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SEASONAL DISTRIBUTION AND HABITAT USE BY SITKA BLACK-TAILED DEER IN SOUTHEASTERN ALASKA

BY
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

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Project No.: W-21-1 Project Title: Big Game Investigations

Job No.: 2.6R Job Title: Seasonal Distribution and Habitat Use by Sitka Black-Tailed Deer in Southeastern Alaska

Period Covered: July 1, 1979 through June 30, 1980

SUMMARY

Deer use levels were measured in 10 clearcut-forest edge sites. There was no detectable response by deer to "edge" in any of the sites studied.

Deer response to forest characteristics in old-growth stands was measured in 199, 1-acre stands on Admiralty and Chichagof Islands during spring 1979 and 1980. It appears that high volume old-growth forest on productive well-drained sites characterized by large, irregularly spaced trees, and an understory abundant in *Cornus*, *Vaccinium*, and *Rubus*, provides the optimum winter habitat for deer.

Ten deer were successfully captured and instrumented during this report period. Since November 1978, 959 relocations have been made. Seasonal home range areas were calculated and examples presented. Old-growth forest was used extensively throughout the year. Alpine and subalpine areas were preferred during summer. Clearcuts were used significantly less than expected during winter and summer.

CONTENTS

BACKGROUND

Background and justification for this study were outlined previously (Schoen et al. 1979).

OBJECTIVES

To develop capture and telemetry techniques for Sitka black-tailed deer, evaluate seasonal distribution, and determine habitat utilization and preference within natural (unlogged) and modified (logged) habitats.

STUDY AREA

The study area has previously been described (Schoen 1978, Schoen et al. 1979).

Edge Study

Introduction

Since first expressed by Leopold (1933), the concept of habitat "edge" has been discussed as providing benefits to wildlife.

Theoretical benefits to deer from edge effects in Southeast Alaska have been discussed by Bloom (1978) and Billings and Wheeler (1979). This edge study was designed to test whether or not there is a measurable response to old-growth/clearcut edges in areas where proximity to the beach and elevational deer movements are not complicating factors.

Procedures

Nine sites in Tenakee Inlet, Chichagof Island, and one site at Winning Cove, Admiralty Island, were sampled in April shortly after snow melt. Transects were established at the edges of clearcuts and extended 656 ft (200 m) into the forest and 656 ft into the clearcut (Fig. 1). The clearcuts ranged in age from less than 1 to about 15 years. We assume that pellet-group sampling at this time is primarily a measure of winter deer use (Fisch 1979). Relative deer use at each site was measured by counting pellet groups within contiguous 3 x 33 ft (1 x 10 m) plots (Schoen 1978) on 10 parallel transects. The forest sites were all uneven-aged, old-growth stands.

Results

In the 10 study sites measured, there was no indication of greater than expected winter deer use near the clearcut-forest edge (Fig. 2). In every site comparison, mean pellet group densities were significantly ($p<.05$) higher in the adjacent old-growth than in the clearcut. Our subjective impressions suggest that the logging slash makes clearcuts, especially those younger than 5 years, much less accessible to deer than forested areas. Furthermore, winter deer use of these clearcut areas was probably severely restricted by excessive snow accumulation.

Although an understory response was observed along the edge of the forest, increased use by deer, as indicated by browsing, was not observed. In several forest edges, wind-throw contributed to reducing accessibility.

Discussion

In an earlier progress report we compared deer use in an uncut block of forest with deer use in a block that had been partially clearcut (Schoen et al. 1979). Overall, the pellet group density was 1.3 times greater in the uncut block, however, the highest pellet group density for any single transect occurred in the beach fringe bordering the clearcut edge. We felt that although this might indicate a positive response to edge by deer, the response was not great enough to compensate for the habitat lost to clearcutting. It appears now that this was not a true edge response, but rather reflected a tendency by deer to winter at as high an elevation as possible (see Telemetry Study and Forest Habitat Study Discussions in this report). In this instance, the deep snow in the clearcut represented an effective barrier to migration out of the beach fringe, and probably accounted for the relatively high deer use immediately below this barrier. These complicating factors were avoided by using an alternate sampling design in 1980.

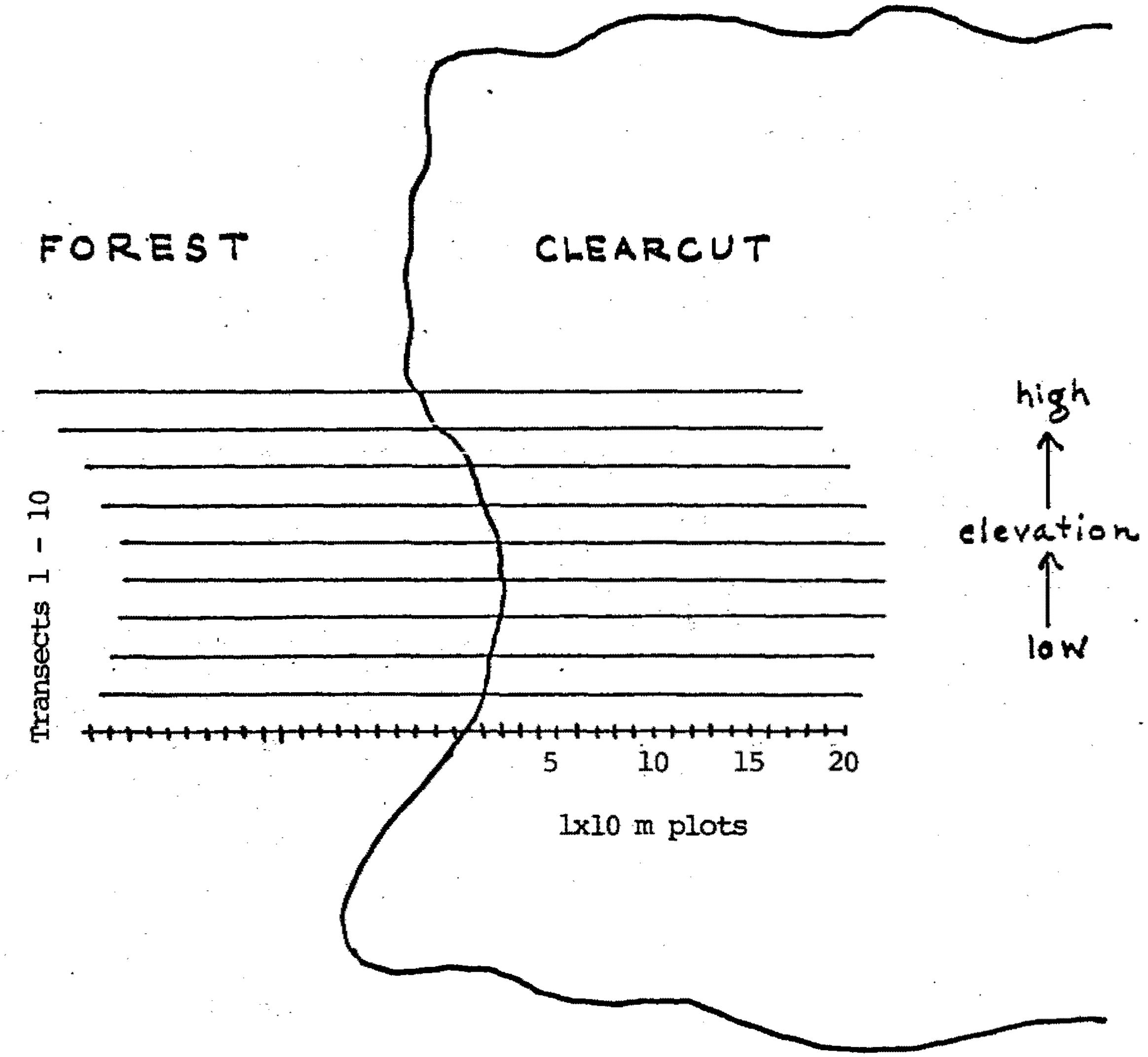

Fig. 1 Sampling scheme for measuring relative deer pellet-group levels along clearcut-forest edges.

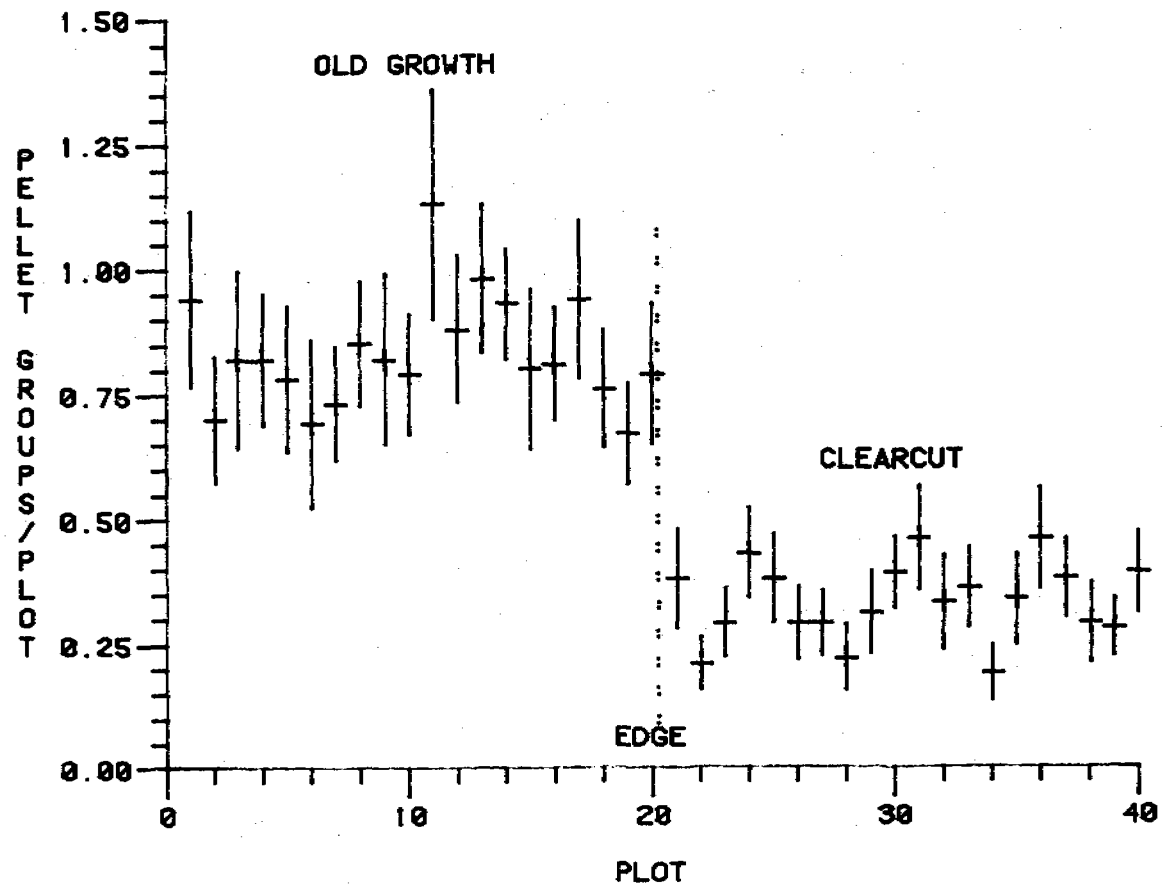

Fig. 2 Pellet group densities in old growth, the old growth/clearcut edge, and clearcuts. Shown is the mean plus or minus the standard error (vertical bar). For each point the number of study sites is 10, and number of observations is 100.

The current edge study on Chichagof and Admiralty Islands indicated that there was no attraction of deer to forest-clearcut edges during winter. Although we observed some understory response within the edge of the forest stand, this same area would presumably accumulate more snow than farther into the forest. Wind-throw along the forest edge also occurred at several sites. Both snow and wind-throw would decrease deer accessibility to the area. Theoretically, even if benefits were derived from opening the canopy, they would be relatively short-lived since most clearcuts become dominated by young even-aged conifer stands within 25 years.

In this study, deer response to forest-clearcut edges was evaluated within uneven-aged, old-growth forests. Perhaps deer would respond to forest edge in managed second growth, but few opportunities exist in Southeast Alaska to test this hypothesis. To our knowledge, there are few data in the literature to support the contention that silvicultural prescriptions for edge actually result in a measurable response from deer. On a conceptual basis, maximum edge might well be found within the mosaic of old-growth forest communities, in contrast to the border between two relatively homogeneous habitat types.

Forest Habitat Study

Introduction

Recent research in Southeast Alaska has documented the importance of old-growth forest habitat as winter range for deer (Schoen and Wallmo 1979, Schoen et al. 1979, Wallmo and Schoen 1980). It is further recognized that old-growth forest is a diverse community, often varying markedly from one acre to the next, and that deer do not use these habitat patches or forest types uniformly. With this in mind, a research program was initiated in spring 1979 to quantify the relationship between forest site characteristics and winter deer use in a variety of old-growth forest communities. This report reviews the methods used in 1979 (see also Schoen et al. 1979) and covers results of that first season's work. Additionally, several new methods were incorporated into the spring 1980 field work and a limited discussion of results is given.

Procedures

Deer response to old-growth forest characteristics was measured on 131, 1-acre (0.4 ha) stands on Admiralty Island between 5 May and 30 June 1979. Stands were located in two areas, one at Winning Cove on Glass Peninsula (60 stands) and the second at Hood Bay on southwest Admiralty (71 stands). Eleven of these stands (2 at Winning Cove, 9 at Hood Bay) supported young, even-aged regrowth. Because of the primary emphasis on old-growth relationships, data from these 11 stands were excluded from the sample. The remaining 120 old-growth stands satisfied three conditions: (1) they were located in commercial quality spruce-hemlock forest, (2) they were accessible to deer throughout most of the winter (i.e. below 600 ft [183 m] elevation)(Schoen et al. 1979), and (3) each stand displayed relatively uniform vegetative and topographic characteristics over the 1-acre area being considered.

At each stand, the elevation, slope, and slope aspect were recorded. Measures of deer use and vegetative characteristics within each stand were collected at nine sample points, spaced as shown in Fig. 3. Deer use was measured by counting the number of pellet groups in four 3 X 33 ft (1 X 10 m) plots radiating from each sample point (i.e. 36 plots/stand). At the midpoint of each pellet plot, percent canopy cover was estimated using a device developed by Wallmo and Fisch of the Forestry Sciences Lab. Because of the untested accuracy of this device, however, canopy cover measurements were discontinued at Hood Bay. Timber characteristics, including stand species composition, mean tree diameter (dbh), mean distance or spacing between trees, and tree density (stems/acre) were measured by the point-centered quarter technique (Cottam and Curtis 1956, Ohmann and Ream 1971). Briefly, this involved selecting the nearest tree over 3 in dbh in each of the four quadrants (bounded by pellet plot lines) at each sample point in the stand. The tree species, dbh, and distance from the sample point were recorded. From these data, mean tree density was calculated. Additional calculated variables included coefficients of variation (Zar 1974) for mean dbh, mean tree spacing, and mean canopy cover (Winning Cove area only) to reflect the within-stand variability of these characteristics.

Understory composition and abundance were measured by recording the presence or absence of 15 common understory plant species in 3.3 ft^2 (1 m^2) circular plots centered on each sample point in the stand. Plot size and distribution were, we believe, sufficient to accurately reflect abundance of the majority of understory species. This assumption was tested at Hood Bay where, in addition to the frequency of occurrence data, biomass of current annual growth was determined for seven plant species/categories in each stand: *Coptis aspleniifolia* (goldthread), *Cornus canadensis* (bunchberry), *Rubus pedatus* (trailing bramble), *Vaccinium* spp. (blueberry), ferns, other shrubs collectively, and other forbs collectively. Biomass data were collected by clipping current annual growth of plants within 0.7 x 1.6 x 4.9 ft (0.2 x 0.5 x 1.5 m) high plots centered on each sample point. Samples were frozen and later dried and weighed for biomass estimates.

Finally, the relative amount of deer browsing in the stand was subjectively estimated by recording a browse index (1 = no evidence of browsing to 4 = very heavily browsed) at each sample point.

Our sampling work, with some changes, was continued in the 1980 field season at Kadashan and other sites along Tenakee Inlet. The changes incorporated in the 1980 field work were mainly procedural. The stand, or macroplot, size remained 1 acre (0.4 ha) in size, but a 10-point sampling system was used instead of nine points.

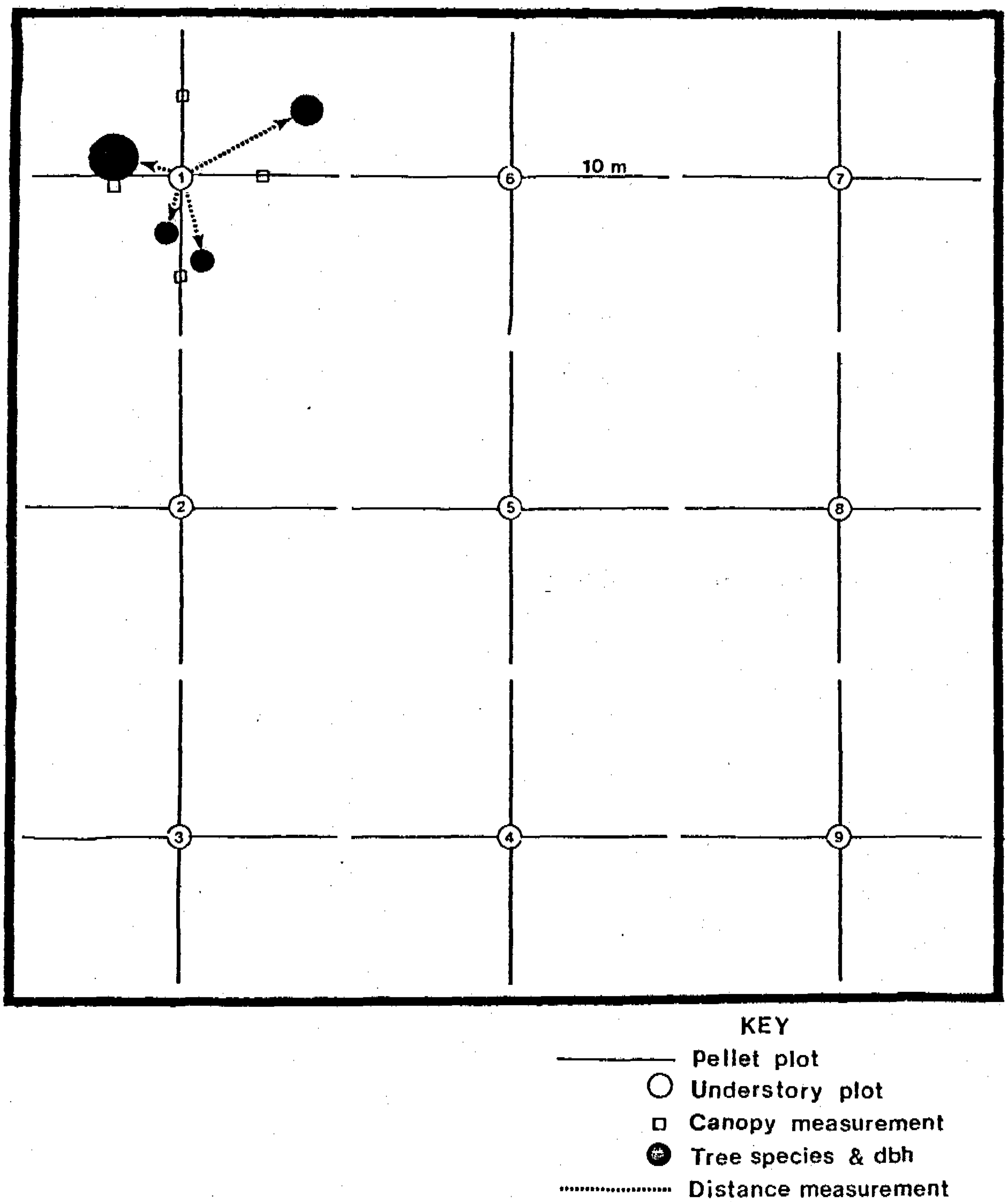

Figure 3. Sampling design for measuring forest characteristics.

In place of a point-centered quarter sampling scheme, we adopted variable plot sampling which employs a wedge prism to select trees for measurement (Dilworth and Bell 1979). To better integrate our methods and results with the Forest Service timber inventory and stand exam programs, several new variables were added to our study. These included classification of tree class, crown class, crown ratio, defect, and tree height (U.S. Forest Service 1979). These variables provide a more complete description of canopy and stand characteristics and permit calculation of the net inventory volume of each stand (Bones 1968). Because these data represent forest attributes which are also estimated in U.S.F.S inventories, they permit a better evaluation of the quality of deer habitat lost to timber harvesting and an appraisal of quality and amount of habitat remaining.

Finally, it was apparent early in the field work that certain pellet groups being counted were freshly deposited and represented early spring rather than winter deer use. To account for any potential seasonal differences in habitat use, we began distinguishing old versus new pellet groups on the data sheets. The criteria used for identifying a new pellet group were presence of a wet mucous sheen and a smooth, even texture in individual pellets. Later analyses will use old, new, and combined pellet group counts as dependent variables. Other stand measurements added to the 1980 field study included *Vaccinium* stem diameters (which are related to biomass [Alaback 1980]), *Vaccinium* height, and tree core data (i.e., tree age and growth trend).

Results

The means and 90 percent confidence intervals for the measured variables are presented in Table 1, illustrating the wide variety of old-growth forest sites sampled. Comparison of data collected at the two study areas shows them to be generally similar, with a few notable differences in the percent occurrence of the rarer understory plant species. Deer use, as measured by pellet group counts, was higher in the Winning Cove sample which, we believe, reflects the somewhat more abundant understory in those stands. The data collected in the two study areas were combined for subsequent statistical analyses.

Percentage frequency data for the 15 understory plant species showed significant deviations from normality in some cases, particularly the rarer species. This is not surprising when working with percentage data, and the distribution is easily corrected, or improved, with the arcsine transformation (Grieg-Smith 1964). Another variable with which underlying distribution varied significantly from normality was the pellet group counts. Again, this is not unusual when dealing with counts in biological situations where one often encounters a few very large values, and a great proportion of smaller values. Transforming these counts by using their square roots resulted in a sample where underlying distribution was normal. Throughout the remainder of this report, pellet group or percentage data refer to the transformed variables.

Table 1. Means and 90% confidence intervals of forest habitat measurements at Winning Cove and Hood Bay, collected May-June 1979.

Variable Measured	Winning Cove (n=58) x	Winning Cove (n=58) (90% CI)	Hood Bay (n=62) x	Hood Bay (n=62) (90% CI)	Combined (n-120) x	Combined (n-120) (90% CI)
Elevation (feet)	182.8	(0.0-429.9)	236.9	(0.0-550.5)	210.8	(0.0-494.4)
Slope (degrees)	14.4	(0.0- 32.4)	16.3	(0.0- 33.3)	15.4	(0.0- 32.6)
Mean Tree Diameter at Breast Height (")	18.2	(12.9- 23.5)	20.1	(13.9- 26.3)	19.2	(13.2- 25.1)
Mean Tree Spacing (feet)	15.9	(12.4- 19.5)	16.7	(11.9- 21.4)	16.3	(12.1- 20.5)
Mean Percent Canopy Cover	57.5	(44.2- 71.9)	n.a.		n.a.	
Tree Diameter Variability (index 0-100)	52.5	(32.4- 72.5)	59.9	(33.0- 86.7)	56.3	(32.0- 80.6)
Tree Spacing Variability (index 0-100)	49.6	(39.2- 60.1)	50.4	(39.0- 60.8)	50.0	(39.7- 60.4)
Canopy Cover Variability (index 0-100)	47.5	(22.1- 72.9)	n.a.		n.a.	
<u>Picea sitchensis</u> (% occurrence)	12.0	(0.0- 36.6)	11.4	(0.0- 31.4)	11.7	(0.0- 33.7)
Tree Density (stems per acre)	180.5	(102.6-258.0)	170.6	(75.6-265.6)	175.4	(89.0-261.7)
<u>Coptis aspeniifolia</u> (% occurrence)	25.9	(0.0- 62.3)	21.9	(0.0- 70.4)	24.5	(0.0- 66.4)
<u>Cornus canadensis</u>	61.5	(17.9-100.0)	49.6	(0.0-100.0)	55.4	(6.4-100.0)
<u>Listera cordata</u>	8.4	(0.0- 28.8)	9.3	(0.0- 30.9)	8.9	(0.0- 29.7)
<u>Menziesia ferruginea</u> (% occurrence)	25.3	(0.0- 58.1)	18.5	(0.0- 54.8)	21.8	(0.0- 56.5)
<u>Maianthemeum dilitatum</u> (% occurrence)	45.0	(3.9- 86.1)	12.4	(0.0- 42.3)	28.1	(0.0- 72.0)
<u>Streptopus spp.</u> (% occurrence)	44.8	(7.0- 82.6)	37.3	(0.0- 78.6)	40.9	(1.3- 80.6)
<u>Rubus pedatus</u> (% occurrence)	57.7	(16.6- 98.8)	45.3	(0.0- 94.5)	51.3	(5.1- 97.4)
<u>Tiarella trifoliata</u> (% occurrence)	31.2	(0.0- 73.5)	17.7	(0.0- 50.4)	24.3	(0.0- 63.1)
<u>Vaccinium spp.</u>	75.3	(36.8-100.0)	61.7	(15.9-100.0)	68.2	(24.8-100.0)
<u>Echinopanax horridum</u> (% occurrence)	15.3	(0.0- 42.4)	8.6	(0.0- 35.0)	11.9	(0.0- 38.7)
<u>Viola spp.</u> (% occurrence)	8.8	(0.0- 70.4)	1.8	(0.0- 13.2)	5.2	(0.0- 25.0)
Ferns (% occurrence)	58.2	(13.0-100.0)	47.3	(0.0- 96.7)	52.6	(4.9-100.0)
Conifer Seedlings (% occurrence)	67.1	(33.0-100.0)	40.9	(0.0- 86.5)	53.5	(8.0- 99.0)
Moneses uniflora (% occurrence)	27.4	(0.0- 59.5)	14.9	(0.0- 42.4)	20.9	(0.0- 52.2)
<u>Lysichiton americanum</u> (% occurrence)	9.6	(0.0- 39.8)	1.3	(0.0- 8.8)	5.3	(0.0- 27.8)
<u>Vaccinium Browse</u> (index 1-4)	2.3	(1.2- 3.5)	2.6	(0.0- 4.0)	2.5	(1.0- 3.9)
Pellet Group Count (per stand)	52.9	(14.3- 91.5)	32.0	(0.0 80.8)	42.1	(0.0- 89.1)

A matrix of significant, zero-order correlation coefficients showing the strength of association between pairs of habitat variables is given in Fig. 4.

Pellet groups are most strongly correlated with the percent occurrence of *Cornus*, and are also signficantly correlated with (in decreasing order) *Vaccinium*, *Maianthemum* (deerberry), *Menziesia* (rusty Menziesia), *Rubus*, conifer seedlings, stand elevation, and evidence of browsing. A number of interesting patterns with respect to plant associations begins to emerge as well. For example, although ferns and *Tiarella* (laceflower) increase in stands having a higher percentage of spruce, *Vaccinium* and *Cornus* decrease. Other relationships are fairly predictable, such as slope increasing with elevation and tree spacing increasing with increasing tree diameter. And not too suprisingly, we find that many of the understory plants are intercorrelated with each other. Where one species is found in abundance, other species are likely to be found as well.

To help sort out these complex interrelationships among the understory species, we submitted the plant frequency data to a cluster analysis (Hartigan 1979). In this analysis, individual species are grouped (or clustered) together in successive steps, based on the strength of their correlation, until all species occur in a single cluster. The results are presented here in the form of a dendogram (Fig. 5). The two most similar species, in terms of their percent occurrence in a stand, are *Cornus* and *Vaccinium*. The next two most similar are *Coptis* and *Rubus*, which soon join with the first pair to form a cluster of four species. We've identified this relatively distinct group as one understory "type" (A, Fig. 5). At that same level of similarity, a second association of *Moneses* (single delight) and conifer seedlings is identified (B, Fig. 5), and *Tiarella* and ferns fall out as a third understory association (C, Fig. 5). These groupings correspond fairly closely with our intuitive impression of plant associations gained from our work in the field.

The most important of these three groups, in terms of winter deer use, is the *Cornus/Vaccinium/Coptis/Rubus* type. Three of these four species are significantly correlated with pellet group counts, and *Cornus* and *Vaccinium* are the first and second most highly correlated with pellet groups of all independent variables. *Cornus*, *Coptis*, and *Rubus* are all evergreen forbs and are therefore available to deer during winter, and *Vaccinium* has green stems which are regularly browsed and may provide some nutritive value to deer in winter.

Viewing the dendogram on another, more general, level we can separate two rather broad understory plant communities within the old-growth forest. The first (I, Fig. 5), includes the previously defined *Cornus* association, the *Moneses* association, and *Menziesia*, *Maianthemum*, and *Listera* (heartleaved twayblade). This major grouping of plants is characteristic of the well-drained, more productive forest sites. Trees in these uneven-aged stands are large and irregularly spaced. The canopy is

	pellet grps.	elevation	slope	tree diameter	diameter variability	tree spacing	tree spacing variability	tree density	percentage spruce	percentage *Coptis*	percentage *Cornus*	percentage *Listera*	percentage *Maianthemum*	percentage *Menziesia*	percentage *Streptopus*	percentage *Rubus*	percentage *Tiarella*	percentage *Vaccinium*	percentage *Echinopanax*	percentage *Viola*	percentage ferns	percentage conifer seedlings	percentage *Moneses*	percentage *Lysichiton*
elevation	.23*																							
slope		.56**																						
tree diameter		.35**	.40**																					
diameter variability																								
tree spacing		.24*	.40**	.64**																				
tree spacing variability				.21*																				
tree density		-.21*	-.36**	-.58**		-.96**																		
percentage spruce		-.36**	-.34**			-.22*		.23*																
percentage *Coptis*									-.24*															
percentage *Cornus*	.58**								-.40**	.41**														
percentage *Listera*										.39**	.27*													
percentage *Menziesia*	.41**										.36**	.31**												
percentage *Maianthemum*	.41**				-.26*					.24*	.40**		.25*											
percentage *Streptopus*			.24*	.30**		.30**		-.27*																
percentage *Rubus*	.29**									.61**	.55**	.28*		.37**										
percentage *Tiarella*		-.22*							.40**						.28**									
percentage *Vaccinium*	.43**								-.29**	.41**	.70**	.36**	.27*	.42**		.59**								
percentage *Echinopanax*						.27*		-.29**									.46**							
percentage *Viola*																	.42**		.33**					
percentage ferns		-.36**							.39**		-.33**	-.22*			.36**		.58**		.28**					
percentage conifer seedlings	.26*				-.41**								.44**	.34**				.24*						
percentage *Moneses*			.21*		-.44**								.27*	.35**	.33**			.30**				.49**		
percentage *Lysichiton*		-.27*	-.36**	-.30**						.26*							.40**			.42**				
Vaccinium browse index	.23*										.36**	.24*	.29**	.24*		.32**		.27*						

Figure 4. Matrix of zero order correlation coefficients showing the relationships between forest habitat variables. (* significant at .01 ** significant at .001).

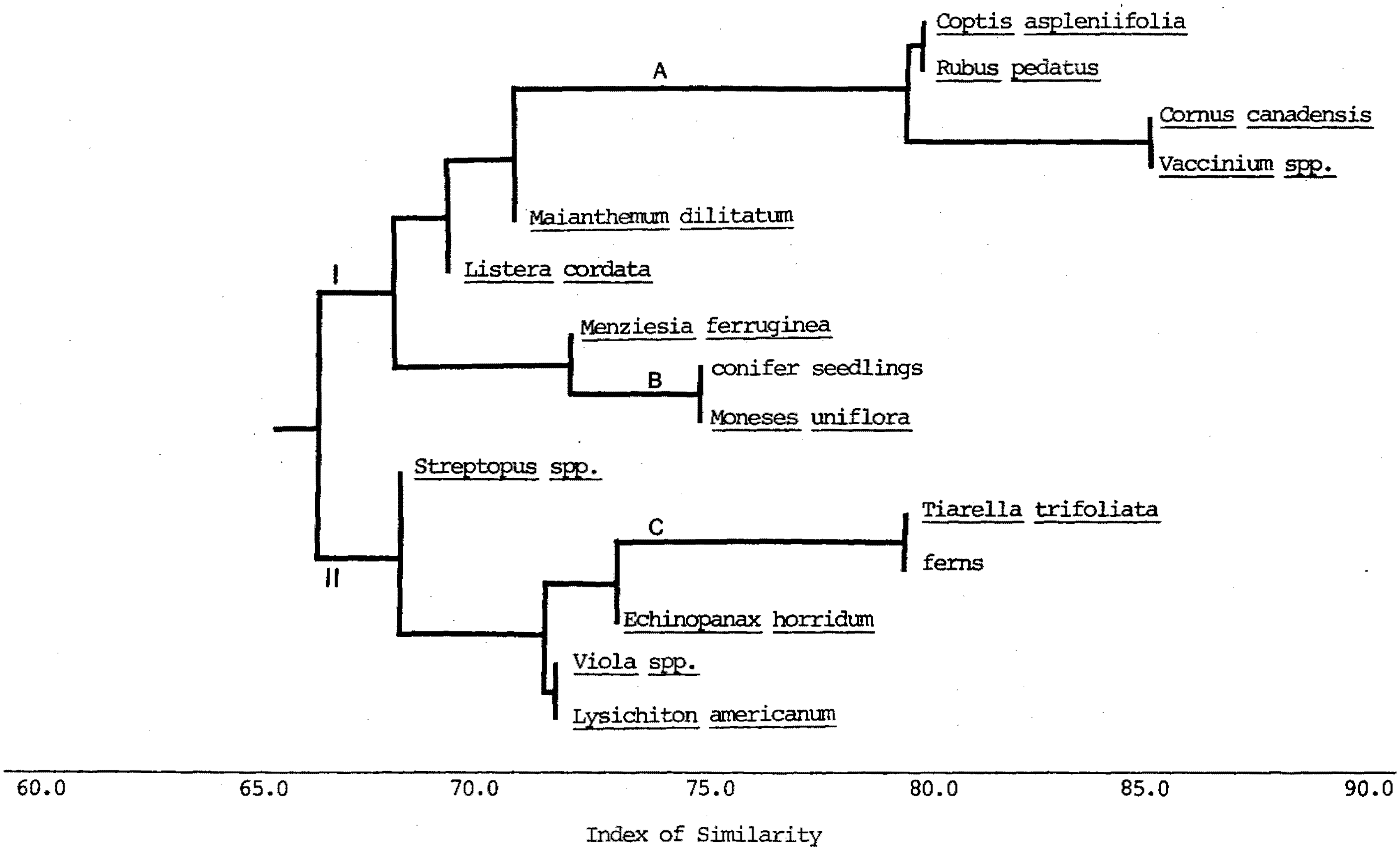

Fig. 5. Dendogram showing understory plant associations. Based on percent occurence data from 120 old-growth stands.

variable, allowing enough light to reach the forest floor that an abundant, diverse understory develops; yet crowns of individual trees are large and strong enough to intercept substantial amounts of snow, making the understory vegetation available to deer. Not suprisingly, all six of the understory species showing significant correlations with deer use occur in this broad community type.

The second major grouping includes the *Tiarella* association, *Echinopanax* (devil's club), *Lysichiton* (skunk cabbage), *Viola* spp. (violets), and *Streptopus* spp. (twisted stalk). These stands are characteristically found on poorly drained, less productive sites. In stands where *Tiarella*, ferns, and Streptopus are abundant we can expect a more even-aged character in the stand. The percentage of spruce in the stand may be higher than average, the canopy relatively closed and uniform, and the understory relatively sparse. Though such a stand may offer deer some limited protection from deep snow, there is little in the way of food on the forest floor. *Echinopanax*, *Lysichiton*, and *Viola* are found in abundance on the wetter, more open sites. Trees are smaller and widely spaced. The understory is occasionally diverse and abundant, and *Coptis* (from group I), might be fairly abundant in such a stand. However, the scant canopy provides relatively little protection from snow, and the forage is probably unavailable during winter. These wet, open sites may receive considerable deer use during relatively mild, winters with little snow and may be important habitat for deer during late spring and summer.

With the interrelationships among the understory plants thus clarified, we return our attention to the question of which specific forest site characteristics are most important to deer. Which topographic characteristics, which timber characteristics, and which understory species or community characteristics are most useful in predicting winter deer use? [To this point our analysis has involved the interpretation of a matrix of simple correlation coefficients. One must use care in implying cause and effect relationships between two correlated variables, however. For example, the fact that pellet groups and *Vaccinium* are signficantly correlated does not mean that deer are attracted to the site by *Vaccinium* per se; deer may, in fact, be attracted to the site by *Rubus*, which in turn is highly correlated with *Vaccinium*.] One method commonly used to isolate the meaningful variables is multiple regression. With multiple regression, those independent variables which are the best predictors of a given dependent variable (in this case, pellet groups) can be identified, while taking into account the interrelationships among the independent variables. The reliability of the regression model (equation) is usually enhanced if we can discount the influence of certain of the independent variables, or otherwise reduce the number to be considered before submitting the data for analysis. Conversely, if there is good reason to suspect a certain variable may be important as a predictor of the independent variable, even though it's not significantly correlated, it should be included in the initial model.

In selecting variables for inclusion in the initial model, we felt it was desirable to include variables from topographic, timber, and understory categories. Obviously, these are all interrelated, and since deer are probably responding most directly to understory, this is where most of the significant correlations with pellet groups could be expected. In the understory category, we included all of those species showing significant correlations with pellet groups in the initial model. These were: *Cornus*, *Menziesia*, *Maianthemum*, *Rubus*, *Vaccinium*, and conifer seedlings. Despite the fact that no timber variables showed a significant simple correlation with pellet groups, we felt that mean dbh and tree spacing variablity could possibly yield significant relationships with pellet groups in a regression analysis. This was based on the hypothesis that, (1) deer require large diameter trees with large canopies to provide protection from excessive snow, and (2) that highly variable spacing characteristic of more uneven-aged, old-growth stands would result in greater light penetration to the forest floor. The only topographic feature included was elevation, which was significantly correlated with pellet groups. Aspect, which one would intuitively expect to be important, was not included because the orientation of the study areas precluded a representative range of slope exposures. The final variable included in the initial model was the *Vaccinium* browse index. This is something of an anomoly since it measures relative deer use instead of a habitat attribute, but because it was significantly correlated with pellet groups it was included.

A backwards, stepwise elimination procedure was used to remove nonsignificant ($p<.05$) variables from the model (Draper and Smith 1966). The resultant model included five significant independent variables and had an r^2 term of 0.49. A summary of the final model including analysis of variance statistics and significant independent variables is given in Table 2. The significant independent variables, in decreasing order of significance, were percent occurrence of *Cornus*, stand elevation, percent occurrence of *Maianthemum*, percent occurrence of *Menziesia*, and variability of tree spacing.

To date, the data collected in spring 1980 have only been analyzed from the aspect of the relationship between deer use and net inventory volume. These results, depicted graphically in Fig. 6, are very similar to results calculated from raw data provided by Barrett, who did a similar study at Hood Bay (Leopold & Barrett 1972, Barrett 1979) (Fig. 7). Results from both studies correspond roughly with our data showing deer use in relation to mean stand diameter class, (Fig. 8). These preliminary results demonstrate a clear preference by deer for higher volume timber stands during the winter period.

Discussion

These results point to *Cornus* specifically, and more generally to the *Cornus/Vaccinium/Rubus/Coptis* understory association, as being the best single indicator of optimum deer winter range.

Table 2. Summary of multiple regression model including analysis of variance statistics and significant (.05) independent variables. Overall r^2=0.49.

Analysis of Variance	D.F.	Sum of Squares	Mean Square	F	Probablity
Regression	5	313.08	62.62	21.50	.001
Residual	114	332.05	2.92		

Variables in the Equation	B	Std. Error B	F	Probability	R^2
Percentage *Cornus*	0.040	0.008	24.69	.001	0.164
Stand elevation	0.062	0.000	12.06	.002	0.256
Percentage *Mianthemum*	0.027	0.008	10.80	.005	0.420
Percentage *Menzesia*	0.027	0.009	8.04	.020	0.456
Variability of tree spacing	0.062	0.025	6.02	.050	0.486
Constant	-1.021				

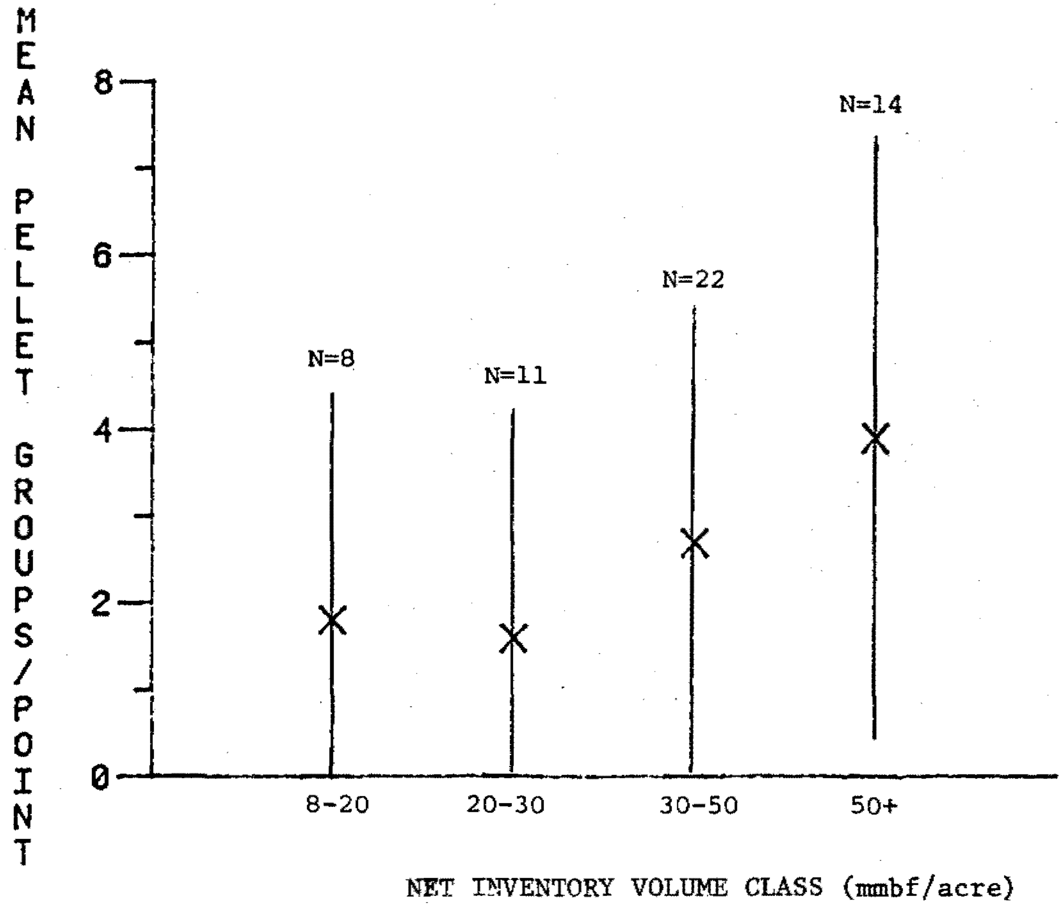

Fig. 6 Winter deer use relative to timber volume, Tenakee Inlet 1980.
(X = mean, bar = 95% confidence). "Old" pellet groups only.

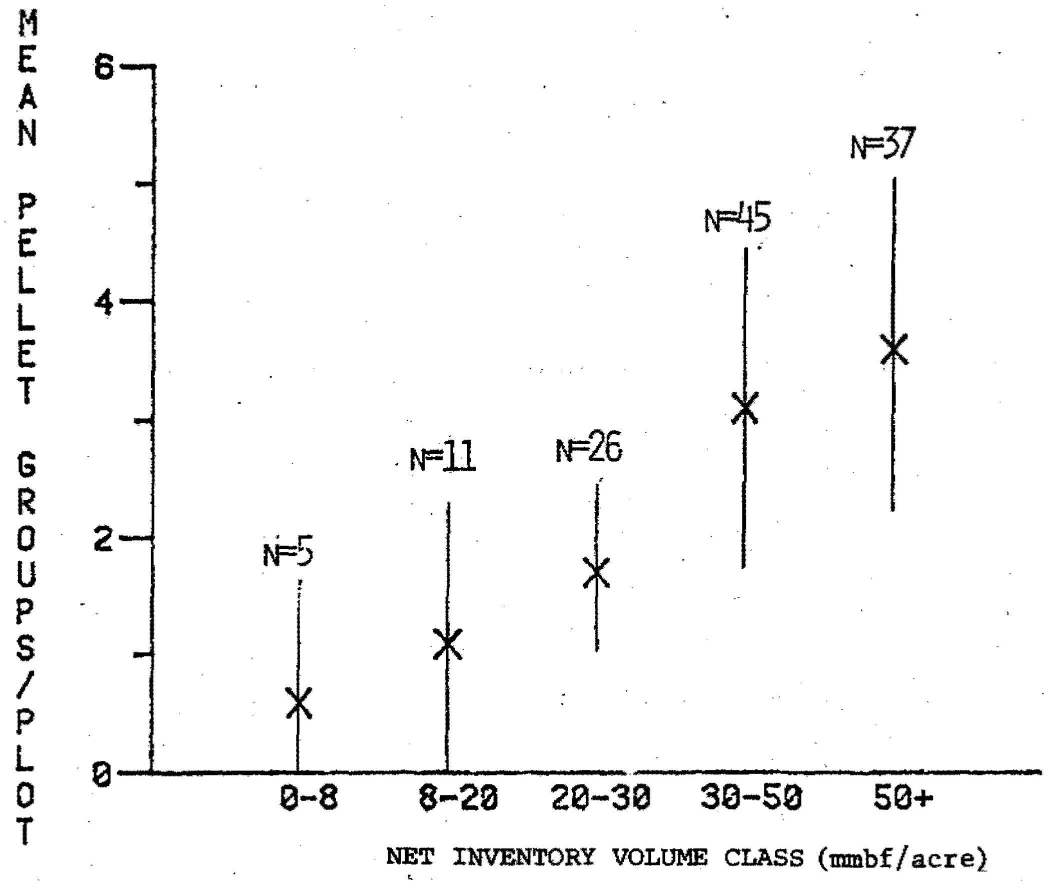

Fig. 7 Winter deer use relative to timber volume, data from Barrett, Hood Bay 1971. (X = mean, bar = 95% confidence). A factor of .75 was used in converting gross volume to net volume.

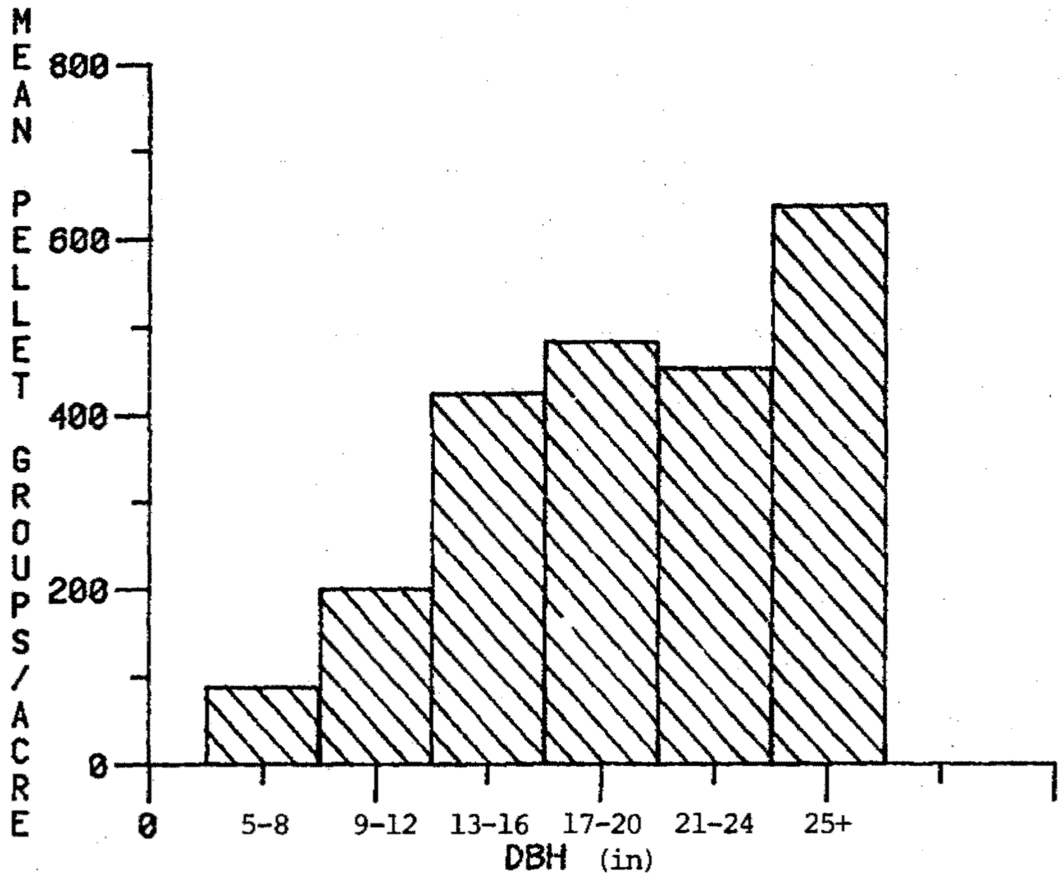

Fig. 8. Deer use with respect to mean stand DBH. Based on 120 old-growth stands.

This of course is not due solely to the presence of *Cornus*, but also to the fact that *Cornus* is characteristic of a timber type which intercepts enough snow to make this forage available. In winter and early spring there may well be deep snow in some of these stands, but it is spotty in distribution. As a result of the large trees and variable canopy, there may be patches in these stands that are completely free of snow. Close examination of these patches reveals a "forest" of leafless *Cornus* stems--obviously the result of foraging by deer. We feel certain that an abundance of *Cornus*, especially when associated with high volume timber, is a reliable indicator of good deer winter range.

The second most significant variable in terms of explaining winter deer use was elevation. This relationship suggests that deer winter as high as snow conditions permit. This generalization is supported by ongoing radio telemetry work with deer (Schoen et al. 1979, and this report), and by research relating to deer use of beach fringes and forest-clearcut edges (Kirchhoff et al. in prep.). We believe that deer winter at as high elevations as possible to maximize the amount of forage available to them through the winter, and move down to the beach fringe only when forced there by deep snow. If deer were restricted to a narrow beach fringe throughout the winter, either by a backing clearcut or by extreme snow conditions, food resources in this restricted area would be rapidly depleted resulting in increased mortality. This has, in fact, been documented along beach fringes backed by clearcuts (Schoen et. al. 1979, Loyal Johnson, per. comm.).

The significance of *Maianthemum* and *Menziesia* as indicators of good deer winter range is somewhat harder to interpret. *Maianthemum* dies back in the winter and is not available to deer, and although *Menziesia* is a shrub and shows evidence of browsing in some areas, its current annual growth is relatively woody and in all likelihood is neither palatable nor highly nutritious to deer. Both of these species are found on better drained forest sites, however, and may be associated with certain (as yet unidentified) forest community characteristics that make the sites attractive to deer. Additional work remains to be done to establish the importance of these two species.

It is not surprising that variable tree spacing turns out to be a significant attribute of good deer winter habitat. A stand with highly variable tree spacing is one which is relatively uneven-aged and on productive sites there are many large trees with full, well developed crowns, interspersed with trees of varying age, size, and crown development. We theorize that the broken, multistoried canopy allows sufficient light to reach the forest floor so that an abundant understory develops, yet snow interception is sufficient so that deer forage is available throughout the winter. This characteristic reflects the high diversity found in many old-growth, climax type stands in Southeast Alaska.

The results showing that high volume timber stands are preferred winter deer habitat are consistent with our subjective impressions gathered in the field. There are limits to how far this volume relationship can be carried, however. For example, we have sampled extremely high volume Sitka spruce stands adjacent to the Kadashan River which received little winter deer use. This high volume spruce forest, with an understory dominated by *Echinopanax*, represents a distinct community type to which this volume relationship does not apply. Similarly, in vigorous, young (less than 150 years old) saw timber stands the volume may exceed 50,000 Bf/acre yet the stands are relatively even-aged, lack structural and floristic diversity, and receive relatively low winter deer use. It is important to apply these results in the context in which the data were gathered (i.e. uneven-aged, commercial quality, mixed hemlock-spruce forest).

These qualifications not withstanding, it is reasonable to conclude that since most of the current timber harvest comes from the higher volume, mixed hemlock-spruce forest, the potential impacts on wintering deer may be much greater than previously suspected. This relationship, as well as other deer/habitat relationships will be examined closely in our analysis of 1980 forest sampling data. Future work will be designed to test and substantiate these initial findings.

Telemetry Study

Introduction

The telemetry study is designed to assess seasonal distribution and home range characteristics of instrumented deer as well as to define seasonal habitat use and preference. Additionally, deer capture and telemetry techniques are being developed as this study proceeds.

Telemetry data, in combination with forest and pellet group sampling, will provide the framework for developing a conceptual model of the seasonal habitat requirements of Sitka black-tailed deer within Southeast Alaska.

Procedures

Additional or revised procedures not described in Schoen et al. (1979) follow:

During late summer 1980, we attempted to capture deer, in alpine and subalpine habitats, from a helicopter. Our approach was similar to that described for goats (Schoen 1978). Deer were immobilized with succinylcholine chloride and also with etorphine (M 99) delivered with projectile syringes from a helicopter. We also attempted throwing a net from the helicopter to tangle deer thus enabling capture without the use of drugs. Helicopters used were a Hiller 12-E and an Allowette. Once a deer was spotted in open country, the aircraft approached close enough for a shot (30-50 ft [9-15 m]) or to throw the net (10 ft [3 m]). Once a deer was hit, the aircraft stayed in the vicinity until the deer went down.

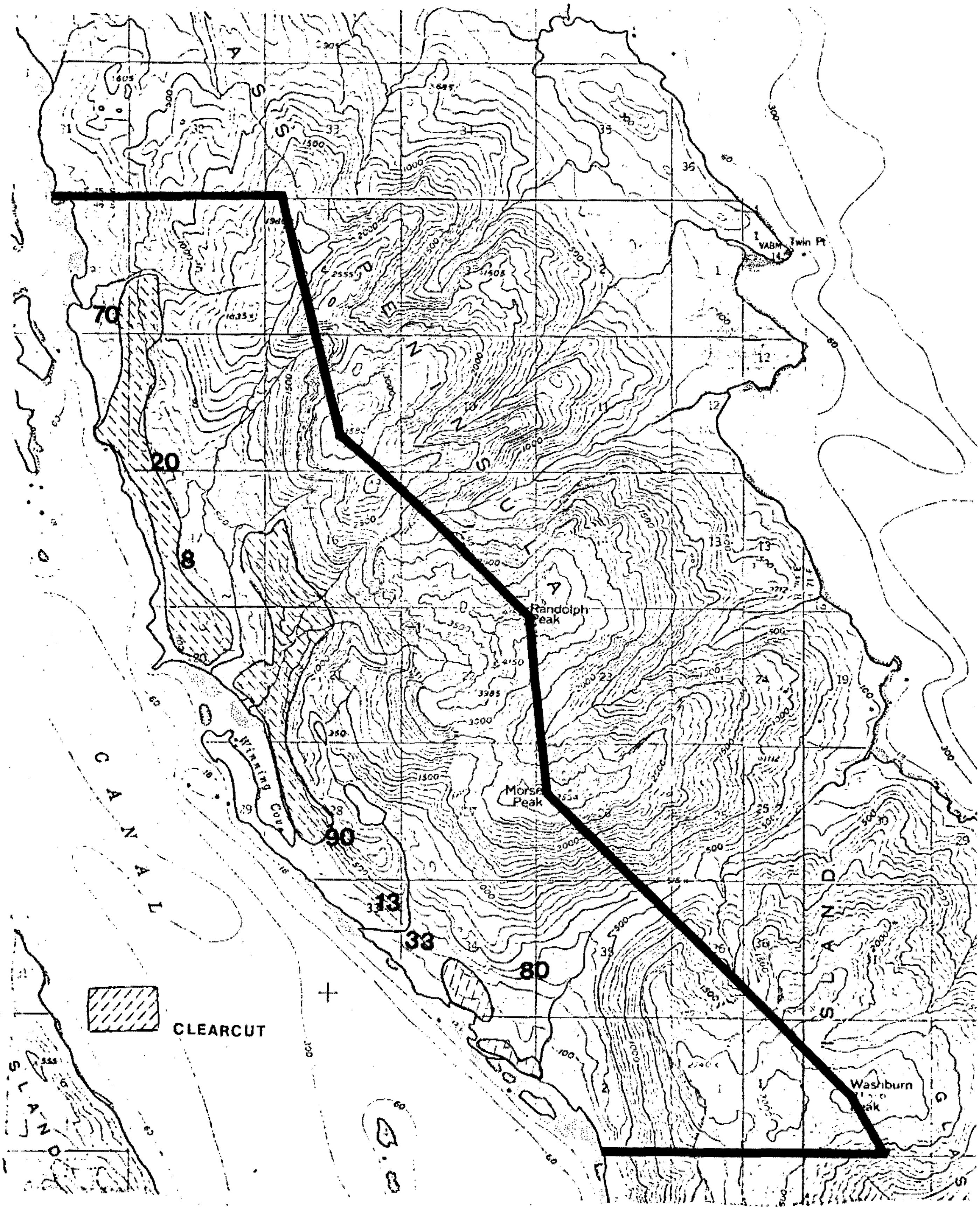

Fig. 9 Border of Winning Cove site and approximate centers of home ranges for instrumented deer used in analysis of clearcut preference.

Table 3. Summary and status of captured deer as of November 1980.

Capture Date	Study Site	Deer #	Age	Sex	Status
11-2-78	Winning Cove	6	Yearling	F	Radio Functional
11-7-78	Winning Cove	20	Adult	M	Spring '80 mortality
11-8-78	Winning Cove	80	Yearling	M	Radio functional
1-3-79	Winning Cove	33	Fawn	M	Winter '79 mortality
1-3-79	Winning Cove	90	Adult	M	Radio functional
1-4-79	Winning Cove	70	Fawn	F	Radio functional
1-18-79	Winning Cove	89	Fawn	M	Winter '79 mortality
2-14-79	Winning Cove	13	Adult	M	Not located since May'79
2-14-79	Winning Cove	51	Adult	M	Never located
2-14-79	Winning Cove	46	Adult	F	Winter '79 mortality
2-16-79	Winning Cove	29	Yearling	M	Not instrumented
2-21-79	Hawk Inlet	24	Yearling	M	Found dead 2 wks. later
2-22-79	Hawk Inlet	5	Adult	M	Spring '80 mortality
2-22-79	Hawk Inlet	74	Adult	F	Radio functional
2-22-79	Hawk Inlet	25	Adult	M	Radio functional
2-23-79	Hawk Inlet	17	Adult	M	Radio functional
2-23-79	Hawk Inlet	3	Adult	M	Spring '80 mortality
2-23-79	Hawk Inlet	18	Yearling	F	Radio functional
2-24-79	Hawk Inlet	43	Adult	F	Winter '80 mortality
2-24-79	Hawk Inlet	16	Yearling	F	Not located since '79
3-6-79	Winning Cove	61	Adult	F	Radio Functional
1-8-80	Winning Cove	8	Yearling	F	Summer '80 mortality
1-22-80	Hawk Inlet	12	Adult	M	Radio functional
1-22-80	Hawk Inlet	19	Fawn	M	Dead 2 wks. later
1-24-80	Hawk Inlet	41	Adult	F	Dead 2 wks. later
1-24-80	Hawk Inlet	42	Adult	F	Radio functional
4-16-80	Bug Island	1	Adult	F	Spring '80 mortality
4-16-80	Bug Island	2	Adult	F	Radio functional
8-26-80	Hawk Inlet	66	2	M	Radio functional
9-11-80	Young Bay	69	Yearling	M	Radio functional
9-11-80	Young Bay	15	Yearling	M	Radio functional

Table 4. Summary of 1980 capture success with free-ranging deer.

Method	Man days	Shots	Hits	Misses	Captures
Hunting in forest	20	14	11	3	1
Hunting in alpine	10	2	0	2	0
Shooting from skiff	28	43	28	15	3
Shooting from helicopter	4	14	12	2	3
Subtotal	62	73	51	22	7
Driving island	25				2
Captured swimming deer	1				1
Driving net	10				0
TOTAL	97				10

During summer 1980, six additional habitat attributes were recorded each time a deer was relocated. These were: percent spruce; timber volume class in thousand board feet per acre (less than 8, 8-20, 20-30, 30-50, and 50+); stand age (even and uneven); drainage (poor, moderate, or well); risk (low, moderate, or high); and patchiness (low, moderate, or high).

Risk indicates the amount of defect in a stand. In a high risk stand there is an increased chance that many of the trees will soon die and be lost from timber production. Patchiness, as used here, indicates the variability within a stand.

The Winning Cove area on the west side of Glass Peninsula provides an opportunity to evaluate the habitat preferences of seven instrumented deer within close proximity of four clearcuts encompassing over 1000 acres (405 ha). Six general habitat types were mapped and their availability estimated over a 10,575 acre (4280 ha) area (Fig. 9) by dot grid technique. In calculating availability, we assumed that during summer and fall all habitat types were available but during winter, alpine and subalpine types were not available because of snow.

A separate analysis was performed for each season. A Chi-square goodness of fit test was used to test the null hypothesis that deer populations occur in each habitat in proportion to its availability. In each table, a column labeled "Adjusted Residual" is included (Everitt 1977) which represents the calculation of a Z score for each cell. The null hypothesis in each case is that the difference between the observed value and the expected value is equal to zero. The hypothesis is rejected for those cells for which the absolute value of this Adjusted Residual exceeds the critical value of the normal distribution at the appropriate level. For example, the critical value at alpha = .05 is 1.96, and at alpha = .10 it is 1.64. The sign of the residual indicates the direction of departure of the expected value from the observed value. Because these analyses are based on multiple observations of relatively few deer, the assumption of random, independent observations cannot be met. Consequently, relationships which are significant at high alpha levels (e.g. .10 and above) should be accepted with some caution (Suzanne Miller, pers. comm.).

Results

Ten deer were successfully captured during this report period, three on the Glass Peninsula and seven in the Hawk Inlet area (Table 3). A summary of capture techniques is presented in Table 4. An estimated 97 man-days were spent in capture activities. Darting deer in the alpine from a helicopter was the most productive technique. Darting deer on the beach from a skiff was the second most productive method. Other techniques attempted included capturing swimming deer driven off small islands and driving deer into a net. Two deer were captured at Bug Island by driving, but none were captured in the net. One deer was captured when it swam across Hawk Inlet. This was simply a chance opportunity. Hunting in the forest and alpine during a foggy period resulted in only one capture.

Fifty-one deer were injected with an immobilizing drug, 47 with succinylcholine chloride and 4 with etorphine (Table 5). The average successful dose for succinylcholine chloride was 12.2 mg for 4 adult and 1 yearling deer. The average time from injection to immobilization was approximately 12 minutes and ranged from 5 to 15+ minutes. This was hard to determine exactly since several deer were found after they had become immobile. Average duration of paralysis was not calculated since many animals were left before they fully recovered. Individual variability to succinylcholine appears to be high. Nine deer died as a direct result of drug immobilization, one drowned following immobilization, and one died within a week of capture. The two summer mortalities were drug overdoses. Of the eight winter drug mortalities, one was an accidental overdose, two were old does in very poor condition, one was a fawn, and four were adults in good condition. Thirty-two deer were not affected by the drug and/or were not located. This appeared to be the result of poor tracking conditions and the narrow margin of drug effectiveness.

Since November 1978, we have accumulated 959 relocations of radio-instrumented deer. This is an additional 475 relocations since the last report period. Ninety-six percent of these relocations were considered accurate to within 25 acres (10 ha) and were used in our analysis of habitat use. To date, our sample of relocations has been divided exactly in half between our two study sites, Hawk Inlet and Glass Peninsula. About 9 percent of our telemetry relocations resulted in visual observations, most of which occurred during summer and early fall.

Home ranges were calculated for calendar seasons within a 95 percent confidence ellipse around individual deer relocations. These data are summarized from fall 1979 through summer 1980 in Table 6. Winter home ranges were smallest, averaging 301 acres (122ha). Summer home ranges were almost double this size at 576 acres (233 ha). Fall and spring ranges were substantially larger; 1248 acres (505 ha) and 3758 acres (1521 ha), respectively. The large size of spring and fall home ranges reflected major movements of some deer between winter and summer ranges.

Movements of most instrumented deer were confined to an area of approximately 512 acres (207 ha) during winter and summer and to approximately 1217 acres (493 ha) during spring and fall. The most extensive movements occurred during spring 1980, when two adult females moved airline distances of 12 mi (31 km) and 28 mi (72.5 km).

Eight examples of seasonal distribution of instrumented deer from both study sites are presented in Fig. 10 through 17. Only two seasonal ranges are displayed for each deer and these have been expanded from the calendar season to represent the periods December through March and June through September.

Table 5. 1980 immobilization results using succinylcholine chloride and etorphine (m99) on Sitka black-tailed deer.

Date	Sex	Age	Drug	Dosage (mg)	Time from Injection to Paralysis (min) [1]	Duration of Paralysis (min) [1]
1-8	F	yearling	succ. chol.	12	5	45
1-8	M	adult	succ. chol.	12	no effect-unable to locate	
1-8	M	adult	succ. chol.	14	mortality	
1-8	M	adult	succ. chol.	11	no effect-unable to locate	
1-8	?	adult	succ. chol.	12	no effect-unable to locate	
1-8	F	adult	succ. chol.	12	no effect-unable to locate	
1-9	M	adult	succ. chol.	12	no effect-unable to locate	
1-9	F	fawn	succ. chol.	10	mortality	
1-9	M	adult	succ. chol.	14	no effect-unable to locate	
1-9	F	adult	succ. chol.	12	no effect-unable to locate	
1-9	F	adult	succ. chol.	12	no effect-unable to locate	
1-9	F	adult	succ. chol.	12	no effect-unable to locate	
1-9	F	adult	succ. chol.	12	no effect-unable to locate	
1-14	M	adult	succ. chol.	13	mortality	
1-14	F	adult	succ. chol.	26	mortality	
1-14	M	adult	succ. chol.	12	no effect-unable to locate	
1-15	F	adult	succ. chol.	12	no effect-unable to locate	
1-15	?	yearling	succ. chol.	11	no effect-unable to locate	
1-15	M	adult	succ. chol.	14	no effect-unable to locate	
1-16	M	adult	succ. chol.	13	no effect-unable to locate	
1-16	M	adult	succ. chol.	13	no effect-unable to locate	
1-16	F	adult	succ. chol.	12	no effect-unable to locate	
1-22	F	adult	succ. chol.	12	mortality	
1-22	M	adult	succ. chol.	12	15	45+
1-22	F	adult	succ. chol.	12	mortality	
1-22	M	yearling	succ. chol.	10	drowned	
1-24	F	adult	succ. chol.	12	no effect-unable to locate	
1-24	F	adult	succ. chol.	12	no effect-unable to locate	
1-24	F	adult	succ. chol.	12	10+	30+
1-24	F	adult	succ. chol.	12	15+	30+
1-30	F	adult	succ. chol.	12	no effect-unable to locate	
2-3	M	adult	succ. chol.	13	no effect-unable to locate	
2-3	M	adult	succ. chol.	12	no effect-unable to locate	
2-3	M	adult	succ. chol.	14	no effect-unable to locate	
2-3	F	adult	succ. chol.	11	no effect-unable to locate	
2-4	F	adult	succ. chol.	11	no effect-unable to locate	
2-4	?	adult	succ. chol.	12	no effect-unable to locate	
3-6	M	adult	succ. chol.	12	mortality	
3-7	M	adult	succ. chol.	14	no effect-unable to locate	
8-20	M	adult	succ. chol.	12	no effect-unable to locate	
8-26	M	adult	succ. chol.	13	15	25
8-26	F	adult	succ. chol.	12	no effect-unable to locate	
8-26	M	adult	succ. chol.	14	no effect-unable to locate	
8-26	M	yearling	succ. chol.	13	mortality	
8-27	M	yearling	succ. chol.	13	no effect-unable to locate	
8-27	M	adult	succ. chol.	14	no effect-unable to locate	
8-27	M	adult	succ. chol.	15	mortality	
9-10	M	adult	M99	3.5	no effect-unable to locate	
9-11	M	adult	M99	3.5	no effect-unable to locate	
9-11	M	yearling	M99	4.0	10	40
9-11	M	yearling	M99	4.0+3.5	25	30

1 Times are estimated because of difficulty in observing deer in the field.

Table 6. Summary of seasonal home ranges of radio-instrumented deer.

	Home range in hectares (acres)			
Season	Mean Area	Range	Standard Deviation	n
Fall 79	505 (1248)	64-1307	410	12
Winter 79-80	122 (301)	42-302	74	15
Spring 80	1521 (3758)	30-12369	3603	13
Summer 80	233 (576	40-563	170	13

Ⓞ DEER 25 JUN 1 80-SEP 30 80 84.2 HECTARES
⊡ DEER 25 DEC 1 79-MAR 31 80 1032.7 HECTARES
|——| 1 KILOMETER

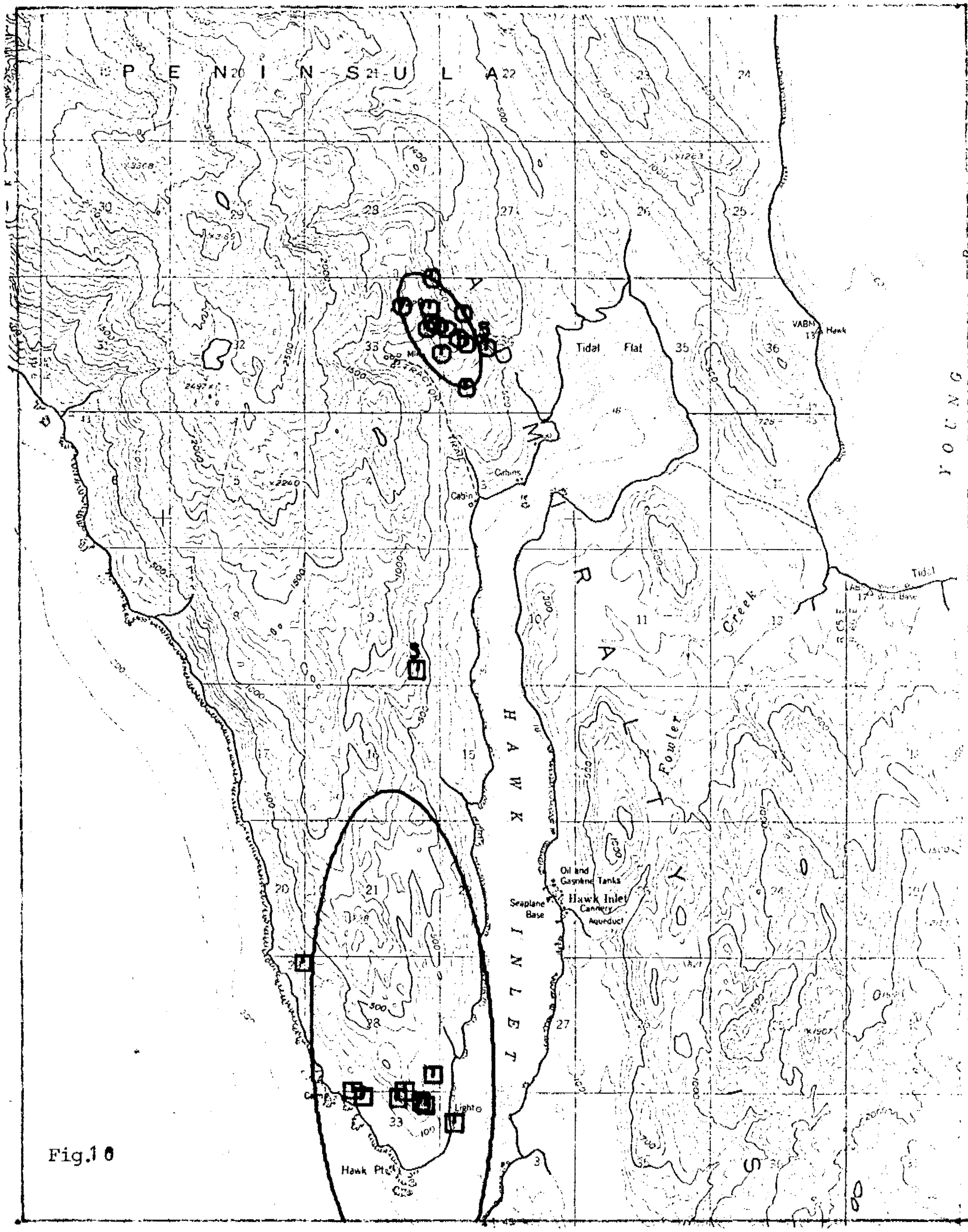

Fig.1 8

Ⓣ DEER 18 JUN 1 80-SEP 30 80 611.1 HECTARES
Ⓤ DEER 18 DEC 1 79-MAR 31 80 93.7 HECTARES

1 KILOMETER

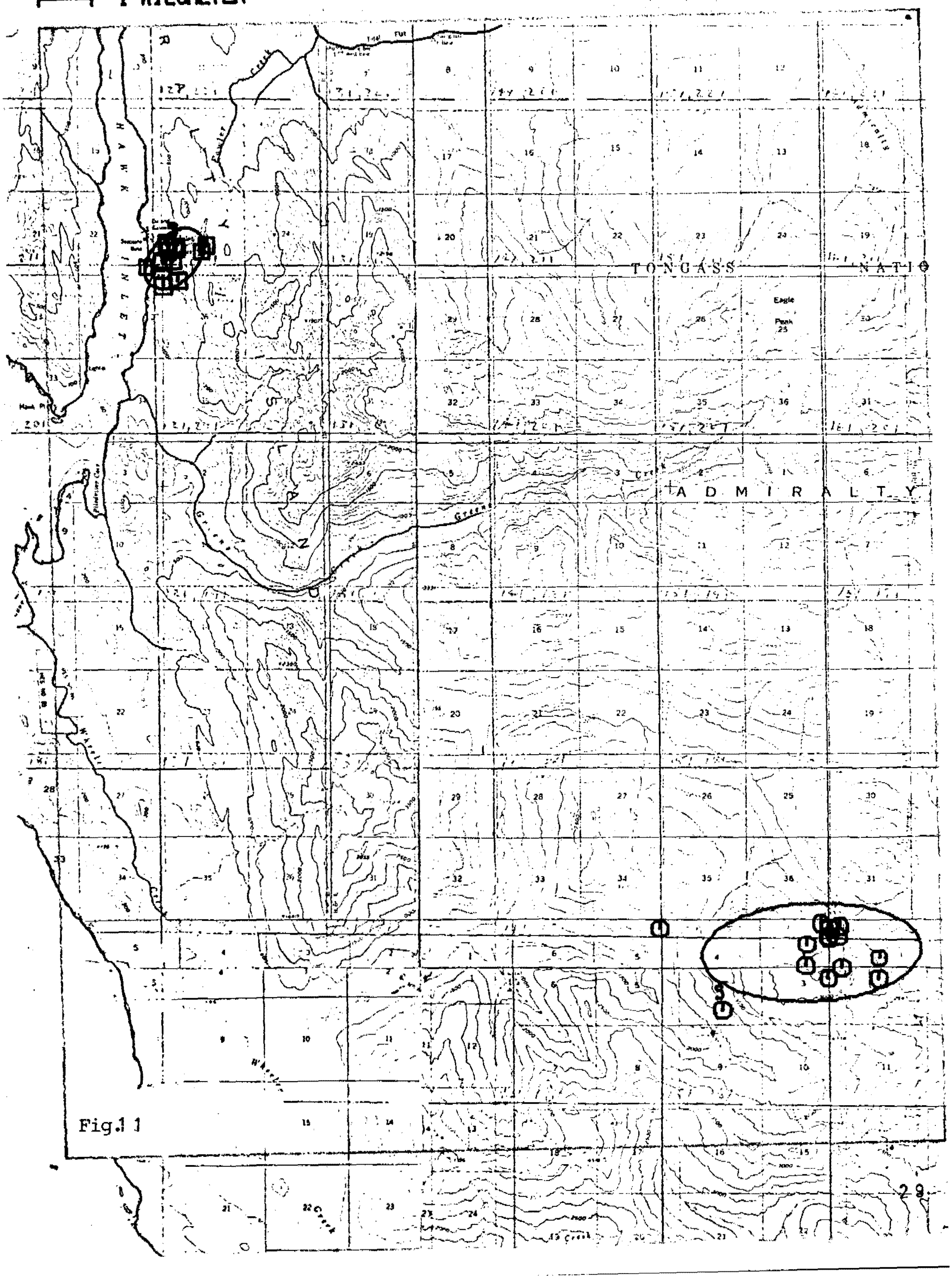

Fig.1 1

◯ DEER 17 JUN 1 80-SEP 30 80 548.2 HECTARES
◻ DEER 17 DEC 1 79-MAR 31 80 86.8 HECTARES
1 KILOMETER

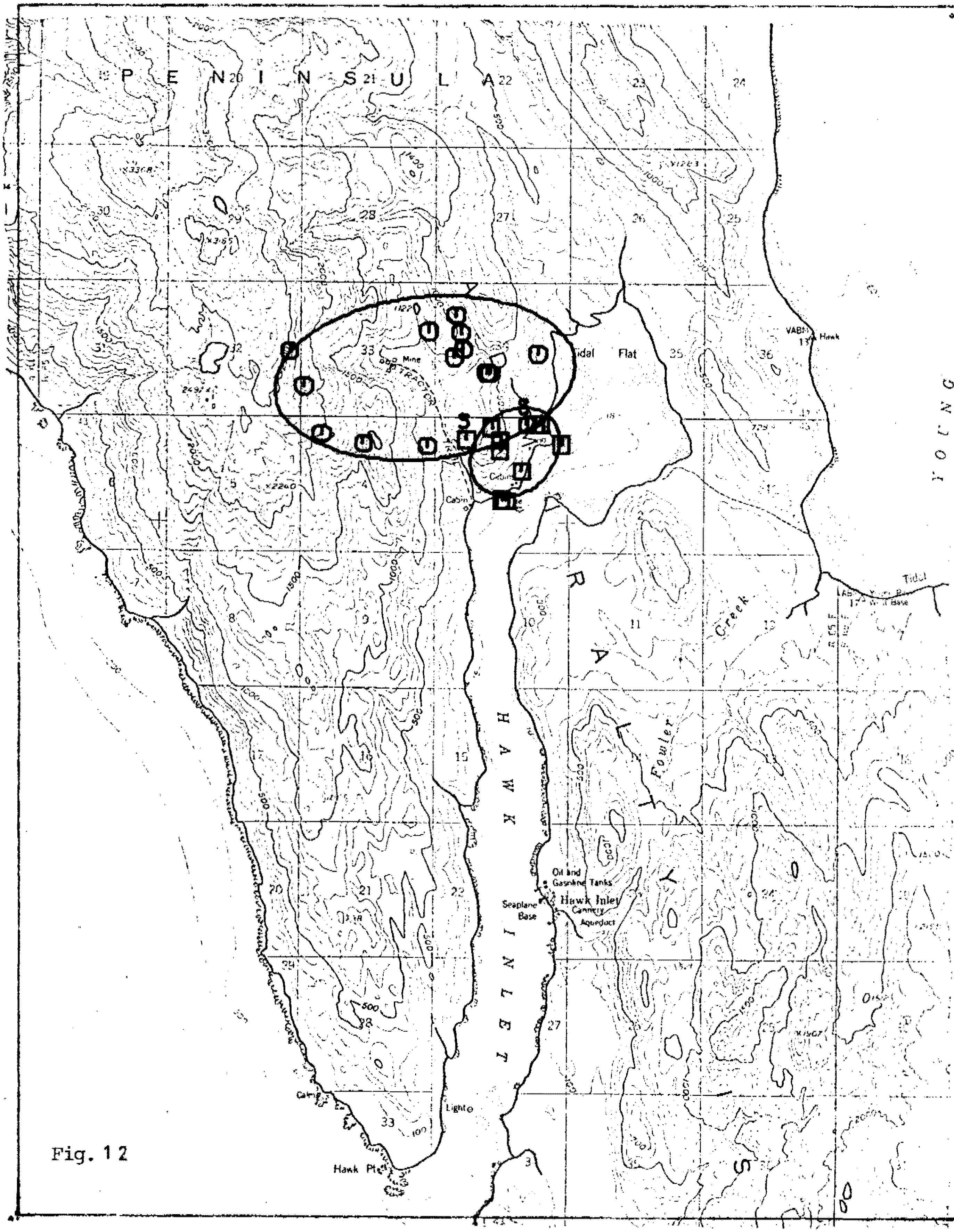

Fig. 12

DEER 61 JUN 1 80-SEP 30 80 146.0 HECTARES

DEER 61 DEC 1 79-MAR 31 80 66.0 HECTARES

1 KILOMETER

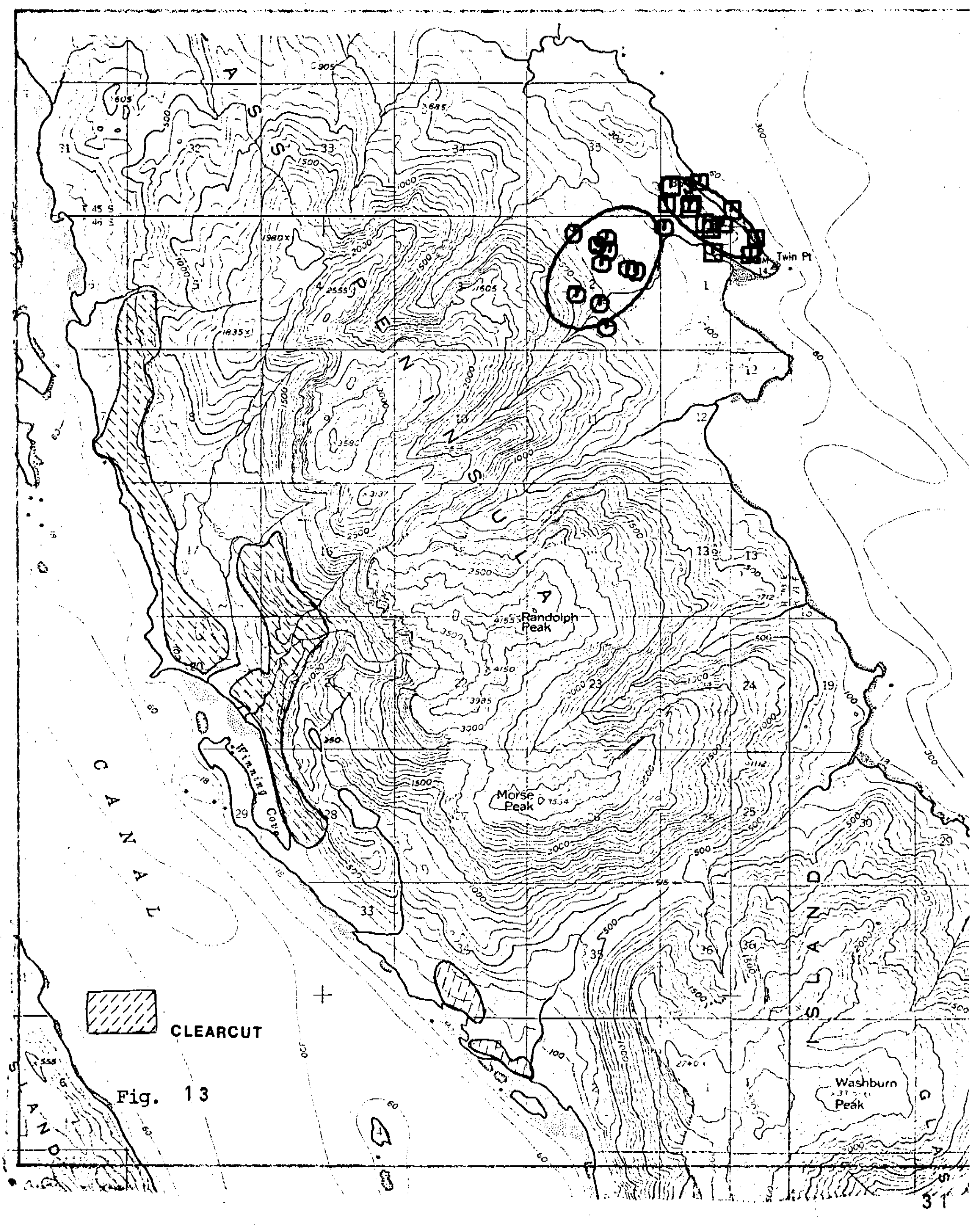

Fig. 13

Ⓤ DEER 80 JUN 1 80–SEP 30 80 367.1 HECTARES

⊞ DEER 80 DEC 1 79–MAR 31 80 388.7 HECTARES

├────┤ 1 KILOMETER

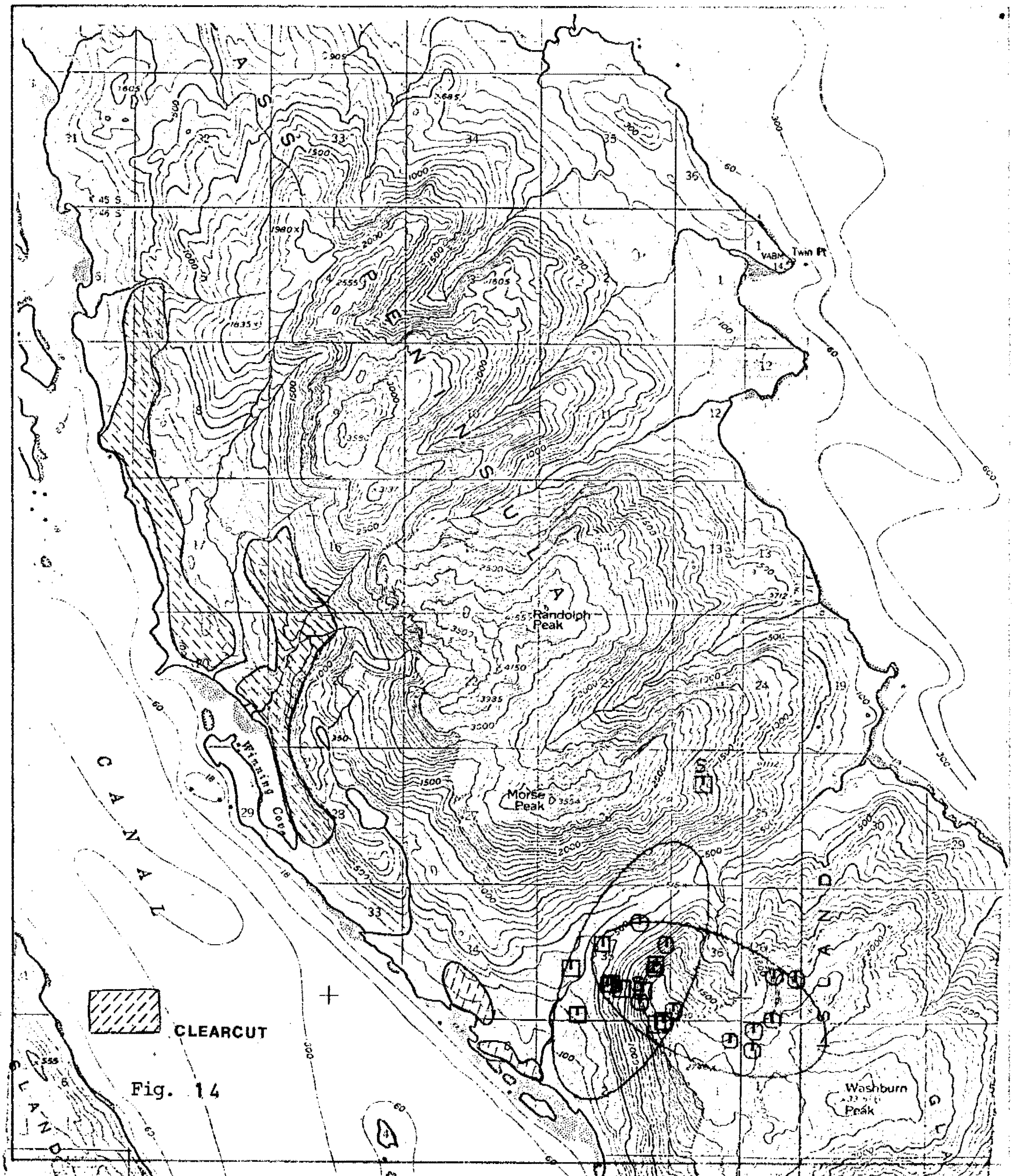

Fig. 14

DEER 90 JUN 1 80-SEP 30 80 418.4 HECTARES

DEER 90 DEC 1 79-MAR 31 80 288.9 HECTARES

1 KILOMETER

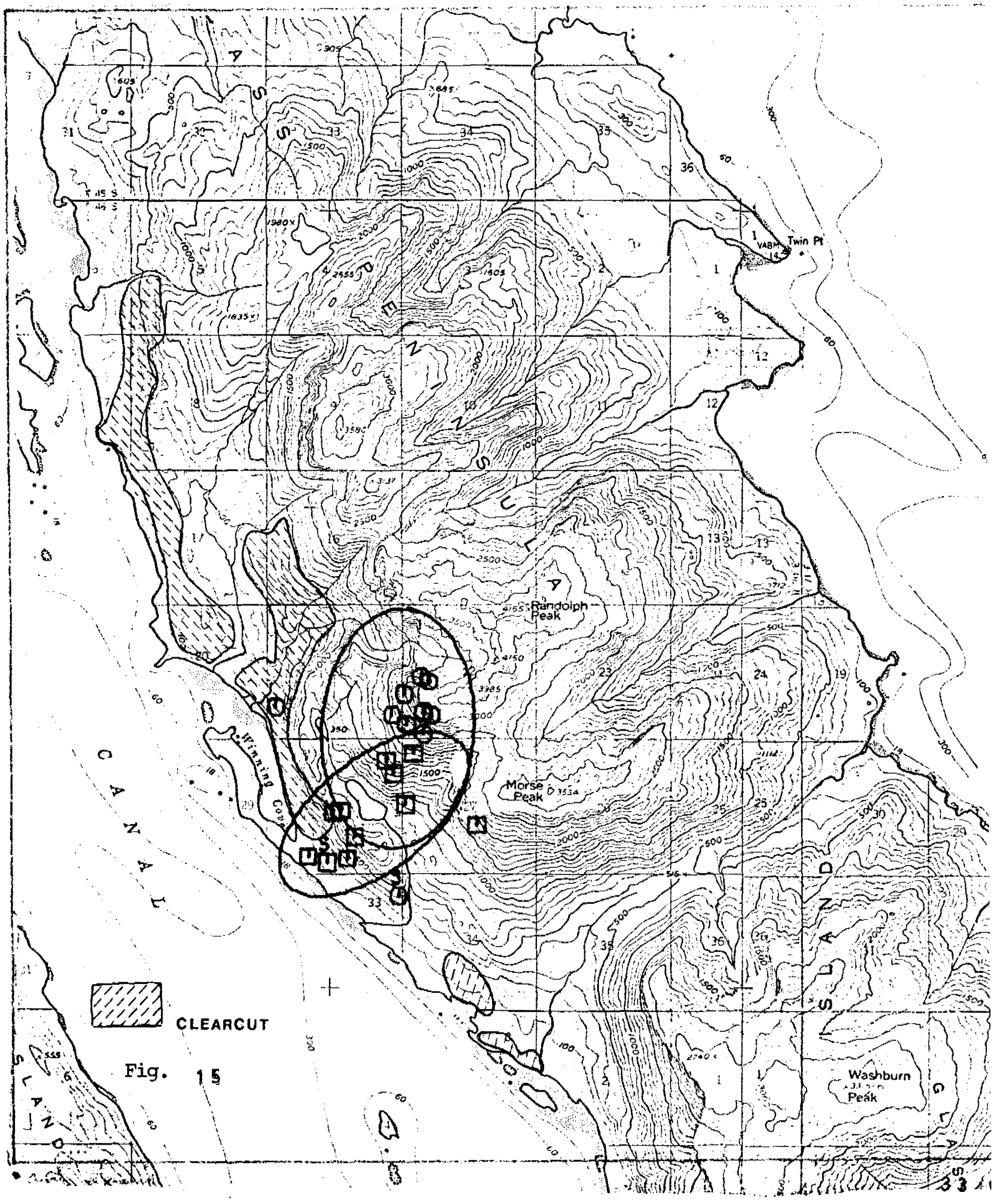

Fig. 15

ʘ DEER 70 JUN 1 80-SEP 30 80 318.5 HECTARES
⊡ DEER 70 DEC 1 79-MAR 31 80 37.7 HECTARES
|——| 1 KILOMETER

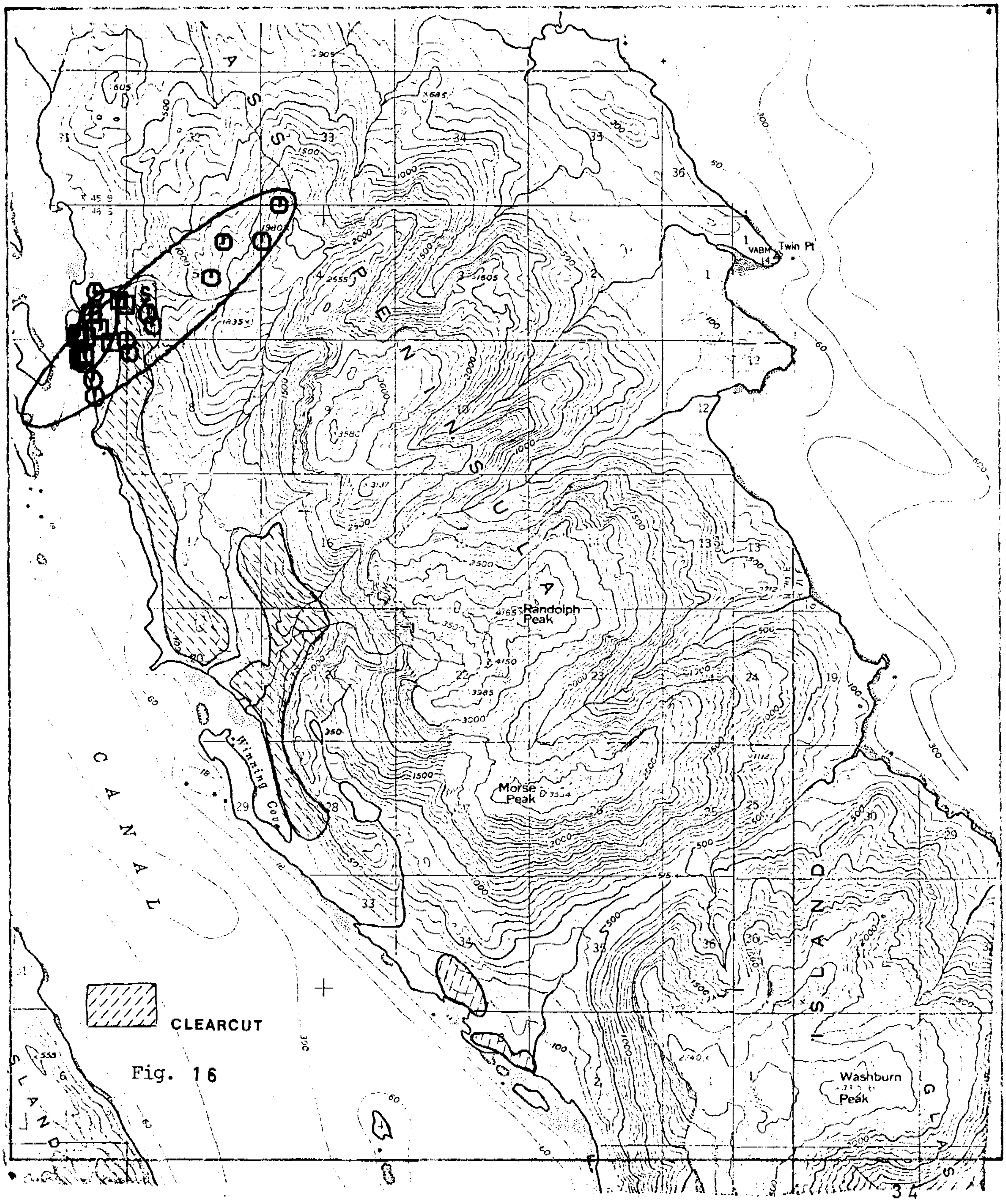

Fig. 16

DEER 74 JUN 1 80-SEP 30 80 161.5 HECTARES
DEER 74 DEC 1 79-MAR 31 80 77.4 HECTARES
1 KILOMETER

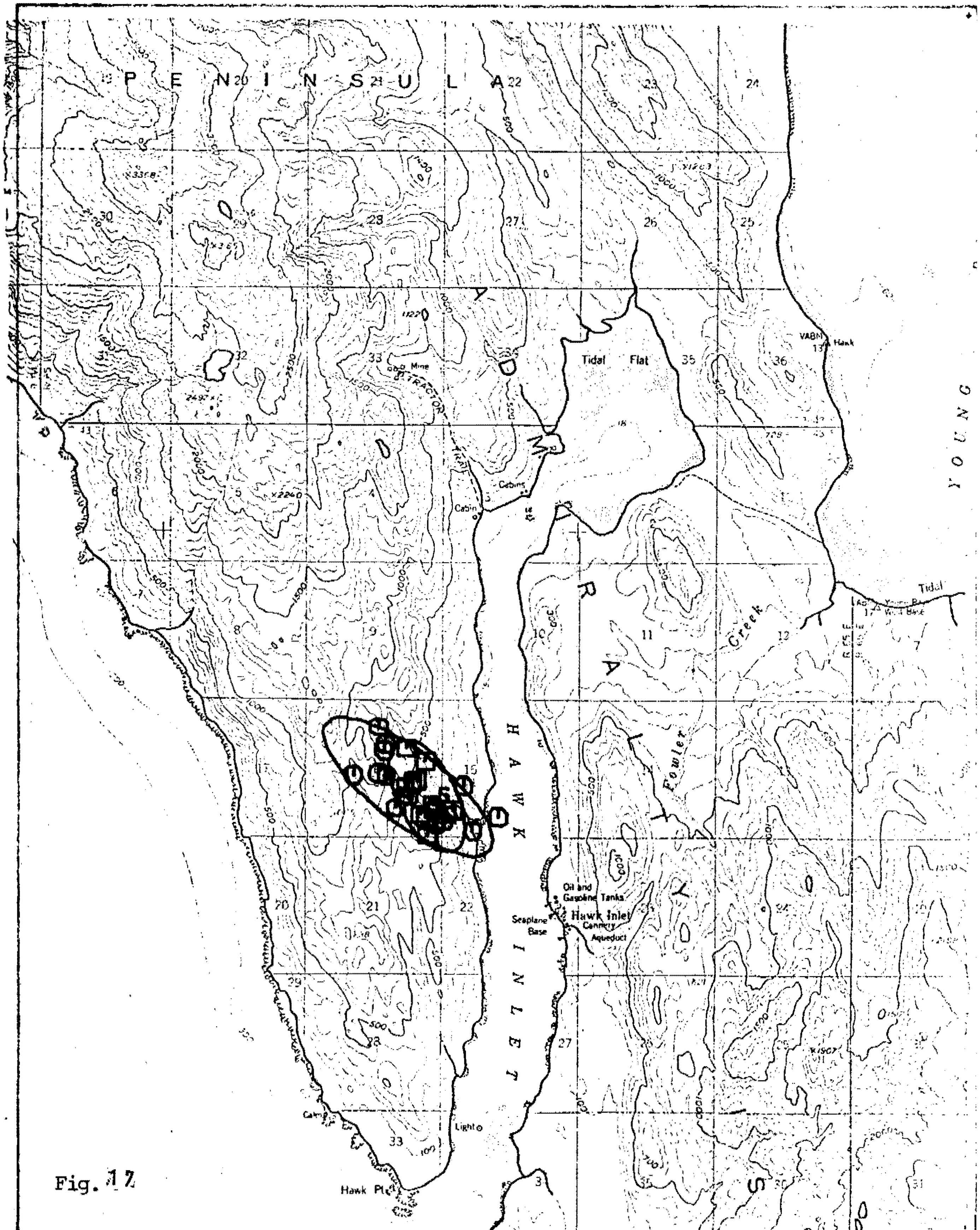

Fig. 17

Several patterns are apparent from these figures. In general, during the winter or energy conservation period, deer home ranges are smaller than during the summer or energy accumulation period. The large winter range of deer #25 (Fig. 10) is an artifact of the expanded time period which includes a transitional location in the winter home range calculation. However, this example and that of Fig. 11 portray distinct seasonal ranges separated by considerable distance. Figs. 12 and 13 represent examples of deer with relatively distinct seasonal ranges in close proximity.

More overlap of ranges is reflected in Figs. 14, 15, and 16 grading into almost complete overlap in Fig. 17. To describe deer as wintering near the beach and summering in the alpine is an oversimplification, obviously not applicable to the population as a whole. Substantial individual variation occurs in home range characteristics probably reflecting both an animal's prior experience and habitat availability.

The mean distance of home range centers from the beach was 0.3 mi (0.48 km) for 16 deer during the period December through March (Table 7). These data are portrayed graphically in Fig. 18. We will assume that during this time period more than half the forest use by our sample populations occurred beyond 0.25 mi (0.4 km) from the beach. This is an important consideration when attempting to define winter range. It is likely to vary geographically with differences in topography and habitat types. Winter snow conditions also vary from year to year and would certainly influence spatial distribution of deer. The two winters during which these data were collected can probably be considered moderate in terms of snow accumulation.

Of nine deer for which we have 2 year's data, seven deer utilized similar winter and summer ranges both years. Two deer exhibited shifts in location of the winter range.

Seasonal habitat use of instrumented deer was evaluated with respect to elevation, slope, aspect, habitat type, percent canopy cover, and percent snow cover. In all comparisons, deer use varied significantly (Chi square, p<>re.001) with season.

Seasonal variation in elevations at which deer were relocated are given in Table 8. Deer used the lowest mean elevation during winter when they were restricted by snow. Highest mean elevation for relocations was during summer when deer were widely distributed and unrestricted in their movements.

During spring, summer, fall and winter, 45, 39, 64, and 97 percent, respectively, of all deer relocations occurred between sea level and 1000 ft (305 m) (Table 9). During the same time periods 4, 45, 7, and 0 percent, respectively, of the relocations occurred above 2000 ft (610 m).

Mean elevations and 90 percent confidence intervals were calculated for 12 instrumented deer from December 1979 through March 1980 (Table 10 and Fig. 18). Data for three of these deer include observations made during the 1978-79 winter. The sample

Table 7. Mean distance (mi) of home range center from beach calculated for individual radio-instrumented deer during the period December through March 1978-79 and 1979-80.

Deer #	Distance from Beach in miles (km)
78-79	
6	0.30 (.48)
20	0.10 (.16)
33	0.10 (.16)
70	0.25 (.40)
80	0.30 (.48)
90	0.05 (.08)
79-80	
3	0.55 (.88)
5	0.30 (.48)
18	0.25 (.40)
20	0.05 (.08)
25	0.35 (.56)
61	0.30 (.48)
70	0.20 (.32)
74	0.55 (.88)
80	0.85 (1.37)
90	0.30 (.48)
n=16 X=0.30 (.48)	S.D.=0.21

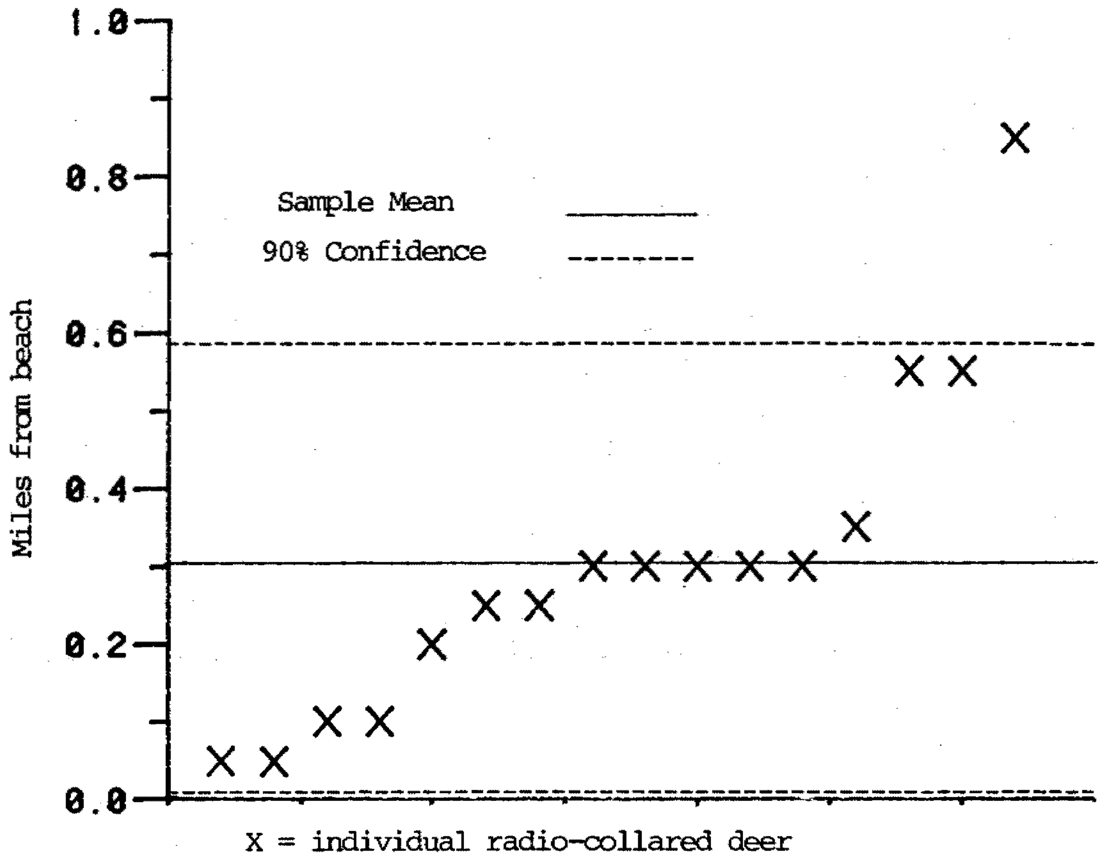

Fig. 18 Mean distance of instrumented deer from beach (December thru March).

Table 8. Mean, range, and standard deviations of deer relocations with respect to elevation and slope by season.

	Elevation in ft (m)				Slope in degrees			
Season	Mean	Range	SD	n	Mean	Range	SD	n
Fall	930 (284)	40-3000	707	121	15	0-51	17	115
Winter	290 (88)	0-1900	346	262	10	0-45	9	262
Spring	537 (164)	0-2200	470	275	12	0-50	10	275
Summer	1384 (422)	20-3500	942	264	15	0-55	12	264

Table 9. Crosstabulation of instrumented deer relocations relative to elevation by season.

ELEV ft		SEASON: SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
	COUNT / COL PCT					
0-500	1.	156 56.7%	67 25.4	42 34.7	208 79.4	473 51.3
501-1000	2.	80 29.1	37 14.0	35 28.9	45 17.2	197 21.4
1001-1500	3.	29 10.5	42 15.9	22 18.2	6 2.3	99 10.7
1501-2000	4.	8 2.9	44 16.7	13 10.7	3 1.1	68 7.4
2001-2500	5.	2 0.7	39 14.8	4 3.3	0 0.	45 4.9
2501-3000	6.	0 0.	30 11.4	5 4.1	0 0.	35 3.8
3001-3500	7.	0 0.	5 1.9	0 0.	0 0.	5 0.5
	COLUMN TOTAL	275 29.8	264 28.6	121 13.1	262 28.4	922 100.0

CHI SQUARE = 335.68174 WITH 18 DEGREES OF FREEDOM

Table 10. Mean elevation and 90% confidence intervals of 12 instrumental deer during the period December through March.

Deer #	Locations	Mean elevation in feet (m)	S.D.	90% confidence interval
70	12	100 (30)	21	71-129
61	12	108 (33)	56	32-184
20[1]	30	133 (41)	244	0-453
25	9	189 (58)	158	0-410
5	10	245 (75)	298	0-657
6[1]	30	275 (84)	161	64-486
17	9	294 (90)	279	0-684
18	10	380 (116)	235	55-705
3	10	615 (187)	372	101-1129
74	10	615 (187)	240	283-947
80[1]	30	640 (195)	597	0-1435
90	111	777 (237)	599	0-1843
12	183	364 (111)	237	59-669

1 Includes two winters' data.

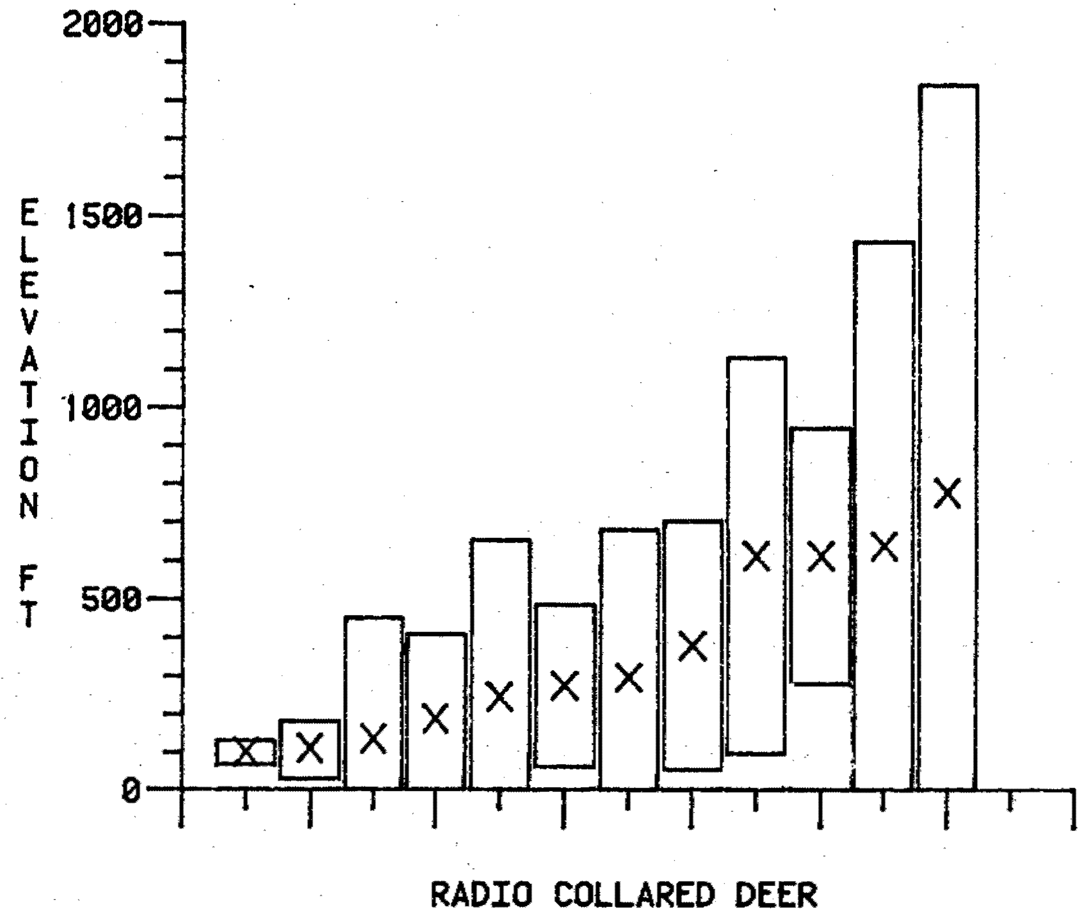

Fig. 19 MEAN ELEVATION AND 90% CONFIDENCE INTERVAL
OF RADIO COLLARED DEER DURING WINTER (DECEMBER THRU MARCH)

mean elevation was 364 ft (111 m) and the 90 percent confidence interval was 59-669 ft (18-204 m). Four of the sample means and seven of the upper confidence intervals reached above the 500 ft (152 m) level. This indicates that a substantial portion of winter deer use occurs above 500 ft.

A seasonal crosstabulation of slope is presented in Table 11. During fall, winter, spring, and summer, the mean slope of deer relocations was 15, 10, 12, and 15 degrees, respectively. Winter mean slope and standard deviation were the lowest of the year, reflecting deer distribution at elevations with correspondingly moderate slopes.

Deer use of aspect is summarized in Table 12. Northerly exposures were utilized most heavily during summer and fall (27 and 26 percent, respectively) and least during spring and winter (12 and 8 percent, respectively). Southerly exposures were utilized similarly during spring, fall, and winter (43, 47, and 41 percent, respectively) while during the summer period use fell to 35 percent.

Seasonal use of habitat type by instrumented deer is presented in Table 13. Old-growth forest, including beach fringe old-growth (within 100 yd [91 m] of the beach), was where most relocations occurred throughout the year. Ninety-two percent of all relocations fell in these two types during winter and spring, while summer and fall use of these types was 60 and 78 percent, respectively.

Use of beach fringe forest was heaviest during winter (26%) and declined through spring, summer, and fall. Subalpine habitat was used substantially only during summer (28%) and fall (12%) while the highest alpine use (8%) occurred during the summer period. The subalpine received far greater use than the upper alpine based both on telemetry surveys and field observations. Deer use of muskegs was highest during fall (6%), declined to 3 percent during spring and summer and was less than 0.5 percent during winter. Other habitat types receiving instrumented deer use included recent clearcuts, beaches, second-growth conifer stands, and beaches.

Seasonal habitat preference of instrumented deer at Winning Cove was evaluated by comparing use to availability. Examination of the Chi-squared statistics in each analysis shows that deer are selecting certain habitats in disproportion to their occurrence during the spring, summer, and winter seasons. Examination of residuals shows which habitats are significantly avoided or selected for within each season.

In spring (Table 14), there were significantly fewer observations than expected in the subalpine and significantly more observations than expected in the beach fringe ($p < .001$). At the .10 level, there were significantly more observations in old-growth forest (exclusive of beach fringe) then expected during spring.

Table 11. Crosstabulation of instrumented deer relocations relative to slope by season.

SLOPE °	COUNT / COL PCT	SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
FLAT	1.	28 10.2%	21 8.0	13 10.7	52 19.8	114 12.4
1-10	2.	140 50.9	103 39.0	36 29.8	126 48.1	405 43.9
11-20	3.	75 27.3	80 30.3	46 38.0	35 13.4	236 25.6
21-30	4.	21 7.6	36 13.6	20 16.5	39 14.9	116 12.6
31-40	5.	8 2.9	14 5.3	4 3.3	9 3.4	35 3.8
41-50	6.	3 1.1	9 3.4	1 0.8	1 0.4	14 1.5
51-60	7.	0 0.	1 0.4	1 0.8	0 0.	2 0.2
	COLUMN TOTAL	275 29.8	264 28.6	121 13.1	262 28.4	922 100.0

CHI SQUARE = 76.82470 WITH 18 DEGREES OF FREEDOM

Table 12. Crosstabulation of instrumented deer relocations relative to aspect by season.

ASPECT	COUNT / COL PCT	SEASON: SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
FLAT	1.	43	36	12	61	152
		15.6	13.6	9.9	23.4	16.5
N	2.	2	15	4	4	25
		0.7	5.7	3.3	1.5	2.7
NE	3.	22	35	17	11	85
		8.0	13.3	14.0	4.2	9.2
E	4.	43	33	4	34	114
		15.6	12.5	3.3	13.0	12.4
SE	5.	31	41	27	18	117
		11.3	15.5	22.3	6.9	12.7
S	6.	16	17	11	11	55
		5.8	6.4	9.1	4.2	6.0
SW	7.	70	34	19	79	202
		25.5	12.9	15.7	30.3	21.9
W	8.	38	31	14	37	120
		13.8	11.7	11.6	14.2	13.0
NW	9.	10	21	11	6	48
		3.6	8.0	9.1	2.3	5.2
RIDGETIP	10.	0	1	2	0	3
		0.	0.4	1.7	0.	0.3
COLUMN TOTAL		275	264	121	261	921
		29.9	28.7	13.1	28.3	100.0

CHI SQUARE = 117.08277 WITH 27 DEGREES OF FREEDOM

Table 13. Crosstabulation of instrumented deer relocations relative to habitat type by season.

HABITAT	COUNT / COL PCT	SEASON: SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
1. BEACH	COUNT	2	0	0	13	15
	COL PCT	0.7	0.	0.	5.0	1.6
2. BEACH FRINGE	COUNT	27	11	4	69	111
	COL PCT	9.8	4.2	3.3	26.3	12.0
3. OLDGROWTH FOREST	COUNT	226	146	90	172	634
	COL PCT	82.2	55.3	74.4	65.6	68.8
4. RECENT CLEARCUT	COUNT	8	3	4	5	20
	COL PCT	2.9	1.1	3.3	1.9	2.2
8. SECONDGROWTH CON	COUNT	0	0	1	1	2
	COL PCT	0.	0.	0.8	0.4	0.2
9. BRUSH	COUNT	1	2	0	0	3
	COL PCT	0.4	0.8	0.	0.	0.3
10. MUSKEG	COUNT	8	8	7	1	24
	COL PCT	2.9	3.0	5.8	0.4	2.6
11. SUBALPINE	COUNT	3	73	14	0	90
	COL PCT	1.1	27.7	11.6	0.	9.8
12. ALPINE	COUNT	0	21	1	1	23
	COL PCT	0.	8.0	0.8	0.4	2.5
COLUMN TOTAL		275	264	121	262	922
		29.8	28.6	13.1	28.4	100.0

CHI SQUARE = 304.75254 WITH 24 DEGREES OF FREEDOM

Table 14. Spring habitat preference of Winning Cove deer.

Habitat	Acres	Preparation of Total Acreage	(O) # Deer Observed	(E) # Deer Expected	O-E	Adjusted Residual	P	$\frac{(O-E)^2}{E}$
Clearcut	1065	.115	8	11.0	- 3	- .963		.818
Muskeg	224	.024	0	2.3	-2.3	-1.542	.20	2.300
Subalpine	1240	.134	0	12.8	-12.8	-3.888	.001	12.800
Beach Fringe	370	.040	14	3.8	10.2	5.340	.001	27.379
Upper Forest	6323	.686	73	65.1	7.9	1.746	.10	.959
	922	.999	95	95.0	0			44.256

$X^2_{[4]}$ .005=14.860 44.256 14.860

In winter (Table 15), there were significantly more observations in beach fringe then expected, and significantly fewer observations in clearcuts and upper forest ($p<.005$). At the .01 level, there were fewer observations than expected in muskeg habitat

In summer (Table 16) , subalpine and alpine were used significantly more than expected, $p<.001$ and $<.01$, respectively, while upper forest and clearcuts were used significantly less than expected, $p<.02$ and $<.10$, respectively.

In fall (Table 17), all habitats were used in proportion to their occurrence with the exception of alpine which was used less than expected ($p<.01$).

These analyses demonstrated no selection for upper forest by deer, but this habitat receives the greatest amount of use in all seasons and also represents the most abundant habitat type. It is a highly variable type and we have evidence that deer use within this type is selective.

Use of open canopies (between 0 and 10 percent) was highest in summer (19%) and accounted for less than 10 percent of total use during the rest of the year (Table 18). The recorded higher proportion of use of this open canopy category during winter compared to spring and fall was the result of a number of relocations in open beach habitat where tidal action melted snow. Use of canopies less than 50 percent was greatest during summer and decreased through fall, spring, and winter in that order. During winter and spring most deer were relocated in forests with canopy coverage between 60 and 80 percent. Few were relocated in forests with canopy coverage greater than 80 percent.

Deer use relative to snow cover is presented in Table 19. During summer, 96 percent of all relocations occurred in areas free of snow. During fall and spring, 77 and 55 percent of relocations were in snow-free areas. However, throughout winter, 60 percent of the relocations occurred in areas with a 75 percent or greater snow cover.

Discussion

Our low success capturing deer this year was attributable in large part to poor weather conditions. During several periods when snow conditions drove deer down to the beaches, we were unable to obtain vessel support because of marginal weather or scheduling problems. When we were in the field, tracking conditions were poor. Many animals which had been hit with an immobilizing dart were not immobilized and/or recovered.

Driving deer off islands can be effective but requires a substantial logistic effort and has limited application. To date, the most productive capture techniques are darting deer in the alpine from a helicopter and darting deer on the beaches in the winter from a skiff. Both techniques are dependent upon favorable weather conditions and also introduce some sample bias. Deer captured in the alpine represent only that portion of the

Table 15. Winter habitat preference of Winning Cove deer.

Habitat	Acres	Proportion of Total Acreage	(O) # Deer Observed	(E) # Deer Expected	O-E	Adjusted Residual	P	$\frac{(0-3)^2}{E}$
Clearcut	1065	.133	5	5.7	-10.7	-2.900	.005	7.292
Muskeg	224	.028	0	3.3	- 3.3	-1.692	.10	3.300
Beach Fringe	370	.046	43	5.5	37.5	16.371	.001	225.680
Upper Forest	6323	.792	70	93.5	-23.5	-5.329	.001	5.906
	7982	.999	118	118.0	0			272.178

$X^2_{[3]}$ .005=12.838 272.178 12.838

Table 16. Summer habitat preference of Winning Cove deer.

Habitat	Acres	Proportion of Total Acreage	(O) # Deer Observed	(E) # Deer Expected	O-E	Adjusted Residual	P	$\frac{(O-E)^2}{E}$
Clearcut	1065	.101	3	7.3	-4.3	-1.678	.10	2.533
Muskeg	224	.021	0	1.5	-1.5	-1.238		1.500
Subalpine	1240	.117	21	8.6	12.4	4.500	.001	17.879
Alpine	1353	.128	14	9.3	4.7	1.650	.10	2.375
Beach Fringe	370	.035		2.5	- .5	- .322		.100
Upper Forest	6323	.598	33	43.6	-10.6	-2.532	.02	2.577
	.0575	1.000	73	72.8	0			29.541

$X^2_{[5]}$ .005=16.750 29.541 16.750

Table 17. Fall habitat preference of Winning Cove deer.

Habitat	Acres	Proportion of Total Acreage	(0) # Deer Observed	(E) # Deer Expected	0-E	Adjusted Residual	P	$\frac{(0-3)^2}{E}$
Clearcut	1065	.101	4	3.8	.2	.108		.011
Muskeg	224	.021	0	.8	- .8	- .903		.800
Subalpine	1240	.117	5	4.5	.5	.251		.056
Alpine	1353	.128	1	4.9	-3.9	-1.887	.10	3.104
Beach Fringe	370	.035	1	1.3	- .3	.268		.069
Upper Forest	6323	.598	27	22.7	4.3	1.423	.20	.814
	10575	1.000	38	38.0	0			4.854

$X^2_{[5]}$ .5=4.351 4.854 4.351

Table 18. Crosstabulation of instrumented deer relocations relative to canopy cover by season.

RCANOPY	COUNT / COL PCT	SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
0-10,	1.	10	51	3	17	81
		3.6	19.3	2.6	9.1	9.6
11-20,	2.	3	17	2	1	23
		1.1	6.4	1.7	0.5	2.7
21-30,	3.	5	24	7	5	41
		1.8	9.1	6.1	2.7	4.9
31-40,	4.	16	35	16	0	67
		5.8	13.3	13.9	0.	8.0
41-50,	5.	35	31	13	6	85
		12.7	11.7	11.3	3.2	10.1
51-60	6.	64	56	30	31	181
		23.3	21.2	26.1	16.6	21.5
61-70	7.	87	46	38	46	217
		31.6	17.4	33.0	24.6	25.8
71-80	8.	51	4	6	69	130
		18.5	1.5	5.2	36.9	15.5
81-90	9.	4	0	0	8	12
		1.5	0.	0.	4.3	1.4
91-100	10.	0	0	0	4	4
		0.	0.	0.	2.1	0.5
	COLUMN TOTAL	275	264	115	187	841
		32.7	31.4	13.7	22.2	100.0

CHI SQUARE = 266.38176 WITH 27 DEGREES OF FREEDOM

Table 19. Crosstabulation of instrumented deer relocations relative to snow cover by season.

SNOCOV	COUNT / COL PCT	SPRING 1.	SUMMER 2.	FALL 3.	WINTER 4.	ROW TOTAL
0	1.	150	252	93	21	516
		54.5	95.5	76.9	8.0	56.0
1-25	2.	53	11	0	8	72
		19.3	4.2	0.	3.1	7.8
26-50	3.	22	1	1	13	37
		8.0	0.4	0.8	5.0	4.0
51-75	4.	19	0	1	20	40
		6.9	0.	0.8	7.6	4.3
76-100	5.	31	0	24	93	148
		11.3	0.	19.8	35.5	16.1
	999.	0	0	2	107	109
		0.	0.	1.7	40.8	11.8
	COLUMN TOTAL	275	264	121	262	922
		29.8	28.6	13.1	28.4	100.0

CHI SQUARE = 677.39661 WITH 15 DEGREES OF FREEDOM

population which is seasonally migratory. Theoretically, deer captured on the beach during winter should be representative of the entire population. However, during less than extreme conditions, some deer may winter at higher elevations than others and these would not be well represented in a sample captured on the beach. This situation needs further investigation.

Currently 15 deer have functional transmitters. Our plans are to instrument an additional 20 to 25 deer. This work will be concentrated primarily in the Hawk Inlet area.

Seasonal home ranges of most instrumented deer ranged from 320 acres (130 ha) to 1280 acres (518 ha). Because of the small sample size the data were not evaluated for differences in age or sex. It should also be noted that these areas are only relative approximations. They were calculated on the basis of a two dimensional surface when in actuality the deer movements occurred on a three dimensional plane. The result is that spring, summer, and fall ranges are underestimates of actual surface area. During these seasons, especially summer, many deer inhabited areas of steeper terrain.

Spring and fall home ranges were largest, reflecting the migratory movements of a portion of the sample population. Winter and summer ranges were small with winter range the most restricted.

Small winter home range size is, theoretically, the result of reduced activity and selective foraging based on a strategy to conserve energy in a relatively uniform, low quality foraging environment relative to summer range. Plans are currently being developed with the Forestry Sciences Lab and Washington State University to evaluate habitat selection in terms of deer energetics.

About half of our sample population made distinct seasonal migrations between winter and summer ranges. Summer and winter home ranges of the remaining deer showed substantial overlap. Migratory deer made greater use of alpine and subalpine habitats while resident deer primarily occupied forested habitat. We are not prepared at this time to estimate what proportion of the population is resident or migratory. This may vary substantially between areas as a result of differences in topography and availability of habitat types.

During the last two winters (December through March), in the areas sampled, home ranges of instrumented deer were generally within 0.6 mi (1.6 k) from the beach and from sea level to 800 ft (244 m) elevation. Although some relocations occurred outside this range, we consider this to be a reasonable geographical description of winter deer range. This could, of course, vary geographically and from year to year. Most of our study area was relatively steep. In areas where well-drained forested slopes are separated from the beach by several miles of muskeg we would expect deer to occur farther from the beach than indicated here. In winters with heavy snowfall deer would conceivably winter at lower elevations than in years with minimal snowfall.

During the winter our sample population was restricted primarily to low elevation, uneven-aged, old-growth forest with canopy coverage between 60 and 80 percent. Habitats such as alpine, subalpine, muskegs, and clearcuts were avoided. During winter these habitats are generally inaccessible to deer because of heavy snow accumulation. These independent data support the data reported by Wallmo and Schoen (1980) which indicate that clearcuts are inferior to old-growth as winter deer habitat in Southeast Alaska. Clearcuts were also avoided during summer when subalpine and alpine habitats were preferred. It appears that clearcuts constitute no special attraction as summer deer range in relation to other high quality habitats available during this season. Relative to availability, subalpine was the most preferred habitat type followed by alpine. However, old-growth forest received the greatest use because of its great abundance.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Edge Study

The concept of "edge" being beneficial to wildlife is a widely accepted tenet in professional circles, yet it is one supported by little quantitative data. Our study was designed to test whether or not there is a measurable increase in deer use along the boundaries, or edge, of young clearcuts in Southeast Alaska. As described in this report, there was no detectable response by deer to any of the clearcut edges studied. These results are of practical value to wildlife managers and timber managers planning timber sales and laying out cutting units. A complete presentation and discussion of the results is given in Kirchhoff et al. (in prep). No further work with clearcut-forest edges is anticipated.

Forest Habitat Study

This work has contributed much towards our appreciation of the forest ecosystem as one of great complexity and diversity. By looking closely at certain attributes of a particular forest stand, and measuring deer use associated with that stand, we can begin to identify certain characteristics to which deer are responding. At present, it appears that low elevation, old-growth forest on a productive site characterized by large, irregularly spaced trees, and an understory community abundant in *Cornus* and *Vaccinium*, provides the optimum winter habitat for deer.

The fact that deer, in winter, select for higher volume old-growth stands is a concept of immediate importance to both wildlife managers and timber managers. This relationship, as well as other forest habitat-deer relationships, should be well understood before making far reaching, and often irreversible, management decisions. Recognizing this, the Department intends to continue with its forest sampling field work, extending it into new study areas. This research will add much to our knowledge of deer-forest relationships, and will enhance our ability to make sound resource management decisions.

Telemetry Study

Radio telemetry work conducted to date has yielded valuable information concerning seasonal movements and habitat selection by deer. Some of the old generalizations regarding use of the forest by deer should be reexamined in light of this new information. For example, it is obvious that use of old-growth forest by deer, irrespective of season, is considerably greater than that of any other major habitat type. Some deer are migratory and may move many miles between summer and winter ranges, others are relatively sedentary and move surprisingly little throughout the year. It is also apparent that although deer are using old-growth forest, in many cases exclusively, their use of this forest is selective. Radio-collared deer use specific types of forest during different seasons, as reflected by data for canopy cover and more recently volume class and drainage class.

Future telemetry work will emphasize the matter of fine-scale habitat selection within the old-growth forest. Deer capture efforts will center in the Hawk Inlet area which is convenient to Juneau and also has a wide variety of forested habitat types available to deer.

Detailed habitat overlays of the study area developed by personnel trained in aerial photo-interpretation will aid in evaluating habitat selection by deer. These maps will describe the forest in terms of recognized volume classes, species composition, stand risk factors and canopy coverage. This approach will be integrated with the forest habitat sampling work and should contribute substantially to our understanding of how deer use their environment.

New Research

All of the research conducted to date, including old-growth-clearcut comparisons, clearcut edge response, telemetry work, and forest habitat sampling, points to the importance of old-growth forest, and more specifically to certain types of old-growth forest, as winter habitat for deer. With that established, it remains to be shown <u>why</u> deer select the specific habitats they do. Research spearheaded by the Forestry Sciences Lab, in cooperation with Washington State University and ADF&G, will be designed to answer this question. The ultimate goal of this work will be to develop a model of deer bioenergetics in Southeast Alaska. The hypothetical costs and benefits to deer associated with specific habitat types will be an integral part of the model. To accumulate the necessary data, FSL and ADF&G will begin studies on deer food habits, forage abundance and availability in different habitats, nutritional quality of available forage, snow conditions associated with specific habitat types, and energy requirements associated with deer locomotion under varying snow conditions.

Management Implications

Much has been learned about the interaction of deer with their natural environment over the past 2 years. A word of caution is appropriate before attempting to apply the findings of this research to wildlife habitat enhancement programs on managed forest land in Southeast Alaska, however. Specific deer-habitat relationships which hold true in the context of old-growth forest may not hold true in a managed second-growth forest. For example, an even-aged regrowth stand can be thinned so that tree spacing variability approaches the optimum, but this may not be effective in and of itself. We've found that this variability factor, which apparently is important to deer, is also significantly correlated with large tree diameters. One without the other may do little in terms of enhancing deer habitat. Complicating wildlife habitat enhancement programs is the consideration that what is habitat enhancement for one species, may be habitat degradation for another. Unfortunately, we have little information on the habitat requirements of most wildlife species in Southeast Alaska.

The complexities of old-growth forest-wildlife relationships in Southeast Alaska are just beginning to be examined and understood. More research will be needed before we can hope to quantify the impacts of forest management on individual wildlife species, or effectively manage even-aged stands to improve them as wildlife habitat. For deer, this latter goal appears remote as long as mature trees, uneven-agedness, and floristic diversity remain integral components of their preferred winter habitat.

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