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

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Volume V

Progress Report
Federal Aid in Wildlife Restoration
Project W-22-2, Job 2.6R

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PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: R. Flynn and M. Thomas, ADF&G; J. McKendrick, Agricultural Experiment Station, Palmer

Project No.: W-22-2 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: 1 July 1982 through 30 June 1983

## SUMMARY

*Cornus canadensis*, an important deer forage species, was collected from high volume old growth, low volume old growth, and clearcut sites in both Juneau and Ketchikan during December 1982. Samples were analyzed for fiber content, digestibility, and important minerals. In general, forage quality was highest in old growth, intermediate in low volume, and lowest in clearcut. Because trends for some parameters were inconsistent between study areas, additional study is recommended.

Data from 51 radio-collared deer instrumented on Admiralty Island from November 1978 through February 1982 were analyzed and a manuscript prepared for publication (see attached draft). An estimated 75% of the population migrated to high elevation summer ranges, while the remainder were residents of the winter range. Migratory deer were found higher in elevation than resident deer during all seasons. There were no differences in distribution between sexes. Home range size during both winter and summer averaged 79 ha with no differences between sexes or migratory and resident deer. Deer generally used the same seasonal home ranges in consecutive years.

Key words: *Cornus canadensis*, habitat use, nutritional quality, seasonal distribution, Sitka black-tailed deer, Southeastern Alaska.

CONTENTS



## BACKGROUND

Background and justification for this project were outlined previously (Schoen et al. 1979). Comprehensive studies of habitat use and selection have been completed and data from these studies are being analyzed and prepared for publication. A manuscript dealing with deer distribution and home range is appended. The only new fieldwork, a preliminary study of Cornus quality in differing sites, is reported herein.

## OBJECTIVES

To develop capture and telemetry techniques for Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), and evaluate seasonal distribution and preference within natural (unlogged) and modified (logged) habitats.

## STUDY AREA

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

## FORAGE QUALITY STUDY

### Introduction

In recent studies, patterns of habitat selection by Sitka black-tailed deer in winter have been attributed to relative forage abundance (Wallmo and Schoen 1980, Rose 1982), and more speculatively, to forage availability as it is influenced by snow (Bloom 1978, Barrett 1979, Wallmo and Schoen 1980, Schoen et al. 1981, Rose 1982). Lower nutritional quality of deer forage has been suggested as a possible reason for low summer deer use in young clearcuts (Wallmo and Schoen 1980, Rose 1982) and along forest/ clearcut edges (Kirchhoff et al. 1983). Few data are available, however, on site-specific variation in forage nutritional quality. Billings and Wheeler (1979) compared nutritional quality of Vaccinium spp. in old growth and clearcuts, finding it superior in old growth. Other studies have concentrated on how nutritional quality varies phenologically, and/or varies between plant species (Klein 1965, Schoen and Wallmo 1979, Rose 1982, Hanley and McKendrick In Press).

Evergreen forbs (e.g., Tiarella trifoliata, Rubus pedatus, Cornus canadensis, Coptis aspleniifolia, and Moneses uniflora) are important foods for deer, particularly in winter (Regelin 1979, Schoen and Wallmo 1979, Rose 1982, Hanley and McKendrick In Press) The forb Cornus canadensis appears to be the most important species in the winter diet of deer (Schoen et al. 1981, Schoen and Kirchhoff 1983).

The purpose of this study was to compare fall nutritional quality of an important forage species, Cornus, in 3 common habitat types (young clearcuts, low volume old growth, and high volume old growth) in Southeast Alaska. The study was exploratory in nature, and these preliminary results will be used in the design of a more comprehensive sampling effort scheduled for fall 1983.

## Materials and Methods

Samples of Cornus canadensis were collected from 3 habitat types in Juneau and Ketchikan in early December 1982. Homogeneous forest stands, 0.4 ha in size, were selected as representative of each habitat type. In each study area, stands were in close proximity to one another and shared similar topographic characteristics (Table 1). Within each stand, 10 sample points were randomly established. At each sample point, the leaves and stems of all Cornus plants within a circular 3 $m^2$-area were collected. On some points, the area was increased to 5 $m^2$ to ensure an adequate sample for laboratory analyses.

Plant samples were placed in plastic bags and stored frozen for 2-3 weeks. Prior to laboratory analysis, plants were dried in a forced-air oven at 40 C for 48-72 hours and ground in a Wiley mill. The measured fiber constituents of the forage included cellulose, lignin, acid detergent fiber (ADF), and neutral detergent fiber (NDF). Digestibility was measured by in vitro dry matter disappearance (IVDMD) trials using microflora from cattle rumen.

Other assays included nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), fat, and total nonstructural carbohydrates (TNC).

## Results and Discussion

The most pronounced differences in *Cornus* nutritional quality occurred between the clearcut and high volume old growth sites, with *Cornus* in the high volume sites being of higher quality (Table 2). Two measures of dietary fiber, NDF and lignin, were higher in the clearcut samples than in the high volume samples ($P < 0.001$).

Cellulose and lignin, 2 components of ADF, were different between clearcut and high volume sites, with cellulose higher in the high volume sites and lignin higher in the clearcut site ($P < 0.05$; Table 2). These 2 components apparently cancel out each other, resulting in no difference in ADF between the 2 sites.

*Cornus* from high volume old growth was more digestible than *Cornus* from the clearcut ($P < 0.001$; Table 2). Nitrogen (N) was higher in *Cornus* collected from the high volume sites ($P < 0.001$; Table 2). Of the other minerals assayed, potassium (K) and magnesium (Mg) were higher in the high volume sites ($P < 0.001$); phosphorus (P) was higher in the clearcut ($P < 0.01$); and there was no difference in levels of calcium (Ca). The remaining 2 assays measured total nonstructural carbohydrates (TNC), which was not different between sites, and fat, which was higher in the clearcuts ($P < 0.001$). Because 9 out of 10 of the Ketchikan high volume samples were insufficient to test for fat, this comparison weights the Juneau high volume samples heavily.

Trends in the combined data were consistent between the Juneau and Ketchikan study sites with the following exceptions: in Ketchikan, calcium was higher in the clearcut than on the high volume ($P < 0.01$), and fat content was not different between the clearcut and high volume samples. In Juneau, there was no difference between high volume and clearcut samples when tested for lignin, cellulose, or phosphorus.

Relationships among certain of the measured chemical parameters were unexpected, and, because of the small sample size, cannot be adequately addressed. For example, measurements of plant fiber (ADF, Lig, cellulose) were not correlated ($P > 0.4$) with digestibility (IVDMD). Digestibility in our samples was most affected by nitrogen (positive effect) and NDF (negative effect) (multiple regression, $R^2 = 0.54$), with other variables being unimportant. Minerals were generally higher in the forage collected from high volume forest, indicating higher quality. Phosphorus was the exception, as was fat content; both were higher in the clearcut. Phosphorous is positively correlated with lignin ($R = 0.485$, $P = \leq 0.001$), and fat is positively correlated with NDF ($R = 0.58$, $P = \leq 0.001$), which may explain why they were higher in the clearcut.

In a comparison of clearcut versus forest (low and high volume sites combined), most of the same trends occur, only the differences between the means are smaller (Table 3). In addition, more inconsistencies between study areas exist. In the Ketchikan area, the trends were the same except there were no significant differences in digestibility (IVDMD), nitrogen, potassium, magnesium, and fat. In Juneau, the trends were the same except there were no differences in lignin, cellulose, and phosphorus. Small sample sizes in individual study areas may account for the lack of statistical significance. Trends on individual study areas were consistent with the combined study areas.

In general, it appears from these preliminary data that high volume sites contain higher quality forage than low volume. Means of 6 variables were significantly different (Table 4). In this comparison, more differences between study areas exist. For some variables, the low volume data contain more variance. In addition, for certain variables, trends between areas are opposite; thus, there is no difference in the combined data set. Forage quality on low volume sites may be more related to soil productivity than to light factors. Forage quality in clearcuts and high volume sites, which more likely share similar soil characteristics, may be a function of light-induced, phenological differences.

More observations are needed, particularly on low volume sites, to make broad inferences about forage quality on different habitat types in Southeast. These results indicate, however, that forage quality, as well as forage quantity and availability, are potentially important factors in determining winter habitat quality for deer.

## ACKNOWLEDGMENTS

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Table 1. General topographic and vegetative characteristics of 3 habitat types sampled in Juneau and Ketchikan, fall 1982.

| | Habitat | | | | | |
|---|---|---|---|---|---|---|
| | Clearcut | | Low volume | | High volume | |
| Topographic/ vegetative characteristics | Juneau | Ketchikan | Juneau | Ketchikan | Juneau | Ketchikan |
| Aspect | W | SW | W | SW | W | SW |
| Elevation (m) | 30 | 50 | 15 | 50 | 30 | 50 |
| Slope (deg.) | 5 | 10 | flat | 15 | 5 | 10 |
| Drainage | mod. | good | mod. | poor | mod. | mod. |
| Age (years) | 5 | 5-10 | >300 | >300 | >300 | >300 |
| Volume (MBF/acre) | 0 | 0 | 8-10 | 10-12 | 25-30 | 20-25 |
| Dom. overstory sp. | -- | -- | hem.[a] | cedar[b] | hem. | hem. |

[a] Western hemlock (*Tsuga heterophylla*).

[b] Alaska cedar (*Chamaecyparis nootkatensis*).

Table 2. Comparison of plant chemistry and digestibility of *Cornus* on clearcut and high volume habitats of combined study areas (Juneau and Ketchikan), fall 1982. Values are expressed as % dry weight composition.

| | Clearcut | | | High volume | | | |
|---|---|---|---|---|---|---|---|
| Assay | *N* | $\bar{x}$ | SE | *N* | $\bar{x}$ | SE | *t*[a] |
| NDF | 15 | 33.36 | 0.66 | 20 | 28.78 | 0.46 | 5.87*** |
| ADF | 20 | 29.01 | 0.41 | 19 | 29.23 | 0.31 | -0.42 |
| Lig | 20 | 11.29 | 0.40 | 19 | 9.98 | 0.35 | 2.47* |
| Cel | 20 | 17.46 | .32 | 19 | 18.96 | 0.30 | -3.40** |
| IVDMD[b] | 20 | 63.35 | 1.35 | 20 | 74.46 | 0.59 | -7.55*** |
| Ash | 19 | 9.41 | 0.12 | 16 | 9.56 | 0.11 | -0.89 |
| N | 20 | 1.24 | 0.04 | 20 | 1.50 | 0.02 | -6.04*** |
| P | 20 | 0.19 | 0.04 | 20 | 0.17 | 0.02 | 2.31* |
| K | 20 | 0.93 | 0.06 | 20 | 1.28 | 0.06 | -4.25*** |
| Ca | 20 | 2.50 | 0.08 | 20 | 2.30 | 0.09 | 1.67 |
| Mg | 20 | 0.36 | 0.13 | 20 | 0.46 | 0.24 | -3.88*** |
| Fat | 20 | 2.59 | 0.13 | 10 | 1.36 | 0.16 | 5.68*** |
| TNC | 20 | 9.13 | 0.52 | 14 | 10.19 | 0.38 | -0.66 |

[a] *t* statistic. *** is significant at 0.001, ** is significant at 0.01, * is significant at 0.05.

[b] % dry matter disappearance.

Table 3. Comparison of plant chemistry and digestibility of *Cornus* on clearcut and old growth (combined high and low volume habitats) of combined study areas (Juneau and Ketchikan), fall 1982. Values are expressed as % dry weight composition.

| | Clearcut | | | Old growth | | | |
|---|---|---|---|---|---|---|---|
| Assay | N | $\bar{x}$ | SE | N | $\bar{x}$ | SE | $t$[a] |
| NDF | 15 | 33.36 | 0.66 | 39 | 29.95 | 0.39 | -4.52*** |
| ADF | 20 | 29.01 | 0.41 | 38 | 29.16 | 0.22 | 0.35 |
| Lig | 20 | 11.29 | 0.40 | 38 | 9.97 | 0.25 | -2.92** |
| Cel | 20 | 17.46 | 0.32 | 38 | 18.82 | 0.27 | 3.14** |
| IVDMD[b] | 20 | 63.35 | 1.35 | 40 | 72.61 | 0.89 | 5.88*** |
| Ash | 19 | 9.42 | 0.12 | 31 | 9.11 | 0.21 | -1.10 |
| N | 20 | 1.24 | 0.04 | 40 | 1.37 | 0.03 | 2.72 |
| P | 20 | 0.19 | 0.01 | 40 | 0.17 | 0.01 | -2.39* |
| K | 20 | 0.93 | 0.06 | 40 | 1.16 | 0.04 | 3.22** |
| Ca | 20 | 2.50 | 0.08 | 40 | 2.33 | 0.52 | -1.83 |
| Mg | 20 | 0.36 | 0.01 | 40 | 0.43 | 0.14 | 3.09** |
| Fat | 20 | 2.59 | 0.13 | 24 | 1.78 | 0.16 | 3.87*** |
| TNC | 20 | 9.73 | 0.52 | 31 | 10.26 | 0.25 | 1.01 |

[a] $t$ statistic. *** is significant at 0.001, ** is significant at 0.01, * is significant at 0.05.

[b] % dry matter disappearance.

Table 4. Comparison of plant chemistry and digestibility of Cornus on high volume old growth and low volume old growth of combined study areas (Juneau and Ketchikan), fall 1982. Values are expressed as % dry weight composition.

| | Low volume | | | High volume | | | |
|---|---|---|---|---|---|---|---|
| Assay | N | $\bar{x}$ | SE | N | $\bar{x}$ | SE | t[a] |
| NDF | 19 | 31.19 | 0.52 | 20 | 28.78 | 0.46 | 3.49** |
| ADF | 19 | 29.09 | 0.32 | 19 | 29.23 | 0.32 | -0.32 |
| Lig | 19 | 9.96 | 0.38 | 19 | 9.98 | 0.35 | -0.04 |
| Cel | 19 | 18.68 | 0.44 | 19 | 18.96 | 0.30 | -0.53 |
| IVDMD[b] | 20 | 70.78 | 1.60 | 20 | 74.46 | 0.59 | -2.16* |
| Ash | 15 | 8.63 | 0.37 | 16 | 9.56 | 0.11 | -2.48* |
| N | 20 | 1.24 | 0.03 | 20 | 1.50 | 0.21 | -7.14*** |
| P | 20 | 0.16 | 0.01 | 20 | 0.17 | 0.01 | -0.31 |
| K | 20 | 1.05 | 0.05 | 20 | 1.28 | 0.05 | -2.87** |
| Ca | 20 | 2.36 | 0.06 | 20 | 2.30 | 0.09 | .58 |
| Mg | 20 | 0.39 | 0.01 | 20 | 0.46 | 0.02 | -2.79 |
| Fat | 14 | 2.07 | 0.22 | 10 | 1.36 | 0.16 | 2.46 |
| TNC | 17 | 10.31 | 0.34 | 14 | 10.19 | 0.28 | .23 |

[a] t statistic. *** is significant at 0.001, ** is significant at 0.01, * is significant at 0.05.

[b] % dry matter disappearance.

Appendix A.

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SEASONAL DISTRIBUTION AND HOME RANGE PATTERNS OF SITKA BLACK-TAILED DEER ON ADMIRALTY ISLAND, SOUTHEAST ALASKA

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Abstract: Fifty-one Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) were radio collared and their movements monitored on Admiralty Island, southeast Alaska, from November 1978 through August 1982. An estimated 75% of the population made seasonal migrations from low elevation winter ranges to high elevation (usually subalpine or alpine) summer ranges; the remainder were year round residents of low elevation ranges. Migratory deer made extensive movements between summer and winter ranges and were located at higher elevations than resident deer during all seasons. In winter, the elevation of all deer locations averaged 124 m. During mild winter conditions (Jan-Mar 1981), deer were found at higher elevations than during more severe winter conditions (Jan-Mar 1982). The mean summer and winter home range size of all radio collared deer was 79 ha. Home range size did not differ between summer and winter, males and females, or resident and migratory deer. With few exceptions, deer returned to the same summer and winter home ranges in consecutive years. In only one case did a deer move permanently from the watershed in which it was captured. Management implications of these findings are discussed.

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Key words: Admiralty Island, deer, home range, *Odocoileus hemionus sitkensis*, old growth, southeast Alaska, telemetry.

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Sitka black-tailed deer are indigenous to the southeast Alaska mainland and adjacent islands of the Alexander Archipelago. Much of this area is subject to heavy winter snowfall which is a major limiting factor on deer population levels (Klein and Olson 1960). Old-growth forest provides deer protection from deep snow, access to nutritional forage, and is considered essential winter habitat (Bloom 1978, Barrett 1979, Wallmo and Schoen 1980, Rose 1982).

Timber harvesting constitutes a major impact on deer habitat in this region. Approximately 7000 ha of old growth is slated for harvest annually on the Tongass National Forest (Schoen et al. 1984). Because harvest centers on productive, low elevation forestland in coastal areas (Hutchison and LaBau 1975) the potential for conflict between deer and timber management objectives is high. Information on the seasonal distribution of deer, particularly during the critical winter season, will enable managers to more accurately delineate important winter range and direct logging activity to less sensitive areas. Where logging overlaps important winter range, effects on deer will vary depending on the extent of migratory behavior displayed by the population, home range size, and the deer's tendency to make small- or large-scale adjustments in home range location in response to changing environmental conditions.

Existing data on seasonal distribution are limited in southeast Alaska (Klein 1965; H.R. Merriam unpubl. rept., Alaska Dept. Fish and Game, Fed. Aid Proj. W-15-12, 1968; Barrett 1979), and none exists on home range characteristics. The environment of Columbian black-tailed deer (O. h. columbianus) on northern Vancouver Island, British Columbia, where old-growth forest is present and winter snow fall is high (Harestad 1979), is most comparable to the situation in southeast Alaska.

The objectives of this study were to determine seasonal distribution and home range characteristics of Sitka black-tailed deer and address the implications for deer-forest management in southeast Alaska. The project was conducted under a cooperative research program of the Alaska Department of Fish and Game through Federal Aid to Wildlife Restoration Projects W-17, W-21 and W-22 and the U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station.

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## STUDY AREA

Admiralty Island, in northern southeast Alaska, is the third largest island (4,310 $km^2$) of the Alexander Archipelago. The topography of Admiralty is varied and rugged, with steep mountains rising to over 1,400 m. The climate is maritime with cool, wet weather predominating. Elevations above 600 m are normally under deep snow for 5 to 7 months of the year and snow accumulations of 10 to 50 cm at sea level are common but variable. Vegetation consists of temperate coniferous rain forests from sea level to about 600 m and subalpine or alpine vegetation at higher elevations. The forest exists in a predominantly old-growth condition characterized by an uneven-age, multilayered overstory, old (300+ years) trees, and an abundant, structurally diverse understory (Schoen et al. 1981). Western hemlock (Tsuga heterophylla) and Sitka spruce (Picea sitchensis) dominate the forest, with poorly drained bogs or muskegs, riparian bands, and brush slopes scattered throughout (Harris and Farr 1974). Neither wolves (Canis lupus) nor black bears (Ursus americanus) occur on Admiralty Island. The only potential natural predator is the brown bear (Ursus arctos).

Hawk Inlet and Glass Peninsula, both heavily forested sites, were selected for intensive radio-telemetry work (Fig. 1). The Hawk Inlet site (300 $km^2$) had minimal logging activity, and included approximately 60 km of marine shoreline and elevations to 1,418 m. Upper elevation brush, alpine, subalpine, and rock habitat types encompassed about 30% of the area, while old-growth forest covered 67%.

The Glass Peninsula site (150 $km^2$) was partially logged and included several small second-growth stands and a 400-ha clearcut harvested during 1970-75. The Glass Peninsula site encompassed approximately 40 km of marine shoreline and elevations to 1,270 m. Upper elevation brush, alpine, subalpine, and rock habitat made up approximately 25% of the area, clearcuts and early seral forests represented 4%, and old growth 70% of the study site.

Deer density on the winter range below 150 m (determined by pellet group sampling, assuming a 6 month deposition period and a defecation rate of 13 groups per day) was 54 per $km^2$ on Glass Peninsula in 1979 and 26 per $km^2$ in Hawk Inlet in 1982 (J. W. Schoen and M. D. Kirchhoff unpubl. data). Both study sites received light to moderate hunting pressure from 1 August through 31 December.

## METHODS

Deer were captured in low elevation beach and forest habitat during winter by immobilization with succinylcholine chloride shot from a "Pneu Dart" gun. In summer, deer were captured in alpine habitat from a helicopter using a net gun, or immobilized with etorphine hydrochloride shot from a "Cap Chur" gun. All captured deer were fitted with ear tags and radio collars (Telonics, Mesa, AZ.).

Telemetry relocations were made from a fixed wing, Helio Courier aircraft with directional H antennas mounted under each wing. Deer were relocated once each week, weather permitting, usually between 0800 and 1800 hours; relocations were recorded on

1:63,360 scale USGS topographic maps. In 9 aerial telemetry trials conducted in forest habitat (J. W. Schoen and M. D. Kirchhoff, unpubl. rep., Alaska Dept. Fish and Game, Fed. Aid Proj. W-22-1, 1983) relocations averaged 24 m (SE = 3.7) from actual location.

Elevation of each deer relocation was estimated with the aircraft's altimeter. Distance to the coast was obtained by measuring the distance from tidewater to the center point of individual home ranges, as plotted on 1:63,360 scale USGS topographic maps.

Generally, as deer moved up in elevation they also moved farther from the coast. To minimize redundancy, results are reported relative to elevation except where trends differ, or where mean values for distance from coast are of interest. Because all but one of our resident deer were females, comparisons between males and females were made with the migratory component of the population only.

Winter and summer (calendar seasons) home ranges were determined by connecting the outer points of relocation for each season to form convex polygons (Mohr 1947). Each home range included a minimum of 5 relocations. The dot grid technique was used to determine the areas of the polygons. Deer were considered to have used the same seasonal home range if ranges in consecutive years overlapped. Fidelity to a specific seasonal range and distances between summer and winter ranges were quantified by measuring the distance between home range centers in consecutive years. A Mann-Whitney U test was used to determine the statistical significance of all 2-sample comparisons at 0.05 alpha levels.

## RESULTS

Fifty-one deer were captured and fitted with radio collars on Admiralty Island between November 1978 and February 1982. Thirty-eight of those deer, 10 from the Glass Peninsula and 28 from Hawk Inlet, were relocated 10 or more times for a total of 1,662 relocations. Thirty-one percent of the relocations occurred in spring, 29% in winter, 22% in summer, and 18% in fall.

Deer were classified as resident if winter and summer home ranges overlapped, or migratory if these ranges were non-overlapping. For radio-collared deer whose resident/migratory status could be determined (some deer captured in winter died before spring), 8 (1 M, 7 F) were resident and 28 (15 M, 12 F) were migratory deer. Because deer were not captured randomly, these proportions do not necessarily reflect resident/migratory makeup of the population as a whole. Thirty-seven percent of the deer captured on the winter range were resident. Because migratory deer wintered higher than resident deer, our capture effort (carried out below 200 m) was likely biased toward resident deer. Considering this bias, we estimated that about 25 percent of the total population were resident deer.

Seasonal Distribution

The elevation and distance to the coast varied among calendar seasons for migratory deer but not for resident deer (Kruskal-Wallis test, $P < 0.001$). Migratory deer moved up in elevation, generally to subalpine or alpine areas, during late spring and early summer while resident deer remained at low elevations (Table 1, Fig. 2). No significant difference in the elevation of migratory males and females were detected during any season.

Winter. All deer relocations averaged 124 m (SE = 6.2) elevation and 0.6 km (SE = 0.1) from the coast. Migratory deer wintered higher (Table 1), but no further from the coast than resident deer. To isolate the influence of snowfall on deer distribution, we contrasted a mild winter period (Jan-Mar 1981) with a moderately severe winter period (Jan-Mar 1982) at Hawk Inlet. Snowfall during these two periods, as recorded at the Juneau airport (20 km distant), was 49 cm and 272 cm in 1981 and 1982 respectively (National Weather Service Data, Juneau). In 1981, under relatively low snow conditions, deer were located at higher elevations ($\bar{x}$ = 220 m, SE = 18.5) than in 1982 ($\bar{x}$ = 136 m, SE = 11.3) ($P < 0.005$). This difference was lessened by the fact that migratory deer, which winter higher than resident deer, comprised 73% of deer relocations during the 1981 period, versus 89% of the 1982 sample.

Spring. Migratory deer were located at higher elevations than resident deer (Table 1). While resident deer remained relatively sedentary, migratory deer made long movements as they traveled to their summer range. The mean distance between the summer and winter range was greater ($P < 0.001$) for migratory ($\bar{x}$ = 7.7 km, SE = 1.9) than resident deer $\bar{x}$ = 0.8 km, SE = 0.2). The greatest linear distance moved between the summer and winter range was 45 km by a migratory adult female. In contrast, the shortest distance between summer and winter range was 0.3 km, by a resident adult female.

Summer. The greatest range in deer distribution occurred during summer when deer were dispersed from sea level to 1100 m. Migratory deer were located at higher elevations during summer than resident deer (Table 1), and were located further from the coast (3.7 km, SE = 0.5) than resident deer (1.1 km, SE = 0.1) ($P < 0.001$).

Fall. Although migratory deer moved down from summer to winter ranges, they continued to be distributed higher than resident deer (Table 1). Between October 15 and December 15, a time period which encompasses the fall rut, migratory deer were located at higher elevations ($\bar{x}$ = 346, SE = 16.4) than resident deer ($\bar{x}$ = 153, SE = 18.4) ($P < 0.001$).

## Home Range Characteristics

Size. The mean summer and winter home range size of radio-collared deer was 79 ha (SE = 9.8). We found no difference in home range size between summer and winter, migratory males and females, or resident and migratory deer (Table 2). The large, yet insignificant, differences between some segments of the population (e.g., migratory versus resident deer in winter) may have been an artifact of small sample size and the conservative nature of the nonparametric significance test used. The data were skewed by 4 unusually large home ranges (>200 ha) which substantially increased the mean home range size for migratory deer.

Fidelity. Data from 18 deer were used to make 28 comparisons of home range location during summers 1979-81. In every case, deer used the same home range in consecutive summers. Data from 26 deer permitted 37 comparisons during winters 1979-82. All these deer had overlapping home ranges in consecutive winters except 1 yearling female, 1 2-year old male, 1 adult female which used different ranges over 2 consecutive years, and 1 adult male which shifted its winter range twice over 3 years. One radio-collared, migratory female used the same summer and winter ranges, separated by 18 km, for 5 consecutive years.

The mean distance between consecutive summer home range centers was 0.5 km (SE = 0.1). The mean distance separating consecutive summer ranges did not differ between males and females or between migratory and resident deer. Mean distance between consecutive winter home ranges was 1.9 km (SE = 0.6) for migratory deer and 0.5 km (SE = 0.1) for resident deer ($P$ = 0.054). There was no difference in winter home range separation between males and females.

One radio-collared deer, a yearling female, moved 13.6 km the first spring following capture to an area where she remained for the next 3 years. This was the only case of permanent dispersal from a watershed.

# DISCUSSION

## Migratory and Resident Deer

Two distinct patterns of seasonal movement, resident and migratory, were exhibited by deer on Admiralty Island. Literature on Columbian black-tailed deer in the Pacific Northwest describe black-tail populations as primarily resident (Dasmann and Taber 1956, Brown 1961, Miller 1970), although Taber and Hanley (1979) refer to deer which make summer migrations in the Cascade Range. Both migratory and resident populations have been described from coastal British Columbia (Cowan 1956, Harestad 1979).

Over most of Admiralty Island and throughout much of southeast Alaska, high elevation alpine habitat is abundant and readily accessible to deer. As a result, migratory behavior is common in deer throughout most of the archipelago and adjacent mainland. Resident deer are common in many areas, but probably less abundant than migratory deer. Deer populations on many smaller islands which have little topographic relief and offer deer no opportunity to make elevational migrations would be exclusively resident in nature.

During the fall rut, migratory deer were located at significantly higher elevations than resident deer. The range of elevations shown by each type, however, suggests sufficient overlap occurs during this period to provide regular genetic interchange. The occasional occurrence of deep snow accumulation in November and early December will result in even greater overlap during some breeding periods ensuring substantial interchange between migratory and resident deer.

Seasonal Distribution

In southeast Alaska, deer distribution is most restricted during winter. During severe winters, or high snowfall periods within a winter, many deer are forced to a narrow band of low elevation forest along coastal beaches. Such conditions occasionally result in catastrophic declines in deer population levels (Klein and Olson 1960). Other winters may be virtually snow free to above 500 m; relatively few deer perish, and little pressure is exerted on low elevation ranges. Typical southeast Alaska winters are characterized by periods of snowfall interspersed with periods of rain. Under these conditions, deer move up and down in elevation in response to changing snow levels, thereby increasing access to available forage. The tendency for deer in southeast Alaska to move to higher elevations in winter as snow conditions moderate has also been reported by others (Barrett 1979; H.R. Merriam unpubl. rep., Alaska Dept. Fish and Game Fed. Aid Wildl. Rest. Proj. W-15-R-2,3, 1968; S.T. Olson unpubl. rep., Alaska Game Comm. Fed. Aid Wildl. Rest. Proj. W-3-R-7, 1952).

In some situations, the ability of deer to move elevationally in winter is hampered by the presence of clearcuts. At the Glass Peninsula site, approximately 5 km of shoreline is backed by a clearcut. Three radio-collared deer wintered in a residual leave strip of timber 50-200 m wide and less than 30 m elevation. These deer rarely moved into or above the clearcut. In contrast, 5 deer in adjacent forest areas regularly made elevational moves of 100 m or more throughout the winter. Because the 3 deer which wintered below the clearcut moved above the clearcut area during summer, we assume their reluctance to do so during winter was attributable to greater snow accumulation in the clearcut than in the adjacent forest.

Although winter deer range in southeast Alaska is defined as that area below 150 m elevation or 0.4 km from the coast (USDA Forest Service. unpubl. rep., Tongass land management plan: wildlife task force working report. 1978), many of our radio-collared deer were distributed beyond this coastal band. Thirty two percent of our winter deer relocations were above 150 m and 52 percent of the winter home range centers were beyond 0.4 km from the coast. Several radio-collared deer wintered 4 to 8 km from the coast. One interior site on Admiralty Island, approximately 9 km from the coast, had winter densities two thirds as high as the mean of 8 coastal sites (J.W. Schoen unpubl. rep., Alaska Dept. Fish and Game Fed. Aid Wildl. Rest. Proj. W-17-10, 1978). Barrett (1979), working on Admiralty during a heavy snow winter in 1970-71, found deer as far as 5 km inland. Both of these sites were at relatively low elevations along drainage systems.

In southeast Alaska, observations of migratory deer in subalpine and alpine habitat suggest a greater proportion of males on high elevation summer range (Klein 1965); studies of black-tails elsewhere also report males using generally higher elevations than females (Lindzey 1943, Cowan 1956, Miller 1970). Our experience capturing deer in the alpine suggests that adult females may be abundant, but often are less conspicuous because of their solitary behavior and a tendency to remain closer to cover. Casual surveys of deer on summer range, therefore, may overestimate the proportion of males in the population. The ratio of males to females in our sample of resident deer (1 M, 7 F) suggests the possibility that more males than females exhibit migratory behavior, with the result that males are distributed higher in the population as a whole. The sample, however, is too small to be conclusive.

## Home Range Characteristics

The size of winter home ranges of radio-collared Sitka black-tailed deer from Admiralty Island was comparable to home ranges of Columbian black tails reported by Dasmann and Taber (1956), Miller (1970), and Harestad (1979). Although their data are limited, Harestad (1979) and Dasmann and Taber (1956) reported that home range size is generally larger in summer than winter; Miller (1970) and Dasmann and Taber (1956) reported larger home ranges for males than females. Our data indicated no significant differences in home range size among winter and summer seasons or between sexes.

Deer showed strong fidelity to their seasonal home ranges. This tendency was exhibited most strongly during summer. Summer ranges are consistently available from year to year, whereas availability of winter range, particularly at higher elevations, varies depending on annual snow accumulation. In winter, deer appear to adjust their winter home range elevationally relative to availability of that range. Such shifts are generally small (i.e., home ranges in consecutive winters overlap) and occur within the same watershed.

Once the home range is established, most deer remain faithful to the area, perhaps for life. The establishment of the home range is probably a result of early experience with the mother (Dasmann and Taber 1956, Nelson and Mech 1981). The composition of the home range determines the array of choices available to the individual, and habitat selection is a function of the available choices. Areas outside of the home range represent "unknown territory" and deer have been known to die of malnutrition rather than travel to an unknown area to search for forage (Dasmann and Taber 1956).

## MANAGEMENT IMPLICATIONS

Klein (1965) found larger deer, faster growth rates, and younger, more productive populations on Woronkofski Island where deer used summer range with greater altitudinal and topographic variation and a higher proportion of alpine and subalpine habitat than on nearby Coronation Island. We suggest these differences are reflected more generally in migratory and resident deer. If so, management information collected on a local population's mortality, productivity, age structure, sex composition, or growth rates may vary depending on the migratory/resident makeup of the population, and where observations are made (e.g. alpine vs. beach surveys). Mortality transects, that have historically been conducted along beaches and beach fringe timber (Klein and Olson 1960), may be biased toward the resident component of the population that winters at lower elevations.

In southeast Alaska, logging old-growth timber will reduce carrying capacity for deer (Wallmo and Schoen 1980, Rose 1982) due to long term reductions in forage production on winter range (Alaback 1982, Wallmo and Schoen 1980). In the case of resident deer, however, clear-cutting would reduce the long term productivity of the summer range as well. Where a mix of resident and migratory deer occur, overbrowsing by resident deer on reduced low elevation summer range may jeopardize the ability of that same range to carry migratory and resident deer through a severe winter.

Identification and retention (from logging) of important deer winter habitat is an important tool available to wildlife managers in southeast Alaska. We have found that deer regularly winter at higher elevations and further from the coast than previously believed. Additionally, habitat selection by deer throughout the winter, and between years, varies with changing snow conditions. Management commonly recommends retention of narrow strips of beach-fringe timber as critical winter habitat. The value of this management action is questionable because only a small proportion of the deer population uses beach fringe in most winters, and of deer that do, their ability to make elevational moves may be constrained by snow in the clear-cut. Deer population losses may be reduced by reserving large blocks of old-growth habitat that maximize opportunities for deer to expand their winter range elevationally during mild winters or open snow conditions within a winter.

Home range fidelity is high both in migratory and resident deer, and permanent dispersal into adjacent watersheds is rare. The lack of significant emmigration in the population may be a function of deer social behavior (Ozoga et al. 1982), or unfamiliarity with conditions outside established home ranges. As a result, loss of habitat in one watershed probably will not prompt large scale movements of deer into adjoining watersheds.

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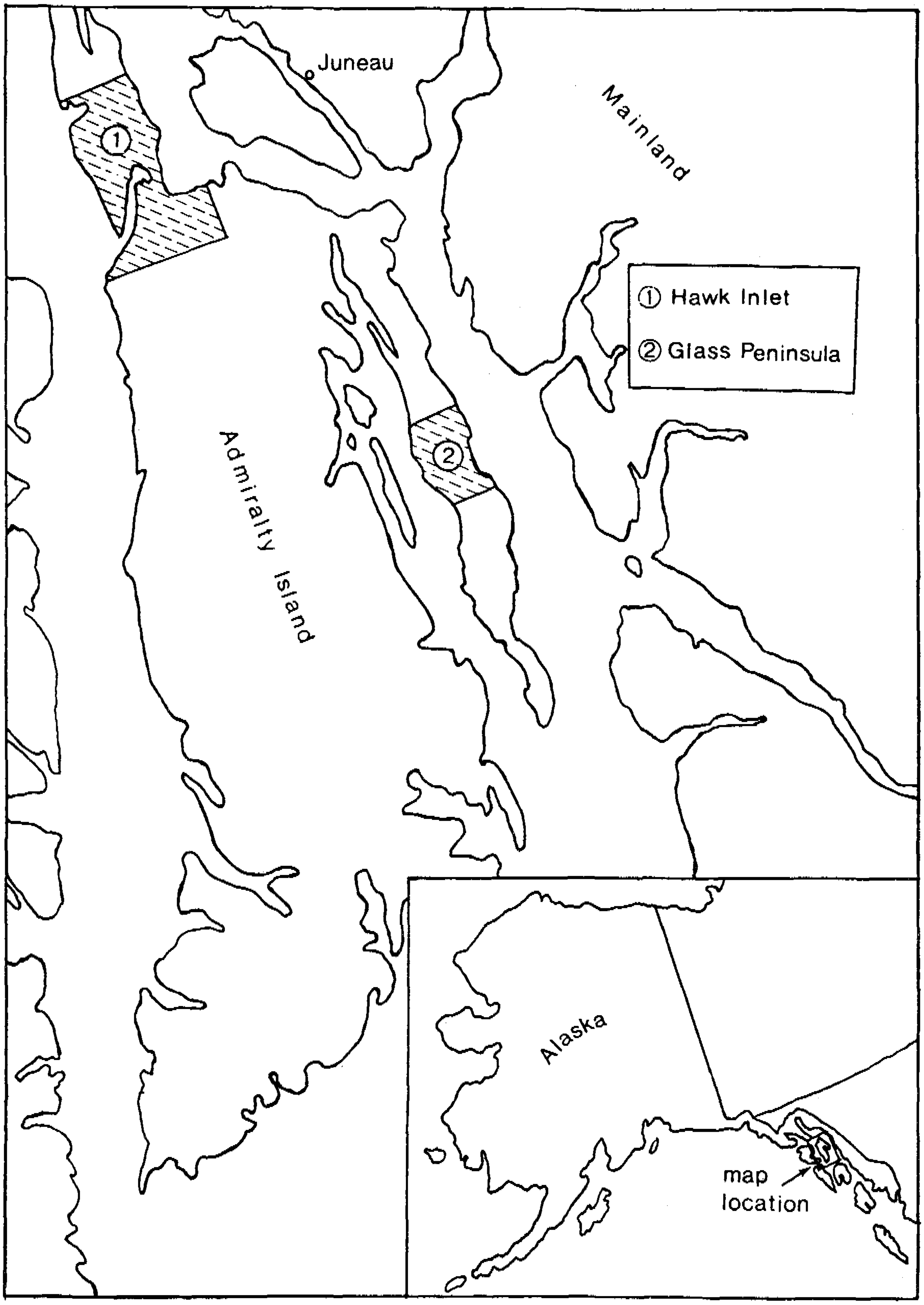


Fig. 1. Location of study areas on Admiralty Island, southeast Alaska.

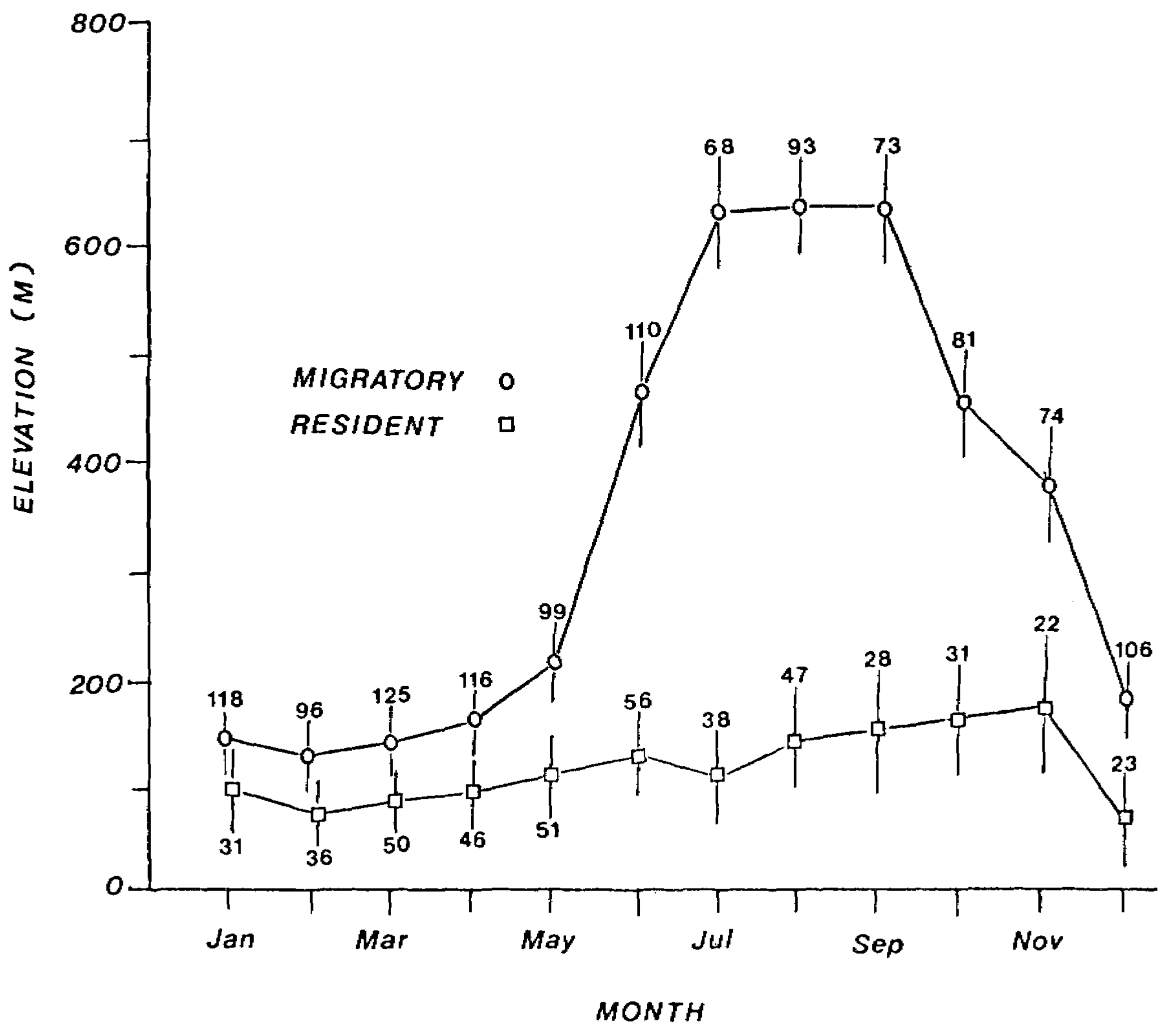


Fig. 2. Mean elevation by month of migratory deer (N = 1,159 relocations) and resident deer (N = 459 relocations) on Admiralty Island. Bars show 95% confidence intervals.

Table 1. Mean seasonal elevation of migratory and resident deer on Admiralty Island.

| | Elevation (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Migratory | | | Resident | | | |
| Season | $\bar{x}$ | SE | N | $\bar{x}$ | SE | N | P[a] |
| Spring | 232 | 9.9 | 335 | 112 | 9.4 | 154 | < 0.001 |
| Summer | 627 | 12.2 | 253 | 133 | 12.2 | 123 | < 0.001 |
| Fall | 368 | 14.9 | 226 | 149 | 15.6 | 71 | < 0.001 |
| Winter | 142 | 8.0 | 345 | 82 | 8.3 | 111 | < 0.001 |

[a] Based on Mann-Whitney U test.

Table 2. Seasonal home range size of radio-collared deer on Admiralty Island.

| | Home Range Size (ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Summer | | | Winter | | | |
| Season | $\bar{x}$ | SE | N | $\bar{x}$ | SE | N | P[a] |
| All deer | 79 | 10.2 | 37 | 79 | 15.6 | 47 | NS[b] |
| Migratory | 88 | 15.1 | 23 | 87 | 19.5 | 37 | NS |
| Males | 92 | 15.3 | 15 | 79 | 17.2 | 24 | NS |
| Females | 82 | 34.1 | 8 | 102 | 46.5 | 13 | NS |
| Resident | 65 | 10.2 | 14 | 48 | 8.6 | 10 | NS |
| Males | 77 | 20.3 | 2 | 51 | 15.3 | 3 | NS |
| Females | 63 | 11.6 | 12 | 47 | 11.1 | 7 | NS |
| Males | 90 | 8.9 | 17 | 76 | 15.4 | 27 | NS |
| Females | 70 | 14.9 | 20 | 83 | 30.6 | 20 | NS |

| Additional Statistical Comparisons | P[a] |
|---|---|
| Migratory vs. Resident, summer | NS |
| Migratory vs. Resident, winter | NS |
| Male vs. Female, summer | NS |
| Male vs. Female, winter | NS |
| Migratory Males vs. Migratory Females, summer | NS |
| Migratory Males vs. Migratory Females, winter | NS |
| Resident Males vs. Resident Females, summer | NS |
| Resident Males vs. Resident Females, winter | NS |

[a] Based on Mann-Whitney test.
[b] NS = P >0.05.