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

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Grant W-27-2
Study 14.16
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STATE OF ALASKA
Tony Knowles, Governor

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RESEARCH PROGRESS REPORT

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AUTHORS: Christopher J. Farmer and David K. Person

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SUMMARY

During this report period we successfully radiocollared 13 deer and 5 wolves, for a total of 67 deer and 8 wolves radiocollared to date. The most efficient technique for capturing deer was net gunning. Darting free-ranging deer was also effective but had numerous limitations. Of the 67 deer instrumented, 31 (46%) have died (26 this report period). The leading cause of mortality for juvenile female deer was starvation during winter. All males captured as fawns survived their first year. Hunting and wolf predation were the primary sources of mortality for yearlings of either sex and for adult females. Hunting was the primary cause of death for adult males. A severe winter with heavy, persistent snow in 1999 caused a large increase in the number of starvation-related mortalities of deer when compared with the mild winter of 1997–98. The persistence of deer pellets was shorter in high-volume, old-growth forest than in other habitat types. We observed longer persistence of pellets in nonforest habitat than in other habitat types. The home ranges of wolves showed low use of the eastern and southwestern portions of the island. All animals on Heceta are being relocated weekly on a random schedule and their locations recorded in a computer database. These relocations will be used to identify home range characteristics and habitat preferences in the final report.

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

CONTENTS

BACKGROUND

Previous research on habitat relationships of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) in Southeast Alaska has focused on patterns of habitat use (Wallmo & Schoen 1980, Rose 1982, Schoen & Kirchhoff 1985, Yeo & Peek 1992). These studies have concluded that deer select old-growth forest over even-aged, second-growth stands, particularly during winter. Patterns of habitat selection typically have been attributed to variation in forage abundance and availability (Wallmo and Schoen 1980), nutritional quality (Hanley et al. 1989), and snow accumulation (Kirchhoff and Schoen 1987).

Measures of habitat use alone generally are not valid for characterizing the value of habitats to a population (VanHorne 1983, Hobbs & Hanley 1990). VanHorne (1983) proposed a measure of habitat quality that included population density, survivorship, and reproduction, yet admitted that such data could not feasibly be obtained in many wildlife studies. VanHorne (1983) and others have noted that source-sink population dynamics can result in high population densities in poor habitats, and, conversely, habitats with low population density may be seasonally important to the population. Hobbs & Hanley (1990) concluded there was a need for studies of habitat use to examine the causal relationships between resources and wildlife populations, and that simple measures of use and availability were likely to obscure important information.

To resolve questions of habitat quality for deer in logged landscapes, it is necessary to go beyond the earlier examinations of use and availability of specific habitat types (e.g., Wallmo & Schoen 1980, Schoen & Kirchhoff 1990). This study examines how deer survival varies as a function of landscape condition and the risk of predation. We describe the condition of the landscape in terms of the composition of plant species, quantity and quality of understory vegetation, and the ability of habitats to intercept snow. Measures used to assess the risk of predation are the distances of deer from centers of activity for wolves, and the amount of hiding cover associated with each habitat type within the home ranges of deer.

OBJECTIVES

To determine how even-aged timber management influences survivorship in Sitka black-tailed deer and interactions between deer and Alexander Archipelago wolves (*Canis lupus ligoni*).

JOBS

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

2. Measure the frequency of use by radiocollared individuals that each habitat type receives and determine diurnal and seasonal patterns of use.

3. Compare adult survivorship, reproduction, recruitment by habitat composition within the home ranges and by landscape type.

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.

This report focuses on results for jobs 2–4. Job 1 was completed during the previous reporting period and the results were summarized in Farmer et al. (1998).

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 several species of blueberry (*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 expansa, Gymnocarpium dryopteris, Blechnum spicant, Polystichum munitum*), and bryophytes (*Sphagnum* spp., *Hylocomium* spp., *Rhytidiadelphus* spp.).

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). Of that cut, 65% was in a young clearcut stage (i.e., less than 26 years old), while 35% was 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). 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 1998–2000.

METHODS

DEER HABITAT USE AND DENSITY

We estimated the activity of deer within habitat types from surveys of pellet groups (Farmer et al. 1998). The persistence of pellet groups varies with season and habitat type potentially confounding the correct interpretation of pellet-group densities. In 1997 we established 2 pellet persistence plots (see Fisch 1978; Kirchhoff 1990) in each of the following broad habitat categories: nonforest, low-volume old-growth forest (LVOG; < 8,000 mbf/acre), young clearcut (1–25 years, SC1), shrub/sapling (26–74 years, SC2), and high-volume old-growth forest (HVOG). Each plot contained 5 pellet-groups (10 pellets per group) arranged 2m apart in an "X" pattern. We monitored these on a monthly basis until pellets were no longer visible. New plots were established at quarterly intervals (May, August, November, February) throughout the year to determine how persistence times varied seasonally. We recorded the mean persistence time of all undisturbed subplots in a given plot. Several subplots were excluded from analysis when deer consumed or moved the marking flags.

To identify differences in pellet persistence, we performed a 2-way analysis of variance (ANOVA), treating season and habitat type as fixed factors. We tested for homogeneity of variances using Levene's test and performed repeated contrasts and post hoc comparisons to identify times of persistence that were different. Season was recorded as the calendar season in which the pellet groups were first deposited.

DEER HOME RANGE COMPOSITION, SURVIVORSHIP, AND REPRODUCTION

During the reporting period, we obtained radiolocations on a randomized schedule with 1 relocation per animal per week. We also monitored radio signals every other day to detect mortality. We investigated mortality signals as soon as possible after detection by homing on the radio collar and locating the animal visually. For all dead deer, we determined cause of death, habitat type, and geographic position of the carcass. Monitoring of home range and mortality will continue throughout the project.

To estimate deer recruitment, we opportunistically captured fawns encountered along roads or in other habitats. We fitted neonate fawns with breakaway radio-telemetry collars (Telonics, Mesa, AZ USA.) that enabled us to monitor them for approximately 6 months. Fawns were considered recruited into the deer population if they were 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 fawns were treated the same way as neonates, except we anticipate being able to monitor them until they are approximately 1 year of age.

We estimated deer survivorship between 1997 and 1999, using the Kaplan-Meier product limit method (Efron 1988, Pollock et al 1989). Survivorship was estimated for juvenile (<1-year-old), yearling (1–2 years old), and adult (>2 years old) age classes. We used least squares regression to estimate parameters and functions for the best fitting survival function for males and females (Lee 1992). Survival functions were tested for goodness of fit using a Chi-square analysis. A significant Chi-square statistic indicated the theoretical distribution fit the data more poorly than a null model allowing for different hazard rates in each interval; the model with the least significant result therefore fit the data best. We also calculated rates of mortality by cause for all males and females.

DEER CAPTURE

We continued deer capture throughout the reporting period and compared 2 capture methods. We used nontelemetered darts to inject Capture-All 5 (concentrated ketamine/xylazine) during daylight hours. We captured deer with this method during June–August 1998 and during May 1999. Approximately 192 man hours (project total = 720) were used darting deer. We also used a net gun to capture deer on the roads at night in September and November 1998, for a total of 168 man hours (project total = 472). Farmer et al (1998) described both methods.

RISK OF PREDATION

To monitor the risk of predation by wolves across the island, we captured wolves in the late summer. We used Nr. 14 Newhouse traps in scent post sets along roadways and trails and blind sets along some trails. We attached the traps securely to small log drags, allowing animals to get off the road system and into thick cover before being stopped. Traps were deployed for a total of 216 trap days in August 1998.

We placed radio-telemetry collars on captured wolves and obtained weekly relocations from the ground when possible. Because wolves were not always detectable from the road system, we also obtained 1 aerial relocation per month.

We used wolf relocations to identify the home range of the island's wolves. Within this home range, we identified seasonal core areas and travel routes. The risk of predation within a habitat was a function of distance of that habitat from the nearest core area, proximity to travel routes, and the utilization distribution determined by home range analysis. Risk of predation was assessed for general habitat types by measuring the mortality rate due to predation in each of the habitat types and by measuring escape cover in those habitat types.

RESULTS

DEER HABITAT USE AND DENSITY

During this report period, heavy, persistent snow caused us to terminate the pellet-persistence study in February 1999. Before that, we had recorded a total of 48 average pellet persistence times for 10 independent plots. These were analyzed by habitat type and season (Table 1). Levene's test for homogeneity of variances indicated that the variances among the categories were heteroscedastic ($F = 5.41$, $P = 0.00$). However, examination of the data showed that this was because the data for the duration of persistence during summer deviated strongly from a normal distribution. Despite this, we proceeded with a two-factor ANOVA because only 1 variance was significantly different from the others, and ANOVA is robust to violations of the assumptions of normality and homogeneity of variances. Habitat ($F = 6.27$, $P = 0.00$) and season ($F = 13.02$, $P = 0.00$) significantly affected pellet-persistence times (Table 2). The interaction effect of season and habitat was not significant ($F = 0.89$, $P = 0.12$).

Repeated Bonferonni contrasts indicated that pellets persisted in nonforest longer than in young clearcuts (4.46 vs 3.66 months, $P = 0.04$). There was no significant difference ($P < 0.05$) in persistence times among young clearcut, shrub/sapling forest and unproductive forest types. Pellets persisted longer in low-volume, old-growth forest than in high-volume, old growth (3.73 vs. 2.93 months, $P = 0.03$). We ranked relative pellet persistence among these habitats as follows: long persistence (nonforest), moderate persistence (young clearcut, shrub/sapling, and LVOG forest), and short persistence (HVOG forest).

Seasonal effects were also in the pellet-persistence data. Repeated Bonferonni contrasts indicated that summer persistence was significantly shorter than persistence in spring across all habitats (2.99 vs. 3.96 months, $P = 0.003$). Summer and fall persistence did not differ significantly ($P > 0.05$). Pellets persisted longer in winter than in fall (4.89 vs. 3.64 months, $P = 0.001$). Seasonal pellet persistence therefore falls into 2 categories: shorter persistence (summer and fall) and longer persistence (spring and winter).

DEER CAPTURE

The capture methods we used were variable in terms of success, mortality rate, and effort per capture (Table 3; project totals). As of 31 May 1999, we captured 103 deer (13 this reporting period). Of these, 67 were successfully collared and released. Twelve others died during or within 1 week of capture (11.6% capture-related mortality). No capture-related mortality occurred during this report period. The other 24 deer were released without collars (adult males and fawns that were too small or shed their collars). The current sample of 36 radiocollared deer contains 4 adult males, 2 yearling males, 2 male fawns, 26 adult females, and 2 yearling females. During this reporting period, 1 radio collar failed and 1 breakaway collar released as designed.

Of 8 darts fired during the reporting period, 3 struck deer and 2 deer were successfully captured. Induction times, using 200-mg ketamine/ml, averaged 4.5 minutes for 11 deer captured thus far by darting on the project. We also captured 13 deer in 29 attempts with the net-gun during the reporting period (45% success rate). Two of these deer shed their collars shortly after release.

Two neonates were captured during the report period. The dense vegetation in early seral habitats made it difficult to search effectively for birthing areas. Most neonates observed on the road system were old enough to evade hand capture. Of 8 juvenile deer captured with the net-gun, 6 were collared. Two shed their collars after release.

DEER HOME RANGE COMPOSITION, SURVIVORSHIP, AND REPRODUCTION

Survival rates varied among age and sex classes of deer (Figures 1–2). Twenty-five deer died during the report period (Table 4). Median survival after capture of males in the study group was 218 days for yearlings and 286 days for adults. All juvenile males survived into the next age class. There was no significant difference between the survival functions for adults and yearlings ($\chi^2 = 1.27$, df = 1, $P = 0.53$). Survival times for males were generated from small sample sizes (11 adults and 8 yearlings); therefore, these conclusions are preliminary.

Median female survival times in the study group were 136 days for juveniles, 246 days for yearlings, and 424 days for adults. Sample sizes were 11, 21, and 36, respectively. The survival functions of female age classes differed significantly (χ^2=15.51, df=2, P = 0.004). This difference was due primarily to the low early survival rate of juveniles. Annual survival rates for adult males and females were similar (0.60 vs. 0.66; Table 4), although the dominant causes of mortality differed (Table 4). The primary cause of mortality for adult males was hunting (30%), while those for adult females were hunting and wolf predation (both 11%). There was a larger difference between the survival of yearling males and females (0.70 vs. 0.80). Yearling males succumbed primarily to wolf predation (18%), and yearling females died from hunting and wolf predation at equal rates (both 10%). A large difference was evident in the survival of juvenile males and females (1.00 vs. 0.33). The primary cause of mortality among juvenile females was starvation (33%). Most starvation deaths in this age class occurred during the severe winter of 1998–99.

RISK OF PREDATION

A total of 8 wolves have been captured and radiocollared to date. One animal dispersed from the island in 1997 and 2 others dispersed during the current reporting period. We captured 5 wolves in August 1998 and followed their movements by weekly telemetry relocations. Observations of the animals at a rendezvous site confirmed that all of the year's offspring (4) were captured. The fifth animal we captured was an adult female that probably died of capture-related injuries in October 1998. We believe that in March 1999 trappers killed the 2 wolves that dispersed from the island during the current reporting period. The resulting winter pack size was 6 animals, of which only 2 were adults. A trapper killed 1 collared juvenile wolf on Heceta in March 1999, leaving a pack of 5 animals on the island at the beginning of the 1999 denning season.

We used the weekly telemetry relocations to generate an adaptive kernel estimate (Worton 1989) of the wolf home range utilization distribution (Figure 3). We based the home range estimate on 146 telemetry relocations of all 8 wolves between 1996 and 1999. The areas within each adaptive kernel may be interpreted as having an equal probability of wolf presence, since they are constructed as probability density functions (Worton 1989).

DISCUSSION

Results of the pellet-persistence study indicate that current pellet-based estimators of deer density may overestimate the relative abundance of deer in some habitat types. Because pellets persist for significantly shorter times in high-volume old growth than in other habitat types, pellet-group sampling that assumes equal duration for persistence among different habitats will overestimate the abundance of deer in habitats other than high-volume old growth. Therefore, estimates of the density of deer within different habitats based on pellet groups must be adjusted to reflect the influence of habitat and season on the duration of the persistence of pellets. The fact that the longest average persistence occurs in the habitat with the least canopy, while the second longest average persistence occurs in a habitat with a closed canopy suggests that some factor in addition to precipitation is important in determining pellet persistence. In performing the fieldwork, we noticed that detritivores such as millipedes and banana slugs were frequently found on the pellet groups in the old-growth habitat types but not in the second-growth types. It is likely the combined effects of precipitation and detritivores account for the habitat and seasonal differences noted. In using the seasonal results of this study, it is important to note that the months falling into each seasonal category may not match usual expectations for the season. For example, "Summer" persistence in this study refers to pellets deposited in August; typically, these persisted through August, September, and October. Thus, in using our results to plan future pellet-based density estimates, it may be helpful to rename the functional groupings to more accurately reflect the actual seasons they characterize.

The survivorship of deer reveals some interesting contrasts among age and sex classes. Juvenile females appear the most seriously affected by severe winters, but adult females also began starving by the end of winter 1999. Although survival of juvenile males was 100%, only 2 of those animals were at risk as juveniles during winter 1999. Interpretation is further clouded by the fact that both males had significant amounts of high-volume old growth in their home range, while only 25% of the at-risk juvenile females did. We do not know what the neonatal mortality rates are for either sex due to our inability to capture neonates.

For yearling and adult age classes, female median survival was greater than male median survival. This is probably an artifact of greater hunting pressure on males. Yearling males and females seem to experience approximately the same risks, but sample sizes for these categories are fairly small. Human-caused mortality is clearly the major factor affecting adult male survivorship, but it is most interesting that this factor occurs in all categories except juvenile males. During the report period, humans illegally killed 6 females and 1 male. When compared to the 3 adult males legally killed by hunters during the same period, the reported legal harvest of deer may substantially underestimate the actual mortality of deer from hunting.

The severe winter that occurred during this report period caused an increase in the rate of mortality from wolf predation, compared to previous years. Some of the mortality was clearly compensatory in which wolves killed deer that already were probably starved beyond recovery. This appears to have resulted from the concentration of deer in residual old-growth stands at low elevation, producing both resource competition for the deer and efficient prey location for wolves. Telemetry during the winter months indicated movement of both species into these old-growth stands.

Since the inception of the project, we have captured 8 wolves on Heceta Island. Young wolves have consistently dispersed from the island and left the pack size fairly stable at about 6 animals. Over the last 3 years, 3 collared wolves have dispersed to other islands. In one case, a male wolf dispersed to Noyes Island, a journey requiring 2 open ocean swims of several kilometers or more. Two of the dispersers and 1 resident juvenile appear to have been killed by trappers, although the radio collars were never returned.

Wolf home range utilization shows a pattern similar to that generated via scat locations (Farmer et al 1998). There is a center of activity corresponding to winter relocations that is along the watersheds north and east of the mountain. A second activity center in the west of the island corresponds to summer relocations and is influenced by the location of the den.

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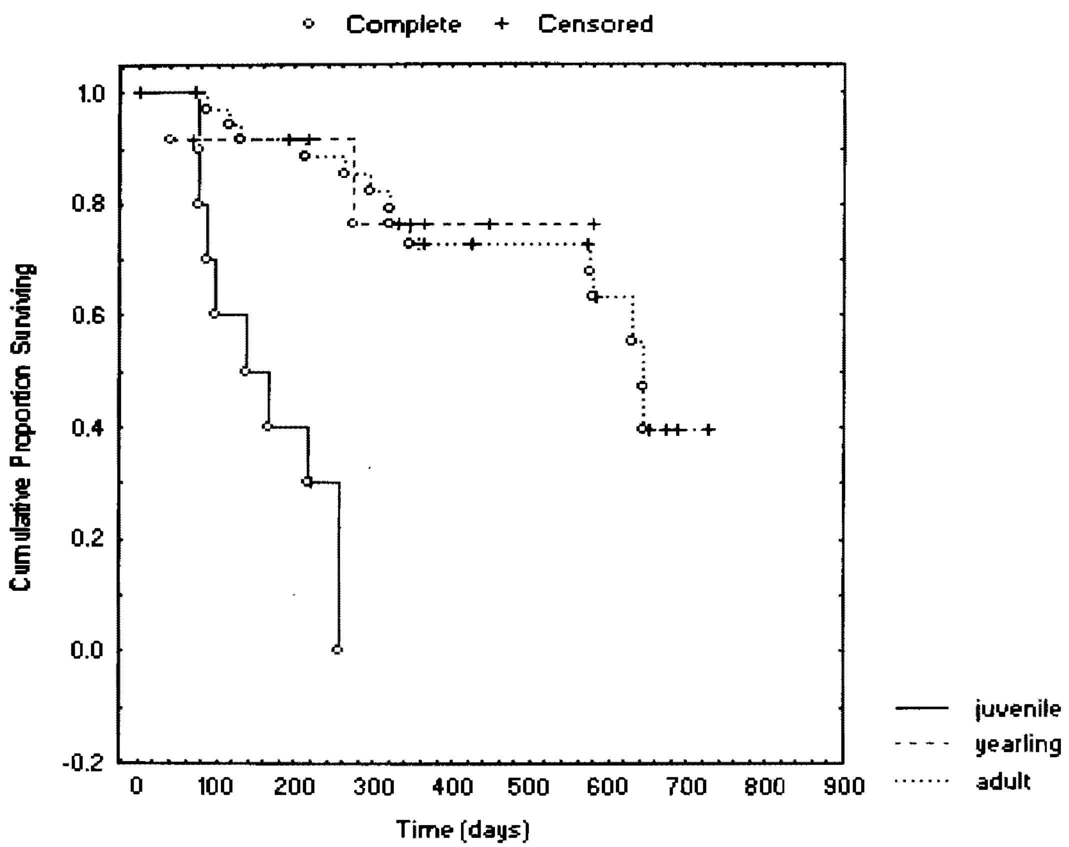


Figure 1. Cumulative proportion of female deer surviving by age class, Heceta Island, Alaska.

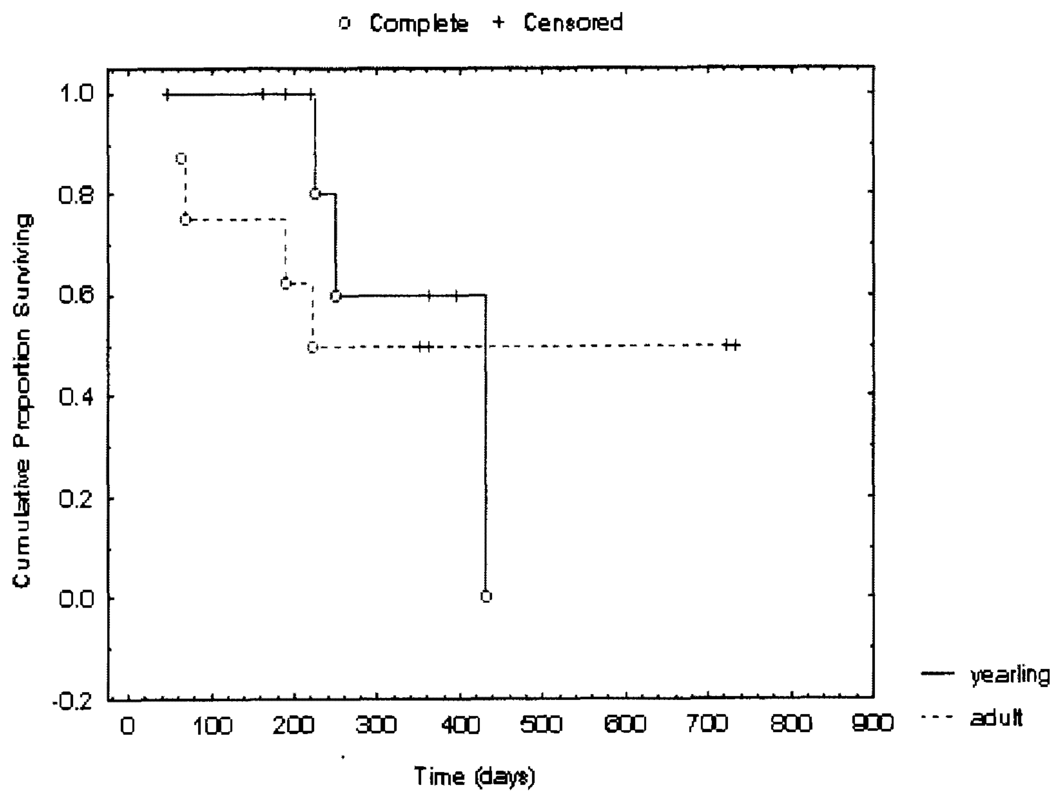


Figure 2. Cumulative proportion of males surviving by age class, Heceta Island, Alaska. Juveniles are omitted because all cases were censored.

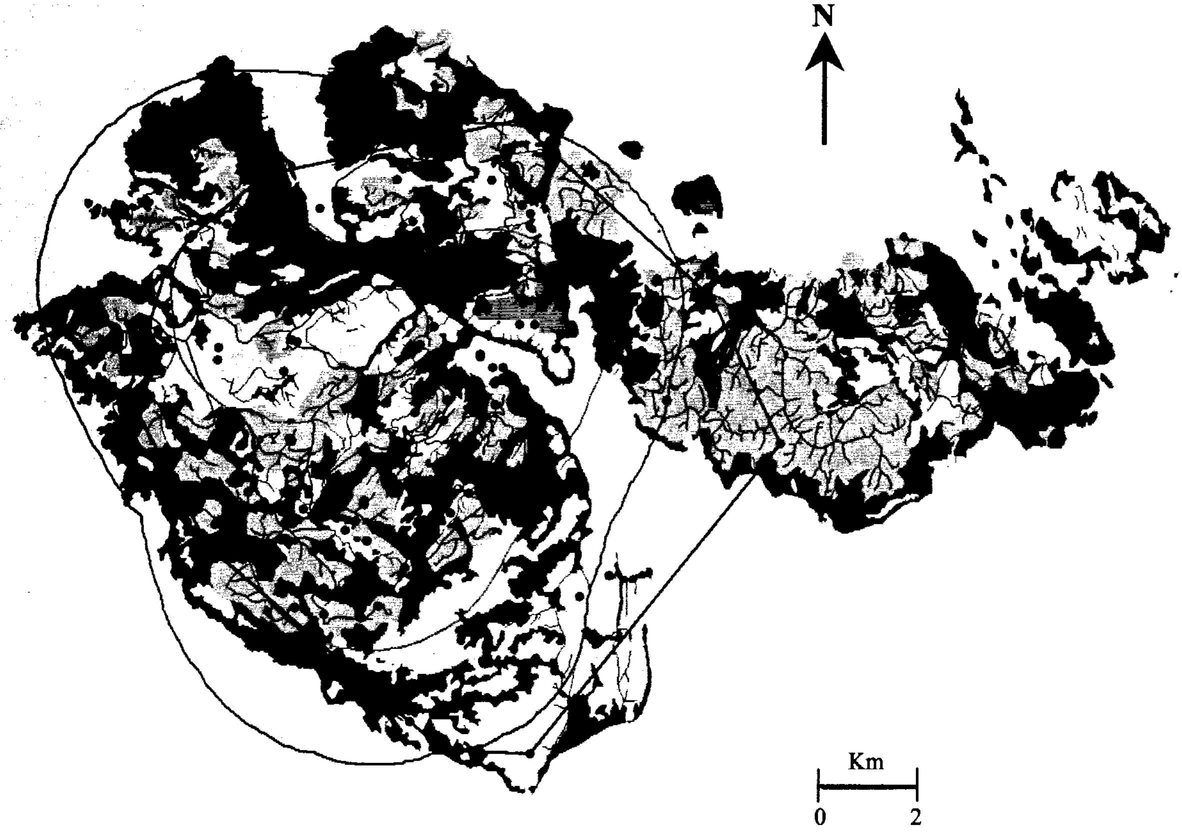


Figure 3. Wolf home range and core areas 1996-98, Heceta Island, Alaska (n = 147 relocations). The black polygon is the 100% MCP, the red contours are the 95% and 50% adaptive kernel home ranges. Map habitat key: gray = alpine, med. blue = lakes and streams, lt.green = muskeg and unproductive old-growth forest, med. green = productive old-growth forest, dark brown = second growth >25 years old, yellow = second growth $\leq$25 years old, orange = unclassified private land, black lines = roads.

Table 1 Mean pellet persistence (months) by habitat and season.

Habitat	Spring	Summer	Fall	Winter	Mean
Nonforest	4.75	2.78	4.80	6.20	4.46
SC1	3.68	3.67	3.90	4.40	3.87
SC2	4.27	4.00	3.20	5.10	4.16
LVOG	3.57	2.75	4.18	4.50	3.73
HVOG	3.53	2.00	2.13	4.20	2.93
Season Mean	3.96	2.99	3.64	4.88	3.82

Table 2 Two-way analysis of variance on fecal pellet persistence by habitat and season.

	Type I Sum of Squares	df	MS	F	*P*
Intercept	701.047	1	701.047	1331.393	0.000
Season	20.565	3	6.855	13.019	0.000
Habitat	13.203	4	3.301	6.269	0.001
Season* Habitat	10.719	12	0.893	1.696	0.122
Error	14.743	28	0.527	---	---
Total	760.278	48	---	---	---

Table 3 Comparison of deer capture methods on Heceta Island, Alaska (All values are project totals as of 30 May 1999).

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	720h	32	21	0	8
Drop Net	851d	48	22	4	4
Net-Gun	472h	199	48	1	12
Other	-	3	3	0	0
Total nr Deer			103	12	24

Table 4 Cause-specific mortalities and mortality rates (in parentheses) of deer, all ages combined.

Females	N	Human	Wolf	Starv.	Wolf/Starv.[1]	Other	Total
6/97–6/98	34	0	2	0	1	0	3
		(0.00)	(0.06)	(0.00)	(0.03)	(0.00)	(0.09)
6/98–6/99	45	6	4	4	4	3	21
		(0.13)	(0.09)	(0.09)	(0.09)	(0.07)	(0.47)
Males							
6/97–6/98	14	0	1	0	0	1	2
		(0.00)	(0.07)	(0.00)	(0.00)	(0.07)	(0.14)
6/98–6/99	15	4	1	0	0	0	5
		(0.26)	(0.07)	(0.00)	(0.00)	(0.00)	(0.33)
Total							
6/97–6/98	48	0	3	0	1	1	5
		(0.00)	(0.06)	(0.00)	(0.02)	(0.02)	(0.10)
6/98–6/99	60	10	5	4	4	3	26
		(0.16)	(0.08)	(0.06)	(0.06)	(0.05)	(0.43)

[1] Cases of wolf predation on deer suffering advanced malnutrition/starvation

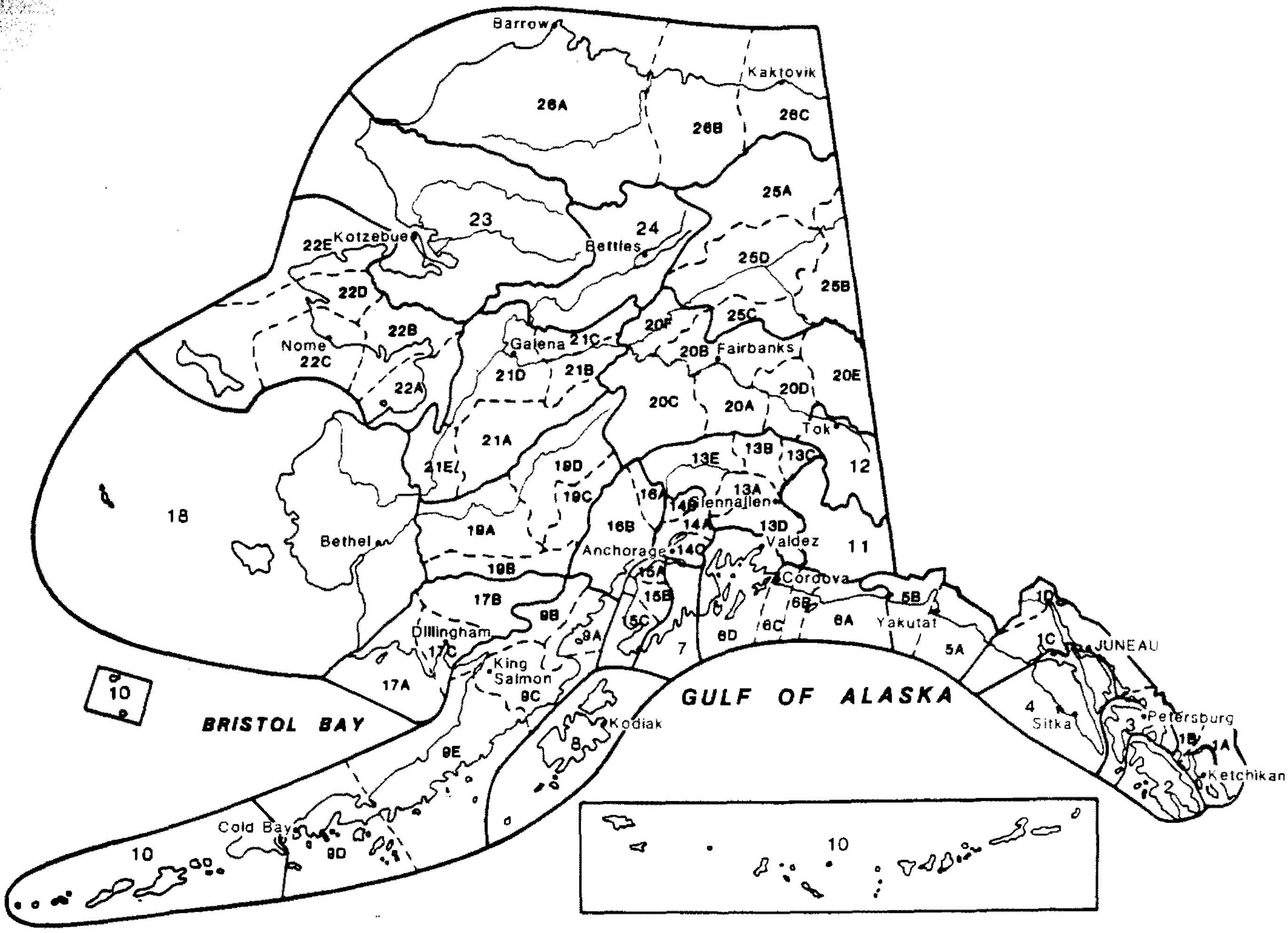
Table 5 Average survivorship and cause-specific mortality rates of deer by age class for 1997–1999.

	Total N[1] At Risk	Survival Rate	Mortality Rate Human	Wolf	Starve	Pred[2]	Other
Adult Male	10	0.60	0.30	0.00	0.00	0.00	0.10
Adult Female	38	0.65	0.11	0.11	0.00	0.08	0.05
Yearling Male	11	0.70	0.12	0.18	0.00	0.00	0.00
Yearling Female	10	0.80	0.10	0.10	0.00	0.00	0.00
Juvenile Male	6	1.00	0.00	0.00	0.00	0.00	0.00
Juvenile Female	12	0.33	0.08	0.08	0.33	0.17	0.00

1 the grand total exceeds the total number of deer reported captured because some animals were at risk in more than one category during the study

[2] Cases of wolf predation on deer suffering advanced malnutrition/starvation

Alaska's Game Management Units



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.

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