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BIRD DIVERSITY AND FOREST SUCCESSION IN THE SUBALPINE ZONE OF KOOTENAY NATIONAL PARK, B.C.

MASTER OF SCIENCE
THESIS RESEARCH

PROGRESS REPORT

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1.0 INTRODUCTION

The purpose of my research is to quantify relationships between avian communities and forest succession in the subalpine zone of Kootenay National Park.

My objectives are to:

1) Determine patterns of bird species diversity in Kootenay National Park.

2) Test hypotheses concerning factors which may contribute to this bird species diversity:
   a) successional stage
   b) habitat structure
   c) effect of ecotones
   d) size of successional habitat patch
   e) location of successional habitat patch

3) Provide recommendations for management of the avifauna of Kootenay National Park.

Field data collection for the study is now complete. I focused on objectives 2a, 2b, and 2c for the 1989 and 1990 summer field seasons. Due to a low patch diversity in the subalpine zone of Kootenay National Park, data was not collected to test objectives 2d and 2e. Objective 1 will be met through analysis of the bird data from the "Ecological Land Classification (ELC) of Kootenay National Park", obtained from the Canadian Parks Service. Objective 3 will be addressed once data analysis is complete.

2.0 HYPOTHESES

H1: Each successional stage will support a unique complement of bird species.

H2: There will be a positive relationship between bird species diversity (BSD) and foliage height diversity (FHD).

H3: The presence of cavity nesting birds will be positively correlated to the presence of snags and stumps.

H4: Bird species diversity at the edge between two successional habitat patches will be greater than the bird species diversity found in homogeneous patches of each successional stage.

H5: The increase in bird species diversity at the ecotone between two different successional habitat patches will become smaller as the contrast between the two successional habitat patches is reduced.

3.0 METHODS

3.1 Choice of Successional Habitat Patches for Censuses

Before going into the field potential successional habitat patches were located on a 1:50,000 fire history map of Kootenay National Park, produced by the Canadian Parks Service regional forester. Potential areas were then previewed in the field. Three of the census areas chosen were within Kootenay National Park, one was located on the Banff National Park side of the Vermilion Pass while the last was located just outside the western boundary of Kootenay National Park. The five successional stages identified are as follows:

1) Recent Clear-Cut (CC) (1 to 3 years old)
   * Because there have not been any recent large fires in the subalpine zone of KNP, clear cut patches outside the park boundary were used to represent an early successional stage.

2) Pole-Sapling (PS) (21 years old)
   * The Vermilion Pass Burn at the north end of KNP was used for the pole-sapling stage.

3) 65 Year Old Lodgepole Pine (LP)
   * Because no homogeneous stands of "middle-aged" lodgepole pine could be found in the subalpine of KNP an extensive area on the Banff side of the Vermilion Pass was used.

4) 164 Year Old Mixed Spruce-Pine-Fir
   * This is a common forest age in the Vermilion Valley. The area between the Paint Pots and Marble Canyon, on the west side of Highway 93, was censused. In addition five plots on the lower slopes of Vermilion Peak, on the east side of the highway, were censused in 1990.

5) 243 Year Old Spruce-Fir
   * A large stand of 240+ spruce-fir adjacent to the Vermilion Pass Burn just north of Marble Canyon was censused. Five additional plots were censused in the Ochre Creek drainage in 1990.

All five stands are at similar elevations (between 1600 and 1880 meters). All stands are in the lower subalpine zone being composed of regenerating shrubs and seedlings, lodgepole pine, Engelmann spruce, subalpine-fir or a mixture of these although

the lowest clear-cut had some Douglas fir present.

3.2 Bird Censuses

A total of 421 circular breeding bird census plots, 211 in 1989 and 210 in 1990, were completed in the five different successional stages. No plots were censused in clear cuts in 1990. This method, where circular plots surveyed from single points are used, is based on a modification of the variable circular-plot technique described by Reynolds, Scott and Nussbaum (1980). Within each successional stage sampling transects were located on aerial photographs and previewed in the field. Points were sampled along the transects at sites 200m apart from about 1/2 hour before sunrise until 10:00 am. In 1989, nine plots were set up in the clear cut areas, and ten plots in each of the 21, 65, 164 and 243-year-old stands. Additional plots were set up for the 1990 field season in the 21, 65, 164 and 243-year-old stands. Each plot had a radius of 100 meters. At each sample plot I remained stationary for one minute before beginning to record bird activity. All birds seen or heard were recorded on a field sheet. Each record was noted as being visual (V), song (S), call (C), or an overflight (F). The distance to each bird, at the location it was first seen or heard, was estimated and plotted on the field sheet. Each successional stage was censused 4 times in both 1989 and 1990 except the clear cut areas which were censused only in 1989. All censuses were carried out between June 1 and June 30 in both years.

3.3 Vegetation Analysis

In order to determine relationships between bird species diversity and forest structure a total of 329 vegetation plots were sampled over the two field seasons. Within each bird plot four vegetation plots were set up at fifty meter intervals along the bird transects (the bird circles were located every 200 meters along a transect). Plots were four meters in radius about

a central point. At each plot location, canopy cover was estimated to the nearest percent for each layer. Five layers were recognized:

1)	Herb-creeping plant layer	-- 0.0	-- 0.5	meters
2)	Low shrub	-- 0.5	-- 1.0	meters
3)	High shrub	-- 1.0	-- 10.0	meters
4)	Main canopy	-- 10.0	-- 20.0	meters
5)	High canopy	-- >20.0	meters	

Using the 1989 data, mean foliage height diversity values for each plot have been calculated using the Shannon-Weaver diversity index formula. In order to get an estimate of crown volume, the crown depth of one representative tree, of each species present, was measured. Using the crown depth and the percent cover of each species an estimate of crown volume for each species can be determined. At every second plot a snag and stump analysis was done. The following were noted:

1) Species of tree (if possible)
2) Height of tree (using a Sunto clinometer)
3) DBH of tree
4) Decay class of tree (solid, decaying or punky)

In addition, at every second plot, the numbers of i) downed trees and ii) trees with dead tops were noted.
A vegetation description form can be found in Appendix I.

3.4 Ecotone (Edge) Effect

To meet objective 2c, circular breeding bird plots were conducted along a transect perpendicular to the edge between the 21-year-old and 243-year-old successional stages. The censusing points for the edge plots were located so that half of the plot was in the 21-year-old stand and half of the plot was in the 243-year-old stand. Because I was only able to set up two transects I had only two edge plots. The edge plots between the 21-year-old and 243-year-old stands were censused in both 1989 and 1990. In addition, for the 1990 field season, circular breeding bird plots

were conducted along one transect perpendicular to the edge between the 164-year-old and 243-year-old successional stages. In order to compare the edge plot densities (which are only half plots) with the full plots in the homogeneous stands, I doubled the edge plot densities.

3.5 Calculation of Bird Densities

Due to the difference in vegetative structure between forest types (or habitat patches) an effective detection distance must be determined for each species in each forest type. I determined effective detection distances for all birds sighted a minimum of 10 times (in a forest type) during the census period. For those species with less than 10 sightings it is suggested that densities should be calculated using "Effective Detection Distances" of birds with similar vocal capabilities. As yet I have not been able to find a list of birds with similar vocal capabilities.

In some of my analyses I have used "number of birds per plot" as my index of density. Although this index of density does not take into account the differences in detectability between forest types it does indicate trends. I have also calculated densities per square kilometer using i) all birds within the full 100 m radius and ii) all birds within a 50 m radius. Following Franzreb (1976), when calculating densities per square kilometer I used either the sum of all songs, calls and visual sightings of a species or the number of songs times 2 to take into account the mate of the territorial male, whichever was greater.

4.0 INITIAL FINDINGS

4.1 OBJECTIVE 1: Patterns of Bird Species Diversity

To meet objective 1, bird data from the "Ecological Land Classification (ELC) of Kootenay National Park", has been obtained from the Canadian Parks Service. As yet no analysis has been done.

4.2 OBJECTIVE 2a: Diversity in Different Successional Stages

Hypothesis 1:

Each successional stage will support a unique complement of bird species.

Results for Hypothesis 1:

Bird species encountered in each successional stage are listed in Table I. Figures 1 and 2 summarize the initial findings in terms of bird density (Figure 1) and species richness (Figure 2) in the different successional stages for each year. I found significant differences (Anova with Tukey test $P<0.05$) in bird densities between successional stages in 1989 although the differences between the 3-year-old and 65-year-old as well as between the 21-year-old and 65-year-old were not significant. In 1989 there was a trend of increasing bird density with increasing stand age with drops in density in the 65 and 243-year-old stands. The same trends were evident in 1990 but there was an increase rather than an a drop in density between the 164 and 243-year-old stands. The bird density used for comparison is simply the mean number of birds encountered per plot (i.e. the number of birds either seen or heard in a 10 minute census period). I also found significant differences (Anova with Tukey test $p<0.05$) in the number of bird species encountered per plot (i.e an estimate of species richness) between four of the five

successional stages. There was not a significant difference in species richness between the 21-year-old and 65-year-old stands or between the 164-year-old and 243-year-old stand. The same trends were evident in 1990 although there was an increase in numbers of species sighted per plot in all ages censused. So far I have only done analysis on bird density and species richness as described. I will be doing analysis using bird diversity as the dependent variable as well.

Table I: LIST OF BIRD SPECIES ENCOUNTERED

Bird Species	Successional Stage CC	PS	LP	SPF	OG
Townsend's Solitaire	X	X			
Dark-eyed Junco	X	X	X	X	X
Pine Siskin	X	X	X	X	X
Robin	X	X	X	X	X
Common Raven	X	X	X		
Chipping Sparrow	X			X	X
Hermit Thrush		X	X	X	X
Swainson's Thrush		X	X	X	X
Yellow-rumped Warbler		X	X	X	X
Bohemian Waxwing		X	X	X	X
Wilson's Warbler		X	X		X
Mountain Chickadee		X	X	X	X
Clark's Nutcracker		X	X		X
Olive-sided Flycatcher		X			X
Spruce Grouse		X	X	X	X
Goshawk		X			
Dusky Flycatcher		X			
Northern Flicker		X	X	X	X
Red-breasted Nuthatch		X		X	X
Townsend's Warbler			X	X	X
Varied Thrush			X	X	X
Ruby-crowned Kinglet			X	X	X
Brown Creeper			X		
Golden-crowned Kinglet			X	X	X
Boreal Chickadee			X	X	X
White-winged Crossbill			X		X
Gray Jay				X	X
Northern Three Toed Woodpecker				X	X
Hammond's Flycatcher				X	
Evening Grosbeak				X	X
Winter Wren				X	X
Tennessee Warbler				X	
McGillavray's Warbler				X	
Black-capped Chickadee					X
Rufous Hummingbird			X		X
Orange-crowned Warbler					X

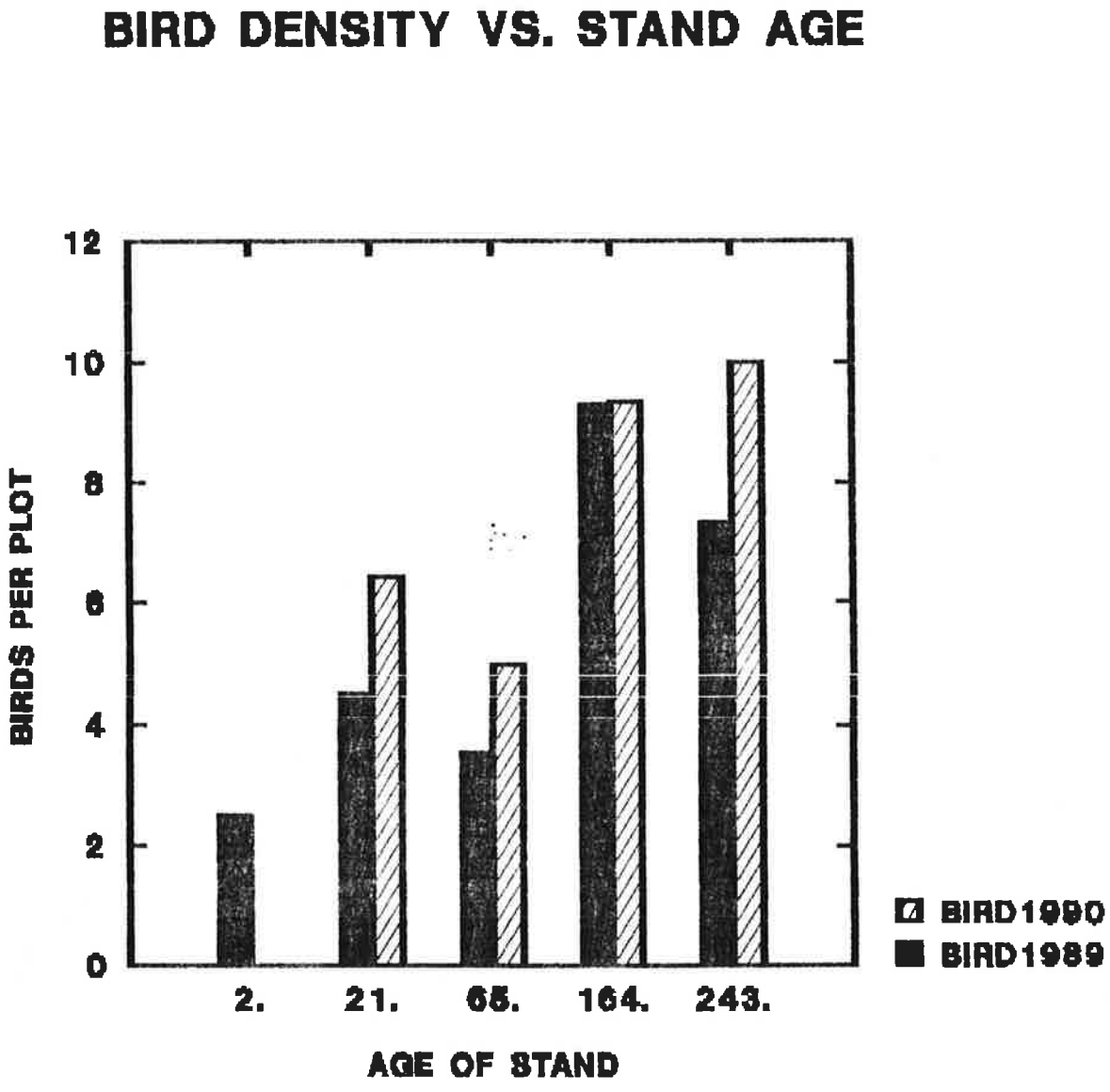

Figure 1. Bird density vs. stand age.

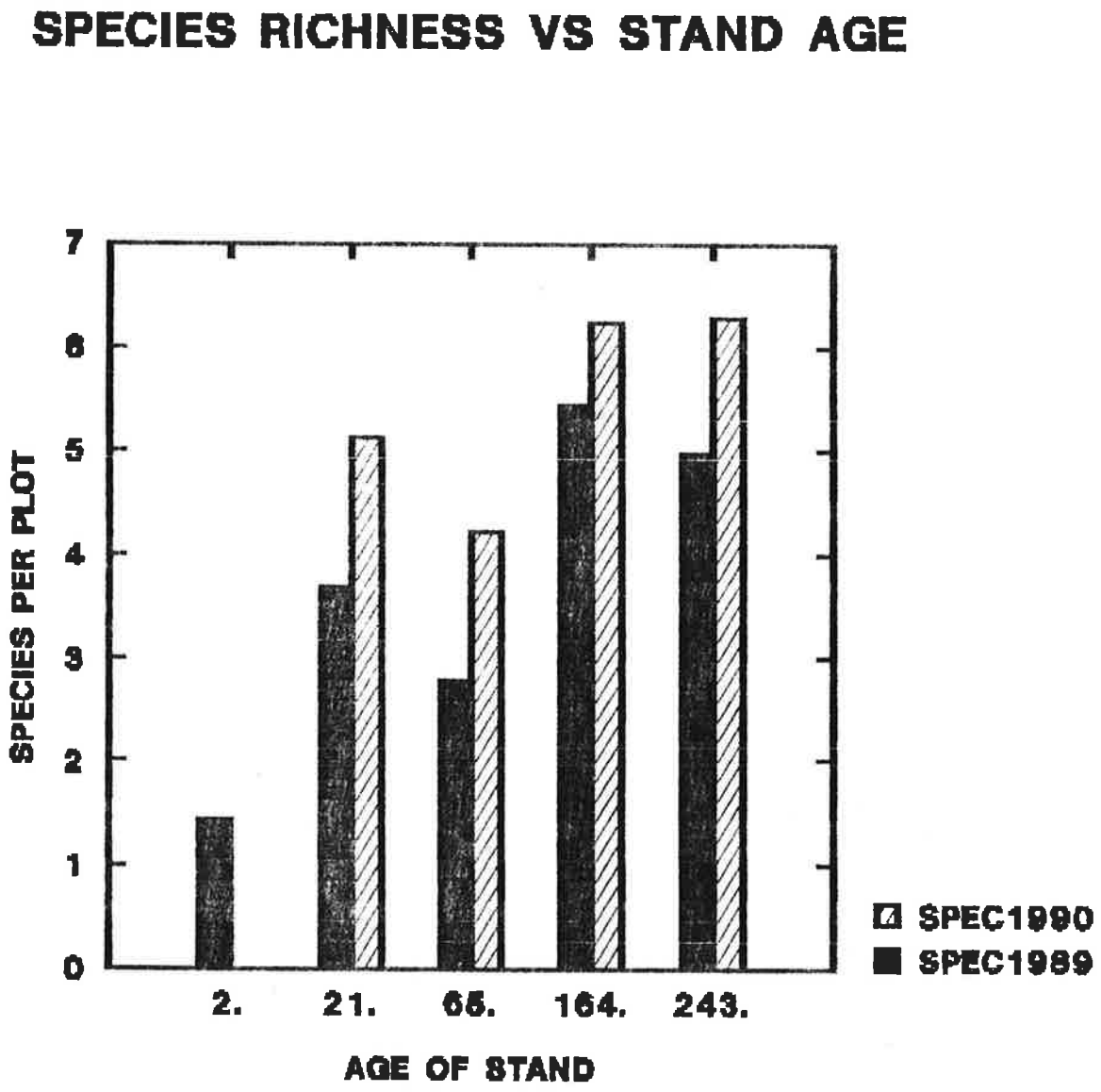

Figure 2. Species richness vs stand age.

4.3 OBJECTIVE 2b: Bird Diversity and Habitat Structure

Hypothesis 2:

> There will be a positive relationship between bird species diversity and foliage height diversity.

Results for Hypothesis 2:

Figure 3 shows the trends of foliage height diversity as a function of stand age. Figure 4 shows the relationship between species richness and foliage height diversity (using the number of species per plot as my index of species richness) based on data collected in 1989. There is a significant (P=0.0001) but not strong (R=0.592 RSQ.=0.350) relationship between species richness and foliage height diversity.

Hypothesis 3:

> The presence of cavity nesting birds will be correlated to the presence of snags and stumps.

Results for Hypothesis 3:

Using data from the 1989 field season the correlation between the density of cavity nesting birds (using the 50 m radius) and the total density of snags and stumps is significant (R=0.440 RSQ=0.350 P=0.017)

FOLIAGE HEIGHT DIVERSITY VS STAND AGE

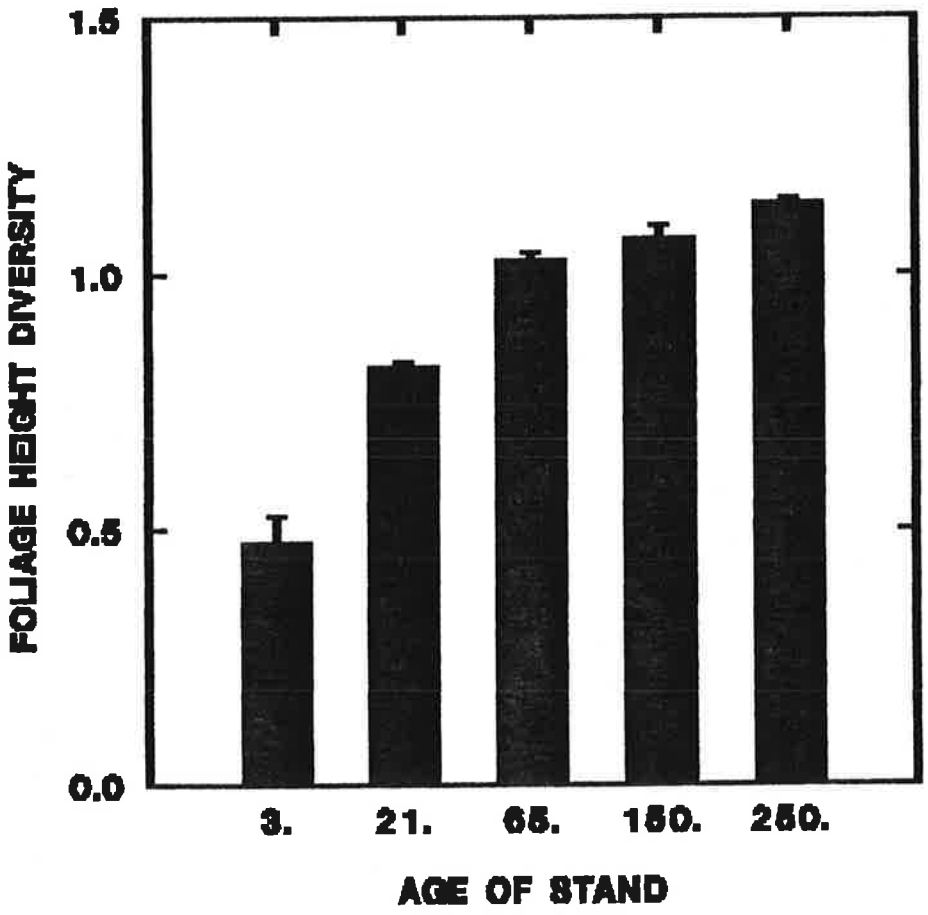

Figure 3. Foliage height diversity vs. stand age.

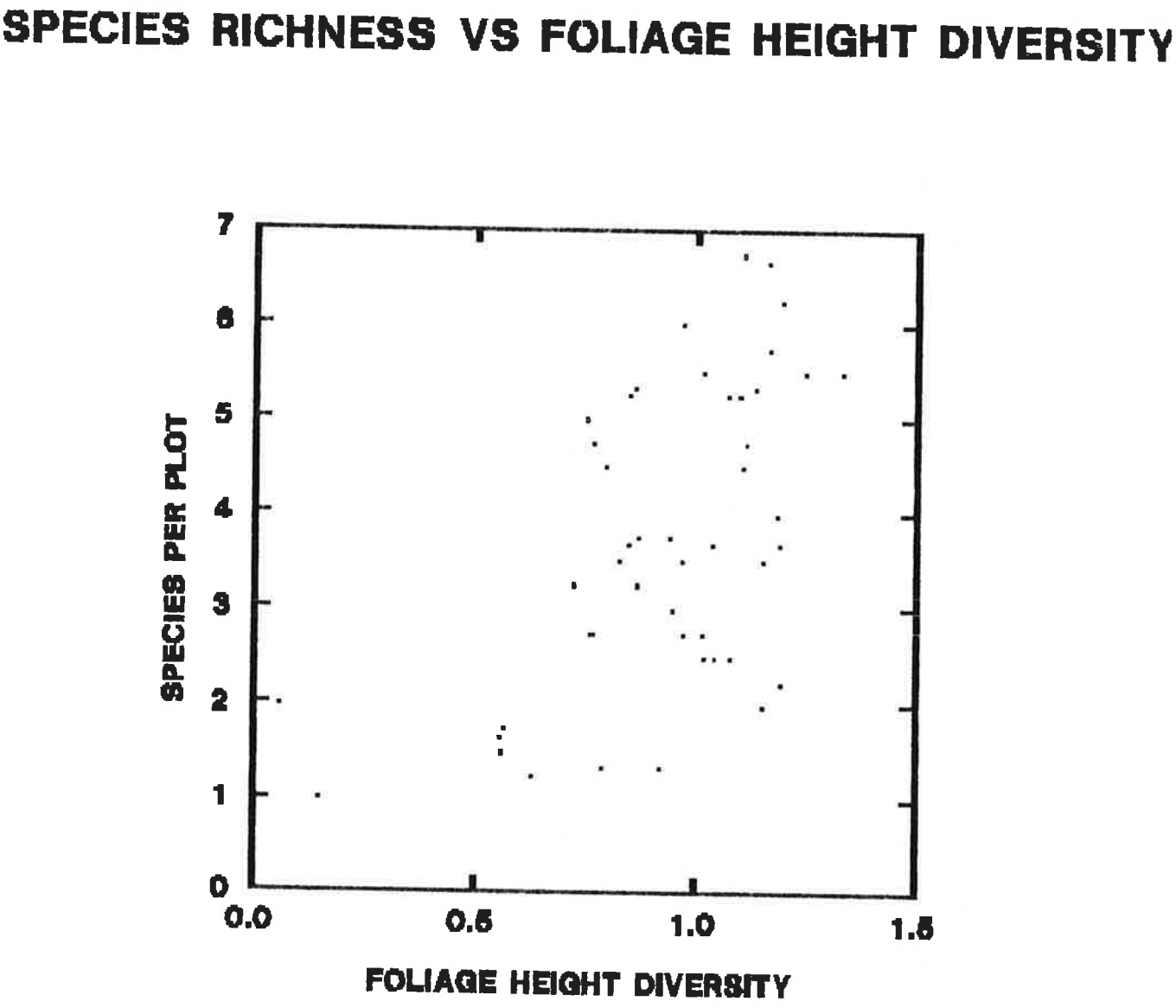

Figure 4. Species richness vs. foliage height diversity.

4.4 OBJECTIVE 2c: The Edge Effect

Hypothesis 4:

> Bird species diversity at the edge between two successional habitat patches will be greater than the bird species diversity found in homogeneous patches of each successional stage.

Results for Hypothesis 4:

Figure 5 summarizes the initial findings. I found significant differences (Anova with Tukey test $P<0.05$) in bird density (using the number of birds per plot as my estimate of density) between the old growth edge plots and all plots found in homogeneous old growth forest but I did not find a significant difference in density between the pole sapling edge plots and all plots found in homogeneous pole-sapling stands. Due to time limitations and other factors, transects between other combinations of edge (i.e. 3-year-old and 65-year-old or 150-year-old and 250-year-old etc.) were not set up or censused during the 1989 field season.

Hypothesis 5:

> The increase in bird species diversity at the ecotone between two different successional habitat patches will become smaller as the contrast between the two successional habitat patches is reduced.

Results for Hypothesis 5:

Data collected to test this hypothesis have not yet been analyzed but will be analyzed in the fall of 1990.

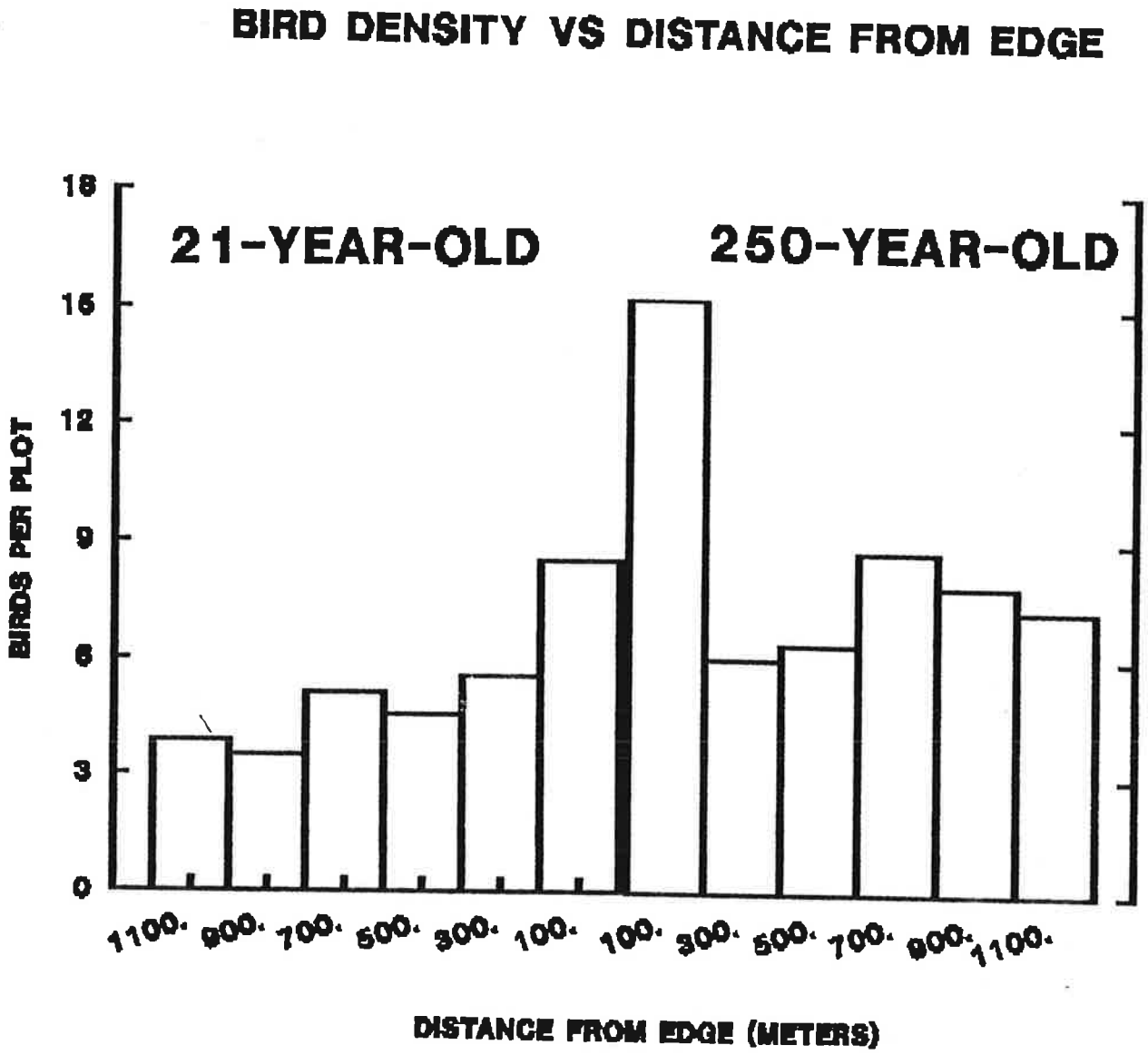

Figure 5. Bird density vs distance from edge.

5.0 WORK SCHEDULE

To date all field data collection, course work and analysis has been on schedule as presented in my research proposal. The work schedule remains as follows:

TERM	
Sept. 88 - Dec. 88	- attend courses at SFU
Jan. 89 - April 89	- attend courses, do literature review and write research proposal
May 89 - August 89	- collect data in the field
Sept. 89 - Dec. 89	- analyze data
Jan. 90 - April 90	- analyze data and attend courses
May 90 - August 90	- collect data in field
Sept. 90 - Dec. 90	- analyze data and write thesis

IMPORTANT DATA
IF FOUND PLEASE
RETURN TO:
D. CATT
KOOTENAY NAT. PARK
BOX 220 RADIUM B.C.
V0A 1M0

APPENDIX I

VEGETATION DESCRIPTION FORM DATE: ___ ___ ___ (D) (M) (Y)

SITE: _____ ECOSITE: _____
PLOT: _____ VEG'N TYPE: _____
SUBPLOT: _____
UTM: __ _____ _____ ASPECT(N,S,E,W): ___

1) FOLIAGE COVER INFORMATION

MAIN CANOPY HEIGHT ____m

LAYER		%COVER	SPECIES COMPOSITION
HERB-CREEP	(0-.5m)	_____	_____
LOW SHRUB	(.5-1m)	_____	_____
HIGH SHRUB	(1-10m)	_____	_____
MAIN CANOPY	(10-20m)	_____	
HIGH CANOPY	(>20m)	_____	_____ ___%LP ___%SF ___%SP

2) SNAGS AND STUMPS (>10cm)

SPECIES	HEIGHT(m)	DBH(cm)	DECAY CLASS
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Solid-Bark On
Decay-Bark Off
Punky-Soft

SNAGS	_____	1 0
		2 low
DOWNED TREES	_____	3 med
		4 high
DEAD TOPS	_____	5 v. high

TOTAL SNAGS _____
TOTAL STUMPS _____

3) CROWN DEPTH (ONE REPRESENTATIVE TREE)

SPECIES	TREE HEIGHT	CROWN HEIGHT
_____	_____m	_____m
_____	_____m	_____m
_____	_____m	_____m

COMMENTS:
_____
_____
_____