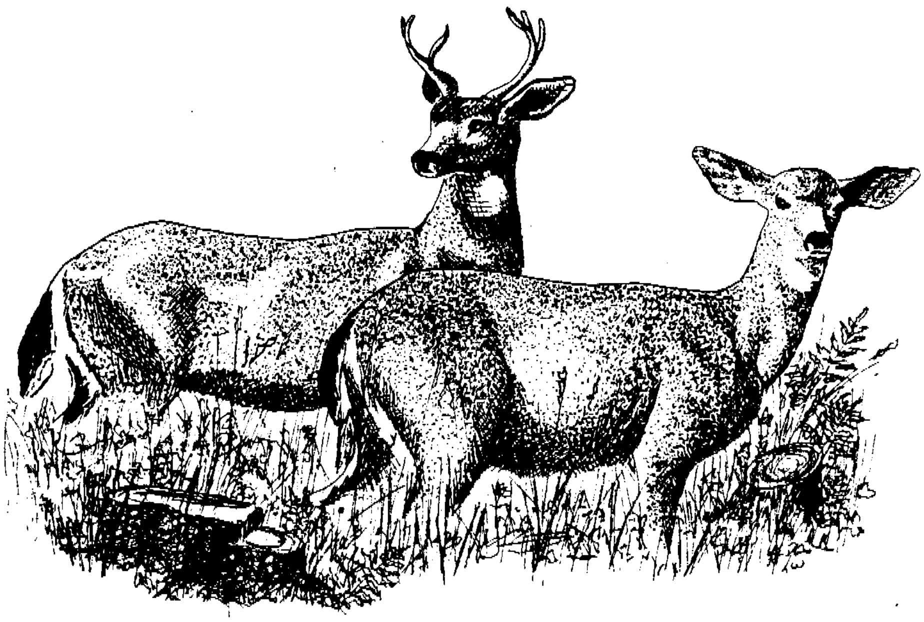
ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

EVALUATION OF DEER RANGE AND HABITAT UTILIZATION IN VARIOUS SUCCESSIONAL STAGES

By: John W. Schoen



STATE OF ALASKA
Jay S. Hammond, Governer

DIVISION OF GAME
Robert A. Hinman, Acting Director
Donald McKnight, Research Chief

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

Final Report
Federal Aid in Wildlife Restoration
Project W-17-10, Job 2.5 R

FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: John W. Schoen, O.C. Wallmo

Project No.: W-17-10

Project Title: Big Game Investigations

Nob No.: 2.5 R

Job Title: Evaluation of Deer Range and Habitat Utilization in Various Successional Stages

Period Covered: July 1, 1977 through June 30, 1978

SUMMARY

Sitka black-tailed deer are indigenous to the coastal forests of Southeast Alaska. Most deer range occurs in the Tongass National Forest, one third of which consists of commercial forest land. Old-growth timber is extensively harvested in this area at the rate of about 7,285 ha (18,000 acres) annually. The objectives of this study were to determine the utilization by deer of regrowth and old-growth forests, relative use of topography, and establish preliminary information on the diversity and abundance of understory vegetation in regrowth and old-growth forests.

Paired regrowth/old-growth sites were selected on Admiralty and Chichagof Islands. Sampling was conducted during spring and fall through pellet-group transects and vegetation plots. Accumulated results from both fall and spring revealed that deer use of regrowth stands from 0 to 147 years old averaged about one-sixth that of old-growth stands. These measurements further suggest that, during the winter period, deer utilized elevations up to 300 m (984 ft.), the highest elevation sampled, and that deer densities appear to be higher on southern than on northern exposures. These topographic relationships, however, need further investigation.

Measurements of understory vegetation indicated that old-growth forests produced a much greater abundance and diversity of understory species than did mid to late successional regrowth from 30 to 147 years old. These data and recent work by other investigators strongly support the contention that the uneven-aged climax forest provides optimal winter habitat for Sitka black-tailed deer. Further, as an ecological community the climax forest is, in a practical sense, a non-renewable natural resource.

CONTENTS

BACKGROUND

Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) are indigenous to the dense coastal forests along the northern British Columbia and Southeastern Alaska coasts from approximately 53° to 58° N latitude. Deer have also been introduced to Yakutat, Prince William Sound and Kodiak and Afognak Islands where they are now well established. The Sitka black-tail occupies the northwesterly extension of this species' range. Thus, deer in Alaska appear to occur at the limit of their environmental tolerance. Deer populations in Southeastern Alaska fluctuate dramatically corresponding to severe winter conditions involving deep snow which restricts the available winter range (Klein and Olson 1960, Merriam 1968, 1970). Deer are an important big game species in Southeastern Alaska and an estimated 5,000 to 14,000 are harvested annually (Alaska Department of Fish and Game 1974, 1975, 1976). This harvest represents an important recreational activity of Southeastern Alaskans as well as providing a valuable meat source for many Southeastern families. This species also provides many nonconsumptive users with abundant viewing opportunities throughout the year.

The Tongass National Forest, approximately 6.5 million ha (16 million acres) in size, is the largest National Forest in the United States. About one third of the Tongass consists of commercial forest land of which in 1976 approximately 13 percent had been harvested (USDA, Forest Service 1977). This harvested portion consists of various successional stages, from 1 to over 100 years post harvest, distributed throughout Southeastern. About 7,285 ha (18,000 acres) are clearcut annually (Harris and Farr 1974). It is anticipated that with increased world demand for wood products, the timber harvest in Southeast will increase in the future. The Forest Service has estimated that the volume of wood fiber produced per acre will increase approximately 70 percent from second-growth forest stands as compared to old-growth stands (USDA, Forest Service 1977). Thus, harvesting of old-growth stands will provide more land for regeneration and will increase long term yields. The rotational cycle for timber harvest in Southeastern has been estimated to be approximately 100 years (USDA, Forest Service 1969).

Most deer range in Southeastern Alaska is located on National Forest land, a substantial portion of which has been committed for timber harvest. Extensive clearcutting within this region has been considered by some (Nelson 1960, Meehan 1974, Leopold and Barrett 1972, Merriam, Johnson and Wood, ADF&G, pers. comm.) as possibly detrimental to black-tailed deer habitat. For example, we know that snow accumulations, an environmental factor greatly affecting black-tailed deer, are least under the old-growth forest canopy (Jones 1974, Merriam 1968). Also, although clearcuts generally increase forage production, this is gradually shaded out as the canopy closes over. The effects of future timber practices within the Tongass National Forest are of substantial and immediate concern to forest-wildlife managers working on the Tongass National Forest.

Southeastern deer populations have been studied in a general way by both the Forest Service and the Alaska Department of Fish and Game (Billings and Wheeler 1978, Bloom 1978, Klein 1964, 1965, Klein and Olson 1960, Merriam 1963, 1966, 1968, 1971, 1973). These studies provide good baseline data on the general ecology and status of black-tailed deer in Southeastern Alaska. However, specific quantifiable data on the relationships of timber management practices to black-tailed deer are currently insufficient for developing sound management guidelines.

With the implementation of the Southeast Alaska Area Guide, the framework for rapid incorporation of sound biological information in resource allocations has been established. The Forest Service and State of Alaska have been committed to cooperatively provide the necessary data. Information needed includes quantitative data on seasonal food habits and nutritional regimes, seasonal habitat use and the effects that timber practices have on forage production, forage availabity and site trafficability. Such data are required in order to provide wildlife-forest managers with the necessary information from which to base sound management decisions, many of which will have long term effects. We began this invesitgation by first comparing the relative densities of deer within regrowth and old-growth forest sites. This study was designed to be the first phase of a well coordinated, cooperative investigation between the Alaska Department of Fish and Game and the Forest Sciences Laboratory (Pacific Northwest Forest and Range Experiment Station, USFS, Juneau).

OBJECTIVES

1. To determine the utilization and relative densities of deer in old-growth and regrowth forest stands of various ages.

2. To determine relative deer use of topography.

3. To establish preliminary information on relative abundance and diversity of selected understory plant species in regrowth and old-growth stands.

STUDY AREA

A study area was chosen on the northern islands of the Alexander Archipelago of Southeastern Alaska (Fig. 1). This area was chosen because it supported measurable densities of deer as well as encompassing a variety of successional forest types ranging from 1-year-old clearcuts

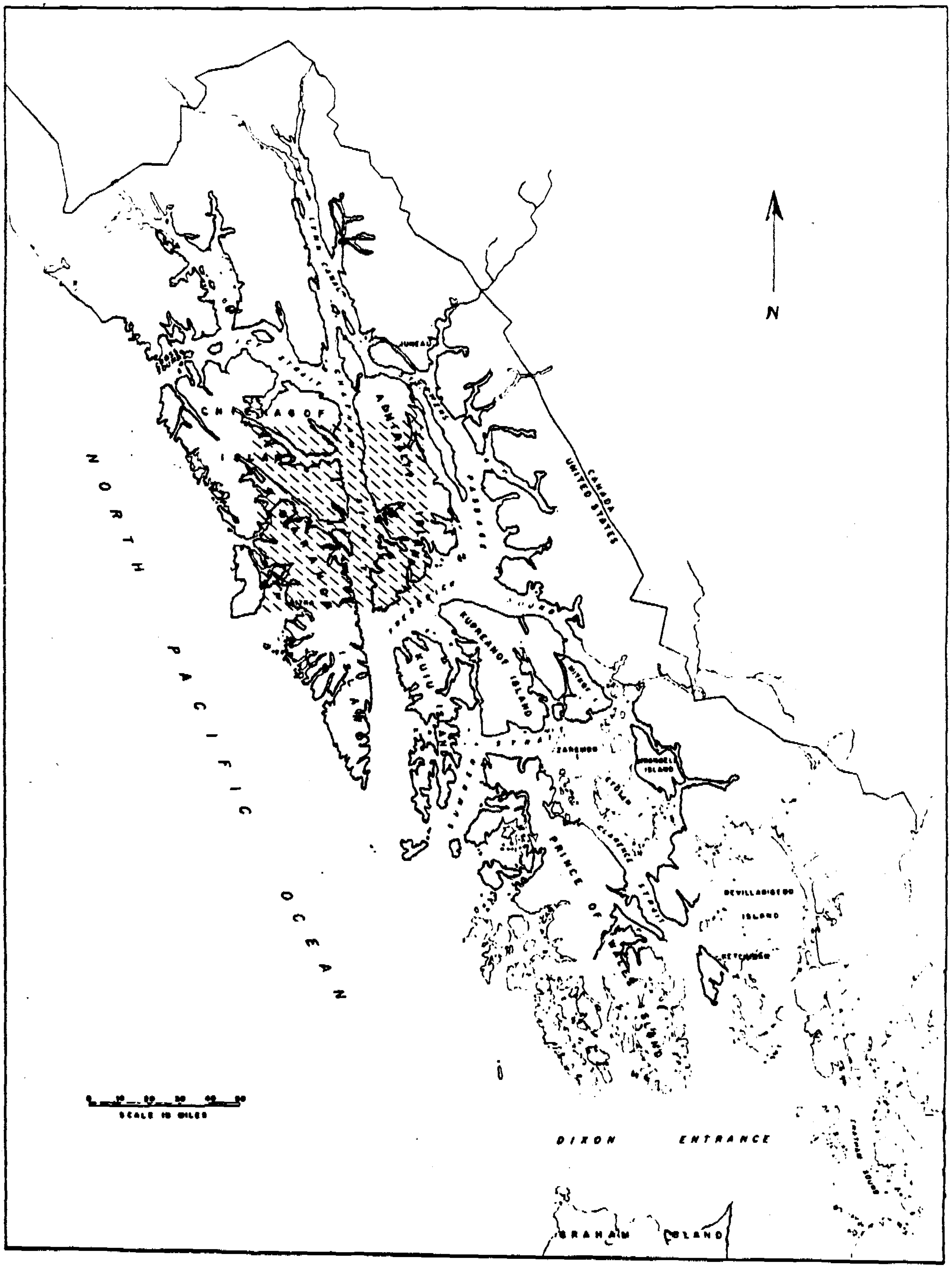


Figure 1. The Alexander Archipelago in Southeastern Alaska. Study area identified in striped portion.

through over 100-year-old regrowth stands to climax forest. Twenty-two different sites within this area were chosen for sampling (Fig. 2). These sites were located primarily on southern Admiralty and east Chichagof Islands.

Chichagof and Admiralty Islands are the second and third largest Islands in the Archipelago; measuring 3,300 Km^2 (2,062 mi^2) and 2,734 Km^2 (1,709 mi^2), respectively. The study area is located between 57° to 58° latitude and 134° to 136° longitude. The topography of the area is rugged with mountains rising from sea level to over 1,400 m (4,600 ft.). Its shoreline is generally steep and rocky but is scattered with many sheltered bays and inlets.

The climate of this area is maritime with cool moist weather predominating. Heavy snow accumulations generally occur during the winter and high elevations are snow covered for 7 to 9 months of the year. Annual precipitation for this area averages about 254 cm (100 in.) while monthly temperatures average about 5.6°C (42°F).

The major retreat of glaciers in this region occurred about 10,000 years ago (Harris et al. 1974). Thus, most soils have developed since that time. Because of the cool temperatures and high moisture, soils in Southeast Alaska are highly organic. These include alpine organic soils, well drained organic soils and wet organic soils. Forest vegetation generally occurs on well drained soils and muskegs are characteristic of wet soils.

The vegetation of this area is dominated by two major habitat types - temperate rain forest and alpine tundra. Interspersed throughout the forest vegetation are poorly drained muskeg areas. Forests of this region are typically western hemlock - Sitka spruce (*Tsuga heterophylla - Picea sitchensis*). These are the primary commercial species found in the area. The average forest site productivity of this area is about 20 percent lower than on the Washington coast and sites contain fewer tree species (Harris and Farr 1978). Other tree species found in the region include Alaska-cedar (*Chamaecyparis nootkatensis*), mountain hemlock (*Tsuga mertensiana*), lodgepole pine (*Pinus contorta*), black cottonwood (*Populus trichocarpa*), and red alder (*Alnus rubra*). Understory species occurring commonly within the forest include several species of blueberry and huckleberry (*Vaccinium* sp.), rusty menziesia (*Menziesia ferruginea*), devils club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), elderberry (*Sambucus racemosa*), skunk cabbage (*Lysichiton americanum*), bunchberry (*Cornus canadensis*), trailing raspberry (*Rubus pedatus*), and goldthread (*Coptis aspleniifolia*).

Conifer forest covers about 48 percent of the land area of the northern Archipelago (USDA, Forest Service 1978). This forest is a highly heterogeneous community reflecting differences in site characteristics and stand history. Of the total forest within this northern region about 26 percent is classified as commercial forest land. Commercial forest land is defined as land capable of growing stands containing 8,000 board feet per acre or greater (Hutchison 1967). Composition of tree species in commercial forest land is about 97 percent western hemlock - Sitka spruce (USDA, Forest Service 1978). Of these two, hemlock predominates.

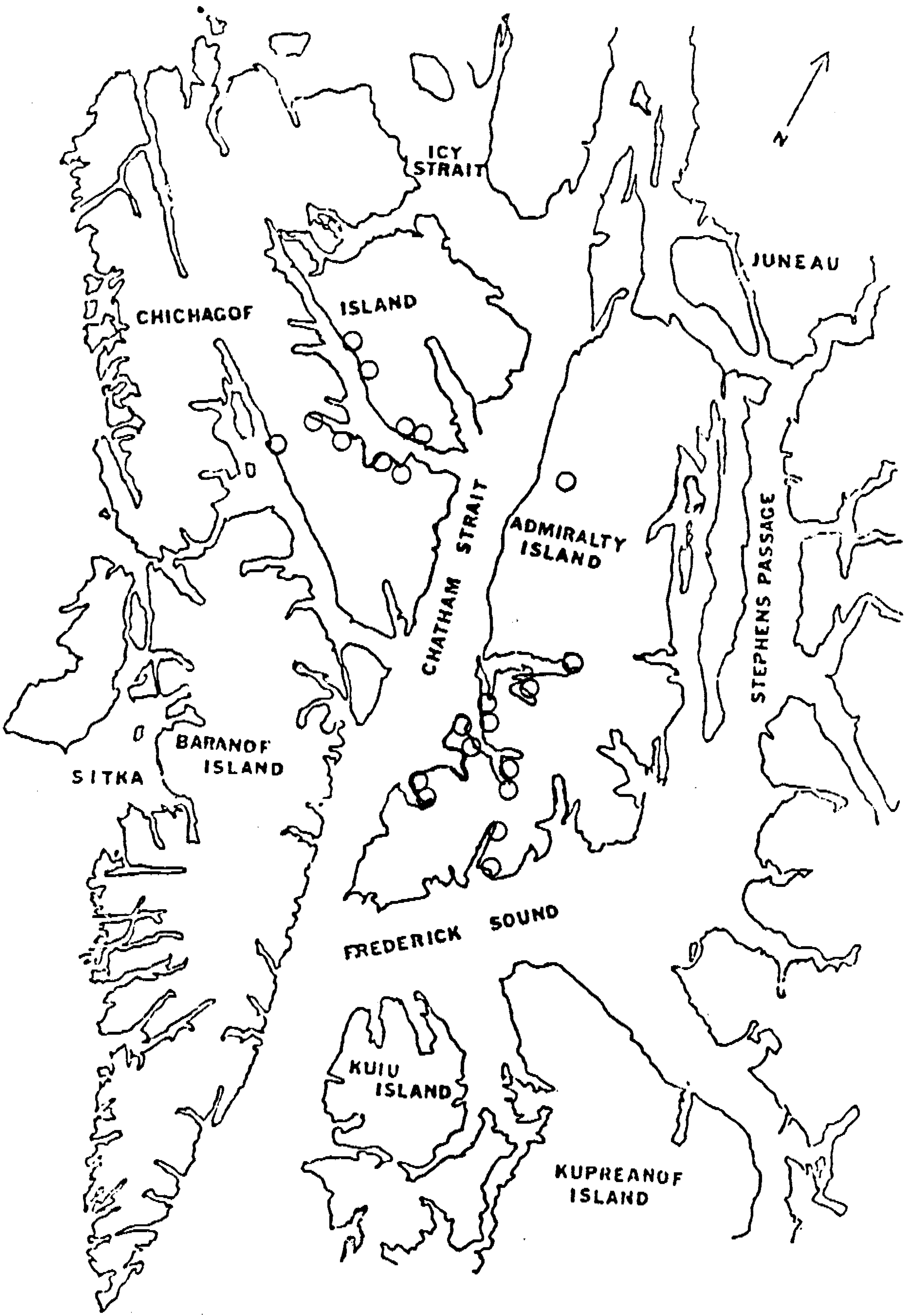


Figure 2. Location of study sites (0) on Admiralty and Chichagof Islands.

Timber harvesting began during the Russian occupation in the early 1800's and has continued to the present. Large scale clearcutting became common during the 1950's when the Forest Service granted two 50-year contracts to major pulp companies. Currently, timber is being harvested at the rate of about 7,285 ha (18,000 acres) per year (Harris and Farr, 1974).

The only big game species occuring within the study area on Admiralty and Chichagof Islands are brown bears (*Ursus arctos*) and deer. Currently, deer densities are relatively high following several unusually mild winters. Deer season begins with bucks only on the first of August with either-sex hunting beginning September 15 and continuing through December. The bag limit is four deer. Hunting pressure has probably had a minimal impact on population levels within the study area.

PROCEDURES

Let us assume that, given a choice, deer will seek out and spend the greatest proportion of their time in the optimum or preferred habitat. If our assumption is correct, a quantitative measure of deer use between two adjacent habitat types should indicate the relative importance to deer of one habitat over another. Our major objective in this investigation was to determine if differences existed in the relative densities of deer utilizing various successional stages of the forest and if so, provide an index of the relative value of several general successional stages in terms of deer habitat.

Our first effort was to determine areas within the Forest where deer densities occurred at measurable levels. This was accomplished through a number of on-the-ground field assessments as well as consulting the Regional Alaska Department of Fish and Game staff. Next, a thorough review of Forest Service timber harvest records was undertaken. This revealed locations and dates of recent clearcuts and even-aged regrowth stands within the study area. We chose to sample regrowth areas of the following age categories: 0-10, 11-30, 31-50, 51-70, 71-100 and 101-150 years. These categories are similar to those established by W. Farr (Forestry Sciences Lab., USFS, Juneau) to study the effects of thinning on timber growth and yield. Each even-aged regrowth site was paired with an adjacent or nearby uneven-aged old-growth stand (climax forest) of similar site characteristics. All regrowth sites were the result of clearcutting except two: Kanalku Bay and Salt Lake in Kootznohoo Inlet, Admiralty Island. These sites were the result of fire.

Relative deer densities within paired sites were determined by using pellet-group densities as an indicator of deer use. The use of pellet-group sampling as a technique in big game sampling has been extensively reviewed by Neff (1968). Each stand was sampled by running parallel transects of continuous 1 x 10 m plots with transects arbitrarily spaced to cover the stand. Sample size varied from 113 to 310 plots per stand in the fall while the spring sample consisted of 300 plots per stand. A transect was run by a two-man crew, one walking a compass bearing and dragging a lead line, the other following the 10 m line and counting the number of pellet-groups along a 1 m width of the line. Presence of pellet-groups within a plot was determined by the approximate center of the group. Any number of pellets was considered a pellet-group. Differences of statistical significance of pellet-group densities between paired plots were determined using a chi-square analysis (Sokal and Rohlf 1973). This was accomplished by testing the null hypothesis that the number of plots with pellet-groups is independent of previous logging history.

Sampling was conducted during September and October 1977 and April and May 1978. The fall sample primarily represented spring and summer use while the spring sample represented fall and winter use. We assume that most pellet-groups in this environment persist for about 6 months before deteriorating. This assumption is supported by the work of Fairbanks (pers. comm.) at the University of Washington and the work of Fisch (1978) at the Forestry Sciences Lab in Juneau.

In the fall sample two paired sites (both old-growth and regrowth) were sampled with one half plot size. These are corrected to be comparable with the other sites and for a total average by doubling the total number of groups found on each site. During both seasons several regrowth sites were compared to the same nearby old-growth site. Thus, the total number of regrowth plots was larger than the total number of old-growth plots.

As a secondary aspect of our pellet-group sampling, vegetation measurements were collected from selected sites during both sample periods. During the fall period plot density was estimated by counting the number of plants (broken down as shrubs, forbs, and ferns) on 0.5-m circular plots. During the spring, plant measurements were recorded as frequency of occurrence of species rather than total abundance. This was less time consuming and considered a more precise measurement, since it was often difficult to distinguish individual plants with many low growing forbs. In both sample periods, plots were located along transects at the beginning of each 1 x 10 m pellet-group plot. Ages of stands sampled ranged from 20 to 147 years. Vegetation sampling was very time consuming thus only a selected sample of sites was measured.

Additional information recorded on each plot during sampling included site characteristics and presence of game trails (Fig. 3). Of the site characteristics, habitat type was of a somewhat subjective nature while topographic features were similar between paired sites. Some general observations can be made, however, with respect to relative deer use of elevation. One site at Lake Florence was established primarily to measure differences in deer use of northerly and southerly exposures. Time and staffing prohibited any further sampling specifically related to topographic variation of deer use.

RESULTS

Deer Use of Regrowth and Old-growth Forest Stands

Fifteen regrowth stands ranging from 4 to 147 years old were sampled during the fall. The relative pellet-group densities in paired regrowth and old-growth sites are presented in Table 1. In no case was use of regrowth stands greater than use of old-growth stands. The degree

Area ____________ Stand Age ____________

Transect no. ____________ Date ____________

Crew Members

Plot No.	Pellet Groups	Hab	Elev	Slope	Aspect	GT	GP	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								

Figure 3. Sample data form for pellet-group sampling.

Table 1. Relative pellet-group densities in old-growth and regrowth sites on Admiralty and Chichagof Islands, Fall 1977.

Site Location	Stand Age (years)	# 1/ Plots	# Pellet-groups	Groups/ hectare	Ratio oldgrowth:regrowth	Significance
Corner Bay	4	309	28	90.6		
	old-growth	310	93	300.0	3.3:1	P<.005
Tenakee 2/	6-10	240	84	350.0		
	old-growth 3/	245	148	601.6	1.7:1	P>.1
Tenakee Inlet	7-11	275	30	109.1		
	old-growth	290	208	717.2	6.6:1	P<.005
Crab Bay 4/	14	300	9	30.0		
	no suitable old-growth available					
Eliza Hbr.	20	200	6	30.0		
	old-growth	163	23	141.1	4.7:1	P<.005
Woewodski Hbr	25	233	29	124.5		
	old-growth	113	32	283.2	2.3:1	P<.005
Hood Bay	30-34	238	40	168.1		
	old-growth	240	167	695.8	4.1:1	P<.005
Hood Bay	57	265	9	34.0		
	old-growth	269	198	736.1	21.7:1	P<.005
Hood Bay	59	300	6	20.0		
	old-growth	300	173	576.7	28.8:1	P<.005
Tenakee 2/	60	240	18	75.0		
	old-growth 3/	245	148	601.6	8.0:1	P<.005
Hood Bay	63	238	35	147.1		
	old-growth	300	162	540.0	3.7:1	P<.005
Hood Bay	72	300	13	43.3		
	old-growth	304	208	684.2	15.8:1	P<.005
Salt Lake	85	195	12	61.5		
	old-growth	194	112	577.3	9.4:1	P<.005
Whitewater Bay	112	200	17	85.0		
	old-growth	200	37	185.0	2.2:1	P<.025
Kanalku Bay	147	200	10	50.0		
	old-growth	200	68	340.0	6.8:1	P<.005
Σ	regrowth	3433	337	98.2		
	old-growth	3128	1629	520.8	5.3:1	P<.005

1/ Plot size = 1 x 10 m
2/ These sites were sample with 1/2 plot size
3/ Same old-growth comparison
4/ This site was not used in calculating averages

of difference ranged from almost two to 28 times more deer use in old-growth stands than in regrowth stands. On the whole, regrowth stands received an average of about one fifth the deer use of old-growth stands. In every comparison except one, the difference in use was statistically significant ($P<.05$). These data are grouped by age categories and presented graphically in Fig. 4. The greatest differences in use were observed in mid-successional regrowth stands ranging in age from about 30 to 100 years. The above data reflect primarily spring and summer deer use.

During April and May 1978 relative pellet-group densities were sampled in 17 paired regrowth and old-growth stands. A summary of these data are presented in Table 2. As in the fall sample, there were no cases where pellet-group densities were higher in regrowth than old-growth stands. The old-growth stands, as a whole, received an average of seven times more deer use than the regrowth stands. The degree of difference ranged from 3.4 to 96 times greater. In the case of one site, a new clearcut not yet 1 year old, we observed no deer use at all. In every case the difference in use between regrowth and old-growth was highly significant ($P<.005$). Regrowth sites where deer use was closest to the use of old-growth were those between 1 to 10 years of age. Average use of regrowth and old-growth by successional age class is presented in Fig.5. These data differ from the fall sample primarily in the higher density of pellet-groups found in the old-growth.

Occurrence of game trails in regrowth and old-growth stands was also recorded. A summary of relative trail densities in paired sites is presented in Table 3. In no case was the number of trails observed in regrowth stands ever greater than the number observed in old-growth. On the average, game trails observed in regrowth were one-third those observed in old-growth.

Deer Use of Topography

From our spring sample of deer use of regrowth and old-growth, four old-growth sites lended themselves to a general analysis of deer use of southerly and northerly exposures. One site in Crab Bay and one at Kadashan have northerly exposures, while two sites on the north shore of Tenakee Inlet have southerly aspects. In addition, we specifically sampled the area east of Lake Florence on west Admiralty for deer use of north and south exposures. The results of these measurements are presented in Table 4.

The average deer use as indicated by pellet-group density was one and a half times higher on south facing slopes than on north facing slopes. On two of three sites, deer use was significantly higher on southerly exposures while on the third site use of north exposures was slightly higher but not statistically significant. Of the three sites measured, Lake Florence is probably most representative of deer response to differences in slope exposure. The other two sites are separated spatially and thus prone to variability of site factors other than exposure.

We found measurable pellet-group densities at all elevations sampled

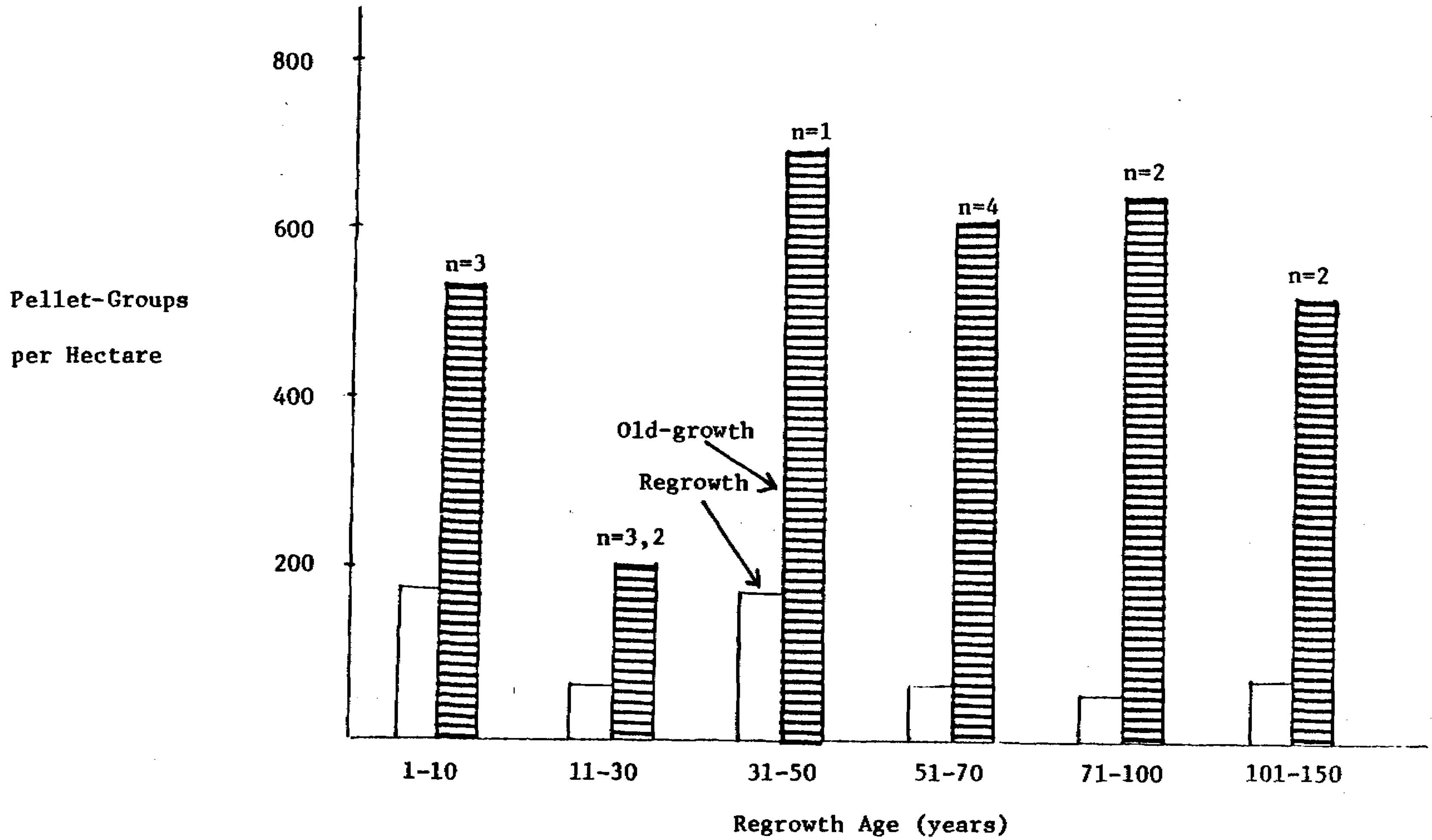


Figure 4. Comparative deer use of regrowth and old-growth stands on Admiralty and Chichagof Islands, Fall 1977.

Table 2. Relative pellet-group densities in old-growth and regrowth sites on Admiralty and Chichagof Islands, Spring 1978.

Site Location	Stand age (years)	# Plots [1/]	# Pellet-groups	Groups/ hectare	Ratio oldgrowth:regrowth	Significance
Crab Bay	0	300	0	0		
	oldgrowth	300	115	383.3	∞:1	P<.005
Corner Bay	4	300	56	186.7		
	oldgrowth	300	193	643.3	3.5:1	P<.005
Tenakee	6-10	300	103	343.3		
	oldgrowth [2/]	300	367	1223.3	3.6:1	P<.005
Tenakee Inlet	7-11	300	97	323.3		
	oldgrowth [3/]	300	327	1090.0	3.4:1	P<.005
Kadashan	13	300	41	136.7		
	oldgrowth	300	411	1370.0	10.0:1	P<.005
Hood Bay	30-34	300	19	63.3		
	oldgrowth	300	251	836.7	13.2:1	P<.005
Hood Bay	30-34	300	117	390.0		
	oldgrowth	300	500	1666.7	4.3:1	P<.005
Hoonah Sound	30-40	300	65	216.7		
	oldgrowth	300	317	1056.7	4.9:1	P<.005
Whitewater Bay	53	300	13	43.3		
	oldgrowth [4/]	300	471	1570.0	36.3:1	P<.005
Hood Bay	59	300	6	20.0		
	oldgrowth	300	576	1920.0	96.0:1	P<.005
Tenakee	60	300	67	223.3		
	oldgrowth [2/]	300	367	1223.3	5.5:1	P<.005
Hood Bay	63	300	29	96.7		
	oldgrowth	300	264	880.0	9.1:1	P<.005
Tenakee Inlet	64	300	56	186.7		
	oldgrowth [3/]	300	327	1090.0	5.8:1	P<.005
Hood Bay	72	300	17	56.7		
	oldgrowth	300	305	1016.7	17.9:1	P<.005
Salt Lake	85	300	17	90.0		
	oldgrowth	300	471	1570.0	17.4:1	P<.005
Whitewater Bay	112	300	86	286.7		
	oldgrowth [4/]	300	471	1570.0	5.5:1	P<.005
Kanalku Bay	147	300	65	216.7		
	oldgrowth	300	416	1386.7	6.4:1	P<.005
Σ	regrowth	5100	864	169.4		
	oldgrowth	4200	4984	1186.7	7.0:1	P<.005

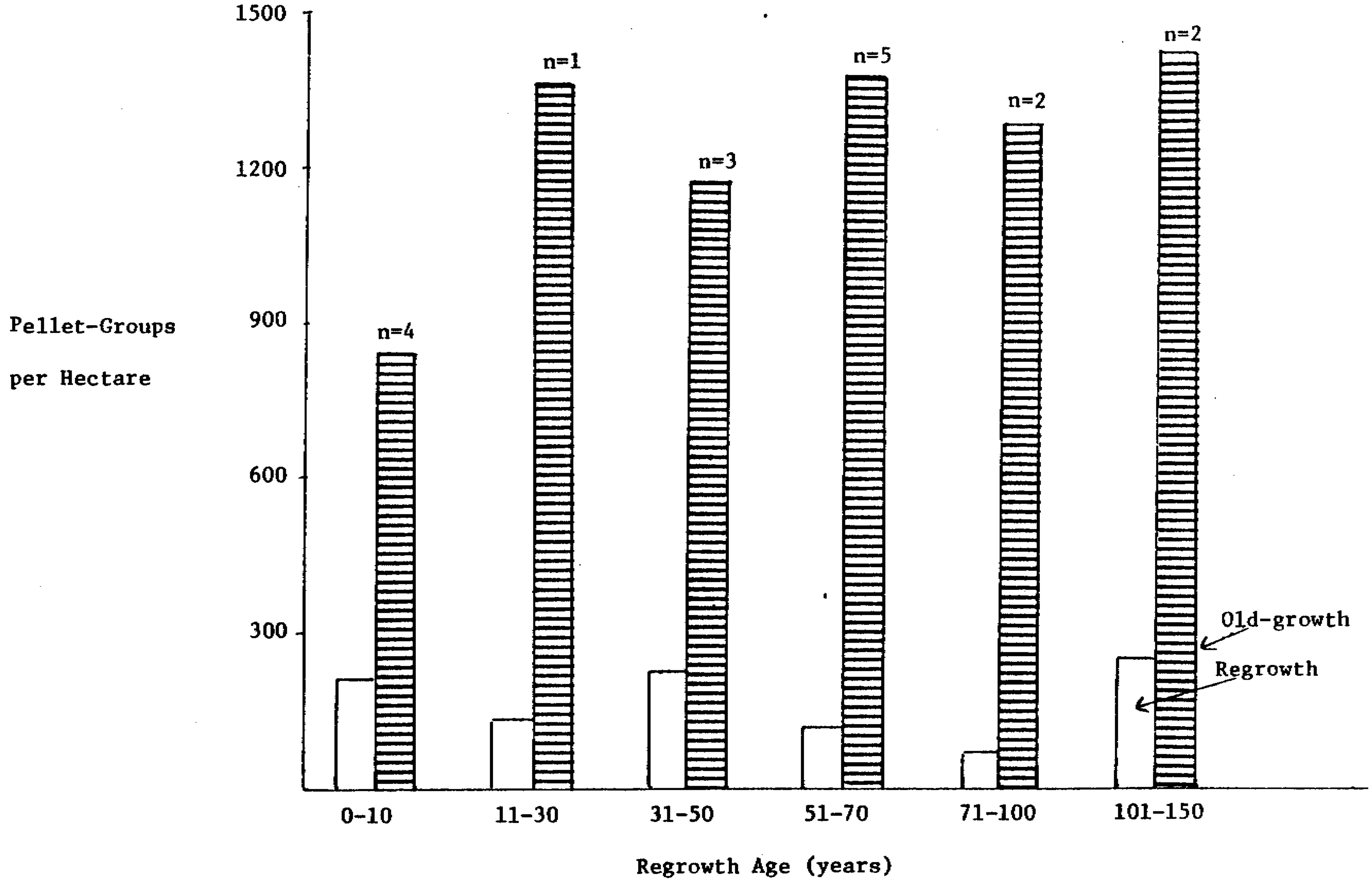


Figure 5. Comparative deer use of regrowth and old-growth stands on Admiralty and Chichagof Islands, Spring 1978.

Table 3. Relative trail density in old-growth and regrowth sites on Admiralty and Chichagof Islands.

Stand age (years)	Trails per hectare[1]	Ratio Oldgrowth:regrowth
0	0	
old-growth	86.7	∞:1
4	23.3	
old-growth	106.7	4.6:1
6-10	16.7	
old-growth[2]	246.7	14.7:1
7-11	36.7	
old-growth[3]	300	8.2:1
13	26.7	
old-growth	123.3	4.6:1
30-40	20.0	
old-growth	133.3	6.7:1
30-34	33.3	
old-growth	270.0	8.1:1
37-47	113.3	
old-growth	206.7	1.8:1
53	36.7	
old-growth[4]	343.3	9.4:1
59	103.3	
old-growth	346.7	3.4:1
60	116.7	
old-growth	246.7	2.1:1
63	26.7	
old-growth[2]	193.3	7.2:1
64	26.7	
old-growth	300.0	11.2:1
72	106.7	
old-growth	206.7	1.9:1
85	40.0	
old-growth	273.3	6.8:1
112	260.0	
old-growth[4]	343.3	1.3:1
147	143.3	
old-growth	300.0	2.1:1
Σ regrowth	65.9	
Σ oldgrowth	219.5	3.3:1

1/ Each stand was sampled with 300 1 x 10 m plots.

2/3/4/ Same old-growth sites.

Table 4. Relative pellet-group densities old-growth stands with northerly and southerly exposures on Admiralty and Chichagof Islands, Spring 1978.

Site Location	Exposure	# Plots	# Pellet-groups	Groups/ hectare	Ratio S:N	Significance
Crab Bay	N	300	115	383.3		
Tenakee Inlet	S	300	327	1090.0	2.8:1	P<.005
Kadashan	N	300	411	1370.0		
Tenakee	S	300	367	1223.3	0.9:1	P>.1
Lake Florence	N	432	234	541.7		
	S	374	385	1029.4	1.9:1	P<.025
Σ	N	1032	760	736.4		
	S	974	1079	1107.8	1.5:1	P>.1

during both field seasons. Although no specific trends were obvious, it appeared that during both summer and winter deer utilized most of the old-growth range sampled. Most sample sites were below 152 m (500 ft.) elevation. However, several sites ranged up to 274 m (900 ft.). There were also no trends observed with respect to steepness of slope. Deer use appeared to be distributed over a variety of slopes. These data, however, are few and preliminary in nature, thus further work is warranted.

Vegetation Measurements

Measurements of understory vegetation in regrowth and old-growth stands were a secondary aspect of this study. A summary of vegetation sampling conducted during the fall is presented in Table 5. The average number of plants per plot in regrowth stands 30 to 63 years old was about one-sixth that of the comparable old-growth sites. The average number of shrubs and forbs in regrowth was approximately one-third and one-fourth the number occurring in the old-growth.

During the spring period, the frequency of occurrence and diversity of several understory plant species were measured on five sites ranging from 30 to 147 years old. The results of these measurements are presented in Table 6. The occurrence of understory forbs, such as *Cornus*, *Rubus pedatus*, and *Coptis*, ranged from 15 to 20 times greater in old-growth sites than in the regrowth stands sampled. The frequency of occurrence of *Vaccinium* was also higher in old-growth, averaging seven times greater. A measure of diversity was the number of plots which contained three or more species. The average old-growth:regrowth ratio was 4:1.

In general, the uneven-aged old-growth forest produced a much greater abundance and diversity of understory plant species than did the mid-successional even-aged regrowth stands. Not only are shrubs more abundant in old-growth stands, but they are also larger and more robust. Further, of the understory forbs and ferns which occur most commonly in regrowth stands (e.g. *Streptopus*, *Maianthemum*, *Athyrium*, and *Gymnocarpium*), most of these die back in the fall and are not available for winter forage. *Cornus*, *Coptis*, and *Rubus pedatus* remain green throughout the winter and these are most abundant in uneven-aged old-growth.

DISCUSSION

To summarize our accumulated results from both the fall and spring sampling, we found an average of over six times the deer use (based on pellet-group counts) in uneven-aged old-growth stands as we did in even-aged regrowth stands from 0 to 147 years old. Using game trails as an index to deer use, regrowth stands averaged one third the winter deer use of old-growth stands. Of the two techniques, I believe the pellet-group count to be a more reliable estimate of relative density. Game trails were, in many cases, difficult to detect and observer variability was high. On southern Vancouver Island, Weger (1977) measured deer use in mature (250+ years) and immature (13-75 years) stands. He determined that the mature stands received significantly more deer use than did the immature stands. Jones (1974) also observed that on Vancouver Island deer

Table 5. Summary of vegetation sampling in old-growth and regrowth forest stands on Admiralty Island, Fall 1977.

Stand Age (years)	n Plots[1/]	Plants/Plot	Plots w/veget. percentage	Mean Plants/Plot Shrubs	Forbs	Ferns
30-40	238	7.67	71	0.87	3.51	2.63
Old-growth	238	26.16	96	1.13	12.00	11.84
57	267	1.48	25	0.29	0.52	0.60
Old-growth	140	38.14	86	3.13	32.34	1.65
59	300	1.46	19	0.33	0.34	0.79
Old-growth	97	22.37	93	2.53	17.87	1.84
63	238	4.53	61	2.15	0.97	0.81
Old-growth	300	12.58	74	3.54	6.66	1.67
Regrowth	1043	3.58	42	0.86	1.25	1.17
Old-growth	775	22.59	84	2.60	4.78	4.78

1/ Plots=0.5 m^2.

Table 6. Relative frequency of occurrence and diversity of selected plant species in old-growth and regrowth forest stands on Admiralty and Chichagof Islands, Spring 1978.

Stand Age (years)	n Plots[1/]	Vaccinium %	Cornus %	Rubus pedatus %	Coptis %	Plots W 3+ species--%
30-40	300	4.3	6.0	3.3	4.0	31.3
Old-growth	300	42.3	60.3	45.3	22.7	67.7
53	300[2/]	2.7	0.3	0	1.3	1.7
Old-growth	300	77.3	47.3	35.0	28.3	74.7
85	300	13.3	3.7	0	0	8.3
Old-growth	300	62.7	44.7	50.0	8.0	45.7
112	300[2/]	7.7	0.3	0	0	15.7
Old-growth	300	77.3	47.3	35.0	28.3	74.7
147	300	15.3	6.3	7.7	0.7	12.0
Old-growth	300	57.7	47.3	38.7	9.0	38.3
Regrowth	1500	8.7	3.3	2.2	1.2	13.8
Old-growth	1200	60.0	49.9	42.3	24.1	56.6
$\bar{x}$ Ratio old-growth:regrowth		7:1	15:1	19:1	20:1	4:1

1/ Plots=0.5 m^2.

2/ Same Old-growth comparison.

use of mature timber was generally greater than use of regrowth stands.

Recall that our fall sample period estimated spring and summer use primarily while the spring sample reflected fall and winter use. Fisch (1978) has determined that most summer pellets deteriorate within 6 months of deposition. He has further observed (pers. comm.) that although winter pellets appear to persist longer most are also indistinguishable after 6 months. Pellet-group densities observed during spring were higher than fall. This reflects increased densities of deer at lower elevations during the winter period. All of our study sites were below 300 m (984 ft.) and during the summer period, deer are more widely dispersed. It is important to recognize in the interpretation of these data, however, that the winter of 1977-78 was generally a light to moderate snow year. Thus, the results obtained here are not representative of a winter with higher snow accumulations. This will be addressed in more detail later.

Although our data on the relationships of topography and deer densities are limited, it appears that deer utilize most of the elevational range we sampled between sea level and 300 m (984 ft.) throughout the year. Further, during the winter period there appears to be preference for southern exposures. Differential use of slope exposure undoubtedly reflects differences in solar radiation which influence snow accumulation. Snow depths are generally greater and snow cover persists longer on northerly than on southerly exposures. Hosely (1967) cited snow depth as the most critical limiting factor impacting black-tailed deer in the Tongass Forest.

These relationships need to be more intensively investigated, however, and a quantitative index of the relative importance of various topographic features developed for each season. Both Olson (1952) and Merriam (1968) described deer as not being confined to one elevational zone during the winter but rather ranging as widely as snow conditions permit. Thus the concept, as applied by some, of a narrow zone ("beach fringe") essential for winter deer survival, needs a more critical evaluation. Leopold and Barrett (1972) described finding significant amounts of deer sign up to 3 mi (4.8 Km) inland and 750 ft. (229 m) elevation during the winter period at Hood Bay on Admiralty Island.

Measurements of understory vegetation indicate that once the conifer canopy closes, the understory community is greatly reduced both in abundance and diversity from that of the climax forest. This is a result of the even-aged character of regrowth stands following clearcutting. Our observations suggest that immediately following clearcutting there is an almost complete elimination of deer forage. However, in several years there is a flush of new vegetation and deer forage becomes abundant, at least during snow free months. Generally, depending on site conditions, in 10 to 15 years the conifer canopy begins to close, light is intercepted, and the forest floor becomes almost devoid of vascular plants. This situation persisted through all of our older regrowth stands up to and including 147 years old. Harris and Farr (1978) stated that on most good sites, grasses, forbs and shrubs are shaded out in 15 to 20 years and remain so for many decades. Robuck (1975) suggested that the forest floor remains relatively free of vascular shrubs, herbs and ferns until about stand age 200 years. Currently the Foresty Sciences Lab has a contract with Oregon State University to pursue this work in greater detail.

From our initial studies, it appears that deer densities are largely proportional to the abundance of available forage. One of the primary results of clearcutting the coastal climax forest is a significant reduction in the diversity and abundance of understory plant species from about 15 to 20 years following cutting to well beyond the rotation period (over 100 years). Although understory species appear to be abundant in clearcuts from several years following logging to about 15 years, they do not remain available during periods of deep snow which often occur throughout much of the winter in Southeast Alaska. It has been well documented that snow accumulations are least under the forest canopy (Schoen and Wallmo 1978, Bloom 1978, Weger 1977, Jones 1973, Merriam 1968). Winter measurements of deer use indicate that high volume old-growth stands, where snow accumulation is the least, support the highest densities of deer (Bloom 1978, Leopold and Barrett 1972). Although Billings and Wheeler (1978) contend that lower volume old-growth sites may provide the best winter deer habitat based on crude protein levels, forage availability is often greatly reduced in these sites because of greater snow accumulations than on higher volume sites. Both the productivity of understory vegetation and the accumulation of snow increase inversely with respect to the overstory canopy.

Much of our philosophy toward deer-forest management stems from the basic idea that opening up the forest, through logging or fire, generally improves deer range, and populations correspondingly increase (Brown 1961, Cowan, 1956 and Leopold 1950). This philosophy was readily applied to the Tongass Forest (e.g. "Timber harvesting can be and generally is beneficial to game bird and animal habitat by providing clearing and increased browse" (USDA Forest Service 1969).

Although it has been well documented by numerous investigators (Clary and Ffolliot 1972, Wallmo et al. 1972, Gates 1968, Pengelly 1963) that understory biomass (deer forage) increases dramatically following removal of the forest canopy, we must follow the successional cycle of forest removal. This has been a significant weakness of most early studies of deer/logging relationships. In many instances, high forage production is short lived (10-20 years) compared to the period of low forage production under second-growth conifer canopies (which may be about 80-90 years on a 100 year rotation). Further, there are situations in northern latitudes or at high elevations where snowfall significantly reduces the availability and hence the benefits of increased forage production (Jones 1975, Pengelly 1963).

On the basis of the results presented here, tentative models of summer and winter deer use of regrowth following clearcutting are presented in Figs. 6 and 7 following Schoen and Wallmo (1978). Note that according to these models the value of early successional clearcuts exists only during the snow free period and is less (as indicated by our data) than the old-growth forest.

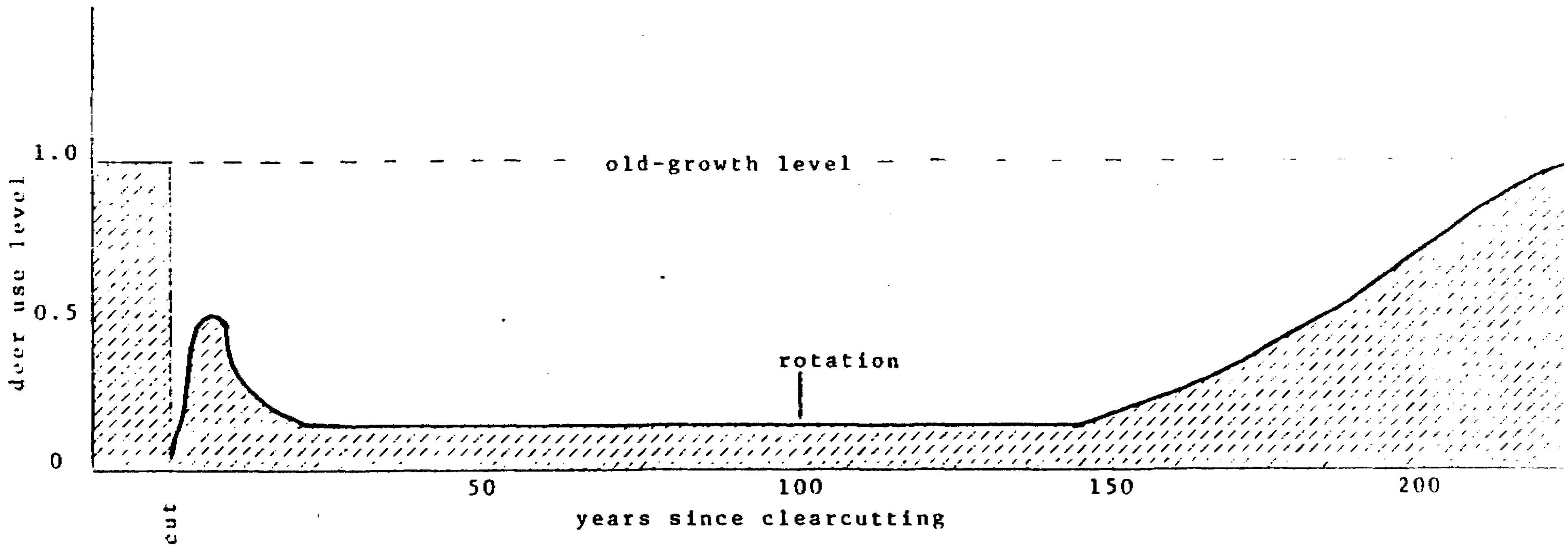


Figure 6. On-site effect of clearcutting on deer use levels during the summer period in Southeast Alaska.

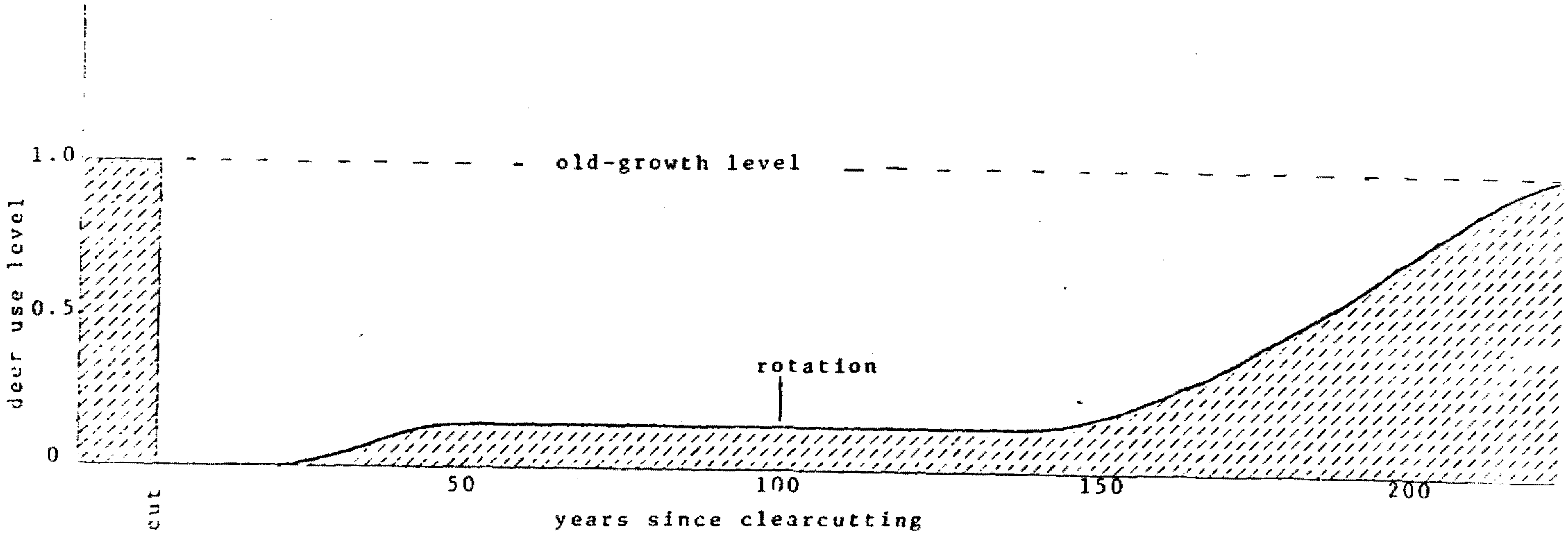


Figure 7. On-site effect of clearcutting on deer use levels during the winter period in Southeast Alaska.

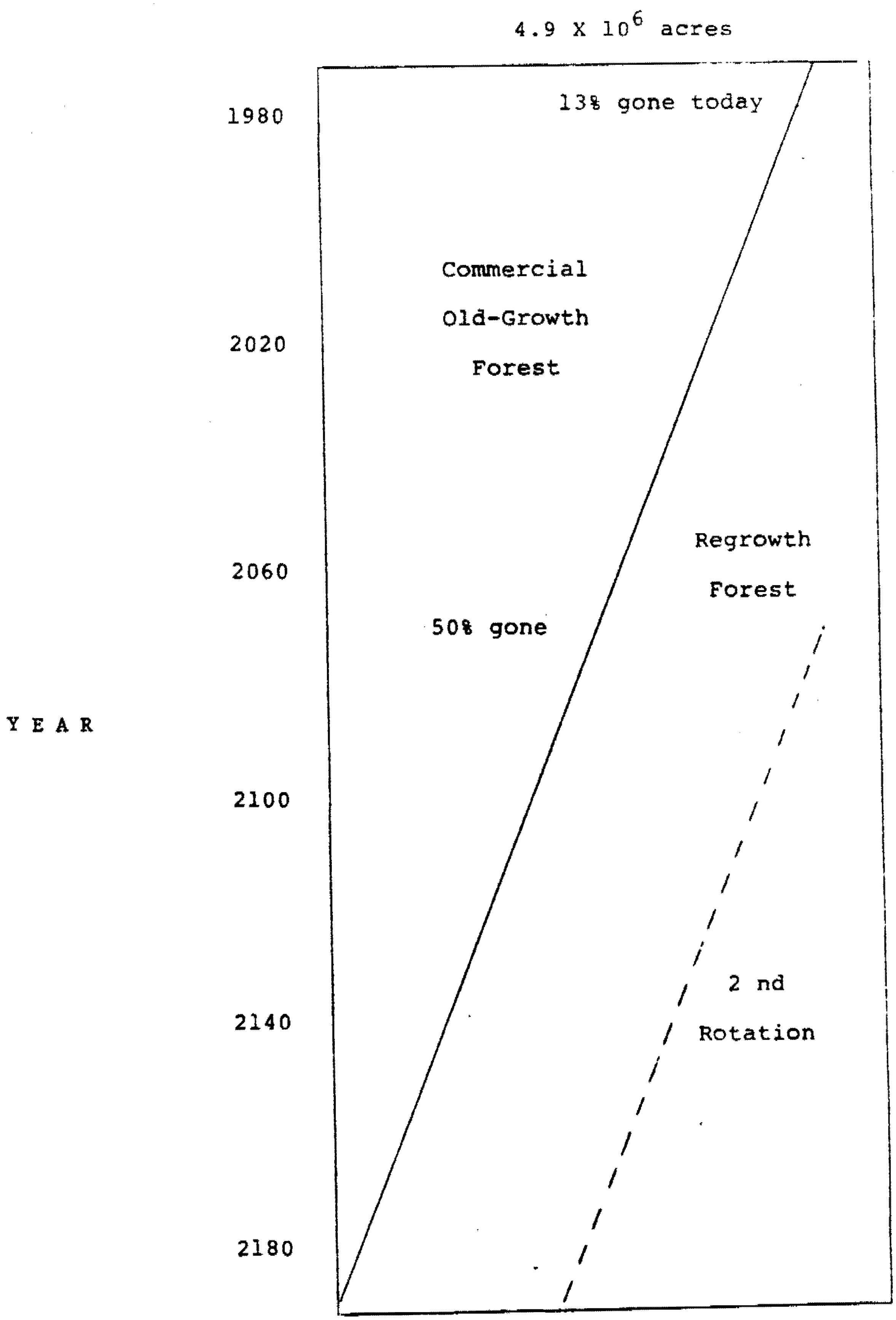


Figure 8. Hypothetical model of the conversion of old-growth to regrowth in the Tongass National Forest.

In short, our data and the work of others (Bloom 1978, Weger 1977, Jones 1975, Leopold and Barrett 1972) strongly suggest that the uneven-aged climax forest (old-growth) is essential winter habitat for black-tailed deer inhabiting the coastal forest of the northern Pacific Coast. This contention was further emphasized at a recent conference on Sitka black-tailed deer held in Juneau on February 22-24, 1978 and co-sponsored by the Alaska Region of the U.S. Forest Service and the Alaska Department of Fish and Game (Wallmo and Schoen, ed. in press).

Given the current rate of harvest and amount of commercial forest land still in old-growth, a hypothetical model (Fig. 8) traces the decline of this old-growth community (optimal deer winter range) from over 1.6 m ha (4 million acres) today to almost none in 200 years (Schoen and Wallmo 1978). This, of course, is only a hypothetical example, but it points out the need for careful planning and quick action if we are to maintain a high level of optimal deer habitat within the Tongass Forest. The situation is further compounded by the fact that the higher volume old-growth stands are being harvested at an accelerated rate. These may in fact be the most important areas to wintering deer during periods of high snow accumulation. Although our data point to the importance of the climax forest, we realize that as a whole it is a highly diverse community and much remains to be learned of the seasonal relationships of black-tailed deer to this unique and, in a practical sense, non-renewable natural resource.

RECOMMENDATIONS

1. If the objective is to maintain Sitka black-tailed deer habitat, substantial amounts of old-growth forest must be maintained indefinitely.

2. It does not appear likely that maintaining small areas immediately adjacent to the beach ("beach fringe") is an adequate measure for preserving deer habitat in Southeast Alaska. Rather it is likely that large blocks of habitat from tidewater to alpine should be maintained. Southern exposures may be of special significance.

3. High volume timber stands may be particularly important during periods of high snow accumulations. Protection of these areas as important winter deer habitat should be given high priority. The rate of harvest of such stands should not exceed their relative availability within the commercial forest land base.

4. Beyond the fact that the climax forest appears to be optimum winter deer habitat, much remains to be learned about the relationships of Sitka black-tails and the diverse ecological community referred to as "old-growth". It is highly recommended that additional studies be undertaken to look more closely at the seasonal habitat use of deer within the climax forest.

ACKNOWLEDGEMENTS

Many individuals were involved in the successful completion of this study. My colleague, Dr. O.C. Wallmo of the Forestry Sciences Laboratory, was of course an equal cooperator in this investigation from its inception, through the field work, and analysis of the data. The opportunity to work with and learn from Charlie was a valuable experience in itself. Without a doubt, our cooperative relationship with the Forestry Sciences Lab has been a great advantage to this investigation and the Department's program in Region I.

Other individuals from the Forestry Sciences Lab who contributed to this study include Al Harris and Bill Farr for their expertise in the field of silviculture and forest ecology in general and Don Schmiege, Director of the Lab, for his overall support of this program.

This project would not have been possible without the enthusiastic and valuable assistance of our field crew: Gordon Fisch, Kathy Hazzard, Geoff Orth, Randy Erb, Dave Beaudin, Ron Bressette, Joe Wallmo, Chuck Munson and Steve Schoen. Several others were also involved for short periods and their help was also appreciated.

Appreciation is also extended to the crews of the Steller and Kittiwake for their assistance and support during our use of their vessels. Thanks too for the flying expertise and local knowledge of Lynn Bennett in our survey of study sites.

Several of our Region I Area Biologists, primarily Harry Merriam, Loyal Johnson and Bob Wood offered valuable advice and criticism. Bob Pegau was primarily responsible for the initiation of this program within the Department and provided valuable leadership and advice in its development. Jack Lentfer and Nate Johnson also provided support, leadership and valuable thinking during the latter stages of the program.

Ivan Frohne and Guy Thornburgh offered assistance and advice in sampling design and statistical analysis. Their help was appreciated. Thanks also to Mickey Lesley for considerable typing of reports and manuscripts.

Appreciation is extended to Don McKnight and Laurie Wojeck for their editorial review. Thanks also to McKnight for his interest and support of this project.

LITERATURE CITED

Alaska Department of Fish and Game. 1974. Annual Report of Survey Inventory Activities. Vol. 4, Part 1, Job 2. Juneau.

Alaska Department of Fish and Game. 1975. Annual Report of Survey Inventory Activities. Vol. 5, Part 1, Job 2. Juneau.

Alaska Department of Fish and Game. 1976. Annual Report of Survey Inventory Activities. Vol. 6, Part k, Job 2. Juneau.

Billings, R. and N. Wheeler. 1978. The influence of timber harvest on yield and protein content of *Vaccinium* browse on three dominant soil types in Southeast Alaska. in Wallmo and Schoen ed., Proc. Sitka Black-tailed Deer Conference. U.S.D.A. Forest Service-Alaska Region. Juneau. In press.

Bloom, A. 1978. Sitka black-tailed deer winter range in the Kadashan Bay area, Southeast Alaska. J. Wildl. Manage. 42(1):108-112.

Brown, E. 1961. The black-tailed deer of western Washington. Wash. Dept. Game Bull. 13. 124 p.

Cowan, I. McT. 1956. Life and times of the Coast black-tailed deer. pp. 523-617. in W.P. Taylor, ed. Deer of North America. Stackpole Co., Harrisburg, Pa. 668 p.

Ffolliott, P.F. and W.P. Clary. 1972. A selected and annotated bibliography of understory-overstory vegetation relationships. Univ. Ariz., Agr. Exp. Sta. Tech. Bull. 198. 33 p.

Fisch, G. 1978. Deer pellet deterioration. in Wallmo and Schoen ed., Proc. Sitka Black-tailed Deer Conference. U.S.D.A., Forest Service-Alaska Region. Juneau. In press.

Gates, B. 1968. Deer food production in certain seral stages of the coast forest. M.Sc. Thesis, Univ. of B.C., Vancouver, 105 p.

Harris, A.S. and W.A. Farr. 1974. The forest ecosystem of Southeast Alaska. 7. Forest ecology and timber management. U.S.D.A. Forest Serv. Gen. Tech. Rep. PNW-25. 109 p.

__________. 1978. Timber management and deer forage in Southeast Alaska. in Wallmo and Schoen ed., Proc. Sitka Black-tailed Deer Conference. U.S.D.A. Forest Service-Alaska Region. Juneau. In press.

Hosley, N.W. 1967. Analysis of forest-wildlife relationships in the Tongass National Forest, Alaska. So. Ill. Univ. and USDA Forest Serv., Inst. Nor. Forestry. 111 p., proc.

Hutchison, I. 1967. Alaska's forest resource. U.S.D.A. Forest Service, Institute of Northern Forestry, Res. Bull. PNW-19. 74 p.

Jones, G.W. 1974. Influence of forest development on black-tailed deer range on Vancouver Island. In Symp. on Wildl. and Forest Manage. in the Pacific Northwest (Corvallis, OR, Sept. 11-12, 1973) Proc.: 139-148.

_________. 1975. Aspects of the winter ecology of black-tailed deer on northern Vancouver Island. MS Thesis, Univ. Brit. Col. 80 p.

Klein, D.R. 1964. Range-related differences in growth of deer reflected in skeletal ratios. J. Wildl. Manage. 32:350-367.

_________. 1965. Ecology of deer range in Alaska. Ecol. Monogr. 35:259-284.

_________ and S.T. Olson. 1960. Natural mortality patterns of deer in Southeastern Alaska. J. Wildl. Manage. 24:80-88.

Leopold, A. 1950. Deer and plant succession. J. Forestry 48(10): 675-678.

_________ and R. Barrett. 1972. Implications for wildlife of the 1968 Juneau Unit timber sale. School of Forestry and Conservation, Univ. of Calif. Berkeley. 49+63 p.

Meehand, W. 1974. The forest ecosystems of Southeast Alaska. No. 4, Wildlife habitats. U.S.D.A. For. Serv. Gen. Tech. Rep. PNW-16, 32 p.

Merriam, H.R. 1963. Sitka black-tailed deer investigations: Natural mortality surveys, Southeast Alaska. p. 20-23 In Alaska Dept. Fish and Game, Fed. Aid Proj. Project Rep. Vol. III, W-6-R-3, Work Plan A. 71 p. Juneau.

_________. 1966. Deer Report. Alaska Dept. Fish and Game, Fed. Aid Project Rep. W-6-R-6 and W-15-R-1. 25 p. Juneau.

_________. 1968. Deer Report. Alaska Dept. Fish and Game, Fed. Aid Project Rep. W-15-R-2 and 3, Work Plan J. 30 p. Juneau.

_________. 1970. Deer fluctuations in Alaska. Paper presented at N.W. Sectional. The Wildlife Society, March 13, Spokane, Wash. On file, A.D.F.&G. Juneau.

_________. 1971 Deer Report. Alaska Dept. Fish and GAme, Fed. Aid Project Rep. Vol. X, W-17-1, Work Plan J, Jobs 1,2,3,4. 21 p. Juneau.

_________. 1973. Deer Habitat Studies. Alaska Dept. Fish and Game. Fed. Aid Project Rep. Proj. W-17-3,4,5. 7 p. Juneau.

Neff, D. 1968. The pellet group count technique for big game trend, census and distribution: a review. J. Wildl. Manage. 32:597-614.

Nelson, U. 1960. The forest-wildlife resources of Alaska. J. Forestry 58 (b) 461-464.

Olson, S. 1952. Black-tailed deer studies. Alaska Fed. Aid Project Rep. W-3-R-7. 9 p. Juneau.

Pengelly, W. 1963. Timberlands and deer in the northern Rockies. J. Forestry 61(10):734-740.

Robuck, W. 1975. Understory vegetation in thinned and unthinned hemlock-spruce stands in Alaska. Prog. Rep. on Coop. Admin. Study FS-PNW-1652:5-8, Pac. N.W. For. and Range Exp. Stn., Forestry Sciences Lab., Juneau. 23 p.

Schoen, J. and O. Wallmo. 1978, Timber management and deer in Southeast Alaska: current problems and research direction. in Wallmo and Schoen ed., Proc. Sitka Black-tailed Deer Conference. U.S.D.A. Forest Service-Alaska Region. Juneau. In press.

Sokal, R. and E.J. Rohlf. 1973. Introduction to biostatistics. W.H. Freeman & Co. SanFrancisco. 368 pp.

U.S.D.A. Forest Service. 1969. Tongass timber management. Alaska Region. Juneau. 12 p.

_______. 1977. Southeast Alaska Area Guide. Alaska Region. Juneau. 280 p.

_______. 1978. Tongass land management plan-landtype/timber task force working report. Alaska Region. Juneau. 43 p.

Weger, E. 1977. Evaluation of winter use of second-growth stands by black-tailed deer. B.S. Thesis. Univ. of B.C., Vancouver. 42 p.

Wallmo, O.C., W. Regelin and D. Reichert. 1972. Forage use by mule deer relative to logging in Colorado. J. Wildl. Manage. 36:1025-1033.

__________ and J. Schoen Ed., 1978. Proc. Sitka Black-tailed Deer Conference. U.S.D.A. Forest Service-Alaska Region. Juneau. In press.

PREPARED BY:

John Schoen
Game Biologist

APPROVED BY:

Acting Director, Division of Game

SUBMITTED BY:

Nate Johnson
Regional Management/Research Coordinator

Research Chief, Division of Game