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Effects of Even-aged Timber Management on Survivorship in Sitka Black-tailed Deer, Southeast Alaska

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RESEARCH PROGRESS REPORT

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STUDY TITLE: Effects of Even-Aged Timber Management on Survivorship in Sitka Black-Tailed Deer, Southeast Alaska

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SUMMARY

The primary objectives of this study are to investigate the influences of even-aged timber management on survivorship and habitat selection of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) and the interactions between deer and wolves (*Canis lupus ligoni*). During this reporting period, we completed sampling 398 vegetation plots to classify habitat. We successfully captured and radiocollared 35 (project total = 50) deer and 2 wolves (project total = 3). Preliminary cluster analyses of the vegetation data suggest 9 logical habitat types, primarily differentiated by age since logging and board feet of standing timber per acre. Use by deer of these age and volume classes, as assessed by pellet-group density, showed high use of high-volume old-growth forest, young clearcuts, nonforested areas, and noncommercial forest. Intermediate use was observed in young seral forests (20–39 years after logging). Lowest use was in older seral forests (>40 years after logging). Consistent with the pellet-group data, track counts during winter revealed higher than expected use by deer of high-volume old growth and lower than expected use of young seral forest. We identified 3 groups of age–volume classes based on hiding cover for deer. We believe these groups will be useful in predicting habitats used by foraging deer, particularly if they are selecting areas that provide both forage and escape cover. Since September 1996, we have captured 84 deer. The rate of success in capturing deer improved during this reporting period because of new capture techniques. The most effective technique was net gunning, which resulted in the capture of 38 deer for an effort of 304 worker-hours (8 worker-hours/deer). Nonetheless, net gunning could only be done at night and was subject to seasonal limitations. Drop nets and rifles shooting nontelemetered darts also were effective. To capture deer year-round, a combination of these methods has proved best. Of the 84 deer captured, 50 have been radiocollared and the rest were released without collars (primarily adult males and fawns that were too small). Twelve deer (14% mortality rate) died in capture events or shortly after capture. Six radiocollared deer have died: 4 from predation by wolves, 1 from illegal hunting, and 1 from natural causes other than predation. Two deer shed their collars. The 2 wolves captured during the reporting period have been relocated weekly since October 1997. Preliminary analysis of home range for wolves on Heceta Island indicated a bimodal utilization distribution. We located radiocollared wolves and deer weekly on a randomized schedule and plotted their locations on low-level aerial photographs. These relocations will be used to identify

home range characteristics and habitat preferences in the next report period. Next year we plan to increase both the number of deer and wolves radio-collared and perform follow-up studies on winter pellet densities and hiding cover.

Key Words: clearcuts, *Odocoileus hemionus sitkensis*, old-growth, Sitka black-tailed deer, Southeast Alaska, survivorship

CONTENTS

BACKGROUND

Previous research on deer-habitat relationships in Southeast Alaska focused on patterns of habitat use (Wallmo and Schoen 1980, Rose 1982, Schoen and Kirchhoff 1985, Yeo and Peek 1992). These studies found higher densities of deer in old-growth forests than in even-aged second growth stands, particularly during winter. These differences in habitat selection have been attributed to forage abundance and availability (Wallmo and Schoen 1980), nutritional quality (Hanley et al. 1989), snow (Kirchhoff and Schoen 1987), and predation risk (Kirchhoff 1994).

Measures of habitat use alone generally are not valid for characterizing the value of habitats to a population (VanHorne 1983, Hobbs and Hanley 1990). VanHorne (1983) proposed a measure of habitat quality that included population density, survivorship, and reproduction, yet admitted that such data could not be collected feasibly in many wildlife studies. Hobbs and Hanley (1990) concluded that in habitat use studies, biologists need to examine causal relationships between resources and wildlife populations and that simple measures of use and availability of habitats would probably obscure important habitat value information. VanHorne (1983) and others noted that source-sink population dynamics can result in high population densities in relatively poor habitats. Conversely, habitats that only appear to support low population densities throughout most of the year may support high seasonal aggregations or be critical habitats during intermittent periods of severe weather.

To resolve questions concerning the quality of habitats for deer in logged landscapes, it is necessary to go beyond comparisons of use and availability of specific habitat types (e.g., Wallmo and Schoen 1980, Schoen and Kirchhoff 1990). In this study I examine how deer survival varies as a function of landscape characteristics and predation risk. Landscape characteristics are described in terms of the composition and percent cover of understory vegetation and the capability of various habitats to intercept snow. The risk of predation by wolves is considered a function of distance from wolf activity centers, den sites, and habitat types.

OBJECTIVES

Our principal objective is to determine how even-aged timber management influences survivorship in Sitka black-tailed deer and interactions between deer and wolves.

1. Characterize the habitat types available to deer in terms of forage composition and abundance, seasonal forage availability, and hiding cover.

2. Measure the use by radiocollared deer of each habitat type and look for daily and seasonal patterns of use.

3. Measure adult survivorship, reproduction, recruitment, and home range composition of adult deer by habitat types and landscapes.

4. Measure the risk of predation associated with individual habitat types as a function of vegetative structure and proximity to wolf den sites or wolf activity centers.

STUDY AREA

The study area is located on Heceta Island (55°45' N, 133°45' W), in Game Management Unit (GMU) 2 in southern Southeast Alaska. Heceta Island is approximately 180 km^2 in area, with 100 km of coastline. The island is underlain with extensive karst limestone deposits and supports productive forest growth, dominated by Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*), with lesser amounts of western red cedar (*Thuja plicata*), Alaska yellow cedar (*Chamaecyparis nootkatensis*), and shore pine (*Pinus contorta contorta*). Common shrubs include blueberry and huckleberry (*Vaccinium* spp.), rusty menziesia (*Menziesia ferruginea*), salmonberry (*Rubus spectabilis*), and devil's club (*Oplopanax horridus*). Ground vegetation is dominated by evergreen forbs (*Cornus canadensis, Coptis asplendifolia, Rubus pedatus, Tiarella trifoliata*), ferns (*Dryopteris dilatata, Gymnocarpium dryopteris, Blechnum spicant, Polystichum munitum*), and bryophytes (*Sphagnum* spp., *Hylocomium* spp., *Rhytidiadelphus* spp.).

Heceta Island supports populations of beaver (*Castor canadensis*), voles (*microtus spp.*), mice (*Peromyscus spp.*), northern flying squirrels (*Glaucomys sabrinus*), and a number of mustelids in addition to wolves and deer. Black bears (*Ursus americanus*) are present on the island but in very low numbers.

Timber harvest on the island began about 1926 and peaked between 1970 and 1985. As of 1996, 42% of the productive forestland had been cut (USFS 1996). Sixty-five percent of the harvested areas are in a young clearcut stage (i.e., less than 26 years old), while 35% are in a closed second growth stage (26–150 years old). An estimated 83% of the island is accessible by road due to logging activities (USFS 1996) and about 70% of the island is within 500 m of a road. Approximately 4 miles of new road were built during the reporting period, and the harvest of an additional 15 million board feet of old-growth timber is scheduled for summer 1998.

METHODS

HABITAT CHARACTERIZATION

We used a stratified random sampling design to obtain a representative sample of all habitats available to deer on Heceta Island. Using the USFS geographic information system (GIS) database, we overlaid a 1 km^2 grid of sample points on a map of the island. We selected 70 random points (each with an associated UTM coordinate) from which to start vegetation-sampling transects. We assigned a randomly selected transect azimuth to each point. Along each transect line, we established 6 0.2 ha circular plots at 100 m intervals. For each 0.2 ha plot, we recorded the age of the stand, the age and volume class of the stand indicated in the USFS GIS database for forest stands, tree height, basal area, hiding cover (Griffith and Youttie 1988), elevation, aspect, and percent ground cover of large, contagiously distributed understory plants. Nested within each 0.2 ha plot, we placed 6 4-m^2 subplots at 10-m intervals along the transect line. For each subplot, we recorded the percent cover of blueberry, huckleberry, and the total shrub layer. We also estimated the modal height of the shrubs. In each subplot, we positioned a 1-m^2 plot within which we estimated the percent cover of evergreen and deciduous forbs.

Statistical analysis

We performed cluster analyses (Johnson and Wichern 1992, Manly 1986) on forest understory variables to identify natural groupings important for deer. We standardized all variables by z-transforming them to equalize the influence of variables on the clustering process. The variables included modal shrub height, percent coverage of deciduous and evergreen forbs, and percent coverage of total shrubs. In addition, the percent coverages of *V. alaskaense/ovalifolium*, *V. parvifolium*, *D. dilatata*, *Gaultheria. shallon*, *L. americanum*, *M. ferruginea*, *O. horridus*, and *R. spectabilis* were included in the analyses as individual variables. We combined the modal height of shrubs and total coverage of shrubs to compute an index of shrub biomass available to foraging deer. We assumed that the maximum height deer would reach was 1.5 meters and divided this maximum by the modal height of shrubs within each 4-m^2 subplot. The upper limit of the ratio was truncated at 1. This ratio was then multiplied by the percent cover of total shrubs to compute the index for each subplot.

We averaged variables for subplots within each 0.2-ha plot and assigned plots to one of 30 habitat categories based on seral forest age or old-growth habitat timber volume. Variables were averaged over plots within each category and means were subjected to cluster analysis. We used 4 linkage algorithms to determine the stability of the clusters: complete, single, unweighted pair-group average, and Ward's linkage (Johnson and Wichern 1992). To determine which of the many possible clustering schemes was most appropriate, we relied on field knowledge of the sample plots, the stability of clustering schemes using different linkage algorithms, and plots of the distances between clusters.

We measured the distance from an observer at the center of each 0.2-ha plot to a point along the transect line at which vegetation totally obscured a range pole. We used the distance as a measure of hiding cover for deer. We performed an analysis of variance on mean hiding cover for the age and volume classes described previously and used the Student-Newman-Keuls and Tukey's post-hoc tests (Zar 1996) to identify homogeneous subgroups.

DEER HABITAT USE AND DENSITY

We conducted fecal pellet counts along each of the 70 vegetation transects, using the variable area transect method (VAT; Parker 1979). Starting at the edge of each 0.2-ha plot, we measured the distance to the center of the first, second, and third pellet groups encountered within 0.5 m of the transect line, to a maximum distance of 50 m. Pellet-group density was calculated following Parker (1979) for each habitat class identified in our cluster analysis.

Because the rate at which pellet groups decay varies with season and habitat type, correct interpretation of the densities of pellet groups requires knowledge of the length of time that pellets will persist. In 1997 we established 2 pellet-group plots (see Fisch 1978; Kirchhoff 1990) in each of the following broad habitat categories: nonforest, unproductive forest, young clearcut (1–25 years), shrub/sapling (26–74 years), and high volume old-growth forest. Each plot contained 5 pellet-groups (10 pellets per group) arranged 2 meters apart in an "X" pattern. These were monitored monthly throughout the year until they were no longer visible. New plots were established at quarterly intervals throughout the year to determine how persistence varies seasonally. We will present results of this experiment in later progress reports.

During the winter months, we used deer track counts to assess winter habitat use in the same habitat categories used for the experimental pellet plots. We established a 16 km-long transect along a roadway that is centrally located on Heceta Island. The transect traverses all of the habitat categories and elevations between 15 and 305 m. After each fresh snowfall the transect was driven slowly, and all instances in which deer tracks crossed the centerline of the road were recorded as a track set. We calculated the length of road passing through each habitat type and converted this to a proportion of the total transect. Tracks were counted only in areas where the habitat type was the same on both sides of the road. We multiplied the proportion of the transect within each habitat type by the total number of tracks counted to arrive at an expected number of tracks per habitat. We compared total observed and expected proportions of track sets per habitat type, using a chi-square test of independence. Significant outcomes were explored using a post-hoc chi-square analysis that incorporates Bonferroni confidence limits. These measures will be repeated each winter.

DEER HOME RANGE COMPOSITION, SURVIVORSHIP AND REPRODUCTION

During the reporting period we monitored radiocollared study animals on a randomized schedule with 1 relocation per animal per week. We also monitored radio signals of each deer every other day to detect mortality. We immediately investigated mortality signals by homing on the radio collar and locating the animal visually. We conducted a necropsy on all dead deer to determine cause of death, and we recorded the habitat type and geographic position of each carcass.

We will continue monitoring radiocollared animals throughout the project to estimate habitat use, home range, and rates of mortality. We will use nonparametric and parametric survivorship functions (Pollock et al. 1989, Efron 1988) to compute daily, interval, and annual survival rates.

To estimate deer reproductive success, we attempted to capture newborn fawns (neonates) of radiocollared female deer and other fawns we encountered. We fitted captured neonates with breakaway radiotelemetry collars (Telonics, Mesa, Az. USA), enabling us to monitor them for 6 months. We will attempt to estimate mortality rates of these neonates and causes of death. Neonates will be followed until December (collars break away after about 6 months). We will consider deer to be recruited into the population if they are alive at 6 months of age. We also captured fawns older than 1 month (juveniles) along the road system and fitted them with larger breakaway collars. These juveniles will be treated the same way as captured neonates, except we anticipate being able to monitor them until approximately 1 year of age.

DEER CAPTURE

We continued deer capture throughout the reporting period and compared 3 capture methods. The drop net method was successful during the last reporting period, and we continued to use it. We operated 9 drop nets along trails identified by searching for areas of high deer use. The nets operated from June–October 1997 and March–May 1998 for a total of 438 trap days (project total = 851).

We continued using nontelemetered darts to inject Capture-All 5 (concentrated ketamine/xylazine) during daylight hours. We captured deer with this method from June–August 1997, requiring approximately 478 worker-hours (project total = 528). We did not continue using telemetry darts due to safety and reliability concerns (Farmer and Kirchhoff 1998).

In October 1997 we experimented with the use of a net gun to capture deer along roadways. This effort was successful, and we used it again in April 1998, compiling a total of 304 worker-hours. We used the net gun to capture deer along roads at night. The method entailed driving the roads slowly while searching with a powerful spotlight. We used the spotlight to provoke deer to run down the road in front of the vehicle. We then chased them and fired a 10- by 10-foot net from the vehicle over the fleeing deer. We handled captured deer without chemical immobilization and only detained them long enough to determine gender, age, weight, and attach a radio collar.

We intensively searched for the neonates of known pregnant radiocollared females and searched opportunistically for nonradiocollared females with neonates. Juveniles were captured using both drop nets and net gun.

RISK OF PREDATION

We attempted to capture wolves on Heceta Island in fall. We used Nr. 14 Newhouse traps in scent post sets along roadways and trails, and blind sets along some trails. The wolf traps were modified by placing cable clamps on the jaws (Person and Ingle, 1995) to increase the offset to 1.4–1.8 cm. We attached the traps securely to small log drags, allowing animals to get off the road system and into thick cover before being stopped. These wolf traps were deployed for a total of 781 trap days in September–October 1997.

We placed radio telemetry collars on captured wolves and, whenever possible, obtained weekly relocations from the ground. Due to the wide-ranging movements of wolves, we also completed 1 aerial relocation per month. When wolves were not in areas accessible from the road system, we did only monthly aerial relocations. We augmented telemetry data by mapping all scat and track locations encountered on the road system. Because we traversed all major roadways on a biweekly rotation, all areas of the road system were equally represented in this sample.

We will use wolf relocations to identify the home range of the island's wolves. Within this home range, we will identify seasonal core areas and travel routes. We will assess risk of predation for deer in a particular location as a function of the location's distance from the nearest wolf core area and its proximity to travel routes used by wolves. Risk of predation will be assessed for general habitat types by measuring the mortality rate of deer due to predation in each habitat type and by measuring escape cover in those habitat types.

RESULTS

HABITAT CHARACTERIZATION

During July and August 1996 we completed 278 vegetation plots (project total = 398). The proportional representation of habitat types achieved in this sample (Figure 1) was approximately the same as the availability of these types on the study area. Cluster analysis of the vegetative data for each of the 30 habitat classes assigned to the 0.2-ha plots (Table 1) indicated the original classes could be condensed into only 14 habitat categories. Further cluster analyses of the vegetative data for these 14 distinct groups indicated the dimensionality of the habitat classes could be reduced to 9 classes that were robust to all of the clustering algorithms used (Figure 2). These clusters represent habitat classes within which the individual habitats are similar on a scale that probably is functionally significant to foraging deer.

We believe that the habitat classes suggested by the unweighted pair group linkage method were the most appropriate for two reasons. First, the algorithm for this method relied on average values for each variable in each class considered. This produced a clustering based on typical forage abundance, which we feel is a variable to which foraging deer realistically would respond. Secondly, dendrograms produced by the 4 linkage methods were similar in overall structure, and each produced only minor variations from the others. The unweighted pair group average method produced clusters that were supported by the other methods. All methods grouped medium and high volume old-growth forests along with young clearcuts less than 20 years of age. Similarly, all methods grouped unvegetated, 40–49, and 70+ age classes with small branch lengths separating the habitat classes. The 20–29 and 30–39 age classes were clustered at intermediate distances by all methods except single linkage, which grouped 30–39 year old seral forest with volume class 4 old growth. Since single linkage uses nearest neighbor distances, this probably reflects the effect of a small number of similar measures (for example, see LYAM , Table 1). The placement of selectively logged forest varied among the 4 clustering methods. Two of the methods grouped it with the 40–49, 70+, and unvegetated types, and 2 placed it closest to unproductive forest. The large branch lengths separating unproductive forest from most of the other clusters were largely due to the abundance of *G. shallon* in this category.

A linkage distance of 2 was used as the breakpoint at which clusters were identified (Figure 2). We based our decision on a plot of linkage distances as a function of the amalgamation step. A significant plateau in the plot at linkage distances of 2.0–2.4 indicated that little further information was added by considering larger clusters (Statsoft 1995). This information was combined with an examination of the variable means by age class (Table 1) to determine a reasonable clustering scheme. The following 9 habitat categories were defined from our analyses:

1. selectively logged forest,
2. low volume old-growth forest (below volume class 4),
3. nonforest,
4. 20–29 year old seral forest,
5. 30–39 year old seral forest,
6. high volume old-growth forest (volume classes 5-7),
7. medium volume old-growth forest (volume class 4),
8. 1–19-year-old clearcut, and
9. unproductive (40–75+-year-old seral forest and unvegetated areas).

With the exception of the old-growth categories (including nonforest), these categories do not match the timber types recognized by the USFS. We will use these categories as the basis of future hypothesis testing in this study. For clarity in this report, however, we will use the currently recognized USFS designations wherever applicable.

Hiding cover, measured as the average distance from the center of a plot at which a range pole was obscured, varied greatly between the original 14 habitat classes that were identified by the initial cluster analysis (Figure 3). An analysis of variance (Table 2) indicated significant differences between the classes (F = 13.068, P = 0.000). Post hoc analyses suggested there were 3 homogeneous subsets of the 14 age-volume classes (Table 3). A second analysis of variance on the pooled means of these subgroups confirmed the differences between them (F = 70.924, P =

0.000). Paired contrasts were significant for all pairs of subgroups ($P < 0.05$). We measured hiding cover as visibility distance, which was intended to provide a relative index to a predator's ability to see deer in a given habitat and to approximate the cues used by deer to assess hiding cover. High values correspond to sparse hiding cover and low values correspond to dense hiding cover. Consequently, subgroups 1, 2, and 3 comprise habitat classes with good, moderate, and poor hiding cover, respectively (Table 3).

Deer Habitat Use

We calculated fecal pellet densities for each of the 14 habitat classes identified by the initial cluster analysis of the vegetation data (Figure 4). Comparison of 95% confidence intervals indicated that habitats may be grouped into 3 broad categories that differ with respect to their relative use by deer. Low use occurred in seral stands aged 40–75 years, with no pellet groups encountered in habitats over 70 years old (n = 12 plots). Moderate use by deer occurred in 0–9-year-old seral forest, and 20–29 year old seral forest. The confidence interval was broad for the 0–9 class, overlapping both moderate and high use categories; however, this was mainly the result of a limited sample (n = 7 plots). High use occurred in all other classes. Although high use was recorded for the 30–39-year-old class, this is probably not representative of the true use of unmodified habitat in this class. All of the 28 plots falling within the 30–39-year-old class were in areas that had been precommercially thinned. This treatment delays canopy closure, and examination of hiding cover data (Figure 3) confirmed that understory growth in these plots was equivalent to that in the 20–29 and 10–19-year-old classes. This habitat also clustered much more closely for measures of understory vegetation with the 20–29-year-old class than with the 40–49-year-old age class (Figure 2). Thus, our data for the 30–39-year-old age class are probably representative of use by deer in younger seral stands.

We combined the data from deer track counts conducted during the winters of 1996–97 and 1997–98. There only were a limited number of days on which snow cover was sufficient to enable counts in all habitat types along the transect. We found significant differences between the observed and expected distribution of tracks (Table 4). Post-hoc analysis indicated that nonforest, unproductive forest, and young clearcuts were used in proportion to availability, while high-volume old growth received higher than expected use and shrub-sapling habitat received lower than expected use (Table 4).

Deer Capture, Reproduction, Survivorship and Home Range Composition

The different capture methods in this study were quite variable in terms of capture success, mortality rate, and labor (Table 5). We captured a project total of 84 deer (61 during this reporting period) with the emphasis on capturing adult females. Of these, 50 were successfully radiocollared and released, 12 died during or shortly after capture, and 22 were released without collars because they were fawns that were too small or they were adult males. The total rate of mortality caused by capture events was about 14% (12/84) and was due primarily to our initial use of neck snares fitted with stops to capture deer.

Six of the 50 radiocollared deer have died: 4 deer died from predation by wolves, 1 died from other natural causes, and 1 was shot illegally. Two deer shed their collars. We are currently monitoring 42 deer (6 adult males, 3 yearling males, 3 male fawns, 23 adult females, 5 yearling females, and 2 female fawns). We have recorded 1500 radio relocations to date.

Of 15 deer struck by darts during the reporting period, 7 were captured, 8 escaped, and no deer died. We fired 19 darts at deer with 79% striking the deer successfully. Escapes were due to the low muzzle velocity at which we fired the darts, which often failed to inject the immobilizing agent. The benefit to this approach was that it produced minimal wounds that required little treatment. Heavier charges would guarantee injection of the immobilizing drug but would result in more serious wounds. Despite the large number of worker-hours needed per capture for this method, it allowed us to be very selective of which deer would be added to the sample. Time for induction using 200 mg ketamine/40 mg xylezine averaged 4.5 minutes for 9 deer captured on the project.

Drop net traps produced 16 captures during the reporting period with a mortality rate of 18.8 %. They required the lowest labor expenditure of any capture method, with each trap requiring 4 hours to set up, 1 hour per week maintenance, and approximately 1 hour per week monitoring time. However, diminishing returns at trap locations indicated that additional labor time will be required to periodically move traps to new locations.

We fired the net gun 170 times and captured 38 deer during the reporting period. One capture-related mortality occurred with this method (2.6%). This method was quite efficient in terms of labor (8 worker-hours per capture) despite the low success rate per shot (22.3%) and generated a large number of captures in only 3 weeks of intensive use. Drawbacks to this method include the need for a 3- to-4-person capture team and a degree of danger to the gunner not present in other methods. This method is unsuitable for areas in which roads are heavily used by vehicles at night.

No neonates were captured during the reporting period. The abundance of thick vegetation on the study area made it unfeasible to search for birth sites. No neonates were observed on the road system until they were of sufficient age to evade hand capture. We captured 13 juveniles with the net gun and drop nets, of which 2 deer died of capture-related causes, 3 died of predation, 1 shed its collar, and 2 were released because the available collars did not fit properly.

RISK OF PREDATION

We captured 2 wolves between September and October 1997 and followed their movements via weekly telemetry relocations. Three other wolves sprung traps but managed to pull out of the traps and escape. Based on our telemetry data and direct sightings of wolves, we estimated the pack size in fall 1997 to be 6 animals. To our knowledge, none of the wolves on Heceta Island was trapped or shot during the 1997–98 trapping season.

We located and mapped a total of 160 scats between September 1996 and May 1998. We used the biweekly surveys of scats to map wolf locations along the road system and generate an adaptive kernel estimate (Worton 1989) of the home range utilization distribution (Figure 5). Although this method only provided information on road use, it was a gauge of the risk of predation for deer in adjacent habitats. About 70% of the habitat on Heceta Island is within 500 m of a road (Figure 6); therefore, the distribution of scats along roads probably was a reasonable expression of the distribution of the risk of predation for deer. In addition, the locations of scats probably reflected the movements of all wolves (total predation risk) rather than only those of collared animals. The method also provided a reasonable estimate of the wolf pack home range that will be updated when we compile a sufficient number of telemetry observations. The utilization distribution showed low use of the eastern portion of the island, as indicated by the small amount of this area included in the 95% adaptive kernel home range. The 50% adaptive kernel revealed a bimodal pattern concentrated around 2 large areas of muskeg and unproductive forest. Any point within each adaptive kernel contour may be interpreted as having a probability that wolves were present greater than or equal to the contour interval (Worton 1989). Telemetry data also suggested that wolves rarely used the eastern quarter of Heceta Island. Contrary to the distribution of scats, however, radiocollared wolves used the southern roadless portion of the island. The lack of roads prohibited our locating fresh scats regularly in this portion of Heceta Island.

DISCUSSION

Analysis of data from 398 vegetation plots suggested a habitat classification scheme that reflected habitat factors likely to be important to deer, such as the availability of forage and hiding cover. We will use this scheme to design a GIS habitat layer with which to compare our radio telemetry, tracks, and scat observations. It should be noted that our habitat assemblages are different from those used by the U.S. Forest Service. Forest Service classifications incorporate factors of importance to foresters and silviculturists and are therefore of limited use in predicting habitat use by deer.

Analyses of our measure of hiding cover (visibility distance) suggested 3 habitat groups, 2 of which included habitats that did not cluster together based on understory forage characteristics. Thus, there probably exist tradeoffs between forage value and security from predation that affect the dispersion of deer among habitats. The availability of forage and hiding cover changes seasonally, particularly in habitats dominated by deciduous vegetation. For example, in open-canopied habitats (young seral forest stands, unproductive forest, alpine, and muskegs), we observed that evergreen forbs senesced in late fall. In closed-canopy habitats these same species of forbs remained green. Consequently, young clearcuts and unproductive forest stands may provide abundant forb cover in summer but very little in winter, regardless of the depth of snow. These seasonal changes should be considered when modeling deer habitat use. We will collect data on hiding cover and the availability of forage in winter. We will then combine these data with the vegetation and hiding cover information from summer in a model that predicts habitat selection by deer. We will use telemetry and pellet group data to test and refine the model.

The pellet-group data indicated deer discriminated among habitat types consistent with results from previous studies (Wallmo and Schoen 1980, Rose 1982, Schoen and Kirchhoff 1985). The density of pellets reflected very low use by deer of older seral stands (40–70+ yrs). Poor hiding cover and low availability of forage characterized these habitats. Habitats that received intermediate and high use were characterized by good hiding cover but the availability of forage ranged from low to high. This suggested that habitat selection by deer may be heavily influenced by availability of hiding cover. Winter pellet group surveys and vegetation plots are needed to determine if these relations vary seasonally. The track count data indicate a strong preference for high volume old-growth forest in winter; nevertheless, this preference may exist only when snow is present. It should be emphasized that analyses of habitat use versus habitat availability are useful descriptive tools, but they are insufficient measures of habitat quality or potential animal density. This study will augment analyses of habitat use with information concerning survivorship, recruitment, and risk of predation. These are factors that, if ignored, will probably confound inferences concerning the value of particular habitats.

Our evaluation of capture methods led us to conclude that a strategy employing net gunning, darting, and drop netting was best for maximizing rates of capture. This is due primarily to seasonal variation in the effectiveness and safety of each technique. Net gun capture is clearly the most efficient method but requires an extensive road system and low use of the road system by humans. Intensive hunting with immobilization darts is probably the next best option, but it is of little value in the winter, when deer are active primarily after dark. Drop nets will reliably capture deer if trapsite transmitters are employed to allow hourly monitoring; however, the mortality rate is higher than the other methods.

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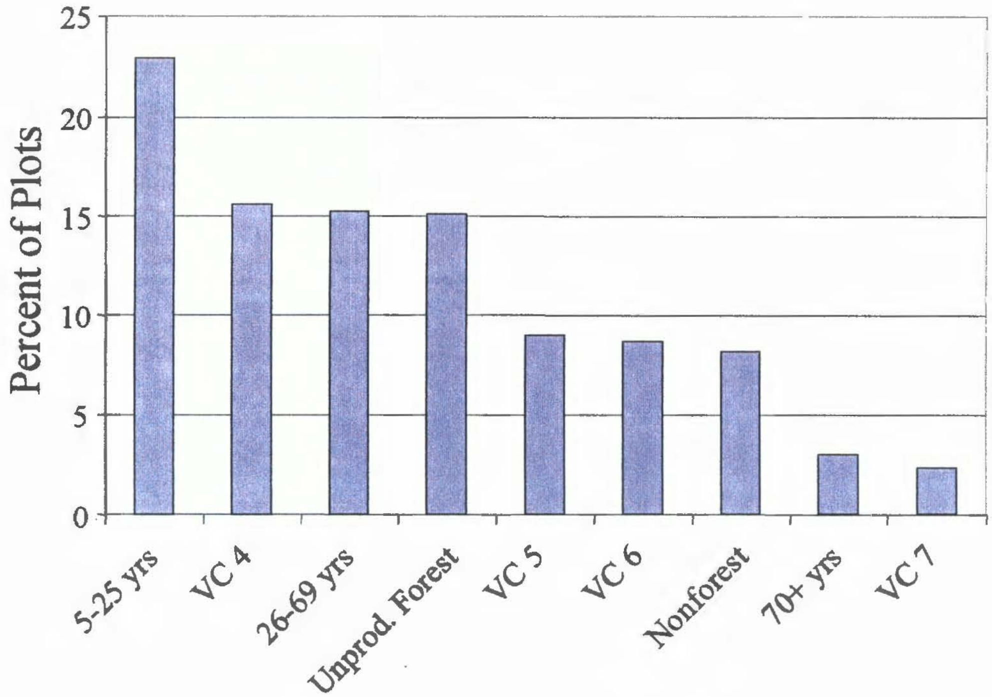
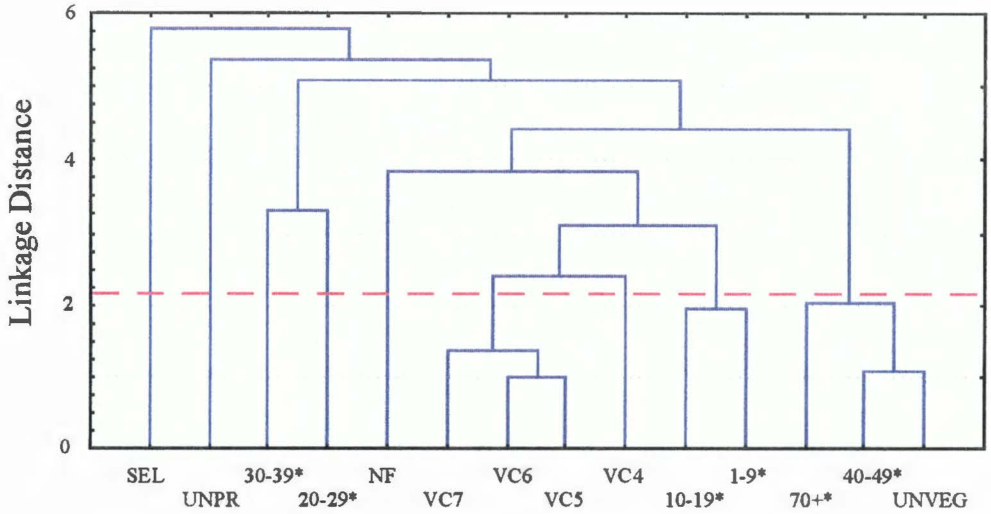


Figure 1. Proportion of vegetation plots within each U.S. Forest Service age-volume class, Heceta Island, Alaska.



KEY:

NF - NON FOREST (MUSKEG, SEDGE, ALPINE)

SEL - SELECTIVELY LOGGED FOREST

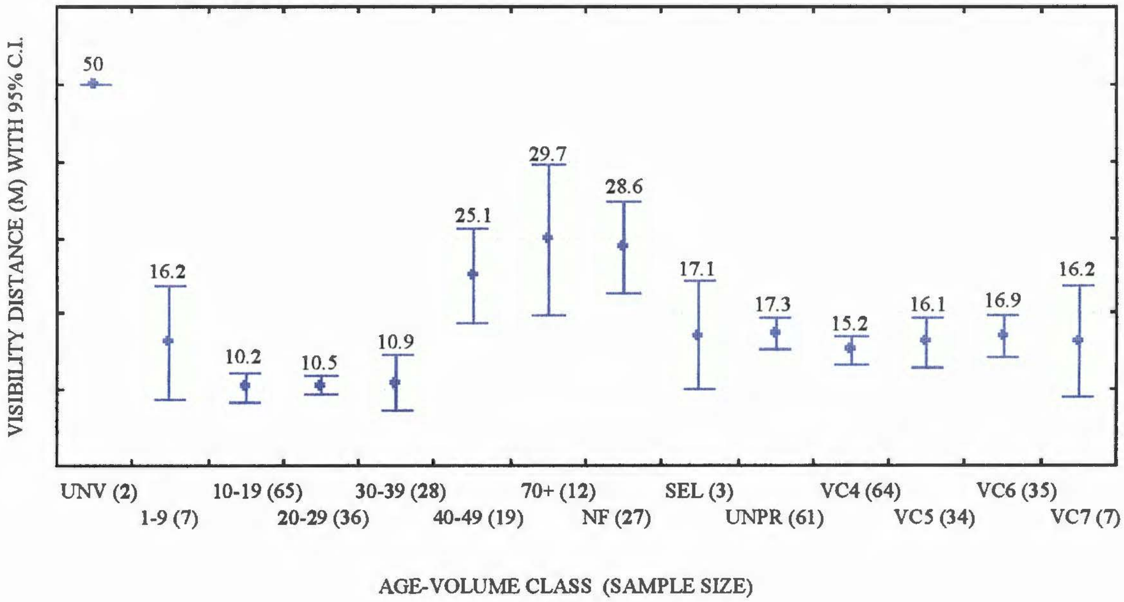
UNPRO - UNPRODUCTIVE OLD GROWTH (VOL CLASS 4)

UNVEG - UNVEGETATED

VC*X* - VOLUME CLASS *X* OLD GROWTH

* NUMERICAL RANGES INDICATE AGE OF SERAL FOREST

Figure 2. Dendrogram produced by cluster analysis of 14 age-volume classes based on forage variables, Heceta Isalnd, Alaska. Dotted line indicates linkage distance above which additional clustering may be inappropriate.



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UNV - UNVEGETATED

VC*X* - VOLUME CLASS *X* OLD GROWTH

* NUMERICAL RANGES INDICATE AGE OF SERAL FOREST

Figure 3. Mean visibility distances (in meters) by age-volume class, Heceta Island, Alaska. The mean visibility distance is considered a measure of hiding cover for deer. The larger the distance the poorer the hiding cover.

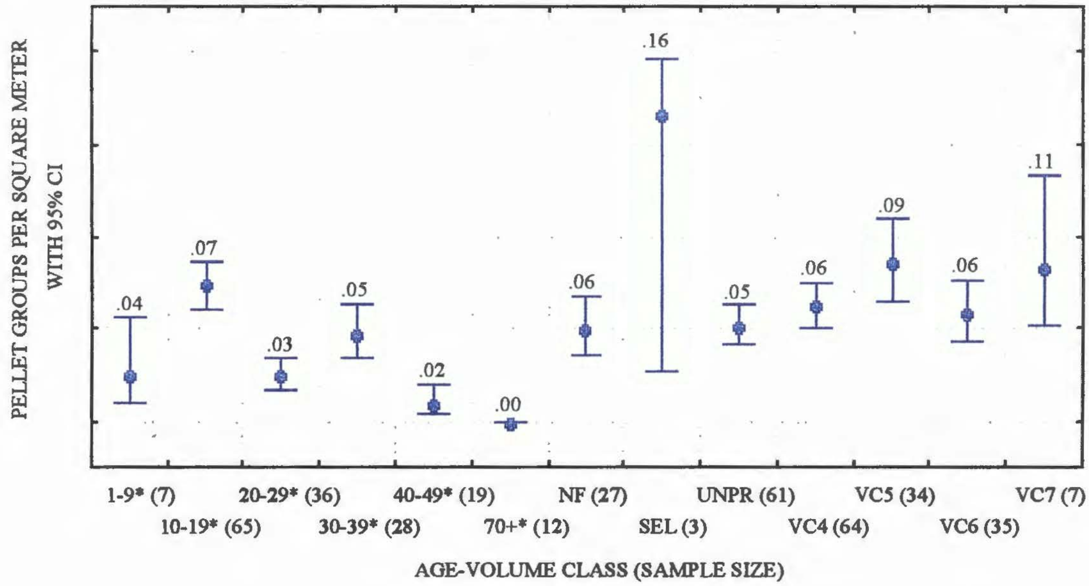

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Figure 4. Density of pellet groups by age-volume class, Heceta Island, Alaska.

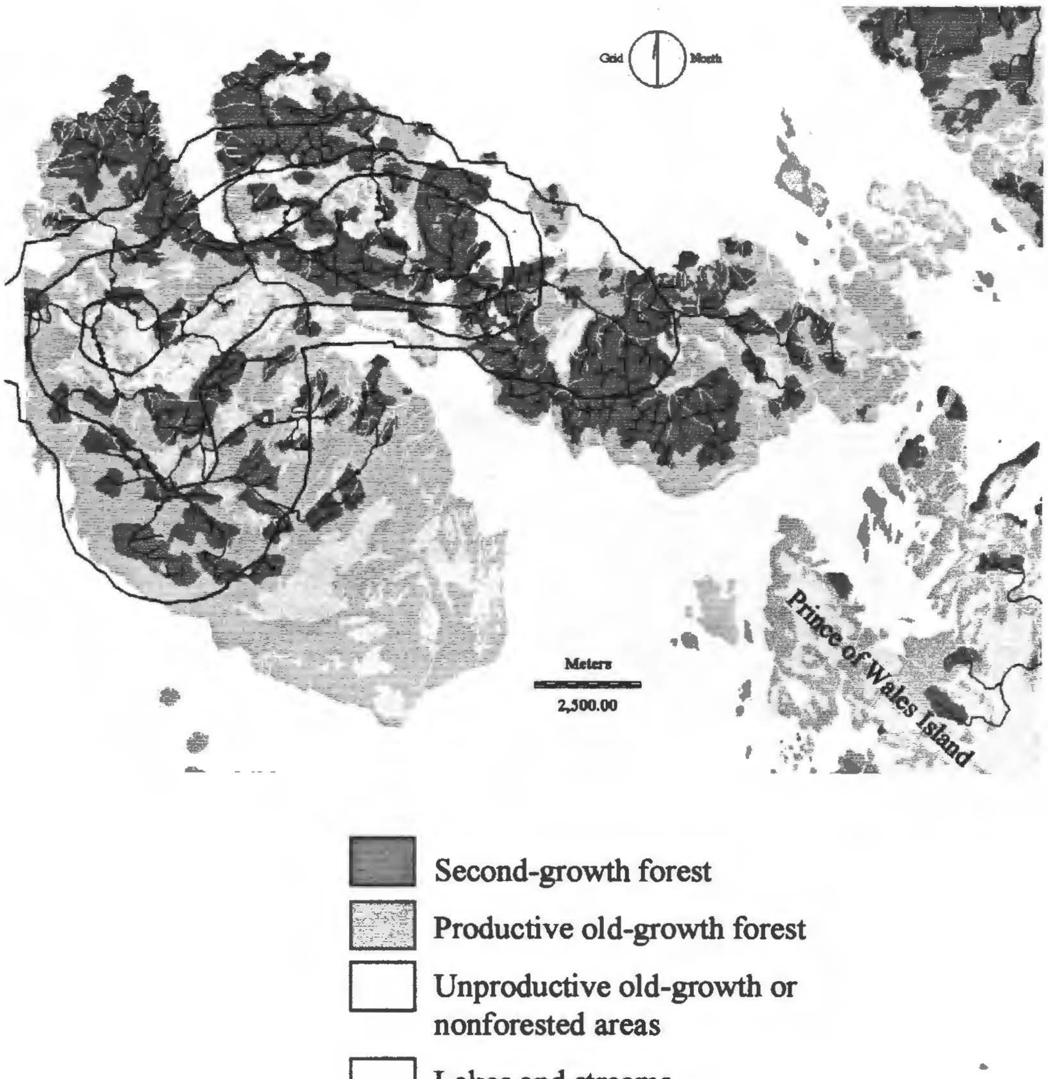


Figure 5. Estimated home ranges for the wolf pack on Heceta Island, Alaska. Home ranges are based on the locations of scats collected between September 1996 and May 1998. The contours represent the 95%, 75%, and 50% adaptive kernel home ranges (Worton 1989). Narrow black lines represent roads and blacks dots show the locations of the scats that were collected.

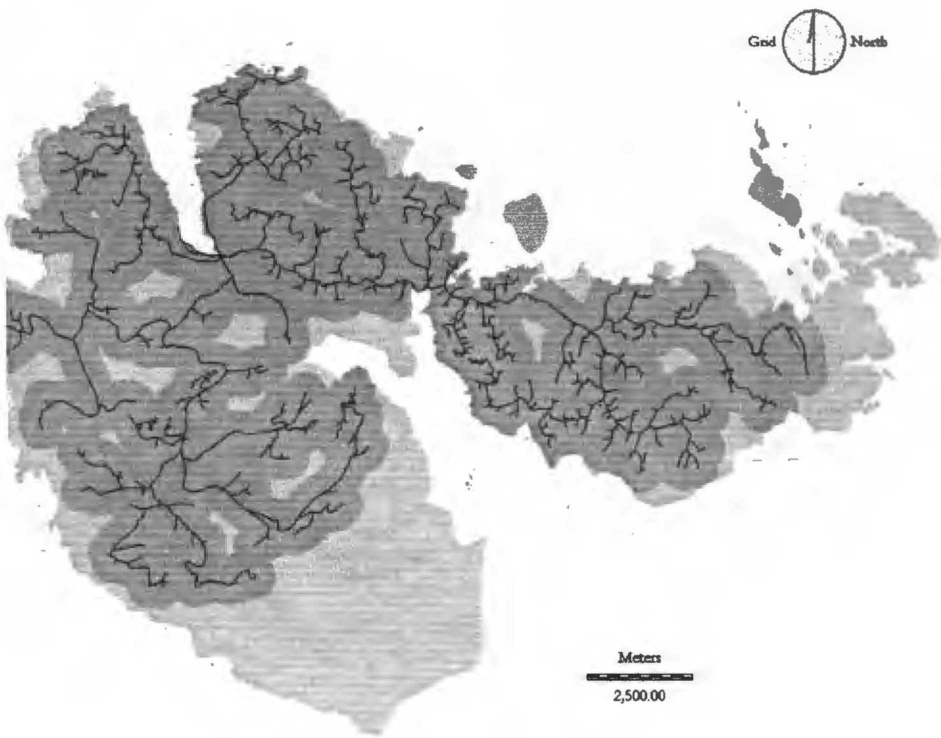


Figure 6. Map of Heceta Island, Alaska, showing the existing roads and areas within 500 meters of the road system (dark gray).

Table 1. Means of understory variables for 30 age–volume habitat classes.

Age/Volume	LYAM	OPHO	MEFE	DRDY	EVFOR	DEFOR	VAPA	VALOV	RUSP	GASH	SHBIO
9	0.0	0.3	6.7	0.0	35.5	1.8	0.3	32.2	0.1	0.0	36.67
10	0.9	0.0	2.7	7.9	15.7	7.2	1.5	32.7	1.1	0.0	40.38
11	1.0	0.2	4.6	5.7	29.5	7.1	1.4	45.7	0.5	0.0	51.52
13	0.0	0.2	2.5	1.9	16.3	2.4	0.2	22.5	0.0	0.0	23.40
15	0.0	0.0	12.9	0.3	36.8	3.4	3.8	43.5	0.7	0.0	47.75
16	0.0	0.0	0.6	3.6	35.4	12.1	0.0	54.9	0.0	0.0	55.13
17	0.0	0.0	1.0	0.0	32.0	4.2	0.0	42.3	0.0	0.0	41.38
18	0.0	1.0	5.8	0.4	23.0	3.7	1.0	34.1	0.8	0.0	38.87
20	0.0	0.0	15.0	2.5	0.0	2.4	0.4	6.7	0.0	0.0	17.78
24	0.3	4.6	16.1	0.6	2.0	3.3	1.7	12.4	15.5	0.0	38.30
25	0.0	0.0	0.0	0.5	12.3	0.3	0.3	29.4	0.0	0.0	26.35
26	0.0	2.1	1.7	1.1	8.3	2.0	3.2	39.7	24.5	0.0	54.88
29	0.0	3.8	6.2	1.1	7.3	4.8	1.9	21.8	11.8	0.0	50.18
30	5.5	2.8	20.8	0.3	19.9	6.5	9.3	36.2	17.4	0.0	63.37
31	0.0	1.9	4.7	2.7	3.8	2.4	1.2	40.3	16.3	0.0	50.86
37	0.0	5.3	10.7	0.0	16.3	2.9	0.6	6.6	15.2	0.0	25.99
44	0.0	0.3	0.3	0.0	0.0	0.1	0.0	1.4	1.8	0.0	2.44
45	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.1	0.3	0.0	2.44
46	0.0	0.0	0.0	1.3	0.6	0.3	0.0	0.1	0.0	0.0	0.11
47	0.0	0.0	0.0	13.0	5.3	3.7	0.0	1.0	0.0	0.0	6.55
71	0.0	0.3	0.0	6.3	0.5	0.2	0.1	0.8	0.0	0.0	0.83
75	0.0	0.0	0.0	11.2	0.0	0.4	0.2	3.1	0.1	0.0	3.39
NF	3.0	0.0	2.3	0.0	9.3	16.8	0.1	10.4	0.1	3.5	18.81
SEL	0.0	16.7	0.0	11.7	5.1	2.4	0.0	13.9	4.4	0.0	17.76
UNPR	5.6	0.1	4.2	0.0	15.3	11.2	1.1	16.5	0.0	18.2	39.57
VC4	5.0	0.9	4.7	2.2	13.7	8.4	1.2	28.6	0.1	2.6	34.72
VC5	1.6	1.2	5.7	1.8	8.5	4.5	2.0	24.5	0.1	0.0	28.12
VC6	1.6	2.2	3.8	2.8	8.9	7.0	1.4	25.7	0.1	0.0	26.81
VC7	0.0	0.0	3.2	2.5	5.3	2.7	1.4	25.8	0.0	0.0	28.01
UNVEG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

Key: DEFOR – % deciduous forbs, DRDY - % *D. dilatata*, EVFOR - % evergreen forbs, GASH – % *G. shallon*
LYAM - % *L. americanum*, MEFE – % *M.* feruginea, NF – % nonforest, OPHO – % *O. horridus*,
RUSP - % *R. spectabilis*, SEL - % selectively logged, SHBIO – shrub index, UNPR - % unproductive forest,
UNVEG - % unvegetated, VC*x* - % *x* volume class, VALOV - % *V. alaskense/ovalifolium*,
VAPA - % *V. parvifolium*

Table 2. Analysis of variance of visibility distance (hiding cover) by habitat class.

	Sum of Squares	df	Mean Square	*F*	*P*
Between Groups	14,922.6	13	1147.891	13.068	0.000
Within Groups	33,642.9	383	87.840	---	---
Total	48,565.5	396	---	---	---

Table 3. Homogeneous subsets based on the mean visibility distance (Tukey's HSD & Student-Newman-Keuls tests $\alpha = 0.05$). Means (in meters) for groups within homogeneous subsets are displayed by subset number.

			Subset	
Age/Volume Class	N	1	2	3
10-19	65	10.189		
20-29	41	10.512		
30-39	22	10.860		
VC4	64		15.211	
VC5	37		16.050	
VC7	6		16.583	
1-9	6		16.233	
VC6	35		16.953	
SEL	3		17.133	
UNPR	55		17.319	
40-49	20			25.100
NF	28			28.629
70+	12			29.738

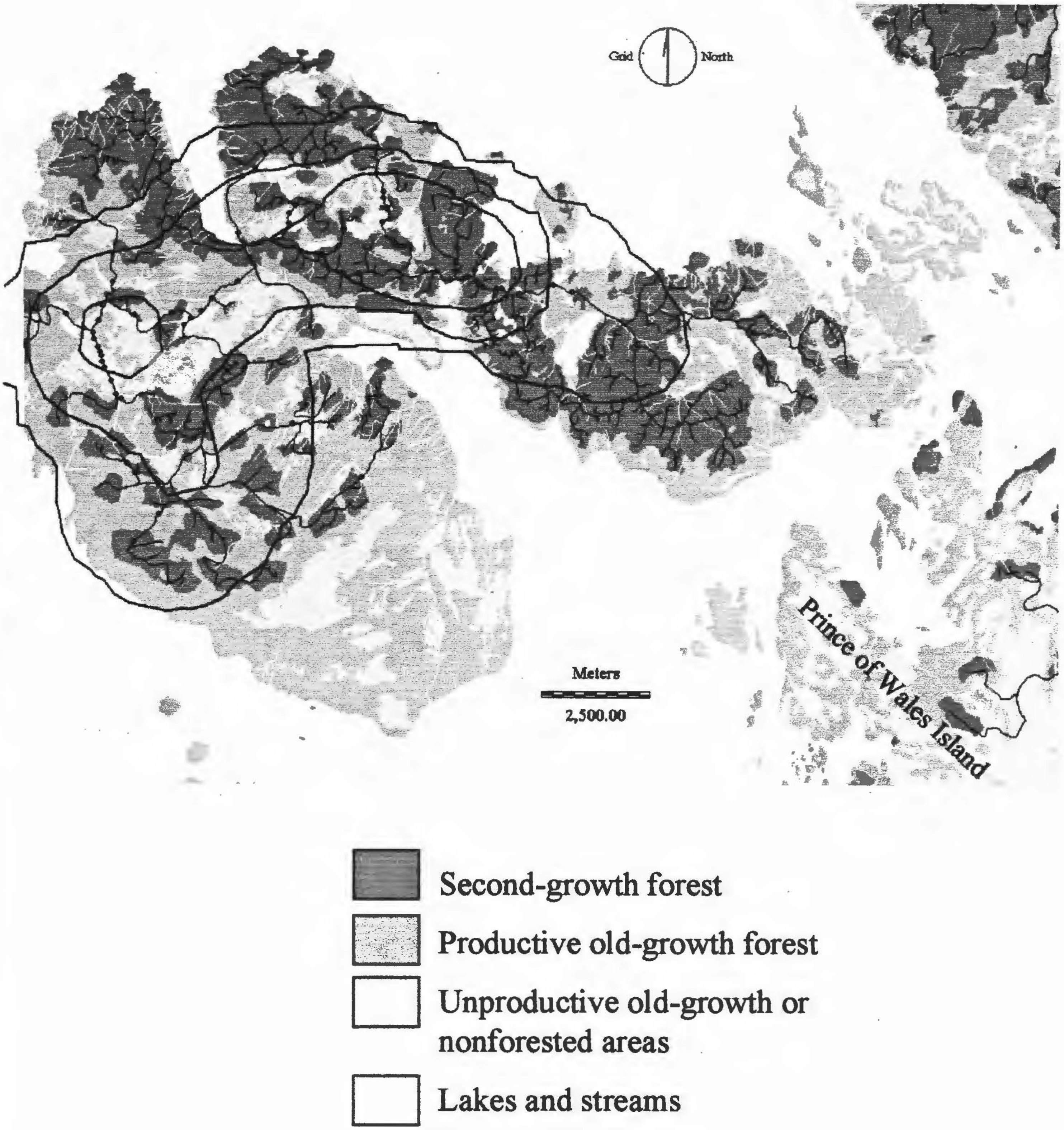
Table 4. Chi-square analysis of deer track counts, 1996-1998, by USFS habitat designation, Heceta Island, Alaska.

Habitat Type	Track Counts Observed	Expected	O-E	$(O-E)^2/E$
Nonforest	8	12.9	-4.9	1.8
Unproductive forest	48	71.1	-23.1	7.6
Young clearcut (1-25)	126	104.9	21.1	4.2
Shrub/Sapling (26-74)	99	196.8	-97.8	48.6
HV old growth	216	111.3	104.7	98.5
TOTAL	497	497	-0.000	160.7

$\chi^2 = 160.7036$, df = 4, P = 0.00000

Table 5. Comparison of deer capture methods on Heceta Island, Alaska. All values are project totals as of 30 May 1998.

Method	Trap days/ Man hrs	Contacts/ Darts fired	Total Captures	Mortalities	Released/ Escaped
Neck snare	974d	33	7	5	0
Telemetry dart	160h	28	2	2	0
Non-telem. dart	528h	28	9	0	8
Drop net	851d	48	28	4	4
Net gun	304h	170	38	1	10
Total deer			84	12	22


Grid North
Meters
2,500.00
Prince of Wales Island
Second-growth forest
Productive old-growth forest
Unproductive old-growth or nonforested areas
Lakes and streams

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

David K. Person and Elizabeth Lucas