

Mount Maxwell

Ref. No.:

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ECOLOGICAL RESERVES COLLECTION  
GOVERNMENT OF BRITISH COLUMBIA  
VICTORIA, B.C.  
V8V 1X4

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VEGETATION CHANGES IN A GRAZING ENCLOSURE  
WITHIN THE BAYNES PEAK ECOLOGICAL RESERVE,  
ON SALTSRING ISLAND, BRITISH COLUMBIA:  
THE EXPERIMENTAL DESIGN

Peggy Frank, 1984

"The plant population that is found growing at a point in space and time is the consequence of a catena of past events. The climate and the substrate provide the scenery and the stage for a cast of plant and animal players that come and go. The cast is large and many members play no part, remaining dormant. The remainder act out a tragedy dominated by hazard, struggle and death in which there are few survivors."

- Harper, 1977

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ABSTRACT: The area within and surrounding an 18 hectare fenced enclosure was mapped in detail as to dominant canopy type. Based on dominant canopy, minimal area for two communities, Garry oak and mixed Garry oak - Douglas fir, were determined using a species composition method. The establishment of five 4' by 8' plots inside the enclosure and five outside for each community to be studied is discussed. The effects of grazing on pure Garry oak and mixed Garry oak - Douglas fir communities will be monitored on Baynes Peak Ecological Reserve, Saltspring Island, according to the sampling design outlined in this paper

## ACKNOWLEDGEMENTS

A project of this magnitude cannot be carried out by a single human and indeed there are many people who have contributed time, money, expertise and lots of energy to this project. I would like to gratefully acknowledge Hans Roemer, John Pendermoss, Bristol Foster and Conrad Thomas of the Ecological Reserves for moral support, advise, plant identifications and graphical contributions.

- The "Friends of the Ecological Reserve" who helped fence and financed much of the overhead costs.
- Tim Collins and Katimavik volunteers for their laughter, enthusiasm and strong bodies needed to put a fence on the steep rocky bluffs of Baynes Peak Ecological Reserve.
- Simon Henson and Pam for their interest, photographs and assistance in the study.
- Mr. Caruthers and members of the Parks Department for logistics in transporting the fencing materials.
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- Ed Dobyms, Dave Fraser and Val Fletcher for suggestions and criticisms.
- and finally Clint Smyth and Marc Bell for giving me the basics (and making me search out some of the answers).



## INTRODUCTION

Saltspring Island is the largest of the Gulf Islands. It is located north of the city of Victoria on Vancouver Island (see Figure 1a). On the west side of Saltspring Island is a 65 ha. parcel of land known as Ecological Reserve #37. The exact location of the Reserve is  $48^{\circ} 48' 20'' - 40''$  N. Lat. and  $123^{\circ} 31' 50'' - 32' 30''$  W. Long. Elevational changes are from 0 - 488 m<sup>+</sup>.

The Baynes Peak Reserve (as it will subsequently be referred to) was established on June 2 1972 to preserve what was then thought to be "an undisturbed stand of Garry oak, (Quercus garryana)" (Krajina et al., 1978). *This is a mistake in blue book.*

Although man has had little direct impact on the Baynes Peak Reserve, (there is evidence of logging at lower elevations), western oak loopers (Lambdina f. somnaria) have caused severe defoliation of both the oak and the Douglas fir trees. An infestation in 1958 lasted 3 years. The present infestation (see Fig. 2) is not expected to last beyond 1983 (Ovanin, 1982). Sheep have roamed the area, probably since about 1860 (Hamilton, 1969). The feral sheep (see Plate 1) have left their mark on the Reserve and the effects of both overgrazing and trampling needs further study. Driver et al. (1979) have shown introduced mountain goats to have varied effects on plant species due to both grazing and physical disturbance. Introduced deer are believed responsible for poor development of the shrub and herb layers on the Queen Charlotte Islands compared to similar old-growth forests in adjacent parts of British Columbia and Alaska (Pojar and Banner, unpublished). Much work has been done on the effects of cattle grazing on vegetation (Adams, 1975; Holecheck, 1981; McLean,

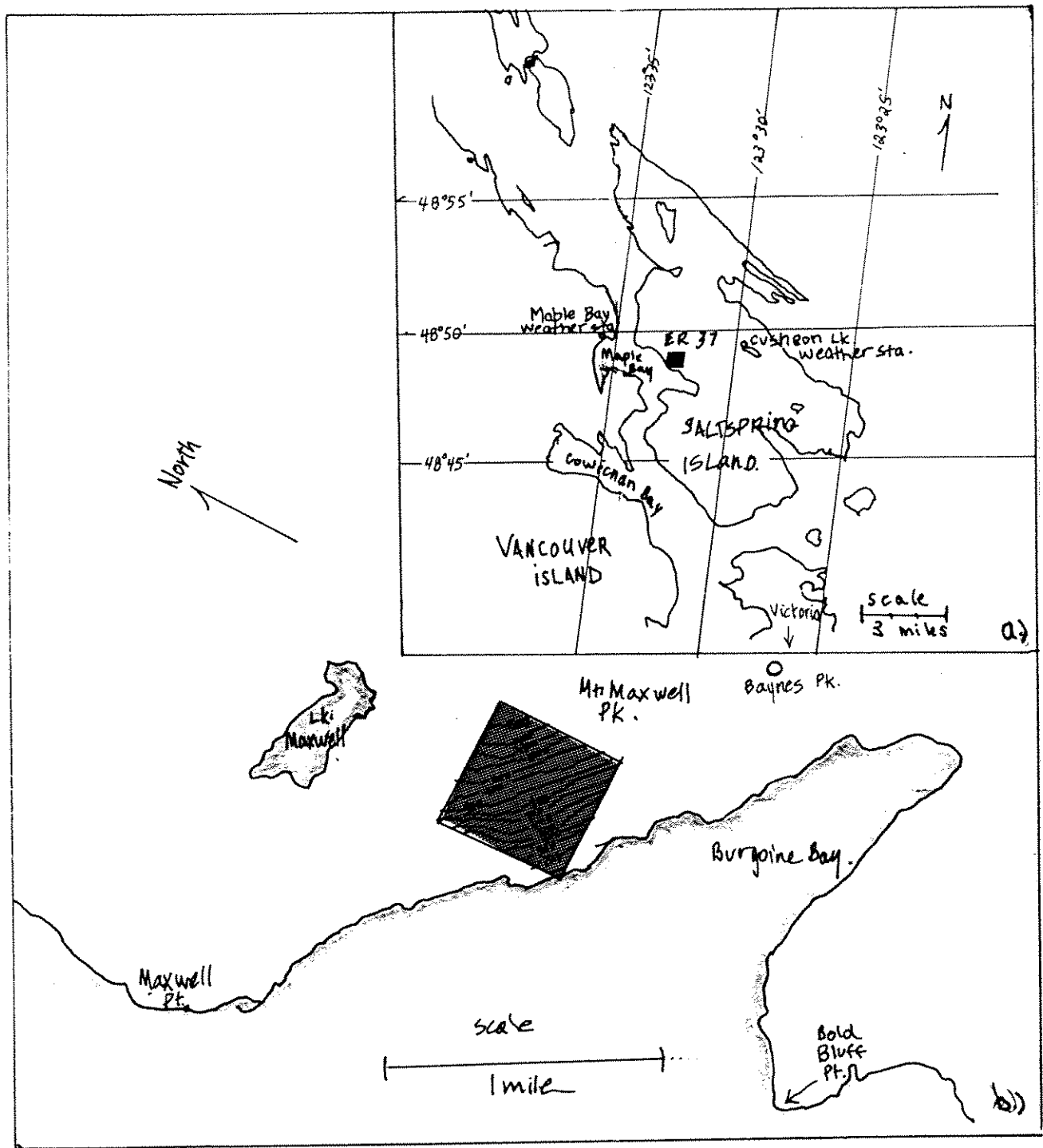


Figure 1. a) Location of Saltspring Island, the Ecological Reserve, and the Cusheon Lake and Maple Bay weather Stations.  
 b) Location of the Baynes Peak Ecological Reserve next to Mt. Maxwell Provincial Park, Saltspring Island.



1972) and studies have shown regeneration of preferred plant species following exclusion of sheep from high altitude blanket bogs (Rawes, 1983) and subantarctic islands (Meurk, 1982). No studies have been done on the vegetation changes following the exclusion of sheep in the coastal Douglas fir Zone of British Columbia, although feral sheep are known to be present on a number of islands in Southern B.C. (Koppel, unpubl.). A series of events beginning around 1981 have created ideal conditions for such a study.

1. <sup>known to be grazed prior to being set aside as a reserve.</sup> Members of the Ecological Reserves Unit, upon visiting ER #37, found evidence of grazing and heavy use by feral sheep. Impact problems were reported to the Ministry of Lands, Parks and Housing and a large quantity of fencing material was given to the Unit.
2. "Friends of the Ecological Reserves" was formed in 1982, when government interest in the environment was waning. The "Friends" agreed to spiritually support a fencing project and coordinate volunteers with the Ecological Reserves Department.
3. Saltspring Island was chosen as one location for a group of young Canadians doing community service work (Katamavik). Beginning in the fall of 1983 they would take on the fencing as one of their service projects; and members of the Natural History Club on Saltspring would transport them up the mountain. Ecological Reserves marked out approximately 18 ha. to be fenced (see figure 3) and fencing began but not without controversy (see Appendix 1 for newspaper clippings from the Gulf Islands Driftwood).

4. In March, 1984, after the magnitude of the fencing project was realized, the "Friends" agreed to financially support the fencing by not only renting equipment, ie. a rock drill, but also by paying a part-time supervisor.

## The Study Area

### 1. Climate

Krajina et al., 1978, describe the climate as Csb (Koppen/Trewarthen) (see Figure 4). From the literature it appears temperature extremes and severe droughts greatly affect the continuity of vegetation (Hamann, 1979). For this reason daily records should be kept at the study area, or a site of similar altitude and exposure (I am presently trying to obtain records for Mt. Tuam, Saltspring Island from Environment Canada). The nearest weather stations maintained by the provincial Ministry of the Environment are at Cusheon Lake and Maple Bay (see Figure 1 a) for locations). The exposure of the station at Maple Bay makes it more comparable to the Reserve; unfortunately, it is no longer in operation.

Comparing the data for the two weather stations suggests that climate varies considerably from location to location and year to year (see Figure 5). General trends are for moderately cool, wet winters (over 100 mm precipitation for at least one month), and moderately warm dry summers with water deficits for 2 months of the summer. The upper elevations of the Reserve probably are wetter in winter and dryer in summer than either Maple Bay or Cusheon Lake. The temperature would be expected to

SALTSPRING ISLAND 48°51'N, 123°30'W, 240' ASL. Record: 30-62 years. 259  
 Months above 50°F: 6, below 32°F: 0, A.M.T.P. 40.41", A.M.S.F. 27.2", snow % A.M.T.P.: 6.73, days with frost, yearly: 52.

E. MAX. T.	58	63	69	82	89	95	101	96	89	79	66	58
M.D. MAX. T.	41.5	46.2	49.1	55.6	62.7	67.6	72.6	71.9	67.4	57.4	48.3	43.6
M.D. T.	36.7	40.3	42.2	47.6	53.8	58.6	62.8	62.4	58.6	50.6	43.1	39.0
M.D. MIN. T.	31.8	34.4	35.3	39.6	44.8	49.6	52.9	52.8	49.7	43.6	37.8	34.4
E. MIN. T.	5	5	14	22	31	33	40	39	31	20	8	6

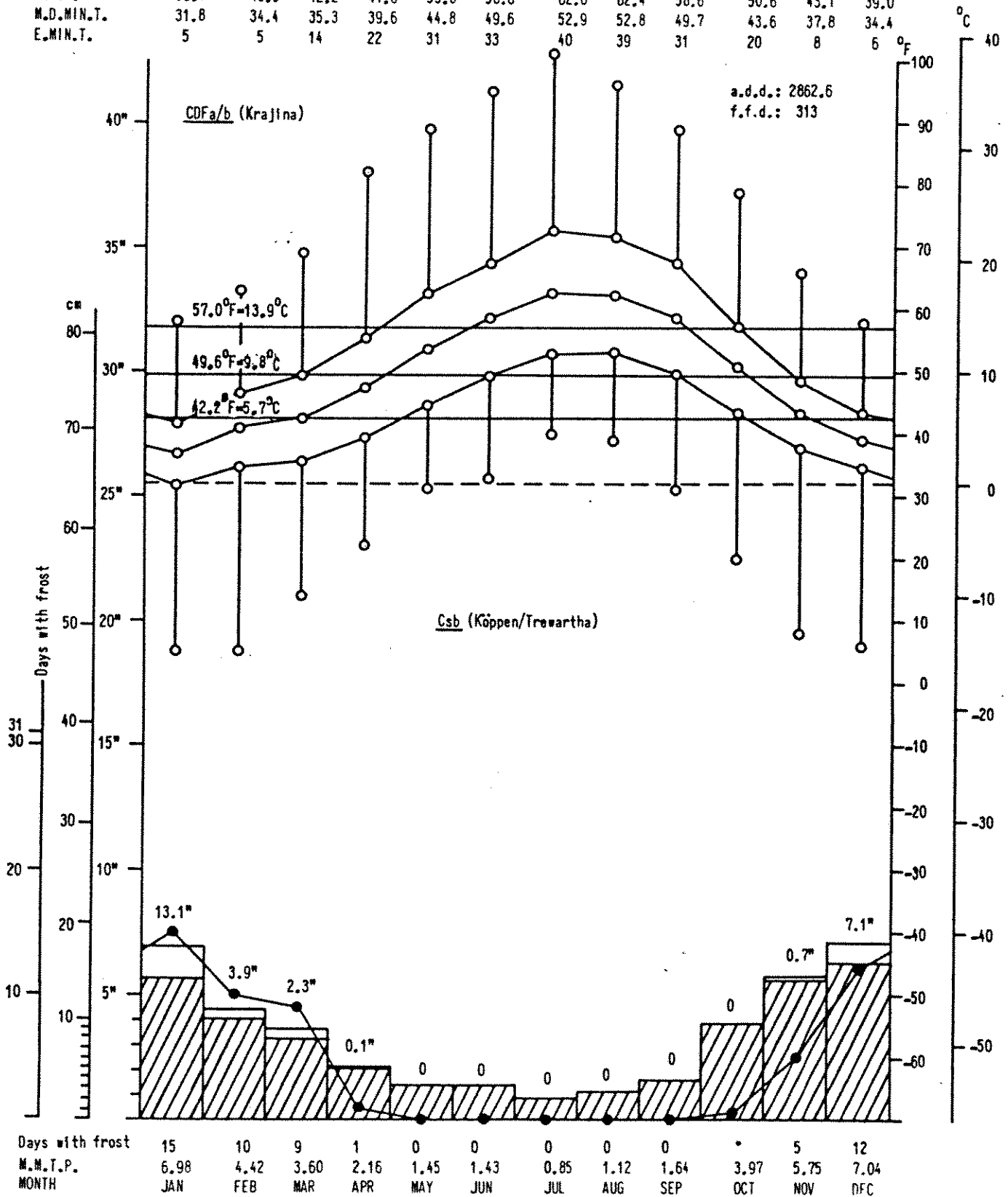


Figure 4. Climate of the Salt Spring Island Area - from Krajina et al., 1978



be more extreme than Cusheon Lake, where the large body of water moderates the climate, or Maple Bay, which is greatly moderated by the nearby ocean, and does not have the altitude of the Reserve (100 m compared to 1500 m).

## 2. Soils

Soils of the Reserve are shallow over green dioritic bedrock (Roemer, 1983). Colluvium is the parent material and the Reserve is characterized by scattered large angular rocks on the ground surface. Soil builds up locally in depressions where a dark Ah horizon covers coarse textured sandy loams. Krajina et al. (1978) call the soils Brunisols and Regosols (Lithosols) although Pojar (unpublished) found development of Podsoles in a few sites (estimated as 15% of the total Reserve area) where a Douglas fir - sword fern (Pseudotsuga - Polystichum) community had established.

Soil development is generally poor and, within the area of proposed fencing, soil depth seldom exceeds 15 cm. Fractures and associated fissures in the bedrock increase the effective rooting depth of vegetative cover (Eis, 1980) (see Plate 2).

## 3. Vegetation

Pojar (unpublished) identified six communities in the Ecological Reserve. These are listed in Table 1. A species list for the Reserve appears in Appendix 2.



- Tim Collins

Plate 2. Mullein (Verbascum thapsus) growing from a fissure in the bedrock.

Table 1. The 6 Vegetation Communities of the Baynes Peak Ecological Reserve (Pojar, unpublished).

Communities	Comments	Percent Cover
1. <u>Pseudotsuga</u> - <u>Arbutus</u> - ( <u>Quercus garryana</u> ) Douglas fir - arbutus - (Garry oak)	scrub forest	10%
2. <u>Pseudotsuga</u> - <u>Polystichum</u> Douglas fir - sword fern	moist slopes grey podsols	15%
3. <u>Rhacomitrium</u> moss	rock outcrop	1%
4. <u>Quercus</u> - grass Garry oak - grass	dry slope forest	25%
5. <u>Pteridium</u> Bracken fern	open logged slopes	1%
6. <u>Quercus</u> - <u>Pseudotsuga</u> Garry oak - Douglas fir	mixed forest	40%

92%  
- other 8%?

Garry oak is the dominant vegetative feature of the Reserve (see Plate 3). This photo also illustrates the lack of understory growth. Browse by feral sheep is believed to be the cause of this and low herb diversity and abundance (see Plate 4).

The objectives of the present study are to design a sampling program to measure a) the effective goat damage to vegetation (shrubs, herbs and mosses); b) the changes in species composition following exclusion of the feral sheep; c) to suggest other environmental stresses and their importance to the vegetation of the Baynes Peak Ecological Reserve.

can't do this.  
is this along major objectives?



Plate 3. The Garry oak (Quercus garryana) of the Baynes Peak Ecological Reserve. Note the Douglas fir on the extreme right of the photo.



There are several requirements of such a sampling design. Sampling must be initiated immediately upon completion of the fence to assess both suitability of selected plots and original state of the vegetation to be protected from sheep. The study must be repeatable in years to come as vegetation may be slow to recover. The sampling must also be repeatable, not by ecologists but simply interested volunteers or ecology students. Voucher specimens must be collected, correctly identified and preserved for future researchers. The sampling must be inexpensive as funds are not available for this work. The design must give valid (statistically) changes in vegetation composition and biomass so that reliable interpretations can be made from the results. Climatic data must be compiled for the study period as well as information on insect infestations or other potentially damaging environmental factors. And finally, because Ecological Reserves are public land and "preserves", the sampling must be as non-destructive as possible and reports must be accessible to, and readable by the layperson.

## METHODS OF STUDY

The vegetation within the enclosure was mapped by first analysing recent air photos (BCC-249-034 -035, July 1980) and then ground checking the community boundaries. Figure 6 is a preliminary mapping of the communities adjacent to the actual fenceline (fencing difficulties were responsible for the amended fenceline). Future large scale air photos will facilitate a more detailed mapping of the dominant communities. The community names used in the present study correspond directly to those used by Pojar. Table 2 compares the two names and percent cover.

Table 2. Comparison of present community names with those used by Pojar, and % cover within enclosure.

Sym.	Community Name	Pojar's name	Percent Cover
R	rock outcrop	<u>Rhacomitrium</u>	16%
G	Garry oak	<u>Quercus</u> - grass	52%
D	Douglas fir	<u>Pseudotsuga</u> - <u>Polystichum</u>	13%
M	Mixed Garry oak - Douglas fir	<u>Quercus</u> - <u>Pseudotsuga</u>	19%

Minimal areas for the Garry oak and the Garry oak - Douglas fir communities were determined using a species composition method (Shimwell, 1971). See Appendix 3 for minimal area curves and species lists. A plot size four times minimal area (ie. 15 m x 8 m) was chosen so that clipping for biomass calculations could be carried out at four intervals in a 10 year period (see Figure 7).

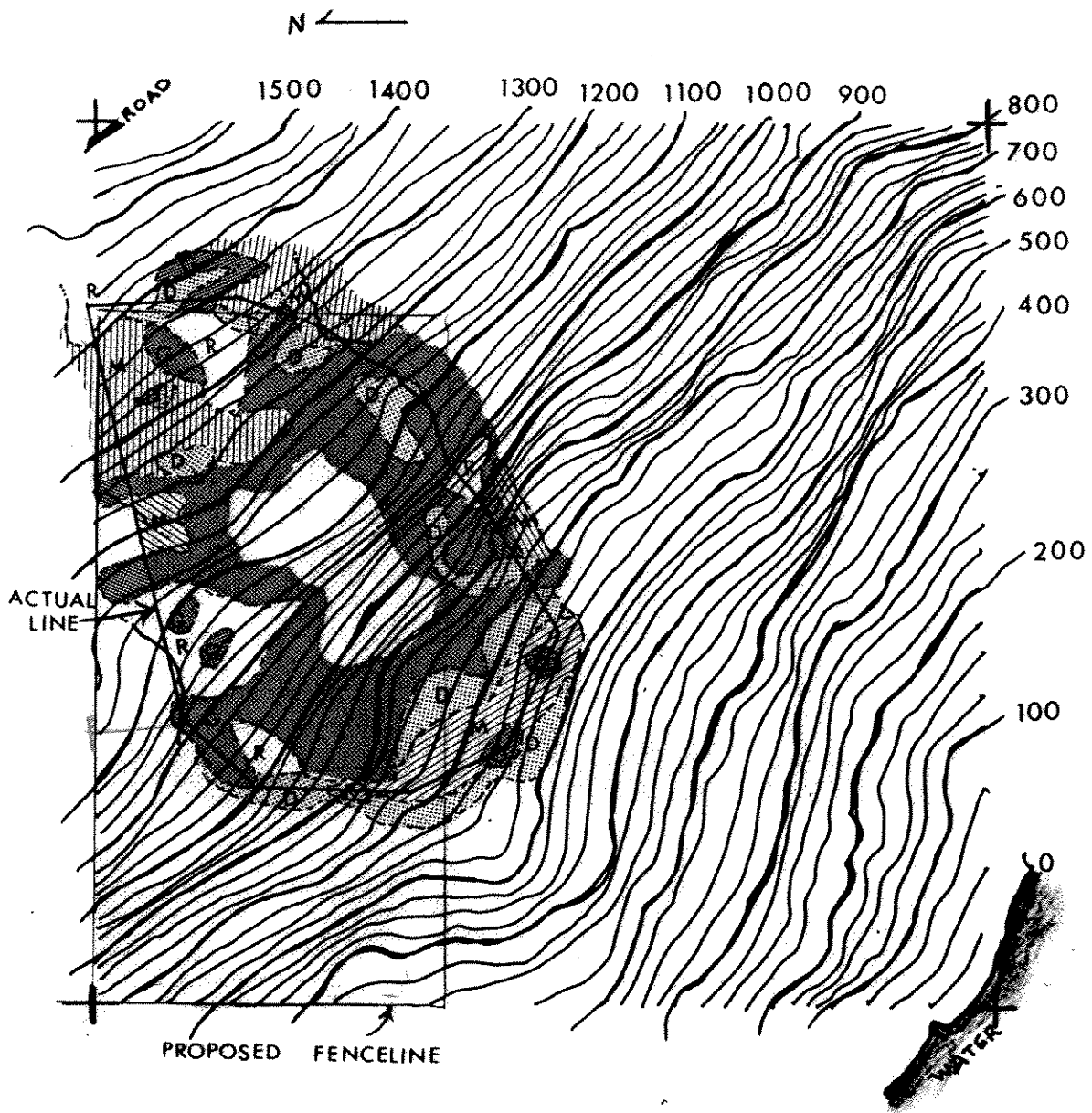
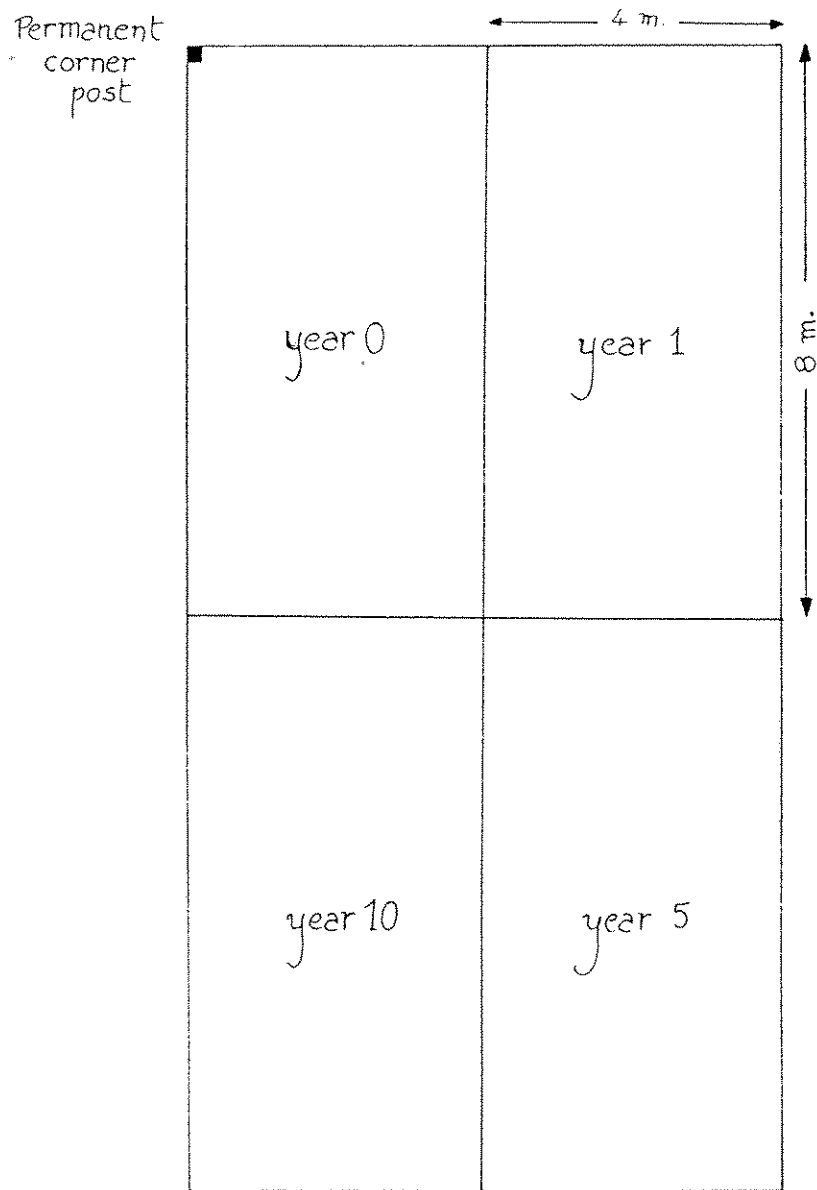


Figure 6. Preliminary map of dominant vegetation adjacent the fenceline in the Baynes Peak Ecological Reserve.  
 R - rock outcrop      D - Douglas fir  
 M - mixed Douglas fir - Garry oak      and G - Garry oak



Plot size and sampling capabilities for each of the communities to be studied. Note each year the location of the sub plot to be clipped will be chosen randomly and no plot will be clipped more than once.

Five plots were then randomly selected within the following areas:

1. enclosed Garry oak
2. enclosed Garry oak - Douglas fir
3. non - enclosed Garry oak
4. non - enclosed Gary oak - Douglas fir

A swath 2 m wide on either side of the fenceline was excluded from sampling due to the tendency of animals to graze along a fenceline. Each plot was marked with a permanent corner post at the NW corner of the plot. Once the fencing is complete (June 1984) and the sheep removed from the enclosure, the sampling for year 0 will be carried out.

Sampling will include species lists, abundance, frequency, density, floristic state, number of buds, height, basal area, and life form. Biomass of the vegetation will be determined using wet and dry weight of clipped vegetation, sorted into species groups. Annual analysis of abundance, frequency, and density will be carried out non-destructively, for those years no biomass sampling is to be done. Repetitive sampling for biomass will be done on year one, year 5, and year 10. Statistically valid differences between those characteristics inside and outside the enclosures will probably be due to the sheep grazing or trampling.

## DISCUSSION

Two way analysis of variance of the initial data (collected as soon as fencing is completed) will show, for each of the two community types, if those five plots outside the enclosure are significantly different from those within. If the initial stratification has been successful, and if five plots are adequate for each treatment, and if the sampling is consistent there should be no significant difference. The data from the initial plots will serve as a baseline and subsequent sampling will document changes in the species composition of the Garry oak and mixed Garry oak - Douglas fir communities. It is absolutely necessary that the methodology be repeatable, plots must be precisely located and marked so they can be relocated, methodology of measurements of cover and other quantities must be defined so that they can be repeated, and the data must be recorded in such a way that it can be used for comparison in following years (see Appendix 4 for proposed data form). Field notes and climatic data kept during the study period will determine if any extreme environmental factors have affected the communities.

Field notes will be used to determine the number of sheep and the intensity of grazing. By experimentation Harper (1977) was able to show a direct relationship between number of predators and density of seedlings. Grazing is known to maintain a system in an early successional stage (Driver et al., 1979). It will be interesting to see if Garry oak or Douglas fir seedlings dominate the understory vegetation within the exclosures. It appears Douglas fir moves in when there is

sufficient soil build up. Garry oak tends to occur in areas where fire probably constitutes a significant site factor - but then, is this true for Douglas fir as well?

In 10 years time those species which are preferred and are susceptible to grazing will likely increase within the enclosure. Non-preferred species may remain as before or decrease in numbers and biomass due to competition with other species. Grazing is only one activity of sheep. Observations have shown the sheep to butt one another off small cliffs causing slippage of large aggregates of plant and soil. Sheep trails and droppings are encountered frequently (do these droppings provide needed nutrients to the site?). In the Olympics, where introduced mountain goats may be a problem to vegetation, Driver et al. (1979) discuss a relative "damage due to goat activity" sequence: trampling > dust bathing > bedding > feeding. Physical disturbance favours plant species able to tolerate trampling and which can colonize bare soil and rock. Successional changes within the enclosure will affect these species. Perhaps in 10 years the picture of the Baynes Peak Ecological Reserve will be more like plates 5 and 6 and less like plate 7.

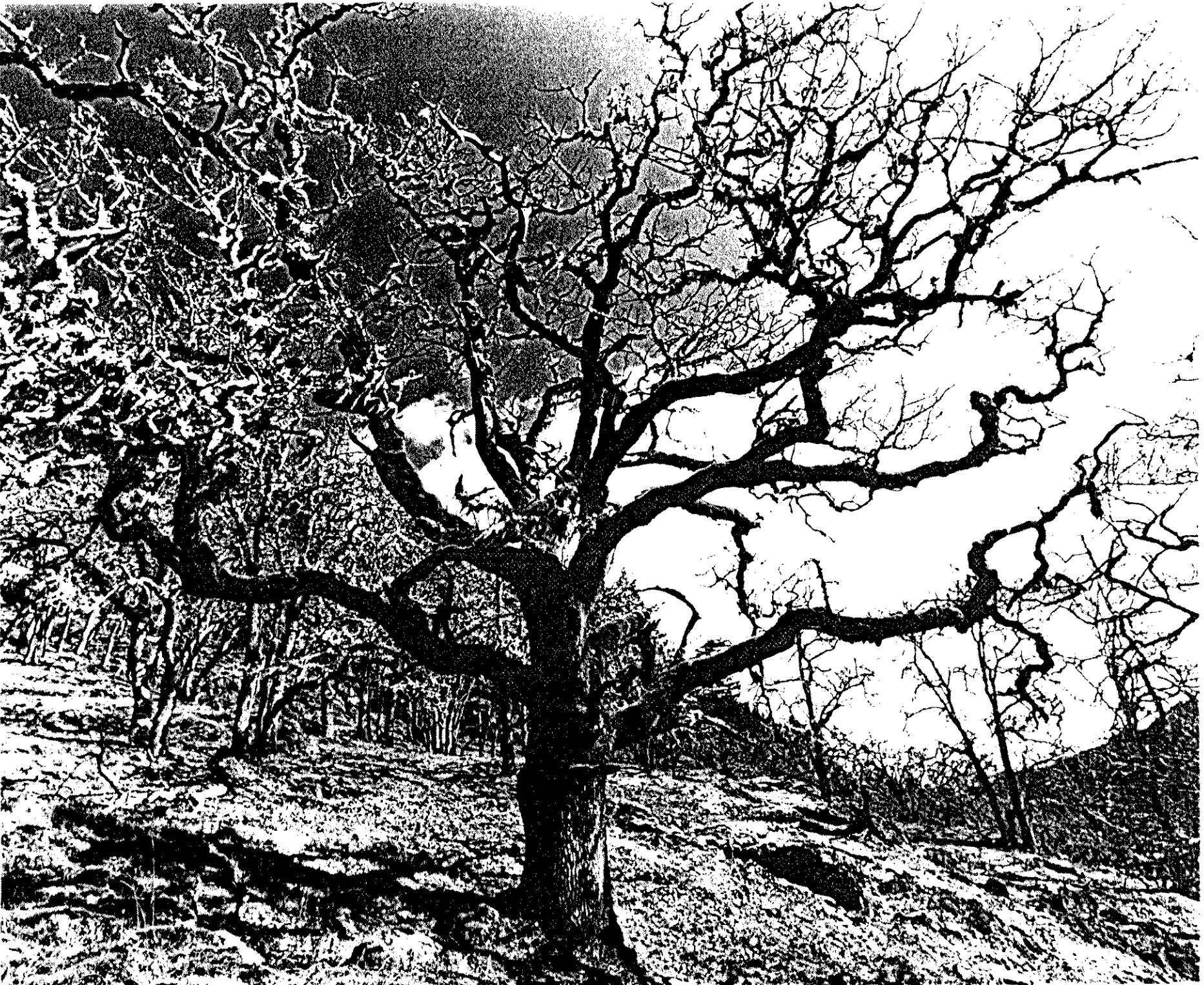
This study is important, not simply for the love of flowers, but in a broader context to give us a guideline to land use. Ecological Reserves will become pocket sanctuaries for all wild organisms as the population of British Columbia grows and development encroaches our wild places. The effects of mixing of land uses (ie. grazing, recreation, preservation, logging) are not clearly understood. Past events have set the stage for a

simple study to show the effects of combining a grazing species with a natural population of plants including a somewhat rare tree - the Garry oak (see plate 8).

The proposed study requires the aid of volunteers and continued support by the Ecological Reserves, the Friends of the Ecological Reserves and the educational institutions. It has been designed so that valid results, from a simple vegetative study, will aid us in making management decisions in natural areas.



Plate 8. A Garry oak tree on the Baynes Peak Ecological Reserve. - Tim Collins



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APPENDIX 2

FLORA OF THE MOUNT MAXWELL ECOLOGICAL RESERVE

DIVISION PTEROPHYTA

SELAGINACEAE - SPIKE MOSS FAMILY

Selaginella wallacei Hieron

Abundant on the rocky, exposed outcrop shoulders with the Rhacomitrium rock outcrop community. This species occupies bare outcrop shoulders in preference to deep soil pockets. By mid-July, most plants in the reserve have been completely desiccated.

EQUISETACEAE - HORSETAIL FAMILY

Equisetum arvense L. (Common horsetail)

Rare, specimens restricted to rich, moist alluvial deposits in seepage areas or to shady, gravelly drainage basins.

POLYPODIACEAE - COMMON FERN FAMILY

Pityrogramma triangularis (Kaulf.) Maxon.

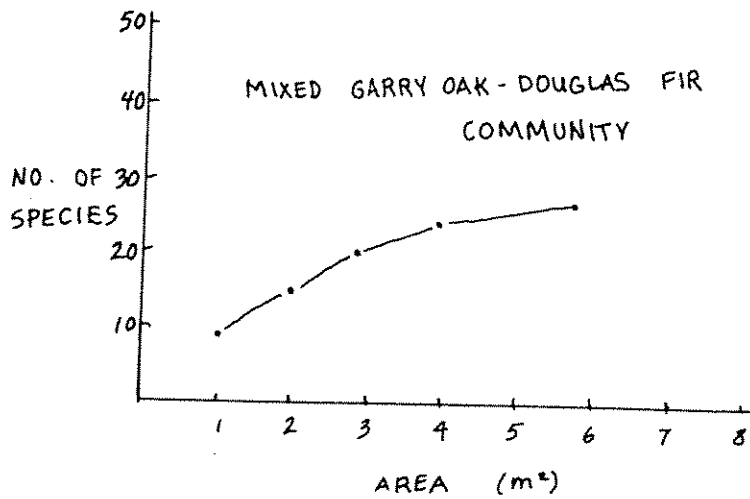
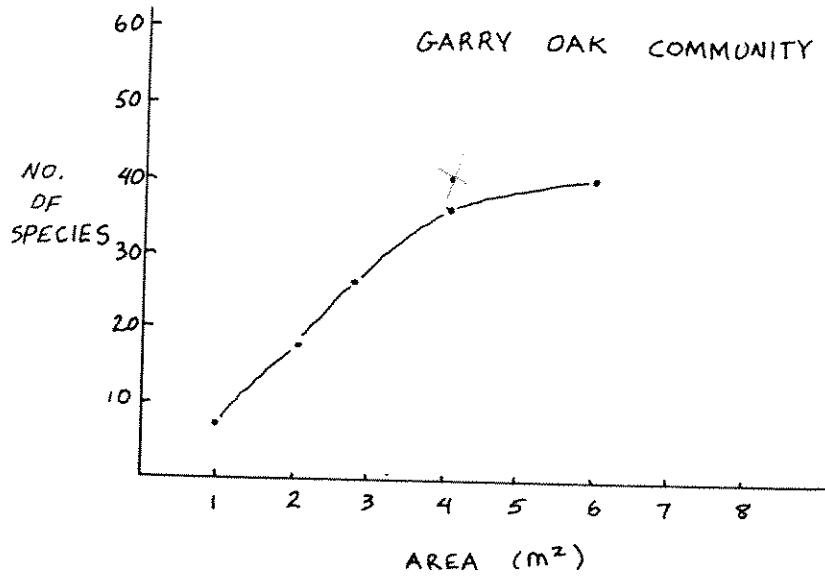
Common; generally associated with crevices and pockets of soil at the base of vertical faces in both the Rhacomitrium rock outcrop and Quercus dry slope communities.

Polypodium hesperimum

Abundant in shaded, rocky areas where the moss cover is well-

APPENDIX 3

Minimal area curves and species lists for the Garry oak and mixed Garry oak - Douglas fir communities.



Species present in Garry oak community on Baynes Peak, Ecological Reserve.

Trees and herbs

<u>Cardamine oligosperma</u> Nutt.	-	little western bittercress
<u>Cerastium viscosum</u> L.	-	sticky chickweed
<u>Claytonia parviflora</u> (Mac.) Greene	-	miner's lettuce
<u>Cystopteris fragilis</u> (L.) Bernh.	-	bladder fern
<u>Daucus pusillus</u> Michx.	-	rattlesnake weed
<u>Digitalis purpurea</u> L.	-	foxglove
<u>Galium aparine</u> (Wallr.) Farw.	-	goose grass
<u>Geranium molle</u> L.	-	dove foot geranium
<u>Geranium</u> sp.	-	stork's bill?
<u>Hieracium albiflorum</u> Hook.	-	hawkweed
<u>Lactuca muralis</u> (L.) Fresen.	-	wall lettuce
<u>Lotus micranthus</u> Benth.	-	small flowered deer vetch
<u>Lithophragma bulbifera</u> Rydb.	-	prairie star
<u>Lychnis coronalis</u> L. Descr.	-	dusty miller
<u>Madia madiodes</u> (Nutt.) Greene	-	woodland tarweed
<u>Myosotis discolor</u> Pers.	-	forget-me-not
<u>Nemophila parviflora</u> Dougl.	-	small flowered nemophila
<u>Oenanthe sarmentosa</u> Presl. ex DC.		
<u>Osmorhiza</u> sp.	-	sweet cecily
<u>Pityrogramma triangularis</u> (Kaulf.) Maxon.	-	triangular fern
<u>Ranunculus</u> sp.	-	buttercup
<u>Rumex acetosella</u> L.	-	sheep sorrel
<u>Sanicula crassicaulis</u> Peopp.	-	Pacific sanicule
<u>Selaginella wallacei</u> Hieron		
<u>Stellaria media</u> (L.) Cyrill	-	chickweed

<u>Symphoricarpos albus</u> (L.) Blake	-	snowberry
<u>Taraxacum officinale</u> Weber	-	dandelion
<u>Trifolium</u> sp.	-	clover
<u>Verbascum thapsus</u> L.	-	flannel mullein
<u>Veronica arvensis</u> L.	-	speedwell
<u>Vicia sativa</u> var. <u>augustifolia</u> L. Wahlb.	-	common vetch

#### Sedge

<u>Carex pennsylvanica</u>	-	sedge
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#### Grasses

<u>Anthoxanthum odoratum</u> L.	-	sweet vernal grass
<u>Bromus mollis</u> L.	-	soft cheat
<u>Cynosurus echinatus</u> L.	-	dog's tail grass
<u>Festuca myuros</u> L.	-	rat's tail grass
<u>F. occidentalis</u> Hook.	-	western fescue
<u>Melica subulata</u> (Griseb.) Scribn.	-	onion grass

#### Mosses and liverworts

<u>Antitrichia curtispindula</u> (Hedw.) Brid.	
<u>Dicranum howellii</u> Hedw.	
<u>Homalothecium nevadense</u> (Hedw.) Robins	
<u>H. pinnatifidum</u> (Wils.) Vaeg.	
<u>Isothecium</u> sp.	
<u>Polytrichum juniperinum</u> Hedw.	
<u>Rhacomitrium</u> sp.	
<u>Stoikseilla oreganum</u> = <u>Eurynchium oreganum</u> (Sull.) Jaeg & Sauerb.	
<u>Tortula ruralis</u> Hedw.	



Species found in mixed Garry oak - Douglas fir community on Baynes Peak Ecological Reserve.

Trees and herbs

<u>Quercus garryana</u> Dougl.	-	Garry oak
<u>Cardamine oligosperma</u> Nutt.	-	little western bittercress
<u>Cerastium viscosum</u> L.	-	sticky chickweed
<u>Claytonia parviflora</u> (Mac.) Greene	-	miner's lettuce
<u>C. perfoliata</u> (Donn.)	-	miner's lettuce
<u>Cystopteris fragilis</u> (L.)	-	bladder fern
<u>Galium aparine</u> (Wallr.) Farw.	-	goose grass
<u>Lactuca muralis</u> (L.) Fresen.	-	wall lettuce
<u>Lithophragma bulbilifera</u>	-	fringecup
<u>Myosotis discolor</u> Pers.	-	forget-me-not
<u>Polystichum munitum</u> var <u>imbricans</u> (D.C. Eat.) Maxon	-	small deer fern
<u>Nemophila parviflora</u> Dougl.	-	small flowered nemophila
<u>Ranunculus</u> sp.	-	buttercup
<u>Rumex acetosella</u> L.	-	sheep sorrel
<u>Stellaria media</u> L. Cyrill	-	chickweed

Grasses

<u>Bromus vulgaris</u> (Hook.) Shear	-	brome grass
<u>Festuca myoros</u> L.	-	rat-tail fescue
<u>Melica subulata</u> (Griseb.) Scribn.	-	onion grass

Mosses and liverworts

Antitrichia curtispindula (Hedw.) Brid.

Homalothecium lutescens (Hedw.) Robins

Homalothecium sp. 2

Isothecium sp. 1

Isothecium sp. 2

Rhytidiadelphus triavetrus  
(Hedw.) Warnst. - electrified cat's tail moss

Stoikseilla oreganum  
= Eurynchium oreganum (Sull.) Jaeg & Sauerb.

Tortula ruralis Hedw.

Barbilophozia lycopodioides - leafy liverwort

Plagiochila porelloides - leafy liverwort