FINAL REPORT

SKAGIT RIVER
RARE BIOLOGICAL ELEMENTS STUDY:

PART 1 - PACIFIC RHODODENDRON COMMUNITIES
PART 2 - SMALL MAMMALS
PART 3 - BATS

Andrew P. Harcombe
Project Manager
Conservation Data Centre

Victoria, B.C.
1994

This project was funded by the
Skagit Environmental Endowment Commission
Grant Number: 93-06

38.

SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION

PROJECT COMPLETION FORM

#922 Seattle City Light Building
1015 Third Ave.
Seattle, Washington
98104
(206) 625-3705

9850 South McGrath Road
P.O. Box 159
Rosedale, B.C.
V0X 1X0
(604) 794-3361

Grant # 93-06

MINISTRY OF ENVIRONMENT
RECEIVED
JUL 12 1994

Project Name Rare Biological Element Study

Grantee B.C. Conservation Data Centre

Address 780 Blanshard St., Victoria, B.C. V8V 1X4

I certify that this project has been completed and funds spent according to the project description and project agreement form dated May 7/93, as amended _____.

Andrew Harcombe — Authorized Signature
July 7, 1994 — Date

Andrew P. Harcombe — Name (typed or printed)
Coordinator — Title
3879798 — Phone

(Grantee: Complete above this line only. A final project status report (Quarterly Report Form) must accompany this form, showing final disposition of all funds.)

****

(SEEC to Complete)	Date	Initials
Final project status report received		
Written report received (if applicable)		
Project Review recommended		
Site Visit (Quality Review attached ___)		
Recommend acceptance of project		

SOURCE OF FUNDS	ORIGINAL BUDGETED AMOUNTS	FINAL APPROVED BUDGET	SPENT BY GRANTEE	UNSPENT FUNDS (OR RETURNED)
SEEC Grant				
Grantee				
Other				
Total				

This project is accepted as complete and the grant closed subject to any audit findings.

For the Commission — Date

SEEC\COMPLET2.FRM 2-3-97

SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION

QUARTERLY REPORT FORM

Seattle City Light Building
1015 Third Ave.
Seattle, Washington
98104
(206) 386-4569

4th Floor
810 Blanshard Street
Victoria, B.C.
V8V 1X5
(604) 356-6124

Grant # 93-06

Quarter: 1 2 3 (4) 1994 (F)

MINISTRY OF ENVIRONMENT
RECEIVED
JUL 12 1994

Project Name Rare Biological Element Study

Grantee B.C. Conservation Data Centre

Contact Person Andrew Harcombe **Phone** (604) 387-9798

STATUS OF FUNDS

SOURCE OF FUNDS	BUDGETED AMOUNTS	AMOUNT REIMBURSED BY SEEC	OBLIGATED OR SPENT BY GRANTEE*	BALANCE OF FUNDS AVAILABLE
SEEC Grant	$46,000.00	$42,192.00 (invoiced)		$3,808.00
Grantee	$10,000.00**		#15,000.00	n/a
Other				
Total Budget	$56,000.00		#15,000.00	$3,808.00

* but not reimbursed by SEEC

STATUS OF WORK

100 % Complete **Date Work Started** 28 - 06 - 93

Estimated Completion Date: Original 31 - 12 - 93 **Revised** 31 - 03 - 94

Description:
Include status of major work items. Explain any financial, scheduling or proposed scope changes. Note invoices submitted or grant amendments requested during the quarter.

The three componenets to the project - bats, small mammals, and rhododendion communitities have been completed. Final reports for the three studies are attached.

** Completing the plant community report involved much more staff time than originally predicted.

Submitted by Andrew Harcombe **Date** May 31/94
Project Manager

SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION

QUARTERLY REPORT FORM

Seattle City Light Building
1015 Third Ave.
Seattle, Washington
98104
(206) 386-4569

4th Floor
810 Blanshard Street
Victoria, B.C.
V8V 1X5
(604) 356-6124

Grant # 94-02

Quarter: (1) 2 3 4 19 94 F

June '94

Project Name Skagit Char Project

Grantee J.D. McPhail

Contact Person J.D. McPHAIL Phone 822-3326

STATUS OF FUNDS

SOURCE OF FUNDS	BUDGETED AMOUNTS	AMOUNT REIMBURSED BY SEEC	OBLIGATED OR SPENT BY GRANTEE*	BALANCE OF FUNDS AVAILABLE
SEEC Grant				
Grantee				
Other				
Total Budget	35,000		$9,274.12	$25,725.88

* but not reimbursed by SEEC

STATUS OF WORK

25 % Complete Date Work Started Ap - 1 - 94

Estimated Completion Date: Original Mar - 31 - 95 Revised ___ - ___ - ___

Description:
Include status of major work items. Explain any financial, scheduling or proposed scope changes. Note invoices submitted or grant amendments requested during the quarter.

Report attached.

J.D. McPhail

Submitted by J.D. McPhail Date July 5, 1994
Project Manager

SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION

QUARTERLY REPORT FORM

Seattle City Light Building
1015 Third Ave.
Seattle, Washington
98104
(206) 386-4569

4th Floor
810 Blanshard Street
Victoria, B.C.
V8V 1X5
(604) 356-6124

Grant # 93-02

Quarter: 1 (2) 3 4 1994

MINISTRY OF ENVIRONMENT
RECEIVED
JUL 11 1994

Project Name SKAGIT BROCHURE

Grantee B C Parks

Contact Person E. B. Kelly Phone 858-7161

STATUS OF FUNDS

SOURCE OF FUNDS	BUDGETED AMOUNTS	AMOUNT REIMBURSED BY SEEC	OBLIGATED OR SPENT BY GRANTEE*	BALANCE OF FUNDS AVAILABLE
SEEC Grant	8000.00	4258.60		3741.40
Grantee	1000.00		1000.00	-
Other				
Total Budget	9000.00	4258.60	1000.00	3741.40

* but not reimbursed by SEEC

STATUS OF WORK

75 % Complete Date Work Started 93 - 06 - 09

Estimated Completion Date: Original 93 - 08 - 16 Revised 95 - 03 - 31

Description:
Include status of major work items. Explain any financial, scheduling or proposed scope changes. Note invoices submitted or grant amendments requested during the quarter.

Brochure to be completed pending change of status from Rrecreation Area to Class 'A' Park.

Submitted by for E.B. Kelly Date 94/07/05
Project Manager

SEEC\PROJ\QUARTRP4.FRM 7-27-92

SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION

QUARTERLY REPORT FORM

Seattle City Light Building
1015 Third Ave.
Seattle, Washington
98104
(206) 386-4569

4th Floor
810 Blanshard Street
Victoria, B.C.
V8V 1X5
(604) 356-6124

Grant # 94-06

Quarter: (1) 2 3 4 19 94 F

B.C. ENVIRONMENT, LANDS AND PARKS
RECEIVED
JUL 11 1994
ASSISTANT DEPUTY MINISTER

Project Name Rhododendron macrophyllum Genetics

Grantee University of Victoria

Contact Person Geraldine A. Allen Phone 721-7110

STATUS OF FUNDS

SOURCE OF FUNDS	BUDGETED AMOUNTS	AMOUNT REIMBURSED BY SEEC	OBLIGATED OR SPENT BY GRANTEE*	BALANCE OF FUNDS AVAILABLE
SEEC Grant	18,000	1,800		16,200
Grantee				
Other				
Total Budget	18,000			16,200

* but not reimbursed by SEEC

STATUS OF WORK

10 % Complete Date Work Started 6 . 15 . 94

Estimated Completion Date: Original 3 . 31 . 95 Revised ___ . ___ . ___

Description:
Include status of major work items. Explain any financial, scheduling or proposed scope changes. Note invoices submitted or grant amendments requested during the quarter.

This work is being carried out as part of the M.Sc. degree requirement of Shana Ford.
Shana has located four Rhododendron stands within the Skagit Valley R.A., and has collected initial site description data as well as leaf samples for analyses. He has also collected samples from two other sites in Manning Provincial Park. Initial lab analyses and sample preparation are now underway.

Submitted by Geraldine A. Allen Date June 30, 1994
Project Manager

SEEC\PROJ\QUARTRP4.FRM 7-27-92

FINAL REPORT

SKAGIT RIVER
RARE BIOLOGICAL ELEMENTS STUDY:

PART 1 - PACIFIC RHODODENDRON COMMUNITIES
PART 2 - SMALL MAMMALS
PART 3 - BATS

Andrew P. Harcombe
Project Manager
Conservation Data Centre

Victoria, B.C.
1994

This project was funded by the
Skagit Environmental Endowment Commission
Grant Number: 93-06

BRITISH COLUMBIA
CONSERVATION DATA CENTRE
780 Blanshard Street, Victoria, B.C., Canada V8V 1X5 Phone: (604)356-0928/29 FAX: 356-9145

General Acknowledgements

The Rare Biological Elements Study was funded by a grant from the Skagit Environmental Endowment Commission. Additional staff time was provided from the Conservation Data Centre (Carmen Cadrin, Syd Cannings, Leah Ramsay, and Andrew Harcombe) and from Laura Friis, Small Mammal Specialist, of the Wildlife Branch of B.C. Environment. Field work was coordinated with B.C. Parks, in part addressing their needs for inventory on the Ecological Reserves, and with Dave Dunbar, Lower Mainland Region, B.C. Environment, who was carrying out other small mammal inventory in the watershed.

The following three parts describe the inventory results for Pacific Rhododendron communities, small mammals, and bats.

Andrew P. Harcombe
May, 1994

DRAFT

THE PACIFIC RHODODENDRON (RHODODENDRON MACROPHYLLUM D. DON ex G. DON) COMMUNITIES OF THE SKAGIT RIVER WATERSHED, BRITISH COLUMBIA

DECEMBER 1993

PREPARED BY: JULIE DESROSIERS
3747 UNION STREET
BURNABY, BRITISH COLUMBIA
V5C 2W2

AND

CARMEN M. CADRIN
CONSERVATION DATA CENTRE
780 BLANSHARD
VICTORIA, BRITISH COLUMBIA
V8V 1X5

FOR: THE SKAGIT ENVIRONMENTAL ENDOWMENT COMMISSION
9850 SOUTH McGRATH ROAD
ROSEDALE, BRITISH COLUMBIA
V0X 1X0

RAFT

ACKNOWLEDGEMENTS

Many people deserve thanks for their help and contributions to this study. I would specifically like to acknowledge Jim Bryce who worked very hard at digging pits and figuring out the soils in less than ideal conditions.

Thanks to Marcus Merkens for sharing his enthusiasm and his canoe. Bob Maxwell's soils training session and verification of some of the soils data was of value. Thanks to Matt Fairbarns for his help with the statistics and for logistic support. Thanks also to the British Columbia Conservation Data Centre for logistical support and to the members of its staff for the much appreciated moral support. Special thanks to George Douglas for his comments on the manuscript. Thanks also to the Wildlife Branch of the Ministry of Environment for providing working space. Financial support for this project was provided by the Skagit Environmental Endowment Commission.

SUMMARY

The report describes the different plant communities of the Skagit Valley which are dominated by or have *Rhododendron macrophyllum* in their shrub layer. Three biogeoclimatic subzones are represented within the Skagit Valley, the Coastal Western Hemlock moist submaritime (CWHms1), the dry submaritime (CWHds) and the Interior Douglas Fir wet warm (IDFww). The community types described here have good correlation to those previously described within the plant association classification for these subzones, with one notable exception: *Rhododendron macrophyllum* is either absent from the previously described units or present in low frequency and cover. It is suggested that the communities described in this report should be considered as the *Rhododendron macrophyllum* subassociation of the more widely distributed and previously documented plant associations. The *Rhododendron macrophyllum - Gaultheria ovatifolia - Cladonia spp.* community is newly described for the area.

Approximately half of the study plots were typical of the *Rhododendron macrophyllum* communities, as described by the *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites* plant association which occurs in both the CWHms1 and CWHds subzones. Most of the other study plots were characteristic of plant associations of the IDFww subzone. These fell into one of three plant associations: *Pseudotsuga menziesii - Paxistime myrsinites - Pleurozium schreberi*; *Pseudotsuga menziesii/Thuja plicata* - Corylus cornuta; and *Pseudotsuga menziesii/Thuja plicata - Acer circinatum.* The remainder of the study plots described the new *Rhododendron macrophyllum - Gaultheria ovatifolia - Cladonia* community type.

DRAFT

TABLE OF CONTENTS

DRAFT

LIST OF TABLES AND ILLUSTRATIONS

TABLES

FIGURES

PLATES

INTRODUCTION

The purpose of this study was to examine the various types of communities within which *Rhododendron macrophyllum* D. Don ex G. Don can be found in the Skagit River Watershed of southwestern British Columbia. No published study prior to the present one has focused directly and solely on gaining a better understanding of the *R. macrophyllum* populations and of their associated communities.

The project was designed to describe and classify the various *Rhododendron macrophyllum* community types of the Skagit Watershed and to correlate them, whenever possible, with the corresponding plant associations of the Biogeoclimatic Ecosystem Classification developed by the B.C. Ministry of Forests.

The specific objectives of this study were to:

1. Review the existing literature pertaining to the plant communities of the Skagit Watershed, especially those with *Rhododendron macrophyllum* as a component of the shrub layer;
2. Carry out field sampling of the communities with *Rhododendron macrophyllum* in the shrub layer;
3. Map out the various plots sampled in the Skagit Watershed in 1993;
4. Classify the *Rhododendron macrophyllum* community types of the Skagit Watershed and correlate them, whenever possible, to the British Columbia Ministry of Forests Biogeoclimatic classification system;
5. Make characterization abstracts for each highly ranked community type listed as an element within the Conservation Data Centre system.

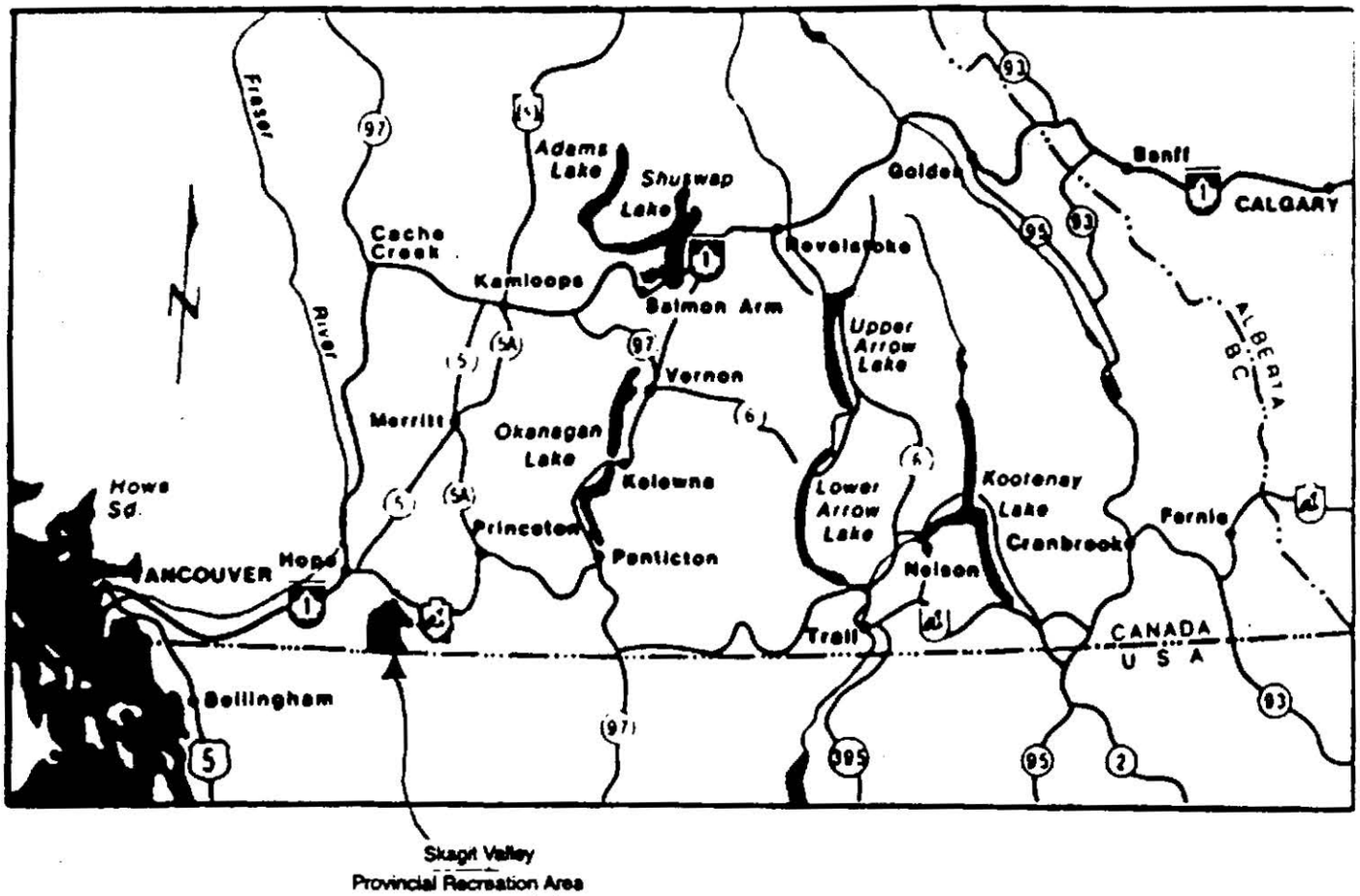
Physical Setting

The Skagit River watershed area (49°N, 121°W) lies within the Cascades Mountains in the Coast Range, just north of the Canada-U.S. international border (Figure 1).

The Skagit River Recreation Area is bordered to the east by Manning Provincial Park and to the west by the Skagit Provincial Forest. Within the Recreation Area, the Skagit valley is enclosed by ranges of the Cascades mountains which rise steeply. The topography is generally rugged, with mostly rounded mountains deeply cut by streams. This area, similarly to Manning Park (Carl *et al.* 1952), was probably glaciated except for a few of the higher and more jagged peaks.

DRAFT

FIGURE 1. The Skagit River Watershed Area



The broader, lower elevations of the Skagit Valley, beginning at 28 Mile Creek, and extending down into Washington State has been mapped as a small pocket of the Interior Douglas-Fir wet warm biogeoclimatic subzone (IDFww) (Ministry of Forests BGC 1987). The Coastal Western Hemlock moist submaritime subzone (CWHms) occurs above the IDFww, except in the southeast corner where it meets a portion of the Engelmann Spruce-Subalpine Fir moist warm (ESSFmw) subzone. Also within the watershed, a few areas in the north west are typical of the Mountain Hemlock (MH) zone, and some of the peaks at sufficiently high elevations to be mapped as the Alpine Tundra (AT) zone.

In the IDF zone, the main factor controlling the climate is the rainshadow of the Cascades mountain range, which constitute a major barrier to the easterly flowing air systems. The IDF climate tends to be continental, with warm dry summers, relatively long growing seasons and short cool winters (Hope *et al.* 1991). In the CWH zone, precipitation has a major influence on the climate, resulting in both cooler summer temperatures and in milder winters (Pojar *et al.* 1991). However, it is likely that in the Skagit area these differences are minimized since both the IDFww and the CWHms subzones occur within the same watershed.

Previous Work on the Community Types of the Skagit Watershed

Presently, little is known on the ecology of *Rhododendron macrophyllum*, one of the rare elements of the flora of British Columbia and Canada. Furthermore, information on the types of communities in which this species occurs is scarce. Prior to 1971, the bulk of the work for the Skagit area consisted of species lists (Carl *et al.* 1952; Underhill 1967). These lists generally described the Manning Provincial Park area, however they included information on the Skagit area.

In the report put out by the International Joint Commission (1971) the plant communities of the Skagit Valley were subdivided into 5 landform-soil units.

A vegetation study of the Lower Skagit Valley in Canada was done by Slaney F.F. and Company Limited (1973). In this study the classification was based on tree, shrub, forb and ground cover types as well as successional stage and specific combinations of ecologically related species. They recognized 15 general plant associations. Though it was noted as being generally associated with Douglas-fir and lodgepole pine, Pacific rhododendron was not described in any of the plant associations, including the "Mature Coniferous Forest" type characterized by the two above-mentioned tree species.

Biophysical wildlife habitat mapping was done for the Skagit River drainage by the Ministry of Environment (Fuhr 1988). Fuhr's study integrated physical and biological elements: he described and mapped areas relatively homogeneous in terms of climatic, physical and vegetational characteristics in relation to their importance to the animals that use them. According to this document, Pacific rhododendron populations were occurring in a total of

three of the community types described in the IDFww and CWHms1 biogeoclimatic subzones. He noted that they were occasionally present in both the 'IDFww Pine-Kinnikinnick' and the 'CWHms1 Clintonia' community types, and also that it was common in the 'CWHms1 Hw Boxwood' community type.

A recent study was put out by the Parks Branch of the B.C. Ministry of Environment (1993) which focussed on the vegetation and wildlife of three of the Ecological Reserves of the Skagit Valley. Pacific rhododendron was reported from one of nine plots in the Skagit Valley River Forest Ecological Reserve. This particular site was classified as being in a zonal IDFww community type (*Pseudotsuga menziesii/Thuja plicata - Corylus cornuta*).

METHODS AND MATERIALS

Field Sampling

Rhododendron macrophyllum surveys were carried out extensively in the Skagit Watershed from 2-27 August 1993; including the Skagit River Recreation Area, an area of about 7400 hectares (19000 acres) (Slaney 1973), and the northwest arm of Manning Provincial Park.

One important aim of the study was to survey as many different types of communities as possible in the time allotted. Using all of the information collected prior to the field period, areas of high concentrations of rhododendron populations were selected for sampling. In total, 46 plots were sampled (Figure 2).

Plots were selected within forest stands containing *Rhododendron macrophyllum* as a component of the understory. Stands were pre-stratified based on previous studies, aerial photos and field reconnaissance. Specific sites were chosen based on the overall homogeneity of the vegetation in the area. Each site was loosely centered on one (or a group of) *Rhododendron macrophyllum* population(s). An area equivalent to 0.04 hectares (20 X 20 m) was delineated around the population(s) using tape measures.

Field methods followed those outlined by the B.C. Ministry of Environment, Lands and Parks and the Ministry of Forests in Describing Ecosystems in the Field (Ministries of Environment and Forests 1990). For each of the 46 plots a vegetation description form, a soil description form and finally a general site description form were filled out.

Vegetation

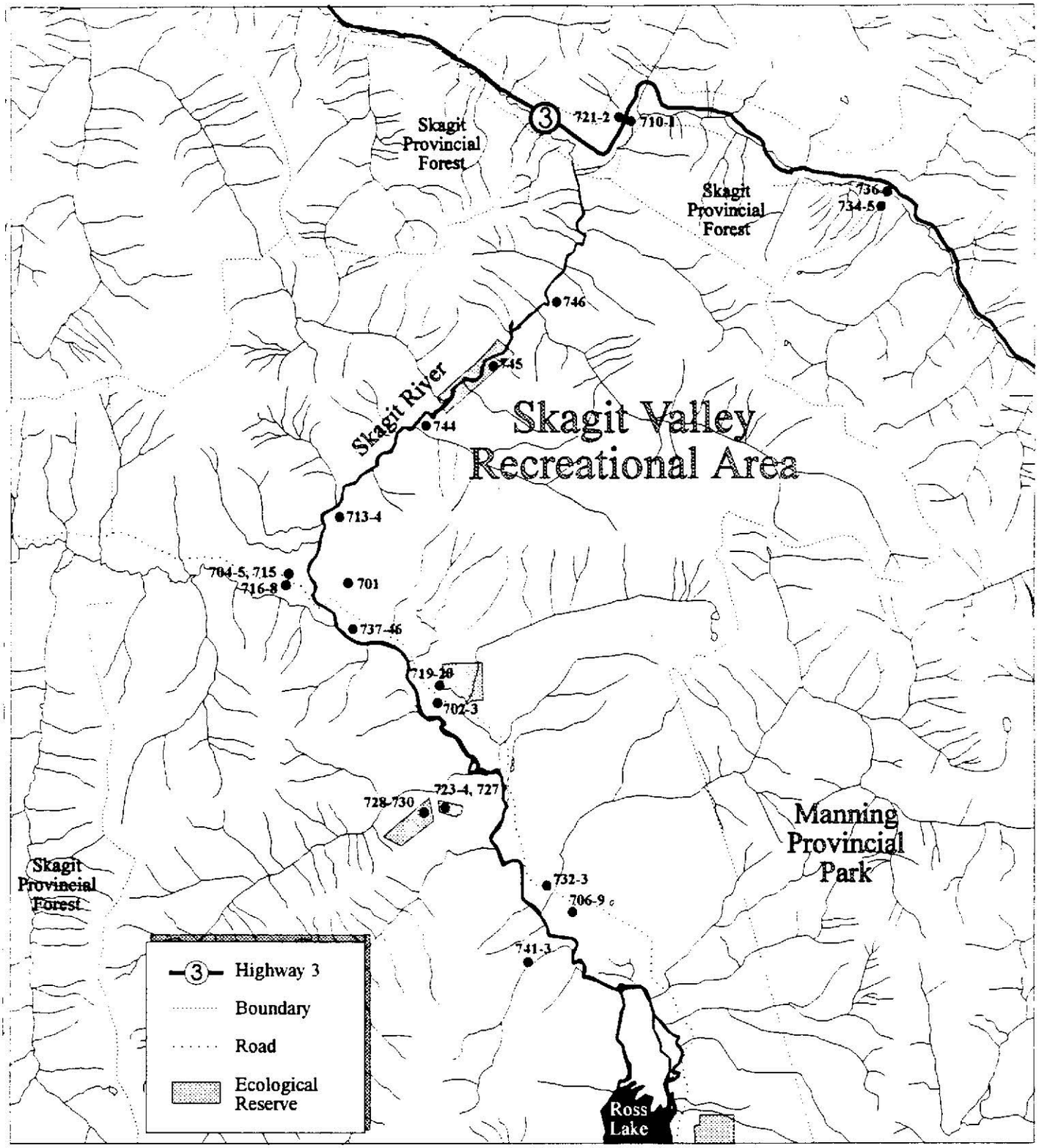
For each plot a species list was drawn up and the percent cover for all species, within each of eight assigned strata, was visually estimated. In most cases, representatives of the dominant and main canopy trees were cored with a tree borer and the number of rings were estimated on site. The diameter at breast height (1.4 m) was measured with a DBH tape on all cored trees (except for those in plots 93702 and 93703). Some general observations were made on the rhododendron populations themselves and occasionally comments on unusual aspects of the stand were added to the form. Nomenclature follows Hitchcock and Cronquist (1973).

Soils

A soil pit was dug within each plot. Soil pit locations were selected to represent the entire site. The pits were 60 X 60 cm with depth depending on site characteristics (Bryce 1993). The

Figure 2.

DRAFT



minimum amount of soil profile data included: horizon designation and thickness, depth, percentage (by volume) of coarse fragments, soil texture, colour, parent material and humus form. Soil texture was determined by hand texturing, colour was obtained using a Munsell colour chart, depth measurements were made with a ruler and the remaining characteristics were estimated visually. The soils were classified to Subgroup level following the Canadian System of Soil Classification (1987). In addition, general comments may have been added to the forms.

Site

At each plot short descriptions were made of the physical location and of the stand itself. Easting and nothing coordinates were estimated. Stands were characterized for aspect, slope, elevation, as well as site position, surface shape and microtopography. Biogeoclimatic zone, successional stage, expected climax and rate of succession were also determined.

The information gathered for the soil description led to the determination of soil type, terrain, soil drainage, perviousness, free water, flood hazard, various edaphic depths (water table, rooting effective, root restricting layers) and surface substrate characteristics were evaluated. Both the soil and vegetation data were considered in order to determine ecological moisture regime, nutrient regime and humus form class.

Moisture and nutrient regime determinations helped in the initial classification of biogeoclimatic site series (Green *et al.* 1993) for each plot. Floristic and environmental data were required in order to make final determinations.

Data Analysis

All of the relevant plot data was entered on the Ministry of Forest's PC-VTAB program (Kayahara 1992) and double-checked for errors. The Twinspan program for multivariate data (Hill 1979a) and the Decorana program for detrended correspondence analysis (Hill 1979b) were used to assist in subdividing plots into categories, in revealing possible outliers and in assessing similarities and dissimilarities of plant community types based on vegetation cover. Finally, the resulting information was evaluated and correlated to environmental data by visual inspection prior to the formulation of the final plant community types.

Four plots were discarded following the initial analysis. Plot 93712 was removed because of the young age of the stand and the resulting array of plant species and cover. Plots 93725, 93726 and 93731 were also discarded since they had been sampled because they were in an area for which very little data had been collected previously, rather than because of the presence of *Rhododendron macrophyllum*. The following results therefore pertain to the 42 remaining plots.

RESULTS

Rhododendron macrophyllum populations: General Findings

Overall, the *Rhododendron macrophyllum* communities sampled in 1993 occurred on mostly well-drained coarse-textured (gravelly) dry soils overlain by fibrimors. The sample plots were between 509 and 869 m in elevation. Many sites showed evidence of fire: fire scars were frequently present on the dominant trees and Bryce (1993) often found charcoal layers in the soil profile.

A total of 128 species were recorded for the Skagit Valley *Rhododendron macrophyllum* communities, of which 11 were tree species, 23 were tall and mid-sided shrubs and 51 species were herbs and short perennial shrubs. The remaining 41 species were cryptogams. The rhododendron populations varied considerably in size. Some were contained within one square meter while others were occupying areas greater than 1 hectare.

A number of plant species were common to virtually all plots. The most important plant species invariably associated (presence class V) with the *Rhododendron macrophyllum* included *Pseudostuga menziesii, Tsuga heterophylla* and *Hylocomium splendens* with, on average, 20 - 25% cover each. Species usually present but represented by a moderate amount of coverage were *Thuja plicata* (12%), *Mahonia nervosa* (7%) and *Pleurozium schreberi* (17%). Those species almost always present but with less than 5% coverage were *Paxistima myrsinites, Linnaea borealis, Chimaphila umbellata, Vaccinium membranaceum, Vaccinium parviflorum* and *Pyrola asarifolia.* Other species frequently associated (presence class IV) with the rhododendron communities included *Pinus monticola, Acer circinatum, Rosa gymnocarpa, Goodyera oblongifolia,* and in the cryptogam layer, *Peltigera aphtosa, Rhytidiopsis robusta* and *Rhytidiadelphus triquetrus.*

Classification

Based on the site, soil and floristic information collected in the field, half of the 42 plots fell into the Wet Warm subzone of the Interior Douglas-fir zone (IDFww) and the other half were in the Coastal Western Hemlock zone. Appendix 1 details the presence and vegetation cover of the group of IDF plots vs the group of CWH plots. Appendix 3 contains the environmental data for all plots, broken down by biogeoclimatic zone.

Interior Douglas-fir Zone

In general, the Skagit IDF plots matched the general description

TABLE 1. Site Characteristics Broken Down by Community Type

Plant association	Pseudotsuga -Paxistima- Pleurozium (8)*	Pseudotsuga -Thuja- Corylus (8)	Pseudotsuga -Thuja- Acer (2)	Rhododendron -Gaultheria- Cladonia (3)	Pseudotsuga - Tsuga - Paxistima (19)	Tsuga - Abies - Hyloc omium (2)
Elevation	514 ** 509-524	540 530-549	656 652-658	551 546-558	627 558-869	555 555
Aspect	flat	flat	east	flat	variable	varia ble
Slope (%)	flat	flat	77 72-87	flat	55 18-140	55 18- 140
Positi on/mes o	LV ***	LV	MD	LV	variable	varia ble
Surfac e shape	straight	straight	mostly straight	mostly straight	variable	varia ble
Soil moistu re	SM-M ***	M	M	SM	SM-M	SM-M
Soil nutrie nt	M ***	M	SM	SM	SM-M	SM-M
Terrai n	FI ***	FI	Mb	FI	FI & Mv	FI & Mv
Coarse fragme nts	40 12-50	23 0-55	40 30-60	47 42-50	38 0-70	38 0-70
Soil type	O.HFP***	O.HFP	O.DYB	O.DYB	16 O.HFP 5 O.DYB	16 O.HFP 5 O.DYB
Rootin g depth	27 20-35	32 20-40	40 40	not av- ailable	26 12-70	26 12-70
Draina ge	W ***	MW	W	not av- ailable	16 W 5 MW	16 W 5 MW
Seral stage	5 OS *** 2 MCC	YCC	MCC	MEC	variable	varia ble
Age of main canopy	102 80-115	89 80-100	103 90-110	110 106-115	116 80-150	116 80- 150

% cover of A layer	52 20-65	62 40-95	63 55-70	12 9-15	67 40-90	67 40-90
% cover of B layer	44 10-70	54 35-65	31 27-38	85 75-90	28 10-80	28 10-80
% cover of C layer	31 20-35	15 5-28	8 3-10	29 15-45	6 1-30	6 1-30
% cover of D layer	42 25-65	47 33-80	67 55-75	15 5-30	45 20-80	45 20-80

* IDF03-7 = 7 plots make up the IDFww/03 group.
** the value on upper line represents a mean, values on lower line represent the range associated with that mean.
*** the symbols follow Meidinger *et al.* (1987).

outlined in Hope *et al.* (1991) for the IDF biogeoclimatic zone in terms of the dominant species, accompanying species and drainage. However, they were slightly different in that they occurred mainly on fluvial deposits rather than on morainal material and the soils tended to be humo-ferric podzols (except for a small cluster of sites on dystric brunisols). These differences may be caused by geomorphological and topographical variations specific to the Skagit area.

In terms of environmental characteristics, the IDF sites could be differentiated from the CWH sites by the following traits: they were generally at lower elevations, almost always on flat terrain with a straight surface shape. They were mainly on old, inactive fluvial deposits on the valley bottom. The age of the main tree canopy was somewhat younger than that of the CWH sites. Vegetation cover in the tree layer (A) was in general less high in the IDF sites. In contrast, vegetation coverage of the tall shrub (B) and herb and low shrub (C) levels was higher in the IDF sites than in the corresponding CWH sites.

Floristically, the IDF sites were dominated by *Pseudotsuga menziesii* (25% cover), with *Thuja plicata* and *Tsuga heterophylla* as companions (13 and 11%, respectively). Other tree species often present in small amounts in the IDF sites included *Pinus contorta, Pinus monticola* and *Abies grandis. Abies lasiocarpa* was the only differential tree species specific to the IDF. This species was frequently present in small amounts.

In the IDF, the common tall shrubs were *Paxistima myrsinites, Vaccinium membranaceum, V. parviflorum, Rosa gymnocarpa* and *Acer circinatum*. The tall shrub species which were found to be specific to the IDF site series included *Spiraea betulifolia, Lonicera ciliosa, Amelanchier alnifolia* and *Salix scouleriana*.

In the herb and short shrub layer, *Chimaphila umbellata, Linnaea borealis, Mahonia nervosa* were virtually always present. Other species frequently encountered were *Cornus canadensis, Goodyera oblongifolia* and *Pyrola asarifolia*. Differential species for the IDF included *Clintonia uniflora, Trientalis latifolia,* and less frequently, *Arctostaphylos uva-ursi* and *Hieracium albiflorum*.

Finally, in the cryptogam layer, the most frequent species included *Pleurozium schreberi* and *Hylocomium splendens* with on average 21% and 18% cover, respectively. Other species usually present in small amounts were *Rhytidiadelphus triquetrus, Rhytidiopsis robusta* and *Peltigera aphtosa*. There were no species distinctly found in the IDF (or the CWH) in this layer.

i) *Pseudotsuga menziesii - Paxistima myrsinites - Pleurozium schreberi* plant association

The seven plots found to be similar to the description for this site

PLATE 1. *Pseudotsuga-Paxistima myrsinites-Pleurozium schreberii* stand

series were located in the dry upper part of the valley, on the flats of the valley floor. These plots were on average drier than the other described IDF sites and they were mid-range in terms of their nutrient regime. The soils were well-drained humo-ferric podzols and the humus form was a fibrimor. These stands were younger on average than in any of the other IDF site series.

Floristically, they differentiated themselves from the other IDF sites in that they tended to have a more developed herb layer and a less developed cryptogam layer. In this site series *Pinus contorta* was a differential species in the tree layer. Other distinguishing species were *Hieracium albiflorum, Listera cordata* and *Melampyrum lineare*. These plots were comparably low in *Acer circinatum* and *Hylocomium splendens* and the vegetation cover of *Arctostaphylos uva-ursi* and *Pleurozium schreberi* was relatively high. In these stands, *Rhododendron macrophyllum* covered on average 27% of the plots, slightly more than the average cover of *Pseudotsuga menziesii*.

ii) *Pseudotsuga menziesii/Thuja plicata - Corylus cornuta* plant association

The eight plots which most closely resembled the description for this site series occurred at the lowest elevations in an area roughly corresponding to the lower part of the Skagit Valley. They tended to be intermediate in most other respects both environmentally and floristically. Though not a single species was distinctly associated with this site series, it is noteworthy that the vegetation cover

PLATE 2. *Pseudotsuga-Thujaplicata-Corylus cornuta* stand

values for *Thuja plicata, Tsuga heterophylla, Paxistima myrsinites* and *Mahonia nervosa* were highest in these plots. *Rhododendron macrophyllum* cover was usually low, averaging 3%.

iii) *Pseudotsuga menziesii/Thuja plicata - Acer circinatum* plant association

Three of the plots located within the IDFww subzone were representative of the *Pseudotsuga menziesii/Thuja plicata - Acer circinatum* plant association. This group of plots was located at a higher elevation than the other IDF plots, on the east facing slopes of the western section of the Rhododendrons Ecological Reserve (ER #106), above the valley floor west of the Skagit River. The soils in these plots were well-drained dystric brunisols developed over morainal deposits and they were all mid-range in terms of moisture regime. These soils were also nutrient-poor.

In these plots the tree and cryptogam layers were particularly well-developed, in contrast to reduced shrub and herb layers. They were characterized by the frequent presence of a selection of species including *Acer glabrum, Rubus parviflorus* and *Holodiscus discolor* in the tall shrub layer; by *Disporum hookeri, Epilobium angustifolium, Festuca occidentalis, Fragaria vesca, Mahonia aquifolium, Polistichum munitum, Pteridium aquilinum* and *Rubus ursinus* in the low shrub and herb layer; and by *Rhytidiadelphus loreus, Dicranum fuscescens, Peltigera canina* and *Brachythecium* species in the cryptogam layer. *Hylocomium splendens* and *Pseudotsuga menziesii* were always present in particularly high cover values (on average, 58 and 44%, respectively).

PLATE 3. *Pseudotsuga-Thuja plicata-Acer circinatum* stand

Rhododendron macrophyllum had a lower cover value in these plots (on average 3%).

These sites were also characterized by the absence of *Pinus contorta, P. monticola* and *Abies grandis* in the tree layer; of *Salix scouleriana* in the tall shrub layer; of *Cornus canadensis, Pyrola asarifolia, Gaultheria ovatifolia* in the herb layer; and of *Dicranum polysetum, Cladina rangiferina, Cladina cornuta* and *Rhacomitrium canescens* in the cryptogam layer.

iv) *Rhododendron macrophyllum - Gaultheria ovatifolia - Cladonia* community

This group of three plots was sampled in the eastern section of the Rhododendrons Ecological reserve, also on the west side of the Skagit River. These sites were typically slightly drier and slightly more nutrient-poor than the zonal ones. The soils were dystric brunisols developed over inactive fluvial sediments. These plots were in some of the oldest IDF stands in the study. The vegetation coverage for this group of plots was atypical in that the tree layer and the cryptogam layers were exceptionally low, while shrub cover was significantly higher than in any other plant association.

PLATE 4. *Rhododendron macrophyllum-Gaultheria ovatifolia-Cladonia* stand

Floristically, *Pseudotsuga menziesii* cover was the lowest (on average 8%), while *Pinus monticola* cover was the highest of the IDF sites (6%, on average). *Thuja plicata* and *Tsuga heterophylla* accounted for very little of the tree coverage in this group of plots. It is in these sites that the rhododendrons were the most prominent: average cover for the three sites reached over 70%. *Rhododendron macrophyllum* and *Shepherdia canadense* were differential species in the shrub layer, and were accompanied by *Paxistima myrsinites*. In the herb layer, vegetation cover was lower than in those plots described by the other IDF sites. *Linnaea borealis* and *Mahonia nervosa* were the main representatives, but with a relatively high coverage of *Arctostaphylos uva-ursi*, and with *Gaultheria ovatifolia* as a distinguishing species. *Goodyera oblongifolia* and *Trientalis latifolia* were missing components of the herb layer (relative to other IDF sites). Other species notably absent from the IDF list were *Rhytidiopsis robusta* and *Dicranum fuscescens*. Otherwise, moss cover was low and the cryptogam layer was represented chiefly by lichens such as *Cladonia* spp., *Rhacomitrium canescens*, and *Peltigera aphtosa*.

Coastal Western Hemlock Zone

In general, the CWH sites were found at higher elevations above and away from the valley floor. They often occurred on slopes of varying steepness. The soils were usually humo-ferric podzols, they had developed mainly on well drained inactive fluvial deposits and were

PLATE 5. *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites* stand

generally on the poor end of the nutrient scale. The humus form was invariably a fibrimor. The CWH sites had higher vegetation cover values for the tree and the cryptogam layers and relatively low values for the tall shrub layer. Vegetation cover in the herb and low shrub layer was particularly low.

In contrast to the IDF sites, the *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites* plant association differed in that *Tsuga heterophylla* was more prominent (31 vs 11% for the IDF). Also, the presence of *Abies amabilis* (instead of *A. lasiocarpa*) as a differential species was a distinguishing characteristic of CWHms1 sites. In contrast, Pleurozium schreberi decreased in cover in the CWH when compared to the IDF sites (13 vs 21% cover, respectively).

In the tall shrub layer, the main species described for the IDF sites were also present but less frequently, and the differential species characteristic to the CWH sites was *Vaccinium scoparium*.

The CWH sites supported fewer herbs, though all of the main ones described for the IDF were present. Though present on average only 50% of the time, two herbs were good indicators of the CWH: *Hypopythis monotropa* and *Listera cordata*. The cryptogam layer was generally well developed. *Hylocomium splendens* tended to cover more of the sites in the CWH than in the IDF (30 vs 18% cover, respectively). Also more prominent than in the IDF was *Rhytidiopsis robusta* whose coverage moderately increased in the CWH sites.

Plate 6. *Tsuga heterophylla-Abies amabilis-Hylocomium splendens* stand

Of the 21 plots occurring in the IDF zone, 18 were floristically and environmentally similar to previously described site series. However the three remaining plots, though exhibiting environmental characteristics typical of the IDFww subzone, failed to match any of the IDF site series in terms of floristics.

Of those plots that did approximate described site series, seven corresponded with the IDFww/03 Fd Falsebox-Pinegrass plant association (Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites site series), eight plots resembled the 01 FdCw Hazelnut site series and three plots were designated as 05 CwFd Vine maple site series (Table 1). Appendix 2 shows summary information on the floristics of the three groups of plots designated within the IDFww site series as well as the undescribed IDF group of plots.

The 21 CWH plots all fell within the ms1/03 FdHw Falsebox site series. However, among those sites a wide range of variability was exhibited for many of the site, soil and vegetation characteristics. Table 2 compares the four IDF and the CWH site types for a range of environmental characteristics.

TABLE 2. Plots Numbers Broken Down by Community Type

SITE SERIES	PLOT NUMBERS: 93-
IDFww/03	701, 702, 703, 720, 737, 738, 739, 740
/01	706, 707, 708, 709, 719, 728, 729, 730
/05	732, 733
/00	723, 724, 727
CWHms1/03	705, 710, 711, 713, 714, 716, 717, 718, 721, 722, 734, 735, 736, 741, 742, 743, 744, 745, 746
/01	704, 715

DISCUSSION

In British Columbia *Rhododendron macrophyllum* occurs mainly in a small pocket along the Skagit River watershed. One small population also exists on Vancouver Island (George Douglas, personal communication). There is very little existing information on the Pacific rhododendron in the US portion of the Skagit watershed or anywhere else in the Cascades in Washington State. The nearest documented populations occur in the Olympic National Forest (see Henderson *et al.* 1989).

The International Joint Commission Report (1971) characterizes the uniqueness of the Skagit Valley as being determined by its low elevation within the Coastal-Interior transition zone. The particular set of environmental elements which *Rhododendron macrophyllum* requires in order to get established and grow are brought together in this valley, where the Coastal Western Hemlock's southern moist submaritime subzone intergrades with the Interior Douglas-fir warm wet subzone. Of the Skagit Valley rhododendron stands sampled in 1993, half fit into the moist submaritime CWH subzone, while the other half belonged to the warm wet IDF subzone.

CWHms1 Subzone Community Type

In general the CWHms1 rhododendron communities were established around the northern tip of the valley floor and at slightly higher elevations along the section of the Skagit River situated North of the valley floor (including Manning Provincial Park's Rhododendron Flats and Cayuse Flats). A handfull of populations were growing in the southwest corner of the watershed; again these were found at slightly higher elevations on east facing slopes above the valley floor.

All of the CWHms1 plots could be loosely described by the relatively dry and nutrient poor FdHw Falsebox site series. This site series corresponds fairly well with the subxeric to submesic CWHms1/Boxwood community type described by Fuhr (1988). Similarities exist between the Skagit CWHms1 communities and the intermediate mesic community types reported by Franklin and Dyrness (1973) for the *Tsuga heterophylla* zone (a zone climatically equivalent to the B.C.'s CWH zone) in Oregon and Washington states. The *Tsuga-Rhododendron macrophyllum-Gaultheria shallon* community type was reported to occur in cool moist sites, and the *Tsuga-Rhododendron macrophyllum-Manonia nervosa* communities were somewhat moister. These community types show similarities to those of the CWHms1 in terms of the prominence of *Tsuga heterophylla* and in herb layer composition and development. However, in these community types rhodendron was described as a dominant species in the shrub layer, a situation which is different than ours. In addition, it is unlikely that these communities are common in proximity to the Skagit Valley since Franklin and Dyrness (1973) reported *Rhododendron macrophyllum* to occur only sporadically in Washington.

Also in the CWHms1 subzone, Fuhr (1988) noted the occasional presence of *Rhododendron macrophyllum* in what he described as the more mesic Cw Clintonia community type. None of the plots submitted to vegetation analysis in the present study corresponded to that community type and are probably not common.

Plant associations of the IDFww subzone:

The IDF community types found in the Skagit Valley are unique in that they have no equivalent in the Pacific Northwest. All of the rhododendron populations corresponding to descriptions for the IDFww subzone were established on the valley floor. Of the 21 plots sampled in the IDFww subzone 18 could be described by one of three community types.

Eight rhododendron populations were growing in mesic and mesotrophic zonal communities (FdCw Hazelnut site series). These communities were typically situated in the moister southern part of the Skagit valley, close to where the river flows into Ross Lake. Current Ministry of Forests vegetation tables show *Rhododendron macrophyllum* to be a minor component of the vegetation cover in 16% of the 45 plots assigned to the zonal site series. Two of the zonal communities were sampled in proximity to the western edge of the Skagit River Forest Ecological Reserve. This study confirms the findings of the Ministry of Environment Skagit Valley Ecological Reserves study (1993) which reported a zonal community in the southwest corner of that ecological reserve.

In this study seven populations were found to be supported by the relatively drier and more nutrient poor Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites community type. These communities were encountered in the northern portion of the valley, which is typically drier than its southern counterpart. Current Ministry of Forests vegetation tables show Pacific rhododendron listed in only one out of 16 plots in the Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites. Characteristics described in Fuhr (1988) for the IDFww/Boxwood Terrace community type approximate this site series. However, Fuhr did not report *Rhododendron macrophyllum* in the Boxwood Terrace community type. He noted that *Rhododendron macrophyllum* was occasionally occurring in the more xeric Pine-Kinnickinnick community type and stated that it preferred moister sites but he failed to describe it as a part of any other IDF community type.

Three of the rhododendron stands sampled in 1993 had developed on comparatively moister and richer sites which can be described by the IDFww/CwFd Vine maple site series. Longitudinally, these communities were encountered roughly at mid-valley point. They were situated at elevations above the valley floor, on northeast facing slopes, on the west side of the valley. In contrast to the findings of this study, *Rhododendron macrophyllum* was not included in the Ministry of Forests vegetation tables for the IDFww CwFd Vine maple site series; however

it is listed for one of the 16 plots sampled in the fresh and nutrient-rich Cw Devil's club-Lady fern site series.

***Rhododendron macrophyllum* - *Gaultheria ovatifolia* - *Cladonia* Community Type**

An area roughly representing the eastern section of the Rhododendron Ecological Reserve (ER #106), on the West side of the Skagit River comprised a unique shrub community type within which *Rhododendron macrophyllum* had special status as a differential dominant species. These communities were typically dry and nutrient poor and were distinct floristically from any of the previously described biogeoclimatic plant associations or site series for the IDFww.

This community type is also different from the rhododendron community types from prior community classifications. The closest communities with dense stands of rhododendron occur in the Olympic National Forests (Henderson *et al.* 1989). The rhododendron-dominated community types classified in their work, such as the *Tsuga heterophylla / Rhododendron macrophyllum,* the *Tsuga heterophylla / Rhododendron macrophyllum / Xerophyllum tenax* communities, are more coastal than those of the Skagit Valley and tend to show floristic similarities to B.C.'s CWH communities.

According to Henderson *et al.* (1989), fire appears to be an important element in the establishment of rhododendron-dominated shrub communities in the Olympic National Forest. The evidence of fire (fire scars on veteran trees and charcoal in the humus layer) was common among rhododendron communities, but we know very little about its role in the ecology of this species.

Protection and Conservation

Most of the rhododendron populations of the Skagit Valley appear to be well established and healthy (Desrosiers 1992). At the present time, most of the area covered by this study is somewhat protected within the Skagit Valley Recreation Area. Further protection is afforded by four Ecological Reserves within the Recreation Area, and Rhododendrons have been reported in varying amounts from three of these. Rhododendron Flats and Cayuse Flats, on Highway 3, are protected as part of the E.C. Manning Provincial Park.

Currently, the B.C. Conservation Data Centre (BCCDC) has assigned the *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites* plant association a provisional ranking of **S3** (rare or uncommon element) at the provincial level. In the IDFww subzone, the zonal plant association, *Pseudotsuga menziesii / Thuja plicata - Corylus cornuta* is presently ranked **S4** (frequent to common element); the *Pseudotsuga menziesii - Paxistima myrsinites - Pleurozium schreberi* plant

association is ranked S5 (common to very common element); and the *Pseudotsuga menziesii/Thuja plicata - Acer circinatum* plant association is ranked **S4**? at this time.

The unique *Rhododendron macrophyllum-Gaultheria ovatifolia-Cladonia* community type is located within the boundaries of the Rhododendron Ecological Reserve (ER #106). This community type has recently been designated critically imperiled (rank of S1) at the provincial level. Fortunately, current accessibility to that ecological reserve is a challenge. It is very important to ensure that this area remains adequately protected.

CONCLUSION

This report describes five different community types within which *Rhododendron macrophyllum* can be found in the Skagit watershed. Half of the surveyed populations showed similarities to the *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima* community type described within in the Coastal Western Hemlock zone.

The other half was split among four community types of the Interior Douglas-fir wet warm subzone, one of which was previously undescribed. Rhododendrons were most common in communities approximating the zonal plant association (*Pseudotsuga menziesii/Thuja plicata - Corylus cornuta*) and the drier *Pseudotsuga menziesii/Tsuga heterophylla - Paxistima myrsinites* community. In addition, it was encountered in communities which can be described as *Pseudotsuga menziesii/Thuja plicata - Acer circinatum*.

Perhaps the most exciting finding of this study pertains to the characterization of the unique rhododendron community type occurring on the flats in the Rhododendrons Ecological Reserve on the west side of the Skagit River. This community type was functionally similar to the other IDFww plots in the study. However, it was very distinct both structurally and floristically from any of the described plant communities.

The information presented in this report furthers our knowledge of the ecology of the *Rhododendron macrophyllum* and the communities it is associated with, and fills a void in the classification of the different communities of the Skagit Watershed.

The report provides a tool which can be used in ascertaining whether the *R. macrophyllum* populations of the Skagit Watershed are currently adequately protected. The results of this study can also assist professionals such as resource managers and ecologists in the decision-making regarding the establishment of protection priorities, the maintenance of adequate habitat and long-term viability for the *R. macrophyllum,* and more generally in the designing of conservation-oriented biodiversity programs.

Recommendations

Rhododendron macrophyllum has not been described as a dominant floristic component in any of the CWH plant associations. In addition, a considerable amount of environmental and floristic variation was observed among the plots ascribed to the CWH. Based on these findings, a revision of the CWH communities in the Skagit Valley is desirable. The results of such a revision could incorporate *R. macrophyllum* as a diagnostic species for a well-defined subassociation of the associations already described for the CWH in the Skagit Valley.

The results of this study support the need for more work to be done on the classification of the various communities both in the IDFww and CWH subzones in the Skagit Valley. It would be interesting and beneficial to gather all the existing information and pool together the environmental and vegetational data on the Skagit River Watershed, in order to submit them to multivariate analyses and other current vegetation tabling analyses. This would permit a general revision and clarification of the existing classification.

LITERATURE CITED

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd edition. Agric. Can. Publ. 1646. 164 pp.

British Columbia Ministries of Environment and Forests. 1990. Describing Ecosystems in the Field. 2nd edition. Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger and T. Vold. Eds. Victoria, B.C.

British Columbia Ministry of Environment. 1993. Vegetation and wildlife findings for three ecological reserves in the Skagit River Valley. B.C. Parks. South Coast Region, Planning and Conservation Services. 66 pp.

British Columbia Ministry of Forests. 1987. Biogeoclimatic Units of the Vancouver Forest Region. Map No. 6. Fraser Valley - Lillooet River.

Bryce, J.T. 1993. Skagit Valley Rhododendron Communities: Soil Report. Unpublished report. 4 pp. Appended to present document.

Carl, G.C., C.J. Guiguet and G.A. Hardy. 1952. A natural history survey of the Manning Park area, British Columbia. Occasional Papers of the British Columbia Provincial Museum. No. 9. 130 pp.

Desrosiers, J. 1992. Pacific rhododendrons (*Rhododendron macrophyllum* D.Don *ex* G. Don) of the Skagit River Valley: a preliminary report. Unpublished report. Vancouver. 27 pp.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service. General Technical Report PNW-8. 417 pp.

Fuhr, B. 1988. Biophysical wildlife Habitat Mapping for the Skagit Valley. Unpublished report for the Habitat Inventory Section of the Wildlife Branch, Ministry of Environment and Parks, Victoria, B.C. 105 pp.

Green, R.N., K. Klinka and P.J. Courtin. 1994. A field guide for site identification and interpretation for the Vancouver Forest Region. Ministry of Forests. Victoria. (In prep.)

Henderson, J.A., D.H. Peter, R.D. Lesher, D.C. Shaw. 1989. Forested plant associations of the Olympic National Forest. USDA Forest Service. Pacific Northwest Region. R6 Ecol. Technical Paper 001-88. 502 pp.

Hill, M.O. 1979a. TWINSPAN: a Fortran program for arranging multivariate data in an ordered two-way table by classification

of the individuals and attributes. Cornell University, Ithaca, NY.

----- 1979b. DECORANA: a Fortran program for detrended correspondence analysis and reciprocal averaging. Ecology and Systematics, Cornell University, Ithaca, NY.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press. 730 pp.

Hope, G.D., W.R. Mitchell, D.A. Lloys, W.R. Erickson, W.L. Harper and B.M. Wikeem. 1991. Interior Douglas-fir zone. *In*: Ecosystems of British Columbia. (D. Meidinger and J. Pojar Eds.). B.C. Ministry of Forests. Special Report Series No. 6. pps 153-156.

International Joint Commission. 1971. Environmental and ecological consequences in Canada of raising Ross Lake in the Skagit Valley to elevation 1725. 191 pp.

Kayahara, G. 1992. PC-VTAB 1.4 User's guide. B.C. Ministry of Forests. Research Branch. Victoria, B.C. 127 pp.

Meidinger, D., E. Hamilton and T. Fleming. 1987. Ecosystem classification program data processing system user's guide. Version 2. B.C. Ministry of Forests and Lands Research Report. 132 pp.

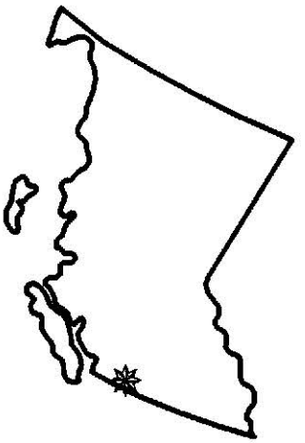
Pojar, J., K. Klinka and D.A. Demarchi. 1991. Coastal Western Hemlock zone. *In*: Ecosystems of British Columbia. (D. Meidinger and J. Pojar Eds.). B.C. Ministry of Forests. Special Report Series No. 6. pps 153-156.

Slaney, F.F. and Co. Ltd. 1971. Rhododendron in the Skagit Valley. The Canadian Skagit. Environmental Newsletter. Vol. 7. 4 pp.

----- 1973. Environmental investigations: proposed High Ross Reservoir. Volume II. Climate, Soils, and Vegetation. City of Seattle. Department of Lighting. 180 pp.

Underhill, J.E. 1967. The plants of Manning Park, British Columbia. Department of Recreation and Conservation. 72 pp.

Skagit Valley Rare Biological Elements: Skagit Small Mammal Inventory



P.A.W. Research Services

Markus Merkens R.P. Bio.
8463 12th Avenue
Burnaby, B.C.
V3N 2L8

Abstract

A small mammal survey was conducted in four ecoreserves and two additional sites within the Skagit Valley in southern British Columbia. Special emphasis was placed on detecting three species of concern: the Trowbridge's shrew, *Sorex trowbridgii*, the mountain beaver, *Aplodontia rufa*, and the Cascade mantled ground squirrel, *Spermophilus saturatus*. Live trapping transects were used to capture a total of 164 individuals made up of 5 species in 1160 trap-nights. Mountain beaver and Cascade mantled ground squirrel burrows and sign were not detected in any of the survey areas. One hundred and thirteen pitfall traps were placed but I did not capture any shrews. The presence of the three species of concern in the valley remains unclear. Small mammals captured in live traps were typical for second growth and old-growth stands in south western B.C. Of the 5 species captured, two were of the genus *Peromyscus*. It appeared that number of *P. oreas* captured was inversely proportional to the number of *P. maniculatus* captured. Habitat partitioning or competition may account for these results. Comments on the purpose and utility of Ecological Reserves are provided. A flow chart outlining a procedure for selecting suitable methods for small mammal surveys is included and recommendations for future studies are made.

Acknowledgements

This survey was made possible through financial support from the Skagit Valley Endowment Commission. P.A.W. Research Services is grateful to Alton Harestad and Tom Sullivan for the loan of equipment and for sharing their ideas with the author. Dave Dunbar and Judy Millar provided material on and maps of the Skagit and Ecoreserves. I thank Laurie Kremsater for providing information on the Skagit area, Carlos Galindo-Leal for discussions on ecoreserves, Julee Desrosiers and Jim Bryce for information on vegetation, and Laura Friis, Syd Cannings, Andrew Harcombe and Leah Ramsay for providing assistance during a field-trip to the Skagit Study Area. I thank Chris Cheng and Danny Tyson for providing technical assistance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

The Skagit River watershed, located in south-western British Columbia and encompassing approximately 8133 ha, contains elements of a transition between coastal and interior biogeoclimatic zones. As such, it offers a unique assemblage of habitat for various species of wildlife. Small mammal species likely to inhabit the Skagit Valley are listed in Table 1 and include both typically interior and coastal species. Superimposed over, and possibly directly attributable to the unique climatic and biotic conditions in the valley, are portions of the geographical ranges of three small mammal species currently of concern in British Columbia. The mountain beaver, *Aplodontia rufa*, the Cascade mantled ground squirrel, *Spermophilus saturatus*, and Trowbridge's shrew, *Sorex trowbridgii*, all potentially exist or have been documented within the watershed (Kremsater 1987). These taxa are at or close to their northern limit of distribution in this valley (Cowan and Guiget 1965). The peripheral nature of these taxa in the valley may make them particularly vulnerable to local extirpation.

Barnard (1986) and Kremsater (1987) have reviewed literature about wildlife in the Skagit Valley and found that data on small mammal populations for the Skagit Valley are extremely scarce and dated. Most written material refers to a study conducted in the early 1970's by Slaney (Slaney 1971, 1973). Intensive museum collections in the Skagit Valley and surrounding areas during the late 1940's provide additional data regarding species presence (Dave Nagorsen pers. comm., Carl *et al.* 1952). There is a need for scientific wildlife studies in the Skagit Valley to determine baseline data, especially on the species mentioned above.

Almost the entire Skagit River watershed south of the junction of the Sumallo and Skagit Rivers is contained within the boundaries of the Skagit Valley Recreational Area (Fig.1) and is therefor afforded some level of protection. Furthermore, four ecological reserves have been established within the Recreation Area (see Table 2). Currently, there is some discussion of converting the Recreation Area to a Class A Park (Judy Millar, pers. comm.).

The Conservation Data Center (CDC) has received funds from the Skagit Environmental Endowment Commission to carry out work on a variety of biological systems in the Skagit River watershed. The composite project entitled "Skagit Valley Rare Biological Elements" is composed of a series of inventory studies encompassing rare habitats, terrestrial vertebrates and vascular plants in the watershed. The interest from Wildlife Branch in rare elements and from Parks Branch in biological components of the ecological reserves in the area have led to the development of this project. In this study, data were collected on small mammal components in the 4 ecological reserves and 2 additional sites located in the Skagit Valley Recreational Area.

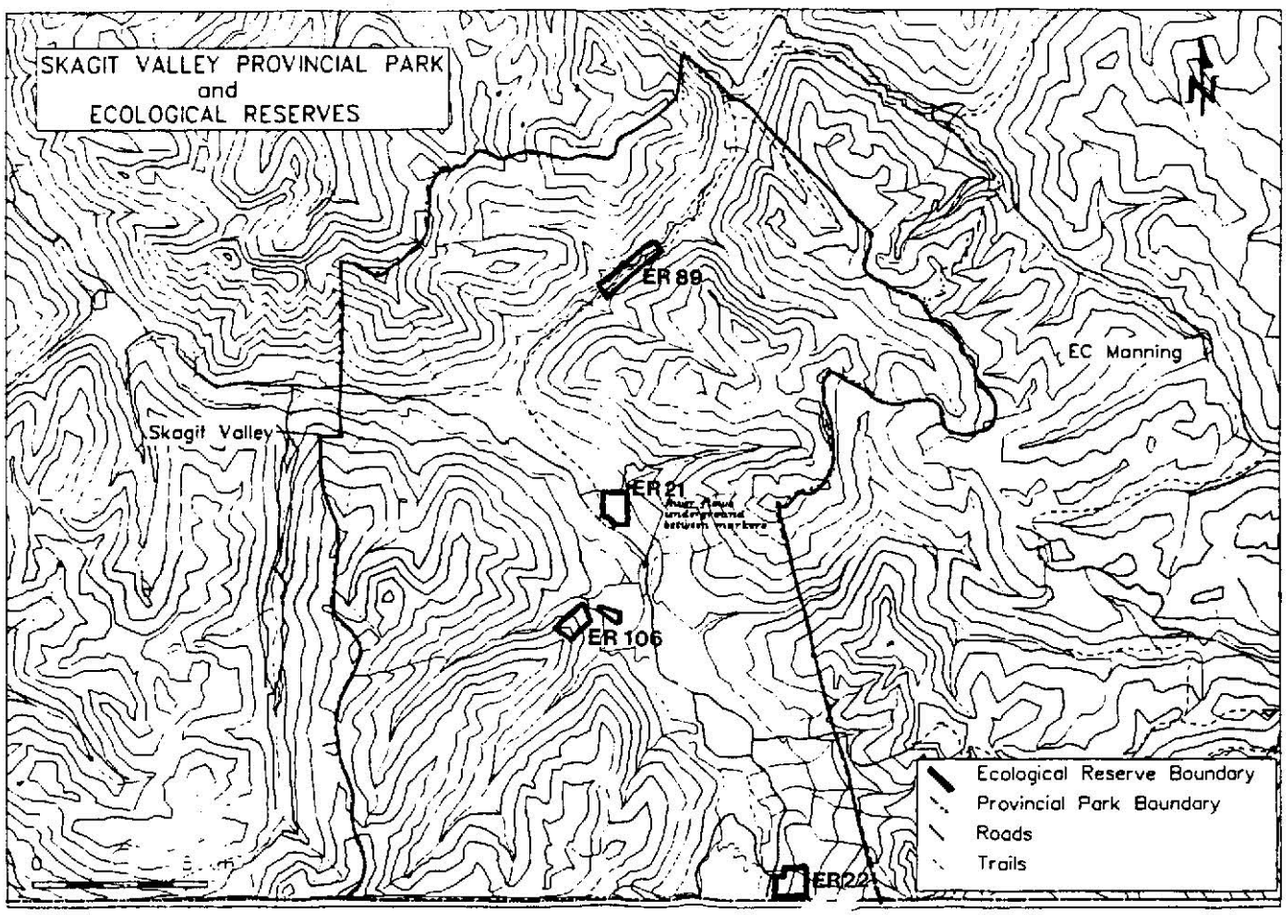


Figure 1. The Skagit Valley Recreational Area and Ecological Reserves.

Table 1. Species list for small mammals (excluding carnivores) whose historical geographic ranges include the Skagit River watershed and neighboring areas.

ORDER	FAMILY	GENUS	SPECIES	COMMON NAME
Insectivora	Soricidae	*Sorex*	*cinereus*	Common shrew
			monticolus	Dusky shrew
			palustris	Water shrew
			trowbridgii	Trowbridge's shrew
			vagrans	Vagrant shrew
	Talpidae	*Neurotrichus*	*gibbsii*	Shrew mole
		Scapanus	*orarius*	Coast mole
Lagomorpha	Leporidae	*Lepus*	*americanus*	Snowshoe hare
Rodentia	Aplodontidae	*Aplodontia*	*rufa*	Mountain beaver
	Arvicolidae	*Clethrionomys*	*gapperi*	Southern Red-backed vole
		Microtus	*longicaudus*	Long-tailed vole
			oregoni	Creeping vole
			richardsoni	Water vole
			townsendii	Townsend's vole
		Ondatra	*zibethicus*	Muskrat
		Phenacomys	*intermedius*	Heather vole
		Synaptomys	*borealis*	Northern bog lemming
	Castoridae	*Castor*	*canadensis*	Beaver
	Cricetidae	*Neotoma*	*cinerea*	Bushy-tailed woodrat
		Peromyscus	*maniculatus*	Deer mouse
			oreas	Columbian mouse
	Erithizontidae	*Erithizon*	*dorsatum*	Porcupine
	Sciuridae	*Glaucomys*	*sabrinus*	Northern flying squirrel
		Marmota	*caligata*	Hoary marmot
		Spermophilus	*saturatus*	Cascade mantled ground squirrel
		Tamias	*amoenus*	Yellow-pine chipmunk
			townsendii	Townsend's chipmunk
		Tamiasciurus	*douglasii*	Douglas' squirrel
			hudsonicus	Red squirrel
	Zapodidae	*Zapus*	*trinotatus*	Pacific jumping mouse

Table 2. Listing of Ecological Reserves located in the Skagit Valley Recreational Area.

#	Name	Size (ha)	Biogeoclimatic Zone	Purpose
21	Skagit River Forest Ecoreserve	73	IDF	To preserve representative valley-bottom forest in an area transitional between coastal and interior climatic conditions.
22	Ross Lake Ecoreserve	61	IDF	To preserve an isolated population of ponderosa pines and other vegetation in a location transitional between coastal and interior climates.
89	Skagit River Cottonwood Ecoreserve	69	CWH	To maintain stands of alluvial black cottonwoods for purposes of hybridization and stock improvement.
106	Skagit River Rhododendron Ecoreserve	70	CWH, IDF	To preserve stands of the rare Pacific rhododendron in a site unlikely to be disturbed by recreational use.

2.0 OBJECTIVES

1. Attempt to determine distribution and relative abundance of the mountain beaver, Cascade mantled ground squirrel, Trowbridge's shrew and other small mammal species in selected areas of the Skagit River watershed.
2. Relate distribution and relative abundance of these and other small mammal species to coarse habitat characteristics.

3.0 METHODS

3.1 Study Area

The Skagit Valley Recreational Area, located in south-western British Columbia, occupies an area of approximately 8133 ha within the Skagit River watershed (Fig. 1). The Skagit River headwaters lie within the Hozameen Range of Manning Park from where the river flows in a generally north-westerly direction until its confluence with the Sumallo River in the

vicinity of Sumallo Grove. From this point the river flows generally in a south-westerly direction through a narrow /steep-walled valley for about 10 km to a point where Silvertipped Creek flows into the river. At this point the Skagit River Valley begins to widen, allowing the river to become somewhat more sinuous until its mouth reaches Ross Lake just north of the 49th parallel, some 20 km south of Silvertipped Creek. The direction of flow along this section of the river is generally south by south-west.

The southern end of the Skagit Valley contains a warmer and drier climate than many more typical watersheds in the area. This is due to a rain shadow created by the Pickett Mountain Range along the west edge of the Skagit Valley. In general, the climate within the Skagit valley is transitional between coastal and interior climates. Biogeoclimatic zones found within the Skagit Valley are extremely diverse for such a small area and include: 1) Alpine Tundra, 2) Mountain Hemlock, 3) Engelmann Spruce - Subalpine Fir, 4) Interior Douglas Fir and 5) Coastal Western Hemlock.

The compression of elevation, climatic variables and transitional nature of the valley have contributed to the diversity of vegetation within the watershed. Both coastal and interior species occupy the area and occur often in unusual juxtaposition. The bulk of the valley is forested with a history of considerable natural and artificial disturbances. The presence of various seral stages, natural meadows, wetlands and a variety of other vegetation types together with the transitional climate create a wide diversity of wildlife habitat.

The 4 ecological reserves contained in the valley were the primary focus of surveys presented here. The vegetation within these have been described in detail elsewhere (B.C. Parks South Coast Region 1993, Desrosiers in prep.). In addition to these reserves, Sumallo Grove in Manning Park and the Chittenden Meadows and adjacent riparian areas were surveyed.

The Skagit River Forest Ecoreserve has been classified as Interior Douglas Fir Wet Warm subzone (IDFww). Habitat classes within the area surveyed were primarily Cedar-Clintonia and secondarily Douglas-fir-Oregon Grape including mature seral (100-150 years) and mature climax (150-250 years) ages (Ministry of Environment, Lands and Parks 1991). Topography was generally flat. No streams were located within the stand, however, evidence of ephemeral water flow was evident through some of the stand.

The Ross Lake Ecoreserve is classified as Interior Douglas Fir Wet Warm subzone (IDFww). Index lines were located in the following vegetation types: CwFd-Vine maple, Fd - Falsebox - Feathermoss, and FdCw - Hazelnut (B.C. Parks South Coast Region 1993). Habitat classes within the area surveyed include Douglas-fir - Oregon Grape, Boxwood terrace and Slope-Saskatoon and Rock-Douglas-fir including young seral (20-100 years), mature seral (100-150 years) and mature climax (150-250 years) ages (Ministry of Environment, Lands and

Parks 1991). Topography was flat to steep and several streams are located along the south edge of the area surveyed (see riparian index lines, Fig. 3).

The Skagit River Cottonwood Ecoreserve is classified as Coastal Western Hemlock Southern Dry Submaritime subzone (CWHds1). Index lines were located in the following vegetation types: FdHw - Falsebox, Ss - salmonberry, and BaCw - Devil's Club (B.C. Parks South Coast Region 1993). Habitat classes within the area surveyed were primarily Hemlock - moss and secondarily Cottonwood - red-osier dogwood of mature seral (100-150 years) ages (Ministry of Environment, Lands and Parks 1991). Topography was generally flat and the Skagit River and the 28-Mile Creek were dominant riparian features.

The lower portion of the Skagit River Rhododendron Ecoreserve is classified as Interior Douglas Fir Wet Warm subzone (IDFww). The upper portion is classified as Coastal Western Hemlock Southern Dry Submaritime subzone (CWHds1). Habitat classes within the lower portion were primarily Cedar - clintonia of young seral (20-100 years) ages (Ministry of Environment, Lands and Parks 1991). The age of the forested area surveyed was much older than previously classified (see Desrosiers in prep.). Habitat classes in the upper portion of the reserve consisted primarily of Hemlock - moss and Rock - Douglas-fir of mature seral (100-150 years) and mature climax (150-250 years) ages (Ministry of Environment, Lands and Parks 1991). Topography on the lower was generally flat and no streams were found within the surveyed area. The upper portion was steep (up to 70°), had an easterly aspect and had no streams in the vicinity of the index line surveyed.

Two additional sites that were surveyed were not contained within any ecological reserves. Sumallo Grove is a small remnant of riparian old-growth at the upper end of the Skagit River. It is dominated by large western red cedar and Douglas-fir trees. The Chittenden Meadows is found within the Interior Douglas-fir Wet Warm subzone (IDFww) and is dominated by a grassland community. The riparian area surveyed near the Chittenden Meadows is also found within in the IDFww subzone and contains Cedar-clintonia habitat of young seral (20-100 years) and mature seral (100-150 years) age classes.

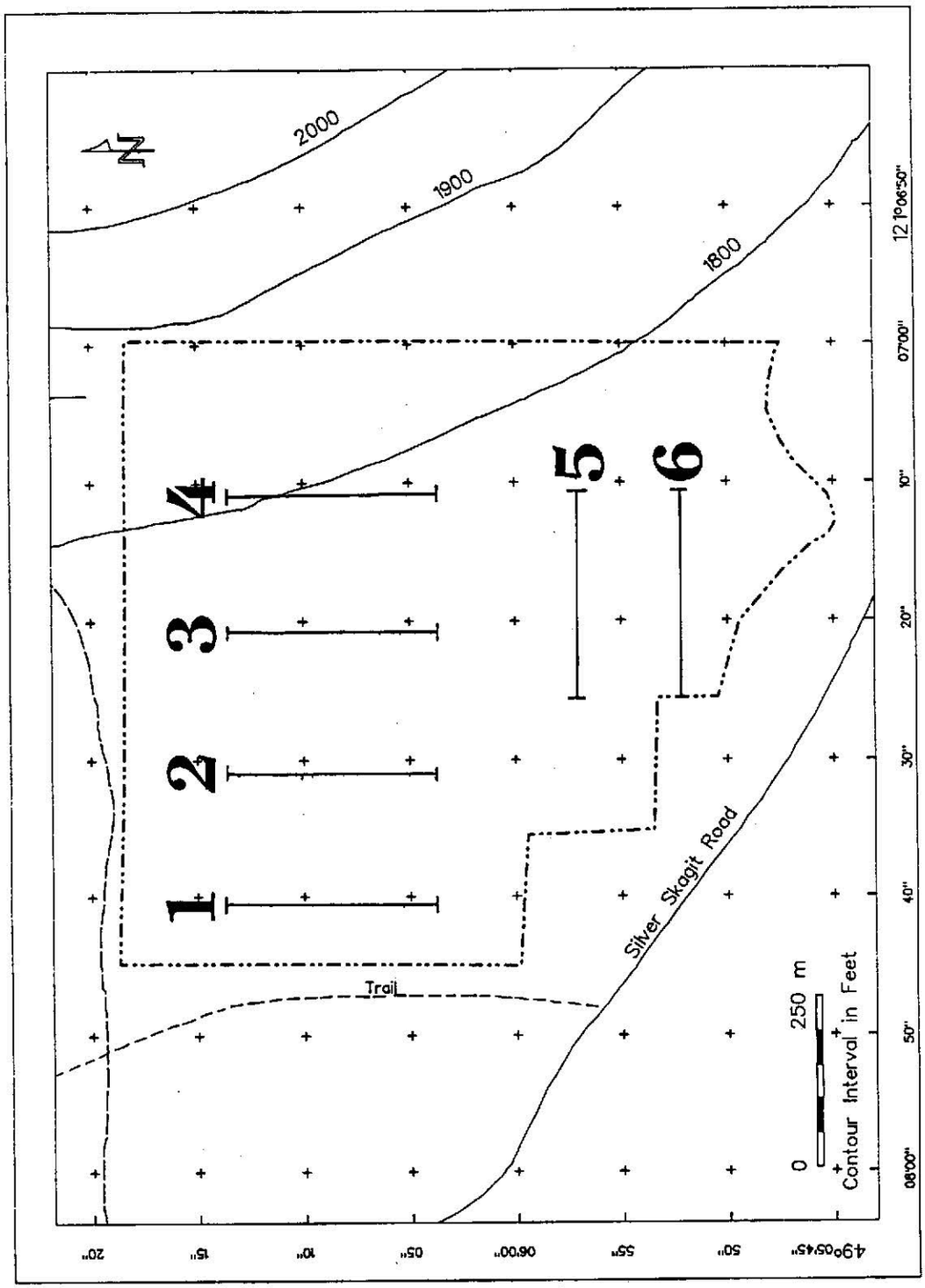


Figure 2. The Skagit River Forest Ecoreserve (ER 21). Numbered lines indicate small mammal live-trapping transects. Trap numbers on lines are 1–20 for each line and numbering commences at numbered end of line.

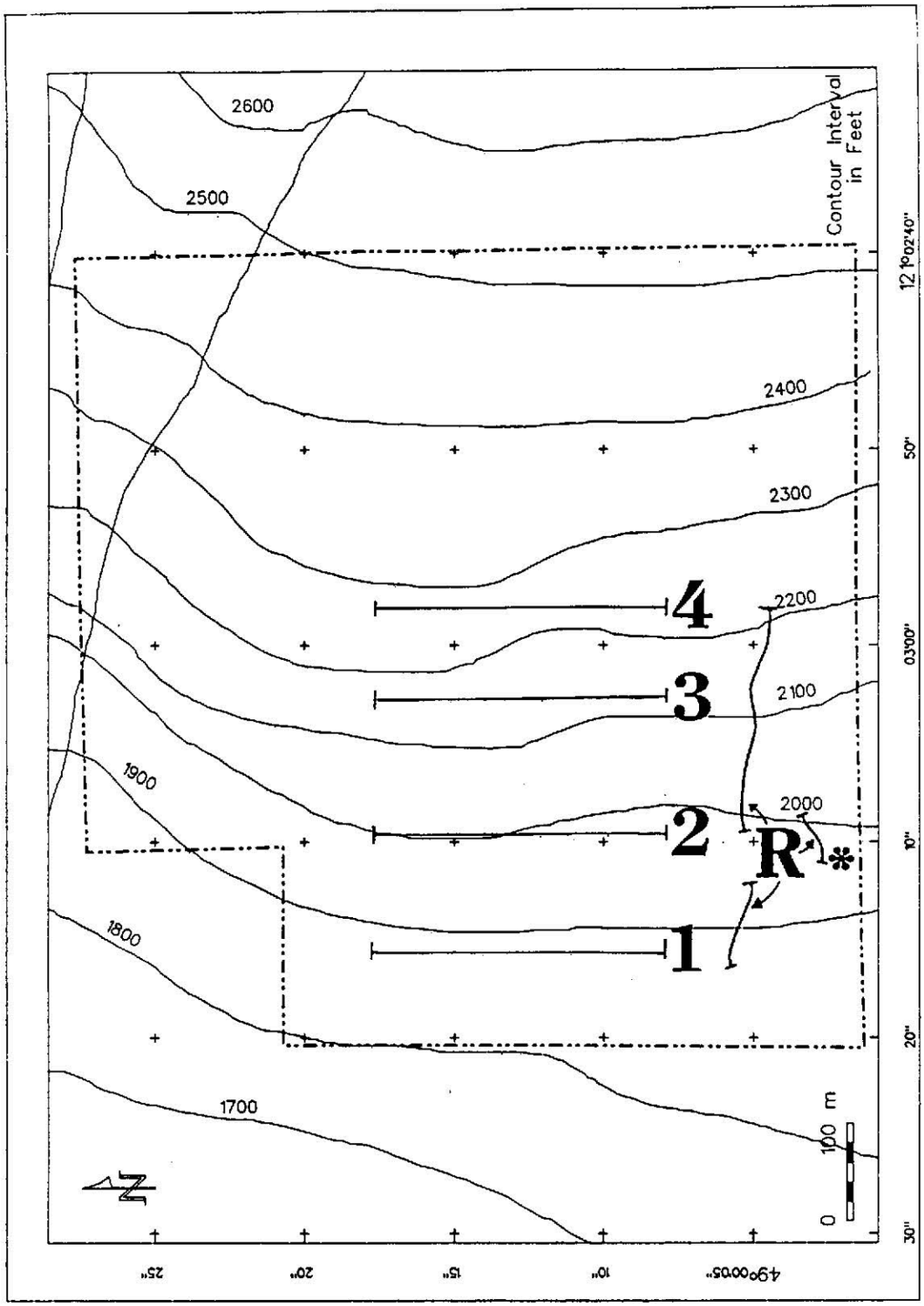


Figure 3. The Ross Lake Ecoreserve (ER 22). Numbered lines indicate small mammal live-trapping transects. Trap numbers on lines are 1–20 for each line and numbering commences at numbered end of line. Trap numbers for the riparian line commence at the eastern end of the composite transect. The asterisk marks the location of the potential abandoned mountain beaver burrow.

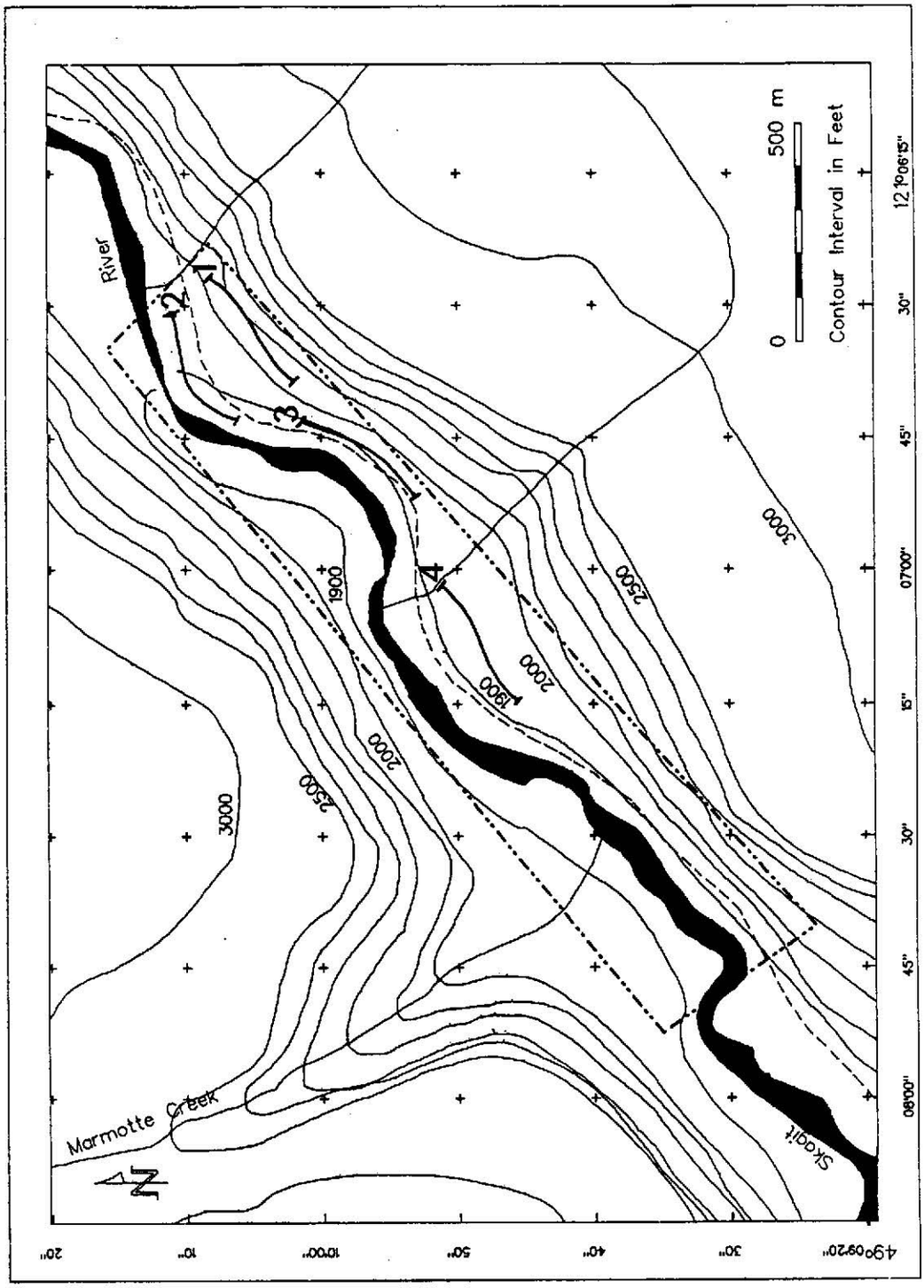


Figure 4. The Skagit River Cottonwood Ecoreserve (ER 89). Numbered lines indicate small mammal live-trapping transects. Trap numbers on lines are 1-20 for each line and numbering commences at numbered end of line.

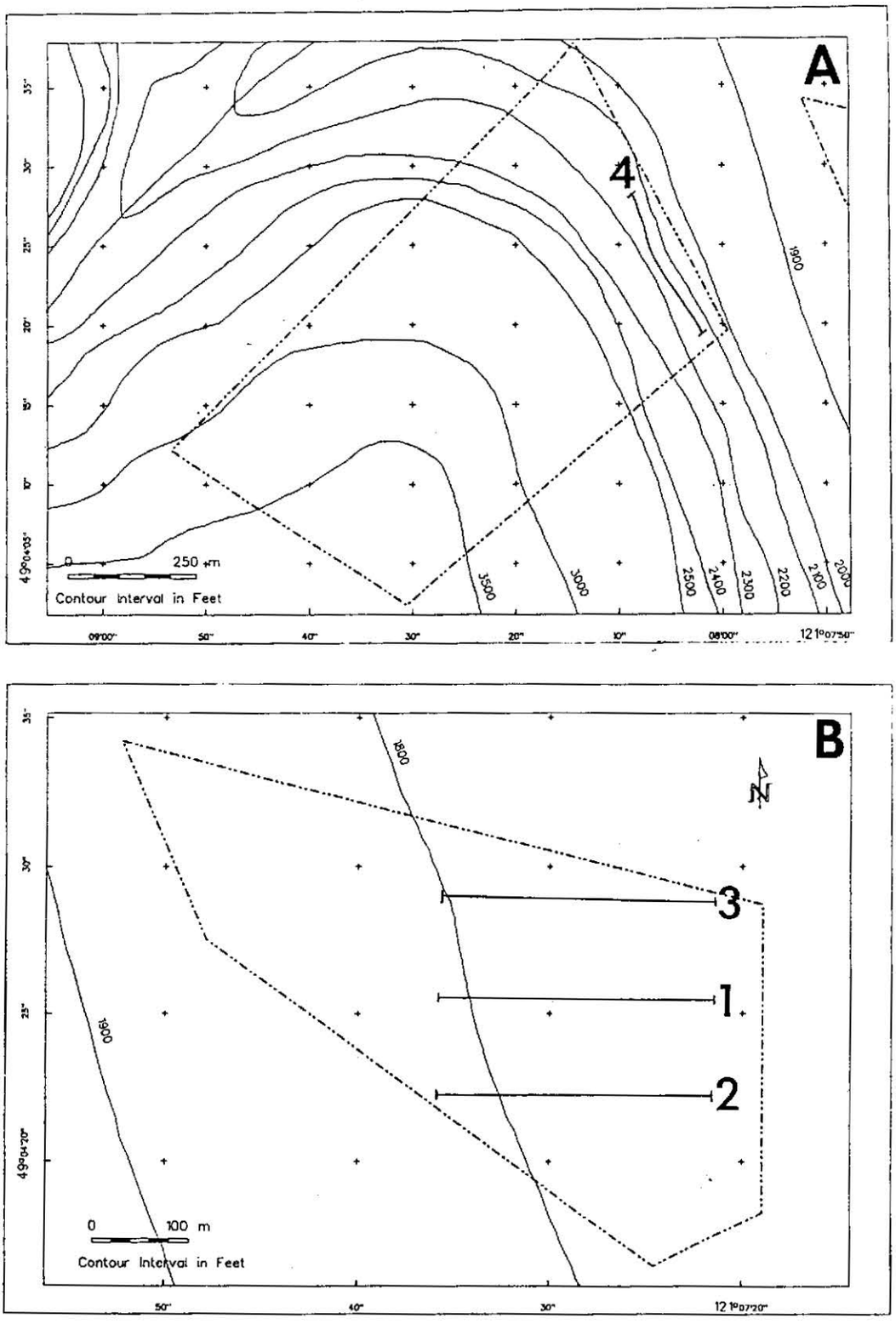


Figure 5. Upper (A) and Lower (B) sections of the Skagit River Rhododendron Ecoreserve (ER 106). Numbered lines indicate small mammal live-trapping transects. Trap numbers on lines are 1–20 for each line and numbering commences at numbered end of line.

3.2 Survey Methods

Within each study area 3 to 6 small mammal index lines were set up, depending on area size and remoteness. Table 3 outlines trapping effort for each study area. See Figs. 2–5 and NTS map submitted with report for exact locations of transects. Each index line consisted of 20 small mammal live–traps (Bolton, Longworth or Sherman) spaced at 15–m intervals. Efficiency of capture for shrews in live–traps and the necessity to euthanize some shrews for identification purposes required the use of pitfall traps in addition to the live traps. For this reason, 8 to 25 groups of 4 'beer cup' pitfall traps were dispersed along transect lines. Live traps were baited with a mixture of peanut butter, oats, and commercial canned cat food. In addition, cotton and a slice of carrot were supplied in live traps for thermal and water requirements of captured animals.

Traps were placed baited and set on the morning of the first day of sampling on any particular site. They were checked on the morning of day 2 and any sprung traps were reset. They were checked again on the morning of day 3 and removed. All specimens captured were identified on site where possible. The "in hand field identification guide" developed by Dave Nagorsen (BCPM) was used in field for evaluation. Specimens captured and released were sexed, weighed and their breeding condition noted where possible. A number of voucher specimens were collected (Appendix 1).

Table 3: Trapping effort and burrow transect lengths for areas surveyed

Survey Area	#Index lines	Total Trap #	Transect length (km)
Skagit River Forest Ecoreserve (ER21)	6	120	3
Ross Lake Ecoreserve (ER22)	6	120	3
Skagit River Cottonwood Ecoreserve (ER89)	4	80	2
Skagit River Rhododendron Ecoreserve (ER106)	4	80	2
Sumallo Grove	3	60	1.5
Chittenden Meadows (meadow) (riparian)	3 3	60 60	1.5 1.5

Transects totaling 1.5–3 km were walked on each study area in search of mountain beaver and ground squirrel burrows and sign. Again length of transect traversed depended on area size and remoteness. Visual inspection of the area 5 m to either side of the transect was used to identify burrow locations where possible. Once burrows were located an intensive survey covering a circular area of 10–m radius was conducted. Tomahawk live–traps were placed at selected burrow locations to verify species. Incidental sightings of all small mammals were recorded when ever species could be identified.

4.0 RESULTS

In total, 4 rodent species and 1 species of carnivore were captured through live–trapping (see data in Appendix 2, summary in Table 4). The most common species on all sites were *Peromyscus* sp. The two species of *Peromyscus* thought to inhabit the valley were present on all survey areas. Some individuals could not be identified to species because they were either juveniles or they had a section of tail amputated. Columbian mouse, *Peromyscus oreas*, and deer mouse, *Peromyscus maniculatus*, numbers were strongly inversely proportional in 5 of the 6 areas surveyed (Fig. 6). I suspect that some type of habitat partitioning or competitive exclusion/interaction may play a role in these observations. The southern red–backed vole, *Clethrionomys gapperi*, was captured in 3 of the 6 study areas. All areas in which this species was captured contained elements of mature or old–growth forests. The northern flying squirrel, *Glaucomys sabrinus*, was captured only in the Skagit River Forest Ecoreserve. The individual captured was a lactating female deep within the stand of trees. A large number of snags are present in the reserve offering nesting sites for squirrels. Furthermore, evidence of small

Table 4. Summary of small mammal captures on all survey areas

Study Area	*Peromyscus sp**	*Peromyscus maniculatus*	*Peromyscus oreas*	*Clethrionomys gapperi*	*Glaucomys sabrinus*	*Mustela erminea*
ER 21	6	4	18	0	1	0
ER 22	8	18	12	1	0	1
ER 89	4	4	24	0	0	0
ER 106	5	6	1	1	0	0
Sumallo	2	3	13	1	0	0
Chittenden	7	20	1	0	0	0

* individuals that could not be identified at the species level

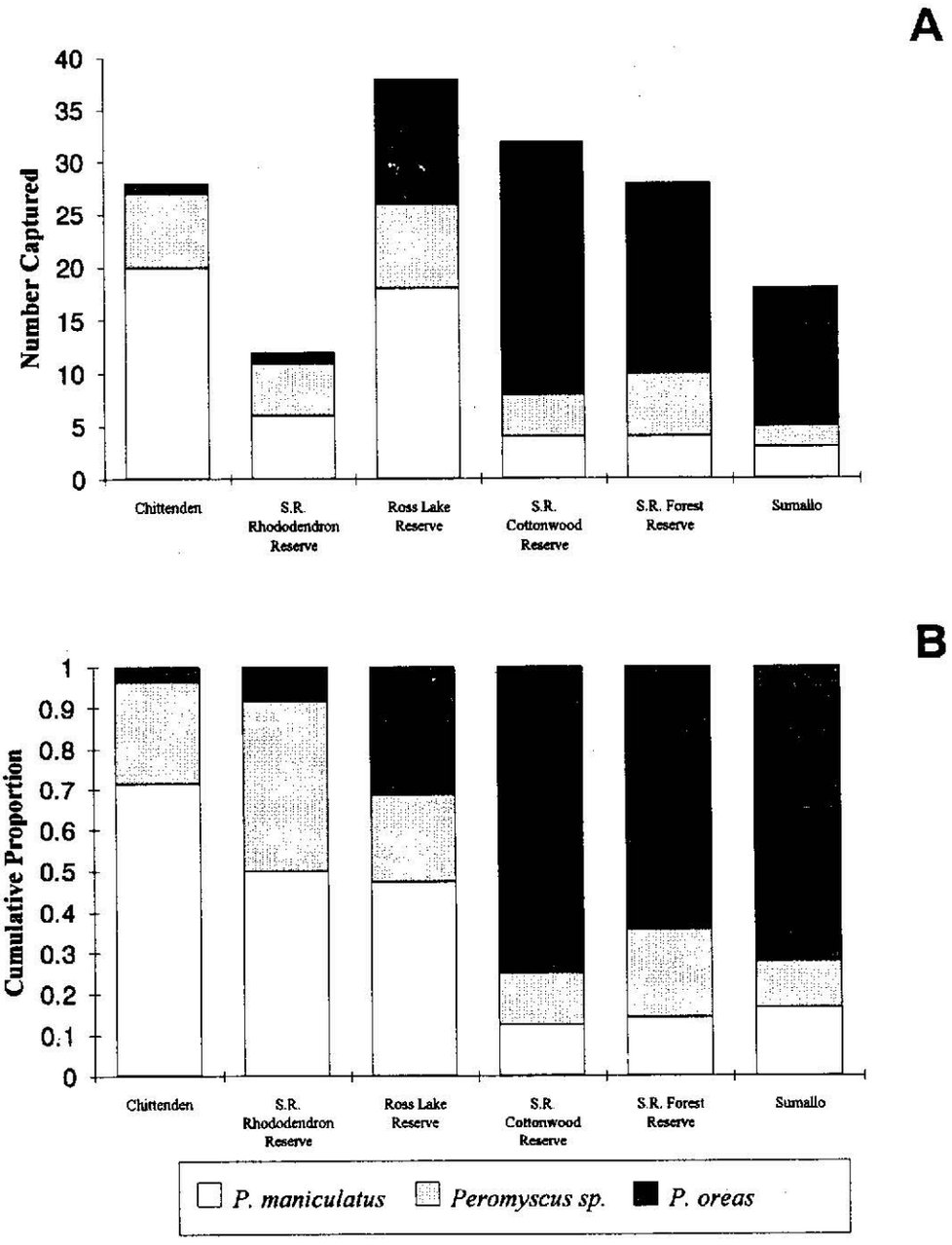


Figure 6. Composition of *Peromyscus* populations in 6 areas surveyed within the Skagit Valley. A) Cumulative number of *Peromyscus* captured. B) Cumulative proportion of *Peromyscus* captured.

mammals digging into the soil, potentially for hypogeous fungi, and elements of old growth structures within this area indicate that the stand would potentially be capable of supporting flying squirrels. One individual ermine, *Mustela erminea*, was captured within the forested area of the Ross Lake Ecoreserve. No small mammals were captured on the Chittenden Meadows, however, a number of captures were made along the Skagit River in the vicinity of the Chittenden suspension bridge (refered to as Chittenden Meadows (riparian) in Table 3).

I didn't catch any small mammals in pitfall traps on any of the study areas. Likewise, no compelling evidence of mountain beaver or Cascade mantled ground squirrel activity was seen on any of the transects. One potential mountain beaver burrow was located on the Ross Lake Ecoreserve, but it appeared to have been abandoned for some time. I placed a live trap near the burrow but did not capture anything. A number of additional small mammal species were seen within the study areas. Evidence of red squirrel, *Tamiasciurus* sp., activity was observed visually or by sound in all areas but the Chittenden Meadows. The Douglas' squirrel, *T. douglasii*, was identified within the Skagit River Forest Reserve. Yellow pine chipmunks, *Tamias amoenus*, were seen on the Skagit River Cottonwood Reserve and the Skagit River Forest Reserve. Snowshoe hare, *Lepus americanus*, were seen at various locations on the Skagit River Forest Ecoreserve and along the Silver-Skagit road at various times.

5.0 DISCUSSION

5.1 Results

The Skagit Valley is an area containing diverse wildlife habitat. This can be attributed to its geographical location, geophysical characteristics, varied climate, geological events (primarily prehistorical), and disturbance regime (natural and man-made). The areas surveyed in this study were primarily valley bottom habitat, most of which has been partially or completely affected by logging activities in the lower sections of the Skagit Valley.

The Skagit River Forest Ecoreserve and forested areas of the Ross Lake Ecoreserve resembled mature stands in structure and function from a wildlife perspective. The Skagit River Forest Ecoreserve appeared to be somewhat more advanced in age, and elements of the stand contained old-growth characteristics from a functional point of view. These types of stands typically exhibit lower wildlife diversity compared to early successional or truly old-growth stands (Yahner 1986). Captures of deer mice and red-backed voles are representative for short-term live-trapping efforts in these types of stands.

More open habitat, like that found in the center of the Ross Lake Reserve, should support a different small mammal community. This was not shown to be the case in the open area of the Ross Lake Reserve. The relatively small size of the open habitat fragment (<10 ha)

and its obvious isolated nature would make it difficult to maintain a viable population of any species requiring specific habitat elements found in open habitat. Without dispersal sinks and immigration from outside populations, the ability to maintain a minimal viable population would be hindered (Gilpin and Soulé 1986).

The Skagit River Rhododendron Ecoreserve has been classified as non-productive on forest cover maps. For this reason, no harvesting has taken place there in the past. The habitat is fairly uniform on the lower section of the reserve and somewhat more diverse on the upper. Only deer mice were captured on the lower section and in addition to the deer mice, one red-backed vole was captured on the upper section. Low animal captures on these two areas compared to other areas surveyed indicate that these areas may be less productive in terms of small mammals.

The Skagit River Cottonwood Ecoreserve located on the upper Skagit River contained a variety of wildlife habitats. However, the forested areas were primarily mature stands, some of which were approaching old growth status. Again, captures of only *Peromyscus sp.* in these stands is indicative of the stand habitat status. The significant riparian effect afforded by the close proximity of the Skagit River did not seem to influence community structure to any great extent, however, the more productive nature of the riparian zone could be seen by the greater number of individuals captured. Cottonwood stands on the south-east bank of the river were limited. It appeared that more significant numbers of cottonwood could be found on the north-west bank.

Greater diversity in small mammals would be expected in the Sumallo Grove given its old-growth nature. However, the limited size of the old-growth fragment may be a restricting factor here as well. At well under 10 ha this old-growth is likely too small to support many old-growth dependent species. Although none of the small mammals listed in Table 1 are strictly old-growth dependent, other larger species of wildlife may have limited opportunity to survive within Sumallo Grove. Captures of *Peromyscus* sp. and red-backed voles are consistent with mature stand communities as well as old growth.

Grassland communities tend to have many Microtine rodents. Potential reasons for failing to capture any individuals within the Chittenden Meadows are discussed later in the discussion of survey methodology. Riparian areas produced a large number of *Peromyscus sp.* as in the Skagit River Cottonwood Ecoreserve. These higher population numbers can be caused by a number of factors. One explanation may be that the habitat is indicative of better habitat quality for the species that respond positively to it. This is probably the case as primary productivity appears to be higher in riparian areas.

It became apparent that two species of *Peromyscus* were present throughout the valley. *Peromyscus maniculatus* and *Peromyscus oreas*, two species that can be identified by their tail

lengths (Nagorsen 1993), were present on all survey areas. Particularly in the Chittenden Meadows (riparian) area, short-tailed mice (*P. maniculatus*) outnumbered long-tailed mice (*P. oreas*) by a considerable number (Table 4, Fig. 6a). When analyzing the relative number of *P. oreas* and *P. maniculatus* in each habitat, patterns became apparent (Fig. 6b). Although these two species share extremely similar ecological requirements, they both existed in the same habitats with *P. oreas* dominating in some habitats and *P. maniculatus* dominating in others. These preliminary results indicate that some process of habitat partitioning or competition is contributing to the patterns of distribution of these two species (see also Merkens, Harestad and Dunbar in prep).

5.2 Species of Concern

Two subspecies of the mountain beaver are found in B.C. *Aplodontia rufa rufa* are found in the Puget Sound lowland area south of the Fraser River from Hope to Langley (Cowan and Guiget 1965). Higher elevation, forested areas in the Cascades are the are the home of *Aplodontia rufa rainieri* (Cowan and Guiget 1965). Limits in geographic range of the mountain beaver are affected by rainfall and edaphic conditions that promote succulent vegetation and moist soil (Feldhammer and Rochelle 1982). For this reason, the transitional nature of the Skagit Valley may provide marginal and/or patchy habitat for the mountain beaver. Limited examples of both sightings and specimens have been recorded near the Skagit Valley (Maurer and Harestad 1983). Mountain beaver have not been recorded within the Skagit Valley, but they likely do exist there.

Of the sites surveyed during my study, only the Skagit River Cottonwood Ecoreserve and the riparian areas near Chittenden Meadows provided potential mountain beaver habitat. A small valley created by the Maselpanik Creek just west of the Skagit Valley Recreational Area may provide a considerable amount of good mountain beaver habitat. This valley is less affected by the rain shadow created by the Pickett Range at the lower end of the Skagit Valley and has undergone a considerable amount of logging in recent history. The disturbances imposed by logging activities can promote luxurious growth of vegetation in openings. Neal and Borrecco (1981) suggested that mountain beaver home ranges were inversely proportional to the proportion of home range lacking tree cover and found that more than one individual home range may occupy part of openings greater than 0.13 ha. Also, many mountain beaver have been sighted at the upper end of the Maselpanik (Keith Furgason, pers. comm.).

The geographic range of the Cascade golden mantled ground squirrel is limited to the Cascade mountains of southwestern British Columbia and western Washington State (Hall 1981). In British Columbia it has been observed as far north as Merritt, as far west as just

north-west of Chilliwack Lake, and as far east as the southern Okanagan (Leung 1991). Habitat requirements for this species are quite varied. They are known to occupy a wide variety of habitat types including krumholz, talus slopes, closed coniferous forests and open meadows (Reichel 1986, Tromboulak 1988). It is suspected that the range of this species is limited by a variety of factors including physical barriers, thermal limitations and interspecific competition (Leung 1991). Limited examples of both sightings and specimens have been recorded within and in the vicinity of the Skagit Valley (Slaney 1973, museum records). Leung (1991) was unable to locate any Cascade mantled ground squirrels at three survey points in the vicinity of the Skagit Valley. Given that the habitat requirements of this species are quite varied, any of the survey areas examined during this study may provide adequate habitat.

The geographic range of the Trowbridge's shrew in B.C. is extremely limited. It has been observed throughout the lower mainland, but is predominantly limited to areas south of the Fraser River. It is one of the most common small mammals in forested ecosystems throughout most of its range in Washington and Oregon (Gilbert and Allwine 1991, West 1991, Aubry *et al.* 1991). Zuleta and Galindo-Leal (1992) found that this species was also the most abundant species in most of the areas they surveyed in the lower mainland of British Columbia. They suggest that presence of this species may be limited by minimal canopy cover. It has also been suggested that Trowbridge's shrew tends to prefer drier habitat than the vagrant shrew. Given the diversity of habitat within the Skagit Valley, one would expect some suitable habitat for the Trowbridge's shrew, however, none have been documented for the Skagit. It is difficult to say whether or not they exist in the valley, and data recently collected elsewhere has not confirmed its presence either (Merkens, Harestad and Dunbar in prep.).

5.3 Ecological Reserves

In British Columbia Ecological Reserves are parcels of land which have been legally protected under the Ecological Reserves Act of 1971. By designating an area as an ecological reserve, it is protected from all consumptive and some non-consumptive resource uses. They are selected and established for various reasons. The purposes for the establishment of the 4 ecological reserves within the Skagit Valley are listed in Table 2. The objectives for reserve establishment are being met in all but perhaps the Skagit River Forest Ecoreserve.

If the purpose of the Skagit River Forest Ecoreserve is to preserve just the vegetative component of this particular "representative valley-bottom forest in an area transitional between coastal and interior climatic conditions," then, by all means, it may be met. However, the term "forest" is much too complex to include only the vegetative component. A forest can be defined by all the abiotic and biotic elements of an ecosystem dominated by trees and the

structural and functional relationships between them. The Skagit River Forest Ecoreserve is a scant 73 ha, and at this size could hardly maintain a functional forest ecosystem for long, if isolated. Certainly some wildlife species playing a role in the forest ecosystem in question have home ranges that are magnitudes of scale larger than the reserve itself. Furthermore, the variability associated with a transitional climate could hardly be covered in such a small area. The diverse nature of the Skagit is directly attributable to the transitional climate. A "representative valley bottom forest" would be very difficult to define under these conditions. Given these arguments, perhaps the purpose of the establishment of this particular reserve should be reviewed.

If the preservation of wildlife components is implied by the objectives of reserve establishment for the other reserves, then they may be too small as well. Various species of small mammals would and can survive in small regions of suitable habitat; some even smaller than 10 ha. For instance, mountain beaver home ranges can be less than 0.5 ha (Martin 1971, Lovejoy 1972, Lovejoy and Black 1979). The continuation of these species' presence is dependent on the continued existence of suitable habitat within a range of a source population. Habitat tends to change with time. Successional changes, natural disturbances and human alteration of the landscape all contribute to this change. The utility of reserves can only be measured with respect to the ability of the surrounding landscape to buffer ecological processes.

5.4 Survey Methodology

Live-trapping was chosen to evaluate small mammal numbers in this survey due to the sensitive nature of the study sites and the concerns of the Parks Branch. From an ethical point of view, it would be the preferred method, especially when dealing with species of particular concern (red or blue listed species). There are, however, a number of factors that make it unsuitable for some studies.

For live-trapping to be effective, a period of prebaiting is required. This allows the animals to become familiar with traps and associate them with food sources. This procedure allows for maximum trappability and is essential for capturing adequate samples of most species of voles (Ritchie and Sullivan 1989). Short-term studies do not allow for this habituation and accordingly, data collected in a short-term survey will necessarily be skewed to emphasize non-microtine species. Such was likely the case here. Furthermore, the effort involved with an intensive live-trapping survey limits the area that can be covered. Variation in the landscape is difficult to include in the study design because of limitations imposed by live-trapping.

An alternative to live-trapping is snap-trapping. In a snap-trapping program, no pre-baiting is required, large areas can be covered and the procedure is much less labour intensive. Like with live-trapping, there are draw-backs to snap-trapping. Sampling is destructive in nature and should be avoided when dealing with small and isolated populations of threatened species. This method is also not suitable for studies in which populations are to be monitored over time. Removal of individuals will certainly affect population processes in various ways. For short-term studies (one or two nights of trapping) only a small percentage of any particular population might be removed.

When choosing methodology for an inventory study, many factors must be taken into consideration. Figure 7 outlines a flow chart one may use to determine which methodology is best suited for use. Parameters important to choice of methodology can include: taxonomic groups of interest, species status, time scale, status of survey area and objectives of study.

6.0 Concluding Remarks

It became apparent that the interests of two groups were trying to be served during this survey. The Wildlife Branch wanted to inventory three species of concern, and the Parks Branch was interested in small mammal inventories within the four ecological reserves. By delineating the survey areas, especially by confining them to rather uniform reserve areas, the opportunity to find habitat critical to the species of concern was limited. As a result, answers for both parties are incomplete. No data for the three species of concern were generated and incomplete inventories for the three reserves were gathered. It may well be that the three species of concern do not inhabit the Skagit Valley. The approach for this portion of the study should have been to identify areas likely to contain the species of concern. If accurate data on species are needed, then more time must be allotted for surveys when dealing with sensitive species or areas. Four days per area is insufficient to complete a small mammal survey using live-traps. Perhaps, in the interest of gaining usable inventory results, future surveys of limited duration should involve snap-trapping techniques. This should be attempted cautiously, recognizing the impact of destructive sampling on threatened or rare species. The flow chart outlined in Figure 7 may be of use for future studies, however, it should be used only as a guideline when determining survey methodology. Many more parameters could be added to the decision making process. It also became apparent that the Skagit Valley is an extremely unique area in terms of the diversity of biological elements. The transitional nature of the area is quite noticeable compared to other areas of transition in the province.

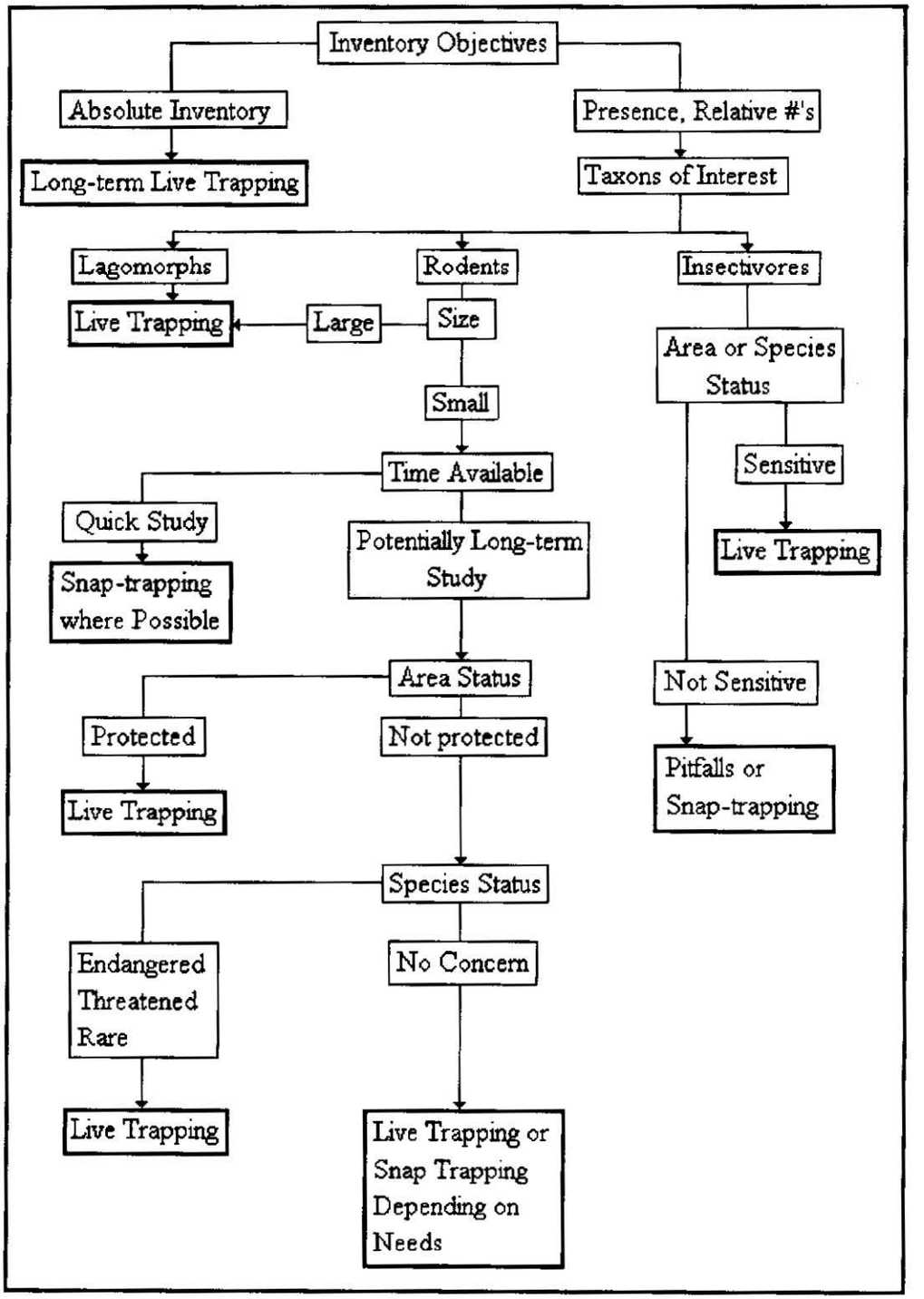


Figure 7. Flow chart outlining potential procedure for determination of small mammal survey methodology. Does not consider non-trapping techniques such as sighting, pellet counts or winter track counts.

7.0 Literature Cited

Aubry, K.B., M.J. Crites, and S.D. West. 1991. Regional patterns of small mammal abundance and community composition in Oregon and Washington. U.S.D.A. Forest Service General Technical Report PNW 285: 285–294.

B.C. Parks South Coast Region. 1993. Vegetation and Wildlife Findings for three ecological reserves in the Skagit Valley. Report submitted to the Skagit Environmental Endowment Commission.

Barnard, T. 1986. Skagit Environmental Endowment Area status of wildlife data. Ministry of Environment and Parks.

Carl, C.C., C.J. Guiget and G.A. Hardy. 1952. A natural history survey of the Manning Park area, B.C. British Columbia Prov. Museum Occ. Paper #9. Victoria.

Cowan, I. McT. and C.J. Guiget. 1965. The Mammals of British Columbia. B.C. Provincial Museum, Handbook 11:1–414.

Desrosiers, J. in prep. The Pacific rhododendron (*Rhododendron macrophyllum*, D. Don x G.Don) communities of the Skagit River watershed, B.C.

Feldhammer, G.A. and J.A. Rochelle. 1982. Mountain Beaver, *Applodontia rufa*. pp. 167–195. In: J.A. Chapman and G.A. Feldhammer (eds.), Wild Mammals of North America. John Hopkins University Press, Baltimore.

Gilbert, F.F. and R. Allwine. 1991. Small mammal communities in the Oregon Cascade Range. pp.257–268. In: L.F. Ruggiero et al. (Technical Coordinators), Wildlife and Vegetation of Unmanaged Douglas–fir Forest. U. S. Department of Agriculture Report, PNW–GTR–285.

Gilpin, M.E. and M.E. Soulé. 1986. Minimum viable populations: processes of species exstinction. In: M.E. Soulé (ed.), Conservation Biology: the Science of Scarcity and Diversity. Sinauer Assoc. Inc., Massachusetts.

Hall, E.R. 1981. The Mammals of North America. J. Wiley and Sons, New York.

Kremsater, L.L. 1987. Non-game Animals in the Skagit Valley of British Columbia: Literature Review and Research Directions. Contract paper prepared for the Ministry of Environment and Parks, January 1987.

Leung, M.A.L. 1991. Conservation Status of the Cascade Mantled Ground Squirrel, Spermophilus columbianus. M.Sc. Thesis. University of British Columbia, Vancouver.

Lovejoy, B.P. 1972. A capture-recapture analysis of a mountain beaver population in western Oregon. Ph. D. Thesis, Oregon State University, Corvallis, Oregon.

Lovejoy, B.P. and H.C. Black. 1979. Movements and home range of the Pacific mountain beaver, *Aplodontia rufa pacifica.* Northwest Sci. 53: 82-89.

Martin, P. 1971. Movements and activities of the mountain beaver, *Aplodontia rufa*. J. Mammal. 52: 717-723.

Maurer, A.L. and A.S.Harestad. 1983.Review of the Biology and Management of the Mountain Beaver, *Aplodontia rufa*. Student Paper, Center for Pest Management, Simon Fraser University, Burnaby, B.C.

Merkens, M., A.S. Harestad and D. Dunbar. in prep. Small mammal communities occupying various seral stages in the Skagit Valley, B.C.

Ministry of Environment, Lands and Parks. 1991. Skagit Valley Recreational Area Biophysical Habitat Inventory. Map prepared by Hugh Hamilton Ltd.

Nagorsen,D. 1993. Guide to the identification of small mammals in British Columbia. Royal British Columbia Museum, Draft Report.

Neal, F.D. and J.E. Borrecco. 1981. Distribution and relationship of mountain beaver to openings in sapling stands. Northwest Sci. 55: 79-86.

Reichel, J.D. 1986. Habitat use by alpine mammals in the Pacific Northwest, USA. Arct. Alp. Res. 18: 111-119.

Ritchie, C. and T.P. Sullivan. 1989. Monitoring methodology for assessing the impact of forest herbicide use on small mammal populations in British Columbia. FRDA Report 81, B.C. Ministry of Forests.

Slaney, F.F. and Co. Ltd. 1971. Environmental investigations Skagit Valley in Canada and indication of consequences from raising the level of Ross Lake. City of Seattle, Dept. of Lighting.

Slaney, F.F. and Co. Ltd. 1973. Environmental investigations proposed high Ross reservoir – Volumes 1–10. City of Seattle, Dept. of Lighting.

Tromboulak, S.C. 1988. *Spermophilus saturatus*. Mammalian Species 332:1–4.

West, S.D. 1991. Small mammal communities in the Southern Washington Cascade Range. pp.269–284. In: L.F. Ruggiero et al. (Technical Coordinators), Wildlife and Vegetation of Unmanaged Douglas–fir Forest. U.S.D.A. Report, PNW–GTR–285.

Yahner, R.H. 1986. Microhabitat use by small mammals in even aged forest stands. Am. Midl. Nat. 115(1):174-180.

Zuleta, G.A. and C. Galindo–Leal. 1992. Distribution and abundance of small mammals at risk in a fragmented landscape. Draft Report for the B.C. Ministry of Environment, Lands and Parks, Wildlife Branch.

APPENDIX 1. Record of voucher specimens collected for study in 1993.

Survey Area	Date	Station	Species*	Sex**	Breeding condition+	Weight (g)	Body (mm)	Tail (mm)	Hind foot (mm)	Ear notch (mm)
Chittenden	31.08.93	3.12	PEMA	M	S	15	166	89	29	18
Chittenden	31.08.93	3.18	PE	F	JUV	13	152	79	20	17
Chittenden	31.08.93	4.18	PEOR	F	NL	20	205	110	23	20
ER 21	19.08.93		PEOR	M	S	24	208	114	23	20
ER 21	19.08.93	2.6	PEOR	M	S	28	209	118	23	20
ER 22	11.08.93	3.18	PEMA	F	L	20	168	86	20	21
ER 22	11.08.93	1.16	PEOR	M	S	25	197	105	23	20
ER 89	27.08.93		PEOR	M	S	25	186	101	22	18
ER106	18.08.93	3.12	PEMA	M	S	17	175	88	20	20
ER106	18.08.93	3.18	PEMA	F	NL	18	169	82	20	19
Sumallo	25.08.93		PEOR	M	S	18	192	101	22	20
Sumallo	25.08.93		PEOR	M	S	23	210	112	23	19

* species codes: PEMA = *Peromyscus maniculatus*, PE = *Peromyscus* sp., PEOR = *Peromyscus oreas*

** sex codes: M = Male, F = Female

+ breeding condition codes: S = testes in the scrotal position, JUV = juvenile, NL = non lactating, L = lactating

Appendix 2. Data for all specimens captured during study.

Survey Area	Date D/M/Y	Station	Species*	Sex **	Breeding+ Condition	Weight (g)	Voucher
ER 22	11.08.93	1.5	PE	M	S	14	yes
		1.16	PE	M	S	25	yes
		3.6	PE	F	NL	16	yes
		3.8	PE	M	S	18	
		3.9	PE	M	S	17	
		3.18	PEMA	F	L	20	yes
	12.08.93	1.3	PEOR	M	S	17	
		1.16	MUER	F	NL	48	
		1.17	PEOR	M		19	
		2.4	PEMA	F	L	22	
		2.5	PEMA	M	A	13	
		2.18	PEMA	M	S	18	
		3.2	PEMA	M	S	17	
		3.13	PEMA	M	A	12	
		4.1	PEMA	M	S	20	
		4.11	PE	M	A	16	
		4.12	PEMA	M	S	19	
		4.15	PE	F	NL	15	
		R0.2	PE	F	NL	13	
		R0.7	PEMA	M	S	23	
		R0.12	PEOR	F	L	21	
		R0.15	CLGA	F	L	25	
		R0.17	PEMA	M	S	23	
		R0.21	PEOR	M	S	25	
		R0.23	PEMA	F	NL	25	
	13.08.93	R0.1	PEMA	M	S	21	
		R0.2	PE	F	NL	13	
		R0.4	PEOR	M	S	23	
		R0.5	PEOR	M	S	20	
		R0.6	PEMA	M	S	25	
		R0.7	PEMA	M	S	26	
		R0.13	PEOR	M	S	20	
		R0.14	PEOR	F	P	25	
		R0.15	PEOR	F	P	26	
		R0.17	PEMA	M	S	20	
		R0.18	PEMA	M	S	18	
		R0.19	PEMA	M	S	18	
		R0.20	PEOR	F	NL	25	
		R0.23	PEMA	F	L	17	
		R0.29	PEOR	M	S	25	
ER 106	18.08.93	1.16	PEMA	F	L	18	
		2.10	PEMA	F	L	22	
		2.15	PEMA	M	A	18	
		3.18	PEMA	M	S	17	yes
		4.12	PEOR	F	P	34	
		4.16	CLGA	F	NL	25	

Survey Area	Date D/M/Y	Station	Species	Sex	Breeding Condition	Weight (g)	Voucher
ER 106	19.08.93	1.16	PE	F	L	19	
		1.20	PE	F	NL	14	
		2.5	PE	M	S	24	
		2.12	PE	F	NL	16	
		2.14	PE	M	A	16	
		3.1	PEMA	F	NL	18	yes
		3.3	PEMA	F	NL	15	
ER 21	19.08.93	2.4	PE	M	S	24	
		2.6	PEOR	M	S	28	yes
		2.17	PE	F	L	22	
		2.20	PE	M	A	18	
		4.9	PEMA	M	S	15	
		4.11	PEOR	M	S	18	
		5.15	PE	M	A	27	
		5.17	PE	F	NL	19	
		5.19	PEOR	M	S	21	
		5.20	PEOR	M	S	25	
		6.8	PEOR	F	P	32	
		6.16	PEOR	M	S	21	
	20.08.93	1.8	PEOR	M	S	25	
		2.13	PEOR	M	S	15	
		2.15	PEOR	M	A	25	
		2.20	PE	M	A	19	
		3.2	PEOR	M	S	22	
		3.11	PEOR	F	L	22	
		3.15	PEOR	F	L	18	
		3.18	PEOR	M	S	21	
		4.7	PEMA	M	S	18	
		4.15	PEOR	M	S	17	
		5.1	PEOR	M	S	21	
		5.17	PEOR	F	P	23	
		6.4	PEOR	M	S	24	
		6.8	PEOR	F	P	27	
		6.9	PEMA	F	NL	9	
		6.15	PEMA	M	S	15	
		6.18	GLSA	F	L	-	
Sumallo Grove	25.08.93	1.7	PEOR	F	NL	20	
		1.10	PEMA	M	S	20	
		1.15	PEOR	F	L	22	
		1.2	PEOR	M	S	25	
		2.1	PEOR	M	S	25	
		2.14	PEOR	M	S	23	yes
		2.18	PEOR	M	S	18	yes
		3.2	PE	M	A	15	
		3.4	PE	F	NL	18	
	26.08.93	1.8	PEMA	F	L	16	
		1.9	PEOR	F	L	18	
		1.15	PEMA	F	NL	14	

Survey Area	Date D/M/Y	Station	Species	Sex	Breeding Condition	Weight (g)	Voucher
Sumallo Grove	26.08.93	2.17	CLGA	F	L	21	
		3.1	PEOR	F	L	23	
		3.5	PEOR	F	NL	18	
		3.12	PEOR	M	S	21	
		3.13	PEOR	M	A	22	
		3.14	PEOR	F	L	22	
		3.18	PEOR	F	P	30	
ER 89	26.08.93	1.2	PEMA	F	L	20	
		1.7	PEOR	F	L	25	
		2.5	PEMA	F	L	19	
		2.8	PEOR	M	S	15	
		2.9	PEOR	M	A	13	
		2.17	PEOR	M	S	18	
		2.20	PEMA	F	L	13	
		3.15	PEOR	M	A	20	
		3.19	PEOR	F	L	22	
		3.20	PEOR	M	S	20	
		4.3	PEOR	M	A	17	
	27.08.93	1.3	PE	M	A	12	
		1.3	PE	M	A	8	
		1.6	PEOR	F	L	19	
		1.9	PEOR	F	L	21	
		2.3	PEOR	M	S	14	yes
		2.7	PEOR	F	L	14	
		2.9	PEOR	F	NL	12	
		2.11	PEOR	F	L	17	
		2.12	PEOR	M	A	12	
		2.16	PEOR	M	S	24	
		2.18	PEOR	M	S	23	
		2.19	PEOR	F	L	17	
		3.1	PEOR	M	S	23	
		3.4	PEOR	F	L	21	
		3.8	PE	M	A	17	
		3.10	PEOR	F	L	22	
		3.14	PE	M	A	18	
		3.20	PEOR	F	NL	20	
		4.2	PEMA	M	S	20	
		4.3	PEOR	F	L	24	
		4.8	PEOR	F	L	22	
Chittenden Meadows	No captures on August 30 and August 31, 1993						
Chittenden Riparian	30.08.93	3.1	PE	M	A	13	
		3.5	PEMA	F	NL	21	
		3.8	PE	M	A	16	
		3.9	PE	F	NL	15	
		3.12	PEMA	M	S	16	
		3.18	PE	F	NL	13	yes
		3.20	PE	M	A	16	

Survey Area	Date D/M/Y	Station	Species	Sex	Breeding Condition	Weight (g)	Voucher
Chittenden Riparian	30.08.93	4.2	PE	M	A	15	
		4.12	PE	F	NL	15	
		4.18	PEMA	F	NL	15	
		5.2	PEMA	M	S	10	
		5.10	PEMA	M	A	11	
	31.08.93	3.5	PEMA	F	NL	19	
		3.8	PEMA	F	NL	19	
		3.9	PEMA	M	S	12	
		3.11	PEMA	M	S	13	
		3.12	PEMA	M	S	15	yes
		4.2	PEMA	M	A	15	
		4.9	PEMA	M	S	15	
		4.12	PEMA	F	NL	16	
		4.15	PEMA	F	NL	14	
		4.16	PEMA	M	A	14	
		4.18	PEOR	F	NL	20	yes
		5.6	PEMA	M	S	21	
		5.8	PEMA	M	S	18	
		5.10	PEMA	M	S	18	
		5.12	PEMA	F	L	18	
		5.14	PEMA	F	NL	16	
		5.16	PEMA	F	NL	14	
		5.17	PE	F	NL	11	
		5.18	PE	F	NL	11	

* PE = *Peromyscus sp.*
PEMA = *Peromyscus maniculatus*
PEOR = *Peromyscus oreas*
MUER = *Mustela erminea*
CLGA = *Clethrionomys gapperi*
GLSA = *Glaucomys sabrinus*

** M = Male
F = Female

\+ L = lactating
NL = not lactating
P = pregnant
S = scrotal
A = Abdominal

APPENDIX 3. Conservation Data Centre Field Observation Forms

Skagit Valley Rare Biological Elements: Skagit Mammal Inventory

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus maniculatus*

Numbers: Male 14 Female 3 Immature _____ Unknown _____

Evidence of Breeding: 3 lactating females, 12 scrotal males

Type of Observation: 17 individuals captured

1 specimen collected

Site name/number ER 22

Location as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 642600 NORTHING 5429400

Date day 11-13 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Douglas-fir - Oregon grape/Boxwood Terrace

Habitat Description two areas: 1) open area dominated by rock and grasses with few Yellow Pine and Douglas-fir interspersed
2) dense second growth Douglas-fir and western red cedar moderate levels of dead and down woody material, sparse understory, small stream

Elevation 1850-2250 feet Slope: 5-60° Aspect: west

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus oreas*

Numbers: Male 7 Female 4 Immature _____ Unknown _____

Evidence of Breeding: 1 lactating female, 2 pregnant females, 6 scrotal males

Type of Observation: 11 individuals captured

_____ specimen collected

Site name/number ER 22

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 642600 NORTHING 5429400

Date day 11-12 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Douglas-fir - Oregon grape/Boxwood Terrace

Habitat Description two areas: 1) open area dominated by rock and grasses with few Yellow Pine and Douglas-fir interspersed
2) dense second growth Douglas-fir and western red cedar moderate levels of dead and down woody material, sparse understory, small stream

Elevation 1850-2250 feet Slope: 5-60° Aspect: west

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Clethrionomys gapperi*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: 1 lactating female

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number ER 22

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference:

ZONE 10U EASTING 642600 NORTHING 5429200

Date day 12 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Douglas-fir – Oregon grape/Boxwood Terrace

Habitat Description Dense second growth Douglas-fir and western red cedar
moderate levels of dead and down woody material,
sparse understory, captured in the vicinity of a small stream
many earthstar fungi along stream

Elevation 2100 feet Slope: 5-60° Aspect: west

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Mustela erminea*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: none

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number ER 22

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference: measured as accurately as possible to capture location
ZONE 10U EASTING 642500 NORTHING 5429300

Date day 12 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Douglas-fir - Oregon grape

Habitat Description Dense second growth Douglas-fir and western red cedar
moderate levels of dead and down woody material,
sparse understory, captured approximately 100 meters from a small stream

Elevation 1900 feet Slope: 5-60° Aspect: west

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus maniculatus*

Numbers: Male 2 Female 4 Immature _____ Unknown _____

Evidence of Breeding: 2 lactating females, 1 scrotal male

Type of Observation: 6 individuals captured

2 specimens collected

Site name/number ER 106

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 636700 NORTHING 5437100

Date day 18-19 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Douglas-fir - Oregon grape

Habitat Description area heavily dominated by rhododendron shrubs
some sparse conifer presence
dry to wet areas

Elevation 1800 feet Slope: none Aspect: below

Comments/Remarks east facing slope

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus oreas*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: 1 pregnant female

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number ER 106

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference:

ZONE 10U EASTING 636100 NORTHING 5437200

Date day 18 month 08 year 1993

Biogeoclimatic Zone CWHds1

Habitat Class Hemlock–moss

Habitat Description steep slope dominated by hemlock overstory and mossy floor
rocky in places, little dead and down woody material

Elevation 2100 feet Slope: 45–60° Aspect: east

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Clethrionomys gapperi*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: none

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number ER 106

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference:

ZONE 10U EASTING 636100 NORTHING 5437200

Date day 18 month 08 year 1993

Biogeoclimatic Zone CWHds1

Habitat Class Hemlock-moss

Habitat Description steep slope dominated by hemlock overstory and mossy floor
rocky in places, little dead and down woody material

Elevation 2100 feet Slope: 45-60° Aspect: east

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus maniculatus*

Numbers: Male 3 Female 1 Immature _____ Unknown _____

Evidence of Breeding: 3 scrotal males

Type of Observation: 3 individuals captured

_____ specimen collected

Site name/number ER 21

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 643700 NORTHING 544300

Date day 19-20 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Cedar-clintonia and Douglas-fir-oregon grape

Habitat Description Dense second growth Douglas-fir and western red cedar
large quantities of dead and down woody material,
well developed understoryof shrubs and herbs

Elevation 1750-180 feet Slope: shallow Aspect: south

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus oreas*

Numbers: Male 13 Female 5 Immature ____ Unknown ____

Evidence of Breeding: 12 scrotal males, 3 pregnant females, 2 lactating females

Type of Observation: 18 individuals captured

1 specimen collected

Site name/number: ER 21

Location: as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 643700 NORTHING 544300

Date: day 19-20 month 08 year 1993

Biogeoclimatic Zone: IDFww

Habitat Class: Cedar-clintonia and Douglas-fir-oregon grape

Habitat Description: Dense second growth Douglas-fir and western red cedar
large quantities of dead and down woody material,
well developed understory of shrubs and herbs
well developed conifer canopy

Elevation: 1750-1800 feet Slope: shallow Aspect: south

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Glaucomys sabrinus*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: 1 lactating female

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number ER 21

Location as per 1:50,000 NTS mapsheet and maps submitted with report

UTM grid reference:

ZONE 10U EASTING 637200 NORTHING 5439700

Date day 20 month 8 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Cedar-clintonia

Habitat Description Dense second growth Douglas-fir and western red cedar
large quantities of dead and down woody material,
well developed understory of shrubs and herbs
well developed conifer canopy

Elevation 1750-1800 feet Slope: shallow Aspect: south

Comments/Remarks

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus maniculatus*

Numbers: Male 1 Female 2 Immature ____ Unknown ____

Evidence of Breeding: 1 lactating female, 1 scrotal male

Type of Observation: 3 individuals captured

____ specimen collected

Site name/number: Sumallo Grove

Location: as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 639600 NORTHING 5453100

Date: day 25-26 month 08 year 1993

Biogeoclimatic Zone: CWHds1

Habitat Class: Forest

Habitat Description: old-growth remnant along-side Sumallo River
Dominated by large western red cedar and Douglas-fir
sparse understory, moderate amounts of dead and down woody material
Some areas within flood plain,forest floor consists of washed rock and sand

Elevation: 2200 feet Slope: variable, no steep sections Aspect: steep valley along east-west axis

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus oreas*

Numbers: Male 6 Female 7 Immature ____ Unknown ____

Evidence of Breeding: 5 lactating females, 1 pregnant female, 5 scrotal males

Type of Observation: 13 individuals captured

____ specimen collected

Site name/number: Sumallo Grove

Location: as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 639600 NORTHING 5453100

Date: day 25-26 month 08 year 1993

Biogeoclimatic Zone: CWHds1

Habitat Class: Forest

Habitat Description: old-growth remnant along-side Sumallo River
Dominated by large western red cedar and Douglas-fir
sparse understory, moderate amounts of dead and down woody material
Some areas within flood plain,forest floor consists of washed rock and sand

Elevation: 2200 feet Slope: variable no steep sections Aspect: steep valley along east-west axis

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Clethrionomys gapperi*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: 1 lactating female

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number: Sumallo Grove

Location: as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference:

ZONE 10U EASTING 639600 NORTHING 5453100

Date: day 25-26 month 08 year 1993

Biogeoclimatic Zone: CWHds1

Habitat Class: Forest

Habitat Description: old-growth remnant along-side Sumallo River
Dominated by large western red cedar and Douglas-fir
sparse understory, moderate amounts of dead and down woody material
Some areas within flood plain,forest floor consists of washed rock and sand

Elevation: 2200 feet Slope: variable no steep sections Aspect: steep valley along east-west axis

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus maniculatus*

Numbers: Male 1 Female 3 Immature ____ Unknown ____

Evidence of Breeding: 3 lactating females, 1 scrotal male

Type of Observation: 4 individuals captured

1 specimen collected

Site name/number: ER 89

Location: as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 637600 NORTHING 5447500

Date: day 26-27 month 08 year 1993

Biogeoclimatic Zone: CWHds1

Habitat Class: Hemlock-moss

Habitat Description: variable habitat, mostly dominated by large cedar in riparian areas
drier upland forest dominated by hemlock and Douglas-fir
riparian areas with heavy shrub layer in places, light forest floor vegetation in drier areas

Elevation: 1800 feet Slope: 0-20° Aspect: north by northwest

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus oreas*

Numbers: Male 11 Female 13 Immature ____ Unknown ____

Evidence of Breeding: 11 lactating females, 7 scrotal males

Type of Observation: 24 individuals captured

____ specimen collected

Site name/number: ER 89

Location: as per 1:50,000 NTS mapsheet submitted with report

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 637600 NORTHING 5447500

Date: day 26-27 month 08 year 1993

Biogeoclimatic Zone: CWHds1

Habitat Class: Hemlock-moss

Habitat Description: variable habitat, mostly dominated by large cedar in riparian areas
drier upland forest dominated by hemlock and Douglas-fir
riparian areas with heavy shrub layer in places, light forest floor vegetation in drier areas

Elevation: 1800 feet Slope: 0-20° Aspect: north by northwest

Comments/Remarks:

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer: Markus Merkens/Chris Cheng Project Name: Skagit Mammal Inv.

Species: *Peromyscus maniculatus*

Numbers: Male 11 Female 9 Immature _____ Unknown _____

Evidence of Breeding: 1 lactating female, 9 scrotal males

Type of Observation: 20 individuals captured

2 specimen collected

Site name/number: Chittenden Riparian

Location: as per 1:50,000 NTS mapsheet submitted with report
all trap sites within 300 m of Chittenden suspension bridge

UTM grid reference: measured to centre of survey area
ZONE 10U EASTING 641800 NORTHING 5431200

Date: day 30-31 month 08 year 1993

Biogeoclimatic Zone: IDFww

Habitat Class: Cedar-clintonia (riparian)

Habitat Description: river bank dominated by shrubs and cottonwood, steep bank areas
dominated by cedar
fast flowing river adjacent to trap sites

Elevation: 1650-170 feet Slope: none Aspect: fully exposed

Comments/Remarks: _____

CONSERVATION DATA CENTRE
FIELD OBSERVATION FORM (ANIMALS)

Name of Observer Markus Merkens/Chris Cheng Project Name Skagit Mammal Inv.

Species *Peromyscus oreas*

Numbers: Male _____ Female 1 Immature _____ Unknown _____

Evidence of Breeding: none

Type of Observation: 1 individuals captured

_____ specimen collected

Site name/number Chittenden Riparian

Location as per 1:50,000 NTS mapsheet submitted with report
all trap sites within 300 m of Chittenden suspension bridge

UTM grid reference:
ZONE 10U EASTING 641800 NORTHING 5431600

Date day 30-31 month 08 year 1993

Biogeoclimatic Zone IDFww

Habitat Class Cedar-clintonia (riparian)

Habitat Description river bank dominated by shrubs and cottonwood, steep bank areas dominated by cedar
fast flowing river adjacent to trap sites

Elevation 1650-170 feet Slope: none Aspect: fully exposed

Comments/Remarks

BAT SURVEY OF THE SKAGIT RIVER WATERSHED IN BRITISH COLUMBIA

by
Mitchell C. Firman
and
Robert M. R. Barclay

Division of Ecology (Behavioural Ecology Group), Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada T2N 1N4

INTRODUCTION

The Skagit river watershed is located in south western British Columbia. The Skagit river flows south, and enters the U.S.A. at Ross lake. Significant water courses that drain into the Skagit river are the Klesilkwa, Sumallo and Skaist rivers, and the Maselpanik, Nepopekeum and Snass Creeks.

The area is part of the boundary between the Coastal and Southern interior biogeoclimatic zones. Many species (flora and fauna) found in this region are at their most eastern or western limits. The purpose of this study was to inventory the bat species in the watershed.

Field work was conducted during August 1993. Bats were caught using mist nets and a Harp trap (Tuttle 1974). All bats caught were identified to species, sex and age (adult or young-of-the-year; Anthony 1988). Each was weighed to the nearest 0.1g and their forearms were measured with calipers. For Long-eared bats additional measurements of the ear, tibia and, third and fifth metacarpals were made, to aid species identification. All bats were released at their point of capture. Passive listening was accomplished with QMC mini-II bat detectors to determine activity and a crude idea of species representation.

SUMMARY

Netting and trapping were conducted at 19 sites, accounting for 24 trapping nights (Table 1). A total of 45 bats were captured (Table 2).

The most common species was the Little brown bat, *Myotis lucifugus*, which accounted for 25 of 45 individuals. The Western small footed bat, *Myotis ciliolabrum*, accounted for 8 individuals and the California bat, *Myotis californicus*, 7. Three Long-legged bats, *Myotis volans*, were captured as well as two long-eared *Myotis*. Species identification of the long-eared bats is pending the evaluation of field measurements by Stan van Zyll de Jong (National Museum of Natural Sciences). Using the ultrasonic bat detectors, two species were identified that were not captured in the trap or nets: *Eptesicus fuscus* (Big brown bat) and *Lasiurus cinereus* (Hoary bat).

BATS CAPTURED

LITTLE BROWN BAT (*Myotis lucifugus*)

Myotis lucifugus was the most abundant and wide ranging bat encountered in the study. Always captured over or near water, it could be expected over any slow moving or still body of water (up to 1740 Meters elev.; Fig. 1). The area is home to both adult males and maternity sites as indicated by

captures of a juvenile and lactating / post-lactating females. We felt confident identifying Little brown bats with the bat detector and identified them at sites where they were not captured (Fig. 1)(see ULTRASONIC DETECTION / VIEWING section).

CALIFORNIA BAT (*Myotis californicus*) AND WESTERN SMALL-FOOTED BAT (*Myotis ciliolabrum*)

Both of these small footed species were usually captured beside or near water but not over it. Our capture of these bats was restricted to the wider valley bottoms (lower Klesilkwa and Skagit rivers) and resulting lower elevations (Fig. 2 and 3). Maternity sites for both species existed as evidenced by lactating and juvenile California bats, and lactating / post lactating Western small footed bats.

Typical coloration for *M. californicus* is a dark brown pelage while *M. ciliolabrum* has a much lighter flaxen coloration (van Zyll de Jong 1985). Non-typical (and typical) color variants of both species were captured which made species identification more difficult. Although color is usually a poor characteristic to separate mammal species, unfortunately it is an important characteristic used to separate these two small-footed bats in the field. For species identification of the small-footed bats, we had to rely on the dorsal view of the snout and the differences in exposed skin (van Zyll de Jong 1985).

LONG-LEGGED BAT (*Myotis volans*)

All three *M. volans* came from the same location on the same evening (Fig. 4). Two of the individuals were captured over a still-water section of the Sumallo R., while the other was caught over the adjacent riverbank. Neither of the two females was reproductively active. The male *M. volans* had enlarged testes indicating preparations to enter the hibernaculum and mate. Little of this bat's biology is known and its relative abundance is usually low.

LONG-EARED MYOTIS SPECIES

Both of the Long-eared bats in this study were caught at the same location with an 11 day interval between the captures (Fig. 4). Interestingly they came from a 'rare' forest type in this region. Each was caught over the Klesilkwa R. in a section surrounded by the largest piece of undisturbed forest we found on the Klesilkwa or lower Skagit Rivers. As was the case in this study, long-eared bats often have low relative abundance compared to other sympatric species. Although no females were captured, the small sample size does not rule out the possibility of females or maternity sites existing in the region.

ULTRASONIC DETECTION / VIEWING

Mist nets and Harp traps are not completely effective, and bats although present can easily remain uncaptured. At dusk, bats can usually be seen with the unaided eye, and even in the dark can be detected by their echolocation calls. Identification by these methods is crude and can only make generalizations about *Myotis* species but can be more specific when dealing with larger bats of other genera. Figure 5 represents the discernibly different echolocation calls heard during this study (using the QMC mini-II bat detector). Unfortunately calls of the same species can vary with geographic distribution or activity type and were often inconsistent with literature values (eg. Fenton and Bell 1981, and Fenton et al. 1983). Identification was made through playback of calls to 'experienced ears' and by comparing calls of free roaming bats with those just captured or released; adjusting literature values accordingly.

The call of the Big brown bat, *Eptesicus fuscus*, was easily identifiable (Fig. 5) even from longer distances (+20 metres). The call of the Hoary bat overlapped that of the Big brown and was hard to distinguish when both were present. The Hoary bats' audible portion of its call was useful for identification but only discernible in very quiet surroundings.

The call of the Little brown was easily identifiable because of its specific frequency range (40-60 kHz), loudness, and rapid changes in both the call intensity and interval between calls. Over the frequency range of the little brown's call, it was most intense at 50 kHz.

Myotis volans had a call very similar to the Little brown bat but differed slightly, with a higher frequency range (40 to 80 kHz) and noticeably lower intensity.

An unidentified bat had a call from 30 to 50 kHz with the highest intensity at 40 kHz. The calls consisted only of clicks and had a slow constant cadence and uniform intensity. On the two occasions when heard, this bat stayed in the vicinity of the detector for repeated passes, making it unlikely to be just a 'commuting' call of an already identified species.

The small footed bats (California and Western small-footed) had calls that varied within 40 to 100 kHz but always covered at least the 50 to 90 kHz range. Call intensity was low and was sometimes undetectable even within a few meters.

Figure 6 illustrates the locations of bats identified only by ultrasonic detection, while specific dates and locations are given in table 3.

NOTE : The frequency of echolocation calls given here is as read from the bat detector. The detectors cover a 6 kHz band width at any given frequency setting.

ECOLOGICAL RESERVES

Ecological reserves in the area were reconnoitered for trapping but were usually small and offered few 'good' trapping sites. Although the Ross Lake (Ponderosa pine) reserve did not have 'ideal' trapping sites, its value as typical of the Interior Douglas fir zone necessitated a try. Unfortunately no bats were captured but calls of the Big brown bats and of an unidentified bat were heard (see Fig. 6).

SPECIES DISTRIBUTION

All species identified in this report are within their known ranges (eg. Nagorsen and Brigham 1993). With two different low elevation biogeoclimatic zones in the area (Interior Douglas fir and Coastal western hemlock) we might expect differential habitat use by the various species. However, all the species that were discerned with regularity were identified in both biogeoclimatic zones (*Myotis lucifugus, M. ciliolabrum, M. californicus*, and *Eptesicus fuscus* ; Table 2). Broad differences in habitat use might be hard to detect with a mobile animal in this limited area and logging practices have probably reduced the vegetational differences that do exist. The less common species might shed more light on preferential habitat use but, unfortunately, were not captured enough to make valid comparisons (not identified from more than one site or sighting).

Elevation seemed to play a more dramatic role in habitat differences. When we climbed to higher elevations differences between biogeoclimatic zones were more apparent. However, the higher sites had a more harsh environment and were only frequented by little brown bats with any certainty.

HISTORICAL BAT RECORDS

Since historical bat records go back to 1905, the history of the area should be reviewed: At the turn of the century development in the area was limited to prospecting, limited settlement and some minor logging. Major Logging operations appeared in the 1940's and worked from the lower Klesilkwa R. into the southern Skagit valley as well as the lower Sumallo River. Good secondary growth covers these disturbed areas now but the trees still do not approach the full size of those they replaced. The Skagit R. was dammed on the American side in the 1950's and this flooded the

valley 1.5 Km into the Canadian side. More recent logging (clear-cut) is clearly visible on Maselpanik creek and the upper Klesilkwa and Sumallo rivers.

The historical bat specimens (Figure 7) were taken using a shot-gun, and therefore have a higher proportion of high flying (larger) bats, which are harder to capture using today's non-destructive sampling techniques.

On July 5, 1905, two Yuma bats (*Myotis yumanensis*) were caught near the confluence of the Klesilkwa and Skagit rivers (Mile-30) and another Yuma was caught on July 16, 1949 at Mile-20 on the Sumallo R. (Fig. 7). We captured *Myotis lucifugus* at Mile-23 and heard them near Mile-15 on the Sumallo R, as well as capturing them at Mile-30. Since Yuma and Little brown bats are difficult to differentiate in the field, our bats may in fact be the same as the museum historical specimens: *Myotis yumanensis*. In this study the differentiation of *M. lucifugus* and *M. yumanensis* was based on skin and pelage color (eg. van Zyll de Jong 1985); although not as accurate as skull measurements (eg. museum specimens) it is less destructive.

On July 14, 1949, a Big brown bat was taken at Mile-23, now Sumallo Grove, at the confluence of the Skagit and Sumallo rivers. Another was taken on July 15, 1949 at Mile-15 on the Sumallo R. (Fig. 7). We noted Big brown bat calls at Mile-23 and numerous other sites (Fig. 6).

On July 15, 1949, a Silver-haired (*Lasionycteris noctivagans*) was caught at Mile-15 on the Sumallo R. and on August 6, 1949, two Silver-haired bats were taken at the Whitworth Ranch (Fig. 7). By this time the ranch had been abandoned for 33 years and the beaver dams were likely there as they are now. We trapped twice at the beaver dams on the edge of the old Whitworth property (Aug 7 & 21). Although we did see large bats with flights unlike those (eg. slow) of Big brown and Hoary bats, we only identified the calls of these two.

On July 5, 1905, a Western red bat (*Lasiurus blossevilli*) was taken near the confluence of the Klesilkwa and Skagit rivers (Fig. 7). We trapped in the area on August 10th and 17th, and again although we saw some larger bats with flight atypical of Big browns we only identified the calls of these.

NOTES / MISC.

Just over the American border at Ross lake is a large maternity colony of *Myotis lucifugus* in an equipment building (Seattle City Light). The building was originally constructed during logging operations (1940's). Each evening the colony initially feeds on the eastern edge of the lake (straddling the border). It should be mentioned that the

level and shoreline of Ross lake changes dramatically with the seasons. Lake level is raised at the end of June for recreation (shoreline shown on most maps) and lowered at the end of September for Hydro-power purposes (the shoreline moving south of the border).

Acknowledgments

This Study would have not been possible without funding from the Wildlife Branch, B.C. Ministry of the Environment, Lands and Parks. Thanks go to the Southern B.C. Provincial Parks Region, B.C. Conservation Data Center, Dave Nagorsen, and the North Cascades region Parks service (U.S.A.) for their help and support. Special thanks to Mike Getty and friends.

Literature cited

Anthony, E.L.P. 1988. Age determination in bats. Pages 47-58 in T.H. Kunz, ed. Ecological and behavioral methods for the study of bats. Smithsonian Inst. Press, Washington. 533pp.

Fenton, M.B. and G.P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. J. Mammal. 62: 233-243

Fenton, M.B., H.G. Merriam and G.L. Holroyd. 1983. Bats of Kootenay, Glacier and Mount Revelstoke national parks in Canada: identification by echolocation calls, distribution, and biology. Can. J. Zool. 61: 2503-2508.

Nagorsen, D.W. and R.M. Brigham. 1993. Royal British Columbia Museum Handbook: Bats of British Columbia. Royal British Columbia Museum. UBC Press, Vancouver.

Tuttle, M.D. 1974. An improved trap for bats. J. Mammal. 55: 475-477.

van Zyll de Jong, C.G. 1985. Handbook of Canadian Mammals 2. Bats. National Museum of Natural Sciences, National Museums of Canada.

TABLE 1. Skagit Watershed Trapping sites

Site	Date (Aug.)	Elev. (Meters)	UTM Coordinates North'n	East'n	#Bats captured	Biogeo-climatic Unit
Upper Sumallo R.	1	940	5452950	628400	0	CWHms1
Sumallo R. Log	2	640	5457750	631200	0	CWHds1
Nepopekeum R.	3	1340	5436600	652800	0	ESSFwm
Sumallo Grove	4	610	5452350	639850	0	CWHds1
Chittenden	5	490	5431200	641800	3	IDFww
Upper Klesilkwa R.	6	580	5444975	623400	2	CWHds1
Beaver Dam	7	490	5433175	640750	8	IDFww
Boundary Cotton Wd	8	580	5443500	629125	0	CWHds1
** Ross Lake Jetty	8	490	5429200	641650	---	IDFww
Maple Road	8	580	5443500	628100	0	CWHds1
Flooded Cotton Wd.	9	490	5430250	641300	2	IDFww
Silvertip Camp	10	550	5443950	633800	8	CWHds1
Grizz - Klesilkwa	11	550	5442250	632750	3	CWHds1
Ponderosa Eco.	12	670	5429500	642600	0	IDFww
Galene Lk. 1	13	1740	5430000	636200	0	ESSFwm
Galene Lk. 2	14	1580	5430100	636450	0	ESSFwm
3.0 Km Klesilkwa	16	550	5442750	630450	0	CWHds1
Silvertiped Crk	17	550	5444850	634400	1	Cwhds1
* Chittenden	18	490	5431200	641800	1	IDFww
Still water Skagit	19	520	5438800	637800	1	IDFww
* Upper Klesilkwa	20	580	5444975	623400	2	CWHds1
* Maple Road	20	580	5443500	628100	0	CWHds1
* Beaver Dam	21	490	5433175	640750	7	IDFww
* Grizz-Klesilkwa	22	550	5442250	632750	1	CWHds1
* Sumallo Grove	27	610	5452350	639850	4	CWHds1
Skagit Cotton Wd.	28	590	5449200	639250	2	CWHds1
* Nepopekeum R.	29	1340	5436600	652800	0	ESSFwm
				Total	45	

* - Second time at site.
** - Observation only, no trapping.

Key to Biogeoclimatic Zones:
CWHds1 - Coastal Western hemlock Zone, Southern Dry Submaritime
CWHms1 - Coastal Western hemlock Zone, Central Moist Submaritime
IDFww - Interior Douglas-fir Zone, Wet Warm
ESSFwm - Engelmann Spruce - Subalpine Fir Zone, Wet Mild

Table 2. Skagit watershed survey - All bats captured.

Date: August	Species	Mass (grams)	Forearm (mm)	Sex	Reproductive condition	Comments
5	M. calif	4.9	32.80	Male	Adult	Dark Brown color
5	M. calif	5.0	35.10	Female	Juvenile	Dark Brown color
5	M. cilio	5.5	33.20	Female	Non-repro	Orange/rust color
6	M. calif	6.0	35.70	Male	Adult	Brown color
6	M. cilio	6.1	35.10	Female	Lactating	Light coloration
6	M. calif	6.5	35.60	Male	Adult	Recapture
7	M. luci	4.8	34.40	Male	Adult	Dark coloration
7	M. luci	5.8	35.20	Male	Adult	Dark coloration
7	M. luci	5.8	34.65	Male	Adult	Dark coloration
7	M. luci	6.5	35.45	Male	Adult	Dark coloration
7	M. calif	4.8	32.40	Male	Adult	Dark Brown color
7	M. calif	5.3	33.20	Male	Adult	Orange/rust color
7	M. luci	7.3	36.70	Female	Non-repro	Dark coloration
7	M. calif	5.0	34.25	Male	Adult	Dark brown color
9	M. luci	5.7	34.00	Female	Non-repro	Dark coloration
9	M. cilio	5.2	33.75	Female	Lactating	Dark brown color
10	M. luci	6.0	36.55	Female	Non-repro	Dark coloration
10	M. luci	6.8	35.50	Male	Adult	Dark coloration
10	M. luci	8.2	38.25	Female	Post lac.	Dark coloration
10	M. luci	7.1	36.20	Female	Post lac.	Dark coloration
10	M. luci	6.5	38.30	Male	Adult	Dark coloration
10	M. luci	6.8	35.05	Female	Non-repro	Dark coloration
10	M. luci	6.5	35.95	Female	Non-repro	Dark coloration
10	M. cilio	5.0	33.00	Female	Lactating	Dark brown color
11	M. luci	8.1	35.85	Female	Post lac.	Dark coloration
11	M. luci	8.0	38.80	Female	Post lac.	Dark coloration
11	Long-ear	4.2	36.80	Male	Adult	Dark coloration
	Tibia 18.2 Ear 18.8 MC3 32.5 MC5 33.1					
17	M. luci	7.8	37.20	Female	Non-repro	Dark coloration
18	M. calif	6.0	33.90	Female	Lactating	Orange/rust color
19	M. luci	7.0	35.20	Female	Post lac.	Dark coloration
20	M. luci	6.5	34.60	Male	Adult	Dark coloration
20	M. luci	7.2	35.05	Male	Adult, enlarged testes	Dark coloration
21	M. cilio	4.8	33.60	Female	Post lac.	Orange/rust color
21	M. cilio	6.0	33.85	Female	Post lac.	Orange/rust color
21	M. cilio	5.5	33.55	Female	Lactating	Orange/rust color
21	M. luci	5.8	35.45	Male	Adult	Dark coloration
21	M. luci	6.4	34.25	Female	Non-repro	Dark coloration
21	M. luci	5.8	-----	Female	Juvenile	Dark coloration
21	M. cilio	4.8	32.10	Male	Adult	Orange/rust color
22	Long-ear	5.2	36.50	Male	Adult	Dark coloration
	Tibia 18.95 Ear 20.45 MC3 34.35 MC5 33.45					
27	M. luci	7.0	37.35	Female	Non-repro	Dark coloration
27	M. volans	8.3	39.60	Male	Adult, enlarged testes	
27	M. volans	7.9	39.90	Female	Non-repro	
27	M. volans	7.2	36.70	Female	Non-repro	
28	M. luci	5.8	35.30	Female	Non-repro	Dark coloration
28	M. luci	7.2	36.25	Female	Lactating	Dark coloration

Abbreviations: M. luci, Myotis lucifugus; M. calif, Myotis californicus; M. cilio, Myotis ciliolabrum; M. volans, Myotis volans; Long-ear, Long-eared Myotis species.

Table 3. Site and date of bats identified by echolocation calls.

Bat Species	Site as named in Table 1	Date (August)
Eptesicus fuscus	Sumallo Grove	4 & 27
	Chittenden	5 & 18
	Upper Klesilkwa R.	6 & 20
	Beaver Dam	7 & 21
	Ross Lake Jetty	8
	Silvertip Camp	10
	Grizz - Klesilkwa	11
	Ponderosa Eco.	12
	3.0 km Klesilkwa	16
	Silvertip Crk.	17
	Still water Skagit	19
	Skagit Cotton wd.	28
Myotis lucifugus	Sumallo R. Log	2
	Nepopekeum R.	3 & 29
	Chittenden	5 & 18
	Ross Lake Jetty	8
	Galene Lk. 1	13
	Galene Lk. 2	14
	3.0 km Klesilkwa	16
Lasiurus cineureus	Beaver Dam	21
	Chittenden	18
Unidentified	Ponderosa Eco.	12
	3.0 Klesilkwa	16

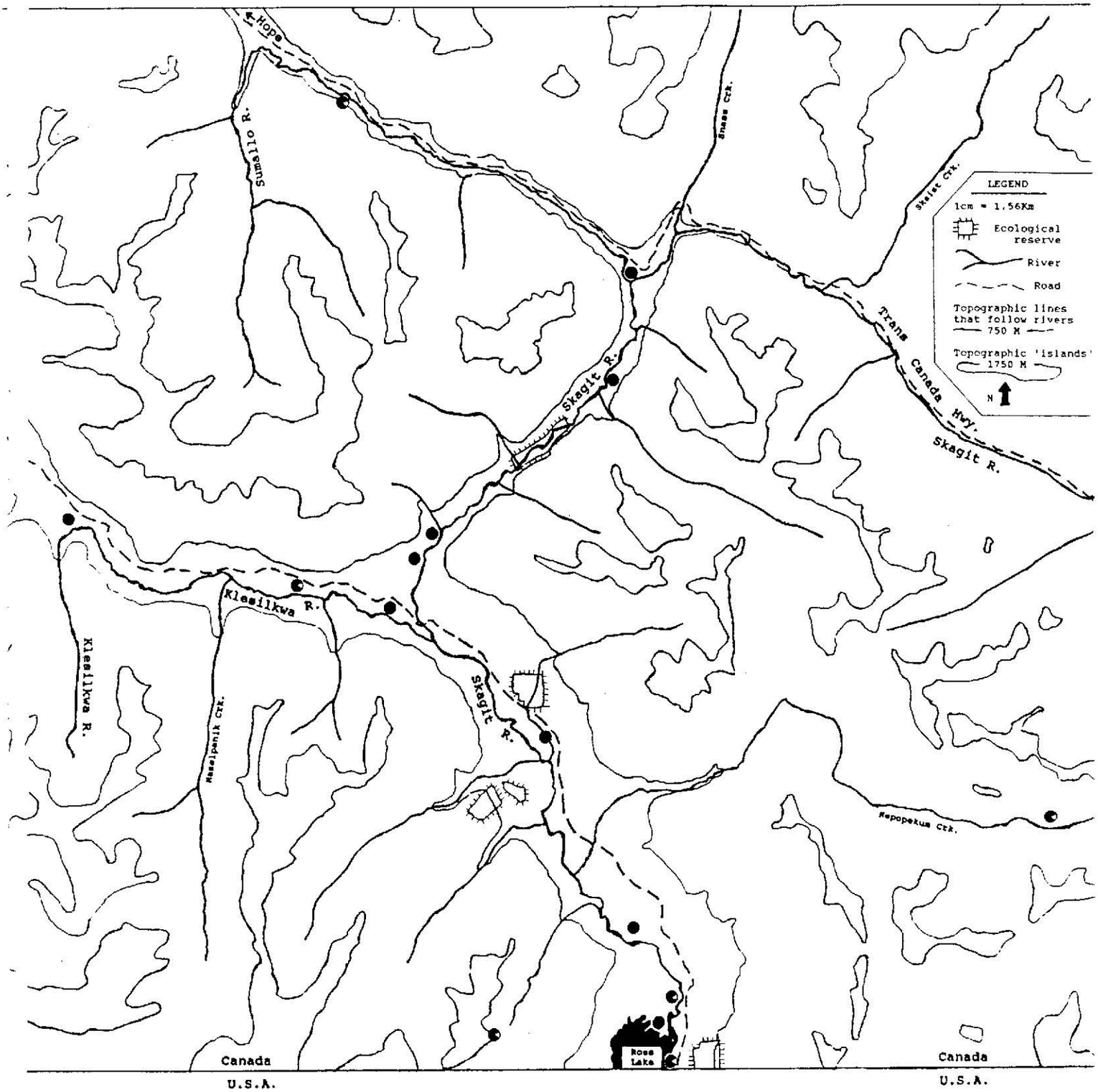


Figure 1. Skagit watershed capture (●) and ultrasonic detection (◐) sites of *Myotis lucifugus*.

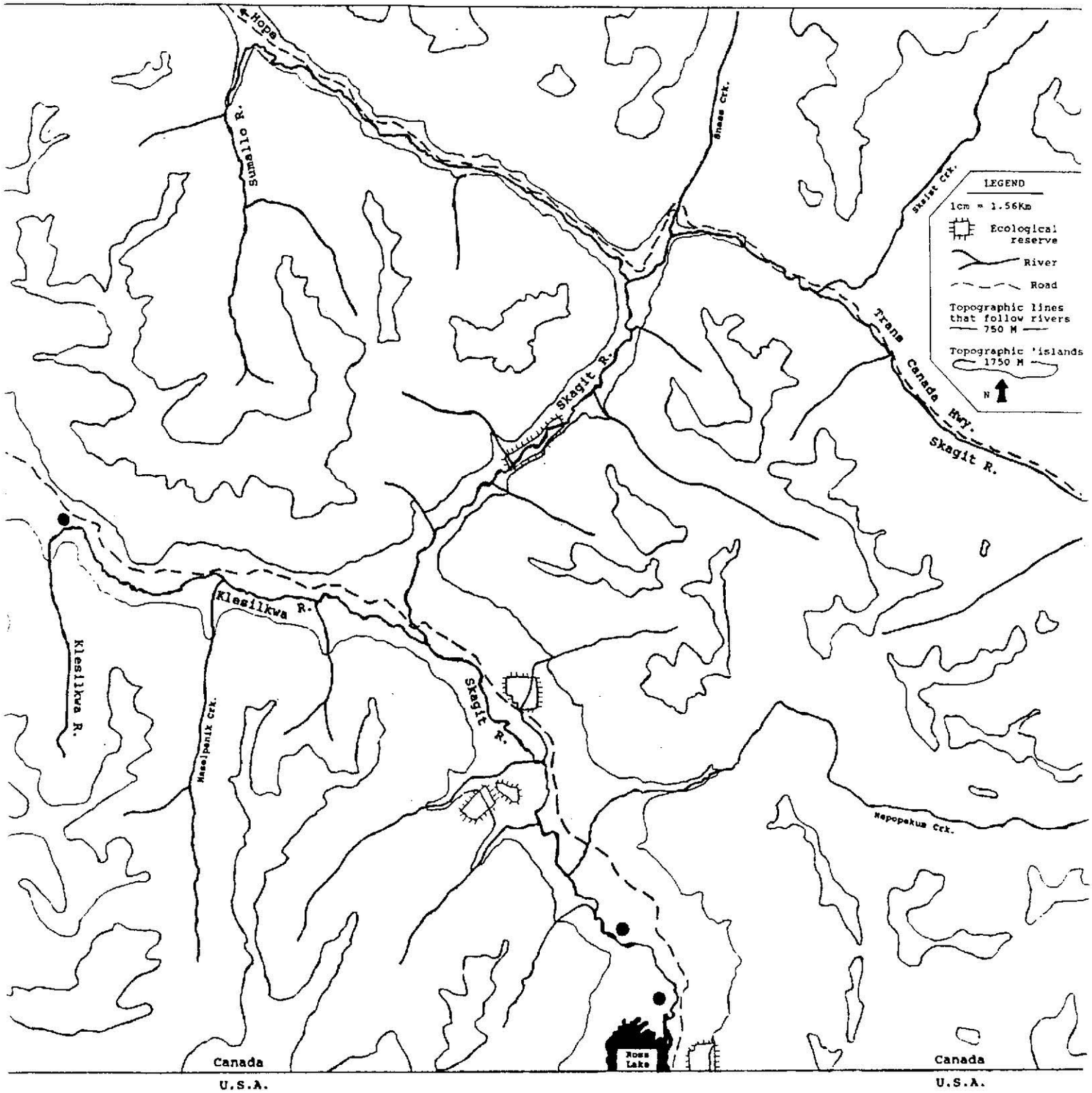


Figure 2. Skagit watershed *Myotis californicus* capture sites (●).

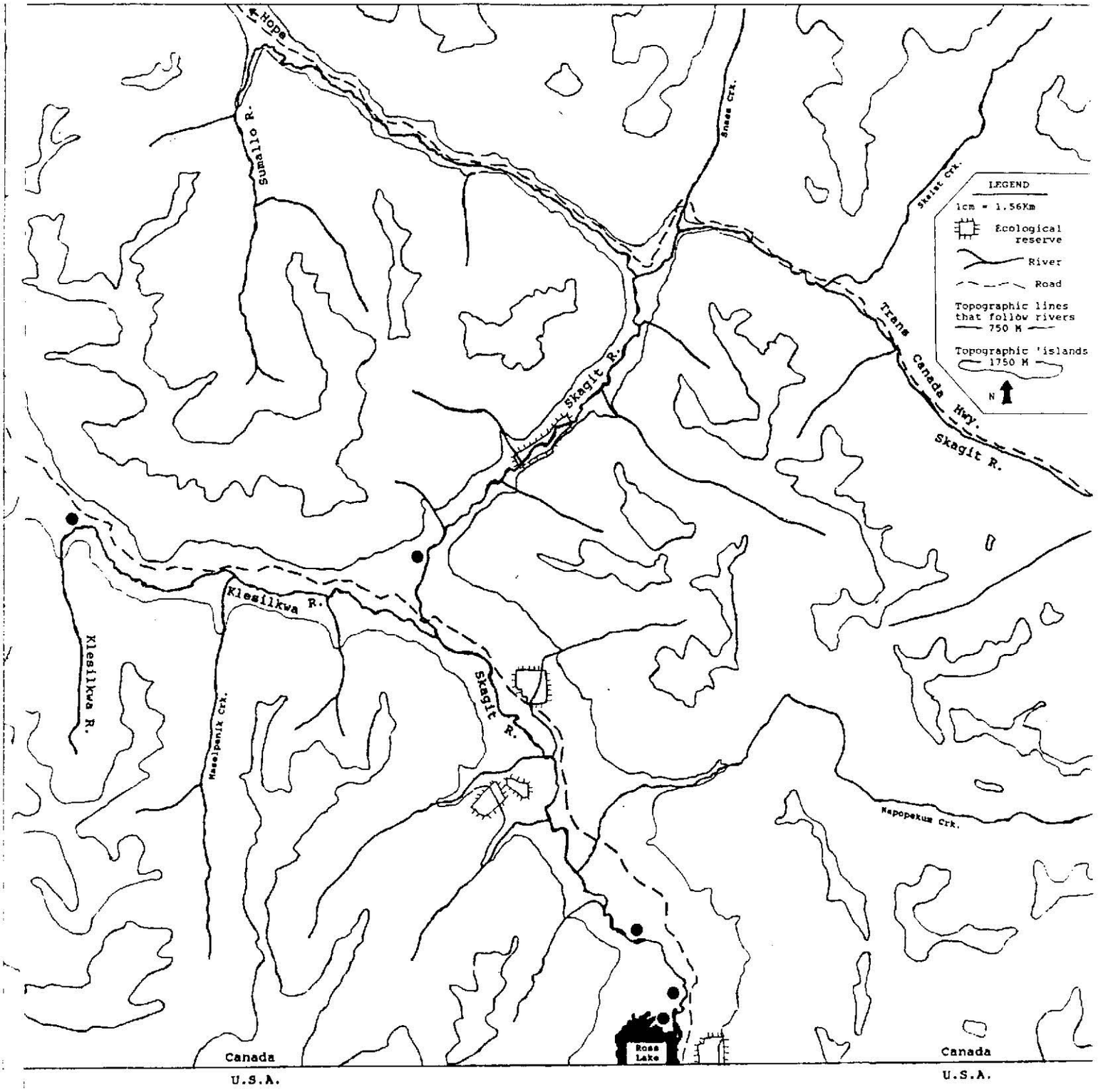


Figure 3. Skagit watershed *Myotis ciliolabrum* capture sites (●).

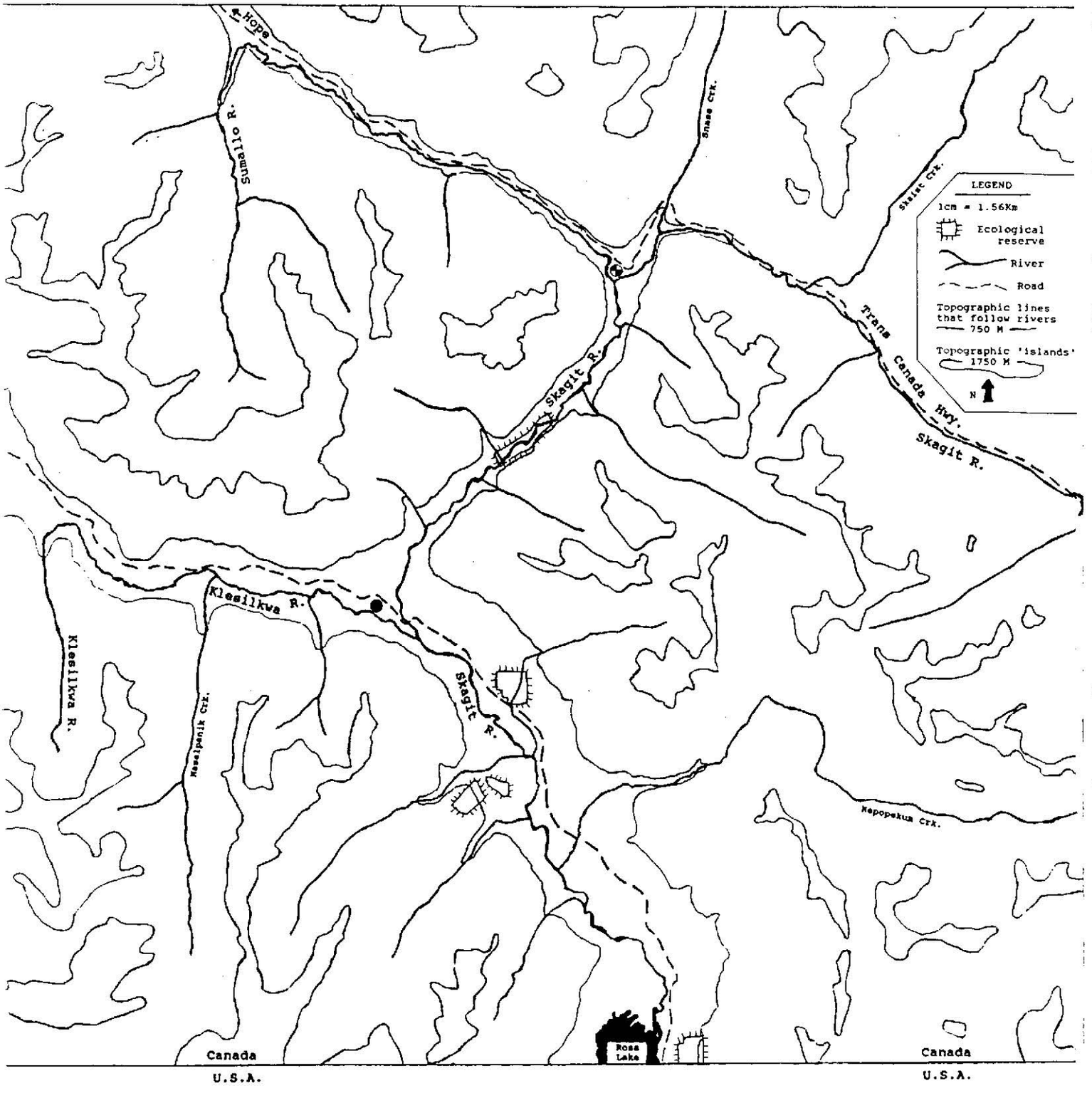


Figure 4. Skagit watershed *Myotis volans* (◔) and Long-eared *Myotis* species (●) capture sites.

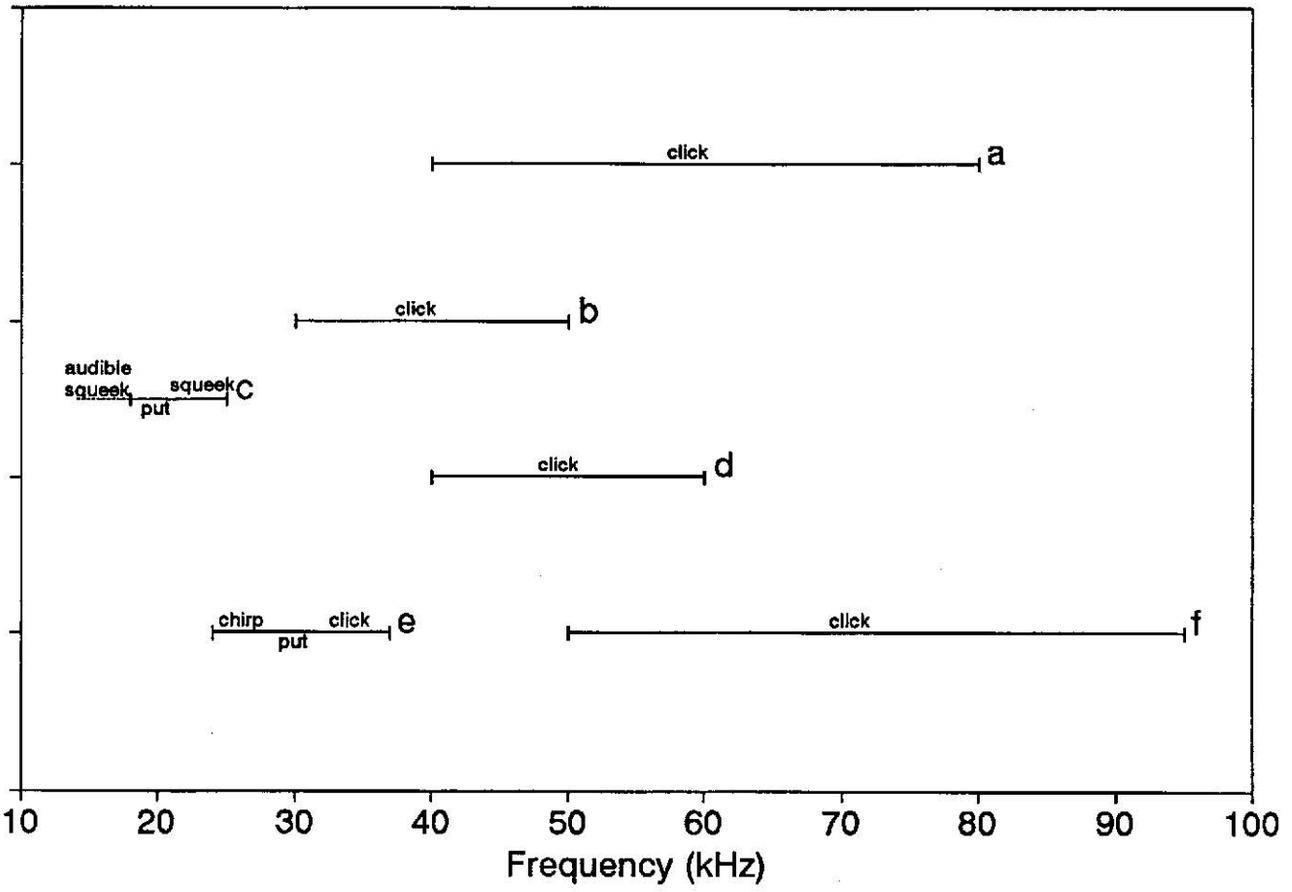


Figure 5. Frequency range and 'sound' of bat echolocation calls detected (QMC mini-II bat detector) in the Skagit watershed: *Myotis volans* (a), unidentified species (b), *Lasiurus cinereus* (c), *Myotis lucifugus* (d), *Eptesicus fuscus* (e), and small footed species (f; *Myotis californicus* and *M. ciliolabrum*).

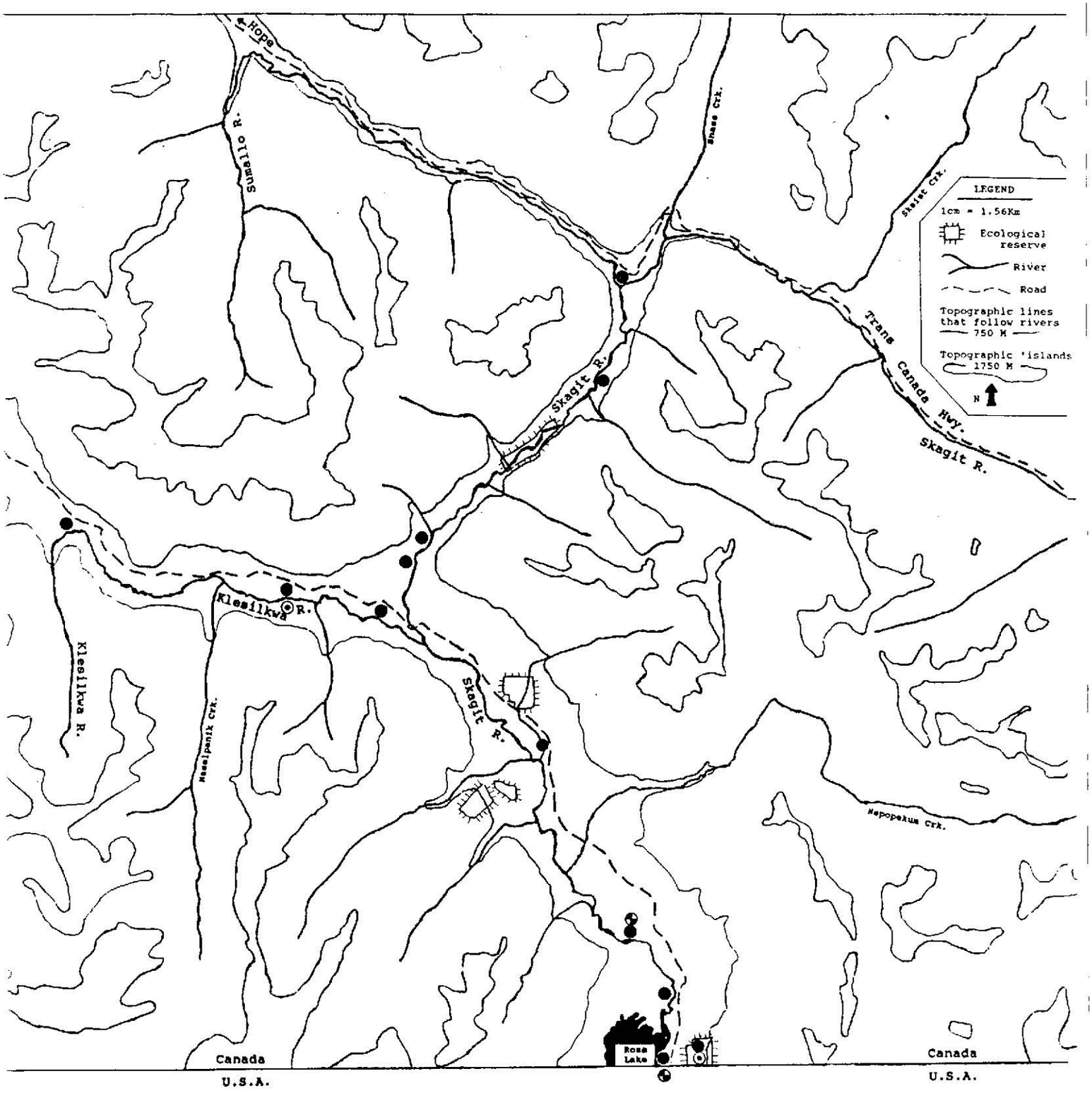


Figure 6. Skagit watershed sites of bats identified only by ultrasonic detection: *Eptesicus fuscus* (●), *Lasiurus cinerus* (◒), and unidentified species (⊙).

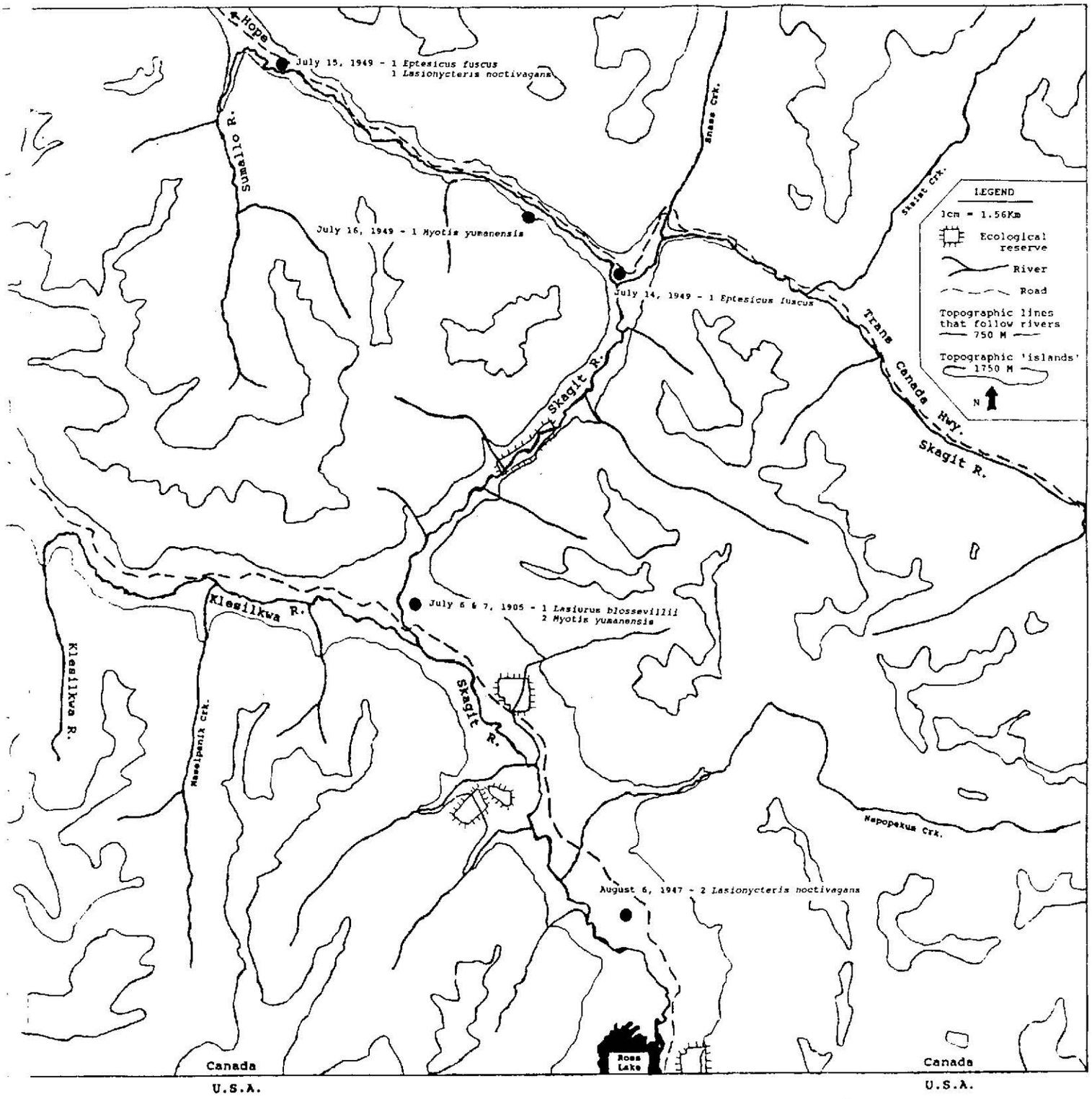


Figure 7. Skagit watershed Historical bat records.