# Radium - Stoddart Bighorn Sheep GPS and VHF Telemetry 2001-2002

## Summary of Activities and Data Collection January – March, 2002

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## Executive Summary

Forest ingrowth into areas that were formerly fire-maintained grassland or open forest is a significant conservation concern for species dependent upon such habitats in the southern Rocky Mountain Trench, including bighorn sheep. There has been significant loss and isolation of natural winter habitat, and increasing use of human-created habitat on the valley bottom. Mid-elevations between winter and summer ranges appear to be used less than in the past.

Habitat restoration within winter ranges on the Trench floor is recognized as an essential element of ecosystem health, and several projects are underway. However, mid-slope areas of the Trench's eastern edge (west flank of the Rocky Mountains) were also historically maintained in an open state by frequent fires, but restoration there is logistically and visually more challenging. Planning is further impeded by a lack of information regarding sedentary use or travel by sheep through such transitional ranges. Thus, restoration of such sites has not yet occurred. Two of the primary goals of this project are to determine whether sites at which habitat restoration is underway on winter range will be used by sheep, and what areas or habitat types sheep use when in transitional ranges, as a means of providing information for habitat restoration there.

We fitted 7 ewes and 3 rams with GPS collars in January and March, 2002. These were set to attempt a fix every 8.5 hours during the winter and every 4.25 hours after March 31. Collars will be remotely dropped in December, 2002. In addition, ground-based telemetry was conducted to collect habitat, behavior and group composition information, check collar and animal status, and provide backup data in the event of collar failure. No detailed results or discussion are provided now, as we have no GPS collar data yet and only very limited ground-based telemetry data.

Preliminary indications are that about 80% of attempted GPS fixes have been successful (based on collar status information transmitted through signals from the collars). Of the 64 telemetry records, 59% were based on visual observations. As expected, habitat use during mid-day telemetry sessions occurred primarily on a golf course, but also included native grassland and closed-canopy forest, road cuts and urban sites. Group size was typically larger for collared ewes than collared rams. Data analysis will be conducted when more complete data are available at the end of the 2002-2003 fiscal year.

## Introduction

### *Problem Statement*

The southern portion of the Rocky Mountain Trench has historically been a fire-maintained ecosystem (FME). Frequent, low-intensity ground fires maintained very open stands of Douglas-fir and ponderosa pine interspersed with grassland (Gayton 1996). However, fire suppression during the past century has resulted in the dramatic ingrowth of conifers into grassland and formerly open forest stands (Rocky Mountain Trench Ecosystem Restoration Steering Committee 2000). Concurrently, there have been significant habitat losses, population declines and additional threats to wildlife species dependent on open habitats, including Rocky Mountain bighorn sheep. Several herds of bighorn sheep still winter in the Trench (Davidson 1994), but fragmentation of their habitat over the past century has been paralleled by isolation in their distribution and marked declines in habitat quality.

The Radium-Stoddart herd of about 140 bighorns winters near Radium Hot Springs, British Columbia. Recently, this band has dramatically reduced its use of historic ranges and has increasingly focused on human-dominated landscapes, such as golf courses, townsites and road margins (Figure 1; Osprey Communications 2001). This is due in part to loss of native winter range and transitional ranges, and changes in migratory routes due to conifer ingrowth, habitat fragmentation, and human encroachment. Several past projects have identified habitat issues and very broad movement patterns for this herd (Stelfox et al. 1985, Davidson 1994, Tremblay 2001). In recent years, volunteer community monitors under the "Bighorn In Our Backyard Project" have recorded the locations and behavior of wintering bighorn sheep of the Radium-Stoddart herd (Osprey Communications 2001). However, there has been no recent collection of movement/habitat use information across the full range of seasonal habitats and elevations using systematic sampling.

Ecosystem restoration is now underway through joint initiatives of government, industry and non-government organizations, including two sites within the Radium-Stoddart winter range being restored in the winter of 2001/2002. These projects involve maintaining most large, old trees, removing understory trees, and burning the understory. While the results of restoration are promising, several concerns remain. One is that it is unclear to what degree bighorns will use restored areas. A second issue is that there is no clear indication of whether interchange between the Radium-Stoddart herd and adjacent bands occurs. Finally and perhaps most importantly, little effort is being made to maintain and restore the migratory corridors and transitional ranges that link valley-bottom winter range with alpine summer range. The extensive fire history along the western flank of the Rocky Mountains was largely a result of frequent fires in the adjacent Trench ascending into the mountain slopes (Gray 2001). Thus, fire suppression on the Trench floor has also caused dense forests to develop at mid elevations, so that the open transitional ranges to which sheep historically had access when moving between summer and winter ranges have largely disappeared. Not only has this resulted in the loss of important habitat, it now forces sheep to remain longer and to be more concentrated on winter ranges, potentially causing increased susceptibility to disease, parasites, predation, vehicle collisions and malnutrition. If we are to include migratory routes and transitional ranges in FME restoration efforts, knowledge of route locations and habitat types is essential to guide the limited ecosystem restoration funding available.

The following progress report summarizes activities completed under contract 01SSFM010b between Slocan Forest Products Ltd, Radium Division, and Sylvan Consulting Ltd. The document follows the standard reporting format for FRBC wildlife inventory projects.

### *Goals*

The four goals to be addressed through the use of GPS collars are:

1. To determine both specific routes and general habitat types used by sheep in moving through transitional ranges between low-elevation winter range and summer ranges in the alpine. This will guide the locations of future ecosystem restoration projects in mid-elevation transitional ranges.
2. To determine to what extent sheep use ecosystem restoration sites following restoration work.
3. To document sites of concentrated sheep activity that can be correlated to lambing locations, mineral licks and other point-source habitat features, so that these sites can be considered in land-use planning decisions relating to recreation, forestry road construction, and municipal expansion.
4. To gain preliminary indications of whether there is any population exchange with nearby herds.

### *Study Area*

The study area includes all current seasonal ranges of the Radium-Stoddart bighorn sheep herd. Collaring occurred in and around Radium Hot Springs when sheep were on their winter range (Figure 1). The exact extent of the area over which sheep will be monitored during the following years will depend upon their movements. However, it is expected to include the Brisco Range from Radium north to roughly Luxor Pass, the Stanford Range from Radium south to about Pedley Pass, and the Rocky Mountain Trench from about Edgewater to Windermere. This is entirely within the Southern Interior Mountains ecoprovince, and includes both the Western Continental Ranges ecoregion (Southern Park Ranges ecosection) and the Southern Rocky Mountain Trench ecoregion (East

Kootenay Trench ecosection). Mountains trend northwest to southeast, so slopes facing the Trench have a general southwest aspect.

Biogeoclimatic units include the IDFun (Windermere Lake unit) and IDFdm2 at lower elevations (separated roughly by Highway 95), and the MSdk, ESSdk, and AT farther upslope (Braumandl and Curran 1992). Winter range is mainly in the IDF and lower MS. Above the level of the Columbia River floodplain on the valley floor, the IDF is a mix of private, provincial Crown, Kootenay National Park, federal Crown, provincial wildlife management area and provincial park land. Types of development in the IDF include urban, industrial, golf courses, rural residential and small agricultural holdings, and open forests managed at an early seral stage for Douglas-fir Christmas trees. There are also historically open Douglas-fir dominated forests and grasslands that have experienced significant conifer ingrowth and encroachment due to fire suppression (some of which are in the process of being restored), patches of trembling aspen, and a limited amount of mature, closed-canopy Douglas-fir, lodgepole pine, aspen and hybrid white spruce forest on cool aspects. Highway 95 runs north-south through the IDF near the western edge of the study area and is joined by Highway 93 from the northeast at Radium Hot Springs. The MSdk, ESSFdk and AT are almost entirely within provincial Crown land and Kootenay National Park. Much of the MS and ESSF facing toward the Trench is on dry, rocky slopes characterized by open canopies (Douglas-fir at lower elevations grading through lodgepole pine, Engelmann spruce, subalpine fir and whitebark pine), though forest stands are shifting toward increased closure in the absence of fire. Cooler aspects within the MS and ESSF are mainly lodgepole pine at lower elevations and Engelmann spruce and subalpine fir higher up. Little of the MS and ESSF within the study area has been logged or accessed by roads due to the rugged terrain and presence of the national park.

### *Acknowledgements*

I wish to thank the following people and organizations for their major contributions to this research: Forest Renewal BC for funding; W. Swan, Osprey Communications, for initiating both the Bighorn in Our Backyard Project and the GPS collar research component of it; V. Jablanczy, Slocan Forest Products, for coordinating contract funding; M. Panian, MWLAP, for assistance with database setup and project development; A. Dibb, Parks Canada, for extensive logistical support and project development; M. Oliver, Parks Canada, for telemetry; I. Ross, Arc Wildlife Services, for darting and collaring; T. Shury, Parks Canada, for overseeing veterinary issues and animal handling quality assurance; H. Schwantje, MWLAP, for animal care advice and arranging immobilization drugs; J. Dubois, Osprey Communications, for mapping; T. Damme and J. Niddrie, Parks Canada, for logistical support, and R. Ferguson, Matrix Resource Services, for reviewing an earlier draft of this report.

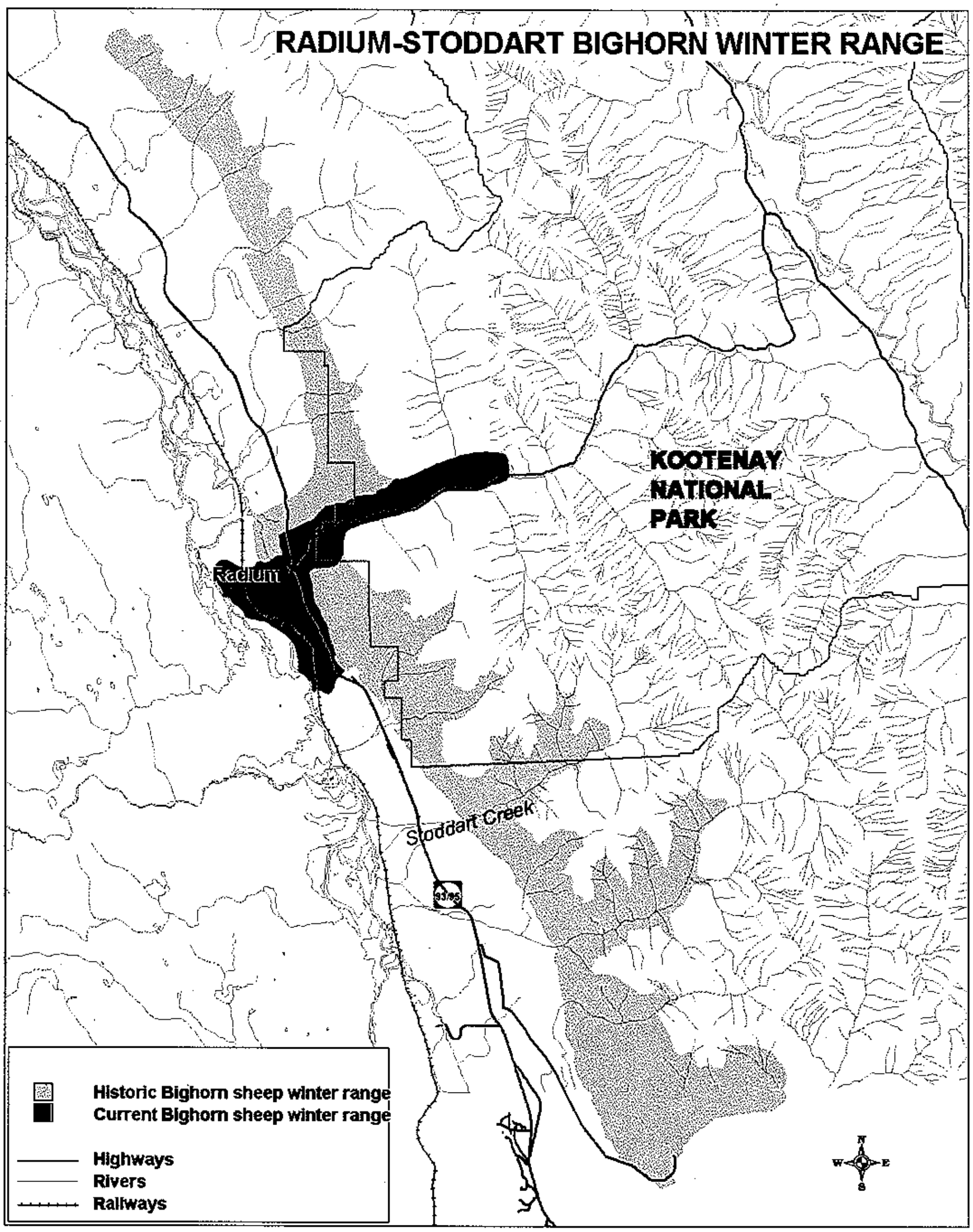


Figure 1. Winter range of bighorn sheep near Radium Hot Springs, British Columbia. Some winter activity by sheep still occurs within the grey-shaded area, but it is heavily concentrated in the red area. All sheep were collared within the red-shaded area. Map courtesy of Osprey Communications, Invermere, BC. Transitional and summer ranges occur upslope and east of winter range.

## Methods

The following section describes methods used to date; it does not include future monitoring and analysis techniques. In January, 2002, we captured 6 ewes and 4 rams, and fitted them with GPS collars (model 2000, Advanced Telemetry Systems, Isanti, Minnesota). Sheep were darted by Ian Ross (Arc Wildlife Services, Calgary) with a Paxarms-brand dart gun. Immobilization was accomplished with xylazine-ketamine or xylazine-telazol. All immobilization information is contained in the attached Excel file: *Radium Sheep Capture Data.*

One ram subsequently died, apparently due to pneumonia caused by aspirating rumen contents while immobilized. We therefore recovered and downloaded GPS fixes from the collar, and collared another sheep in March. As we could not find any rams in safe locations for handling, we collared another ewe, bringing the total to 7 ewes and 3 rams.

We intended to spread the capture effort across the known winter range of the Radium-Stoddart herd, including within the Stoddart Creek ecosystem restoration block and also near Windermere Creek. However, no sheep at Stoddart Creek were in locations where they could be darted safely, and we could not locate any sheep at Windermere. Therefore, all sheep were darted within Radium Hot Springs and on adjacent Crown land, as indicated in the attached files: *Radium Sheep Capture Data* (Excel) and *Radium Sheep Telem March 2002* (Access; see stratification layer 3).

GPS collars were set to attempt a fix every 8.5 hours until March 31, at which point they will shift to a 4.25-hour interval. Collars are scheduled to be removed via a remote drop-off mechanism in December, 2002. At that point, data will be downloaded and analyzed. Sheep were also located weekly by M. Oliver, Kootenay National Park, using standard ground-based radiotelemetry techniques. This was done:

- as a backup in the event of collar failure;
- to check collar status (a doublet every sixth beat indicates that the most recent GPS fix attempt was successful; a slow beat rate indicates low battery);
- to visually check whether collars were causing problems to the sheep; and
- to collect group composition data (sex/age classes coded according to RIC level 2 classification standards; Ministry of Environment, Lands and Parks 1998a), habitat use information (using categories modified from local Terrestrial Ecosystem Mapping; Kernaghan et al. 2001) and behavior/foraging information.

A standardized field form and coding key were used to record these data (attached Excel file: *Sheep Telem Form*), which were then entered into the attached Access database *Radium Sheep Telem March 2002.*

## Results

Sheep radiolocation data included both approximate fixes taken to determine collar status, and more accurate and detailed records of group composition, habitat use and behavior. Telemetry data had been collected for less than two months at the time of writing, so detailed analyses are not yet possible. The database to date is in the Access file *Radium Sheep Telem March 2002*, and is summarized in Table 1.

Table 1. Telemetry summary and GPS collar apparent successful fix rate (SFR) to February 28, 2002 for bighorn sheep collared in January and March, 2002, at Radium Hot Springs, British Columbia.

| Sheep | Visual Observations | Telemetry-Only Observations | Apparent SFR[1] | Habitat Types[2] | Group Size ($\bar{x}$, range) |
|---|---|---|---|---|---|
| F01 | 5 | 2 | 6/6 | GC, DT | 48 (37-66) |
| M02 | 1 | 7 | 5/6 | GC, AnW | 9 (9) |
| M03 | N/A | N/A | 28/29 | N/A | N/A |
| F04 | 8 | 0 | 6/6 | GC, UR | 26 (5-66) |
| M05 | 3 | 3 | 5/5 | GC, RC, AnW | 7 (1-17) |
| F06 | 3 | 3 | 4/5 | GC, AnW | 30 (20-39) |
| F07 | 6 | 2 | 3/6 | GC, AnW, DT | 32 (11-43) |
| M08 | 1 | 5 | 5/5 | GC, UR, RC | 17 (17) |
| F09 | 6 | 1 | 4/6 | GC, AnW, DT | 29 (12-43) |
| F10 | 5 | 3 | 3/6 | GC, AnW, UR | 24 (4-39) |
| F11 | N/A | N/A | N/A | N/A | N/A |
| TOTAL | 38 | 26 | 41/51 (exc. M03) | | |

[1] Based on proportion of times VHF collar signal indicated that the most recent fix attempt had been successful. In the case of M03, from whom the collar was retrieved and downloaded, rate is based on GPS collar records.

[2] AnW = antelope-bush – bluebunch wheatgrass, DT = Douglas-fir – lodgepole pine – pinegrass – twinflower, GC = golf course, RC = road cut, UR = urban

Of the 64 telemetry records, 59% were associated with visual locations of sheep, and group composition, habitat and behavior records were made for the majority of those. The apparent SFR, as indicated by the proportion of times that collar VHF signals indicated the most recent GPS fix attempt had been successful, was calculated from very small samples, and varied between 50 and 100% ($\bar{x}$ = 80%). The retrieved collar from M03 had 28 successful fixes in 29 attempts, but most of those attempts were made when the ram was sick and therefore immobile on an exposed rock outcrop so may over-represent typical rates. Habitats used during the midday telemetry sessions were primarily on a golf course, but also included the antelope-bush – bluebunch wheatgrass and the Douglas-fir – lodgepole pine – pinegrass – twinflower site series, road cuts and urban areas. Group size varied from 1 to 66, with ewes typically occurring in larger groups.

## Discussion

Without any GPS collar data available yet, and with telemetry data from only about 7 weeks, no conclusions can be drawn from the data. The collars appear to be functioning properly, with the majority of attempted fixes successful. As anticipated, sheep predominantly moved into human-influenced habitat types during the day, mainly The Springs golf course. No telemetry locations are available from late afternoon through early morning, but all the sheep appeared to move into the rock bluffs immediately south of Sinclair Creek each evening.

A full discussion of data will be made in the 2002-2003 report, when GPS collar data will be available.

## Critique of Inventory Protocols

This project did not include classic "inventory" in the sense of conducting a census. Animal handling and telemetry methods were consistent with the relatively general guidelines provided in *Live Animal Capture and Handling Guidelines for Wild Mammals, Birds, Amphibians & Reptiles* (Ministry of Environment, Lands and Parks 1998c) and *Wildlife Radio-telemetry* (Ministry of Environment, Lands and Parks 1998d). Those documents provided useful guidance for their respective activities, although neither activity could be conducted adequately without field experience. Capture and collaring data were recorded on the RIC-standard animal handling forms (Ministry of Environment, Lands and Parks 1998b). Those forms provided sufficient space and categories to record all the relevant information.

## Management Recommendations

Given the initial stage of this project, it would not be appropriate to make any management recommendations yet, except to note that multi-jurisdictional management will be essential, as the collared sheep were located on private, provincial Crown, federal Crown, and national park lands.

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# PREMIER RIDGE - DIORITE

# Terrestrial Ecosystem Mapping (T.E.M.) Project

## VOLUME I

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April 25, 2000

**TABLE OF CONTENTS**

# LIST OF PLATES, FIGURES, TABLES AND APPENDICES

## LIST OF PLATES



## LIST OF FIGURES



## LIST OF TABLES

**LIST OF APPENDICES**



**LIST OF APPENDICES (cont.)**



## 1.0 INTRODUCTION

Terrestrial Ecosystem Mapping (TEM) was initiated in the Premier Ridge - Diorite Landscape Unit (see Plate 1) in 1996 by the Ministry of Forests, Invermere District and Ministry of Environment, Cranbrook. However, for a variety of reasons, the project was not completed by the original consultant, Jim Poriz of Ecological Insights, Coleman Alberta. Responsibility for the project was transferred to Crestbrook Forest Industries (CFI) and in June of 1999 CFI of Cranbrook, BC issued a Request For Proposals for the completion of the 1:20,000 Terrestrial Ecosystem Mapping (TEM) in the Premier Ridge - Diorite Landscape Unit. *JMJ Holdings Inc.* of Nelson B.C. was awarded the contract; the original consultant did not submit a proposal to complete the work.

The initial contract, in 1996, supported ecosystem pre-typing, an initial working legend, and some fieldwork. The focus of this sampling was primarily for range related interests. The subsequent contract awarded in September of 1999 to *JMJ Holdings Inc.* supported completion of field sampling to 15% polygon visitation, re-working existing bioterrain polygons, assessment and correction of existing plot data and VENUS and GRAVITI data bases, and initiation and completion of site series mapping. Bioterrain and site series mapping was done to RIC 1998 (Ecosystems Working Group, 1998) standards and quality assurance procedures. Owing to budgetary constraints wildlife suitability ratings and an expanded legend were not completed under this contract. However, these important elements of this TEM mapping project can be completed at a later date when funding becomes available.

The objective of the TEM in Premier Ridge - Diorite was to complete the project to RIC 1998 (Ecosystems Working Group, 1998) standards and to provide an ecological classification from which interpretations about a variety of forest management issues could be generated.

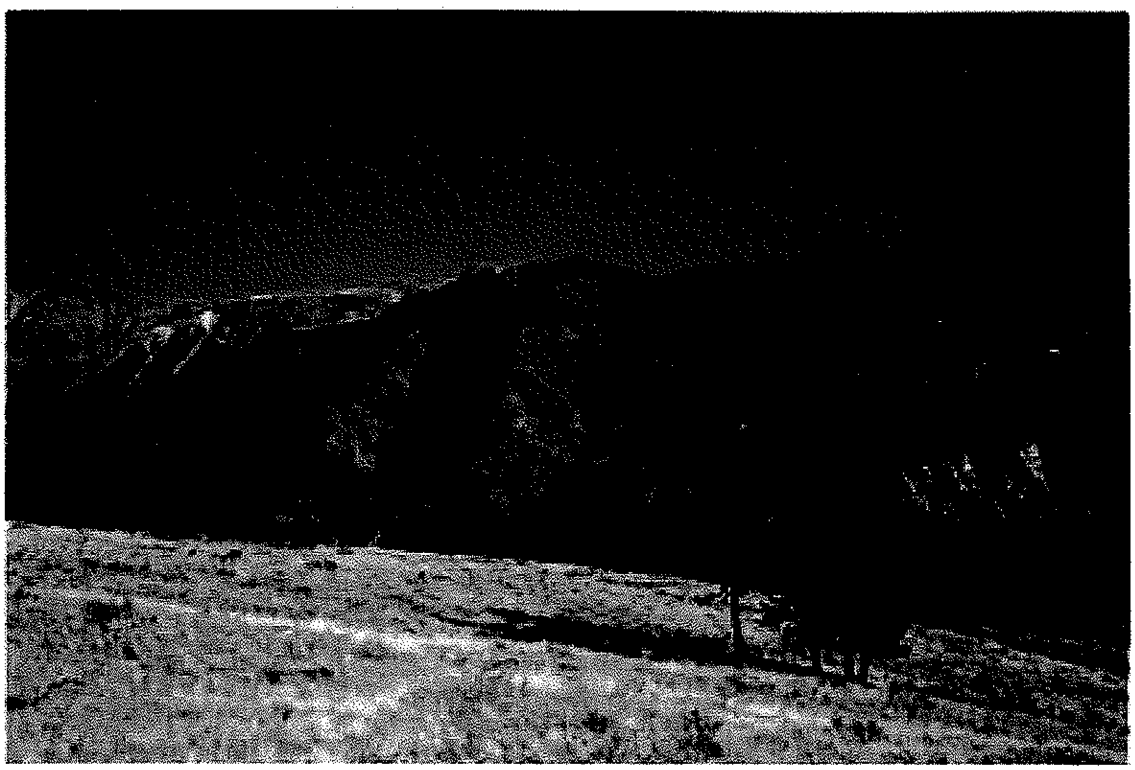

Plate 1. Overview of the Premier Ridge - Diorite study area.

## 1.1 OBJECTIVES

The following objectives were proposed and met in this project:

1. To complete bioterrain ecosystem unit mapping and digitize to RIC 1998 (Ecosystems Working Group and Ecological Data Committee, 1998) standards for TEM and Digital Data Capture.
2. To execute a sampling plan for completion of field work in 1999 to survey intensity level 5 at a polygon inspection rate of 7%. Actual inspection rate achieved was 15% which just makes it into the survey intensity level 4.
3. To enter new data into VENUS and GRAVITI databases and to correct and synthesize with existing databases.
4. To create a digital plot location map to RIC 1998 (Ecological Data Committee, 1998) standards.
5. To follow appropriate quality assurance ( QA) procedures during all steps of the mapping and insure sign-off is obtained for each activity.

## 1.2 LOCATION

The study area covers all of Landscape Unit 4 in the Invermere Forest district, and is located just east of the Kootenay River, between Canal Flats and Wasa Lake, BC (see Figure 1). It is approximately 36,900 ha. in area and includes all of the Diorite Creek drainage. It ranges from the Kootenay River to the West, to the Lussier River in the Northeast, to headwaters of Diorite Creek in the Southeast, and to Wolf Creek in the South.

The study area is located on the following 1:20,000 TRIM maps (see Figure2):

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082J.012

082J.002

082G.092

082G.093

082G.082

082G.083

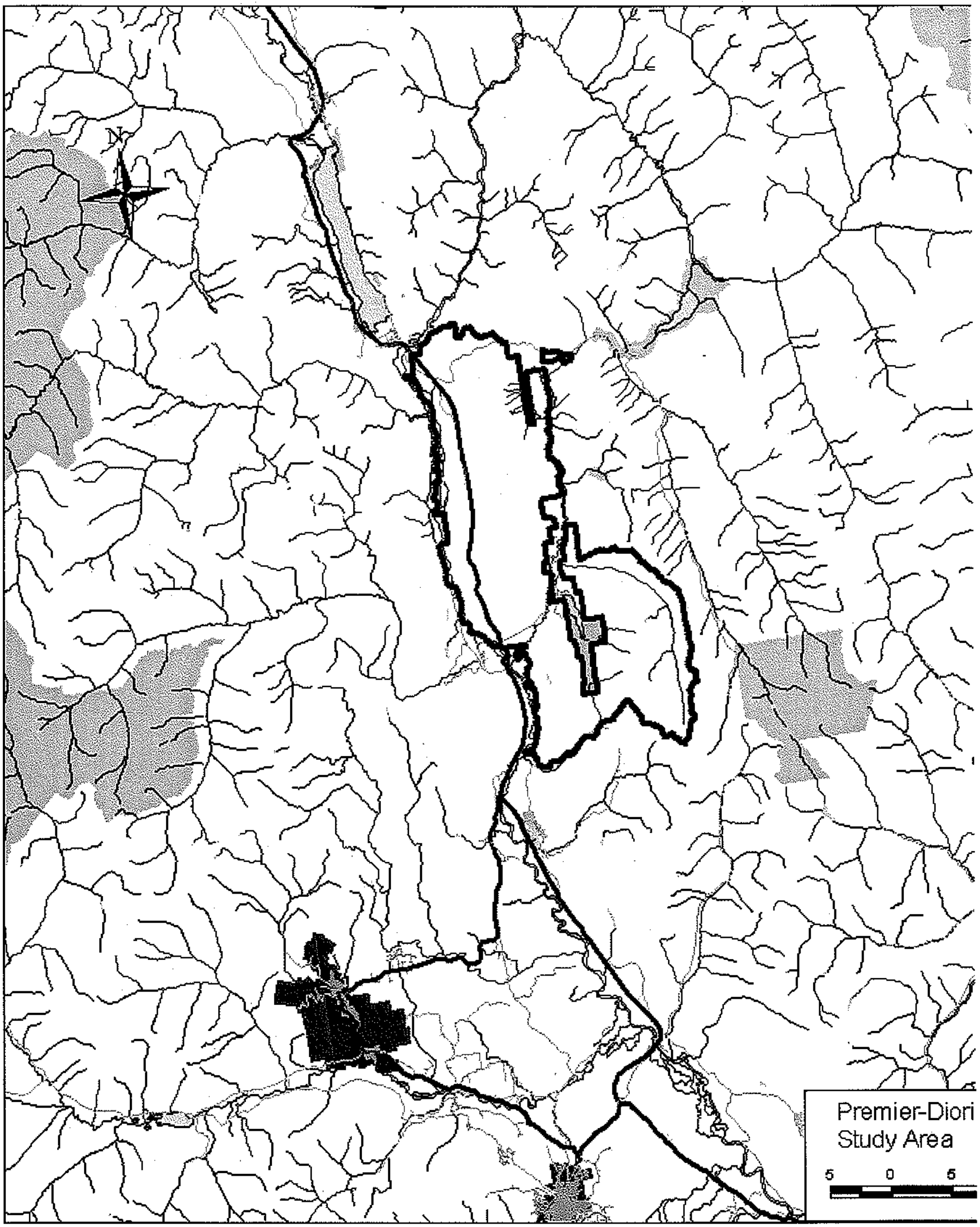
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Figure 1. Premier Ridge – Diorite TEM Project Location

## 2.0 ECOSECTION AND BIOGEOCLIMATIC CLASSIFICATION OF PREMIER RIDGE - DIORITE

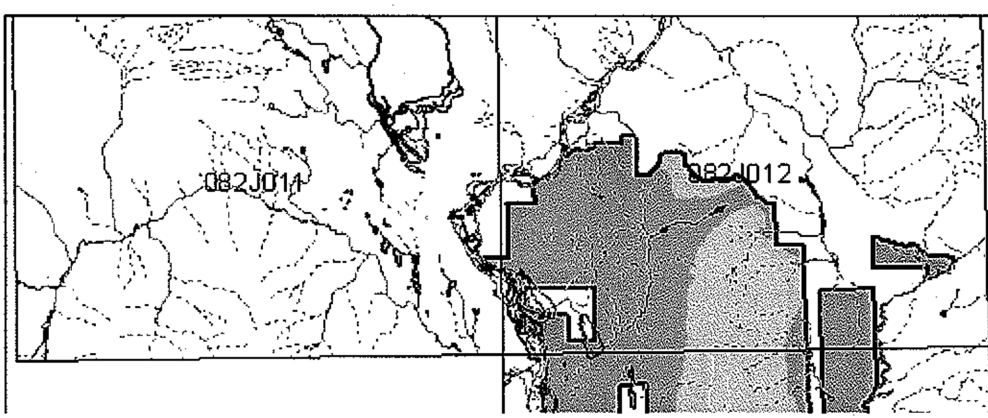
**Ecoregions** are large regional-sized, ecological land units that have similar macroclimate, physiography, vegetation and wildlife potential. Five levels of Ecoregion Classification are recognized including Ecodomain, Ecodivision, Ecoprovince, Ecoregion and Ecosection. Following the ecological land classification hierarchy set forth by Demarchi (1996), Premier Ridge - Diorite is located within the Humid Temperate Ecodomain, the Humid Continental Highlands Ecodivision, the Southern Interior Mountains Ecoprovince, and in both the Southern Rocky Mountain Trench Ecoregion and the Western Continental Ranges Ecoregion.

**Ecosections** are subregional units within ecoregions that are similar in climate, landforms, bedrock geology, soils, and plant and animal distributions. Demarchi (1996) classifies Premier Ridge - Diorite as being located within both the East Kootenay Trench (EKT) and Southern Park Ranges (SPK) Ecosections.

The East Kootenay Trench (EKT) is a broad, flat glacial plain with a distinctive rainshadow and is dominated by Douglas-fir and lodgepole pine forests. The PPdh2 and most of the IDFdm2 are within this ecosection.

The Southern Park Ranges (SPK) is a large area of rugged mountains intersperced by long narrow valleys. It is dominated by hybrid white spruce and lodgepole pine at lower elevations and subalpine forests at higher elevations.The MSdk, ESSFdk, ESSFdku, ESSFdkp, AT, and a small portion of IDFdm2 (in the Northeast portion of the study area) are within this ecosection.

**Biogeoclimatic Zones, Subzones and Variants** occur within each Ecosection and are classified using the Ministry of Forests Biogeoclimatic Ecosystem (BEC) system (Braumandl and Curran 1992). These units represent groups of ecosystems under the influence of the same regional climate. Premier Ridge - Diorite is located in the Dry Climate Region (PPdh2, IDFdm2, MSdk, ESSFdk, ESSFdku, ESSFdkp, and AT). These seven biogeoclimatic subzones represented in Premier Ridge - Diorite (Figure 2) are briefly described below.



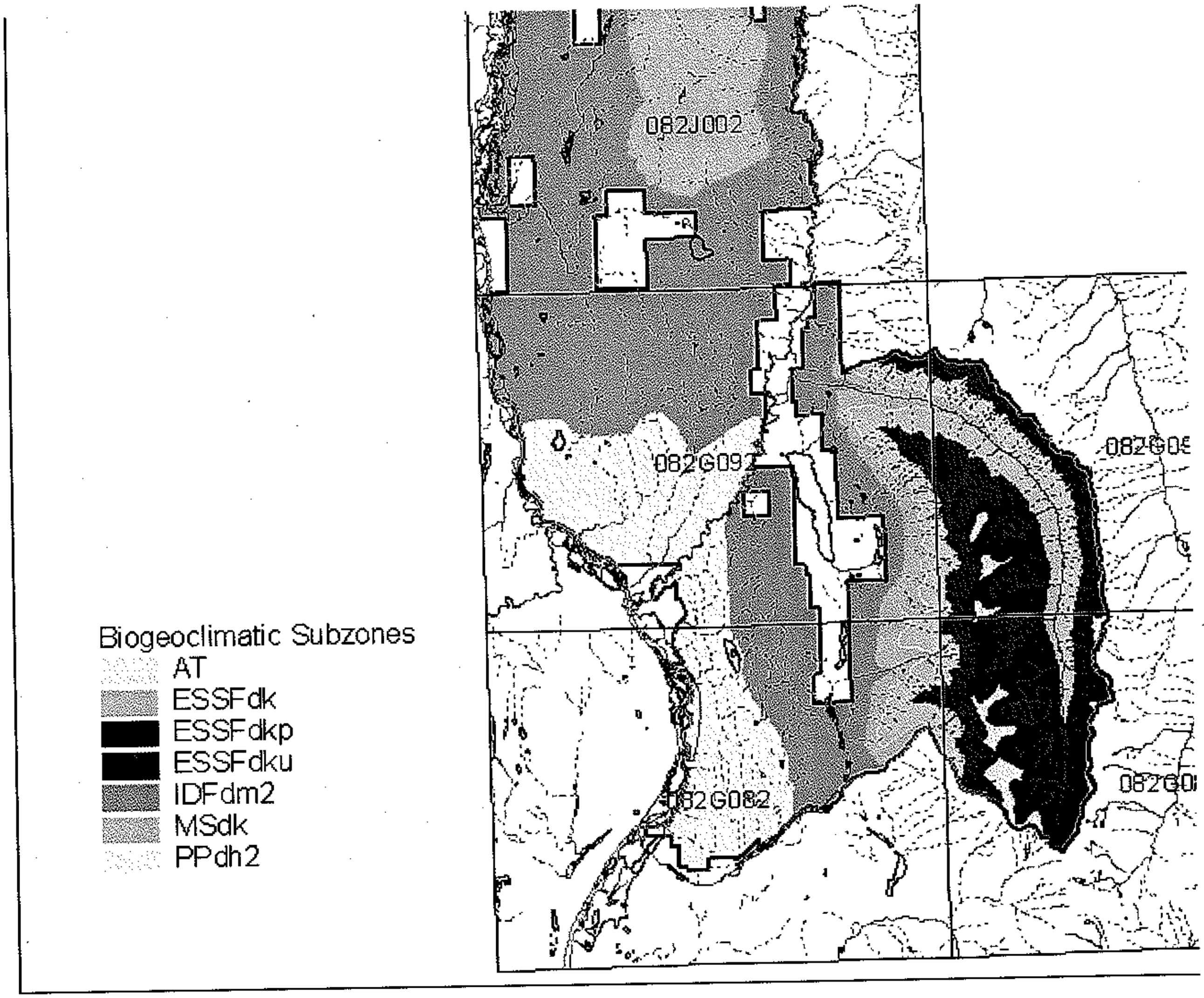



Figure 2. Biogeoclimatic Subzones within the Premier Ridge – Diorite L.U.

Plate 2. Typical PPdh2 site.

**1) PPdh2** - The Kootenay Dry Hot Ponderosa Pine Variant generally occurs between 700 and 900m in elevation (see Plate 2). It is found in the Southwestern portion of the study area. This zone is characterized by very hot, very dry summers and mild winters with very light snowfall. Zonal sites (Braumandl and Curran 1992) support open stands of Ponderosa pine and Douglas-fir. Common species in the understory include bluebunch wheatgrass, saskatoon, prairie rose, and rosy pussytoes. There has been extensive fire, grazing, and logging disturbance within this subzone in Premier Ridge – Diorite (see Plate 3). This subzone supports a wide variety of wildlife species dependent on open forests and is an especially important winter range for mule deer, white-tailed deer and elk.

Plate 3. Example of fire disturbance within the PPdh2 subzone.

Plate 4. Typical IDFdm2 site.

2) **IDFdm2** - The Kootenay Dry, Mild Interior Douglas-fir Variant occurs generally between 900 and 1300m in elevation on warm aspects and between 900 and 1200m on cool aspects (see Plate 4). It is found in Premier Ridge - Diorite at lower elevations including Premier Ridge proper. This zone is characterized by hot, very dry summers and cool winters with very light snowfall. Mature zonal sites (Braumandl and Curran 1992) support stands of Douglas-fir; however, due to frequent wildfires, mixed seral stands of Douglas-fir and lodgepole pine are more common. There has been extensive fire, grazing, and logging disturbance within this subzone in Premier Ridge - Diorite. This subzone supports a wide variety of wildlife species dependent on open forests and is an especially important winter range for mule deer, white-tailed deer and elk.

Plate 5. Typical MSdk site.

3) **MSdk** -The Dry Cool Montane Spruce Subzone occurs between 1300 and 1650m in elevation on warm aspects and between 1200 and 1550m on cool aspects (see Plate 5). It is found at mid elevations of the north half of the study area as well as in the Southeast. This zone is characterized by warm, dry summers and cold winters with light snowfall (Braumandl and Curran 1992). Mature zonal sites support stands of hybrid white spruce and subalpine fir with minor amounts of Douglas-fir; however, due to widespread wildfires, extensive stands of lodgepole pine exist today. This subzone is important autumn and early winter range for deer, elk and moose. It is an important habitat for grizzly bear and the remaining old-growth pockets are key to the maintenance of insect-feeding, cavity-nesting bird populations which, in turn, aid in control of forest insect pests.

Plate 6. Typical ESSFdk site.

4) **ESSFdk** - The Dry Cool Engelmann Spruce Subalpine Fir Subzone occurs between 1650 and 2050m in elevation on warm aspects and between 1550 and 1920m on cool aspects (see Plate 6). It is found in the Southeast portion of Premier Ridge - Diorite as well as a small area in the Northern section. This zone is characterized by cool, dry summers and very cold winters with moderately heavy snowfall (Braumandl and Curran 1992). Mature zonal sites support stands of subalpine fir and Engelmann spruce. Old growth stands in this subzone are important for the maintenance of wildlife populations while seral stages provide highly productive deer, elk and moose summer range. Avalanche and riparian areas provide good habitat for grizzly bear.

Plate 7. Typical ESSFdku site.

5) **ESSFdku** - The Upper Dry Cool Engelmann Spruce Subalpine Fir Subzone (Kernaghan et al.1997,1998) occurs between 2050 and 2400m in elevation on warm aspects and between 1950 and 2300m on cool aspects (see Plate 7). It is located above the ESSFdk in the Southeast portion of the study area. This zone is characterized by cool, dry summers and very cold winters with heavy snowfall. Mature zonal sites support stands of subalpine fir, Engelmann spruce and subalpine larch. Late lying snow and frost pocketing create a mosaic of forest and permanent meadows. This newly described subzone is not documented in Braumandl and Curran (1992) and has been described by Kernaghan et al (1997, 1998). Old growth stands in this subzone are important for the maintenance of wildlife populations, while seral stages provide highly productive deer, elk and moose summer range. Avalanche and riparian areas provide good habitat for grizzly bear.

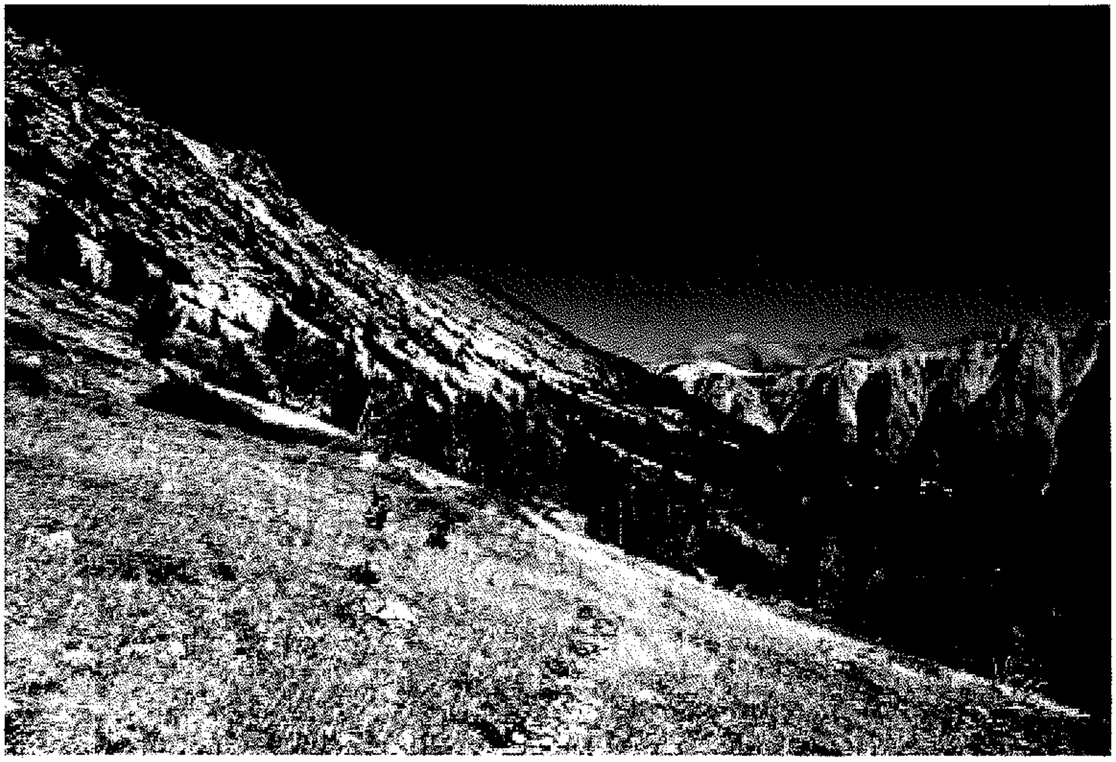


Plate 8. Typical ESSFdkp site.

6) **ESSFdkp** - The Dry Cool Engelmann Spruce Subalpine Fir Parkland Subzone occurs between 2400 and 2520m in elevation on warm aspects and between 2300 and 2500m on cool aspects (see Plate 8). It is a transition above the continous forest and the alpine tundra. This zone is characterized by short, cool and dry summers and very cold winters with heavy snowfall. Mature zonal sites support patchy stands of krummholtz subalpine fir and Engelmann spruce. Late lying snow and frost pocketing create a landscape of scattered tree islands and permanent meadows.

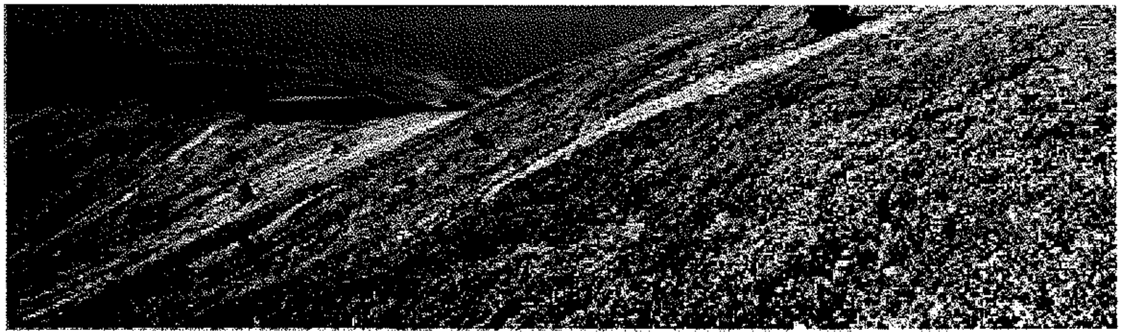


Plate 9. Typical AT site.

7) **AT** - Alpine Tundra biogeoclimatic zone occurs at elevations above 2520m in elevation on warm aspects and above 2500m on cool aspects (see Plate 9). It encompasses the high, treeless peaks of the Rocky Mountains at the Southeastern edge of Premier Ridge - Diorite. This zone is characterized by short, cool and dry summers and very cold winters with heavy snowfall. Much of the subzone is non-vegetated and zonal vegetated sites are characterized by mountain avens and arctic willow with no conifers.

## 3.0 METHODS

### 3.1 PRE-STRATIFICATION OF ECOSYSTEMS USING THE BIOTERRAIN APPROACH

Bioterrain mapping is based on primary terrain and soil mapping standards, it includes any ecologically significant feature which is thought to influence the function of an ecosystem (Ecosystems Working Group, 1998).

The first step was to map terrain according to the Terrain Classification System for British Columbia (Howes and Kenk, 1997). These surficial units were subdivided by features such as directional exposure, depth to water table, avalanche zones, vegetated rock and very thin rubble surfaces, talus, cliffs, and significant changes in bedrock. The features considered important for this study area were agreed upon with the client, technical experts and the consultant's team. These subdivisions attempt to identify and classify as many habitats and sensitive site conditions as possible for the basis for the ecosystem map (Ecosystems Working Group, 1998).

These units of bioterrain were initially mapped by Joel Fitzpatrick as solid lines in ink on air photos using a number 2 size pen. They were sent to the appropriate technical expert (Larry Lacelle, MOELP, Resources Inventory Branch) for approval. When site series mapping commenced we found that extensive correction and subdivision of these lines was necessary to facilitate site series mapping. As the air photos were gettting damaged by the extent of the changes and the type of ink originally used, we choose to make new linework in a digital format and use this for the basis of the bioterrain and site series mapping. This linework was sent for correlation and the improvements recognized and accepted. Consequently, the most up-to-date bioterrain map exists in digital format and is included in Appendix VII. Final terrain mapping consists of numbered polygons and a hard copy bioterrain database.

### 3.1.1 AIR PHOTO INTERPRETATION

Air photo interpretation was accomplished using 1:20,000 scale, 1991, black & white air photos and with checks of more recent structural stage and resource development using 1:20,000 forest cover maps and recent LANDSAT imagery. Due to the nature of black and white photography, the presence of alpine vegetation and the difference between herb and between low (3a) and tall (3b) shrubby structural stages was sometimes difficult to interpret. For polygons that were indicated as being logged on the forest cover map after the date the air photos were taken, the logging was deemed to be clearcut even though there may have been some partial cuts.

## 3.2 SAMPLING

The ecosystem survey intensity level achieved in the field was 4 with 15% polygon visitation. Ecosystem data was collected to the standards set forth the Field Manual for Describing Terrestrial Ecosystems (1998). Sample plots were chosen subjectively to best represent the distribution of ecosystems and structural stages within each biogeoclimatic unit. There was also extensive range sampling done under the 1996 contract, however some of the data was not made available to us and could not be incorporated into plot databases. Gail Berg, MOF Invermere has this data. If this data was incorporated into the mapping, the survey intensity level would be considerably higher. Due to budgetary constraints in the 1999 contract, wildlife surveys were not completed. However, some wildlife sampling was done 1997 by Ecological Insights. Observations or sign of the species found during the sampling in Premier Ridge - Diorite can be found in Appendix V. Rare element lists were compiled and can be found in Appendix VI.

### 3.2.1 DATA FORMS

Detailed data for vegetation, site, soil, and wildlife was collected on "Ecosystem Field Forms" (revised FS882) and Ground Inspections and Visual plot data was collected on "Ground Inspection Forms" all according to the standards set forth in the "Field Manual for Describing Ecosystems" (1998). Some of this original plot data can be found in Appendix IV.

Plots were subjectively located in homogenous areas representing a spectrum of site series and structural stages, and were 0.04 ha in area. The standard size for a sample plot is 20 x 20 m, but the shape of the plot was varied according to the spatial distribution of the ecosystem unit. A plot sampling a narrow riparian site may be 10 x 40m in size.

## 3.3 BIOTERRAIN ATTRIBUTES

Bioterrain attributes were typed following the standards of Howes and Kenk (1997) and RIC 1998

Bioterrain attributes were typed following the standards of Howes and Kenk (1997) and RIC 1998 (Ecosystems Working Group, 1998). Symbology follows the system of Howes and Kenk (1997). Complex polygons can have up to three terrain units within a single polygon. Percentage distribution of terrain units was represented by deciles from 1 to 10 (1=10% and 10=100%).

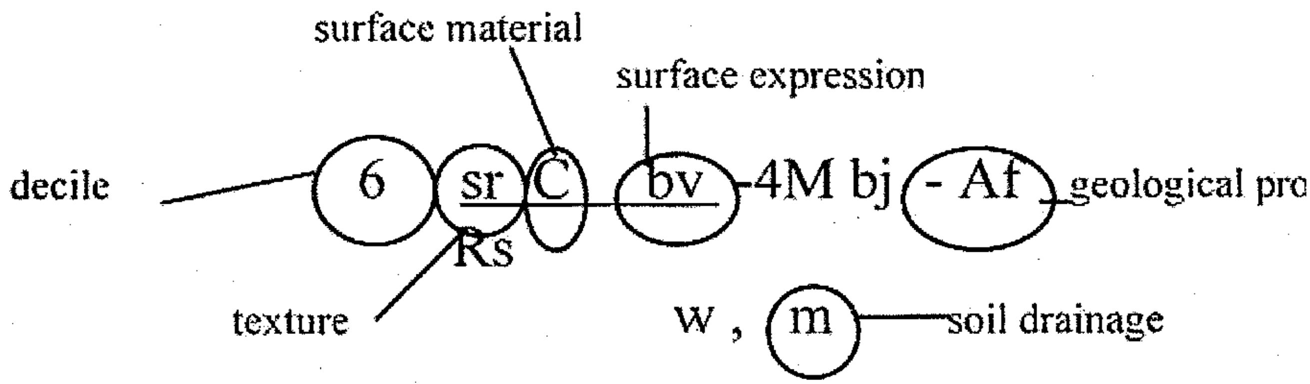
| TEXTURE | SURFICIAL MATERIAL | SURFACE EXPRESSION | GEOLOGICAL PROCESS | SOIL DRAINAGE |
|---|---|---|---|---|
| a=blocks | A= anthropogenic material | a=moderate slope (25-50%) | A=avalanches | x = very rapid |
| b=boulders | C=colluvial | b=blanket (>1m thick) | B=braided channel | r = rapid |
| c=clay | D=weathered bedrock | c=cone | C=cryoturbation | w = well |
| d=mixed fragments | E=eolian | d=depression | D=deflation | m =moderately well |
| e=fibric | F=fluvial | f=fan | E=channelled | i = imperfect |
| g=gravel | FG= glacial fluvial | h=hummocky | F=slow mass movement | p = poor |
| h=humic | I=ice | j=gentle slope (,<25%) | H=kettled | v = very poor |
| k=cobbles | L=lacustrine | k=moderately steep | I=irregular channel | |
| m=mud | LG=glaciolacustrine | m=rolling | J=anastamosing channel | |
| p=pebbles | M=morainal | p=plain | K=karst processes | |
| r=rubble | N=aquatic | r=ridged | M=meandering channel | |
| s=sand | O=organic | s=steep (>70%) | N=nivation | |
| u=mesic | R=bedrock | t=terrace | P=piping | |
| x=angular fragments | U=undifferentiated material | u=undulating | R=rapid mass movement | |
| z=silt | | v=veneer (20-100cm thick) | S=solifluction | |
| | | w=mantle of varing thickness | U=inundation | |
| | | x=thin veneer (2-20cm thick) | V=gully erosion | |
| | | | W=washing | |
| | | | X=permafrost | |
| | | | Z=periglacial processes | |
| | | | $^A$ = active process | |

| | | | | |
|---|---|---|---|---|
| | | | $^{I}$ = inactive process | |

(from Howes and Kenk, 1997)

Table 1: Bioterrain Unit Letter Notation

EXAMPLE TERRAIN POLYGON NOTATION




This polygon label would be read as:

60% sandy, rubbly Colluvial blanket-veneer, overlying steep rock; well drained and

40% Morainal blanket, gently sloping,with freqent avalanching; moderately well drained

### 3.4 ECOSYSTEM UNIT MAPPING

An ecosystem map unit incorporates site series, site modifiers and structural stage into a label. Ecosystem units were mapped using airphoto interpretation and sample plot data according to the standards set forth in Standard for Terrestrial Ecosystem Mapping in BC (RIC 1998). Ecosystem units were mapped within the boundaries of the pre-stratified bioterrain polygons. Bioterrain polygons were split when natural disturbances, such as fire, or cultural disturbances such as logging, resulted in two strongly contrasting structural stages. Pre-stratified bioterrain polygons were also subdivided by biogeoclimatic subzone boundaries.

Sample plots were classified to site series for the PPdh2, IDFdm2, MSdk and ESSFdk using Braumandl and Curran (1992); and for the ESSFdku, ESSFdkp, and AT to site series used by Kernaghan et al (1998).

Polygons with sample plots were used as mapping control points for site series and structural stage classification and terrain relationships. Site series were identified within each unsampled polygon using the algorithms set forth in the working legend (see Appendix III). The characteristics of the terrain unit, sample plots that occurred within similar polygons, and structural stages from differences in air photo textures and age class information from forest cover maps were utilized to map unsampled polygons. Up to three site series were mapped within each polygon.

Site modifying codes were used with a site series designation when it differed from what is described as typical for that site series (see Table 2). When specific features of the site significantly altered the nature of the floristics of an ecosystem unit, that unit received a separate description in the expanded legend. Modifiers increase the resolution of the mapping. Braumandl and Curran (1992) site series were described in more general terms based on forest management objectives.

| |
|---|
| a - active floodplain |
| c - coarse textured soils (loamy sand, sand) |
| d - deep soil ( >100cm) |
| f - fine textured soils (heavy clay, silty clay, silt clay loam) |
| g - gullied |
| h - hummocky |
| j - gently sloping (< 25%) |
| k - cool, northerly or easterly aspect (>25% slope, 285 - 135 degrees) |
| m - medium textured soils |
| n - fluvial fan or cone |
| p - peaty material |
| q - very steep(>100 % slope) cool aspect ( 285 - 135 degrees) |
| r - ridged |
| s - shallow soil ( 20 - 100cm deep) |
| t - terraced |
| v - very shallow soil (< 20 cm deep) |
| w - warm,southerly or westerly aspect (>25% slope 135 - 285 degrees) |
| x - drier than average |
| y - wetter than average |
| z - very steep (>100 % slope) warm aspect ( 135 - 285 degrees) |

Table 2: Site series modifiers

Percentage distribution of ecosystem units was represented by deciles from 1 to 10 (1=10%, 9=90% and 10=100%). Two letter codes are followed by structural stage designations 1-7 (non-vegetated - old forest) (see Table 3). In addition, up to two site modifiers may be present (in lower case) that represent different site conditions than the typical defined for the site series.

| |
|---|
| 1 - Non-Vegetated/Sparsely Vegetated (<20% herb and shrubs, <10% trees) |
| 2 - Herb (<10% trees,<20% shrubs, >20% herbs) |
| 3 - Shrub/Herb (<10% trees,>20% shrubs, under 10m tall) |
| 3a - Low Shrub (generally < 20 yrs and under 2m tall) |
| 3b - Tall Shrub (generally < 40 yrs and 2-10m tall) |
| 4 - Pole/Sapling (generally 20-40 yrs, >10m tall) |
| 5 - Young Forest (40-80 yrs) |
| 6 - Mature Forest (80-140 yrs) |
| 7 - Old Forest (> 140 yrs) |

Table 3: Structural stages

Detailed descriptions of structural stages can be found on page 21 of the RIC (1998) TEM Methodology.

EXAMPLE ECOSYSTEM UNIT LABEL

**7FAk5 3FGk7**

### 3.4.1 NAMING OF ECOSYSTEM MAP UNITS

Ecosystem units are defined as occurring in a typical situation which is described by MOELP provincial site series coding standards (Ecosystems Working Group, 1998)(see Appendix II). Where an ecosystem unit is mapped as occuring on the typical site it is followed by the qualifier 'typic'. For example, the Bl - Azalea - Foamflower (FA) typically is found on gently to moderately sloping sites with deep medium textured soils. When it is mapped on these sites it is called the Bl - Azalea - Foamflower; typic ecosystem unit (FA). However, if this unit were sampled and that plant community were found to also occur on steep cool aspects, the name in these situations would be modified to be called Bl - Azalea - Foamflower; cool aspect ecosystem unit (FAk) to reflect the the fact that it is a local occurence and not typical for that unit, but no other unit is appropriate to describe it.

### 3.5 SITE SERIES MAPS

Site series maps can be found in Appendix IX. They were generated using ARC INFO and the methods described in section 4.2.1.

### 3.6 WORKING LEGEND

While in the field, a working legend was developed to assist tracking the frequency with which combinations of bioterrain and site series were sampled. The working legend is then used as a basis for algorithm development to define the observed relationships between terrain, slope, aspect and site series based on sample plots (see Appendix III).

### 3.7 PLANT IDENTIFICATION

Unknown plants were collected, pressed and labelled in the field. Identification was completed in January, 2000. Botanical nomenclature is according to Douglas, Straley and Meidinger Vascular Plants of British Columbia, Parts 1-4. Some plant materials were sent to provincial specialists for verification. A list of species noted in Premier Ridge - Diorite is included in Appendix 1. A number of species were identified by the previous consultant as being Provincially Red – listed according to the Conservation Data Centre of BC. These are noted in the plant lists. We were not given the voucher specimens with the existing plot cards from the previous consultant, so we have no way of verifying the red-listed species. However, some of the red-listed species were noted as being collected in ecosystems where those species would not normally be found.

### 3.8 DATA ANALYSIS

Each plot was allocated to an existing MOF site series by using the keys provided in Braumandl and Curran (1992), and Kernaghan et al (1997,1998). For the subzones not described by Braumandl and Curran (1992), the ESSFdku, ESSFdkp and AT, site series were based on the adjacent TEM projects from Steamboat Mountain (Kernaghan et al. 1998) with the approval of the Regional Ecologist.

## 4.0 DATABASES

### 4.1 VENUS AND GRAVITI DATABASES

VENUS (Vegetation and Environment NexUS) and GRAVITI are databases created by the Ministries of Forests and Environment in Victoria that houses a provincial database for vegetation, site, soil, wildlife from Ecosystem Field Forms (FS882) and Ground Inspection Forms. The program can also sort and summarize vegetation and environmental data used to aid in the classification and correlation efforts in T.E.M. and other vegetation mapping projects.

### 4.2 BIOTERRAIN AND ECOSYSTEM DATABASE

R.I.C.(1998) standard EXCEL 7.0 spread sheets were used to record bioterrain and ecosystem attributes for each polygon. Each row describes a polygon number with up to three terrain and ecosystem attributes. The content of each column follows the format suggested by the technical coordinator. The bioterrain and ecosystem database is found in Appendix VIII. Standards follow RIC 1998 (Ecosystems Working Group, 1998).

### 4.3 SPATIAL DATABASE

Bioterrain polygons were digitized from typed 1:20,000 air photos using controlled monorestitution with TRIM 1 - Z axis control points. These polygons were presented in draft format on TRIM base maps. After field sampling the polygons were refined and numbered. Polygon numbers were added to the spatial files.

ARC INFO GIS version 7.2.1 was used as the processing system for the spatial component of the TEM database. In accordance to the RIC standards manual, (Standard for Terrestrial Ecosystem Mapping (TEM) Data Capture in BC.1998), polygons representing ecosystem units were delineated by a contiguous ARC/INFO coverage for the study area. Each polygon within the coverage is assigned a unique number which corresponds to a record within the ecosystem database.

The non-spatial component of the TEM database is a table representing the ecosystem and terrain attributes of mapped polygons. Each record in the table describes a single ecosystem unit. A unique number for each record links to a single polygon in the spatial data (polygons) and the TEM attributes (table). The tabular database is structured as per RIC standards, in an ASCII Comma Separated Value (CSV) file.

## 5.0 SUBZONE AND SITE SERIES OVERVIEW

Tables were generated showing the number of hectares of each site series and structural stage within each subzone. The N/A in the site series tables refer to the non vegetated, sparsely vegetated, and anthopogenic units (see Appendix II). The N/A in the structural stage tables refer to the non vegetated, sparsely vegetated, and anthopogenic units that do not require a stuctural stage based on RIC 1998 (Ecosystems Working Group, 1998) standards.

### 5.1 PPdh2

The PW (01) site series strongly dominates 83% of the PPdh2 (see Table 4). The second most common site series is the WJ (02) at 6%. The most common structural stage in the PPdh2 is 5 (49%) (see Table 5). There is no structural stage 7 (old forest) in the PPdh2 because of repeated disturbances of fire and logging. The PPdh2 has three rare plant associations. The CD (04) and the WJ (02) site series, representing 8% of the PPdh2, are both red listed. The AR (03) site series representing 3% of the PPdh2, is blue listed (see Appendix VI).

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| PPdh2 | PW | 01 | 4390.9 |
| PPdh2 | WJ | 02 | 327.1 |
| PPdh2 | AR | 03 | 134.4 |
| PPdh2 | CD | 04 | 78.4 |
| PPdh2 | SF | 00 | 2.9 |
| PPdh2 | CF | N/A | 218.3 |
| PPdh2 | RP | N/A | 41.1 |
| PPdh2 | RI | N/A | 26.5 |
| PPdh2 | LA | N/A | 25.4 |
| PPdh2 | ES | N/A | 24.3 |
| PPdh2 | PD | N/A | 13.5 |
| PPdh2 | OW | N/A | 11.1 |
| PPdh2 | MU | N/A | 10.2 |
| PPdh2 | GP | N/A | 4.9 |
| PPdh2 | GB | N/A | 2.4 |
| PPdh2 | RO | N/A | 0.9 |
| PPdh2 | TA | N/A | 0.2 |
| Total | | | 5312.5 |

Table 4: Site series allocation in hectares in the PPdh2.

| **Subzone** | **Structural Stage** | **Area (hectares)** |
|---|---|---|
| PPdh2 | 5 | 2613.6 |

| | | |
|---|---|---|
| PPdh2 | 6 | 1167.3 |
| PPdh2 | 3 | 674.0 |
| PPdh2 | 2 | 564.0 |
| PPdh2 | 4 | 133.3 |
| PPdh2 | N/A | 117.5 |
| PPdh2 | 1 | 42.9 |
| PPdh2 | 7 | 0 |
| Total | | 5312.5 |

Table 5: Structural stage allocation in hectares in the PPdh2.

### 5.2 IDFdm2

The DT (01) site series dominates 65% of the IDFdm2 (see Table 6). The second most common site series is the DS (03) at 19%. The most common structural stage in the IDFdm2 is 5 (56%) (see Table 7). As in the PPdh2 there is no structural stage 7 (old forest) in the IDFdm2 because of repeated disturbances of fire and logging. The IDFdm2 has four rare plant associations. The SF (00) and DS (03) site series, representing 19% of the IDFdm2, are both red listed. The AW (02) and BH (06) site series, representing 5% of the IDFdm2, are both blue listed (see Appendix VI).

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|
| IDFdm2 | DT | 01 | 11773.0 |
| IDFdm2 | DS | 03 | 3404.3 |
| IDFdm2 | AW | 02 | 708.8 |
| IDFdm2 | SP | 04 | 619.0 |
| IDFdm2 | SH | 07 | 273.2 |
| IDFdm2 | BH | 06 | 253.5 |
| IDFdm2 | SS | 05 | 222.1 |
| IDFdm2 | SM | 00 | 22.6 |
| IDFdm2 | SF | 00 | 21.4 |

| | | | |
|---|---|---|---|
| IDFdm2 | CT | 00 | 13.6 |
| IDFdm2 | CL | 00 | 8.5 |
| IDFdm2 | BU | 00 | 0.8 |
| IDFdm2 | RO | N/A | 208.8 |
| IDFdm2 | RP | N/A | 146.3 |
| IDFdm2 | RI | N/A | 119.6 |
| IDFdm2 | OW | N/A | 97.4 |
| IDFdm2 | TA | N/A | 92.3 |
| IDFdm2 | GB | N/A | 37.9 |
| IDFdm2 | ES | N/A | 22.3 |
| IDFdm2 | LA | N/A | 12.7 |
| IDFdm2 | GP | N/A | 9.3 |
| IDFdm2 | PD | N/A | 3.8 |
| Total | | | 18074.8 |

Table 6: Site series allocation in hectares in the IDFdm2.

| **Subzone** | **Structural Stage** | **Area (hectares)** |
|---|---|---|
| IDFdm2 | 5 | 10226.7 |
| IDFdm2 | 6 | 3159.2 |
| IDFdm2 | 3 | 2982.2 |
| IDFdm2 | 4 | 773.7 |
| IDFdm2 | N/A | 383.1 |
| IDFdm2 | 1 | 379.2 |
| IDFdm2 | 2 | 170.7 |
| IDFdm2 | 7 | 0 |

| | | |
|---|---|---|
| Total | | 18074.8 |

Table 7: Structural stage allocation in hectares in the IDFdm2.

### 5.3 MSdk

The LP (04) site series dominates 62% of the MSdk (see Table 8). The second most common site series is the SG (01) at 13%. The most common structural stage in the MSdk is 6 (48%) (see Table 9). Stand ages tend to be somewhat older in the MSdk than in the PPdh2 and IDFdm2. However, there is no structural stage 7 because of past disturbances.

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|
| MSdk | LP | 04 | 3288.2 |
| MSdk | SG | 01 | 692.5 |
| MSdk | LJ | 03 | 967.0 |
| MSdk | SW | 02 | 45.5 |
| MSdk | AF | 00 | 31.2 |
| MSdk | AS | 00 | 26.4 |
| MSdk | SS | 05 | 16.8 |
| MSdk | AW | 00 | 6.5 |
| MSdk | SM | 00 | 3.2 |
| MSdk | EF | 00 | 0.3 |
| MSdk | FC | 00 | 0.1 |
| MSdk | RO | N/A | 165.1 |
| MSdk | TA | N/A | 75.5 |
| MSdk | CL | N/A | 27.2 |
| MSdk | RI | N/A | 0.8 |
| Total | | | 5346.3 |

Table 8: Site series allocation in hectares in the MSdk.

| Subzone | Structural Stage | Area (hectares) |
|---|---|---|
| MSdk | 6 | 2548.5 |
| MSdk | 5 | 1418.0 |
| MSdk | 3 | 1019.4 |
| MSdk | 1 | 267.9 |
| MSdk | 4 | 88.2 |
| MSdk | 2 | 3.6 |
| MSdk | N/A | 0.8 |
| MSdk | 7 | 0 |
| Total | | 5346.3 |

Table 9: Structural stage allocation in hectares in the MSdk.

### 5.4 ESSFdk

The FS (04) site series dominates 46% of the ESSFdk (see Table 10). The second most common site series is the DM (02) at 22%.This indicates large areas of drier sites. The most common structural stage in the ESSFdk is 6 (55%) (see Table 11). Stand ages tend to be somewhat older in the ESSFdk than in the PPdh2 and IDFdm2. However, there is no structural stage 7 because of past disturbances.

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|
| ESSFdk | FS | 04 | 1316.5 |
| ESSFdk | DM | 02 | 621.7 |
| ESSFdk | AF | 00 | 105.7 |

| | | | |
|---|---|---|---|
| ESSFdk | FA | 01 | 105.5 |
| ESSFdk | FM | 05 | 63.3 |
| ESSFdk | EF | 00 | 52.6 |
| ESSFdk | AS | 00 | 43.2 |
| ESSFdk | SE | 00 | 41.7 |
| ESSFdk | FH | 06 | 22.3 |
| ESSFdk | AW | 00 | 6.3 |
| ESSFdk | TA | N/A | 277.5 |
| ESSFdk | RO | N/A | 167.9 |
| ESSFdk | CL | N/A | 15.0 |
| ESSFdk | MO | N/A | 3.2 |
| Total | | | 2842.4 |

Table 10: Site series allocation in hectares in the ESSFdk.

| Subzone | Structural Stage | Area (hectares) |
|---|---|---|
| ESSFdk | 6 | 1561.2 |
| ESSFdk | 1 | 463.6 |
| ESSFdk | 5 | 462.5 |
| ESSFdk | 3 | 225.2 |
| ESSFdk | 4 | 72.5 |
| ESSFdk | 2 | 57.4 |
| ESSFdk | 7 | 0 |
| Total | | 2842.4 |

Table 11: Structural stage allocation in hectares in the ESSFdk.

### 5.5 ESSFdku

The FG (00) site series dominates 25% of the ESSFdku (see Table 12). The second most common site series is the PJ (00) at 16%. The most common structural stage in the ESSFdku is 6 (40%) (see Table 13). The second most common structural stage is 1 (non vegetated). Stand ages tend to be older in the ESSFdku than in the lower elevation subzones. Structural stage 7 (old forest) is fairly common at 9% of the ESSFdku.

| **Subzone** | **Site Series** | **Site Series Number** | **Area (hectares)** |
|---|---|---|---|
| ESSFdku | FG | 00 | 896.1 |
| ESSFdku | PJ | 00 | 566.6 |
| **Subzone** | **Site Series** | **Site Series Number** | **Area (hectares)** |
| ESSFdku | LH | 00 | 255.9 |
| ESSFdku | FS | 00 | 183.3 |
| ESSFdku | LG | 00 | 128.1 |
| ESSFdku | PV | 00 | 98.4 |
| ESSFdku | PW | 00 | 68.3 |
| ESSFdku | HG | 00 | 39.3 |
| ESSFdku | FH | 00 | 13.7 |
| ESSFdku | LM | 00 | 12.7 |
| ESSFdku | CH | 00 | 4.1 |
| ESSFdku | FA | 00 | 2.7 |
| ESSFdku | TA | N/A | 713.8 |
| ESSFdku | RO | N/A | 460.4 |
| ESSFdku | MO | N/A | 44.9 |
| ESSFdku | PD | N/A | 24.8 |
| ESSFdku | RU | N/A | 8.4 |
| ESSFdku | OW | N/A | 7.6 |
| Total | | | 3530.0 |

Table 12: Site series allocation in hectares in the ESSFdku.

| Subzone | Structural Stage | Area (hectares) |
|---|---|---|
| ESSFdku | 6 | 1409.1 |
| ESSFdku | 1 | 1227.5 |
| ESSFdku | 7 | 319.4 |
| ESSFdku | 3 | 288.3 |
| ESSFdku | 2 | 124.6 |
| ESSFdku | 5 | 97.4 |
| ESSFdku | N/A | 32.4 |
| ESSFdku | 4 | 31.3 |
| Total | | 3530.0 |

Table 13: Structural stage allocation in hectares in the ESSFdku.

### 5.6 ESSFdkp

The EM (00) site series occurs on 8% of the ESSFdkp (see Table 14). The second most common site series is the YW (00) also at 8%. The most common structural stage in the ESSFdkp is 1 (66%) (see Table 13). Only 34% of the ESSFdkp is vegetated. And of that 34%, only 5% is structural stage 7 (old forest).

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|
| ESSFdkp | EM | 00 | 115.3 |
| ESSFdkp | YW | 00 | 114.6 |
| ESSFdkp | WF | 00 | 92.0 |
| ESSFdkp | AW | 00 | 73.3 |
| ESSFdkp | DV | 00 | 43.3 |

| Subzone | Site Series | Site Series Number | Area (hectares) |
|---|---|---|---|
| ESSFdkp | LM | 00 | 26.6 |
| ESSFdkp | FS | 00 | 12.7 |
| ESSFdkp | TA | N/A | 492.5 |
| ESSFdkp | RO | N/A | 385.0 |
| ESSFdkp | MO | N/A | 34.9 |
| ESSFdkp | RU | N/A | 9.2 |
| ESSFdkp | OW | N/A | 2.1 |
| ESSFdkp | PD | N/A | 1.6 |
| Total | | | 1403.1 |

Table 14: Site series allocation in hectares in the ESSFdkp.

| Subzone | Structural Stage | Area (hectares) |
|---|---|---|
| ESSFdkp | 1 | 921.6 |
| ESSFdkp | 2 | 210.8 |
| ESSFdkp | 6 | 149.4 |
| ESSFdkp | 3 | 88.6 |
| ESSFdkp | 7 | 23.0 |
| ESSFdkp | 5 | 6.0 |
| ESSFdkp | N/A | 3.7 |
| ESSFdkp | 4 | 0 |
| Total | | 1403.1 |

Table 15: Structural stage allocation in hectares in the ESSFdkp.

### 5.7 AT

The AW (00) site series occurs on 12% of the AT (see Table 16). The second most common site series is the SL (00) at 2%. The most common structural stage in the AT is 1 (66%) (see Table 17). Only 15% of the AT is vegetated. The rest is dominated by rock and talus.

| **Subzone** | **Site Series** | **Site Series Number** | **Area (hectares)** |
|---|---|---|---|
| AT | AW | 00 | 44.8 |
| AT | SL | 00 | 8.5 |
| AT | BP | 00 | 1.6 |
| AT | TA | | 175.6 |
| AT | RO | | 137.0 |
| AT | RU | | 1.3 |
| Total | | | 368.8 |

Table 16: Site series allocation in hectares in the AT.

| **Subzone** | **Structural Stage** | **Area (hectares)** |
|---|---|---|
| AT | 1 | 313.9 |
| AT | 2 | 54.9 |
| Total | | 368.8 |

Table 17: Structural stage allocation in hectares in the AT.

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