston Publishing Co. Inc. Reston, Va.

Crawford, H. S. 1984. Habitat management. Pages 629-646 in L. K. Halls, ed., White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa. 870pp.

Daubenmire, R. 1968. Plant communities: A textbook of plant synecology. Harper and Row, Inc., New York. 300pp.

Fuller, T. K. 1991. Do pellet counts index white-tailed deer numbers and population change? J. Wildl. Manage. 55:393-396.

Garrott, R. A., G. C. White, R. M. Bartmann, L. H. Carpenter, and A. W. Alldredge. 1987. Movements of female mule deer in northwest Colorado. J. Wildl. Manage. 51:634-643.

Hildebrand, P. R. 1971. Biology of white-tailed deer on winter ranges in the Swan Valley, Montana. M. S. Thesis, Univ. of Montana, Missoula. 91pp.

Hitchcock, C. L. and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. of Washington Press, Seattle. 730pp.

Irwin, L. L., and J. M. Peek. 1979. Shrub production and biomass trends following five logging treatments within the cedar-hemlock zone of northern Idaho. Soc. Amer. For. 25:415-426.

Laursen, S. B. 1984. Predicting shrub community composition and structure following management disturbance in forest ecosystems of the intermountain west. Ph.D. Diss., University of Idaho, Moscow.

McLean, A. 1969. Fire resistance of forest species as influenced by root systems. J. Range Manage. 22:120-122.

Miller, W. 1977. Resistance of blue huckleberry to prescribed fires in a western Montana larch-fir forest. U.S.D.A. For. Serv. Res. Pap. INT-188. 33pp.

Mueggler, W. 1965. Ecology of seral shrub communities in the cedar-hemlock zone of northern Idaho. Ecol. Monogr. 35:165-185.

Neff, D. J. 1968. The pellet-group count technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32:597-614.

Nyquist, M. O. 1973. Deer and elk utilization of successional forest stages in northern Idaho. Ph.D. Diss., Washington State Univ., Pullman. 86pp.

Pauley, G. R. 1990. Habitat use, food habits, home range, and seasonal migration of white-tailed deer in the Priest River drainage, north Idaho. M. S. Thesis. Univ. of Idaho, Moscow. 153pp.

Pengelly, W. L. 1961. Factors influencing production of white-tailed deer on the Coeur d'Alene National Forest, Idaho. USDA For. Serv. Northern Region, Missoula, MT. 190pp.

Rogers, L. L. 1987. Seasonal changes in defecation rates of free-ranging white-tailed deer. J. Wildl. Manage. 51:330-333.

Rustagi, K. 1983. Determination of sample size in simple random sampling. For. Sci. 29:190-192.

Ryel, L. A. 1971. Evaluation of pellet-group surveys for estimating deer populations in Michigan. Ph.D. Diss., Michigan State Univ., East Lansing. 237pp.

Telfer, E. 1974. Logging as a factor in wildlife ecology in the boreal forest. For. Chron. 50:1-5.

Verme, L. J., and D. E. Ullrey. 1984. Physiology and nutrition. Pages 91-118 in L. K. Halls, ed., White-tailed deer: ecology and management. Stackpole Books, Harrisburg, PA. 870pp.

Vogl, R. and C. Ryder. 1969. Effects of slash burning on conifer reproduction in Montana's Mission Range. Northwest Sci. 43:135-147.

Woods, G. P. 1984. Habitat selection of white-tailed deer in the Pend d'Oreille Valley, British Columbia. M.S. Thesis, Univ. of Idaho, Moscow. 361pp.

Wright, H. 1972. Shrub response to fire. In C. Mckell, J. Blaisdell, and J. Goodin (eds.), pp. 204-217. Wildland shrubs - their biology and utilization. U.S.D.A. For. Serv. Gen. Tech. Rept. INT-1. 494pp.

Zager, P. E. 1980. The influence of logging and wildfire on grizzly bear habitat in northwestern Montana. Ph.D. Diss., Univ. of Montana, Missoula. 131pp.

CHAPTER IV: MANAGEMENT RECOMMENDATIONS

SCOPE

These management recommendations compliment those presented by Pauley (1990) and augment the habitat management guidelines outlined by Jageman (1984). These recommendations specifically address the Priest Lake watershed. White-tailed deer behavior and habitat requirements vary regionally, and this should be taken into consideration when applying these recommendations outside of the Priest Lake area.

My study defined white-tailed deer habitat use during an abnormally mild winter and my findings are not representative of habitat requirements during a normal or severe winter. Based on the years 1931-80, maximum snow accumulations for the upper Priest River drainage averaged 75 cm (Finklin 1983). Snow accumulations on the Chipmunk winter range reached a maximum of only 36 cm during my study.

WINTER HABITAT MANAGEMENT

Introduction: Pauley (1990) identified old growth forest as an important component of winter range in the Priest

River drainage and suggested that old growth stands may enhance white-tailed deer productivity and survival. I did not document the degree of old growth selection reported by Pauley (1990), however. Deer selected mature stands of coniferous forest on the Chipmunk winter range during my study. Preferred winter habitats throughout my study area were dominated by a Douglas-fir and grand fir overstory with a mixture of lodgepole pine, western red cedar, and western hemlock. Mean tree ages ranged from 65 to 91 years and overstory canopy coverages averaged 85% (S.E. = 0.6).

I expect much greater use of older forested stands during normal and extremely severe winters. Only 6.6% of the winter range habitat that Pauley (1990) defined along the Priest River was forested with old growth forest and yet deer use of these areas exceeded 60% during mid-winter (Pauley 1990). Numerous other studies in the northwest have also reported selection of climax forest by white-tailed deer during winter (Hildebrand 1971, Drolet 1976, Mundinger 1980, Woods 1984, Berner 1985, Jenkins 1985).

Recommendations: I strongly agree with Pauley's suggestion to maintain existing stands of old growth forest on winter range habitat in the Priest Lake watershed. Pauley's results suggest that old growth forest along Priest River and Priest Lake is vital to white-tails during periods of severe winter weather. However, existing stands of old growth are not large enough to provide adequate shelter for all deer wintering in the Priest Lake watershed. Low elevation winter range habitat along Priest Lake and Priest River should be excluded from timber harvest until forested stands with structural attributes similar to old growth develop.

Pauley (1990) found that mid-winter habitats were characterized by forested stands with overstory canopy coverages averaging 87% (S.E. = 1.4). Mean tree diameter (dbh) was 35 cm (S.E. = 0.9) and overstory tree density was 508 stems/ha (S.E. = 30.3). These structural attributes represent stands which were used during a relatively mild winter in the Priest Lake watershed (Pauley 1990). Winter range habitat which will provide adequate shelter during severe winter conditions should meet, or exceed, these structural criteria.

Pauley (1990) reported that whitetails selected stands of western red cedar and western hemlock almost exclusively during mid-winter. I do not recommend that these overstory species be replaced with more commercially desirable species such as Douglas-fir and western white pine. It is doubtful that the canopy architecture of these species will provide the same cover value as cedar and hemlock. In addition, western red cedar is an important winter forage item for Priest Lake whitetails (Pauley 1990).

I recommend the silvicultural prescriptions outlined by

Pauley (1990) after adequate winter range habitat has developed. These prescriptions are designed to provide suitable winter habitat for white-tailed deer in the Priest Lake watershed while allowing for a limited degree of timber harvest.

Further delineation of suitable winter habitat for whitetails should be conducted prior to implementing long-term management strategies. Idaho Department of Fish & Game winter surveys conducted in the 1960's and 1970's found the largest concentrations of wintering whitetails along the shores of lower Priest Lake and along the northern extent of Priest River. Although these surveys closely agree with my observations, winter range boundaries have been found to change over time. In any given winter range, deer concentrations can vary throughout the winter and from year to year (Drolet 1976, Boer 1992). Periodic ground and aerial surveys would allow the accurate delineation of winter range habitats under a variety of climatic conditions. Winter surveys would also make it possible to test the validity of existing winter range delineations based on structural and elevational criteria. Although the identification of individual wintering areas is vital, Boer (1992) recommends that individual wintering areas be aggregated within a watershed and the area managed as a whole. This landscape approach would allow for the transient nature of deer wintering areas, and would address deer habitat requirements on a forest-level scale (Boer 1992).

I strongly agree with the recommendations of Jageman (1984) and Pauley (1990) to exclude ski trails and snowmobile trails from white-tailed deer winter ranges in the Priest Lake watershed. Such disturbances increase deer activity and energy expenditures, and may reduce winter survival (Dorrance et al. 1975, Root et al. 1988).

CLEARCUTTING ON WINTER RANGES

Many wildlife managers recommend small clearcuts ($\leq$ 8 ha), strip clearcuts less than 60 m wide, and group selection cuts on winter ranges to create an interspersion of cover and forage (Gill 1957, Krefting 1962, Boer 1978, Mundinger 1980, Owens 1981, Jageman 1984). While this has proven to be a valuable management strategy in some areas, in the Priest Lake drainage cutting units should be restricted to less critical sites adjacent to wintering areas. Cutting units within winter habitats will further fragment existing forested stands and will be at the expense of thermal cover. A more desirable alternative would be to place cutting units in close proximity to white-tailed deer winter ranges and along migratory routes. Deer should not be "boxed in" by clearcutting around winter ranges, however.

Corridors should be left between winter ranges to provide access to all wintering areas.

Pauley (1990) and I found that openings within winter ranges were avoided by white-tailed deer during all winter periods. These openings were characterized by sparse shrub cover during the growing season and served primarily as foraging areas during the early spring. Artificial openings located adjacent to wintering areas will provide accessible spring forage without sacrificing thermal cover. Following the delineation of core winter habitats, the migratory routes demarcated during this and previous studies would provide guidelines for cutting unit placement.

Cutting units should be designed on a stand-by-stand basis. Characteristics of each forested stand, including its shelter quality, age, composition, condition, deer use, and relationship to adjacent stands should be considered prior to determining the proportion of each stand to be cut. Small clearcuts less than 4 ha in size or strip cuts less than 61 m wide are recommended (Jageman 1984, Pauley 1990). Broadcast burning of residual slash is the recommended post-harvest site treatment (Irwin 1976). Site treatments should not incorporate scarification, herbicide applications, or other practices designed to discourage shrub growth.

The availability of browse in clearcuts is expected to decline as succession advances (Cowan et al. 1950). Mueggler (1965) and Nyquist (1973) found the availability of browse started to decline 20 to 30 years after logging and burning in the cedar-hemlock zone of northern Idaho. In addition, some shrub species grew to heights that are unavailable to deer prior to this time (Nyquist 1973). Prescribed burning can be a practical management tool to address this problem (Leege 1968). Leege and Hickey (1971) reported that spring and fall burning reduced crown height and promoted sprouting of many shrub species in the cedar-hemlock zone. The timing of subsequent burning will depend on the rate at which preferred browse grows beyond the reach of deer. Considering the variability of site factors between units, the determination of burn intervals will likely have to be made on a site by site basis.

REFERENCES CITED

Berner, K. L. 1985. Winter and spring habitat selection by white-tailed deer in a western Montana second-growth forest. M.S. Thesis, Univ. Montana, Missoula. 98pp.

Boer, A. 1978. Management of deer wintering areas in New Brunswick. Wildl. Soc. Bull. 6:200-205.

______ 1992. Transience of deer wintering areas. Can. J. For. Res. 22:1421-1423.

Carlson, C. E., D. G. Fellin and W. C. Schmidt. 1983. The Western Spruce Budworm in Northern Rocky Mountain Forests: A Review of Ecology, Past Insecticidal Treatments and Silvicultural Practices. In: Management of Second-Growth Forests: The State of Knowledge and Research Needs. Montana Forest and Conservation Experiment Station, Univ. Montana, Missoula.

Cowan, I. M., W. S. Hoar, and J. Hatter. 1950. The effects of forest succession upon the quantity and the nutritive values of woody plants used as food by moose. Can. J. Res., D, 28:249-271.

Dorrance, M. J., T. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39:563-569.

Drolet, C. A. 1976. Distribution and movements of white-tailed deer in southern New Brunswick in relation to environmental factors. Can. Field Natur. 90:123-136.

Finklin, A. L. 1983. Climate of Priest River Experimental Forest, northern Idaho. U.S.D.A. For. Serv. Gen. Tech. Rep. RM-159. 53pp.

Gill, J. D. 1957. Review of deer yard management 1956. Game Div. Bull. 5.: Maine Department of Inland Fish and Game, Augusta. 61pp.

Hildebrand, P. R. 1971. Biology of white-tailed deer on winter ranges in the Swan Valley, Montana. M. S. Thesis, Univ. of Montana, Missoula. 91pp.

Irwin, L. L. 1976. Effects of intensive silviculture on big game forage sources in northern Idaho. In Elk-logging-roads Symp, p 135-142. Forest, Wildlife and Range Exp. Stn, Univ. Idaho, Moscow. 142pp.

Jageman, H. 1984. White-tailed deer habitat management guidelines. For., Wild., and Range Exp. Stn. Bull. No. 37. Univ. of Idaho, Moscow. 14pp.

Jenkins, K. J. 1985. Winter habitat and niche relationships of sympatric cervids along the North Fork of the Flathead River, Montana. Ph.D. Thesis, Univ. of Montana, Missoula. 141pp.

Krefting, L. W. 1962. Use of silvicultural techniques for improving deer habitat in the lake states. J. Forest. 60:40-42.

Leege, T. A. 1968. Prescribed burning for elk in northern Idaho. Proc. Tall Timbers Fire Ecol. Conf. 9:235-253.

______ and W. O. Hickey. 1971. Sprouting of northern Idaho shrubs after prescribed burning. J. Wildl. Manage. 35:508-515.

Mueggler, W. 1965. Ecology of seral shrub communities in the cedar-hemlock zone of northern Idaho. Ecol. Monogr. 35:165-185.

Mundinger, J.G. 1980. Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana. Pages 8-92 in Montana Deer Studies. Job Prog. Rep. W-120-R, Montana Dep. Fish, Wildlife, and Parks, Helena, MT.

Nyquist, M. O. 1972. Deer and elk utilization of successional forest stages in northern Idaho. Ph.D. Diss., Washington State University, Pullman.

Owens, T. E. 1981. Movement patterns and determinants of habitat use of white-tailed deer in northern Idaho. M. S. Thesis, Univ. of Idaho, Moscow. 80pp.

Pauley, G. R. 1990. Habitat use, food habits, home range, and seasonal migration of white-tailed deer in the Priest River drainage, north Idaho. M. S. Thesis, Univ. of Idaho, Moscow. 153pp.

Root, B. G., E. K. Fritzell, and N. F. Giesmann. 1990. Migrations by white-tailed deer in northeastern Missouri. Prairie Nat. 22:185-190.

Woods, G. P. 1984. Habitat selection of white-tailed deer in the Pend d' Oreille Valley, British Columbia. M.S. Thesis, Univ. Idaho, Moscow. 361pp.

APPENDICES

Appendix A. Availability of habitat categories on 4 winter ranges in the Priest Lake watershed of northern Idaho. Availabilities based on the relative area of habitat categories within the composite minimum convex polygon of all deer locations. Composite home ranges (CHR) were independently calculated for each winter range. PICO = *Pinus contorta*, PSME = *Pseudotsuga menzisii*, THPL = *Thuja plicata*, TSHE = *Tsuga heterophylla*.

	Chipmunk		Eastside		Coolin		Reeder	
	ha	%	ha	%	ha	%	ha	%
Elevation (m)								
730 - 819	152.3	63.8	204.9	32.7	854.8	93.6	47.9	63.3
820 - 909	48.4	20.3	268.1	42.8	58.5	6.4	27.7	36.7
910 - 1000	38.0	15.9	153.5	24.5	----	----	----	----
Slope (%)								
0 - 5	138.7	58.1	38.8	6.2	711.5	77.9	9.8	13.0
6 - 15	45.1	18.9	133.4	21.3	129.7	14.2	36.7	48.5
16 - 25	29.1	12.2	309.8	49.4	72.1	7.9	16.3	21.6
> 25	25.8	10.8	144.5	23.1	-----	----	12.8	16.9
* Aspect								
North/East	17.9	7.5	35.4	5.7	25.8	2.8	4.2	5.6
South/West	82.1	34.4	552.3	88.2	176.0	19.3	61.6	81.4
Forest Canopy Cover (%)								
< 65	22.6	9.5	66.0	10.5	196.4	21.5	22.1	29.2
65 - 80	58.8	24.6	162.7	26.0	97.2	10.6	12.9	17.1
> 80	157.3	65.9	397.8	63.5	619.7	67.9	40.6	53.7
Forest Structure								
Non - Forested	19.8	8.3	32.4	5.2	172.6	18.9	10.7	14.2
Pole Timber	103.1	43.2	191.5	30.5	244.8	26.8	31.1	41.1
Mature Timber	102.4	42.9	364.3	58.1	495.9	54.3	33.8	44.7
Old Growth	13.4	5.6	38.8	6.2	-----	----	----	----
Cover Type								
THPL/TSHE	91.3	38.2	285.5	45.5	621.3	68.0	45.8	60.6
PICO/PSME	127.6	53.5	321.4	51.3	119.4	13.1	19.1	25.3

* Determined for terrain with >5% slope.

Appendix B. Results of chi-square analysis used in testing for significant differences between the use and availability of habitat categories by white-tailed deer within the Priest Lake study drainage during the winters of 1990-91 (Reeder) and 1991-92 (Chipmunk, Eastside, Coolin).

Habitat Categories	Winter Range							
	Chipmunk		Eastside		Coolin		Reeder	
	χ^2	P	χ^2	P	χ^2	P	χ^2	P
Elevation (m)	17.95	> 0.001	33.16	> 0.001	* 0.30	0.582	15.99	> 0.001
Slope (%)	19.78	> 0.001	223.78	> 0.001	11.43	0.010	51.90	> 0.001
Aspect	* 1.89	0.170	444.52	> 0.001	* 0.03	0.866	30.36	> 0.001
Forest Canopy (%)	12.20	0.007	51.60	> 0.001	27.36	> 0.001	25.23	> 0.001
Forest Structure	35.37	> 0.001	124.44	> 0.001	27.50	> 0.001	38.06	> 0.001
Cover Type	32.65	> 0.001	* 3.40	0.066	* 0.29	0.589	22.34	> 0.001

* Chi-square statistic not significant at 0.05 alpha level.

Appendix C. Winter use of physiographic features by white-tailed deer in the Priest Lake watershed of north Idaho. Expressed as the proportion of radio locations for each range and for the composite of all ranges.

	Winter Range				
	Chipmunk (n=80)	Eastside (n=103)	Coolin (n=87)	Reeder (n=71)	Composite (n=341)
Topographic Feature					
Ridgetop	0.0	0.0	0.0	0.043	0.009
Slope	0.250	0.553	0.161	0.479	0.366
Bench	0.138	0.301	0.023	0.239	0.179
Bottom	0.612	0.146	0.816	0.239	0.446
Horizontal Feature					
Convex	0.138	0.214	0.092	0.183	0.158
Level	0.750	0.485	0.816	0.324	0.598
Concave	0.075	0.175	0.011	0.169	0.109
Undulating	0.037	0.126	0.081	0.324	0.135

Appendix D. Density (stems/ha) of sapling (5-11 cm) and overstory tree species (12-49 cm) measured at winter locations of radio-collared white-tailed deer in the Priest Lake watershed of north Idaho. Only species with greater than 50 individuals (n) sampled are presented.

	Chipmunk			Eastside			Coolin			Reeder		
	$\bar{X}$	SD	(n)	$\bar{X}$	SD	(n)	$\bar{X}$	SD	(n)	$\bar{X}$	SD	(n)
Sapling Species												
Grand fir	107.2	101.1	(71)	156.9	346.4	(146)	252.6	517.5	(156)	868.5	993.4	(77)
Douglas-fir	209.4	323.2	(99)	78.3	122.7	(128)	-----	-----	-----	-----	-----	-----
Western red cedar	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Western hemlock	-----	-----	-----	-----	-----	-----	-----	-----	-----	390.1	305.2	(53)
Overstory Species												
Grand fir	121.8	83.9	(107)	324.3	663.9	(179)	223.5	259.9	(251)	149.3	111.4	(99)
Western larch	-----	-----	-----	-----	-----	-----	-----	-----	-----	424.3	540.6	(89)
Lodgepole pine	123.1	144.1	(207)	146.1	121.2	(51)	-----	-----	-----	-----	-----	-----
Douglas-fir	192.1	307.3	(198)	188.3	297.5	(352)	-----	-----	-----	-----	-----	-----
Western red cedar	-----	-----	-----	125.1	164.4	(66)	214.7	266.3	(66)	175.5	299.9	(117)
Western hemlock	-----	-----	-----	94.8	121.0	(61)	242.6	312.1	(110)	647.7	903.5	(53)

Appendix E. Understory plant species recorded in clearcuts and their surrounding forest in the Priest Lake watershed of northern Idaho. Species with coverages <0.2% are not presented.

Abbreviation	Scientific Name	Common Name
SHRUBS		
AMEALN	Amelanchier alnifolia	serviceberry
BERREB	Berberis repens	Oregon grape
CEAVEL	Ceanothus velutinus	shinyleaf ceanothus
PACMYR	Pachystima myrsinities	mountain lover
ROSSPE	Rosa spp.	rose
RUBLEU	Rubus leucodermis	rasberry
RUBPAR	Rubus parviflorus	thimbleberry
SALSCO	Salix scouleriana	scouler willow
SHECAN	Shepherdia canadensis	buffaloberry
SPIBET	Spiraea betulifolia	white spiraea
SYMALB	Symphoricarpos albus	common snowberry
VACSPE	Vaccinium spp.	huckleberry
SUBSHRUBS		
ARCUVA	Arctostaphylos uva-ursi	kinnikinnick
CHIUMB	Chimaphila umbellata	prince's pine
CORCAN	Cornus canadensis	bunchberry dogwood
LINBOR	Linnaea borealis	twinflower
HERBS/FORBS		
ACHMIL	Achillea millefolium	common yarrow
ADEBIC	Adenocaulon bicolor	pathfinder
ANAMAR	Anaphalis margaritacea	pearly everlasting
ANTSPE	Antennaria spp.	pussytoes
APOAND	Apocynum androsaemifolium	spreading dogbane
ARANUD	Aralia nudicaulis	wild sarsaparilla
ASACAU	Asarum caudatum	wild ginger
CIRSPE	Cirsium SPP.	thistle
CLIUNI	Clintonia uniflora	queencup beadlily
COPOCC	Coptis occidentalis	western goldthread
EPISPE	Epilobium spp.	fireweed
EUPESU	Euphorbia esula	leafy spurge
FRASPE	Fragaria spp.	strawberry
GALTRI	Galium triflorum	sweetscented bedstraw
GAUOVA	Gaultheria ovatifolia	Oregon wintergreen
GODOBL	Godyera oblongifolia	rattlesnake plantain
HIESPE	Hieracium spp.	hawkweed
LONSPE	Lonicera spp.	honeysuckle
MITBRE	Mitella breweri	Brewer's mitrewort
OSMCHI	Osmorhiza chilensis	mountain sweet cicely
PYRASA	Pyrola asarifolia	pink wintergreen
SMIRAC	Smilacina racemosa	false Solomon's seal
SMISTE	Smilacina stellata	starry Solomon's seal
TRIREP	Trifolium repens	white clover
VERTHA	Verbascum thapsus	mullein
VIOORB	Viola orbiculata	round-leaved violet

Appendix F. Canopy coverages of understory plant species in forested stands adjacent to clearcuts sampled in the Priest Lake watershed of northern Idaho. Refer to appendix E for complete species names. Species with coverages <0.2% are not presented.

Understory Species	UNIT NUMBER 1		2		3		4		5		6		7	
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
SHRUBS/SUBSHRUBS														
AMEALN	0.20	0.45	0.60	0.55	----	----	0.80	0.84	----	----	----	----	0.20	0.45
ARCUVA	----	----	0.80	0.84	----	----	----	----	6.40	6.77	----	----	9.80	8.41
BERREP	1.20	1.64	----	----	----	----	0.20	0.45	3.20	2.59	0.20	0.45	1.20	1.64
CHIUMB	1.00	0.71	5.20	2.39	1.20	1.30	6.40	2.51	1.40	2.61	3.40	1.14	2.20	2.39
CORCAN	4.20	2.95	8.00	8.00	----	----	13.20	7.26	1.20	1.79	1.00	1.00	----	----
LINBOR	7.00	2.74	14.80	2.59	3.20	2.17	11.60	5.32	14.00	3.32	3.40	2.19	12.40	7.16
PACMYR	4.40	5.32	15.80	6.98	----	----	4.00	2.45	11.80	15.35	----	----	5.20	2.95
ROSSPE	2.00	1.00	----	----	----	----	0.80	1.30	1.40	1.14	----	----	0.60	0.89
SALSCO	----	----	0.60	1.34	----	----	----	----	----	----	----	----	----	----
SHECAN	----	----	0.20	0.45	----	----	0.40	0.55	----	----	----	----	----	----
SPIBET	0.80	0.84	2.40	1.67	----	----	1.80	1.10	1.00	1.22	0.60	0.89	0.60	0.55
SYMALB	1.40	0.89	----	----	----	----	----	----	0.60	0.55	----	----	0.20	0.45
VACSPE	0.60	0.89	3.60	2.51	2.60	1.14	2.80	2.59	2.80	4.02	1.40	1.14	7.60	2.88
HERBS/FORBS														
ACHMIL	----	----	----	----	----	----	----	----	0.20	0.45	----	----	----	----
ADEBIC	0.40	0.55	----	----	----	----	----	----	----	----	----	----	----	----
ARANUD	6.00	3.61	----	----	----	----	----	----	0.60	1.34	0.20	0.45	0.20	0.45
ASACAU	----	----	----	----	----	----	----	----	----	----	----	----	----	----
CLIUNI	7.20	3.10	4.20	0.84	0.80	0.84	5.20	2.39	2.60	2.61	3.20	1.30	1.40	0.55
COPOCC	----	----	----	----	----	----	----	----	----	----	4.40	3.65	1.40	1.14
FRASPE	0.20	0.45	0.20	0.45	----	----	----	----	1.40	1.14	----	----	1.40	1.95
GALTRI	0.60	0.89	----	----	----	----	----	----	----	----	----	----	----	----
GAUOVA	----	----	2.00	1.87	----	----	2.00	1.87	----	----	0.40	0.55	----	----
GODOBL	0.20	0.45	----	----	----	----	----	----	----	----	----	----	----	----
HIESPE	0.20	0.45	0.20	0.45	----	----	----	----	1.00	1.00	0.20	0.45	0.80	0.45
LONSPE	0.40	0.89	----	----	2.00	0.45	----	----	0.20	0.45	0.40	0.55	0.60	0.89
MITBRE	2.20	3.19	----	----	----	----	----	----	0.20	0.45	----	----	----	----
OSMCHI	----	----	----	----	----	----	0.40	0.89	----	----	----	----	----	----
PYRASA	----	----	0.40	0.89	----	----	0.40	0.55	----	----	----	----	----	----
SMISTE	2.80	2.59	----	----	----	----	----	----	1.00	1.73	0.20	0.45	1.60	3.05
SMIRAC	----	----	----	----	----	----	----	----	----	----	----	----	----	----
VIOORB	0.40	0.55	0.40	0.55	----	----	0.20	0.45	0.40	0.55	0.40	0.55	0.60	0.89

Appendix F. Continued.

Understory Species	UNIT NUMBER 8 %	8 S.E.	9 %	9 S.E.	10 %	10 S.E.	11 %	11 S.E.	12 %	12 S.E.	13 %	13 S.E.	14 %	14 S.E.
SHRUBS/SUBSHRUBS														
AMEALN	----	----	----	----	----	----	0.20	0.45	1.20	1.79	----	----	----	----
ARCUVA	----	----	----	----	----	----	----	----	0.60	1.34	----	----	----	----
BERREP	----	----	----	----	1.00	2.24	----	----	0.40	0.55	----	----	0.20	0.45
CHIUMB	0.60	1.34	----	----	----	----	----	----	5.20	2.49	4.20	4.32	1.00	1.22
CORCAN	----	----	----	----	0.40	0.89	1.00	2.24	4.60	4.16	----	----	----	----
LINBOR	6.80	6.98	----	----	2.40	2.61	2.60	3.71	9.20	3.03	3.20	2.68	3.40	5.64
PACMYR	----	----	----	----	0.20	0.45	----	----	8.80	6.72	----	----	0.20	0.45
ROSSPE	0.40	0.55	----	----	0.40	0.89	----	----	1.20	2.17	----	----	----	----
SALSCO	----	----	----	----	----	----	----	----	0.20	0.45	----	----	----	----
SHECAN	----	----	----	----	----	----	----	----	1.20	2.17	----	----	----	----
SPIBET	----	----	----	----	----	----	0.20	0.45	0.60	0.55	----	----	----	----
SYMALB	0.40	0.89	----	----	----	----	----	----	0.60	0.89	----	----	0.20	0.45
VACSPE	2.20	3.03	----	----	----	----	1.80	0.84	2.20	2.17	2.40	2.61	----	----
HERBS/FORBS														
ACHMIL	----	----	----	----	----	----	----	----	----	----	----	----	----	----
ADEBIC	0.40	0.55	----	----	0.80	1.30	----	----	----	----	----	----	----	----
ARANUD	0.20	0.45	----	----	0.80	1.30	0.60	0.89	----	----	----	----	----	----
ASACAU	----	----	----	----	3.40	6.54	0.40	0.55	----	----	----	----	----	----
CLIUNI	0.60	1.34	0.40	0.55	2.40	3.21	1.80	0.84	4.80	4.32	2.00	1.41	----	----
COPOCC	----	----	0.20	0.45	----	----	----	----	----	----	----	----	0.20	0.45
FRASPE	0.20	0.45	----	----	----	----	----	----	0.20	0.45	----	----	----	----
GALTRI	0.60	0.89	----	----	0.80	1.79	----	----	----	----	----	----	----	----
GAUOVA	0.60	1.34	0.20	0.45	----	----	0.20	0.45	1.00	1.00	0.40	0.55	0.20	0.45
GODOBL	0.20	0.45	----	----	----	----	----	----	----	----	----	----	0.20	0.45
HIESPE	0.20	0.45	----	----	0.20	0.45	----	----	0.80	1.10	----	----	1.20	1.30
LONSPE	----	----	----	----	----	----	----	----	----	----	----	----	----	----
MITBRE	----	----	0.40	0.55	0.80	0.84	0.40	0.55	----	----	1.20	3.19	----	----
OSMCHI	----	----	----	----	0.20	0.45	0.40	0.89	0.20	0.45	----	----	----	----
PYRASA	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SMISTE	----	----	----	----	1.40	2.61	0.60	0.89	----	----	----	----	0.20	0.45
SMIRAC	----	----	----	----	0.60	1.34	----	----	----	----	----	----	----	----
VIOORB	0.60	0.89	----	----	1.00	1.22	----	----	1.60	1.52	0.20	0.45	0.20	0.45

Appendix G. Percent composition of understory plant species in forested stands adjacent to clearcuts sampled in the Priest Lake watershed of northern Idaho. Refer to appendix E for complete species names. Species with coverages <0.2% are not presented.

Understory Species	UNIT NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14
SHRUBS/SUBSHRUBS														
AMEALN	0.45	0.96	----	1.49	----	----	0.36	----	----	----	1.89	2.70	----	----
ARCUVA	----	1.28	----	----	10.13	----	17.56	----	----	----	----	1.35	----	----
BERREP	2.69	----	----	0.37	5.06	1.01	2.15	----	----	5.49	----	0.90	----	2.94
CHIUMB	2.24	8.33	8.11	11.94	2.22	17.17	3.94	4.05	----	----	----	11.71	31.15	11.76
CORCAN	9.42	12.82	----	24.63	1.90	5.05	----	----	----	2.20	9.43	10.36	----	----
LINBOR	15.70	23.72	43.24	21.64	22.15	17.17	22.22	45.95	----	13.19	24.53	20.72	24.59	38.24
PACMYR	9.87	25.32	----	7.46	18.67	----	9.32	----	----	1.10	----	19.82	----	2.94
ROSSPE	4.48	----	----	1.49	2.22	----	1.08	2.70	----	2.20	----	2.70	----	----
SALSCO	----	0.96	----	----	----	----	----	----	----	----	----	0.45	----	----
SHECAN	----	0.32	----	0.75	----	----	----	----	----	----	----	2.70	----	----
SPIBET	1.79	3.85	----	3.36	1.58	3.03	1.80	----	----	----	1.89	1.35	----	----
SYMALB	3.14	----	----	----	0.95	----	0.36	2.70	----	----	----	1.35	----	2.94
VACSPE	1.35	5.77	35.14	5.22	4.43	7.07	13.62	14.86	----	----	16.98	4.95	16.39	----
HERBS/FORBS														
ACHMIL	----	----	----	----	0.32	----	----	----	----	----	----	----	----	----
ADEBIC	0.90	----	----	----	----	----	----	2.70	----	4.40	----	----	----	----
ARANUD	13.45	----	----	----	0.95	1.01	0.36	1.35	----	4.40	5.66	----	----	----
ASACAU	----	----	----	----	----	----	----	----	----	18.68	3.77	----	----	----
CLIUNI	16.14	6.73	10.81	9.70	4.11	16.16	2.51	4.05	33.33	13.19	16.98	6.76	14.75	----
COPOCC	----	----	----	----	----	22.22	2.51	----	16.67	----	----	----	----	2.94
FRASPE	0.45	0.32	----	----	2.22	----	2.51	1.35	----	----	----	0.45	----	----
GALTRI	1.35	----	----	----	----	----	----	4.05	----	4.40	----	----	----	----
GAUOVA	----	3.21	----	3.73	----	2.02	----	4.05	16.67	----	1.89	2.25	3.28	2.94
GODOBL	0.45	----	----	----	----	----	----	1.35	----	----	----	----	----	2.94
HIESPE	0.45	0.32	----	----	1.58	1.01	1.43	1.35	----	1.10	----	1.80	----	5.88
LONSPE	0.90	----	2.70	----	0.32	2.02	1.08	----	----	----	----	----	----	----
MITBRE	4.93	----	----	----	0.32	----	----	----	33.33	4.40	3.77	----	8.20	----
OSMCHI	----	----	----	0.75	----	----	----	----	----	1.10	3.77	0.45	----	----
PYRASA	----	0.64	----	0.75	----	----	----	----	----	----	----	----	----	----
SMISTE	6.28	----	----	----	1.58	1.01	2.87	----	----	7.69	5.66	----	----	2.94
SMIRAC	----	----	----	----	----	----	----	----	----	3.30	----	----	----	----
VIOORB	0.90	0.64	----	0.37	0.63	2.02	1.08	4.05	----	5.49	----	2.25	1.64	2.94

Appendix H. Canopy coverages of understory plant species in clearcuts sampled in the Priest Lake watershed of northern Idaho. Refer to appendix E for complete species names. Species with coverages <0.2% are not presented.

Understory Species	UNIT NUMBER													
	1		2		3		4		5		6		7	
	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.	%	S.E.
SHRUBS/SUBSHRUBS														
AMEALN	----	----	----	----	----	----	0.20	0.45	----	----	1.80	1.64	0.40	0.55
ARCUVA	0.60	0.55	32.80	3.70	2.60	2.07	25.80	5.76	14.80	5.59	14.00	6.52	31.00	6.67
BERREP	4.80	7.16	----	----	----	----	1.20	1.64	3.40	2.41	1.20	1.17	3.80	1.48
CEAVEL	8.60	8.76	0.20	0.45	2.40	5.37	----	----	----	----	7.60	1.52	----	----
CORCAN	0.20	0.45	1.80	0.84	----	----	1.80	0.84	0.40	0.89	1.20	1.10	0.20	0.45
LINBOR	----	----	----	----	1.20	1.30	0.40	0.55	1.60	1.14	0.80	0.84	2.20	1.30
PACMYR	0.80	1.79	1.20	1.64	----	----	1.00	1.73	1.40	1.14	1.60	1.67	1.20	1.64
ROSSPE	2.40	2.19	0.20	0.45	----	----	----	----	0.60	0.89	----	----	----	----
RUBLEU	5.20	3.11	----	----	2.40	3.05	----	----	----	----	----	----	----	----
RUBPAR	0.60	1.34	----	----	----	----	----	----	----	----	----	----	----	----
SALSCO	----	----	----	----	0.20	0.45	----	----	----	----	----	----	----	----
SHECAN	----	----	1.20	1.30	----	----	1.00	1.22	----	----	----	----	----	----
SYMALB	1.40	2.19	----	----	----	----	----	----	0.80	1.30	1.00	1.41	0.20	0.45
VACSPE	----	----	----	----	----	----	----	----	----	----	0.40	0.89	----	----
HERBS/FORBS														
ACHMIL	----	----	----	----	----	----	0.20	0.45	4.80	3.56	1.80	1.48	0.40	0.89
ANAMAR	----	----	----	----	----	----	0.20	0.45	0.40	0.89	0.20	0.45	----	----
ANTSPE	----	----	0.20	0.45	1.20	1.30	0.20	0.45	1.20	0.84	1.60	3.05	0.20	0.45
APOAND	----	----	0.40	0.55	----	----	----	----	----	----	----	----	----	----
ASACAU	----	----	----	----	----	----	----	----	----	----	----	----	----	----
CIRSPE	2.20	2.95	0.20	0.45	2.80	2.39	0.60	0.89	0.40	0.89	----	----	----	----
COPOCC	----	----	----	----	----	----	----	----	----	----	0.20	0.45	----	----
EPISPE	16.60	8.62	----	----	2.80	0.84	0.80	0.45	----	----	1.20	1.64	0.60	0.55
EUPESU	0.60	1.34	----	----	----	----	----	----	----	----	----	----	----	----
FRASPE	2.00	2.00	4.00	0.71	0.20	0.45	8.60	4.51	9.80	5.26	5.00	2.55	3.00	3.00
GALTRI	----	----	----	----	----	----	----	----	----	----	----	----	----	----
HIESPE	----	----	0.60	0.89	0.60	0.89	0.80	0.84	1.00	1.00	0.20	0.45	0.20	0.45
LONSPE	----	----	----	----	----	----	----	----	0.20	0.45	----	----	----	----
MITBRE	----	----	----	----	----	----	----	----	0.20	0.45	----	----	----	----
TRIREP	----	----	----	----	----	----	----	----	----	----	1.20	1.79	0.20	0.45
VERTHA	1.20	1.64	----	----	----	----	----	----	----	----	----	----	----	---
VIOORB	----	----	----	----	----	----	----	----	----	----	0.40	0.55	0.60	0.

Appendix H. Continued.

Understory Species	UNIT NUMBER 8 %	S.E.	9 %	S.E.	10 %	S.E.	11 %	S.E.	12 %	S.E.	13 %	S.E.	14 %	S.E.
SHRUBS/SUBSHRUBS														
AMEALN	0.40	0.89	----	----	----	----	0.20	0.45	----	----	----	----	----	----
ARCUVA	2.20	1.64	----	----	----	----	----	----	18.20	7.89	2.00	2.00	----	----
BERREP	----	----	----	----	----	----	----	----	1.20	0.84	----	----	----	----
CEAVEL	1.80	3.03	----	----	----	----	----	----	3.20	7.16	0.40	0.89	----	----
CORCAN	----	----	----	----	0.60	1.34	1.00	1.41	1.40	0.89	----	----	----	----
LINBOR	0.20	0.45	1.40	2.61	0.40	0.55	4.40	5.59	1.20	1.64	2.80	1.92	0.80	1.30
PACMYR	1.40	0.89	2.40	1.82	0.40	0.55	2.40	2.07	1.20	1.30	0.20	0.45	0.60	0.89
ROSSPE	----	----	----	----	0.20	0.45	0.20	0.45	----	----	0.20	0.45	----	----
RUBLEU	----	----	2.00	1.58	1.80	1.30	----	----	----	----	4.40	2.07	0.20	0.45
RUBPAR	----	----	0.40	0.55	----	----	----	----	----	----	----	----	----	----
SALSCO	----	----	4.00	6.16	----	----	----	----	----	----	----	----	----	----
SHECAN	----	----	----	----	----	----	----	----	1.60	1.67	----	----	----	----
SYMALB	0.20	0.45	0.40	0.89	----	----	0.40	0.55	0.20	0.45	----	----	----	----
VACSPE	----	----	----	----	----	----	2.00	1.87	0.20	0.45	----	----	----	----
HERBS/FORBS														
ACHMIL	2.80	1.30	----	----	0.80	0.84	1.00	1.41	0.20	0.45	----	----	----	----
ANAMAR	----	----	1.40	2.19	----	----	0.20	0.45	0.80	0.84	1.80	2.17	----	----
ANTSPE	----	----	2.40	2.88	1.00	1.73	2.60	1.14	0.20	0.45	----	----	2.60	2.79
APOAND	----	----	----	----	2.40	3.36	----	----	0.80	1.30	----	----	----	----
ASACAU	----	----	----	----	0.20	0.45	----	----	----	----	----	----	----	----
CIRSPE	----	----	0.80	0.84	2.00	2.35	----	----	0.80	0.45	3.20	2.95	5.00	2.00
COPOCC	----	----	----	----	----	----	----	----	----	----	----	----	----	----
EPISPE	1.80	0.84	1.60	1.67	8.40	3.29	0.40	0.55	2.20	1.30	6.80	2.17	7.00	4.24
EUPESU	----	----	----	----	2.60	2.41	----	----	----	----	----	----	----	----
FRASPE	10.40	4.39	11.20	6.18	4.60	3.91	7.00	3.67	6.20	2.39	----	----	----	----
GALTRI	----	----	----	----	0.60	0.55	----	----	----	----	----	----	----	----
HIESPE	----	----	1.00	1.00	0.40	0.55	----	----	1.60	3.58	3.20	3.11	10.60	2.07
LONSPE	----	----	----	----	----	----	----	----	----	----	----	----	----	----
MITBRE	----	----	----	----	0.20	0.45	----	----	----	----	----	----	----	----
TRIREP	----	----	----	----	1.80	2.68	5.80	1.79	----	----	----	----	----	----
VERTHA	0.40	0.89	----	----	0.60	0.55	----	----	0.40	0.55	2.40	4.83	----	----
VIOORB	----	----	0.40	0.55	----	----	8.60	11.41	0.40	0.89	----	----	----	----

Appendix I. Percent composition of understory plant species in clearcuts sampled in the Priest Lake watershed of northern Idaho. Refer to appendix E for complete species names. Species with coverages <0.2% are not presented.

Understory Species	UNIT NUMBER													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SHRUBS/SUBSHRUBS														
AMEALN	----	----	----	0.40	----	2.88	0.75	9.46	----	----	0.35	----	----	----
ARCUVA	0.99	63.32	10.83	51.90	26.43	22.36	58.49	7.43	----	----	----	35.83	4.55	----
BERREP	7.89	----	----	2.38	6.07	1.92	7.17	----	----	----	----	2.36	----	----
CEAVEL	14.14	0.39	10.00	----	----	12.14	----	6.08	----	----	----	6.30	0.91	----
CORCAN	3.29	3.47	----	3.57	0.71	1.92	0.38	----	----	1.19	1.76	2.76	----	----
LINBOR	----	----	5.00	0.79	2.86	1.28	4.15	0.68	3.85	0.79	7.75	2.36	6.36	0.86
PACMYR	1.32	2.32	----	1.98	2.50	2.56	2.26	4.73	6.59	0.79	4.23	2.36	0.45	0.86
ROSSPE	3.95	0.39	----	----	1.07	----	----	----	----	0.40	0.35	----	0.45	----
RUBLEU	8.88	----	10.00	----	----	----	----	----	5.49	3.56	----	----	10.00	0.86
RUBPAR	0.99	----	----	----	----	----	----	----	1.10	----	----	----	----	----
SALSCO	----	----	0.83	----	----	----	----	----	11.54	----	----	----	----	----
SHECAN	----	2.32	----	1.98	----	----	----	----	----	----	----	3.15	----	----
SYMALB	2.30	----	----	----	1.43	1.60	0.38	0.68	1.10	----	0.70	0.39	----	----
VACSPE	----	----	----	----	----	0.64	----	----	----	----	3.52	0.39	----	----
HERBS/FORBS														
ACHMIL	----	----	----	0.40	8.57	2.88	0.75	9.46	----	1.58	1.76	0.39	----	----
ANAMAR	----	----	----	0.40	0.71	0.32	----	----	3.85	----	0.35	1.57	4.09	----
ANTSPE	----	0.39	5.00	0.40	1.79	2.56	0.38	----	6.59	1.98	4.58	0.39	----	9.48
APOAND	----	0.77	----	----	----	----	----	----	----	4.74	----	1.57	----	----
ASACAU	----	----	----	----	----	----	----	----	----	0.40	----	----	----	----
CIRSPE	7.57	0.39	11.67	1.19	0.71	----	----	----	2.20	3.95	----	1.57	4.55	20.69
COPOCC	----	----	----	----	----	0.32	----	----	----	----	----	----	----	----
EPISPE	27.30	----	11.67	1.59	----	1.92	1.13	7.43	4.40	17.79	0.70	4.33	15.45	30.17
EUPESU	0.99	----	----	----	----	----	----	----	----	5.14	----	----	----	----
FRASPE	3.29	7.72	0.83	17.06	17.50	7.99	5.66	35.14	30.77	9.09	12.32	12.20	----	----
GALTRI	----	----	----	----	----	----	----	----	----	1.19	----	----	----	----
HIESPE	----	1.16	2.50	1.59	1.79	0.32	0.38	----	2.75	0.79	----	3.15	7.27	36.21
LONSPE	----	----	----	----	0.36	----	----	----	----	----	----	----	----	----
MITBRE	----	----	----	----	0.36	----	----	----	----	0.40	----	----	----	----
TRIREP	----	----	----	----	----	1.92	0.38	----	----	3.56	10.21	----	----	----
VERTHA	1.97	----	----	----	----	----	----	9.46	----	1.19	----	0.79	5.00	----
VIOORB	----	----	----	----	----	0.64	1.13	----	1.10	----	3.52	0.79	----	----

Appendix J. Hiding cover (%) in clearcuts and their adjacent forest in the Priest Lake watershed of northern Idaho.

	UNIT NUMBER													
	1		2		3		4		5		6		7	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Hiding Cover (%) In Clearcut														
0.0 - 0.5 m	74.0	22.2	60.0	15.8	50.0	18.4	54.0	11.9	40.0	11.7	87.0	6.7	88.0	7.6
0.5 - 1.0 m	33.0	32.5	9.0	20.1	5.0	8.7	23.0	18.6	2.0	4.5	81.0	5.5	86.0	15.2
0.1 - 1.5 m	14.0	21.0	5.0	11.2	1.0	2.2	17.0	20.5	7.0	13.0	75.0	12.3	77.0	14.8
Hiding Cover (%) In Adjacent Forest														
0.0 - 0.5 m	95.0	5.0	96.0	2.2	67.0	16.1	97.0	2.7	83.0	12.0	94.0	5.5	73.0	13.5
0.5 - 1.0 m	90.0	14.6	80.0	5.0	50.0	23.7	92.0	5.7	71.0	24.1	91.0	8.9	43.0	16.8
1.0 - 1.5 m	89.0	11.4	65.0	14.6	32.0	31.7	79.0	15.2	66.0	24.9	95.0	8.7	28.0	22.5

Appendix J. Continued.

	UNIT NUMBER													
	8		9		10		11		12		13		14	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Hiding Cover (%) In Clearcut														
0.0 - 0.5 m	87.0	17.2	98.0	4.5	68.0	12.0	94.0	8.9	64.0	12.9	65.0	18.4	85.0	7.1
0.5 - 1.0 m	67.0	32.9	90.0	14.6	10.0	11.7	78.0	23.6	15.0	20.6	3.0	4.5	13.8	8.5
0.1 - 1.5 m	64.0	17.8	80.0	27.2	2.0	4.5	73.0	25.6	4.0	6.5	0.0	0.0	0.0	0.0
Hiding Cover (%) In Adjacent Forest														
0.0 - 0.5 m	97.0	4.5	83.0	16.0	75.0	21.5	98.0	2.7	90.0	9.4	71.0	15.2	71.0	12.9
0.5 - 1.0 m	96.0	4.2	55.0	44.2	66.0	23.0	99.0	2.2	73.0	28.4	45.0.	16.6	57.0	9.1
1.0 - 1.5 m	93.0	9.8	60.0	35.8	50.0	29.4	98.0	2.7	77.0	19.2	46.0	12.9	42.0	19.6