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

AND

FOOD HABITS OF SITKA BLACK-TAILED DEER IN SOUTHEASTERN ALASKA

BY
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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: John W. Schoen, Matthew D. Kirchhoff, and Thomas A. Hanley

Project No.: W-21-2 Project Title: Big Game Investigations

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

2.7R Job Title: Food Habits of Sitka Black-tailed Deer in Southeastern Alaska

Period Covered: July 1, 1980 through June 30, 1981

SUMMARY

This report describes the methods used in establishing a set of permanent 0.4 ha (1 a) plots for study of deer-forest relationships, provides further analysis of data reported in last year's progress report, describes the methods and baseline data for a study of deer population response to forest succession on a group of islands south of Petersburg, reviews progress in the ongoing telemetry study, and reports on a comparative study of rumen and fecal analyses for deer diet determinations.

One hundred and twenty 0.4 ha plots were permanently established within old-growth forest in the Hawk Inlet study area, Admiralty Island. Overstory and understory variables were measured and deer pellet groups counted during April and May. No data were analyzed during this reporting period.

Further analysis of last year's overstory-pellet group relationships indicated that although deer use during winter had been positively correlated with net timber volume, the correlation was negative during spring. This was interpreted as indicating that deer use different kinds of forest habitat under different seasonal/environmental conditions and that no single type of habitat is optimal under all winter-spring conditions.

Baseline data on deer pellet group densities were obtained during April for a group of 6 islands south of Petersburg. Four of the islands had been extensively clearcut and now support moderate to

high deer populations. These high levels are attributed to the recent history of mild winters in this area, and the early successional stage of forest development. These data will be used in subsequent years to test the prediction that deer populations will decline markedly following a severe winter, or with advancing succession on the clearcut islands.

Only 4 deer were captured for the telemetry study during this reporting period. Four hundred and seventy-six relocations of telemetered deer were obtained. Results indicated that while some deer migrate to high elevation habitat during summer, others reside year-round in low elevation forest. Strong fidelity to home range was exhibited by all of 13 deer for which 2 or more years of data were available.

Eighteen deer were collected during winter for diet, reproduction, and condition studies. Fetal rates averaged 1.8 fawns for 5 adult does. Evergreen forbs and half-shrubs were the most abundant forages in both rumen and fecal samples during a relatively snow-free winter. Condition of individual animals was variable.

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 (*Odocoileus hemionus sitkensis*), and evaluate seasonal distribution and preferences within unlogged and logged habitats.

STUDY AREA

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

Edge Study

Results of this study were reported in Schoen et al. (1981). A manuscript has subsequently been submitted to the *Journal of Wildlife Management* (Appendix A).

Forest Habitat Study

Introduction:

Recent research in southeast Alaska has shown the importance of old-growth forest as winter habitat for deer (Wallmo and Schoen 1980). The term "old-growth," however, encompasses a wide range of forest conditions reflecting local variability in soils, topograhpic conditions, and history of disturbance (e.g. windthrow). We expect deer and other wildlife to utilize this fine-grained mosaic of forest conditions selectively. The objectives of this study were twofold: (1) to identify forest types in terms of vegetative composition and structural characteristics of the overstory, and (2) to relate winter deer use to vegetation and topography.

Procedures:

The study was initiated in spring 1979 and has been continued each spring in different study areas, with minor modifications in methods. Methods used in 1979 and 1980 are described in Schoen et al. (1979, 1981).

Field work was conducted from 8 April through 22 May in Youngs Bay and Hawk Inlet on the Mansfield Peninsula, Admiralty Island. One hundred and twenty 0.4 ha (1 a) sample stands of old growth were identified and measured. A stand location card was filled out for each stand, allowing us to relocate stands periodically to monitor seasonal and annual fluctuations in deer use, or collect additional vegetative data.

All stands were located within deer winter range (i.e., below 150 m [492 ft]) and were selected to represent a wide variety of forest conditions. Attempts were made to situate each stand so vegetative and topographic conditions were relatively uniform over the 0.4 ha area being measured. At each stand, mean elevation, slope, and slope aspect were recorded. Deer use and understory plant frequency were measured at 9 evenly spaced sample points within each stand. Deer pellet groups were counted in 4 - 1 x 10 m (3 x 33 ft) plots radiating from each sample point (i.e., 36 1 x 10 m plots per stand). Pellet groups were subjectively identified as old or new according to criteria given in Schoen et al. (1981).

In 70 (58%) of our stands, the beginning and end of each pellet plot were permanently marked with wire flags, and all pellets within the plot were removed. By clearing plots, we ensure that pellet groups counted in subsequent sampling are deposited over a known time period, enabling us to measure seasonal use. Also, by comparing pellet group densities on cleared versus uncleared plots over a known time period the average persistence of pellet groups (i.e., how long it takes for the average pellet group to become unrecognizable) can be determined, and a correction factor applied to counts on uncleared plots.

Understory composition and abundance were measured by recording the presence or absence of 16 common plant species (Table 1) in 1.0-m^2 circular plots centered on each sample point in the stand. The average height of Vaccinium in the immediate vicinity (within 5 m of each point) was estimated.

A variable plot sampling method (Dilworth and Bell 1979) was used to select trees for measurement of overstory variables (Table 2) at the even-numbered sample points in each stand. Also, the percentage ground cover of dead and down material on the forest floor (within 5 m of sample point) was estimated.

Results and Discussion:

Data collected during this reporting period have not yet been analyzed; results will be presented in our next progress report. The results presented and discussed below were collected in spring 1980 and are based on data discussed briefly in Schoen et al. (1981).

One of the most significant and often cited results of this work was the positive relationship between high winter deer use and high stand volume (Schoen et al. 1981). This relationship is important because these high volume stands which may be most important to the overwinter survival of deer are also relatively rare within the forest (Fig. 1). The management conflicts are readily apparent when one considers that most of these higher volume stands are located at lower elevations near tidewater and are economically the most desirable for timber harvest.

Although there was a general trend of increasing deer use in higher volume old-growth stands during winter 1979-80, the data were quite variable. Some high volume spruce (Picea sitchensis) stands had low pellet group densities while some low volume stands had relatively high densities of pellet groups. Spruce stands characterized by an understory of Opolanax and Tiarella previously have been identified as having relatively low value as winter deer habitat (Schoen et al. 1981). These high volume stands occur in riparian bottomlands which probably accumulate more snow than the adjacent well-drained, forested upslopes. Further, the understory community associated with these stands does not include an abundance of those species (Cornus, Rubus, Coptis, Vaccinium) which deer seem to prefer.

We suspected that the relatively high use found in some low volume stands was a result of early spring deer use following snow melt. One problem with using pellet group counts, as opposed to telemetry, is that pellet groups provide information over a time interval rather than measurements which can be associated with specific point-in-time conditions. In the Hawk Inlet study area, we have the ability to cross check our deer habitat preference data utilizing both telemetry and pellet group techniques.

Table 1. List of 16 understory plant species, or species groups, identified as either present or absent in 1.0-m^2 circular plots evenly distributed within each sample stand.

Scientific Name	Common Name
Coptis asplenifolia	Fernleaf Goldthread
Cornus canadensis	Bunchberry
Listera cordata	Heartleaf Twayblade
Menziesia ferruginea	Rusty Menziesia
Maianthemum dilatatum	Deerberry
Streptopus spp.	Twistedstalk
Rubus pedatus	Five-leaf Bramble
Tiarella trifoliata	Laceflower
Vaccinium spp.	Blueberry/Huckleberry
Vaccinium spp.[1]	
Oplopanax horridus	Devilsclub
Viola spp.	Violets
	Ferns
	Conifer Seedlings
Moneses uniflora	Single Delight
Lysichitum americanum	Yellow Skunkcabbage

[1] Dwarf, evergreen variety

Table 2. Overstory variables measured or recorded for each species in each sample stand. Trees were selected using a 40-BAF relaskop at even-numbered sample points.

basal area of sawtimber (DBH $\geq$ 9")
basal area of poletimber (5 $\leq$ DBH $\leq$ 9")
height to 40% dbh
diameter at breast height
sawtimber volume[1]
risk category[2]
defect[2]
tree class[2]
crown class[3]

[1] Calculated from: Bones, James T. 1968. Volume tables and equations for old growth western hemlock and Sitka spruce in Southeast Alaska. Pacific Northwest Forest and Range Exp. Sta. Res. Note. PNW-91, 11pp.

[2] Classification system from: USDA Forest Service. 1979. Silvicultural examination and prescription handbook. FSH 2409.26d R10 mimeo.

[3] Proportion of total tree height supporting live canopy.

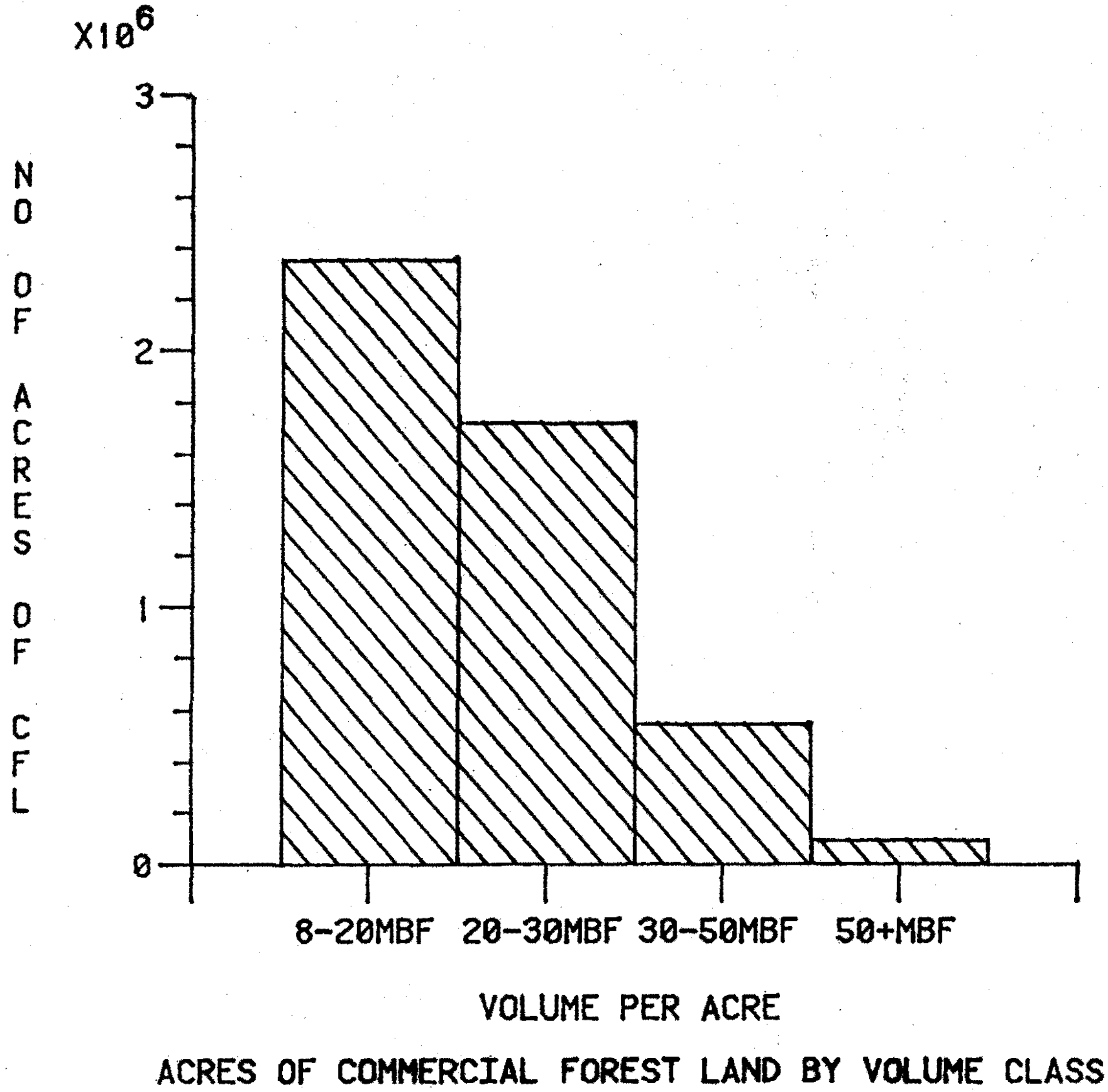

Fig. 1. Number of acres of commercial forest land (CFL) in each of 4 volume classes on the National Forest in southeast Alaska.

We believe that deer utilize high volume old-growth stands when snow accumulation is greatest, expanding their range into lower volume stands as snow-free areas increase. This would relieve pressure on the high volume areas when conditions improve during spring, and also in warm, snow free periods during the winter. The relationship between winter deer use of hemlock(Tsuga hetrophylla)-spruce forest types, and volume, was examined by eliminating spruce forest types (e.g. greater than 33% spruce composition) from our sample, and reporting trends in old and new pellet groups separately (we assume new pellet groups reflect recent spring use). The resulting relationships are depicted in Fig.2.

Deer Response to Forest Succession on 6 Small Islands South of Petersburg, Alaska

Introduction:

Recent deer-forest investigations (Bloom 1978, Barrett 1979, Schoen et al. 1981) have indicated that old-growth forests on productive sites are very important in maintaining the winter carrying capacity for Sitka black-tailed deer in southeast Alaska. It has been suggested by Longhurst and Robinette (1982), however, that based on evidence of high deer numbers on several extensively logged islands in the Petersburg area, the importance of old growth to deer may be less in some parts of southeast Alaska. The purpose of this study was to measure deer densities on 6 small islands near Petersburg (Rynda, Greys, Sokalof, Liesnoi, Big Level, and Little Level) to establish baseline values for comparisons in subsequent years.

With the exception of Rynda and Greys, these islands have been extensively clearcut within the last 10 to 30 years. Winter snow conditions during the last 10 years have been relatively mild. Thus, we could expect to find moderate to high densities of deer in those areas at this time. We can predict, however, that following a winter of substantial and prolonged snow accumulation and/or conifer canopy closure resulting from even-aged second-growth regeneration, deer levels will decline sharply. This hypothesis can be tested by measuring relative deer levels currently and again following a year of extensive snow accumulation or after canopy closure.

Procedures:

Six islands were sampled including 2 uncut islands (Greys and Rynda), several clearcut-dominated islands (Little Level, Big Level and Liesnoi), and Sokolof Island which had a mix of habitats including old growth, mid and late successional clearcuts, alder, and blowdowns.

Relative deer densities were measured using the pellet group count technique described by Wallmo and Schoen (1980). Transect

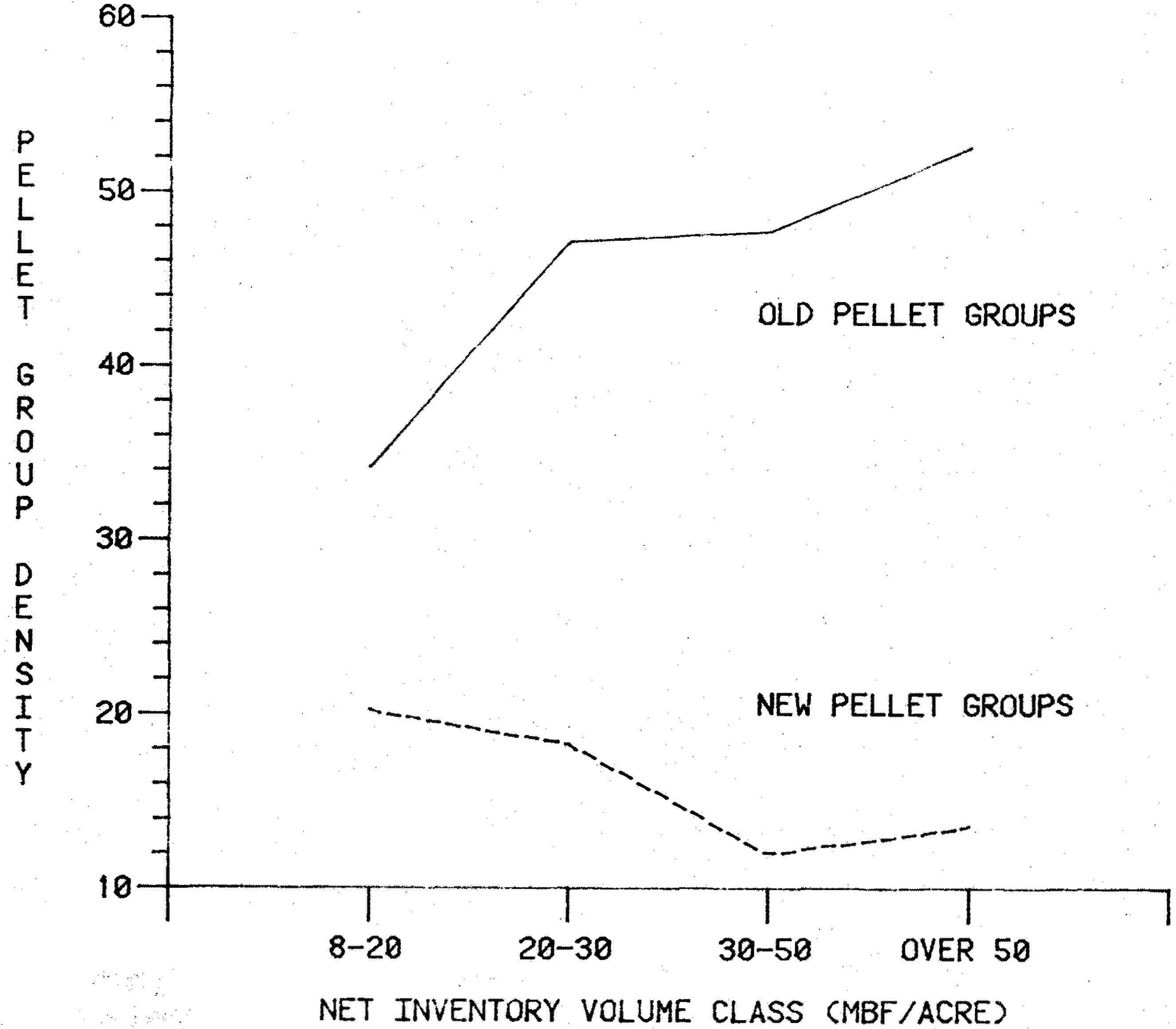

Fig. 2. Relationship between stand volume and pellet group density in the Tenakee Inlet area, southeast Alaska. High spruce sites (33% spruce) were excluded. New pellets are assumed to represent spring use; old pellets represent overwinter use.

lines were laid out systematically across each island. The sampling intensity for each island (Table 3) averaged 0.75 plots per acre. Maps of the islands showing transect routes are on file.

Because of time limitations, Rynda and Liesnoi were not completely sampled, thus the lower sampling intensities for those areas. Both islands are relatively homogeneous with respect to gross habitat (Liesnoi is nearly all late successional clearcut; Rynda nearly all old growth). Habitat was described as being 1 of 7 categories. These are listed and defined in Table 4.

Results and Discussion:

Pellet group densities are summarized by island for each type of habitat in Table 5. Densities on all islands averaged 285 pellet groups per acre, ranging from 49 pellet groups per acre on Greys Island to 496 pellet groups per acre on Little Level Island. In comparison, during the same time period, pellet groups per acre from north and south Admiralty Island were 411 (Schoen and Kirchhoff unpublished data, n plots = 4,176) and 545 (E. L. Young unpublished data, n plots = 390), respectively. For the 4 islands which have received substantial timber harvest the average pellet groups per acre was 365.

Because the number of plots in many habitat types on the islands are low, comparison of pellet group densities among these habitats are not possible. The only island where a valid comparison can be made is Sokolof, where the mean pellet groups per acre in old growth was 438 compared to 262 for clearcuts. This followed a relatively mild winter when we would expect most use of clearcuts to occur.

In comparing deer densities on islands that have been substantially logged (Little Level, Big Level, Sokolof and Liesnoi) with islands that are unlogged (Greys and Rynda). The low densities measured on Rynda and Greys were unexpected given our present understanding of deer forest relationships. Low deer densities there are probably a reflection of the low quality of old growth present. Relative to other areas we have worked in, including the residual old growth on Sokolof, the quality of old-growth habitat on Rynda was inferior winter range for deer. The soil was thin and poorly developed; gravel and boulders were in many places overlain by little more than a thin, mossy mat. The timber tended towards spruce, was small to average in size was relatively even-aged, and there was a conspicuous absence of large, dominant trees. The understory was dominated by Oplopanax and Tiarella, both typically associated with high composition spruce stands which are inversely correlated with deer use (Schoen et al. 1981).

The term "old growth" covers a wide range of forest conditions, not all having equal value to deer. Considering the recent history of mild winters, the early successional stage of the

Table 3. Sampling intensity on selected small islands - spring 1981.

Island	No. of Acres	No. of Plots	Sampling Intensity (plots/acre)
Liesnoi	156	78	.5
Little Level	312	228	.7
Big Level	864	799	.9
Greys	492	568	1.2
Rynda	2,100	561	.3
Sokolof	2,076	1,800	.9

Table 4. Types of habitat identified on 6 small islands south of Petersburg.

Habitat Type	Description
old growth	uneven-age, silviculturally overmature forest (>8,000 board feet per acre).
late-successional clearcut	15-30 year-old even-age conifer stands.
mid-successional clearcut	5-14 year-old young regeneration.
alder	15-30 year-old clearcut with alder dominating.
non-commercial forest land	old growth (<8,000 board feet per acre).
blowdown	area of recent (<25 year) extensive windthrow.
muskeg	poorly drained organic bog

Table 5. Number of deer pellet groups per acre by island and type of habitat on 6 small islands south of Petersburg, spring 1981.

Island Habitat	Mean	Standard Deviation	No. of Plots
Little Level	495.6	701.8	228
old growth	520.7	765.4	7
mid clearcut	557.5	768.0	154
late clearcut	275.7	455.6	47
muskeg	135.0	233.8	3
non-CFL	595.6	556.7	17
Big Level	307.7	518.9	799
mid clearcut	128.4	278.2	41
late clearcut	183.8	384.3	357
muskeg	505.6	656.0	157
non-CFL	370.8	549.7	154
blowdown	427.5	589.8	90
Sokolof	346.7	536.9	1,800
old growth	437.7	626.2	570
mid clearcut	311.9	527.2	718
late clearcut	208.4	339.6	103
non-CFL	405.0	233.8	7
alder	264.4	386.1	177
blowdown	352.8	468.1	225
Rynda	49.1	163.9	561
old growth	45.9	159.2	521
non-CFL	0	0	10
alder	0	0	2
blowdown	130.2	247.8	28
Greys	49.2	161.9	568
old growth	49.5	162.3	565
blowdown	0	0	3
Liesnoi	311.5	412.4	78
regrowth	310.3	415.0	77
non-CFL	405.0	0	1

vegetation on logged islands, and the relative inferiority of old growth on Greys and Rynda, these old-growth dominated islands currently have lower deer densities than nearby logged islands.

Given the current situation, deer densities on Little and Big Level, Sokolof, and Liesnoi Islands will probably be sharply reduced following the next winter of substantial snow accumulation or (if winters are mild) within 5 to 10 years as regrowth stands close and dominate the islands. The extent of this reduction can be monitored by repeating our pellet group sampling following a rigorous winter.

Telemetry Study

Introduction:

The telemetry study is designed to assess seasonal distribution and home range characteristics of individual deer, as well as to determine 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 in southeast Alaska.

Procedures:

Procedures have been described previously in Schoen et al. (1979, 1981).

Results and Discussion:

Only 4 deer were successfully captured during this report period. Three were captured in the alpine by cap-chur gun immobilization from a helicopter and 1 was captured by stalking with a Pneu-Dart gun in the forest. Approximately 24 man-days were spent in the field from December 1980 through March 1981 with only 1 successful capture. Our poor results were attributed to a very mild, open winter. During this period deer were widely distributed and difficult to capture. After a reasonable effort, capture attempts were discontinued. A summary of the status of instrumented deer captured through this reporting period is presented in Table 6.

From 1 July 1980 through 30 June 1981, 476 relocations of radio-instrumented deer were recorded. No flights were conducted during November because of poor flying conditions. From November 1978 through June 1981, we have accumulated over 1,200 relocations of radio-instrumented deer in the Winning Cove and Hawk Inlet study areas. Future telemetry work will focus on the

Table 6. Summary and status of captured deer as of November 1981.

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	hunter kill 11-80
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, hunter kill 10-81
2-21-79	Hawk Inlet	24	yearling	M	found dead 2 weeks later
2-22-79	Hawk Inlet	5	adult	M	spring '80 mortality
2-22-79	Hawk Inlet	74	adult	F	not located since 11-81
2-22-79	Hawk Inlet	25	adult	M	not located since 6-81
2-23-79	Hawk Inlet	17	adult	M	hunter kill 12-80
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 weeks later
1-24-80	Hawk Inlet	41	adult	F	dead 2 weeks 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	not located since 10-80
8-26-80	Hawk Inlet	66	2	M	radio functional
9-11-80	Young Bay	69	yearling	M	not located since 3-81
9-11-80	Young Bay	15	yearling	M	radio functional
12-31-80	Hawk Inlet	35	adult	F	spring '81 mortality

Hawk Inlet area exclusively. This is also where we will concentrate our forest habitat sampling.

Of 17 deer captured on the winter range, 11, or approximately 2/3, made distinct seasonal migrations into the higher alpine and subalpine. Airline distances between summer and winter ranges ranged from 1.6 km (1 mi) to 45 km (28 mi). The actual route travelled in this latter case was estimated to be approximately 72 km (45 mi). This movement is likely an extreme; most summer and winter ranges are probably separated by less than 10 km (6 mi).

Strong home range fidelity was displayed by instrumented deer for both the winter and summer range (Table 7). Of 13 deer, only 2 (yearlings) made shifts in their winter ranges then stayed with the new winter range the following year. It appears that most deer, both migratory and resident, probably use the same or similar ranges year after year.

During the next report period, color aerial photographs will be used to estimate availability, within the study area, of the habitat variables recorded during the telemetry flights. From these data and telemetry data, we will calculate seasonal habitat preference for the population. No additional analysis was accomplished during this report period.

Deer Diet Composition Study

Introduction:

Few quantitative data are available on the plant species composition of diets selected by Sitka black-tailed deer in Alaska. Early work indicated that *Vaccinium* spp. was of major importance in determining the winter carrying capacity for deer (Olson 1952, Klein 1957a, 1957b, Olson and Klein 1959, Merriam and Batchelor 1963, Merriam 1965, 1967, 1968). More recently, however, it appears that evergreen forbs and subshrubs are important to the overwinter health of deer (Merriam 1970, 1971, Schoen and Wallmo 1979, Regelin 1979).

This report summarizes the work accomplished to date on the cooperative Alaska Department of Fish and Game - Forestry Sciences Laboratory (USDA Forest Service) diet composition studies. The objectives are to determine winter diet composition of Sitka black-tailed deer in northern southeast Alaska, evaluate rumen and fecal analysis techniques, and test the hypothesis that herb-layer, evergreen forages are highly preferred and valuable deer winter diet constituents, but, their consumption is limited by availability (Hanley 1981 study plan PNW-1652-03-A2.1). Seasonal availability of plant nutrients is also being studied (Hanley 1981 study plan PNW-1652-03-A1.2).

A draft manuscript comparing fecal and rumen analysis techniques, with a summarization of the results of our food habits analysis to date, has been submitted to Northwest Science for publication (Appendix B).

Procedures:

From January through March, deer were collected on Admiralty and northeast Chichagof Islands. Animals were stalked in the forest and shot when encountered. From each animal, the whole rumen-reticulum was collected as well as 20 fecal pellets from the rectum. Kidneys, lower jaws, blood sample, right femur, and female reproductive tract were also collected. Other data included standard body measurements, whole weights on some animals, and a survey of external and internal parasites.

Analysis of rumen and fecal material and treatment of the data are described by Hanley et al. in Appendix B.

Results and Discussion:

From January through March, 18 deer were collected (Table 8). This sample included 12 males and 6 females ranging in age from fawns to over 10 years. Most animals were considered to be in fair to good condition for this time of year. Fetal rates by age class were: fawn 0 (n = 1), yearling 2 (n = 1), adult (2-10 years) 2.33 (n = 3), and adult (10+ years) 0 (n = 1). Although our sample is inadequate for drawing firm conclusions, the reproductive rate of 1.8 fawns per adult doe, if representative of the population, is high compared to other areas (Connolly 1981).

The herb-layer evergreen forbs and subshrubs Cornus, Rubus and Coptis, were the most abundant forage species in both rumen (50%) and fecal (36%) samples. Cornus alone accounted for 34 and 24% composition of rumen and fecal samples, respectively. In contrast, Vaccinium stems accounted for only 4 and 5% composition of rumen and fecal samples, respectively.

Winter 1981 was open with little snow accumulation on the ground. Thus, our data represent a situation where forage choice was relatively unrestricted. We would assume that the proportional use of woody shrub species would increase while herb-layer evergreen forbs and subshrubs would decrease during winters of greater snow accumulation. This year's data reflect the importance of the herb-layer species and complement the results of our forest habitat study (Schoen et al. 1981) which identified the strong relationship between deer density and the frequency of Cornus.

Table 7. Winter and summer home range fidelity of instrumented deer.

Deer No.	Age at Capture	Sex	Winter Same Range : No. of Years	Summer Same Range : No. of Years	Resident/ Migratory
6	yearling	F	2:3	3:3	M
20	adult	M	2:2		M
80	yearling	M	2:3	3:3	M
90	adult	M	2:2	2:2	M
70	fawn	F	3:3	3:3	R
5	adult	M	2:2		M
74	adult	F	3:3	3:3	R
25	adult	M	2:3	2:2	M
3	adult	M	2:2		M
18	yearling	F	3:3	3:3	M
61	adult	F	3:3	3:3	R
12	adult	M	2:2	2:2	R
42	adult	F	2:2	2:2	M

Table 8. Summary of deer collected January through March 1981.

accession #	date	sex	age[1]	fetus #♂, #♀	area collected	general condition	parasites[2]
83090	1-21	M	fawn	-	Hawk Inlet	poor	1, 2, 3
83091	1-22	M	1½	-	Whitestone Hbr.	fair	none obsvd.
83092	1-22	F	3½	1, 1	Whitestone Hbr.	good	2, 3
83093	1-22	F	5+	1, 2	Whitestone Hbr.	good	2
83094	2-23	M	fawn	-	Tenakee Inlet	poor	none obsvd.
83095	2-03	M	1½	-	Hawk Inlet	poor	none obsvd.
83096	2-23	M	fawn	-	Tenakee Inlet	poor	none obsvd.
83097	2-20	F	5+	1, 1	Winning Cove	fair	2
83098	2-23	M	1½	-	Tenakee Inlet	good	1
83099	3-17	M	fawn	-	Tenakee Inlet	fair	none obsvd.
83100	2-24	M	fawn	-	Tenakee Inlet	fair	1
83101	2-24	F	fawn	0	Tenakee Inlet	fair	1
83102	2-24	F	1½	1, 7	Tenakee Inlet	good	none obsvd.
83103	2-24	F	10+	0	Tenakee Inlet	poor	1
83104	3-19	M	adult	-	Kruzof Island	good	2
83105	3-19	M	adult	-	Kruzof Island	good	2
83106	3-19	M	1½	-	Kruzof Island	good	2
83108	3-19	M	adult	-	Kruzof Island	good	2

[1] based on tooth eruption and wear.

[2] 1 = lungworms, 2 = roundworms, 3 = tapeworms

IMPLICATIONS FOR MANAGEMENT

Deer habitat use varies seasonally, annually, and geographically relative to differing environmental conditions and habitat availability. Retaining suitable deer winter range in areas scheduled for timber harvest then, is not a simple matter of identifying a single type (e.g., high volume) and retaining it. High volume, hemlock-dominated old-growth stands in most areas appear to be valuable wintering areas for deer, and without them deer would likely be hard-pressed to survive a severe winter. Saving these stands, however, to the exclusion of all others would artificially restrict deer to these stands even in mild to moderate winters. The result could be "islands" of overbrowsed deer range. In the next moderate to severe winter, deer could reasonably be expected to suffer dramatic declines due to the poor quality of this "core" winter range. Theoretically, there exists for any given geographic area an optimal mix of forest types or volume classes which will support the maximum number of deer over a long period of time. This mix will vary with average winter conditions, frequency of severe winters, level of predation, quality and extent of summer range, and, in some instances, island size. At this point, we do not have the knowledge needed to identify the optimum habitat mix for sustaining a given deer population level in specific areas. This is the direction in which research must proceed, and in time, these goals can be realized. A more realistic approach to forest and deer (and other wildlife) management might be to identify large areas (e.g. drainages or [value comparison units] VCU's) which currently support or have the potential to support abundant populations of deer and/or other desired wildlife species. These drainages then should be exempted from any development, <u>in their entirety</u>, on the premise that an adequate mix of habitat types exists in this area and development (especially logging) radically alters the balance. Maintaining large areas intact helps ensure that the habitat requirements of deer during all seasons and years (and for that matter all species inhabiting that drainage) will be preserved.

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DEER USE IN RELATION TO FOREST CLEAR-CUT EDGES IN SOUTHEAST ALASKA

Key Words: clear-cut, deer, edge, *Odocoileus hemionus sitkensis*, old growth

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The belief that "edge" confers benefits to wildlife (Leopold 1933) is considered applicable to deer (*Odocoileus* spp.), especially in situations where edge occurs between relatively open areas and cover areas (Thomas 1979, Thomas et al. 1979). Accordingly, timber removal by the clear-cut method has become accepted as a means of

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increasing edge and enhancing habitat for deer and other wildlife (Resler 1972, Telfer 1974, Patton 1975, Thomas 1979, Thomas et al. 1979). In southeast Alaska, Billings and Wheeler (1979:111) recommended clear-cutting to create "small (preferably less than 8 hectares) irregularly shaped openings with multiple entry to maintain edge" as a method of improving habitat for Sitka black-tailed deer (Odocoileus hemionus sitkensis). This recommendation was based on a measured increase in annual production by shrubs (Vaccinium spp.) in the residual forest within 30 m of the clear-cut edge. Recognizing that winter snowpack would prohibit use of the clear-cut by deer, they assumed snow depths in the forest edge would be sufficiently reduced to permit deer to be attracted to the available browse. We hypothesized that deer use within this 30 m ecotone would be measurably higher than forest deer use beyond this zone. Lacking comparable data, the same hypothesis was tested on the clear-cut side of the edge.

The objective of our study was to describe winter deer use as related to forest clear-cut edges in the Western hemlock - Sitka spruce (Tsuga heterophylla - Picea sitchensis) old-growth forest type in southeast Alaska. This study was one phase of a joint research program conducted by the U.S. Forest Service and the Alaska Department of Fish and Game, the latter as a part of Federal Aid in Wildlife Restoration Project W-21-1.

METHODS

In April 1980, distribution of fecal pellet groups along forest clear-cut edges was measured at 9 sites on Tenakee Inlet, Chichagof Island, and 1 site on Glass Peninsula, Admiralty Island in southeast

Alaska. Measuring fecal pellet densities is an established method of estimating relative animal-time units of the presence of ungulates (Neff 1968). Although evaluation of habitat preferences based on pellet group counts should be approached cautiously (Neff 1968, Collins and Urness 1981), the technique, in certain situations, provides reliable information.

Information on the persistence of deer fecal pellets in southeast Alaska (Fisch 1979) and under similar conditions in the Northwest (Bunnell 1979, Fairbanks 1979) indicated that most of the pellet groups counted in early spring would represent deer use during the previous winter. Pellet groups were counted on contiguous, end-to-end, 1 x 10 m plots (Wallmo and Schoen 1980) on 10 parallel, evenly spaced transects extending from the edge 200 m into the forest and 200 m into the clear-cut. Length of the edges varied, so the spacing between the transects varied, ranging from 10 to 30 m apart. Transects were situated so that they crossed the vertical (uphill-downhill) edges of clear-cuts, thereby controlling for the influence of elevation and snow depth on deer distribution (Klein 1965). Clear-cut areas were situated on moderate slopes between sea level and 100 m elevation, and averaged 5.4 (SD, ± 3.4) years in age. Forested areas were uneven-aged old growth with structural characteristics similar to those described by Franklin et al. (1981).

RESULTS

Pellet group density in old growth was higher (Wilcoxon paired sample test, $\underline{P}<0.05$) than in adjacent clear-cuts for the 10 study sites combined and was higher (Mann-Whitney U test, $\underline{P}<0.05$) in 9 of 10 individual site comparisons (Table 1). Low winter use of clear-cuts

Table 1. Pellet group densities measured in old growth and clear-cut habitat at ten sites on Admiralty and Chichagof Islands, southeast Alaska. For each mean, N = 200 plots.

Site	Old growth		Clear-cut		Significant difference[1] ($P<0.05$)
	$\bar{X}$	SD	$\bar{X}$	SD	
1	0.94	1.46	0.30	0.64	*
2	0.39	0.81	0.12	0.41	*
3	0.53	1.08	0.17	0.54	*
4	1.17	1.96	0.34	0.73	*
5	0.35	0.77	0.04	0.25	*
6	1.76	2.22	0.55	0.97	*
7	0.66	1.46	0.22	0.58	*
8	0.66	1.19	0.57	1.18	N.S.
9	0.61	0.98	0.10	0.38	*
10	1.22	1.47	0.90	1.31	*
All sites	0.83	1.47	0.33	0.81	*[2]

[1] Mann-Whitney U test.

[2] Wilcoxon paired sample test.

relative to old growth has been documented elsewhere in the southeast archipeligo (Wallmo and Schoen 1980; Rose 1982) and in the Pacific Northwest (Jones 1974, Weger 1977, Harestad 1979, Hebert 1979) and presumably results because forage is less available in the clear-cuts during periods of high snow accumulation (Bloom 1978, Wallmo and Schoen 1980).

We found no evidence of increased deer use near old growth clear-cut edge (Fig. 1). Pellet group densities within the 30 m forest ecotone were not different (Wilcoxon paired sample test, $\underline{P}<0.05$) from densities beyond the ecotone for the 10 study sites combined, and for 8 of 10 of the individual site comparisons (Mann-Whitney U test, $\underline{P}<0.05$) (Table 2). On the two sites where densities were different, use was higher in the zone farther from the edge. Likewise, densities within the clear-cut ecotone were not different than densities beyond the ecotone for the 10 study sites collectively, and for 8 of 10 individual site comparisons (Table 2). As before, where differences were significant (two sites), use was higher in the zone farther from the edge.

The variability of pellet group counts in clear-cuts and in old growth was compared using a coefficient of variation ($SD/\underline{X}$). Overall, counts in clear-cuts were more variable (CV = 2.42) than counts in old growth (CV = 1.76), indicating that what use did occur in clear-cuts was concentrated in small areas.

DISCUSSION

Although the literature contains numerous references to edge effect and its purported benefits to deer, few studies provide actual measurement data which demonstrate these benefits. Willms (1971)

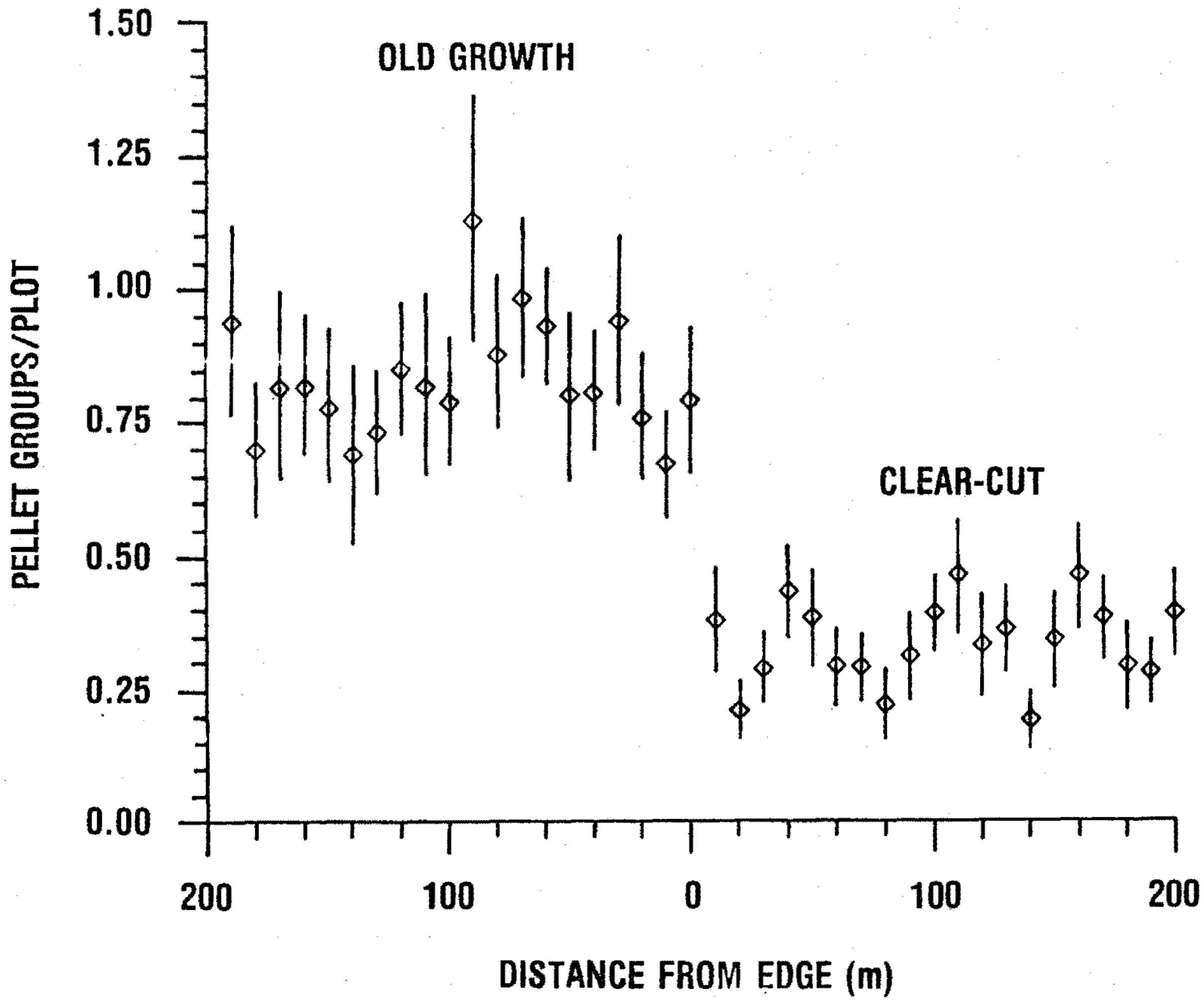

Fig. 1. Mean and 90% confidence limits of pellet group densities in successive 1 x 10 m belt plots extending from the edge into 10 old-growth stands and 10 adjacent clearcuts. For each mean, N = 100 plots.

Table 2. Pellet group densities measured within and beyond old growth and clear-cut ecotones at ten sites on Admiralty and Chichagof Islands, southeast Alaska.

Site	Old Growth					Clear-cut				
	Within ecotone (N = 30)		Beyond ecotone (N = 170)		Significant difference[1] (P<0.05)	Within ecotone (N = 30)		Beyond ecotone (N = 170)		Significant difference[1] (P<0.05)
	$\bar{X}$	SD	$\bar{X}$	SD		$\bar{X}$	SD	$\bar{X}$	SD	
1	1.00	1.39	0.94	1.47	N.S.	0.57	0.97	0.25	0.56	N.S.
2	0.53	0.90	0.36	0.80	N.S.	0.17	0.59	0.11	0.37	N.S.
3	0.20	0.55	0.59	1.14	*	0.07	0.25	0.19	0.54	N.S.
4	1.40	1.92	1.13	1.97	N.S.	0.07	0.25	0.39	0.78	*
5	0.40	0.67	0.34	0.79	N.S.	0.07	0.37	0.04	0.23	N.S.
6	1.30	1.47	1.85	2.33	N.S.	0.80	1.16	0.51	0.92	N.S.
7	0.10	0.31	0.76	1.55	*	0.20	0.41	0.22	0.60	N.S.
8	0.63	1.13	0.67	1.21	N.S.	0.43	1.11	0.59	1.19	N.S.
9	0.83	1.05	0.58	0.97	N.S.	0.20	0.66	0.09	0.30	N.S.
10	1.00	1.17	1.26	1.52	N.S.	0.37	0.89	1.00	1.35	*
All sites	0.74	1.21	0.84	1.51	N.S.[2]	0.29	0.77	0.34	0.82	N.S.[2]

[1] Mann-Whitney U test.

[2] Wilcoxon paired sample test.

documented slightly higher winter deer (_O. h. columbianus_) use along edges between logged and "mature" forest on Northern Vancouver Island, British Columbia; and Reynolds (1962, 1966) shows variable response by deer to edge, with no evidence of increased edge use on some study sites. It is logical that deer response to edge will vary from one area to the next depending on local habitat conditions.

The benefits to wildlife of increasing edge are associated, in theory at least, with a resultant increase in habitat diversity (Patton 1975, Thomas 1979, Thomas et al. 1979). In contrast to even-aged or regrowth forests, the composition and structure of old growth are relatively diverse (Franklin et al. 1981). In southeast Alaska, old growth provides a mosaic of cover and foraging areas resulting from the natural mixture of centuries-old dominant trees, openings created by dead and fallen trees and poorly drained sites, old subdominant trees, and scattered, small stands of saplings and pole-sized trees. Snow depths are variable, reflecting variation in the continuity, density, and height of the forest canopy. The low, evergreen forbs (e.g., _Cornus canadensis_, _Coptis aspleniifolia_, _Rubus pedatus_, and _Tiarella trifoliata_) are available under the crowns of older trees where snow is shallow or absent, and browse is also abundant in the small openings. The ever-changing array of irregular patches of vegetation in all different ages is characteristic of old growth and has been labeled the "Shifting Mosaic Steady State" (Bormann and Likens 1979). Very likely, the advantages of interspersion of cover and openings for deer are maximized in this old-growth forest mosaic.

Hoover (1971) has shown that interruption of the forest canopy by logging results in increased snow accumulation in the residual forest near the edge of the opening. For deer, then, the value of increased browse production along clear-cut edges may be negated by decreased availability, and important evergreen forbs could be totally eliminated from use. Increased blowdown of trees along the forest edge may also significantly impede travel by deer and further decrease forage availability in the ecotone.

We conclude that the value of man-made edge to deer can not be assumed without careful, local evaluation. In southeast Alaska, man-made edges offer no apparent advantages to deer in an old-growth environment that naturally provides high habitat diversity and excellent winter habitat conditions.

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APPENDIX B.

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Relationships Between Fecal and Rumen Analysis for Deer Diet Assessments in Southeast Alaska

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Abstract: Rumen and fecal samples obtained from 13 Sitka black-tailed deer (_Odocoileus hemionus sitkensis_) from 21 January through 13 March 1981, were analyzed to determine percentage dry weight composition of plant species and forage classes. Mean results, using the two types of samples, were similar (percentage similarity = 65 and 77 % for plant species and forage classes, respectively). Forbs and ferns, however, were consistently more abundant in rumen than fecal samples, while graminoids, mosses, conifers, and lichens were more abundant in fecal than rumen samples. Biases, advantages, and disadvantages of the two techniques are discussed.

Key Words: Rumen analysis, fecal analysis, diet determination techniques, southeast Alaska, _Odocoileus hemionus sitkensis_, Sitka black-tailed deer.

Running head: Fecal and rumen analysis

Introduction

The composition of diets selected by wild, free-ranging ungulates is very difficult to determine. It is important for evaluating the nutritional quality of diets and for understanding animal-habitat relationships. Direct methods of determining diet composition, such as esophageal fistula (Veteto et al. 1972) or bite count (Wallmo and Neff 1970) methods, can be used only with tame, or at least very human-tolerating, animals. Diet determinations for wild, free-ranging ungulates must rely on indirect methods, such as forage site examinations (Cole 1959), stomach analysis (Korschgen 1962, Dirschl 1962), or fecal analysis (Croker 1959, Storr 1961). Forage site examinations suffer from the obvious problems of measuring what is not there (has been eaten) and the very site-specific nature of the data. Stomach and fecal analyses are the most commonly employed methods of determining diet composition of wild, free-ranging ungulates.

The principal advantage of stomach analysis is that much of the contents consist of macroscopic fragments that can be identified readily with minimal equipment needs. The principal disadvantages are that animals must be killed or captured to obtain samples and that forages that are readily digested or rapidly passed from the stomach tend to be under-represented while those that are slowly digested and/or passed tend to be over-represented. The latter is a special problem with rumen analysis (Bergerud and Russell 1964, Gaare et al. 1977). That technique results in over-estimation of the poorer quality forages and underestimation of the better forages. The principal advantage of fecal analysis is that fecal samples are relatively easy to obtain and don't require handling of animals; hence, it is possible to obtain large sample sizes without disturbing the study population. The principal disadvantages are that plant fragments must be identified microscopically, thus requiring much technician training, and that highly digestible and/or poorly identifiable forages tend to be under-represented, while poorly digestible and/or highly identifiable forages tend to be over-represented in the diet determination (Adams et al. 1962, Slater and Jones 1971, Dearden et al. 1975, Havstad and Donart 1978).

The purpose of this study was to compare the results of analyses of rumens and feces obtained from Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) in southeast Alaska. It was not possible to compare these results with actual, known diets, since such data were not available to us. Still, it is important to have some understanding of how rumen and fecal results differ from one another to better enable comparisons with results reported for one or the other method in the literature. This offers a better basis for appraising the results from either method or from their use in combination. No such comparison has been made previously for Sitka black-tailed deer or for the forages of southeast Alaska or coastal British Columbia.

Methods

The data were obtained as paired rumen and fecal samples from 13 deer shot from 21 January through 17 March 1981. All seven males and six females, ranging from fawns to very old animals (10+ yrs), were collected in the vicinity of Admiralty Island (Hawk Inlet and Winning Cove) and northeastern Chichagof Island (Tenakee Inlet and Whitestone Harbor), approximately latitude 58°N, longitude 135° W. The winter of 1980-81 was very mild, with little or no snow at sea level during the time deer were collected. Animals were obtained by hunting in old-growth forest, beach-fringe, muskegs, and one recent clearcut. Animals were shot as encountered. From each animal, the rumino-reticulum was excised whole, and about 20 fecal pellets were obtained from the rectum. Materials were frozen and returned to the laboratory. Two 100-200-ml samples were obtained from each completely thawed rumen for determination of plant species composition. The samples were collected by thoroughly mixing the rumino-reticular contents and quickly removing a sample with a tubular suction device. Such samples were found to be highly uniform in terms of dry matter content, particle size distribution, and species composition (D. E. Spalinger, unpublished report on file at Forestry Sciences Laboratory, Juneau). The two samples from each rumen were combined and washed through standard soil screens. All material that did not pass through a 2.00-mm screen was retained, ovendried, and separated by plant species. The rumen composition was expressed as percentage oven-dry weight of each plant species. Fecal samples were prepared by mixing in a Waring blender and washing through a 0.074-mm screen. Five microscope slides per sample were prepared according to procedures described by Sparks and Malechek (1968) such that approximately three identifiable plant fragments occurred in each microscope field of view at 100-power magnification. Frequency of occurrence of each plant species in each of 20 microscope fields per slide (100 fields per sample) was determined and converted to percentage relative density (Sparks and Malechek 1968), which is assumed to be directly proportional to percentage ovendry weight (Sparks and Malechek 1968).

The treatment of these data as paired-samples requires the assumption that each deer consumed a constant diet during the approximately 1-week period preceding its collection. Drastic shifts in the diet could result in very different meals being represented in the upper and lower digestive tracts.

This assumption of constant diet detracts from statistically valid paired-sample comparisons; but it permits examination of trends, which would not be possible by treating the data as two independent sets. The lack of snow during the collection period and the wide variety of habitats from which the deer were obtained should have tended to maximize the variation between deer in our collection.

The data were analyzed in terms of plant species and forage classes. The overall mean compositions of the rumen and fecal samples were compared by calculating their percentage similarity (*PS*) by Czekanowski's Index (Feinsinger et al. 1981):

$$\underline{PS} = \sum_{\underline{i}} \min(\underline{p_i}, \underline{q_i}) \times 100,$$

where $\underline{p_i}$ is the proportional dry weight of item *i* in the rumen, and $\underline{q_i}$ is the proportional dry weight of item *i* in the feces. Trends in rumen-fecal relationships within forage classes were examined by plotting for each forage class the paired-sample results from each of the 13 deer. Their simple correlation coefficients were calculated as measures of the strength of the relationships for these particular data, and the linear regression relationships between fecal and rumen composition were plotted for illustrative purposes only. Since forages differ greatly in their microscopically identifiable characteristics, each of the more common forages was subjectively categorized as to its identifiability in deer feces: poorly, moderately, or highly identifiable. This was intended to aid in the interpretation of these and other fecal data.

Results and Discussion

Rumen and fecal methods yielded generally similar results, both in terms of plant species composition (Table 1) and forage class composition (Figure 1). The percentage similarities were 65 and 77 %, respectively. Herb-layer, evergreen half-shrubs, especially Cornus canadensis, were the most abundant foods in both rumen and fecal material. Conifers, especially Chamaecyparis nootkatensis and Tsuga spp., were next most abundant, and graminoids and mosses were least abundant. It also is evident, however, that some forages were consistently over/under-represented in one technique relative to the other. Forbs and ferns, for example, were consistently more abundant in rumen than fecal samples, while graminoids, mosses, and to a lesser extent conifers, were more abundant in fecal than rumen samples (Figure 2, Table 2).

Among the forbs, Lysichiton americanum and Coptis aspleniifolia were consistently very poorly represented in the fecal samples. Both are presumably highly digestible (L. americanum was very young with tender shoots); neither was believed to be poorly identifiable microscopically (Table 3). Tiarella trifoliata appeared to be equally well represented in fecal and rumen samples. The only paired sample that had a higher composition of forbs in the feces than the rumen was a sample that was especially high in T. trifoliata (17 % in feces, 12 % in rumen) and contained no other forbs. In all 12 of the other paired samples, forbs were under-represented in the feces relative to the rumen.

Herb-layer, evergreen half-shrubs, especially Cornus canadensis, tended to be under-represented in the fecal samples relative to the rumen samples when

Table 1. Mean percentage composition, range, and percentage frequency of forages in 13 rumen and fecal samples from Sitka black-tailed deer collected during 21 January through 17 March 1981

FORAGE CLASS/ Species	Feces: Percentage composition	Feces: Range	Feces: Percentage frequency[1/]	Rumens: Percentage composition	Rumens: Range	Rumens: Percentage frequency[1/]
FORBS						
<u>Coptis</u> <u>aspleniifolia</u>	1	0-4	69	9	0-19	92
<u>Lysichiton</u> <u>americanum</u>	t[2/]	0-1	38	4	0-19	69
<u>Moneses</u> <u>uniflora</u>	t	0-t	8	0	0	0
<u>Pyrola</u> <u>secunda</u>	t	0-t	38	0	0	0
<u>Tiarella</u> <u>trifoliata</u>	2	0-17	62	2	0-12	85
HERB-LAYER, EVERGREEN HALF-SHRUBS						
<u>Cornus</u> <u>canadensis</u>	24	2-46	100	34	14-54	100
<u>Rubus</u> <u>pedatus</u>	11	1-37	100	7	1-32	100
<u>Vaccinium</u> spp.[3/]	t	0-1	46	1	0-3	92

(Continued)

Table 1. (continued)

FORAGE CLASS/ Species	Feces: Percentage composition	Feces: Range	Feces: Percentage frequency	Rumens: Percentage composition	Rumens: Range	Rumens: Percentage frequency
SHRUB LEAVES						
Empetrum nigrum	t	0-3	23	t	0-t	15
Ledum palustre	9	0-42	62	3	0-19	46
Oxycoccus microcarpus	t	0-1	31	0	0	0
Phyllodocae spp.	0	0	0	t	0-6	8
Vaccinium vitis-idaea	0	0	0	t	0-2	38
unknown	t	0-2	46	4	0-23	46
SHRUB STEMS						
Alnus spp.	t	0-t	8	0	0	0
Vaccinium spp.	5	t-16	100	4	0-10	92
unknown	1	0-5	69	6	0-17	92
CONIFERS						
Chamaecyparis nootkatensis	14	0-51	69	11	0-47	54
Picea sitchensis	0	0	0	t	0-t	23
Pinus contorta	t	0-3	15	0	0	0
Tsuga spp.	15	1-67	100	7	t-26	100

(Continued)

Table 1. (continued)

FORAGE CLASS/ Species	Feces: Percentage composition	Feces: Range	Feces: Percentage frequency	Rumens: Percentage composition	Rumens: Range	Rumens: Percentage frequency
GRAMINOIDS 4/	2	0-7	85	t	0-t	38
FERNS 5/	2	0-18	31	4	0-38	38
LICHENS						
Lobaria spp.	5	0-44	85	0	0	0
Usnea spp./*Alectoria* spp.	t	0-1	38	1	0-3	77
other lichens	0	0	0	2	0-14	77
MOSSES						
Hylocomium spp./*Rhytidiadelphus* spp.	4	0-16	100	t	0-1	69
Sphagnum spp.	1	0-1	69	t	0-t	15
KELP (*Fucus furcatus*)	3	0-25	69	3	0-17	77

1/ Presence or absence in 13 samples
2/ t = trace = < 0.5 percent
3/ decumbent, evergreen variety
4/ primarily *Elymus* spp. and *Carex* spp.
5/ primarily *Dryopteris dilatata*

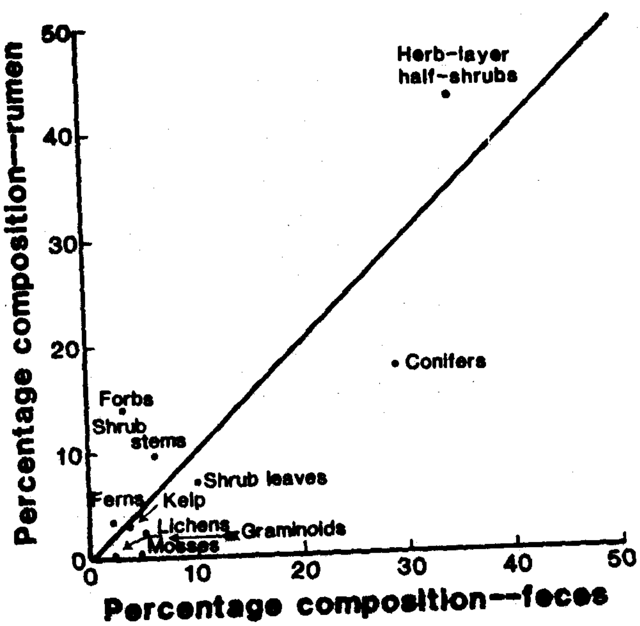
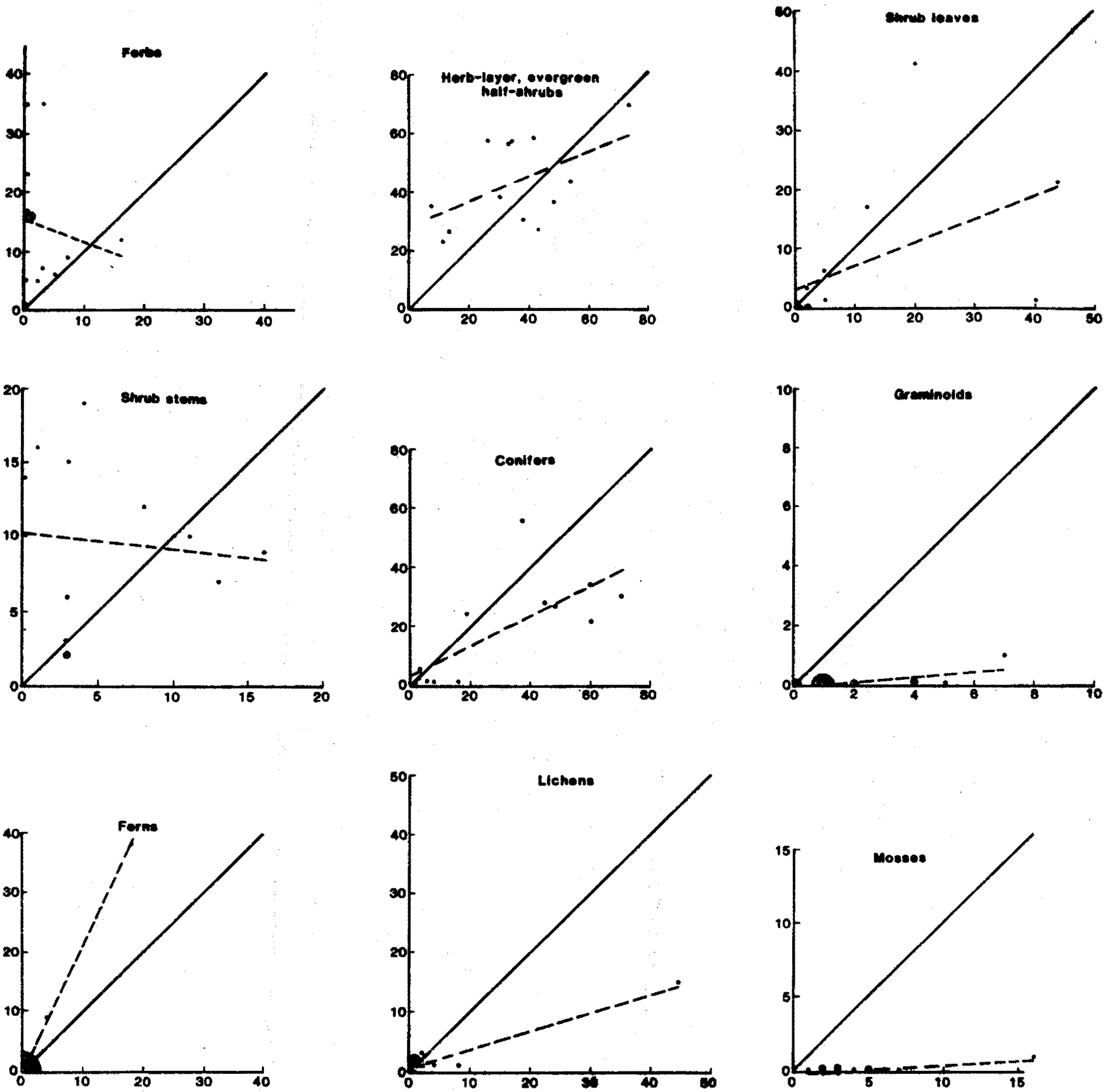


Fig. 1. Mean percentage composition of fecal and rumen samples. Solid line indicates 1:1 relationship.



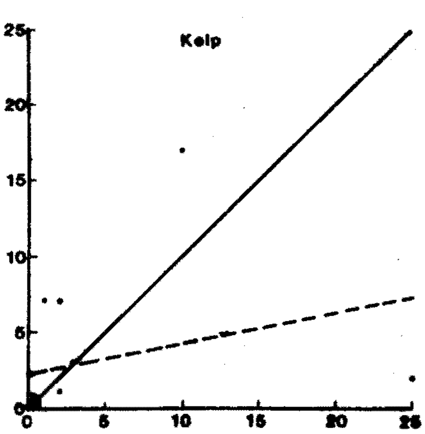


Fig. 2. Percentage composition of 13 paired rumen and fecal samples (solid circles), plotted for each of 10 forage classes. Solid line indicates 1:1 relationship; broken line indicates linear regression best-fit relationship (see Table 2 for regression statistics). Horizontal axis is percentage composition in feces; vertical axis is percentage composition in rumens.

Table 2. Linear regression statistics relating forage class composition of rumen contents to fecal contents.

Forage Class	Intercept (a)[1/]	Slope (b)[1/]	Correlation coefficient	Significance level[2/]
Forbs	15.5	-0.39	0.14	NS
Herb-layer half-shrubs	27.6	0.43	0.53	0.05
Shrub leaves	2.8	0.40	0.49	NS
Shrub stems	10.3	-0.11	0.10	NS
Conifers	3.0	0.51	0.73	0.01
Graminoids	-0.1	0.09	0.67	0.01
Ferns	-0.1	2.12	1.00	0.001
Lichens	0.7	0.31	0.95	0.001
Mosses	-0.2	0.06	0.89	0.001
Kelp	2.3	0.20	0.30	NS

1/ Percentage rumen composition = a + b(percentage fecal composition)

2/ NS = not statistically significant at the $\alpha = 0.05$ level

Table 3. Subjective evaluation of the microscopic identifiability of common forages in deer feces.

Highly identifiable	Moderately identifiable	Poorly identifiable
Lysichiton americanum	*Coptis aspleniifolia*	*Moneses uniflora*
Ledum palustre	*Tiarella trifoliata*	*Pyrola secunda*
Vaccinium spp. stems	*Cornus canadensis*	*Vaccinium* spp.[1/]
Chamaecyparis nootkatensis	*Rubus pedatus*	*Alnus* spp. stems
Picea sitchensis	*Empetrum nigrum*	
Pinus contorta	lichens	
Tsuga spp.	*Fucus furcatus*	
graminoids		
ferns		
mosses		

1/ decumbent, evergreen variety

their abundance was low in both fecal and rumen samples. We believe that this relationship is real; it is to be expected if rumen turnover rate decreases with decreasing abundance of cell solubles in the diet. Digestion of herb-layer half-shrubs should be more complete at lower rumen turnover rates, and increased digestion would decrease their identifiability in the feces. Shrub leaves consisted primarily of Ledum palustre, which was believed to be highly identifiable microscopically and tended to be over-represented in the fecal samples relative to rumen samples. A high proportion of unknown leaves (23 %) in one rumen sample was responsible for the anomolously high data point for shrub leaves in Figure 2. No clear relationships were evident in the comparison involving shrub stems.

Conifers, graminoids, lichens, and mosses tended to be over-represented in the fecal samples relative to rumen samples. Among the conifers, only Chamaecyparis nootkatensis and Tsuga spp. were represented to any important degree. All conifers, graminoids, and mosses were believed to be highly identifiable microscopically, which probably accounted for their greater representation in the fecal than rumen samples. Lichens were not especially highly identifiable microscopically, and their digestibility is presumably relatively high (Rochelle 1980). They had a very low specific gravity, however, and may not have fit the assumption of a 1:1 relationship between relative frequency and dry weight in the feces. Ferns were under-represented in the feces relative to rumens, probably due to very high digestibility (ferns were primarily Dryopteris dilatata and were in the tender, young, fiddle-head stage at the time they were eaten). No clear relationships were evident in the comparison involving kelp (Fucus furcatus).

Implications

Several general trends are evident and provide valuable insight into the relative merits of rumen and fecal analyses for deer diet assessments in southeast Alaska in winter and early spring. Forbs and ferns tend to be under-represented, while graminoids, mosses, and conifers tend to be over-represented in fecal analysis relative to rumen analysis. This pattern has been observed by other investigators (Anthony and Smith 1974, Dearden et al. 1975, Kessler et al. 1981) and is believed to be related directly to differential digestibility and identifiability of forages. Since highly digestible forages also are under-represented in rumen analysis relative to actual diet composition (Gaare et al. 1977), this bias is exaggerated in fecal analysis. Both techniques tend to over-estimate diet constituents of poorer quality (i.e., digestibility) and underestimate those of higher quality.

In a more general sense, however, both techniques provided rather similar results. Fecal analysis has a practical advantage over rumen analysis in that animals do not need to be killed or captured to obtain fecal samples. The ability to obtain greater sample sizes with fecal analysis than with rumen analysis and the ability to obtain fecal samples repeatedly from the same study area without disturbing the study population are very important considerations to be made when choosing between the two techniques. In most situations, the advantages of fecal analysis far outweigh the disadvantages relative to rumen analysis. Neither technique yields actual diet composition data; both techniques have biases. These biases must be kept in mind when designing experiments and evaluating fecal or rumen composition data in terms of diet composition.

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