RECREATION PLANNING FOR COASTAL B.C. PARKS: AN ECOLOGICAL (BIOPHYSICAL) INVENTORY AND ANALYSIS APPROACH

by

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ABSTRACT

Theory of ecological (biophysical) land classification is presented. The theory of integrated ecological land classification, mapping and analysis is applied to recreational land planning. An approach to recreational site-suitability analysis appropriate for reconnaissance level inventories and analyses of recreation capabilities is presented.

Clague Mountain Park, Kitimat, B.C. served as a case study for applying the recreation site-suitability analysis approach developed. Landforms, identified using the Terrain Classification System (Ministry of Environment, 1978), served as the basis upon which selected ecologically-significant parameters were inventoried and analyzed. The parameters used in this analysis included topography, depth to bedrock, frost action, flood hazard, vegetation, climate and various soil characteristics, including moisture regime, texture, stoniness, rockiness, permeability and erosion hazard. The activities considered in this analysis included camping (intensive), hiking (summer), picnicking/day use, cross-country skiing, downhill skiing, mountain climbing/mountaineering, tobogganning, snowmobiling and snowshoeing.

The recreational suitability of the park was summarized in tables and maps. It was found that this site-suitability analysis approach provided an effective means for establishing an area's recreational suitability. It is recommended that the findings of this analysis be used to assist in any future recreation planning and management within the park.

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1.0 INTRODUCTION

Efficient and effective natural resources planning and management requires a sound generally accepted approach to resources inventory and analysis. The purpose of this thesis is to discuss the theories and concepts of ecological (biophysical) land classification and to show how it can serve as a partial basis for undertaking outdoor recreation suitability analysis. The major premise of this thesis is that, the interactive physical and biological factors of the environment can be used as indicators of the land's ability to sustain specific uses. Such environmental attributes can govern the form, intensity, duration and general sustainability of resource uses in given landscapes. This approach is not all encompassing for it does not account for the contributions of social, historical, archeological, political and economic factors.

In this thesis a small municipal park situated in northwestern British Columbia was assessed as to its suitability for each of nine selected outdoor recreational activities. This analysis of Clague Mountain Park, Kitimat, B.C., was undertaken using established, activity-specific sets of ecologically significant environmental parameters. The activities included were camping (intensive), hiking (summer), picnicking/day use, cross-country skiing, downhill skiing, mountain climbing/mountaineering, tobogganning, snowmobiling and snowshoeing.

The objectives of this thesis are:

1. to illustrate the theory and potential contribution of integrated land classification, mapping and analysis to more efficient and effective planning of the recreational resource base,
2. to present sets of ecologically-significant parameters for specific recreational activities which will aid in the establishment of the limitation of given landscapes for each of these activities,
3. to develop an approach to recreational site-suitability analysis appropriate for reconnaissance level inventories and analyses of the recreational capability of the Coast Mountain region of British Columbia,
4. to apply the recreational site-suitability approach developed to Clague Mountain Park, Kitimat, B.C.,
5. and, to derive recommendations that will aid in the future planning, development and management of Clague Mountain Park.

2.0 THEORY OF ECOLOGICAL (BIOPHYSICAL) LAND CLASSIFICATION

2.1 Concepts of Classification

Assume that an area is to be inventoried, classified and interpreted for its suitability for recreation development, what is the "best" or most "optimum" classification scheme to use? As might be suspected, there is no "best" approach to land classification. Various systems of land classification are contrivances developed to suit specific needs, hence they are not truths than can be discovered. Classification is the ordering or arranging of objects into groups or sets based on similarities or relationships. The social, economic, administrative and environmental characteristics of the environment and their interrelationships foster the development and application of a host of classification schemes. Such schemes are based on land characteristics, present use, use capabilities, recommended use, need for effectuation of programs and other criteria that aid in meeting societys' needs and aspirations.

If supply inventory and classification systems are to be useful they should meet the following requirements:

1. "The classification must be as objective as possible to adequately define the land classes in terms of inherent biophysical potential for resource production." (Driscoll, 1978).
2. The landscape features upon which the classes are based should be permanent. "It is understood that some elements of the system; for example vegetation and soil, change as a result of resource management practises. However, some diagnostic characteristics (land surface configuration and climate) remain relatively permanent and the class orders of the classification can be inferred by induction or deduction." (Driscoll, 1978).
3. The system must be flexible, general and of use over defined geographic areas if it is to be functional in predicting a range of information over a large number of environmental situations.

4. From a practical standpoint it should be formed on concepts and logic that are understood by non-technical people, permit inclusion into an overall empirical computer-oriented information system, and be designed and documented for ease of identification and mapping of field sites.
5. Selected classes should facilitate inductive, as well as deductive assessments to be developed in the context of the feature of interest or the particular purpose of the study. Different fields of generalizations call for different classifications (Bailey et al, 1978).
6. The classification system should facilitate the collection of remotely sensed data at various scales of intensity and at different times of the year (sequential photographic and remotely sensed imagery).

As indicated previously, one of the major applications of land classification systems has been in the derivation of land capability or capacity estimates, be it for recreational pursuits or other of mans' activities. Classification provides a framework for an interdisciplinary inventory of the resources which control land capability (capacity). "Land capability" in this context refers to the physical carrying capacity of an area as defined by the inherent ability of the landscape to sustain a given use (Block, 1976). Land units will be assessed in terms of their capacities to support a range of selected recreational activities. In this thesis land unit suitability is the inherent capacity of a land unit to support a given use but does not include the land unit's ability to attract such use, accessibility to it nor any social or economic considerations.

2.2 Concept of Ecological (Biophysical) Classification

What does ecological (biophysical) land classification mean? This term is used to denote an integrated approach to land survey, in which land is inventoried, classified and mapped as distinct ecosystems (Welch, 1977; Rowe, 1978; Wiken, 1978). "Land" includes both biotic (physical-chemical) components of the environment and their interactions as they influence human activities. To establish a sense of order and consistency in land classification, the Canada Committee on Ecological (Biophysical) Land Classification (CCELC) proposed that this integrated approach be known as "ecological (biophysical) land classification" (ELC). The primary objective of CCELC is, "to encourage the continued development and to promote the application of a uniform ecological (biophysical) approach to land classification for resource planning, management and environmental impact assessment purposes" (Wiken, 1978). In effect the CCELC has taken on the responsibility to co-ordinate the development of the Canadian Land Classification System.

Ecological land classification attempts to express the interactive character of the lands' components and human activities. A better understanding of these interactive properties facilitates improved management of the natural and anthropogenic resource base. A more detailed discussion of ELC is given in 2.3. Establishing the interrelationships in a given ecosystem can be difficult, as ecosystem behavior is not linear. ELC attempts to simplify these relationships between different areas of land in a spatial hierarchical fashion.

Over the past four decades numerous ELC studies have been undertaken in Canada, with subsequent studies improving the methods and findings of previous ones. In a vast and unsettled country like Canada, the ELC approach has proven invaluable for differentiating and classifying ecologically-significant segments of the land surface. For areas which warrant more detailed study the ELC's hierarchical framework allows a more refined evaluation. Lacate (1969) proposed an ELC system which recognized several levels of generalization. This system has become the "model" for approaches in Canada. The four levels which comprise Lacate's system are:

Land Region: an extensive area of contiguous landscapes with a complex of physiographic patterns distinguished by regional climate as expressed by vegetational complexes. Boundary delineation is on the basis of the macro biota-soil indicators of latitudinal and longitudinal climatic change.

Land District: is a component of Land Region, being characterized by a distinctive pattern of relief, geological structure, geomorphic evolution and associated regional vegetation. Boundary delineation is on the basis of macro changes in relief and/or bedrock geology.

Land System: is a component of a Land District, being characterized by a recurring pattern of landforms, soils and vegetation. Mapping units at the Land System level are identifiable on airphotos primarily as patterns of landforms and vegetation. Boundary delineation is on the basis of meso changes in surficial geology and landform.

Land Type: is a component of Land System, being characterized as a topographic combination of soil texture, drainage and a succession of vegetation. The Land Type is the fundamental land classification unit; often being used as a basis for rating the biological carrying capacity of a given area or for other resource management purposes for which more specific and highly detailed capability ratings might be required. Boundaries are delineated on the basis of changes in slope and in variations in soil materials and depth. (Lacate, 1969; Oswald and Senyk, 1977; Rowe, 1978.)

2.3 Landform and Related Ecological Parameters

Having introduced an overall framework and the major premises of ELC, the parameters that are deemed "ecologically-significant" in ELC will be discussed. Before proceeding it should be noted that although there is a common approach to ELC, the selection of parameters is dependent on local needs and available methods of collection (Welch, 1977; Rowe, 1978).

In practise ELC surveys rely on perceived boundaries which define areas displaying certain uniform or interconnected traits. Parameters selected to describe these traits serve as benchmark indicators or generators of function and process in the landscape. Selection of parameters will be dependent on limitations in time, monies, manpower and other resources, recognition of local needs and project objectives.

Landforms are one of the more commonly used and interpreted landscape features (Gimbarzevsky, 1978b). Landforms are defined as:

a) ".... natural terrain units (including geologic elements and transported or residual soils) that, where developed under similar conditions of climate, weathering, erosion and mass wasting, will exhibit a predictable range of physical and visual characteristics. Therefore, soils developed from similar parent materials (under similar conditions) are related and have similar engineering properties." (Way, 1978).

b) "The various shapes of the land surface resulting from a variety of actions such as deposition or sedimentation (eskers, lacustrine basins), erosion (gullies, canyons) and earth crust movements (mountains)." (Agric. Can., 1976).

c) ".... areas of land or topographic features that are defined in terms of their shapes and slope patterns, the materials that produce the relief, and, wherever possible, in terms of their mode of origin. Landforms are areas of land, or topographic features, that provide the framework to which patterns and changes in vegetation and soils can be geographically related." (Lacate, 1969).

Recognition and interpretation of landforms and associated surficial geology serves to establish a geographic framework to which soil, vegetation, climate and land use information can be related and subsequently extrapolated over adjacent landscapes. In British Columbia the Resource Analysis Branch's Terrain Classification System is a prime example of how landform recognition and interpretation can serve as a framework to which other ecological parameters can be related (Min. of the Envir., 1978) (*refer to Appendix VIII).

The classification system used to assess the landform features, soils and parent materials in this thesis is that proposed by the RAB (Min. of the Envir., 1978). Further, in this thesis all references made to either "land units" or "land systems" imply the areas of the landscape as defined by Lacate's (1969) "Land System" level of classification.

In practise it has been shown that aerial photo interpretation techniques facilitate systematic mapping of the physical characteristics of the landscape (Gimbarzevsky, 1978b).

The combined use of existing reports and maps, ground checks and airphoto interpretations enables one to classify and accurately delineate landforms based on observed or deduced physical and biological landscape attributes. The inherent attributes of landform govern the sustainability for selected resource uses. As a prerequisite to sound land planning and management it is imperative that a comprehensive and quantitative knowledge of the ecological attributes of the landscape be attained (Jurdant et al, 1974).

The characteristics of natural vegetation have been found to be closely linked with landform. The integration of vegetation into ecological land inventory has proven inadequate due to the lack of a generally accepted descriptive method for vegetation, the absence of a framework for classifying Canadian vegetation types, the rapid reaction of vegetation to disturbance and the presence of variable vegetation cover on similar landforms. There is a need for parameters that are independent of successional or man-induced changes (Gimbarzevsky, 1978b; Rowe, 1978). Vegetation is usually inventoried and classified on the basis of vegetation structure, such as stratification, height, percent cover and crown closure, species composition by stratum and species abundance (numbers and percent coverage). Although vegetation is not as suitable as landform, as a framework for ELC, it has proven useful for inventorying and interpreting for wildlife, recreation, timber and other resources and resource uses. Vegetation is an indicator of soil condition, hence, facilitates the identification and mapping of soil texture, permeability, salinity, fertility, moisture and drainage classes, depth to seasonal watertable and soil taxonomic classes (Lacate, 1969; Gimbarzevsky, 1978b; Way, 1978).

In British Columbia, vegetation classification has been heavily influenced by Krajina's (1969) concept of Biogeoclimatic Zonation. Krajina's approach expresses the combined influence of climate and physiography on the dominant vegetation, with each Biogeoclimatic Zone being named after the dominant climatic climax tree species on mesic sites within each Zone. Although it is one of the most ecologically advanced vegetation classification systems in use today, it suffers from some poorly defined boundaries arising from insufficient data (U.B.C. Forest Club, 1971).

In this thesis the vegetation-related parameters were based on the inherent characteristics of the Coastal Western Hemlock Zone (Wet Subzone), the Mountain Hemlock Zone (Forest and Parkland Subzones) and the Alpine Zone. Realizing the drawbacks of integrating vegetation into ELC, it nevertheless plays an important role in establishing a sense of the ecological unity of an area.

Climate represents the average weather conditions of an area and, hence, limits the existing or planned activities in an area. Climate is reflected in an area's biological activity, which, in turn, determines the suitability of an area for a variety of uses, i.e., valley bottoms, with their normally higher levels of biological productivity, would probably be more suitable for a wider range and greater intensity of use than high elevation alpine areas, characterized by short growing seasons and extremes in temperatures, wind and insolation. Climate is often deduced from patterns of vegetation, landform and drainage characteristic of an area (Oswald and Senyk, 1977; Rowe, 1978).

In rugged mountainous areas of British Columbia the varied macro-relief has pronounced modifying influences on regional climates (Oswald and Senyk, 1977). On a larger scale, landforms can have pronounced influences on their surrounding micro-climates. Slopes and aspects will determine the amounts of solar radiation, wind and precipitation landforms will receive (Gimbarzevsky _et al_, 1978). Air temperature, precipitation, wind, relative humidity and solar radiation are the climatic categories often used to inventory and describe landform units.

Bennett (1977) proposed a climatic classification scheme for recreation in British Columbia (Appendix III). Climate represents only one parameter of the ELC framework, hence should be considered in conjunction with vegetation, landform, water bodies, animal communities and man.

2.4 Strengths and Weaknesses of Ecological (Biophysical) Classification

Up to this point, discussion has centered on the concept of ELC and its associated ecologically-significant parameters. Why bother with this approach? The following actual or presumed strengths and weaknesses will indicate respectively why some individuals and agencies favour or avoid using the ELC approach. (It should be noted that the stated strengths and weaknesses are generalized and that each project should be evaluated on its own merits.)

The ELC approach has proven useful because:

1. The hierarchical framework of the ELC method, its ability to portray the landscape at widely divergent scales and its form of presentation based on the concept of ecological unity makes the ELC approach unparallelled in processing landscape data for planning purposes (Luff and Ojamaa, 1978; Rowe, 1978). ELC has the provision to integrate subsequent, more intensive investigations into previously completed reconnaissance surveys (Gimbarzevsky, 1978b).
2. It provides for an holistic overview of the natural environment and often results in the derivation of versatile surveys (Gimbarzevsky, 1978b; Rowe, 1978; Wiken, 1978).
3. It emphasizes the documentation of the more stable land characteristics, thus maintaining and enhancing the data bases' utility in the long run.

4. It represents one of the most effective uses of remote sensing technology.
5. It allows, in theory, for the evaluation and possible improvement upon current or expected land use practices by recognizing and accounting for:

- the thresholds and limits of land ecosystems,
- the range of management strategies available,
- the environmental impact of proposals by indicating the degree of compatibility with the land systems,
- the significance of new technologies,
- the low risk alternatives that are possible,
- the opportunities for renovation and sequential land occupation,
- and, the cost advantages that may be realized over interpretive surveys or comparable number of single disciplinary studies, i.e., less detailed single disciplinary programs often have higher unit costs due to redundancies in the areas of transportation, field work, staff support, cartographic map production and computer data manipulation.

The ELC approach has proven limited because:

1. It lacks an agreed upon taxonomic system.
2. The costs associated with ELC surveys can be quite formidable. ELC survey costs are related directly to the complexity and size of the area under study, required amount of detail and form of data presentation (Oswald, 1976; Gimbarzevsky, 1978b).

3. The time required to undertake ELC surveys may pose a problem as there is often a need for a quick response accompanied by sound decision making, e.g. exploration and development in areas rich in natural resources. Oswald (1976) stated that the biophysical mapping of the Yukon Territories and considerably smaller areas would require a minimum two year period.
4. Application of the ELC system can be limited by aircraft scheduling, weather conditions, incidence of forest fires, travel distance among base camps, ground access and other aspects of data collection, manipulation and presentation.

2.5 Methodology for Ecological Inventory and Analysis

The success of ELC studies is dependent on the use of a generally recognized and applied methodological framework. The framework is based on the ability of investigators to inventory, classify and map ecologically significant patterns, thus yielding variously scaled divisions of the landscape (Gimbarzevsky, 1978b; Rowe, 1978). Derivation of representative and understandable taxonomic systems will be dependent on the range of disciplines and interest groups involved in ecological land surveys. If delineated land units are to be meaningful investigators must maintain the dynamic sense of landscape processes and the meaning of spatial patterns. Landscape processes can be interpreted by direct observation or through inference. In areas as vast and unsettled as Canada, a great deal of terrain analysis information has been gathered using inference (Fulton et al, 1974). Inference can be used to determine whether an area has sand, silt or clay surficial parent material through an analysis of the drainage patterns of the area. Inference has been proven effective in assessing soil moisture and fertility, erosion hazard, flood hazard, climate, vegetation condition, slopes, potential land uses and wildlife populations. Use of airphotos and airphoto interpretation, coupled with supportive ground checks, has shown to be invaluable in ELC studies. Airphotos aid in the preliminary field reconnaissance work and mapping of ecologically-significant units, as well as the final compilation and presentation of findings (Lacate, 1969; Rowe, 1978).

Upon reviewing the works of Gimbarzevsky (1978a and 1978b); Gimbarzevsky et al (1978); Lacate (1969); Oswald (1976) and Way (1978) it was found that one overall methodological framework could be used to summarize the ELC approaches proposed by these authors. The data collection and analysis procedures which follow formed the basis of the approach used in the case study portion of this thesis. The following points illustrate the procedures which comprise the aforementioned overall ELC framework:

1. Resource Data Acquisition

   a) Preliminary work:

   - Gather and review all pertinent information on the area to be surveyed, paying close attention to information related to bedrock geology, geomorphology, soils, climate, vegetation, land use, hydrology and wildlife communities,

b) Systematic airphoto analysis:

- Extensive use should be made of remotely sensed date in the form of oblique photographs, large and small scale airphotographs, photo mosaics and satellite imagery,
- The quality, date, scale, and type of aerial photography will have significant influences on the visibility of patterns formed by the key ecological parameters,
- The use of aerial photographs facilitates the observation of landscape patterns that cannot be perceived from ground surveys,
- Prior to going into the field, it is advised that preliminary photo interpretation of the parameters previously mentioned, be undertaken; this will aid in field location and planning the field work,
- Pre-field photo interpretation represents a first approximation of a systematic stratification of the land surface and delineation of ecologically-significant segments of the landscape,
- Pre-field photo interpretation and mapping of patterns of the landscape requires that finite boundaries must often be drawn for conditions that do not actually have finite boundaries, thus resulting in a certain amount

of mapping error at all scales of mapping. Boundary establishment will rely on observed and inferred characteristics of the landscape.

c) Field verification:

- All ELC studies should include some form of field verification or "ground truthing". Ground truthing is required to add support to the final classification and validity of the survey data.
- As this is usually the most costly phase of ELC studies, it is essential that adequate planning and preparation take place prior to going into the field.
- Attention should focus on the collection of information relevant to the aspects of land, vegetation, wildlife, hydrology, climate and land use. Information may be kept in the form of field notes, photographs, tape recordings, and field samples of flora, fauna and soil. Rapid field inventories are made possible through the use of standardized forms. An example of one such form is illustrated in Appendix I.

d) Classification:

- Following a thorough review of all pertinent information, pre-field photo interpretations and field information, the study area is systematically classified and mapped on the basis of landform units and selected ecological parameters, keeping in mind the intensity and purpose of the mapping survey and insuring that the final classification scheme is readily understandable and useable by resource managers and land use planners. It should be remembered that data collection and analysis procedures should be designed with the anticipated land use(s) in mind.

- At this time, revisions and corrections are made to the preliminary photo interpretations for the area, with boundaries being modified in light of ground truthing information.

2. <u>Resource Data Presentation</u>

- This phase involves the preparation of base maps, transferring of resource details from interpreted aerial photographs to the base for compilation of resource maps and area determination and tabulation by resource classes for inclusion in summary tables. Transference of resource details from interpreted airphotos can be accomplished using a reflecting projector or sketchmaster for low relief areas. For areas with extremes and/or complexity of relief, e.g. the mountainous coastal zone of British Columbia, stereoplotting systems, such as the <u>Radial Kail Line Plotter</u>, the <u>Stereotop</u> or the <u>Bausch and Lomb Zoom Transfer Scope</u>, can be used.

3. <u>Interpretation of Resource Data</u>

- Up to this point attention has been focused on data collection, representation and summation. This phase represents the application of derived findings relating to the ecological characteristics of the area under study. Resource maps and summary tables are used to present information in condensed, understandable formats.

- To aid management planning and decision making, the kind, location and areal extent of primary ecological resources are often expressed through the use of conventional symbols which indicate the basic characteristics of the delineated map units, i.e., ecologically-significant segments of the landscape.
- These ecological characteristics and their associated positive or negative effects on the suitability of the map unit for a particular purpose, may be interpreted from the resource maps and expressed in terms of capability classes for biological productivity or suitability for selected recreational activities or for other uses of interest.
- To aid in planning, land units which have similar use-limitations or suitability ratings for the same anticipated land use(s), are often grouped together into what have been called ecological planning units (Luff and Ojamaa, 1978).

2.6 Summary

Ecological land classification aids in resource planning and management through the recognition of the systematic relationships in the landscape and the impacts of human activities.

Its hierarchical framework facilitates the inventory, classification, mapping and interpretation of ecologically-significant features of the landscape. It has proven well suited as a means of conducting integrated surveys of inaccessible areas of Canada, which often lack any previous or systematic resource information. In urban and regional planning, Luff and Ojamaa (1978) stated that the apparent lack of consideration of ecological data in these areas was due to the lack of applicable ecological information and to the limited understanding of the biological and physical sciences by planners. If planners and other resource managers are to meet the needs and aspirations of the public and specific interest groups a sound and generally accepted approach is needed.

3.0 AREA CLASSIFICATION FOR SELECTED RECREATIONAL ACTIVITIES - CLAGUE MOUNTAIN PARK

Attention will now focus on the application of ELC for recreational suitability analysis. The ecological parameters used to establish the recreational suitability within the case study area were landform and parent material, topography, soil moisture regime and drainage, erosion hazard, flood hazard, climate and vegetation. Other parameters that are of importance, but were not used, include soil texture and permeability, stoniness, rockiness, depth to bedrock or impervious layer, frost action and unique site features. Sections 3.4.4 to 3.4.8 and 3.7 of this chapter will present each of these parameters and illustrate how they might be used for recreational suitability analysis.

3.1 Case Study

Clague Mountain Park, a small municipal park situated in northwestern British Columbia is the area of interest. This study concentrates on the supply potential of recreational opportunities within the park, with only minimal, indirect references being made to the present and potential future recreational demands on the park. Assessment of the supply of recreational opportunities is limited to the nine previously mentioned recreational activities. This park was chosen because,

- it lacked any form of natural resource inventory that would be of use in future planning and development of the park,
- it is contained within the Municipality of Kitimat and with the increased economic growth currently being experienced in the area it (the park) is forecasted to sustain ever increasing levels of recreational use, hence, warrants attention,
- and, it contains a diversity of landscape types, hence lends itself well to the application of ELC and site suitability analysis.

Although no attempt was made to assess the water bodies and stream courses within the park, the aquatic component of the park plays a vital role in the park's ecological processes, establishment of its physical carrying capacity and aesthetic appeal.

The prime objective of this study is to develop overall suitability ratings of the park for each of the selected recreational activities. These ratings are established on the basis of the site requirements of the activities. One application of this land suitability analysis would be the development of land use policies and general site plans for the park.

3.1.1 Location and Size

Clague Mountain Park forms a part of the Municipality of Kitimat, a small community of approximately 13,000 people situated 645 air Kilometers (400 air miles) northwest of Vancouver, B.C. (Figure 1). The park is found within latitude 54°04' to 54°07' north by longitude 128°41' to 128°47' west. The 1921 hectare (4747 acre) park is situated four kilometers (2.5 miles) northwest of Kitimat (Figures 2 and 3). Access into the east side of the park is by way of a system of interconnecting old and actively used logging roads (Figure 4). At present, access into the Bowbyes Lake area of the park, from the north, is limited, but is forecasted to improve as Eurocan Pulp and Paper Co. Ltd. continues to develop its T.F.L. 40 timber holdings in the vicinity of the Little Wedeene River. Movement within the park is concentrated along a network of rough hiking trails which originate at the parking lot on the

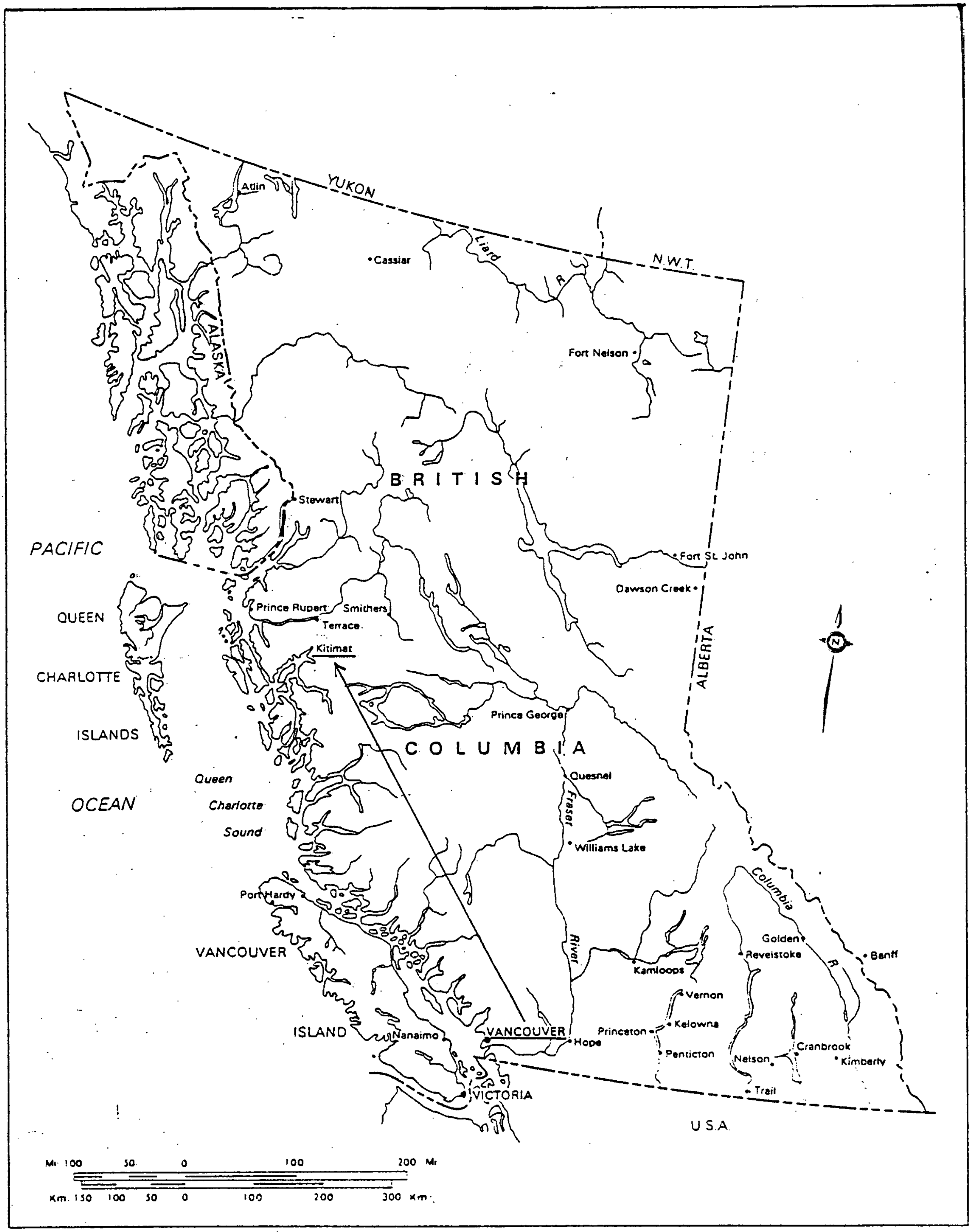


Fig.1. Map of British Columbia

Fig.2. Oblique Photograph of Clague Mountain Park,
Kitimat, B.C.

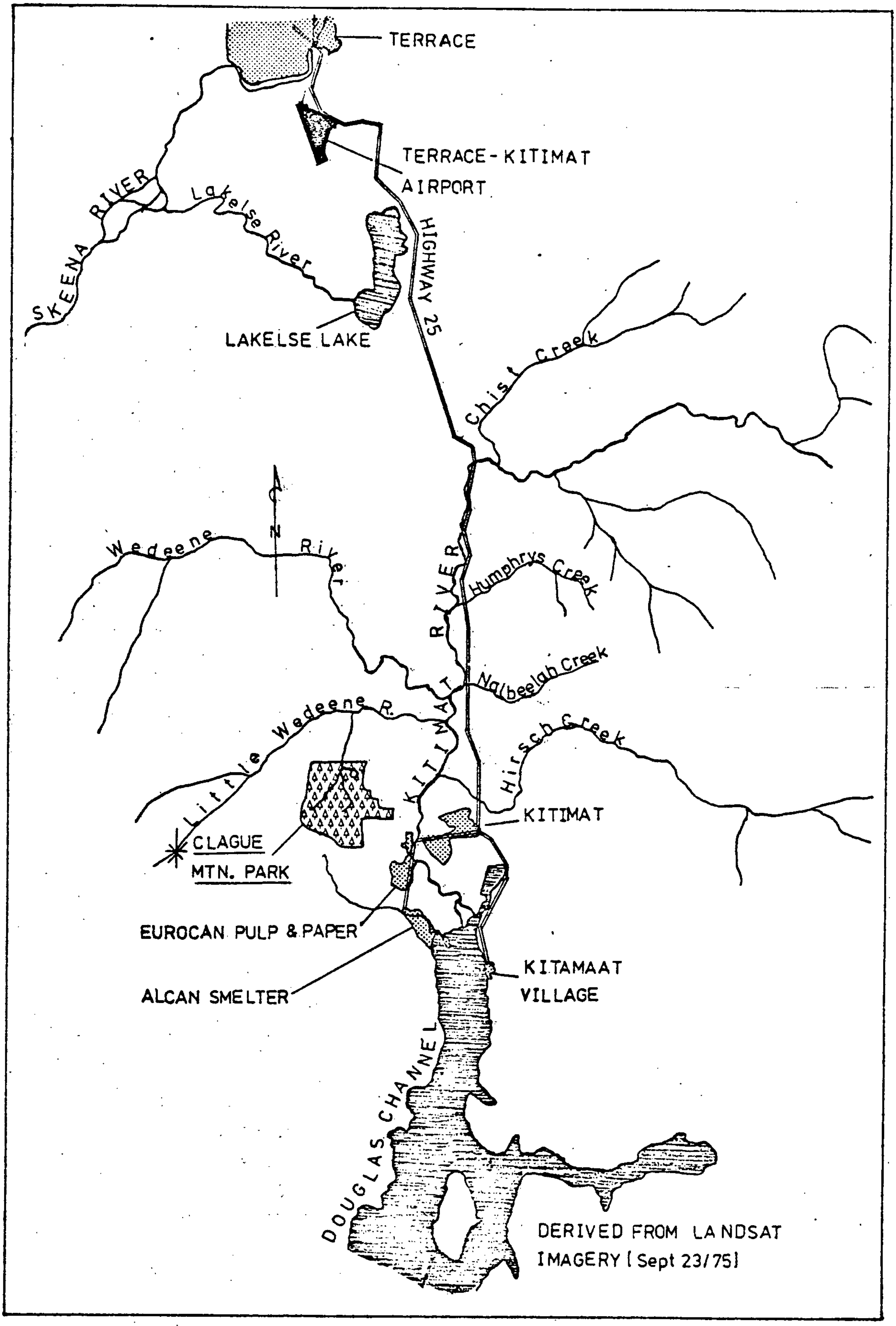


Fig.3. Map of Kitimat-Terrace Valley showing location of Clague Mountain Park, Kitimat, B.C.

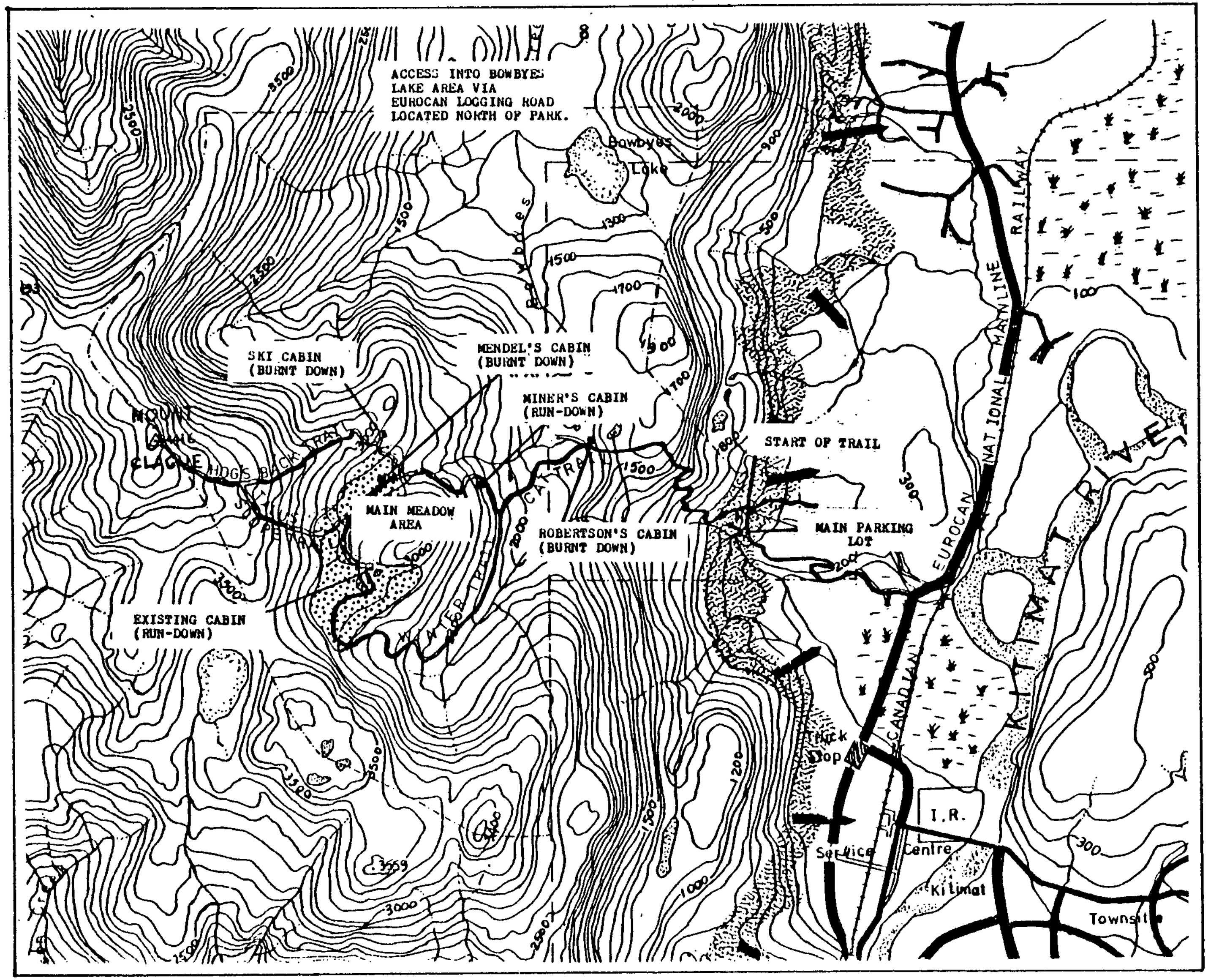


Fig.4. Map of Clague Mountain Park, Kitimat, showing existing trail network and major park areas. Nominal scale: 1:50,800

east side of the park. From the parking lot the trails make their way into the subalpine and alpine areas. Access into the park from the east side has been greatly improved with the development of a mining access road. For a comprehensive description of the main trail into Clague Mountain Park, refer to the discussion by Blix (1977) in Appendix IV. As yet, no system of trails has been established in the Bowbyes Lake area of the park (Figure 4).

3.1.2 History and Land Use

Clague Mountain Park was initially leased from the Province of B.C. by the District of Kitimat in August of 1963, pursuant to Lease No. 7318 (Lease Indenture). Annual rental on the lease is $185.50, subject to review every five years. The lease was last reviewed on August 1, 1978. At the time of establishment, it was declared that the park be preserved and used as a wilderness reserve, providing recreational enjoyment for hikers, skiers, campers and other outdoor enthusiasts (Kitimat District Municipality, 1965). In January of 1965 the Planning Department of the District of Kitimat drafted regulations to control park use with respect to timber cutting, cabin building, disposal of refuse, fire prevention, prohibition of hunting and other activities which may occur within the park (Appendix V).

On July 14, 1969 the Director of Lands, of the then Department of Lands, Forests and Water Resources, Victoria, B.C., granted an access road permit to Mr. N. Robak for the purpose of mining exploration within the park. A second party to show interest in the mineral deposits within the park was Bowbyes Mines Ltd. of Prince George, B.C. Both of these operators are no longer active within the confines of the park. The mining activities and associated access road helped to open the park to recreational traffic, both pedestrian and vehicular. Unfortunately, in the process of locating and constructing the access road, environmental damage was done to the soils, vegetation, wildlife habitats and aquatic environments. The access road, which in reality is a rough cat road, follows the contours of the land, seeking out the easiest routes, which often run adjacent to or through streams, through sensitive subalpine meadow environments and up steep slopes composed of materials prone to erosion (Figure 4). As this road forms the major access route into the park, from the east, it is essential that it be upgraded and realigned to facilitate continued, probably increased levels of recreation traffic.

Over the years, the Bowbyes Lakes area of the park has received much attention as a possible site for winter-based recreational activities. On August 26, 1971, Western Resort Planning Service (Burnaby, B.C.) submitted a report to the District of Kitimat stating that, ".... the Clague Mountain-Bowbyes Lake site met all of the major requirements for the establishment of a good ski facility", further it was stated that, "The ski terrain in the proposed area (Clague Mountain-

Bowbye Lake) can more than meet the requirements of any skier whether beginner, intermediate or expert." (Western Resort Planning Service, 1971). Subsequent to the Western Resort Planning Service report, Bruneski (1972) undertook a study of the recreation skiing potential of numerous sites in the Kitimat-Terrace Valley. Bruneski (1972) found that the Clague Mountain-Bowbyes Lake area is too open, i.e., the scattered vegetation provides little in the way of shelter from wind and direct sunlight, especially above the 915 meter (3000 foot) elevation, an avalanche danger exists, most of the skiable terrain is situated on east facing exposures, access into the area would be difficult and costly, and that, generally, the area is not suitable for conventional ski development but has excellent potential for helicopter skiing and ski touring by advanced and expert skiers. Since these two reports presented opposing assessments of the suitability of this area for downhill ski development, it is imperative that before any winter and/or summer-based recreation development is undertaken in this area, a comprehensive inventory, classification and analysis of the natural resource base be undertaken.

In September of 1971 a joint effort on the part of the Aluminum Company of Canada Ltd. and Eurocan Pulp and Paper Co. Ltd. resulted in a feasibility study being undertaken on two proposed routes into the Clague Mountain-Bowbyes Lake area (Philpot and Vrooman, 1971). The purpose of this study was to establish the optimum route into the Bowbyes Lake recreation area. The major finding of this study was that a proposed route, which would enter the park from the north and run parallel to Bowbyes Creek until it intercepted a section of level ground west of Bowbyes Lake, would be the most feasible and provide the only reasonable access into the proposed ski development area. The other route, which would run from the Service Centre to Bowbyes Lake across the east face of Clague Mountain, was determined to be inappropriate due to problems with excessively steep and broken topography, numerous rock outcrops, two major canyons, hazards associated with falling rock and snow avalanches and the associated high construction and maintenance costs.

The recreation activities presently taking place in the park include, hiking (summer), picnicking and day use (including photography and nature study), limited trail bike and off-road vehicle riding along the "cat trail", primitive wilderness camping (summer and winter), rock climbing, cross-country skiing, snowshoeing and snowmobiling. With the anticipated future increases in the population of Kitimat and nearby communities, brought on by industrial expansion, establishment of new firms and other regional growth factors, will come increased demands for goods, services, accommodation and recreational opportunities.

As the forest base of Kitimat-Terrace Valley continues to dwindle, as a result of the activities of the local forest companies, and the availability and cost of fuel for automobiles begin to influence the behavior of both the local and tourist populations, i.e., with increased fuel costs there may be a corresponding decrease in the distance travelled by the individuals to partake in recreational activities, greater pressures will be put on recreational areas adjacent to Kitimat. The close proximity of Clague Mountain Park to Kitimat and the diversity and intensity of outdoor recreational opportunities that are potentially suited to this area warrants the need for sound planning and development if this area is to provide recreational enjoyment to its users in the years to come.

3.2 Landform, Parent Material and Bedrock Geology

Landform is the major framework used for classifying landscapes into ecologically-significant, homogeneous land units. Similar landforms will often exhibit similar textures of surficial parent materials, vegetational complexes and growing conditions and as a consequence, similar landforms within a climatic region will often have similar productive and physical carrying capacities.

The park displays a wide range of landforms and associated parent materials, including fluvial (alluvial), glaciofluvial, organic, colluvial, morainal and exposed bedrock landforms. Five main genetic (landform) categories, i.e., colluvial, fluvial (includes glacio-fluvial), morainal, organic and bedrock, and twenty-three subcategories (landform units) were identified using the Terrain Classification System approach (Min. of the Envir., 1978).

At lower elevations (30 to 670 meters above sea level) on the east side of the park can be found a large, continuous area of moderately well to well graded accumulations of glaciofluvial sands, gravels and boulders. Fluvial deposits occur adjacent to and southwest of Bowbyes Lake. The fluvial landform deposits were derived from transported materials brought down by mountain streams to areas with low slope gradient southwest of Bowbyes Lake and adjacent to existing and old stream courses within the park. Areas of colluvial deposition can be found throughout the park, with the greatest concentration being in the form of active and inactive talus slopes in the subalpine and alpine areas. Colluvial deposits in these areas are typically non-sorted to poorly sorted with particle sizes ranging from fine clays to massive boulders and blocks of rock. Morainal landforms, in the form of level to steep blankets of rubbly moraine, and till (ground moraine), deposited by valley glaciers, comprise 50% of the total park area. Generally speaking, the morainal deposits consist of well-compacted materials that are usually non-stratified and contain a mixture of particle sizes. In areas of low slope gradient or closed basins, abundance of moisture, prolonged snow cover and vegetation growth characterized by greater rates of accumulation than decay, one is likely to find organic deposits. Areas of the park which contain organic deposits include the marsh lands adjacent to Bowbyes Lake, the open meadow areas southwest of Bowbyes Lake, the level to hilly sub-alpine areas which comprise the Main Meadow area and its immediate surroundings and an area situated in the northeast corner of the park, within the Subalpine Mountain Hemlock and Alpine Zones (Figure 5). An extensive area of bedrock, that ranges from being completely bare to being covered with a thin mantle of unconsolidated material, forms the west and south boundary of the park.

As an illustration of the major landform categories and parent material found within the park, the following discussion will deal with a line transect that was "walked" in the field and later plotted in the office. Figure 5 indicates the location of this transect and Figure 6 provides a graphic representation of its side profile. Generally, as one goes from east to west in the park, starting at the parking lot and heading due west towards the summit of Clague Mountain, one would encounter the following landforms:

1. a fairly level pitted glacial outwash deposit to a steep glacio-fluvial landform, i.e., using the Terrain Classification System terminology (Appendix VIII) this area is labelled $F^{G}bs$ - V, (30 to 600 meters a.s.l.),
2. a level to subdued morainal landform, i.e., $M^{I}m$ - H, dotted with kettles, small ponds and accumulations of organic soils (600 to 690 meters a.s.l.),

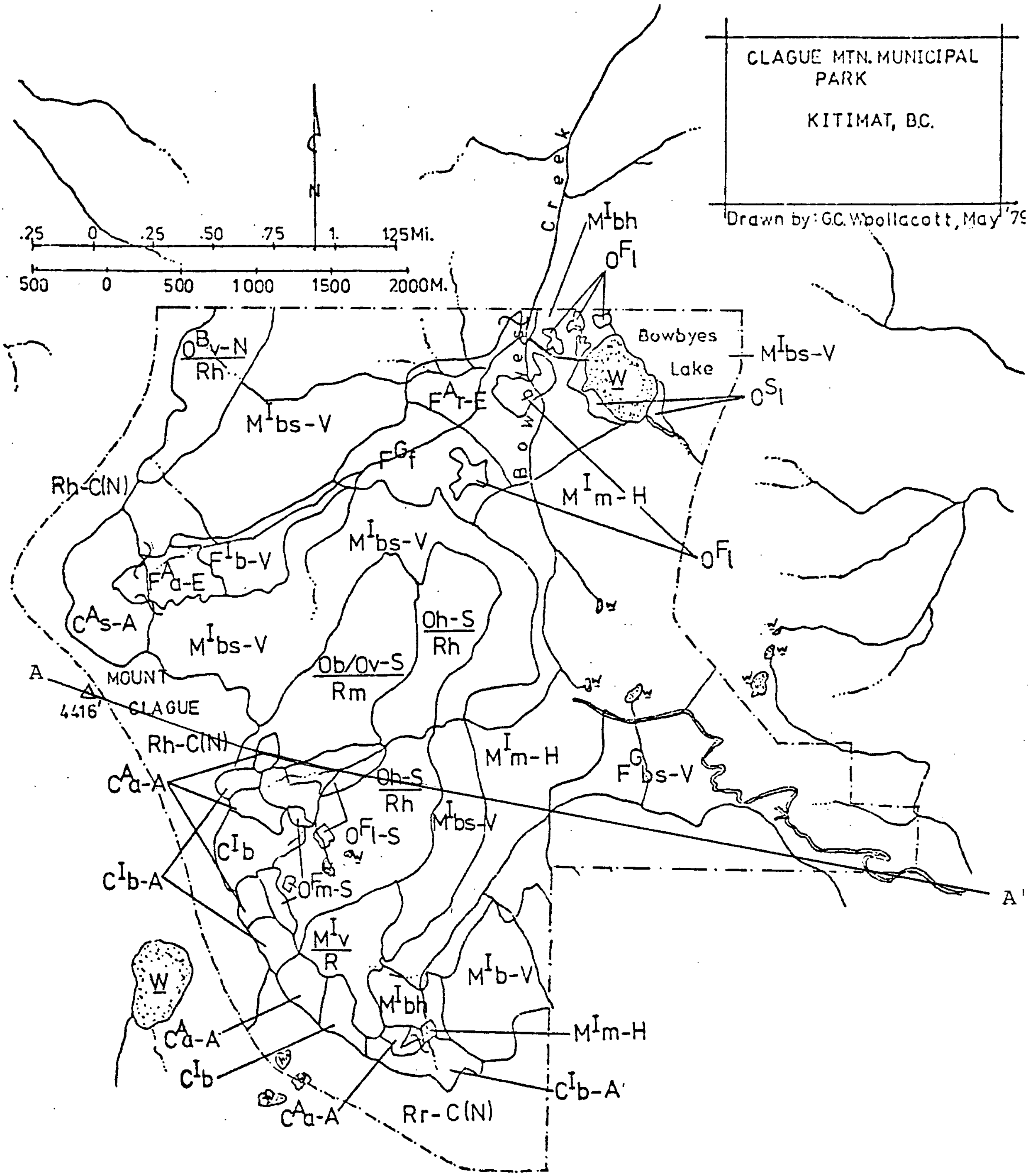


Fig.5. Terrain Units of Clague Mountain Park.
A-A' line transect illustrated in Figure 6.

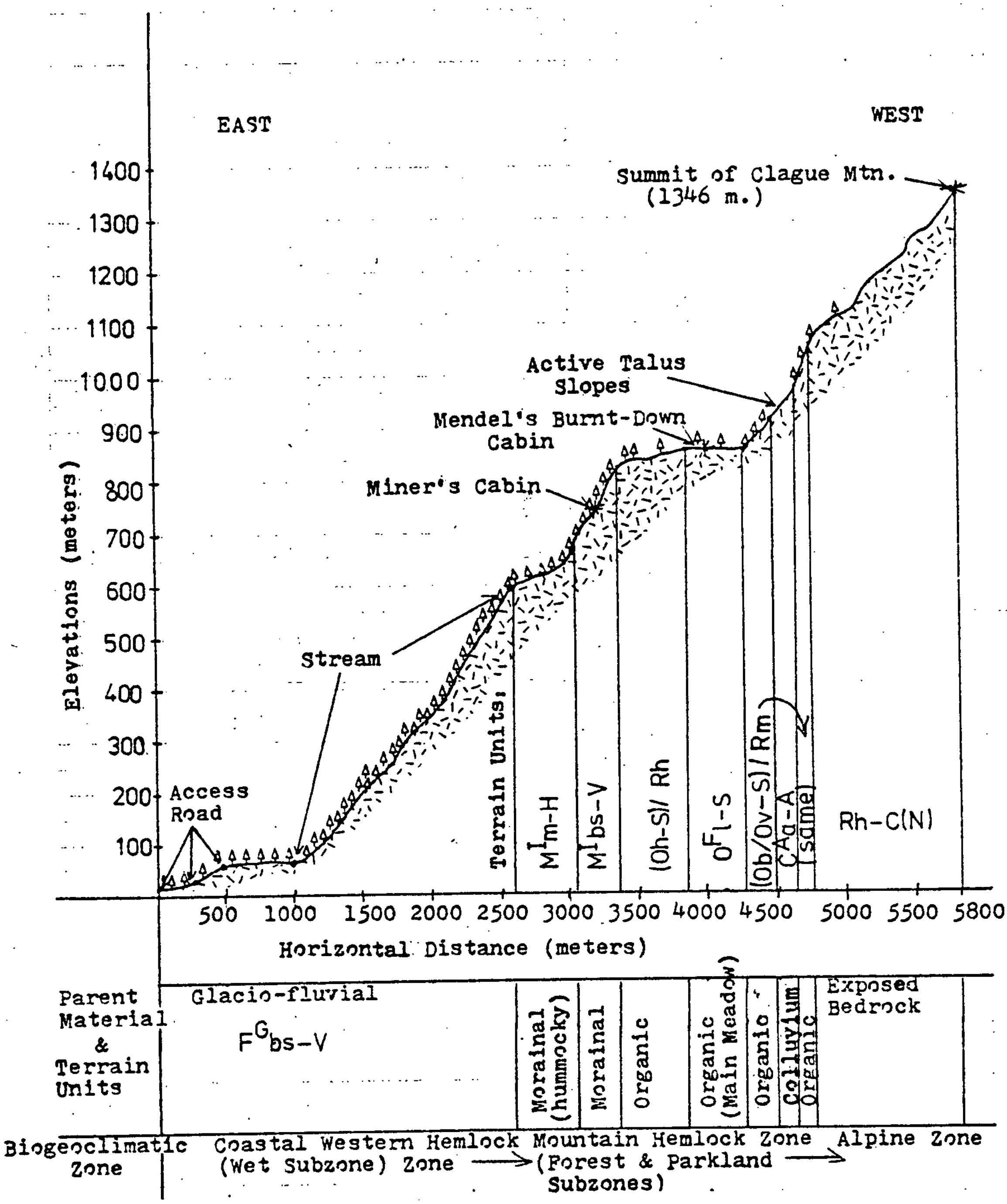


Fig.6. Graphic illustration of profile delineated by A-A' line transect of Clague Mountain Park, Kitimat, B.C.

3. a steep, extensively eroded and heavily treed morainal landform, i.e., $M^{I}bs - V$ (690 to 820 meters a.s.l.),
4. three organic landform types, i.e., $\frac{Oh - S}{Rh}$, $O^{F}l - S$ and $\frac{Ob/Ov - S}{Rm}$, that are, typically, level, subdued or hummocky over fine textured colluvium or fluvial material and serve to mask the underlying bedrock (820 to 1050 meters a.s.l.),
5. a narrow zone (150 to 200 meters wide) of active colluvial slopes (talus and rockfall areas), i.e. $C^{A}a - A$ (920 to 975 meters a.s.l.),
6. and, finally, an area of extensive exposed bedrock and bedrock covered by a thin mantle of unconsolidated material, i.e., this area is labelled as Rh - C(N) and ranges from approximately 1050 to 1346 meters a.s.l. This area is a typical "krummholz" landscape, being inhabited by scattered clumps of low lying alpine heathers, lupines and grasses, as well as dwarf yellow cedar, amabilis fir and common juniper.

The characteristic bedrock of Clague Mountain Park and surrounding region consists of igneous intrusive granitic (chiefly granodiorite and quartz diorite) rock with minor gneiss and schist (Ryder, 1978). The bedrock type is relatively resistent to weathering, resulting in slopes that are generally steep and terrain that is quite rugged. Physical weathering disintegrates this rock type into extremely coarse rubble on colluvial slope (talus) and large boulders in till deposits.

Chemical weathering of the olivine, pyroxene, augite, hornblende, biotite and calcic feldspar minerals of granitic bedrock yields granular, gritty residues composed of mixtures of quartz, potash and sodic feldspar crystals. These residues form a major portion of the sandy, gritty tills and sandy outwash deposits that are often found in areas of igneous intrusive granitic bedrock.

3.3 Topography

The structural characteristics and relief of landforms are used to describe what is commonly called "topography". Hills, knolls, plateaus, flats, depressions, troughs, scarps and rolling terrain are some of theterms used to describe the collective effect of the physical features of the landscape. The Terrain Classification System developed for B.C. makes use of "surface expressions" to denote topographic relief, where the surface expression of genetic materials (parent materials) is their form (assembly of slopes) and pattern of forms (Min. of the Envir., 1978).

Slope measures the extent to which a surface varies from the horizontal and is usually expressed in percent or degrees. Measurements of slope can be made in the field with the aid of instruments such as the Abney or Suunto, while in the office, slope estimates can be made using existing topographic maps. Slope greatly affects all forms of recreation. With increased slope there is an increased potential for both surface erosion and mass soil movement (Swanston and Dyrness, 1973; Hawes, 1974). With increased slope there is usually a corresponding increase in site preparation, facility construction and subsequent maintenance costs. Generally, in terms of surface erosion, slopes less than five percent have few limitations whereas slopes greater than 30 percent have severe limitations. In the context of mass soil movement, slopes less than 30 percent have a few limitations whereas slopes greater than 30 percent have a greater degree of limitation (Hawes, 1974). Vold (1975) found that steep slopes posed major limitations for both trails and camp grounds. Slopes greater than 60 percent (30 degrees) will prove to be severely limiting for almost all recreational uses and developments. Conversely, mountaineering (rock climbing), downhill skiing, wilderness hiking and viewing of scenic areas require steeply sloping terrain if the recreational pursuit is to be both personally gratifying and technically feasible (Montgomery and Edminster, 1966; Min. of the Envir., 1976).

Aspect refers to the orientation of a body or surface and it is usually described as being level, north, northeast, east, southeast, south, southwest, west or northwest facing basedon compass measurements. The range of aspects can have profound influences on what types and levels of activities will occur in an area. Campgrounds and picnic areas require the drier, warmer weather and maximum sun exposure afforded by south facing and level exposures, but should avoid areas of long snow duration, higher moisture retention and cooler temperatures, typical of north facing exposures. Conversely, for winter sports such as downhill skiing, north facing exposures are favoured, except for areas with extreme cold conditions, whereas, southwest facing slopes, with characteristically high rates of snow deterioration should be avoided.

Using existing topographic maps and field experience, Clague Mountain Park was classified into 13 slope classes and eight aspect classes, as shown in Figures 7 and 8, respectively. Selection of slope class ranges was governed by the site requirements of the nine selected recreational activities.

3.4 Soils

Soil characteristics aid in the selection of potential recreational sites. The suitability of soil for recreational activities can be established using the following soils-related properties: moisture, drainage, texture, permeability, stoniness, rockiness, depth to bedrock or impervious layer, frost action, erosion potential, flood potential and soil taxonomic grouping (Montgomery and Edminster, 1966; Stevens, 1966; James, 1973; Hawes, 1974; Vold, 1975; Eekman, 1976; Jubenville, 1976; Min. of the Envir., 1976). These properties can be determined using physical measurement, chemical analysis and through direct observation and inference. As an example, erosion potential can be inferred from slope, landform, soil texture, parent materials, soil porosity, meterological factors

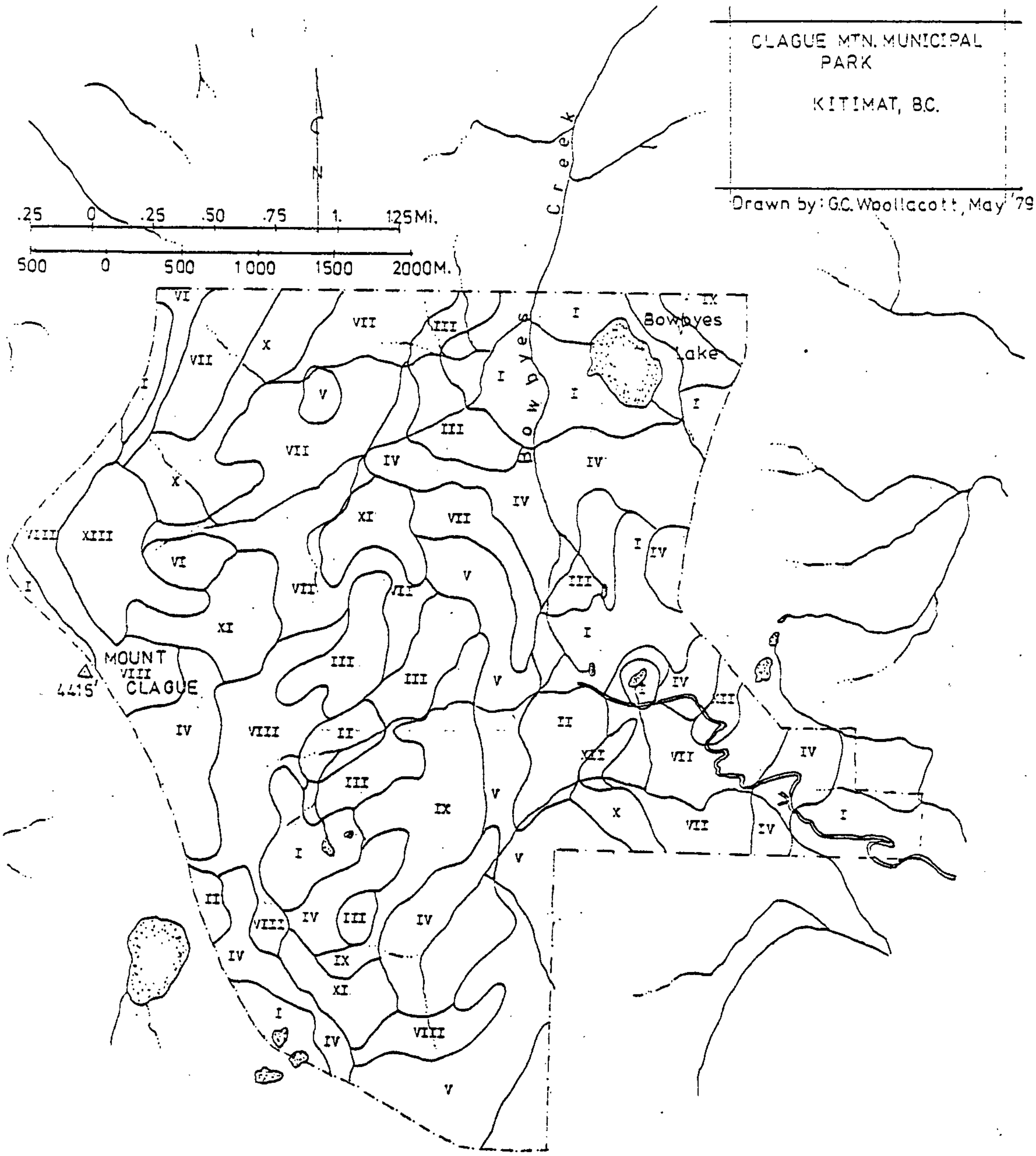


Fig. 7 . Slope Classification of Clague Mountain Park.
Key: (note intervals are variable)

I	0-5%	VIII	41-50%
II	6-10%	IX	51-60%
III	11-15%	X	61-70%
IV	16-25%	XI	71-80%
V	26-30%	XII	81-100%
VI	31-35%	XIII	101%+
VII	36-40%		

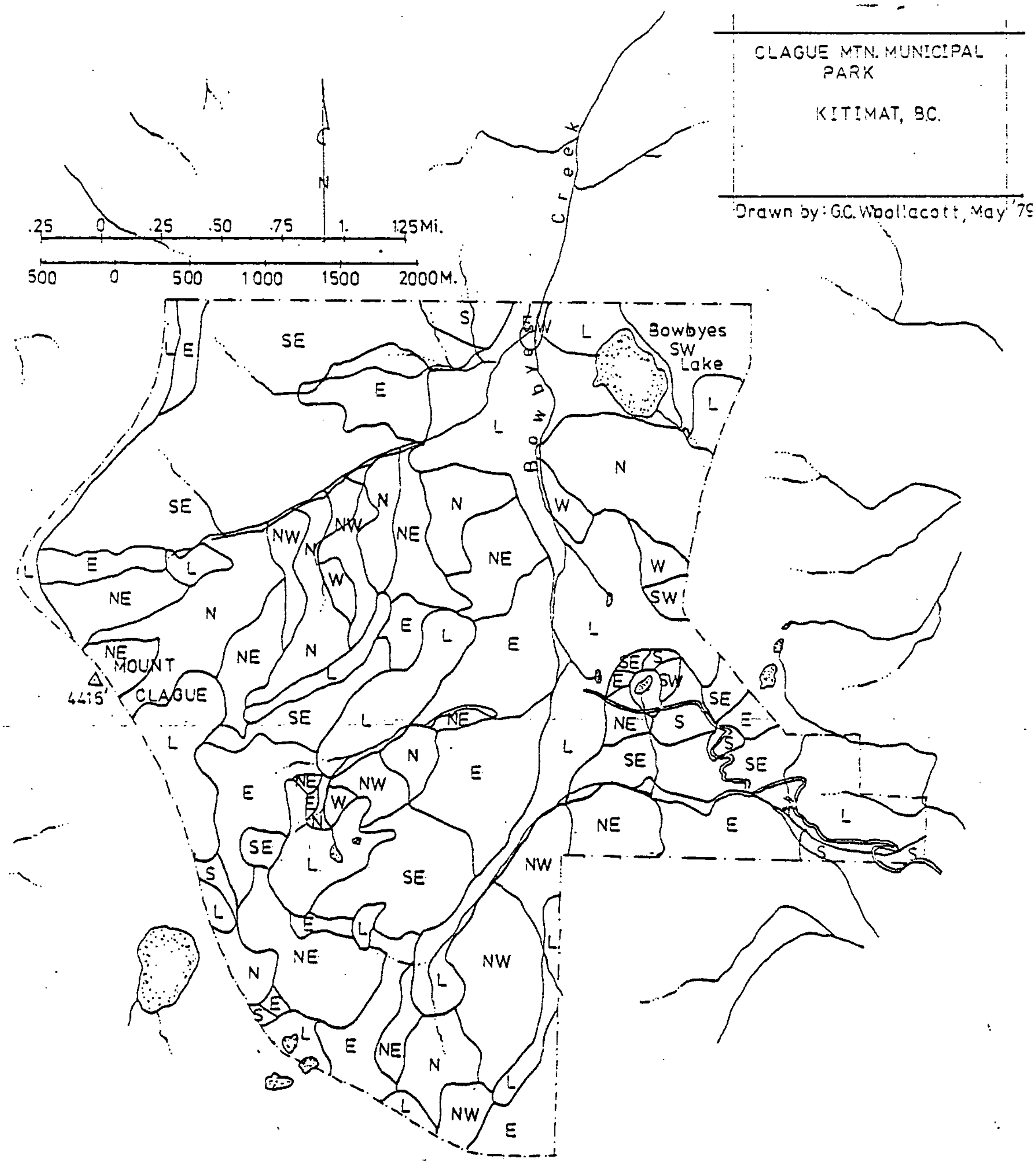


Fig. 8. Aspect Classification of Clague Mountain Park.

Key:

N - north	S - south
NE - northeast	SW - southwest
E - east	W - west
SE - southeast	NW - northwest
L - level	

and plant and litter cover. Flood potential can be determined using existing drainage patterns, meterological information, landform characteristics and the condition of vegetation adjacent to water courses.

No detailed soils inventory and mapping has been done for Clague Mountain Park. Due to constraints arising from the lack of existing information, time and monies, as well as the limited expertise of the author in the area of soils identification, classification and analysis, no attempt was made to undertake an extensive study of the soil landscapes found within the park. Knowledge of soils and soils characteristics is one of the most important elements to consider in the selection of potential areas for new site development and in the management of existing sites. It is recommended that prior to the establishment of new facilities or upgrading of existing structures, trails and roads within the park, that a comprehensive study of the park's soils be undertaken. For the purpose of this study, only three soils-related parameters were used to aid in the establishment of the recreational suitability of the delineated landform units, these being, erosion hazard potential, flood hazard potential and soil moisture regime.

Although not a steadfast rule, in general, different landforms and associated parent materials are characterized by different soils types that have developed as a result of unique combinations of pedogenic processes operating within and characteristic of each landform. In Appendix II the characteristic Soil Orders, Great Groups and parent materials of the Coastal Western Hemlock, Mountain Hemlock and Alpine Biogeoclimatic Zones are indicated. The aforementioned zones are all found within Clague Mountain Park (Figures 6 and 13).

3.4.1 Soil Moisture Regime and Drainage

Soil moisture or hygrotope classes refer to the moisture regimes of soil during snow-free periods and not following snowmelt, prolonged rainy or dry periods. The moisture regime of the soil is a combination of the local climate and internal and external drainage. Within a climatic region soil drainage is controlled by the texture of surface material and depth to the underlying bedrock. External drainage is a function of topography, texture and vegetation. Two other deterministic factors are slope and aspect, because they control the drying power of the air (Gimbarzevsky, 1964).

Soil drainage is probably the most important soil property affecting the suitability of a soil for recreation use (Vold, 1975). Soils that are wet for a majority of the year pose severe limitations for campsites, recreational roads and trails, picnic grounds and other intensive use areas. Dry soils can prove limiting due to an inability to establish and maintain suitable vegetative cover, dust problems and difficulties associated with vehicular movement in these soils (Montgomery and Edminster, 1966; Eekman, 1976). Soil moisture regimes can be inferred from soil drainage properties, topographic relief, parent material and seepage and/or ponding on the soil surface. The categories used to describe the soil moisture regimes are as follows:

a) Very dry to dry - (very xeric to xeric) knolls and peaks of rocky outcrops or lithic (ranker-like) soils of convex relief on ridge crests. Soils are shallow and well drained.

b) Moderately dry - (moderately xeric) well drained soils on convex relief of upper slopes or stony glacial tills of convex or straight relief. Seepage absent during snow-free periods.

c) Mesic - medium textured (loamy) soils of straight to shallow convex relief. Soils have good drainage and seepage is absent or rarely present. If present, seepage is deep in the profile and occurs only during the snow-free periods.

d) Hygric - moderate to imperfectly drained soils of straight to concave relief. Gleying is evident in the soil profile and seepage water is usually present. The maximum water level in soil may be at or near the soil surface for part of the snow-free period.

e) Hydric - soils with imperfect to very poor drainage. Soils are saturated or inundated for most of the year. Concave or straight relief usually on lower slopes, spring-water swamps, stream edges and moors. (Brooke *et al*, 1970).

Soil drainage is the rate of removal of water from soils in relation to additions. It is affected by a number of factors, including texture, structure, slope gradient, length of slope, water holding capacity, soil permeability and evapotranspiration. Rapidly to moderately well drained soils have few limitations for recreation activities and associated facilities, while poorly drained and very poorly drained soils have significantly greater limitations (Hawes, 1974; Min. of the Envir., 1976). Imperfectly drained soils present a greater limitation for intensive recreational use than for extensive use, e.g. family campgrounds versus wilderness hiking trails.

Gross drainage pattern is an important identifier of landforms and provides valuable insight into the suitability of an area for various recreational activities (Way, 1978). Analysis of the general physiography and drainage patterns of rivers, creeks and gullies will provide insight into the underlying bedrock, type of surface and sub-surface materials, textures and landforms characteristic of an area. The following soil drainage classes are useful for classifying the internal and external drainage characteristics of soils: very rapidly drained, rapidly drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained (Agric. Can., 1978).

Clague Mountain Park is located within the Kitimat Ranges of the Coast Mountains of British Columbia (Figure 9). The Kitimat Ranges are comprised of granitic mountains which

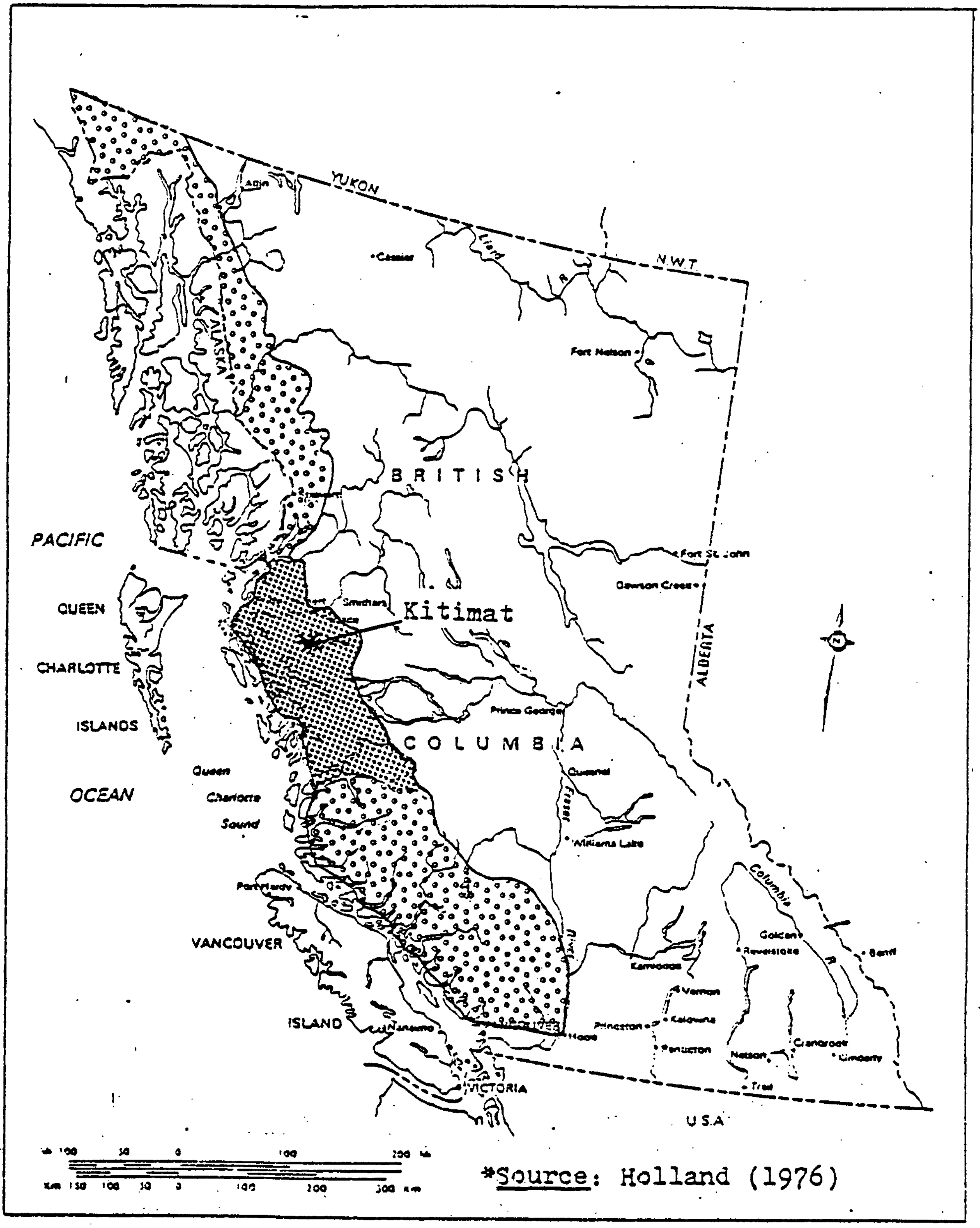


Fig.9. Physiographic subdivisions of British Columbia.

Coast Mountains — Kitimat Ranges (within Coast Mountains) extend from the Nass River in the North to Burke Channel and the Bella Coola River in the south (Holland, 1976). Mountains within these ranges are characterized by heavily eroded granitic rock of the Coast Intrusives, with the rather bold, massive mountains of monolithic granite being common features of these ranges. Mountain peaks within the Kitimat Ranges are between 1980 and 2300 meters (6500 and 7500 feet) in height, being, characteristically, round-topped and dome-like in appearance.

Glaciation of this area has resulted in rounded ridges and summits of all but a few of the highest mountains, as well as wide spread deposits of glacio-fluvial material in the valley bottoms and on higher elevation benches. One rather unique feature of the western margin of the Kitimat Ranges is that cirque erosion often reached sea-level. The Kitimat Ranges are characterized by a spectacular system of fiords which developed as a result of intensive glaciation of British Columbia's mountainous coastline. These ranges have significantly fewer glaciers than those to the north and south, with no extensive icefields remaining. Within the park, permanent snowpacks exist in the form of rather limited accumulations of snow which can be found in sheltered gullies and on north facing slopes.

The major drainages which dissect the Kitimat Ranges are aligned and flow in an east to west direction. Runoff from the park flows into the Kitimat River system by way of the

Little Wedeene River to the north (of the park) as well as streams which flow to the east and south of the park. Bowbyes Lake is the major catchment within the park with lesser ponds and higher elevation tarns being evident. On the basis of photo interpretive work done by the author, Clague Mountain Park was divided into three rather distinct watershed areas (Figure 10). Runoff from watershed areas "A" and "B" flows into the Little Wedeene River by way of Bowbyes Creek, and, subsequently, into the Kitimat River. Watershed area "C" drains into the Kitimat River by way of an, as yet, unnamed stream which flows eastward, paralleling the main trail into Clague Mountain Park.

The usual heavy snowfalls and high levels of precipitation occurring throughout the year in this area, results in active year-round stream flows. During the spring melt, ephemeral streams become bubbling freshets which overflow their banks, flooding streamside areas and level marshlands found within the park. The rapid runoff and high flow volumes result in extensive reworking of both the glacio-fluvial and glacial till deposits found within the park, leading to deep gully formation and the transport of large volumes of material.

Based on ground reconnaissance and airphoto interpretation Clague Mountain Park was classified into five soil moisture regime categories (Figure 11).

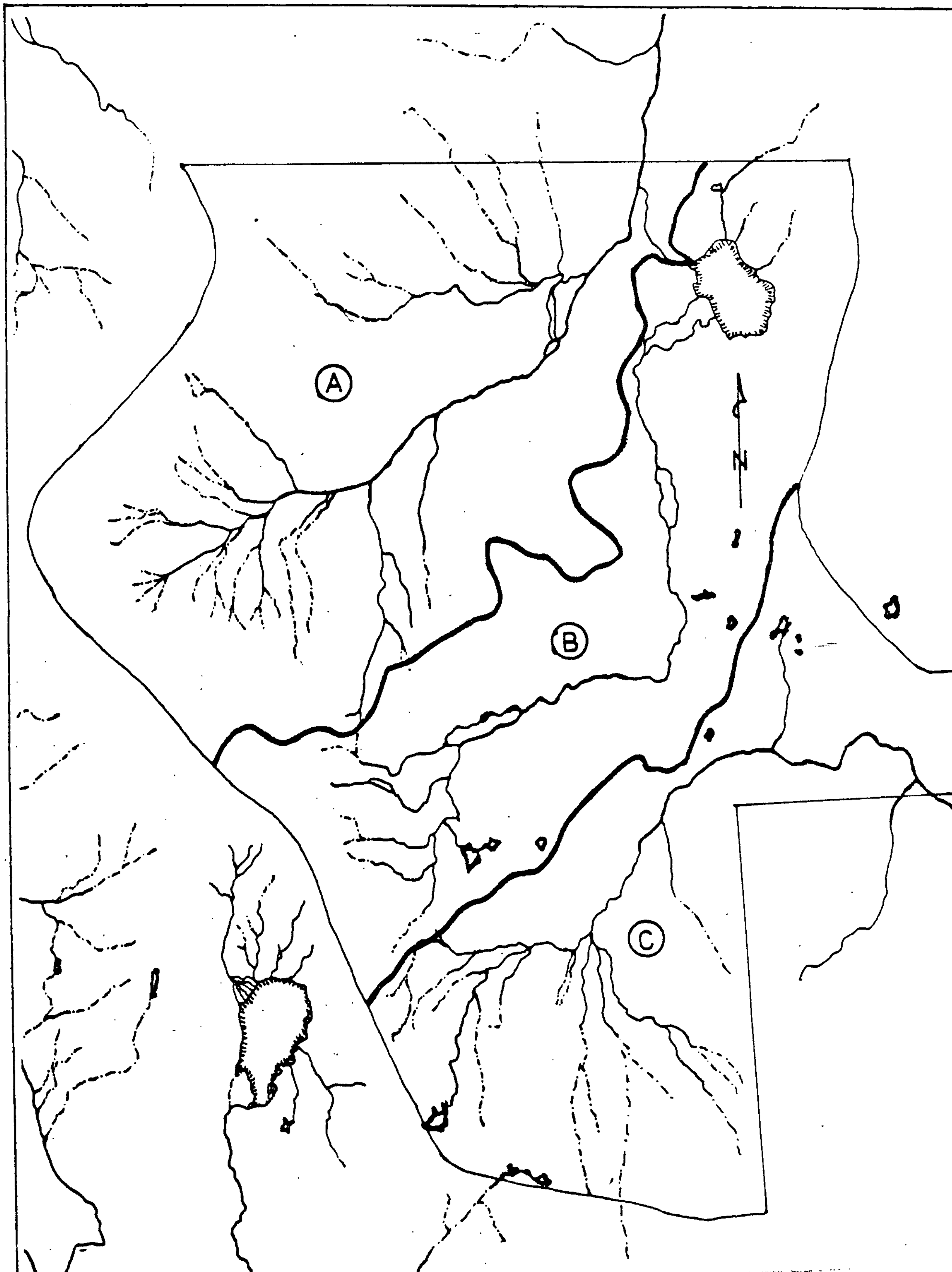


Fig.10. Watershed areas of Clague Mountain Park, Kitimat,B.C.

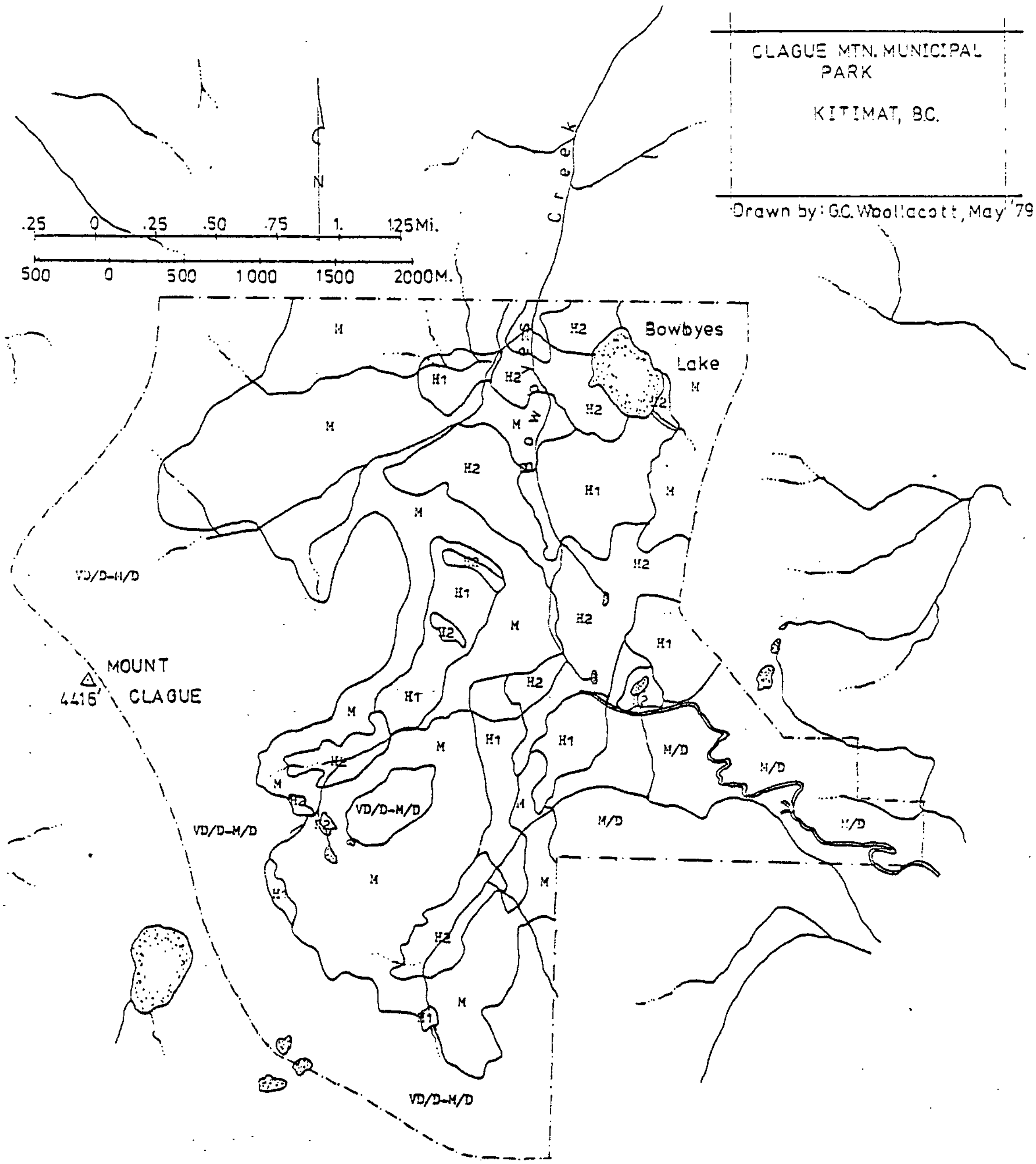


Fig. 11. Soil Moisture Regime Classification of Clague Mountain Park.

Key:

Soil Moisture Regime	General Limitation for Use*
VD/D - M/D: very dry to dry to moderately dry	None to Slight
M/D : moderately dry	None to Slight
M : mesic	Moderate
H1 : hygric	Severe
H2 : hydric	Severe

* Recreational uses.

3.4.2 Erosion Hazard

Erosion is the wearing away of soil or rock through the actions of running water, wind, ice, gravity and other geological processes. The criteria used to establish the erosion potential of an area are slope and landform (length of slope and topographic relief), parent material, soil texture, soil porosity, meterological factors (form, amount and duration of precipitation), and soil compaction properties (as influenced by soil texture and moisture content) (Swanston and Dyrness, 1973). With increased slope there is an increase in erosion potential. Parent materials high in quartz, e.g. granite, quartz diorite, granodiorite and high quartz sandstones, develop into soils which have high erosion potential. Soils derived from basalt, andesite or gabbro have low erosion potential.

A major deterrent to surface erosion is the presence of an adequate plant and litter cover. It is of prime importance that site planning and development allows for the continued establishment and growth of both natural and man-induced vegetational communities (Densmore and Dahlstrand, 1965; Stevens, 1966; Rothwell, 1971; Swanston and Dyrness, 1973).

Erosion patterns, density of occurrence and steepness of gradient will indicate the cohesiveness of soils and the texture of surficial deposits. Gully analysis has shown to be useful for identifying landforms, slope profiles, soil textural classes and soil drainage characteristics. In general, U-shaped gullies form on silts, sands and sandy clays, V-shaped gullies are indicative of granular materials (course, clean sands and gravels), and wide, soft-bottomed or broad-shaped gullies develop in semi-plastic or plastic materials high in clays. Table 1 would prove useful for establishing the overall suitability of an area for a range of recreational activities.

Table 1. Guide for Assessing Soil Erosion Hazard[1]

Surficial Material	0-5%	5-9%	9-30%	30-60%	60%+
Lacustrine	moderate	high	high	high	high
Organic	"	"	"	"	"
Morainal (fine textured)	"	moderate	"	"	"
Morainal (medium textured)	low	low	moderate	"	"
Colluvial (cryoturbated)	"	"	"	"	"
Colluvial	"	"	"	moderate	"
Fluvial[2]	"	"	low	"	"

[1] Source: Vold (1976) in "Biophysical Soil Resources and Land Evaluation of the Northeast Coal Study Area (B.C.): 1976-77: Vol. I.

[2] Erosion by rivers and streams on floodplains is not evaluated here.

Table 1 was used to establish the erosion hazard ratings of the delineated landform units within Clague Mountain Park. The ratings are given in Table 14: Ecological (Biophysical) Characteristics of Landform Units, of Section 4.0.

3.4.3 Flood Hazard

Flooding can result from high levels of precipitation, rapid snowmelt, failure of man-made retaining structures, removal of extensive areas of forest cover through natural causes and/or the activities of man. Flood hazard ratings of areas pertain to the normal "season of use", e.g. from late November to the end of April for downhill skiing in the south-western part of B.C. Establishment of flood hazard ratings is complicated by the current move towards "all seasons" recreational developments. The degree of flooding can be described as being none, rare, occasional or frequent (Griffin, 1977). Areas subject to no or rare flooding have a none-slight to moderate limitation for most recreational activities and associated facilities. Rare flooding implies the occurrence of inundation sometime over a period of several years. Areas susceptible to seasonal flooding (regular occurrence) or subject to occasional or frequent flooding are ranked as having moderate to severe limitations depending on the activity and its specific site requirements.

Sites with moderate flooding limitations are unsuitable for permanent development such as campgrounds with buildings, tables, roads, camp pads and other facilities susceptible to flood damage (Hawes, 1974). The use of wells and on-site sewage disposal systems would be limited in areas susceptible to occasional or frequent flooding. Areas subject to frequent flooding (3 to 4 times) during season of use or flooding occurring in response to limited rainstorms would be unsuitable for intensive use and suitable for extensive use only during the drier periods of the year (Min. of the Envir., 1976).

Based on ground reconnaissance and airphoto interpretation Clague Mountain Park was delineated into areas of none to slight, moderate and severe flood potential (Figure 12).

3.4.4 Texture and Permeability

Soil texture refers to the relative proportions of soil separates, i.e., sands (2.00 to .05 mm in diameter), silts (.05 to .002 mm in diameter) and clays (less than .002 mm in diameter). Texture is related to such soil characteristics as drainage, permeability, cohesion, erodibility, compactability and nutrient availability. These soil characteristics influence vegetative productivity and affect the amount and type of recreation use that may occur in a given area. Soils high in clay become sticky when moist and require long drying times after wetting. Soils that are composed of loose sands can prove to be undesirable as they are often unstable when dry. The last point illustrates the concepts of permeability, which is a measure of the ability of soil to transmit water and air, and cohesion, which is the ability of soil to stick together.

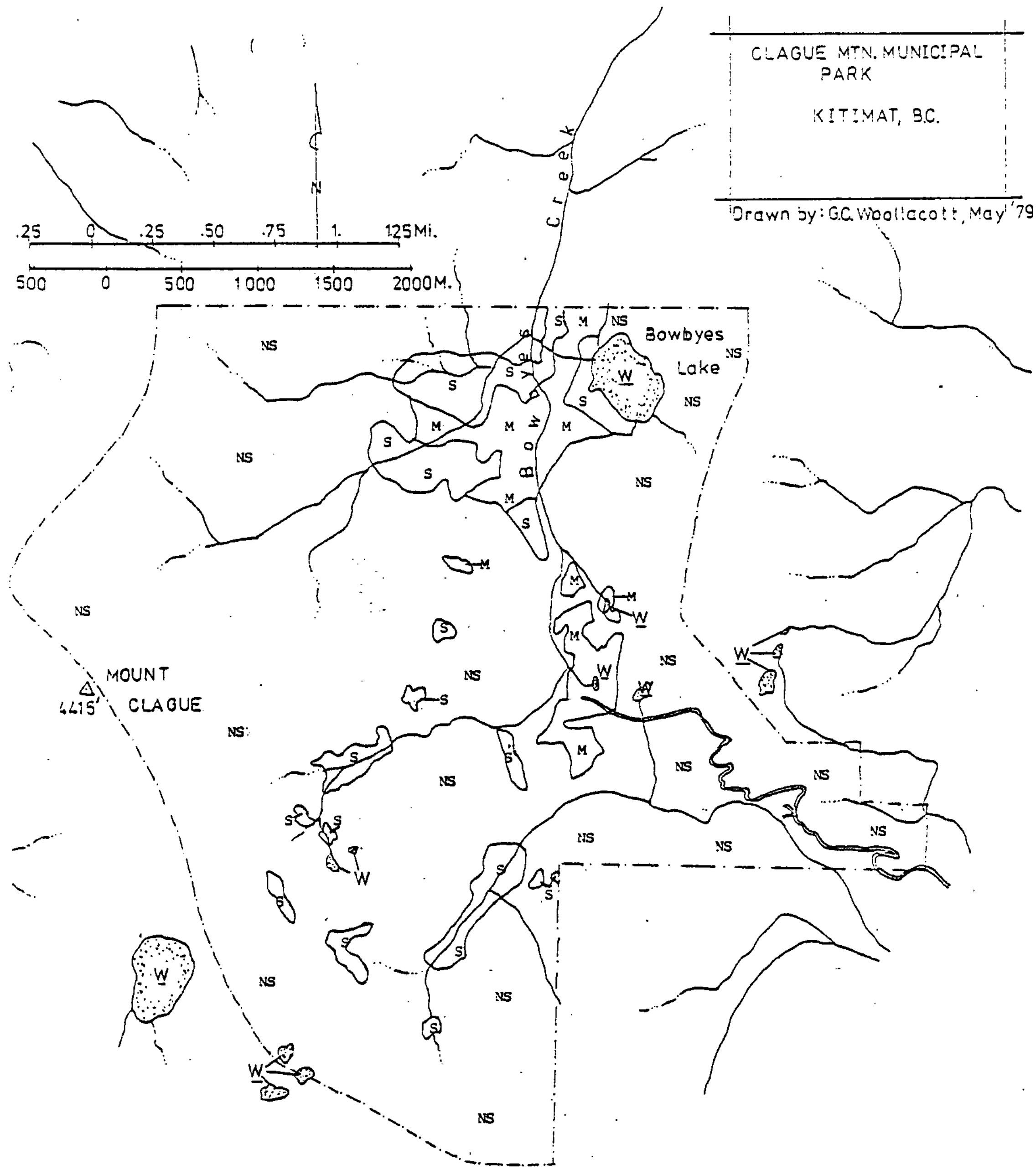


Fig.12 . Flood Hazard Rating of Clague Mountain Park.

Key:

Flood Hazard Rating	General Limitations for Use*
Nil (very low)	NS - none to slight
Nil to Slight (moderate)......	M - moderate
Moderate to Severe (high).....	S - severe

W : water bodies

* Recreational uses.

Permeability measures the rate at which gases or liquids pass through or penetrate the soil. It is dependent on texture, cohesion, compaction, existence of impervious layers, soil structure, moisture condition of soil profiles and horizon porosity. Soils which are high in clay have low permeability but high cohesiveness, making them subject to puddling and compaction when wet, thus causing drainage restrictions.

Soils high in sand are highly permeable but quite unstable when dry. Deficiencies in soil nutrients and/or moisture levels often restrict the use of these soils. Sandy soils tend to be highly erodable and dusty when dry. Sandy loam and loam textured soils are permeable with good cohesive properties which result in few textural limitations. These soils exhibit only slight limitations for most intensive and extensive recreational activities.

3.4.5 Stoniness

Stoniness refers to the proportion of stones in or on the soil's surface, expressed as the percentage of land surface or soil profile occupied by stones or rock fragments coarser than 15 cm (6 in) in diameter (Agric. Can., 1978). Cobbles, flags, boulders and all other types of stones in excess of this maximum size limit are called "course fragments". Montgomery and Edminster (1966) considered all stones or rock fragments in excess of 25.4 cm (10 in) in diameter as being course fragments. The range of stoniness classes is from non-stony ("no modification" under the U.S.D.A. system of classification) to excessively stony ("stony-rubble land" under the U.S.D.A. classification system), or from less than .01 to 50.00% and greater of the total surface or soil profile, respectively, being occupied by stones greater than 15 cm (6 in) in diameter (U.S.D.A., 1951; Montgomery and Edminster, 1966; Agric. Can., 1978). Increasing restrictions on the type and intensity of recreational use will occur as the size and/or density of soil fragments increase. As the content of stones increases a corresponding increase in the costs associated with site preparation and the installation and maintenance of facilities will result. Soils that are exceedingly or excessively stony are considered to have severe limitations for use (Agric. Can., 1978).

A moderately coarse fragment limitation (50 to 75% by volume) would seriously limit intensive development and pose only minimal problems for extensive recreational activities, e.g. hiking and wilderness camping. Where the coarse fragment represents over 75% of the total soil surface or profile, virtually all intensive recreational activities would be prohibited (Min. of the Envir., 1976).

3.4.6 Rockiness

Rockiness refers to that portion of the land's surface which consists of exposed bedrock, rock outcrops or patches of thin soil over bedrock. Rockiness classes range from non-rocky ("no midification" under the U.S.D.A. system of classification) to excessively rocky ("rock outcrop" under the U.S.D.A. system of classification). The exposed bedrock defined by these classes range from less than 2 to 90% and greater of the surface area, respectively (U.S.D.A., 1951; Montgomery and Edminster, 1966; Agric. Can., 1978). Bedrock poses severe limitations for most recreational activities requiring site preparation and facility development and maintenance. Septic tank facilities, water and electrical services, foundation construction, road building and many other site development activities will be prohibited in areas of excessive bedrock. The combined influence of exposed bedrock on steep slopes eliminates most intensive and extensive recreational activities.

3.4.7 Depth to Bedrock or Impervious Layer

Shallow soils over bedrock or impervious layers will have varying degrees of limitation depending on the extent and type of required site development. Concern for depth to bedrock or impervious layer is vital when planning for buildings, septic tank filter fields, road locations, camping and picnic areas, paths and hiking trails and intensive play areas (Min. of the Envir., 1976). Soils less than 1 meter (3 feet) deep will pose severe limitations for buildings and soils less than .6 meters (2 feet) deep will have severe limitations for play areas (intensive use) (Montgomery and Edminster, 1966). Allowance should be made for the affects of other factors such as frost heave, piping, soil texture classes, bearing capacities, slope and internal and external drainage and moisture regime. Poor soil drainage can prohibit construction of on-site sewage disposal facilities. Shallow soils will limit the rooting depth of plants and hinder the establishment and maintenance of vegetation cover due to a decreased soil moisture holding capacity and higher levels of soil erosion.

3.4.8 Frost Action

The heaving of soil subgrades due to the formation of ice lenses and the subsequent loss of stability on thawing is known as frost action (U.S. Dept. of the Interior, 1974). The severity of frost action will depend on the type of soil, availability of a source of water and time rate of fluctuation of temperature about the freezing point. Fine-textured loams and silts are particularly susceptible to frost action due to their inherent capillarity and perviousness. Soil particles that are brought to the surface by frost action are susceptible to erosion by wind, water and/or gravity.

In an attempt to classify frost action, the Resource Analysis Branch (Victoria, B.C.) established a frost action rating system based on modifications to existing U.S.D.A. Soil Conservation Service (U.S.D.A., 1971) guidelines (Table 2: Vold, 1977). Under this system soil is ranked as being of low, moderate or high frost action on the basis of soil texture. Texture will have a significant influence on the extent to which frost action will occur in soils. The proposed system is shown in Table 2:

Table 2: Frost Action Classification by Soil Texture Classes[1]

Frost Action Class

	Low	Moderate	High
Unified Soil Classes[2]	GW, GP[3], GW-GM, GP-GM, SW, SP, SW-SM, & SP-SM	GM, GC[4], SC, CH & SM (medium sands)	ML, MH, OL, OH, CL & SM (fine sands)

1 Source: Vold (1977).

2 Definitions and potential frost action ratings for major third level divisions of the Unified Soil Classification System are contained in Appendix IX.

3 These soils are rated as high in the Alpine Zone or Subalpine Krummholz Subzone, or when imperfectly to poorly drained.

4 These soils are rated as moderate in the Alpine Zone or Subalpine Krummholz Subzone.

In alpine and subalpine zones three types of frost action have been recognized (Ryder, 1976). Frost shattering is the process whereby bedrock or rock fragments are split and broken due to the expansion pressures of freezing pore water and water in fractures. The intensity of frost shattering is dependent on the amount of available moisture, nature of rock material, the number of frost (freeze-thaw) cycles and the freezing rate. Blockfields, mountain top detritus (till mantle), block slopes, block streams, rock glaciers and talus slopes develop when frost shattered debris creeps, flows and/or falls down slope. Frost heaving is the upward displacement of objects (soil particles and rock fragments) resulting from pressures generated by freezing water. Frost heaving usually occurs when there is an abundance of moisture in the soil substrate, a gradual fall of temperature leading to a slow descent of the freezing point, and soil or surficial material of silt or silt loam texture. The third type of frost action is known as frost sorting. The "patterned" ground characteristic of frost sorting, consist of circles, polygons, and nets on horizontal or gently sloping ground and steps and strips on moderately sloping surfaces.

3.5 Vegetation

In areas of recreational use, be it intensive or extensive, the vegetation component should be included in site planning and development. The ability of a site to support different types and intensities of recreational use is governed by the capacity of soils to establish and maintain vegetative cover. As an example, the low lying, slow growing plants of high elevation alpine meadows are quite susceptible to damage resulting from trampling and campsite establishment. Conversely, the protection and enhancement of vegetative ground cover facilitates the prevention and control of erosion, which could lead to soil and general site degradation (Densmore and Dahlstrand, 1965; Montgomery and Edminster, 1966; Stevens, 1966). Plant communities perform vital roles in biogeochemical (Nutrient) and water cycling (Lautenbach et al, 1974). Trees and other ground cover contribute to the visual enjoyment and scenic integrity of natural resources, provide shelter from direct sunlight, high winds, drifting snow and other climatic factors, help to attenuate noise by absorbing and reflecting sound, provide a sense of privacy by screening out the views, sounds and smells of other users, perform a vital role as habitat for wildlife populations (permanent and seasonal) and help to prevent or diminish the effects of rock slides, snow avalanches and other naturally occurring or man-induced phenomena.

The suitability of vegetation for recreational activities can be established on the basis of sensitivity, resiliency, density, height and vegetation type (including hazard and nuisance categories) (Murray et al, 1971; Burden and Randerson, 1972; Hawes, 1974; Eekman, 1976; Min. of the Envir., 1976; Alberta Rec. & Parks, 1979).

3.5.1 Vegetation Parameters Used to Assess Recreation Capability

Sensitivity is the ability of vegetation to withstand various intensities and types of recreational uses. Recognizing that the degree of sensitivity varies from species to species, what is of greater concern is the ability of each vegetation type to recover from or re-establish after destructive use. The process of recovery or re-establishment is described in terms of community succession. As an example, in alpine and subalpine environments the rate of succession is low, particularly where soils are shallow or unstable. The short growing season, harsh climate, limited time available for plants to complete their life cycles and the fragile nature of vegetation communities, make certain areas of the subalpine and alpine environments highly vulnerable to irreversible destruction by man (Lautenbach et al, 1974; Eekman, 1976). Physical damage to vegetation cover will often lead to the establishment of resistent and often less spectacular weedy species at the expense of more susceptible (fragile) flowering plant species (Corns, 1976; Eekman, 1976). Vegetation that is frozen, brittle and not protected by snow or adjacent vegetation will suffer irreversible damage if it is crushed by man, whether on foot or through the use of all-terrain vehicles.

Vegetation density is the percent cover or number per given area of individual vegetation types, i.e., species or vegetation strata. Vegetation density will have a very direct bearing on the intensity and type of recreational activity that can occur in an area as well as the costs of site preparation. Insufficient vegetation can pose a problem where vegetation is required for screening users from one another or where users require shelter from direct sunlight, high winds or other climatic factors.

Vegetation height generally refers to the vegetation strata, be it understory shrub vegetation or the overstory canopy. Of concern to recreationists is the height of vegetation overhang or clearance under the vegetation. Both the overall height and height to overhang are of importance as they influence the type and intensity of recreational pursuits. Vegetation with low overhang will pose varying degrees of limitation depending on the specific minimum clearance requirements of given activities. As with vegetation density, the height of vegetation will influence the degree to which snow accumulates, which, in turn, will dictate the type, intensity and duration of winter-based recreational activities.

Areas characterized by a large variety of plant species are often better suited for aesthetic appreciation and nature studies (Hawes, 1974). In recreation site planning and development it is essential that hazard and nuisance vegetation species are accounted for. Species such as devil's club, poison ivy, stinging nettle, salmonberry, gooseberry and rose can be both a hazard and a nuisance. Mosses and other turfy vegetation will pose moderate to severe limitations for mountain climbing, as exposed, dry bedrock is essential for safe climbing. In areas planned for intensive use camping and picnicking, an abundance of nuisance and/or hazardous vegetation will increase the costs of site preparation and maintenance, and may prove to be a source of ongoing aggravation following site development. The site requirements of recreational activities and the period of activity (spring, summer, fall and/or winter) should be considered when assessing an area for nuisance and/or hazardous vegetation.

Based on studies done by Jarvinen and Schmid (1971), Masyk (1973), and Wanek (1971) it was found that snowmobiling is or can;

a) be a major cause of damage to shrubs, saplings and other vegetation adjacent to designated snowmobile trails, as well as in areas of uncontrolled use,

b) result in decreased soil temperatures as a result of snow compaction and subsequent deep freezing, which in turn can seriously affect the survival of soil microbes and subnivean plant and animal communities,

c) be blamed for incidences of wildlife harassment, littering, and air and noise pollution, which in turn can significantly decrease the opportunities for others to enjoy a given area,

d) result in alterations to alpine meadow habitats so that certain animal and plant species normally found in these areas may be destroyed or forced to migrate to other areas,

e) and, result in extensive site degradation arising from intensive use of steep slopes, use of areas with southern exposures and use of trails too early or too late in the season, when snow cover is inadequate.

3.5.2 Recreation Suitability Rating Using Biogeoclimatic Zones

Eekman (1976) presented an approach which used Biogeoclimatic Zones (Krajina, 1969) to establish recreation suitability ratings. Under this approach plant associations are assigned recreation suitability ratings on the basis of somewhat subjective assessments of vegetation sensitivity, resiliency (recovery and re-establishment of damage plants), density, height and type and the site factors of hygrotype, drainage, snow duration, ground water depth, seepage characteristics, slope, permeable soil depth, thickness of humus layer and stoniness of soil profile.

The three Biogeoclimatic Zones used to assess recreational suitability within Clague Mountain Park were the Coastal Western Hemlock Zone (CWH with Wet Subzone), the Mountain Hemlock Zone (MH with Parkland and Forest Subzones) and the Alpine Zone (AT). Figure 13 shows the spatial extent of these zones within the park. Appendix II contains descriptions of each of the aforementioned zones, followed by summaries of the characteristic species of each of the plant associations of each zone and generalized suitability ratings of these associations for the set of selected recreational activities.

Not all of the plant associations for each zone are found within the park. The characteristic plant associations of the Coastal Western Hemlock Zone (Wet Subzone) include <u>Tsugo-Strutheopteretum spicant</u>, <u>Lysichito-Vaccinietum</u>

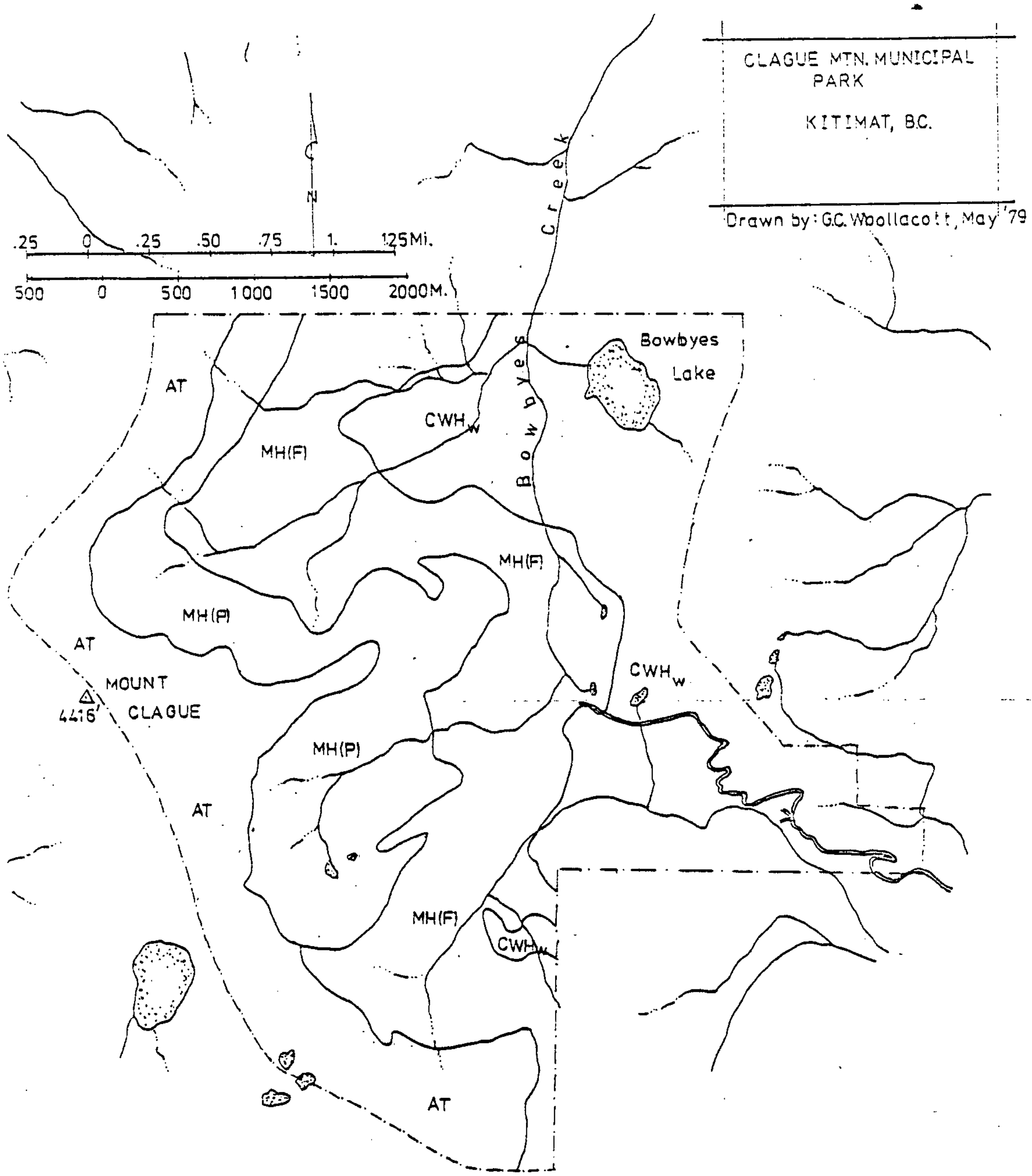


Fig. 13. Biogeoclimatic Zonal classification of Clague Mountain Park.
Key: (after Krajina (1969))
AT - Alpine Zone
MH(F) - Mountain Hemlock Zone, Forest Subzone
MH(P) - Mountain Hemlock Zone, Parkland Subzone
CWH(w) - Coastal Western Hemlock Zone, Wet Subzone

alaskaense, Thyjo-Oplopanicetum horridus, and Populo-Loniceretum involucratae; of the Mountain Hemlock Zone (Forest Subzone) include all those indicated in Appendix II; of the Mountain Hemlock Zone (Parkland Subzone) include all those indicated in Appendix II except the Vaccinio-Tsugetum mertensianae plant association; and of the Alpine Zone include all those indicated in Appendix II. Refer to Appendix VI for photographs showing some of the common vascular plants and shrubs found within Clague Mountain Park.

3.6 Climate

Climate plays a key role in the selection of recreation areas and the types and intensities of recreational activity pursued in these areas. Climatic parameters such as temperature, wind, duration of sunshine and precipitation will aid in determining the suitability ratings for an area as well as having a direct influence on the capacity of an area to attract and sustain recreational activities (Bennett, 1977). The specific climatic or meterological factors that are considered important for establishing the carrying capacity and suitability rating of an area for various recreational activities are listed in Table 3:

Given that climatic factors will affect people differently, which ones can be used to inventory, classify and rank areas as to their suitability for recreational use? Bennett (1977) selected temperature, precipitation, sunshine (solar

Table 3. Recreation Activity-Related Climatic Factors[1]

1. Precipitation - amount (mean annual, mean monthly and mode), form, duration (mean number of precipitation days), pattern (distribution), snow depth, snow quality and snow season.

2. Temperature - mean annual and monthly, daily highs and lows, monthly record of extreme or record of daily highs and lows, mean length of frostfree period, average start and finish dates and degree hours that are frost-free.

3. Wind - mean wind velocity and direction by day and month, record of extreme highs by month, wind and storm variability, intensity and duration, calculated wind chill factors, and specific hazards associated with exposure to high winds (storms).

4. Solar Radiation - mean and total number of sunshine hours by month and annually, duration of sunshine is of major importance for establishing summer and winter recreation capability.

5. Other Climatic Factors and Associated Phenomena - rate and amount of evaporation, relative humidity, ice formation, thickness and duration, occurrence of fog, hail, and seasonal or unexpected storms, water and soil temperature regimes, snow avalanches and soil slumping or mass wasting, atmospheric pressure and density and the occurrence of frost.

[1] Source: Jurdant et al (1974); Verberg (1974); Jubenville (1976); Edmonton Region. Plan. Comm. (1977); Bennett (1977) and Alberta Rec. & Park (1979).

radiation) and wind to establish recreational suitability ratings. These four factors were chosen because they represent the climatological data currently available in B.C., i.e., they have been quantified, they have a direct influence on a range of recreational pursuits and their roles in climate-recreation interactions are fairly well understood.

When classifying areas as to their climatic suitability for recreation, it is important to consider the range of recreational activities and weather conditions which will affect their pursuit, the availability of climatic data, the seasonal variation of climatic conditions and the range of values of climatic parameters encountered over the entire area under study, e.g. province of B.C. Under Bennett's (1977) approach, each of the four climatic factors are defined and separated into suitability classes, with Class I being the most suitable and Class V being the least suitable for the pursuit of recreational activities (refer to Appendix III). Following a review of the site requirements for each of the selected recreational activities and the definitions of climatic factor suitability classes, the suitability classes were allocated into one of three generalized suitability categories, i.e., none-slight, moderate or severe. As an illustration of this procedure, refer to the following excerpt from Table 5 (p. 72): Ecological (Biophysical) Limitations for Camp Areas (Intensive Use):

Once the suitability classes of each of the four climatic factors have been assigned to one of the three generalized suitability classes these generalized classes are then used to classify areas for recreational suitability based on the degree of limitation each climatic factor has on the activity(s) being evaluated.

Excerpt from Table 5:

Item Affecting Use	Degree of Limitation[1] None-Slight	Moderate	Severe
Climate[2]			
Temperature	Class 1	Class 2h or 2k	Class 3h, 3k, 4k, 5k
Precipitation	Class 1	Class 2 or 3	Class 4 or 5
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	Class 1	Class 2 or 3	Class 4 or 5

[1] Refer to Section 3.8 for definitions of none-slight, moderate and severe limitation classes.

[2] Source: Bennett (1977). Camping (intensive) is classified as a land-passive summer/transition activity. Refer to Appendix III for a summary of the climatic criteria used to derive suitability ratings and for definitions of each of the climatic factors of temperature, precipitation, wind and sunshine.

3.6.1 Climate of Clague Mountain Park

No specific climatic data are available for Clague Mountain Park. However, it is possible to gain insight into its climate by referring to the park's Biogeoclimatic Zones, data collected by Environment Canada for Kitimat (Envir. Can., 1975a, 1975b and 1976), and Bennett (1976), on the subalpine and alpine zones of British Columbia.

The park's climate is marine mesothermal or mild microthermal humid to rainy, with slight to moderate snow cover, in the lower elevation Coastal Western Hemlock Zone; microthermal subcontinental (subalpine) humid, with heavy snow cover, in the mid-elevation (305 to 762 meter) Mountain Hemlock Zone; and alpine tundra in the higher elevation (greater than 900 meter) Alpine Zone (Appendix II). The park has wet autumns and dry summers, with 30 to 40% and 10 to 15%, respectively, of the total annual precipitation occurring during these periods.

In the subalpine and alpine environments the precipitation generally increases with increasing elevation, with maximum amounts occurring at the base of clouds (Bennett, 1976). Subalpine and alpine areas usually have colder annual minimum temperatures, lower maximum temperatures and diurnal ranges which are less than adjacent lower elevation areas due to stronger winds and the lower density of the atmosphere. Air temperatures at high elevations tend to decrease with elevation at an average rate of 5 to 6°C per 1000 meter rise in elevation. The combined influence of lower temperatures and increased precipitation result in increased snow accumulations. Winds are usually stronger and more persistent at higher elevations. Wind plays a major role in the clearing and transporting of snow, and, when combined with the influence of local topography, it determines the distribution of snow. At higher elevations the atmosphere is, generally, thinner, cleaner and drier resulting in a decreased amount of radiation scattering, increased levels of incoming ultraviolet radiation, extreme nocturnal cooling at the surface and harmful affects on vegetative cover, especially those species located within one meter of the surface, i.e., surface species are subject to extreme diurnal temperature variations.

The climate of the lower elevations of the park (sea level to approximately 300 meters) can be inferred from meterological data collected at Atmospheric Environment Service (A.E.S.) climate stations located along the Kitimat-Terrace Valley. The climatic data collected at the Kitimat Townsite A.E.S. station was deemed appropriate due to its close proximity to the park, its extended period of data collection and the diversity of climatic information collected and readily available relative to the other A.E.S. stations in the valley. Table 4 summarizes the climatic parameters of temperature, precipitation (rain and snow), sunshine and wind specific to the Kitimat Townsite A.E.S. station.

The foregoing climatic data is representative of the lower elevations of the park, with notable differences between this data and the actual climatic conditions found within the park arising due to variations in slope, aspect, elevation, nature of the dominant air masses and cloud conditions. As climate will play a major role in determining the suitability of the park for the set of recreational activities, it is important that it be adequately inventoried, assessed and incorporated into the overall site planning and development process.

Table 4: Climatic Data for Kitimat, B.C.: Including Temperature, Precipitation, Sunshine, and Wind.

Temperature Data[1]	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	Period
Mean daily temp. (°C)	-4.2	0.0	2.3	5.8	10.3	14.0	16.2	15.9	12.6	6.8	1.6	-1.9	6.6	1941 - 70
Mean daily max. temp. (°C)	-1.7	2.9	6.3	10.6	15.9	19.1	21.1	20.4	16.8	9.7	3.8	.2	10.4	1941 - 70
Mean daily min. temp. (°C)	-6.7	-2.9	-1.6	1.1	4.6	8.9	11.3	11.4	8.3	4.0	-.7	-4.0	2.8	1941 - 70
Mean monthly temp. for 1976 (°C)	-2.2	-1.7	.6	6.0	7.8	11.7	13.3	14.4	12.2	6.7	3.3	1.1	6.1	1976 (1 year)
Mean monthly temp. (°C)	-4.4	0.0	2.2	6.1	10.6	13.9	16.1	16.1	12.8	6.7	1.7	-1.7	6.7	1941 - 70
Temp. extremes for 1976:														
Highs:	7.8	M[2]	8.9	M	M	25.0	27.8	27.2	24.4	16.7	12.2	7.8	36.1	1976 (1 year)
Lows:	-20.0	-11.1	-15.6	-2.8	-1.1	.6	3.9	5.0	1.7	-1.7	-3.9	-6.7	-25.0	1976 (1 year)

Precipitation Data[1]	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	Period
Mean rainfall (cm)	15.7	16.8	14.5	12.8	7.5	5.8	5.3	8.1	19.5	34.5	24.3	19.2	184.0	1941 - 70
Mean snowfall (cm)	178.8	100.6	45.0	12.7	0.0	0.0	0.0	0.0	0.0	7.4	58.9	133.6	537.0	1941 - 70
Mean total precip. (cm)[3]	33.6	26.8	19.0	14.1	7.5	5.8	5.3	8.1	19.5	35.3	30.2	32.3	237.7	1941 - 70
No. of days with measurable rainfall	10	12	13	14	12	10	12	15	15	22	17	13	165	1941 - 70
No. of days with measurable snowfall	13	8	7	2	0	0	0	0	0	1	6	11	48	1941 - 70
No. of days with measurable precipitation	20	17	16	14	12	10	12	15	15	22	20	22	195	1941 - 70

Sunshine Data[4]	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	Period
No. hours of bright sunshine for 1976	M	69	81	130	115	154	77	126	109	M	50	23	M	1976
No. hours of bright sunshine for 1941-70 period	47	66	124	157	211	201	217	173	123	62	37	29	1447	1941 - 70

Wind Data[5]	Jan.	Feb.	Mar.	Apr.	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	Period
Predominant wind directions & associated ave. wind speed (km/hr)	N22.4	N14.6	S11.1	S12.4	S11.9	S12.7	S12.7	S11.6	S11.1	S11.4	N13.2(33%)[6] S12.6(32%)	N17.5	N13.5(27%)[7] S12.1(43%)	1967 - 72

Note: the maximum observed hourly wind speed during the 1967-72 period was 56 km/hr (35 mph) from the north.

1. Sources: Environment Canada (1975a, 1975b, and 1976).
2. Abbreviation "M" represents missing data.
3. Total precipitation is the sum of the rainfall plus the water equivalent of the snowfall, which is normally obtained by dividing the snowfall amount by 10, i.e., 10 cm of snow (uncompacted) is approximately equivalent to 1 cm of water.
4. Source: Environment Canada (1976).
5. Source: Environment Canada (1975c).
6. Indicates that for 33% of Oct. the wind was from the north at 13.2 km/hr and for 32% of Oct. the wind was from the south at 12.6 km/hr.
7. Indicates that for 27% of the year the wind was from the north at 13.5 km/hr and for 43% of the year the wind was from the south at 12.1 km/hr.

3.7 Unique Site Features

Unique site features refer to those ecological parameters which aid in establishing the suitability of a site for recreational activities but have either not been previously dealt with or have received only a broad, cursory treatment. These features are meant to elaborate on and/or introduce concepts different from those discussed in conjunction with landform and parent material, topographic relief, soil moisture regime and drainage, texture, permeability, stoniness, rockiness, depth to bedrock or impervious layer, frost action, erosion hazard, flood hazard, vegetation and climate.

Mountain climbing is one activity that can illustrate what is meant by "unique site features" and how they aid in establishing the suitability of a site for this activity. Areas that have none-slight limitations (good suitability) for mountaineering are characterized by rock structures which are firm and stable, being igneous (granite or grabbo) or metamorphic (gneiss or schist) preferrably, concave sites with low (velocity) winds, and rock types that possess an abundance of cracks and fractures, and are typically rough textured. At the other extreme, areas that have severe limitations (poor suitability) for mountaineering are characterized by crumbly, unstable rock types such as sedimentary rock (sandstone or limestone), unstable glacial detritus and recent volcanic materials, convex sites with evidence of high winds, areas with active surface seepage and/or runoff (water), areas that are known or suspected of being of high avalanche and/or rockfall hazard, and areas with smooth, well-weathered rock types devoid of "hand-holds" and/or covered with a thin mantle of turfy vegetation.

3.8 Site Limitations for Selected Recreational Activities

The ecological parameters previously discussed were used to describe the site limitations for the selected recreational activities. The suitability of a site for these activities will also be dependent on the nature of the activity, season of participation, size of user groups and other factors of supply and demand.

Various authors provide insights into the limitations posed by the site parameters on the selected recreational activities (Archer, 1963; Montgomery and Edminster, 1966; Brooke et al, 1969; Murray et al, 1971; Denney, 1972; Culbert, 1974; Hawes, 1974; Verburg, 1974; Fogg, 1975; Vold, 1975; Eekman, 1976; Jubenville, 1976; Min. of the Envir., 1976; Bennett, 1977; Alberta Rec. & Parks, 1979). Tables have been drawn up which summarize each activity's ecological site limitations. The parameters selected are those factors of the environment which were likely to influence the type and intensity of recreation use. Ecological parameters used to evaluate an area for a specific activity are ranked as being of none-slight, moderate to severe limitation for the intended recreation use. Suitability classes are defined as follows:

<u>None to Slight Limitation</u> - a rating of none to slight (good suitability) indicates that if there are limitations (as indicated by deviations about the site requirements) they will be generally easy to overcome without special planning or management procedures.

<u>Moderate Limitation</u> - a rating of moderate (moderate suitability) indicates that the limitations identified can generally be overcome with good planning, design and/or management at a moderate cost.

<u>Severe Limitation</u> - a rating of severe (poor suitability) indicates that even with good planning and management the limitations will be difficult to overcome. Areas with severe limitations are generally unsuitable or require special and often costly procedures to make them suitable for a specified recreation use.

The choice of activities was made on the basis of what major recreational activities were actually occurring or would most likely occur within and adjacent to Clague Mountain Park. Determination of an area's suitability for one or more of the aforementioned recreational activities was made on the basis of the previously discussed ecological parameters and their associated degrees of limitation for each of these activities. As a result of an extensive review of the literature, Tables 5 to 13 were derived.

Table 5 : Ecological(Biophysical) Limitations for Camp Areas (Intensive Use)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[2.]	Well to moderately well drained soils with no ponding. Depth to watertable should be sufficient so as not to adversely affect use and/or construction. Very dry (xeric) to moderately dry (subxeric) moisture regime.	Moderately well drained soil and somewhat poorly drained soils with no ponding. Mesic moisture regime.	Well drained, moderately well drained and somewhat poorly drained, with infrequent ponding of short duration; poorly and very poorly drained soils. Hygric to hydric moisture regime.
Surface Soil Texture[2.]	Moderately coarse to medium textured soils; sandy loams to loams; soils not subject to blowing. (sl,fsl,vfsl,l and ls). Fertile soils containing a high % of medium-coarse textured soil material and high in organic matter as well.	Coarse textured soils; loamy sands (ls) not subject to blowing; medium to moderately fine textured soils; silt loams (sil) to silty clay loams (sicl). (cl,scl,sicl,sil,ls, and s)	Fine textured soils; clays with poor permeability; loose sands (s) with low cohesion, soils subject to blowing or with unstable surface. (organic, c,sic,sc, and loose s)
Permeability[2.]	High to moderate (.5cm/hr to .5 - 5.cm/hr)	Moderate (.5 to 5.cm/hr)	Poor (0 to .5cm/hr)
Stoniness[2.]	.01% of surface occupied by rock fragments 15cm (6in) in diameter. Non-stony.	.01 - 3.% of surface occupied by rock fragments 15cm (6in) in diameter. Slightly to moderately stony.	3. - 50.% of surface occupied by rock fragments 15cm (6in) in diameter. Very to excessively stony.
Rockiness[2.]	.01% of surface occupied by exposed bedrock. Non-rocky.	.01 - 3.% of surface occupied by exposed bedrock. Slightly to moderately rocky.	3. - 50.% of surface occupied by exposed bedrock. Very to excessively rocky.

Table 5 : Ecological(Biophysical) Limitations for Camp Areas (Intensive Use). (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Slope[2.]	0 - 9.% (0 - 5.1^{0}) level to gently sloping. 0 - 2.% may have drainage problems.	10. - 15.% (5.7 - 8.5^{o}) gentle to moderately sloping.	16.%+ (9.1^{o}+) moderately to very steeply sloping.
Aspect[2.]	S, SE, SW or level aspects are drier, warmer in cool weather and afford maximum sun exposure.	W for afternoon and evening sun and cool mornings. E for morning sun and shade from evening sun, usually have cool evenings.	N, NE or NW aspects characterized by long snow duration, high moisture retention and cooler temperatures.
Erosion Hazard[3.]	Low (stable)	Moderate (metastable)	High (unstable)
Frost Action[3.]	Low (moderate in alpine or subalpine krummholz zone)	Moderate (high in alpine or subalpine krummholz zones or when imperfectly to poorly drained)	High
Flooding[2.]	No to rare occurence; being of nil to slight flood hazard.	No to rare occurence; being of nil to slight flood hazard, with flooding occurring very infrequently during season of use.	Occasional to frequent occurence; being of moderate to severe flood hazard during season of use.
Vegetation[2.] Sensitivity	Low sensitivity vegetation type with fast rate of succession.	Medium sensitivity vegetation type with moderate rate of succession.	High sensitivity vegetation type with slow rate of succession.
Density	Low to medium density not posing problems to movement. Mixed stands with fairly open crown cover, with understory for privacy while providing shelter.	Medium density resulting in reduced ease of movement.	Medium to high density; significantly impeding movement.
Height[4.]	Trees averaging over 6 m. (20 ft).	Trees and shrubs 4.6 - 6 m (15 - 20 ft)	Trees and shrubs less than 4.6 m (15 ft)

Table 5 : Ecological (Biophysical) Limitations for Camp Areas (Intensive Use). (continued)

Items Affecting Use[1]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[5]			
1. Coastal Western Hemlock Zone (CWH)	Tsugetum-heterphyallae Piceo-Symphoricaroetum albus	Pseudotsugo-Gaultheretum shallon Tsugo-Gaultheretum shallon Populo-Loniceretum involueratae Piceo-Oplopanicetum horridus Pseudotsugo-Cladonietum pacificae	Thujo-Polystichetum munitum Tsugo-Abietetum amabilis Tsugo-Struthioteretum spicant Lysichito-Vaccinietum alaskaense Copo-Lysichetum Kamtschatcense Thujo-Oplopanicetum horridus
2. Mountain Hemlock Zone (MH)	Vaccinio-Tsugetum mertensianae	Phyllodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Cladothamno-Tsugetum mertensianae Abieto-Tsugetum mertensianae	Leptarrheno-Calthetum leptosepalae Saxifragetum tolmiei Caricetum nigricantis Streptopo-Abietetum amabilis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoro-Sphagnetum
3. Alpine Zone (AT)			Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Caricetum spectabilis Luetkeetum pectinatae Anaphaleto-Lupinetum arctici Mimuleto-Epilobietum latifolii Valerianetum sitchensis Junipereto-Penstemonetum menziesii Silenetum acaulis Phyllodoceto-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis Bog Peat - Sphagnum Association
Climate[6]	Land-Passive Summer/Transition Activity		
Temperature	Class 1	Class 2h or 2k	Class 3h, 3k, 4k, or 5k
Precipitation	"	Class 2 or 3	Class 4 or 5
Wind	"	" 2 or 3	" 4 or 5
Sunshine	"	" 2 or 3	" 4 or 5

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classifications schemes set out in the Canada Soil Information System (Agric. Can.,1978)
2. Source: Alberta Rec. and Parks(1979), Archer(1963), Brooke et al(1969), Denney(1972), Eekman(1976), Fogg(1975), Hawes(1974), Jubenville(1976), Min. of the Envir.(1976), Montgomery & Edminster(1966), Murray et al(1971), Raine(1979), or Verberg (1974).
3. Source: Vold(1977). Based on parent material type, slope classes, and soil surface texture.
4. Source: Murray et al(1971)
5. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities. Suitability ratings were derived by the author using an interpretive approach similar to that proposed by Eekman(1976). The vegetation parameters used to establish the suitability ratings of plant associations include vegetation sensitivity, resiliency, density, height, and type (including nuisance and hazard categories).
6. Source: Bennett(1977). Refer to Appendix III for "Summary Criteria for the Climate Suitability for Recreation Classification".

Table 6 : Ecological (Biophysical) Limitations for Cross-Country Skiing

Items Affecting Use[1]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[2]	*Refer to Table of Ecological (Biophysical) Limitations for Downhill Skiing.		
Surface Soil Texture[2]	* " " " " "	" " " "	" .
Permeability[2]	* " " " " "	" " " "	" .
Slope[2]	0 - 5.% (0 - 2.9°)	6. - 10.% (3.4 - 5.7°)	11.%+ (6.3°+)
Aspect[2]	E, NE, N, NW for deepest snow; except for the extreme conditions of high elevations or for northern latitudes. Preference is given to "warmer" slopes on SE, S, or W aspects.	W, SE or S aspects are acceptable on less steep runs, somewhat sheltered from the sun's rays during the winter months.	SW aspects receives moderate rating if topography and/or vegetation shelters runs. Aspect is characterized by prolonged exposure to the sun's rays.
Flooding[2] (of facilities)	No to rare occurence; being of nil to slight flood hazard. No flooding during the year.	No to rare occurence; being of slight to moderate flood hazard, with flooding occurring infrequently (1 or 2 times) during the year.	Occasional to frequent occurence; being of moderate to severe flood hazard with flooding occurring more than 2 to 4 times during the year.
Vegetation Density[2,4]	Low to medium understory density, adequate to insure ease of movement yet provide a degree of shelter from wind and direct sunlight on exposed sites. Alternation between closed forest areas and open ground is desirable.	→	Very dense understory, greatly impeding movement; dense overstory that blacks out a majority of the sunlight. At times dense patches of vegetation aid to deter snowmobilers from using cross-country and other winter-sports trails.
Height[5]	In forested areas trees over 6.1 m (20 ft) are preferred; this will vary with species and branching habit.	→	Trees less than 6.1 m (20 ft) generally; may be more or less depending upon species, branching habit, and resultant influence on freedom of movement.

Table 6 : Ecological (Biophysical) Limitations for Cross-Country Skiing. (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[6.]			
1. Coastal Western Hemlock Zone (CWH)			
2. Mountain Hemlock Zone (MH)	** Approximated by Ratings of Plant Associations for Trails (Summer Use) Snow depth, freezing and other winter-related factors may result in rating certain associations more favourably than others in terms of cross-country skiing; generally; however, the ratings given should adequately reflect the degree of limitation posed by each association on this specific recreational activity.		
3. Alpine Zone (AT)			
Climate[2.]	Land-Active Winter Activity		
Temperature	Class 2h, 1, 2k, or 3k	Class 3h	Class 4h or 4k
Precipitation[8.]	Class 3	Class 2 or 4	Class 1 or 5 (extremes in snowfall)
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	Class 1	Class 2 or 3	Class 4 or 5
Snow Depth[9.]	61 - 122 cm (2 - 4 ft)	30 - 61 cm (1 - 2 ft)	Less than 30 cm (1 ft) and greater than 122 cm (4 ft) of snow.
Temperature[10.]	-2 to -10°C	-11 to -26°C	Greater than -2°C and Less than -26°C

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can., 1978).
2. Source: *refer to Table of Ecological (Biophysical) Limitations for Camp Areas (Intensive Use), footnote 2.
3. Source: Vold(1977)
4. Source: Alberta Rec. & Parks(1979), Jubenville(1976) and Murray et al(1971).
5. Source: Murray et al(1971)
6. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
7. Source: Bennett(1977). Refer to Appendix IIIfor "Summary of Criteria for the Climatic Suitability for Recreation Classification".
8. Cross-country skiing requires a moderate amount of precipitation in the form of snow. An N value of 55 was assumed for the Coast Range of B.C. based on a review of data from existing A.E.S. weather stations.
9. Refers to snow that is loose (non-compacted). Excessively deep snow will impede movement unless it is suitably packed prior to using. Source: Alberta Rec. & Parks(1979), Green(1980), and Pientok(1980).
10. Source: Alberta Rec. & Parks (1979)

Table 7 : Ecological (Biophysical) Limitations for Downhill Skiing

Items Affecting Use[1]	Degree of Limitation: None-Slight	Moderate	Severe
Soil Moisture & Drainage[2]	Well to moderately well drained soils with no ponding. Very dry (very xeric) to mesic moisture regime.	Moderately well drained soil and somewhat poorly drained soils with no ponding. Mesic moisture regime.	Well drained, moderately well drained and somewhat poorly drained, with infrequent ponding of short duration, poorly and very poorly drained soils, eg. meadows. Hygric to hydric moisture regime.
Surface Soil Texture[2]	Moderately coarse to medium textured soils; sand loams to loams (sl, fsl, vfsl, and l). Gravelly to non-gravelly soils. Soil cover should be thick, or extensive distribution, and stable in relation to rock outcrops, eg. till veneer over bedrock.	Medium to fine textured soils; silt loams to sand clays, loamy sands (sil, sicl, scl, cl, sc, and ls).	Fine textured soils; clays, loose sands, and soils subject to blowing (si, c, c, and s). Organic silts, silt clays and clays; peat and other highly organic soils.
Permeability[2]	High to moderate (5.cm/hr to .5 - 5.cm/hr).	Moderate (.5 - 5.cm/hr)	Poor (0 - .5cm/hr)
Slope[2]	0 - 40.% (0 - 21.8°)	41 - 80.% (22.3 - 38.7°)	81.%+ (39.0°)
Aspect[2]	N, NE, or NW except for the extreme cold conditions of high altitudes or for northern latitudes. E aspect is good because slopes do not face the sun during the critical afternoon period.	W is useable if intervening topography or vegetation to the west aids in shading the runs. S and SE aspects are acceptable on less steep terrain at higher elevations (the concentration of solar energy on south facing slopes can cause rapid deterioration of existing snow.	SW aspects should be avoided at all times.
Erosion Hazard[3] *	Low * Based on parent material and slope classes.	Moderate	High
Frost Action[3] **	Low ** Based on soil surface texture.	Moderate	High
Flooding[2] (of facilities)	No to rare occurence; being of nil to slight flood hazard. No flooding during the year.	No to rare occurence; being of slight to moderate flood hazard, with flooding occurring infrequently (1 or 2 times) during the year.	Occasional to frequent occurence; being of moderate to severe flood hazard with flooding occurring more than 2 to 4 times during the year.
Vegetation[2] Sensitivity	Low sensitivity vegetation type able to withstand heavy useage and is characterized by a fast rate of succession.	Medium sensitivity vegetation type with moderate rate of succession, susceptible to degradation.	High sensitivity vegetation type with slow rate of succession, being susceptible to irreversible damage.
Density	Low to medium density, sufficient to cut winds and allow for snow accumulation.	→	Open areas that increase exposure to winds and direct sunlight, eg. mountain tops.
Height	Sufficient to provide adequate shelter from wind and direct sunlight.	→	No to short vegetation that offers no or only minimal protection from the effects of wind and direct sunlight and does not permit snow accumulation.

Table 7 : Ecological (Biophysical) Limitations for Downhill Skiing. (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[4.]			
1. Coastal Western Hemlock Zone (CWH)		Pseudotsugo-Gaultheretum shallon Tsugetum-heterophallae Tsugo-Gaultheretum shallon Tsugo-Abietetum amabilis	Thuja-Polystichetum munitum Tsugo-Struthiopteretum spicant Lysichito-Vaccinietum alaskaense Copto-Lysichetum kamtschatcense Thujo-Oplopanicetum horridus Populo-Loniceretum involucratae Piceo-Oplopanicetum horridus Piceo-Symphoricaroetum albus Pseudotsugo-Cladonietum pacificae
2. Mountain Hemlock Zone (MH)	Vaccinio-Tsugetum mertensianae Abieto-Tsugetum mertensianae	Phyllodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Cladothamno-Tsugetum mertensianae Streptopo-Abietetum amabilis	Leptarrheno-Calthetum leptosepalae Saxifragetum tolmiei Caricetum nigricantis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoro-Sphagnetum
3. Alpine Zone (AT)		Caricetum spectabilis Luetkeetum pectinatae Mimuleto-Epilobietum latifolii Valerianetum sitchensis	Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Anaphaleto-Lupinetum arctici Juniperato-Penstemonetum menziesii Silenetum acaulis Phyllodoco-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis Bog Peat - Sphagnum Association
Climate[5.]	Land-Active Winter Activity		
Temperature	Class 1, 2k, or 3k	Class 2h or 3h	Class 4h or 4k
Precipitation[6.]	Class 4 or 5	Class 3	Class 1 or 2
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	Class 1	Class 2 or 3	Class 4 or 5
Snow Depth7.	Over 254 cm (100 in)	152 - 254 cm (60 - 100 in)	Less than 152 cm (60 in)

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
2. Source: *refer to Table of Ecological(Biophysical) Limitations for Camp Areas (Intensive Use), footnote 2.
3. Source: Vold(1977)
4. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
5. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification".
6. Precipitation in the form of snow is vital for downhill skiing. The precipitation conversion used is 1.0 in.rain = 10.0 in. snow (Min. of Agric.,1976). A review of the climatological data from the established A.E.S. stations in B.C. indicated that the number of days per season with measurable precipitation (N value) averaged about N=55. for the Coast Range, as defined by Holland(1976).
7. Refers to loose snow depth (non-compacted). Source: Alberta Rec. & Parks(1979) and Fogg(1975).

Table 8 : Ecological (Biophysical) Limitations for Mountain Climbing:Mountaineering

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[2.]	Very rapidly to rapidly drained soils; with not ponding nor seepage during period of use. Very dry (very xeric) to dry (xeric) moisture regime.	Well to moderately drained soils; with no ponding and seepage being very rare. Moderately dry (subxeric) to mesic moisture regime.	Imperfectly to very poorly drained soils; with infrequent ponding and very occasional seepage. Hygric to hydric moisture regime.
Slope[2.]	51 - 100% (27-45^{O})	101 - 175% (45-60^{O})	176%+ (60^{O}+) or 0 - 50% (0 - 27^{O})
Aspect[2.]	S,SE or SW for drier, warmer climbing. Mountaineers require warmth and ample sunlight to insure safe climbs on dry sites.	E for warm mornings, cooler evenings, or W for cool mornings and warmer evenings.	N, NW, or NE exposures are not preferred due to the higher moisture and colder temperatures found in these aspects.
Unique Site Features[2.]	Rock structures must be firm and stable, being igneous (granite or grabbo) or metamorphic (gneiss or schist) preferrably; concave sites with low winds are best. Rock types characterized by cracks, fractures and rough texture are preferred.	⟶	Crumbly, unstable rock types such as sedimentary rock (sandstone or limestone), unstable glacial detritus, and recent volcanic materials are hazardous for climbing. Windy, convex areas; areas with active surface seepage and/or runoff; areas known or suspected of being of high avalanche and/or rockfall hazard as well as smooth well-weathered rock types devoid of "hand-hold" pose severe limitation for mountaineering. "Avalanches are the number one killer of coastal (B.C.) climbers." (Culbert,1974).
Vegetation[2.] Type	* For safety reasons and due to the nature of the activity, none to very sparse vegetation is preferred. When locating new routes care must be taken to avoid areas of dense underbrush in valley bottoms and sheltered draws, as well as rock faces and ledges covered with mosses and other low lying vegetation lifeforms (heathers and krummholz amabilis fir).		

Table 8 : Ecological (Biophysical) Limitations for Mountain Climbing : Mountaineering. (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[3.]			
1. Coastal Western Hemlock Zone (CWH)		Pseudotsugo-Gaultheretum shallon Pseudotsugo-Cladonietum pacificae	Tsugetum heterophallae Thujo-Polystichetum munitum Tsugo-Gaultheretum shallon Tsugo-Abietetum amabilis Tsugo-Strutheopteretum spicant Lysichito-Vaccinietum alaskaense Copto-Lysichetum kamtschatanse Thujo-Oplopanicetum haorridus Populo-Loniceretum involucratae Piceo-Oplopanicetum horridus Piceo-Symphoricaroetum albus
2. Mountain Hemlock Zone (MH)		Vaccinio-Tsugetum mertensianae Phyllodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Saxifragetum tolmiei	Leptarrhens-Calthetum leptosepalae Caricetum nigricantis Cladothamno-Tsugetum mertensianae Abieto-Tsugetum mertensianae Streptopo-Abietum amabilis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoro -Sphagnetum
3. Alpine Zone (AT)	Junipereto-Penstemonetum menziesii Abieto-Chamaecyparetum nootkatensis Bog Peat - Sphagnum Association	Caricetum spectabilis Luetkeetum pectinatae Valerianetum sitchensis Silenetum acaulis Phyllodoco-Cassiopetum mertensianae	Gymnomitrieto-Polyrichetum norvegici Caicetum nigricantis Sibbaldietum procumbentis Anaphaleto-Lupinetum arctici Mimuleto-Epilobietum latifolii
Climate[4.]	Land Active Summer/Transition Activity (Predominately)		
Temperature	Class 2h, 1, or 2k	Class 3h or 3k	Class 4h or 4k
Precipitation	Class 1	Class 2 or 3	Class 4 or 5
Wind	" 1	" 2 or 3	" 4 or 5
Sunshine	" 1	" 2 or 3	" 4 or 5

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out inthe Canada Soil Information System (Agric. Can.,1978).
2. Source: Alberta Rec. & Parks(1979), Culbert(1974), Kolankiewicz(1980), and Montgomery & Edminster(1966).
3. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
4. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification".

Table 9 : Ecological (Biophysical) Limitations for Picnicking/Day Use[1.]

Items Affecting Use[2.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[3.]	Well to moderately well drained soils with no ponding. Depth to watertable should be sufficient so as not to adversely affect use and/or construction. Dry (xeric) to mesic moisture regime.	Moderately well drained soils and somewhat poorly drained soils with no ponding. Mesic moisture regime.	Well drained, moderately well drained and somewhat poorly drained with infrequent ponding of short duration; poorly and very poorly drained soils. Hygric to hydric moisture regime.
Surface Soil Texture[4.]	Moderately coarse to medium textured soils; sandy loams to loams; soils not subject to blowing (sl, fsl, vfsl, l and ls)	Coarse textured soils; loamy sands (ls) not subject to blowing; medium to moderately fine textured soils; silt loams (sil) to silty clay loams (sicl); (cl, scl, sicl, ls and s).	Fine textured soils; clays (c) with poor permeability; loose sands (s) with low cohesion; soil subject to blowing or with unstable surface; (organic, c, sic, sc and loose s).
Permeability[4.]	High to moderate (5.cm/hr+ to .5 - 5.cm/hr)	Moderate (.5 - 5.cm/hr)	Poor (0 - .5cm/hr)
Stoniness[4.]	Less than .01% of surface occupied by rock fragments greater than 15 cm (6 in) in diameter. Non-stony.	.01 - 3.% of the surface occupied by rock fragments greater than 15 cm (6 in) in diameter. Slightly to moderately stony.	3. - 50.% of the surface occupied by rock fragments greater than 15 cm (6 in) in diameter. Very to excessively stony.
Rockiness[4.]	Less than .01% of the surface occupied by exposed bedrock. Non-rocky.	.01 - 3.% of the surface occupied by exposed bedrock. Slightly to moderately rocky.	3. - 50.% of the surface occupied by exposed bedrock. Very to excessively rocky.
Slope[5.]	0 - 9.% (0 - 5.1^{o}) **0 - 2.% (0 - 1.1^{o}) may have problems with ponding and/or soil mositure. 3. - 5.% (1.7 - 2.9^{o}) is the preferred slope range.	;0. - 15.% (5.7 - 8.5^{o})	16.%+ (9.1^{o}+)
Aspect[5.]	S, SW or SE are the preferred aspects.	E or W.	N, NW, or NE should be avoided due to cooler temperatures and continual shading.
Erosion Hazard[6.]	Low (stable).	Moderate (metastable).	High (unstable).
Frost Action[6.]	Low.	Moderate.	High.
Flooding[4.] (of facilities)	No to rare occurence; being of nil to slight flood hazard. No flooding during season of use.	No to rare occurence; being of slight to moderate flood hazard with flooding occurring infrequently (1 or 2 times) during season of use.	Occasional to frequent occurence; being of moderate to severe flood hazard with flooding occurring more than 2 to 4 times during season of use.
Unique Site Features[7.]	Variety of topography preferred to enhance aesthetic quality of area. Historic, cultural, and/or natural features add to the overall experience, eg. open areas and secluded woodlands, unique flora and fauna, panoramic views, relics of bygone days and proximity to water resources (lakes, streams, river and/or ocean).		Monotonous landscapes with view to distant areas obscured by trees or other obstructions. Limited numbers and variety of natural flora and fauna in an area. Close proximity to developments and/or resource extraction activities as well as natural or man-caused hazards which may seriously reduce the level of enjoyment experienced in an area. Lack of or inaccessibility to water resources is of major concern.

Table 9 : Ecological (Biophysical) Limitations for Picnicking/Day Use[1]. (continued)

Items Affecting Use[2]	Degree of Limitation		
	None-Slight	Moderate	Severe
Vegetation[7]			
Type & Sensitivity	Mixed or pure stands of coniferous or deciduous tree species, to provide shade during the hot periods of the day as well as add to the scenic quality of the site. Understory vegetation somewhat resistent to this intensive recreational activity are preferred.	→	Dense stands of coniferous and/or deciduous trees should be avoided. Vegetation with thorns, stinging hairs, and other noxious characteristics act to deter picnickers and day user alike, eg. Devil's club, stinging nettle, poison ivy and salmonberry bushes. Vegetqation sensitive to even light levels of use should be avoided, eg. flowering herbs of alpine meadow areas.
Plant Associations by Zone[8]			
1. Coastal Western Hemlock Zone (CWH)	Tsutetum-heterophallae Populo-Loniceretum involucratae Piceo-Symphoricaroetum albus	Pseudotsugo-Gaultheretum shallon Pseudotsugo-Cladonietum pacificae	Thujo-Polystichetum munitum Tsugo-Gaultheretum shallon Tsugo-Abietetum amabilis Tsugo-Struthiopteretum spicant Lysichito-Vaccinietum alaskaense Copto-Lysichetum kamtschatcense Thujo-Oplopanicetum horridus Piceo-Oplopanicetum horridus
2. Mountain Hemlock Zone (MH)	Vaccinio-Tsugetum mertensianae	Phyllodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Cladothamno-Tsugetum mertensianae Abieto-Tsugetum mertensianae	Leptarrheno-Calthetum leptosepalae Saxifragetum tolmiei Caricetum nigricantis Streptopo-Abietetum amabilis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoto-Sphagnetum
3. Alpine Zone (AT)		Anaphaleto-Lupinetum arctici	Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Caricetum spectabilis Luetkeetum pectinatae Mimuleto-Epilobietum latifolii Valerianetum sitchensis Junipereto-Penstemonetum menziesii Silenetum acaulis Phyllodoco-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis Bog Peat-Sphagnum Association

Table 9 : Ecological (Biophysical) Limitations for Picnicking/Day Use[1]. (continued)

Items Affecting Use[2]	Degree of Limitation: None-Slight	Moderate	Severe
Climate[9]	Land-Passive Summer/Transition Activity		
Temperature	Class 1 or 2h	Class 3h or 2k	Class 4h, 3k, or 4k
Precipitation	Class 1	Class 2 or 3	Class 4 or 5
Wind	" 1	" 2 or 3	" 4 or 5
Sunshine	" 1	" 2	" 3, 4 or 5

1. Many ecologial (biophysical) factors which establish the suitability of an area for Campgrounds can be used to establish the suitability of an area for Picnicking/Day Use activities due to the great similarity in their general design and maintenance requirements (Verberg,1974).
2. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
3. Source: Brooke et al(1969) and Montgomery & Edminster(1966).
4. Source: Montgomery & Edminster(1966).
5. Source: Alberta Rec. & Parks(1979), Montgomery & Edminster(1966), Murray et al(1971), and Vold(1977).
6. Source: Vold(1977).
7. Source: Alberta Rec., Parks and Wildlife(1976), Alberta Rec.& Parks(1979), Murray et al(1971), and Verberg(1974).
8. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
9. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification".

Table 10 : Ecological (Biophysical) Limitations for Snowmobiling

Items Affecting Use[1]	Degree of Limitation: None-Slight	Moderate	Severe
Slope[2]	0 - 8% (0 - 4.6^{o}) may vary depending on snow conditions.	9 - 15% (5.1 - 8.5^{o}) with a maximum sustained gradient of 15% (8.5^{o}).	16%+ (9.1^{o}+) For short pitches gradient of climb ranges from 20 to 25% (11.3 - 14.0^{o}).
Aspect[3]	N, NW, NE or level for snow accumulation and shade "effect". In more northerly latitudes and/or at higher elevations warmer south facing aspects may be preferred. Varied aspect provides for a more enjoyable experience.	W, E, or SE.	SW or S due to prolonged exposure to the direct rays of the sun, resulting in snowmelt and/or ground exposure.
Unique Site Features[2]	Flat, stable surficial deposits. Level to rolling topography. No natural and/or man-caused obstacles. Absence of flora and fauna susceptible to snowmobile damage and/or disturbance.		Alpine meadows, avalanche hazard areas, cliffs and other steep terrain, thermal pools, road crossings, areas of wildlife concentration, (including subnivean flora and fauna), lake and stream crossings, wetland areas; forest plantations, fences guy wires, and all other natural and/or man-caused hazardous areas.
Vegetation Sensitivity[2]	Grasses and other species resistent to compaction and resultant reduced growing season and deep freezing effects; species with deep root systems that aid in their survival; species with fast rates of succession and high resilency to adverse useage.		Shrubs, saplings, and other vegetation adjacent to trails and subject to mechanical damage; reduced growing season and deep freezing effects due to snow compaction are especially critical in high alpine areas; species with low rates of succession, shallow root systems and fragile vegetative structures may be totally eliminated.
Density[4]	Low density to open areas that allow for ease of movement over and/or through vegetation cover, eg. lodgepole pine and aspen cover (mature).		Dense under- and/or overstory vegetation types that makes access virtually impossible, eg. alder, willow, and salmonberry bushes adjacent to streams.
Height[5]	Cleared of vegetation overhang to a height of greater than 10 ft (3 m).	Cleared of vegetation to 8 - 10 ft (2.4 - 3 m) overhang.	Less than 8 ft (2.4 m) clearance between vegetation overhang and top of snow.
Height[6] (Tree)	Over 20 ft (6.1 m); will vary depending on species, density, snowpack depth, and other site factors.		Less than 10 ft (3 m) (rough estimate)

Table 10 : Ecological (Biophysical) Limitations for Snowmobiling. (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[7.]			
1. Coastal Western Hemlock Zone (CWH)	Tsugetum heterophallae Populo-Loniceretum involucratae Piceo-Symphoricaroetum albus	Pseudotsugo-Gaultheretum shallon Thuja-Ploystichetum munitum Tsugo -struthiopteretum spicant	Tsugo-Gaultheretum shallon Tsugo-Abietetum amabilis Lysichito-Vaccinietum alaskaense Copto-Lysichetum kamtschatcense Thujo-Oplopanicetum horridus Piceo-Oplopanicetum horridus Pseudotsugo-Cladonietum pacificae
2. Mountain Hemlock Zone (MH)	Abieto-Tsugetum mertensianae		Vaccinio-Tsugetum mertensianae Leptarrheno-Calthetum leptosepalae Phullodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Saxifragetum tolmiei Caricetum nigricantis Cladothamno-Tsugetum mertensianae Streptopo-Abietetum amabilis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoro-Sphagnetum
3. Alpine Zone (AT)		Anaphaleto-Lupinetum arctici Mimuleto-Epilobietum latifolii	Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Caricetum spectabilis Luetkeetum pectinatae Valerianetum sitchensis Junipereto-Penstemonetum menziesii Silenetum acaulis Phyllodoco-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis Bog Peat - Sphagnum Association

Table 10 : Ecological(Biophysical) Limitations for Snowmobiling. (continued)

Items Affecting Use[1]	Degree of Limitation		
	None-Slight	Moderate	Severe
Climate[8]	Land-Active Winter Sport		
Temperature	Class 2h, k, 2k or 3k	Class 3h	Class 4h or 4k
Precipitation[9]	Class 4 or 5	Class 3	Class 1 or 2
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	" 1	" 2 or 3	" 4 or 5
Snow Depth[10]	Greater than 4 ft (1.2 m)	2 - 4 ft (.6 - 1.2 m)	Less than 2 ft (.6 m)
Temperature[11]	-2 to -16 ^{o}C	-17 to -30 ^{o}C	Less than -30 ^{o}C or greater than -2 ^{o}C.

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
2. Source: Alberta Rec. & Parks(1979), Alberta Rec., Parks, and Wildlife(1976), Fogg(1975), Jubenville(1976), Markel(1980), and Murray et al(1971).
3. Source: Alberta Rec. & Parks(1979), Fogg(1975), and Masyk(1973).
4. Source: Jubenville(1976) and Murray et al(1971).
5. Source: Fogg(1975).
6. Murray et al(1971).
7. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
8. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification"
9. Snowmobiling requires ample amounts of precipitation in the form of snow. An N value of 55. was assumed for the Coast Range of B.C. based on a review of data from existing A.E.S. weather stations.
10. Source: Alberta Rec. & Parks(1979) and Markel(1980).
11. Source: Alberta Rec. & Parks(1979).

Table 11 : Ecological (Biophysical) Limitations for Snowshoeing

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[2.]	*Refer to Table of Ecological (Biophysical) Limitations for Downhill Skiing.		
Surface Soil Texture[2.]	* " " " " "	" " " " " .	
Permeability[2.]	* " " " " "	" " " " " .	
Slope[2.]	0 - 10% (0 - 5.7°)	11 - 15% (6.3 - 8.5°)	16%+(9.1°+) Short pitches of 20 - 25% (11.3 - 14.0°) are acceptible.
Aspect[2.]	A variety of slope orientations is preferred; N facing slopes in areas with low snowfall; S facing slopes in areas where warmth of snowshoer is important, eg. northern latitudes and/or higher elevations.		
Erosion Hazard[3]*	Low. * Based on parent material and slope classes.	Moderate.	High.
Flooding[2.] (of facilities)	No to rare occurence; being of nil to slight flood hazard. No flooding during the year.	No to rare occurence; being of slight to moderate flood hazard, with flooding occurring infreq- ently (1 or 2 times) during the year.	Occasional to frequent occurence; being of moderate to severe flood hazard with floodingoccurring more than 2 to 4 times during the year.
Vegetation[2.]			
Density	Low vegetation density; open areas with adequate shelter from winds and direct rays of the sun.		Continuous medium to high density areas, which may effectively inhibit movement of the snowshoer; possibly, cutting out much of the needed warming effects of the sun.
Height	Vegetation height over 20 ft (6.1 m) overstory; low underbrush absent with vegetation overhang high enough, i.e., 8 - 10 ft (2.4 - 3.0 m) above normal snow levels, to allow for ease of movement.		Abundance of low underbrush and/or short overstory vegetation so as to seriously impede movement, eg. willow, forest plantations and salal.

Table 11 : Ecological (Biophysical) Limitations for Snowshoeing. (continued)

Items Affecting Use[1]	Degree of Limitation		
	None-Slight	Moderate	Severe
Plant Association by Zone[4]			
1. Coastal Western Hemlock Zone (CWH)			
2. Mountain Hemlock Zone (MH)	** Approximated by Ratings of Plant Associations for Trails (general - summer/transition/winter). Vegetation factors, such as species height, density and vigor, and the "masking" of obstacles, such as woody debris, rocks, shrubs and seepage sites, with snow may result in rating certain associations more favourably than others, in terms of suitability for snowshoeing; generally, however, the ratings given should adequately reflect the degree of limitation posed by each of the associations on this specific activity.		
3. Alpine Zone (AT)			
Climate[5]	Land-Active Winter Activity		
Temperature	Class 2h, k, 2k, or 3k	Class 3h	Class 4h or 4k
Precipitation[6]	Class 4 or 5	Class 3	Class 1 or 2
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	Class 1	Class 2 or 3	Class 4 or 5
Snow Depth[7]	Greater than 4 ft (1.2 m)	2 - 4 ft (.6 - 1.2 m)	Less than 2 ft (.6 m)
Temperature[7]	-2 to -21°C	-22 to -40°C	Greater than -2°C or Less than -40°C

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
2. Source: *refer to Table of Ecological (Biophysical) Limitations for Camp Areas (Intensive Use), footnote 2.
3. Source: Vold(1977).
4. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
5. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification".
6. As with snowmobiling, snowshoeing requires ample amounts of precipitation in the form of snow. An N value of 55. was assumed for the Coast Range of B.C. based on a review of the climatological data from existing A.E.S. weather stations.
7. Source: Alberta Rec. and Parks(1979).

Table 12 : Ecological (Biophysical) Limitations for Tobogganning

Items Affecting Use[1]	Degree of Limitation		
	None-Slight	Moderate	Severe
Soil Moisture & Drainage[2]	*Refer to Table of Ecological(Biophysical) Limitations for Downhill Skiing.		
Surface Soil Texture[2]	* " " " " "	" " " " " .	
Permeability[2]	* " " " " "	" " " " " .	
Slope[2]	10 - 40% (5.7 - 21.8°) Tot/Beginner/Intermediate	41 - 50% (22.3 - 26.6°) Expert	51%+ (27.0°+) or 0 - 9% (0 - 5.1°)
Aspect[2]	NW, N, NE or SE aspects. At more northerly latitudes and/or at higher elevations where cooling may pose a problem, south facing slopes are preferred.	S, W, or E aspects. W aspects have cooler mornings, while E aspects have cooler evenings. S aspects are acceptable given adequate sunlight and depending on slope of hill.	SW aspect. Susceptible to prolonged exposure to sun during crucial part of the day; with decreasing slope, the severity of the limitation posed by the SW orientation becomes less, with the rating becoming more favourable.
Erosion Hazard[3]*	Low. * Based on parent material and slope classes.	Moderate.	High.
Flooding[2] (of facilities)	No to rare occurence; being of nil to slight flood hazard. No Flooding during the year.	No to rare occurence; being of slight to moderate flood hazard with flooding occurring infrequently (1 or 2 times) during the year.	Occasional to frequent occurence; being of moderate to severe flood hazard with flooding occurring more than 2 to 4 times during the year.
Vegetation[2] Type	Open grassland type with few low lying shrubs and a border of coniferous tree for shade and protection from winds and direct rays of the sun, yet allowing for snow accumulation.	→	Closed forest type and/or an area of dense undergrowth, with both types seriously hindering an areas usefulness for toboganning. Avoid areas with natural and/or man-caused hazards, eg. cliffs, avalanche areas, roadways or logging operations.

Table 12 : Ecological (Biophysical) Limitations for Tobogganing. (continued)

Items Affecting Use[1.]	Degree of Limitation None-Slight	Moderate	Severe
Plant Association by Zone[4.]			
1. Coastal Western Hemlock Zone (CWH)	Tsugetum heterophallae	Pseudotsugo-Gaulteretum shallon Thujo-Polystichetum munitum Tsugo-Gaultheretum shallon Tsugo-Abietuetum amabilis Tsugo-Struthiopteretum spicant	Lysichito-Vaccinietum alaskaense Copto-Lysichetum kamtschatcense Thujo-Oplopanicetum horridus Poplo-Loniceratum involucratae Piceo-Oplopanicetum horridus Piceo-Symphoricaroetum albus Pseudotsugo-Cladonietum pacificae
2. Mountain Hemlock Zone (MH)	Abieo-Tsugetum mertensianae	Vaccinio-Tsugetum mertensianae	Leptarrheno-Calthetum leptosepalae Phyllodoco-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinetum deliciosi Saxifragetum tolmiei Caricetum nigricantis Cladothamno-Tsugetum mertensianae Streptopo-Abietetum amabilis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparetum nootkatensis Eriophoro-Sphagnetum
3. Alpine Zone (AT)		Mimuleto-Epilobietum latifolii	Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Caricetum spectabilis Luetkeetum pectinatae Anaphaleto-Lupinetum arctici Valerianetum sitchensis Junipereto-Penstemonetum menziesii Silenetum acaulis Phyllodoco-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis Bog Peat - Sphagnum Association

Table 12 : Ecological(Biophysical) Limitations for Tobogganning. (continued)

Items Affecting Use[1.]	Degree of Limitation		
	None-Slight	Moderate	Severe
Climate[5.]	Land-Active Winter Activity		
Temperature	Class 3h, 2h, k and 2k	Class 3k	Class 4h or 4k
Precipitation	Class4 or 5	Class 3	Class 1 or 2
Wind	Class 1	Class 2 or 3	Class 4 or 5
Sunshine	Class 1	Class 2 or 3	Class 4 or 5
Snow Depth[6.]	Greater than 2 ft (.6 m)	1 - 2 ft (.3 - .6 m)	Less than 1 ft (.3 m)
Temperature[7.]	0 to -12 ^{o}C	-13 to -24 ^{o}C	Less than -25 ^{o}C or greater than 0 ^{o}C

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
2. Source: *refer to Table of Ecological (Biophysical) Limitations for Camp Areas (Intensive Use), footnote 2.
3. Source: Vold(1977).
4. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
5. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification".
6. Snow depth refers to loose (non-compacted) snowfall. Source: Alberta Rec. and Parks(1979) and Fogg(1975).
7. Source: Alberta Rec. and Parks(1979).

Table 13 : Ecological(Biophysical) Limitations for Trails (Summer Use)

Items Affecting Use[1]	Degree of Limitation: None-Slight	Moderate	Severe
Soil Moisture & Drainage[2]	Well to moderately well drained soils. Very dry (very xeric) to mesic moisture regime.	Well to moderately well drained soils subject to seepage or ponding and somewhat imperfectly drained soils. Mesic to hygric moisture regime.	Poorly to very poorly drained soils subject to ponding. Hygric to hydric moisture regime.
Surface Soil Texture[2]	Moderately coarse to medium textured soils; sandy loams to loams. (sl, fsl, vfsl, and l). Gravelly and non-gravelly soils.	Medium to fine textured soils; silt loams to sand clays; loamy sands. (sil, sicl, scl, cl, sc, and ls).	Fine textured soils: clays; loose sands and soils subject to blowing. (sic, c, and s). All soils that are very gravelly composed of very thin and flat coarse rock fragments and/or very cobbly. Organic silts, silt-clays and clays; peat and other highly organic soils.
Permeability[2]	High to moderate (5.cm/hr to .5 - 5.cm/hr).	Moderate (.5 - 5.cm/hr).	Poor (0 - .5cm/hr).
Slope[2]	0 - 30.% (0 - 16.7°) level to steeply sloping.	30. - 70.% (16.7 - 35.0°) steep to very steeply sloping.	71.%+ (35.4°+) extremely sloping causing movement to be slow and extremely hazardous.
Aspect[2]	S, SW, SE, E, W, and level. Variety of slope orientations is desired.	N, NW, and NE aspects can result in cooler, less favourable conditions especially in winter.	No aspect poses severe limitations for paths and trails (summer use).
Erosion Hazard[3]	Low (stable)	Moderate (metastable)	High (unstable)
Frost Action[3]	Low (rated as moderate in alpine zone or subalpine krummholz zone)	Moderate (rated as high in alpine zone or subalpine krummholz zone or when imperfectly to poorly drained)	High
Flooding[2]	No to rare occurence during season of use; being of nil to slight flood hazard.	Regular light flooding may be expected during season of use; being of moderate flood hazard.	Irregular, moderate to heavy frequent flooding during season of use; being of severe flood hazard.
Unique Site Features[4]	Trail should allow for variety of experiences: panoramic views, benches, ridges and valleys, open spaces, forested areas, high points away from development, exposure to unique communities, and run along water bodies.	→	It is important that the ecological integrity of the area is maintained by avoiding unstable, hazardous areas such as creek bottoms subject to sudden and damaging floods, steep slopes, rock bluffs, and hazardous resource use or extraction areas, and ecologically sensitive areas such as meadows, rare or unique flora & fauna, and shorelines around high mountain lakes, swamps and boggy land, and ecological reserves. Selected areas must be able to withstand anticipated use levels.

Table 13: Ecological (Biophysical) Limitations for Trails (Summer Use). (continued)

Items Affecting Use[1.]	Degree of Limitation: None-Slight	Moderate	Severe
Vegetation[2.]			
Sensitivity	Low sensitivity vegetation type with fast rate of succession.	Medium sensitivity vegetation type with moderate rate of succession.	High sensitivity vegetation type with slow rate of succession.
Density	Low to medium density not posing problems to movement, eg. moss, and small scattered shrub undergrowth in old growth sitka spruce forest.	Medium density, eg. coniferous forest with vaccinium understory.	Medium to high density; significantly impeding movement, eg. salmonberry bushes along stream bank.
Height	Low underbrush absent or such that movement is not impeded.	Low underbrush and shrub vegetation impedes movement.	Vegetation drastically hinders movement and significantly reduces the amount of direct sunlight.
Plant Association by Zone[5.]			
1. Coastal Western Hemlock Zone (CWH)	Pseudotsugo-Gaultheretum shallon Tsugetum-heterophallae Populo-Loniceretum involucratae Piceo-Oplopanicetum horridus Pseudotsugo-Clasonietum pacificae	Tsugo-Gaultheretum shallon Tsugo-Abietetum amabilis	Thuja-Polystichetum munitum Tsugo-Struthiopteretum spicant Lysichito-Vaccinietum alaskaense Copto-Lysichetum Kamtschatcense
2. Mountain Hemlock Zone (MH)	Vaccinio-Tsugetum mertensianae Cladothamno-Tsugetum mertensianae Abieto-Tsugetum mertensianae	Phyllodocao-Cassiopetum mertensianae Nano-Tsugetum mertensianae Vaccinietum deliciosi Saxifragetum tolmiei Streptopo-Abietetum amabilis	Leptarrheno-Calthetum leptosepalae Caricetum nigricantis Oplopanaco-Thujetum plicatae Lysichito-Chamaecyparietum nootkatensis Eriophoro-Sphagnetum
3. Alpine Zone (AT)	Anaphaleto-Lupinetum arctici Bog Peat - Sphagnum Association	Caricetum spectabilis Luetkeetum pectinatae Valerianetum sitchensis Junipereto-Penstemonetum menziesii Silenetum acaulis Phyllodoceto-Cassiopetum mertensianae Abieto-Chamaecyparetum nootkatensis	Gymnomitrieto-Polytrichetum norvegici Caricetum nigricantis Sibbaldietum procumbentis Mimuleto-Epilobietum latifolii

Table 13 : Ecological (Biophysical) Limitations for Trails (Summer Use). (continued)

Items Affecting Use[1]	Degree of Limitation: None-Slight	Moderate	Severe
Climate[6]	Land Active Summer Activity		
Temperature	Class 2k, 1 or 2h	Class 3k or 3h	Class 4k or 4h
Precipitation	Class 1	Class 2 or 3	Class 4 or 5
Wind	"	" 2 or 3	" 4 or 5
Sunshine	"	" 2 or 3	" 4 or 5
Temperature (^{o}C)[7]	11 - 20^{o}C (Ave. preferred 18 - 20^{o}C)	0 - 10^{o}C or 21 - 27^{o}C	less than 0^{o}C or greater than 28^{o}C (extremes)

1. The categories used to describe the "Items Affecting Use" were translated into equivalent bases using the terminology and classification schemes set out in the Canada Soil Information System (Agric. Can.,1978).
2. Source: *refer to Table of Ecological(Biophysical) Limitations for Camp Areas (Intensive Use), footnote 2.
3. Source: Vold(1977)
4. Source: Alberta Rec. and Parks(1979), Denney(1972), Fogg(1975), Jubenville(1976), Murray et al(1971), and Verberg(1974).
5. Refer to Appendix II for detailed descriptions of each of the Biogeoclimatic Zones and their plant associations as well as generalized suitability ratings of plant associations for the selected recreational activities.
6. Source: Bennett(1977). Refer to Appendix III for "Summary of Criteria for the Climatic Suitability for Recreation Classification
7. Source: Alberta Rec. and Parks(1979)

3.9 Ecological Approach to Recreation Suitability Analysis

Having previously identified the criteria often used to inventory, classify and assess distinct ecological landform units and the site limitations of the selected recreational activities, this section presents an approach which facilitates assessment of an area's suitability for the selected recreational activities. The approach can be used to identify parcels of land that are homogeneous, i.e., distinct landform units, as well as rate these parcels as to their intrinsic suitability for each of the nine selected recreational activities.

The approach selected is based on the "rules of combination" approach to land suitability analysis and the generation of land suitability maps as discussed by Hopkins (1977). The reasons for selecting this approach are that,

- it can handle the interdependency which exists among factors, i.e., ecological parameters used to establish recreational suitability,
- it provides for explicit identification of regions (distinct landform units),
- and, it also provides for explicit determination of ratings, i.e., establishment of suitability ratings for each landform unit on the basis of site requirements of the recreational activities, as described in the context of a set of significant ecological criteria.

The rules of combination approach assigns suitabilities to sets of combinations of types, i.e., ecological criteria, rather than to single combinations. Rules are expressed in terms of verbal logic rather than in terms of numbers and arithmetic, as is the case for other approaches to land suitability analysis (Hopkins, 1977).

The first step in the analysis is to establish a set of relevant ecological parameters for each of the selected recreational activities. These parameters serve to describe the natural environment and facilitate the determination of the suitability of specific areas for one or more of the selected recreational activities.

In order to provide a stable, readily identifiable base upon which to inventory, classify and assess the parameters, the area under study is broken down into distinct landform units using the Terrain Classification System approach to landform analysis (Min. of the Envir., 1978). This constitutes the second step of the analysis. Ground checks and the use of airphoto interpretation will improve the accuracy and speed with which this procedure is undertaken. The product of this procedure is a base map showing the spatial patterns and distributions of the distinct landform units.

The third step in the analysis, is the derivation of resource factor maps using the environmental parameters relevant to the recreational activities under consideration. Factor maps should be at a common scale and format. The scale, format and detail of the derived maps will be dependent on the objectives of the study, the availability of existing information and other factors which will influence the intensity, scope and detail of the land suitability analysis procedures. Factor maps should be on stable transparent material, e.g. mylar, permitting ease of viewing and the establishment of the suitability of delineated landform units for one or more recreational activities. Figures 14 to 16 are schematic illustrations of slope, aspect and soil moisture regime factor maps.

The fourth step entails overlaying each factor map, one at a time, onto the base map, then summarizing, in tabular and map formats, the inherent ecological characteristics of each landform unit previously identified on the base map. Figure 17 illustrates this procedure.

Once all landform units have been assessed as to their inherent ecological limitations, they are rated for their suitability to sustain the selected recreational activities. In Section 3.8 the tables listing the ecological limitations for each of the nine selected recreational activities are used to establish the overall suitability of a landform unit for each activity. Environmental parameters which pose severe limitations (poor suitability) for one or more specific recreational activities, generally override the ratings given to all other parameters of the same landform unit. For landform units where the limitations posed by a specific environmental parameter is borderline between two degrees of limita-

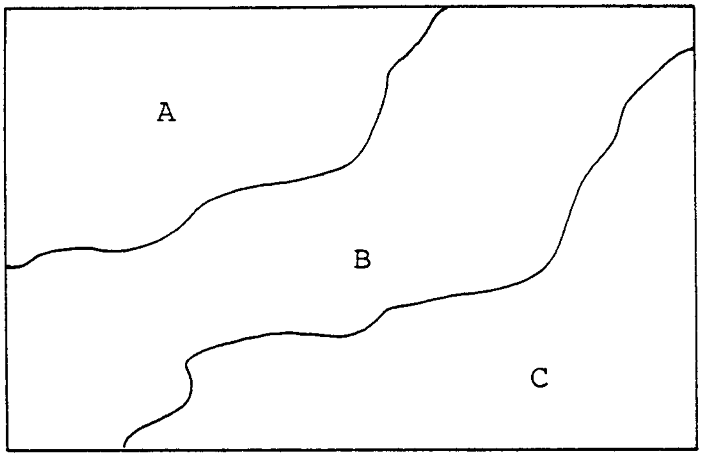


Fig.14. Slope Factor Map

Zone A : 0 to 20% slope
Zone B : 21 to 40% slope
Zone C : 41%+ slope

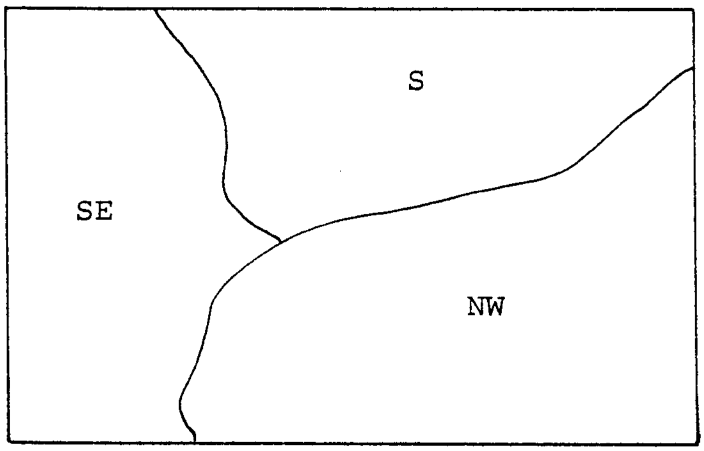


Fig.15. Aspect Factor Map

Zone NW : Northwest orientation
Zone SE : Southeast orientation
Zone S : South orientation

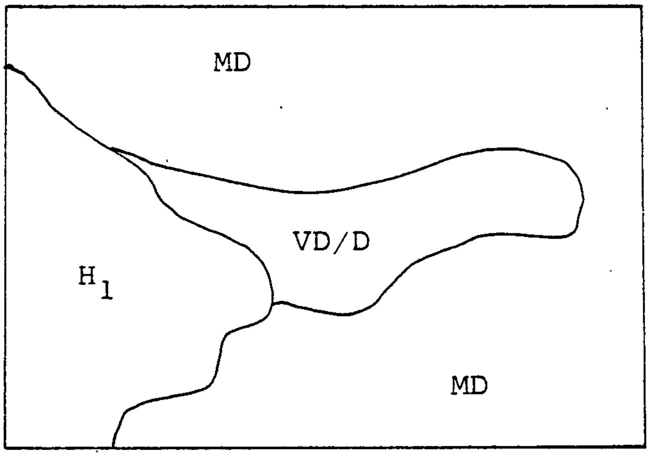
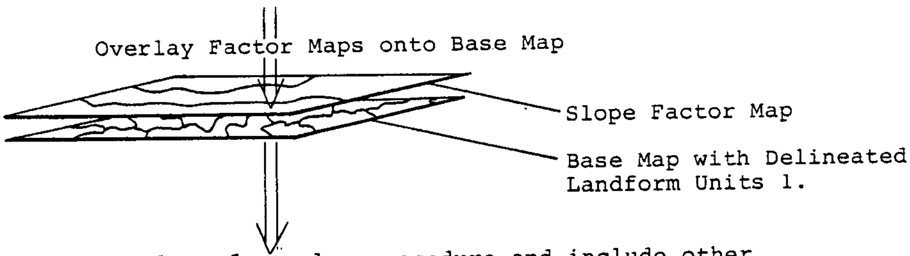


Fig.16. Soil Moisture Regime Factor Map

Zone MD : Moderately dry
Zone VD/D : Very dry to dry
Zone H_1 : Hygric



Summarize results of overlay procedure and include other descriptive categories. Repeat this procedure for each landform unit, for each factor map. Tabulate overlay results as follows :

Landform Unit Descrip.	Parent Material Group 1.	Area (ha) 2.	Area (% of total) 3.	Range of Elevation (m)	Soil Moisture Regime 4.

table continued ......

Aspect (major)	Flood Hazard 5.	Erosion Hazard 6.	Biogeoclimatic Zone (Subzone incl.) 7.	Slope Range (%)

1. Derived using the Terrain Classification System approach developed by the Ministry of the Environment (1978).
2. Areas (ha) can be estimated using the "dot grid" approach or with a planimeter.
3. Percent of total area is equal to (area of landform unit ÷ total area of study area) × 100.
4. Abbreviations to be used for Soil Moisture Regimes include, VD/D - very dry to dry, MD - moderately dry, M - mesic, H1 - hygric and H2 - hydric. Bracketed classes represent minor components of the landform units' soil moisture regimes.
5. Abbreviations to be used for Flood Hazard ratings include, NS - none to slight, M - moderate and S - severe.
6. Abbreviations to be used for Erosion Hazard ratings include, L - low, M - moderate and H - high. Ratings are derived on the basis of parent materials and slope classes, predominately.
7. Abbreviations to be used for Biogeoclimatic Zone (Subzones), as defined by Krajina (1969), include, CWH(W) - Coastal Western Hemlock (Wet Subzone), MH(F) - Mountain Hemlock Zone (Forest Subzone), MH(P) - Mountain Hemlock Zone (Parkland Subzone) and AT - Alpine Zone. Use of compound classes implies that two or more zones represent significant portions of the landform unit being described.

Fig.17. Generation of Ecological Data for Landform Units

tion (none-slight to moderate or moderate to severe) a review of the limitations posed by all environmental parameters will be necessary prior to establishing a generalized composite suitability rating of each landform unit, for each recreational use. The environmental parameters used to establish the suitability of landform units for the selected recreational activities, are not equally influential in establishing a landform unit's suitability. When considered in aggregate, they (the parameters) provide an indication of the overall suitability of landform units for specific recreational activities. Using this approach to land suitability analysis a summary table is formulated to show the generalized suitability ratings of landform units and their associated limiting factors. A second outcome of this approach is a set of maps, one for each recreational activity, showing which level of suitability characterizes each landform unit or grouping of landform units. No attempt is made to account for the intercompatibility of the various recreational uses. The suitability of each landform unit, for each recreational activity, is derived from assessments of the capability of the environmental features of the landform unit to sustain a particular use, as well as on the requirements and characteristics of each recreational use.

3.10 Survey and Mapping Methodology

For the purpose of this study, the ecological information, required to establish the suitability ratings of the park for each of the nine selected recreational activities, was inventoried, classified and interpreted on the basis of the integrated approach to ecological land classification (ELC) as discussed in Section 2.4.

The Terrain Classification System approach to landform classification and analysis (Min. of the Envir., 1978) was used to subdivide the park into discrete terrain units, i.e., landform units, thereby providing a base upon which relevant ecological parameters could be interpreted and from whence could be derived generalized suitability ratings of each unit for each of the nine selected activities (Figure 5). The characteristics of the Biogeoclimatic Zones found within the park (Appendix II) provided clues as to the suitability of each of the three zones for the set of activities. Through the combined use of airphoto interpretation, ground reconnaissance data and relevant reports and publications, the aforementioned ecological parameters were identified, mapped and tabulated for the entire study area (refer to Figures 7, 8, 11, 12 and 13).

Once the park had been classified and mapped using the selected ecological parameters, the delineated landform units were assessed, in terms of each of the selected parameters, using a map overlay approach, with the findings of this assessment being summarized in a tabular format. The final step in this approach to recreational site suitability analysis entailed assessing each landform unit as to its suitability, i.e., poor, moderate or good suitability rating based on the degree of limitation, for each of the nine recreational activities using the activity-specific ecological limitations discussed in Section 3.8. The results of the generalized suitability analysis, in the form of both tables and maps, could then be used, at some time in the future, to aid in the establishment of land use and general site development plans for the park.

4.0 LANDFORM UNIT DESCRIPTIONS AND SUITABILITY RATINGS FOR SELECTED RECREATIONAL ACTIVITIES

Twenty-three different landform units were delineated within Clague Mountain Park. The general categories identified were comprised of landform units originating from colluvial, fluvial (alluvial), morainal, organic, and bedrock parent materials. Table 14 summarizes the ecological characteristics of each landform unit and includes information pertaining to the area (hectarage) and range of elevations over which each landform unit extends. Table 15 provides a summary of the generalized suitability ratings for each landform unit for the set of selected recreational activities. Figures 18 to 26 illustrate the generalized suitability ratings that are indicated in Table 15. In the construction of the aforementioned

Table 14 : Ecological (Biophysical) Characteristics of Landform Units.

Landform Unit 1. Description	Parent Material Group	Area 2. Hec. (Ac.)	Area 3. (% of Total)	Range of Elev. (Meters)	Soil Moisture Regime 4.	Slope Range (%)	Aspect (Major)	Flood Hazard 5.	Erosion Hazard 6.	Biogeoclimatic Zonation 7.
$C^{A}a$ - A	Colluvial	29.1(71.8)	1.5	884-1067	VD/D - M/D	41 - 80%	N,NE,E	NS	H	MH(F&P)-AT
$C^{I}b$	"	31.9(78.8)	1.7	853-1067	VD/D - M/D	41 - 80	NE,E,SE	NS	H	MH(F&P)-AT
$C^{I}b$ - A	"	30.5(75.3)	1.6	823-1097	VD/D - M/D	41 - 80	N,NE,E	NS	H	MH(F&P)-AT
$C^{A}s$ - A	"	43.9(108.6)	2.3	762-1280	VD/D - M/D	70 - 101+	N,NE,E,SE	NS	H	AT-MH(P)
$F^{A}a$ - E	Fluvial	17.7(43.8)	.9	640-792	VD/D - M/D	31 - 35	N,NE,E,SE,	NS	M	MH(P)
$F^{I}b$ - V	"	43.9(108.6)	2.3	488-732	VD/D-M/D-M	31 - 40	N,NW,Level	NS	M	MH(F&P)
$F^{G}bs$ - V	"	22.7(56.1)	1.2	0-671	M/D	16 - 70	NE,E,SE,S, Level	NS	M	CWH(W)
$F^{G}f$	"	49.6(122.6)	2.6	396-518	M - H_2	11 - 40	N,NE,E,SE,S Level	Majority S, with NS or M	L	CWH(W)-MH(F)
$M^{I}b$ - V	Morainal	63.1(155.9)	3.3	671-945	M -(VD/D-M/D)	16 - 50	NW	NS	M	CWH(W)-MH(F)
$M^{I}bh$	"	17.7(43.8)	.9	366-823	M - (H_2)	16 - 60	N,NE,E, Level	Majority NS, with M or S	M	MH(F)
$M^{I}bs$ - V	"	438.8(1084.3)	22.8	396-1097	(VD/D-M/D)-M	26 - 80	All aspects	NS	H	MH(F&P) with minor CWH(W)
$M^{I}m$ - H	"	338.8(837.3)	11.7	366-762	(M)-H_1-H_2	0 - 30	N,W,E,Level	Majority NS, with M or S	M	CWH(W)-MH(F)
$\frac{M^{I}v}{R}$	"	34.7(85.8)	1.8	762-945	(VD/D-M/D)-M	11 - 80	NE,SE,E, Level	NS with Small Area S	H	MH(F&P)
$\frac{Ob/Ov - S}{Rm}$	Organic	83.6(206.7)	4.4	640-1037	VD/D-M/D-M	11 - 50	NW,N,NE,SE, E,Level	NS	H	MH(P)-AT
$\frac{Oh - S}{Rh}$	"	147.5(364.4)	7.7	579-960	(VD/D-M/D)- M-H_1-H_2	0 - 60	NW,N,E,SE, Level	NS with Small Areas of M or S	M	MH(F&P)
$O^{F}1$	"	22.7(56.1)	1.2	366-457	H_2	0 - 15	Level	S	M	CWH(W)

Table 14 : Ecological (Biophysical) Characteristics of Landform Units. (continued)

Landform Unit 1.	Parent Material Group	Area 2. Hec.(Ac.)	Area 3. (% of Total)	Range of Elev. (Meters)	Soil Moisture Regime 4.	Slope Range (%)	Aspect (Major)	Flood Hazard 5.	Erosion Hazard 6.	Biogeoclimatic Zonation 7.
$O^F1 - S$	Organic	15.6(38.5)	.8	823-684	H_2	6 - 10	N,NW,E,Level	S	M	MH(P)
O^S1	"	8.5(21.0)	.4	366-396	H_2	0 - 5	Level	S	M	CWH(W)
$O^Fm - S$	"	7.8(19.3)	.4	914-945	H_1-H_2	0 - 5	N,NE,E,Level	S	H	MH(P)
$\frac{O^Bv - N}{Rh}$	"	48.6(120.1)	2.5	884-1097	VD/D-M/D-(M)	31 - 40	E,SE	NS	H	MH(P)-AT
Rh - C(N)	Bedrock	198.5(490.5)	10.3	975-1346	VD/D-M/D	0 - 50	All aspects	NS	L	AT
Rr - C(N)	"	121.9(301.3)	6.3	823-1128	VD/D-M/D	0 - 40	NW,N,NE,E, Level	NS	L	MH(F)-AT
W	Water	28.6(70.7)	1.5	396-1128	N/A	N/A	Level	N/A	N/A	CWH(W)-MH(F&P)-AT
	Total =	1921.0(4747.0)	100%							

1. Derived using the Terrain Classification System developed by the Min. of Environment (1978).
2. Area (hectarage) was estimated using the "dot grid" approach.
3. Area of landform as % of total park area = (number hec. of landform unit/total area of park) × 100 .
4. Abbreviations used for Soil Moisture Regimes represent : VD/D -very dry to dry, M/D - moderately dry, M - mesic, H_1 - hygric & H_2 - hydric. Bracketed classes are minor components of the landform units' soil moisture regimes.
5. Abbreviations used for Flood Hazard rating represent: NS - none to slight, M - moderate and S - severe. Refer to Section 3.2.3.8 of thesis.
6. Abbreviations used for Erosion Hazard ratings represent: L - low, M - moderate, and H - high. Refer to Section 3.4.2 of thesis. Derived on the basis of parent materials and slope classes.
7. Abbreviations used for Biogeoclimatic Zone (subzones), as defined by Krajina(1969), represent: CWH(W) - Coastal Western Hemlock (Wet Subzone), MH(F) - Mountain Hemlock Zone (Forest Subzone), MH(P) - Mountian Hemlock Zone (Parkland Subzone) and AT - Alpine Zone. Use of compound classes implies that two or more zones represent significant portions of the landform units being described.

Table 15 : Generalized Suitability Ratings of Landform Units for Selected Recreational Activities[1.]

Land form Unit Label 2.	Landform Unit Description 3.	Campgrounds	Hiking Trails (Summer)	Downhill Skiing	Cross-Country Skiing	Snow-mobiling	Snow-shoeing	Tobogganing	Mountain Climbing: Mountaineering	Picnicking/ Day Use
C_1	$C^{\Lambda}a - A$	Severe: slope aspect erosion vegetation type	Moderate: soil moisture slope aspect Veg. type	Moderate -Severe: slope erosion veg.type	Severe: slope	Severe: slope veg. type	Moderate -Severe: slope veg.type	Severe: slope veg. type	Slight-Moderate: aspect veg. type	Severe: slope aspect erosion veg. type
C_2	$C^{I}b$	Severe: slope aspect erosion veg. type	Moderate: soil moist. slope aspect veg.type	Moderate -Severe: slope erosion veg.type	Severe: slope	Severe: slope veg.type	Moderate -Severe: slope veg.type	Severe: slope veg.type	Slight-Moderate: aspect veg.type	Severe: slope aspect erosion veg.type
C_3	$C^{I}b - A$	Severe: slope aspect erosion veg.type	Moderate: soil moist. slope aspect veg.type	Moderate -Severe: slope erosion veg.type	Severe: slope	Severe: slope veg.type	Moderate -Severe: slope veg.type	Severe: slope veg.type	Slight-Moderate: aspect veg.type	Severe: slope aspect erosion veg.type
C_4	$C^{\Lambda}s - A$	Severe: slope aspect erosion veg.type	Moderate -Severe: slope aspect veg.type	Severe: slope erosion	Severe: slope erosion	Severe: slope erosion veg.type	Severe: slope	Severe: slope veg.type	Severe: aspect erosion	Severe: slope aspect erosion veg.type
F_1	$F^{\Lambda}a - E$	Severe: slope aspect veg.type	Slight -Moderate: aspect erosion veg.type	Slight-Moderate erosion veg.type	Severe: slope	Severe: slope veg.type	Severe: slope	Moderate -Severe: veg.type	Severe: slope aspect veg.type	Severe: slope aspect
F_2	$F^{I}b - V$	Severe: slope aspect	Moderate -Severe: slope aspect erosion veg.type	Slight-Moderate erosion veg.type	Severe: slope veg.type	Severe: slope veg.type	Severe: slope	Severe: veg.type	Severe: slope aspect	Severe: slope aspect
F_3	$F^{G}bs - V$	Severe: slope	Moderate -Severe: slope erosion veg.type	Moderate -Severe: slope erosion veg.type	Severe: slope	Severe: slope	Severe: slope	Moderate -Severe: slope veg.type	Moderate-Severe: soil moist. aspect veg.type	Severe: slope
F_4	$F^{G}f$	Moderate -Severe: soil moist. slope flooding	Moderate -Severe: soil moist. flooding veg.type	Moderate -Severe: soil moisture flooding veg.type	Severe: slope flooding veg.type	Moderate slope veg.type	Moderate -Severe: slope	Moderate veg.type	Severe: soil moisture slope veg.type	Severe: soil moist. flooding
F_5	$F^{\Lambda}r - E$	Moderate -Severe: soil moist. flooding	Moderate -Severe: soil moist. flooding veg.type	Severe: flooding veg.type	Moderate: flooding veg.type	Slight-Moderate veg.type	Slight-Moderate veg.type	Severe: veg.type	Severe: soil moist. slope veg.type	Moderate -Severe: soil moist. flooding
M_1	$M^{I}b - V$	Severe: slope aspect	Moderate: aspect erosion veg.type	Slight-Moderate erosion veg.type	Severe: slope	Severe: slope	Moderate -Severe: slope veg.type	Moderate -Severe: slope veg.type	Severe: slope aspect veg.type	Severe: slope aspect
M_2	$M^{I}bh$	Moderate -Severe: soil moist. slope aspect veg.type	Moderate: soil moist. slope	Moderate -Severe: soil moist. slope	Severe: slope	Severe: slope veg.type	Moderate -Severe: slope veg.type	Severe: veg.type	Severe: soil moist. slope veg.type	Severe: soil moist. slope aspect veg.type

Table 15: Generalized Suitability Ratings of Landform Units for Selected Recreational Activities[1] (continued)

Landform Unit Label	Landform Unit Description	Campgrounds	Hiking Trails (Summer)	Downhill Skiing	Cross-Country Skiing	Snow-Mobiling	Snow-Shoeing	Tobogganing	Mountain Climbing Mountaineering	Picnicking/ Day Use
M_1	M^{T}bs - V	Severe: slope erosion	Moderate -Severe: slope erosion	Moderate -Severe: slope erosion	Severe: slope erosion veg.type	Severe: slope veg.type	Severe: slope veg.type	Severe: slope veg.type	Severe: Veg.type	Severe: slope erosion veg.type
M_4	M^{T}m - H	Severe: soil moist. veg. type	Severe: soil moist.	Severe: soil moist. veg.type	Slight -Moderate: veg.type	Moderate veg.type	Slight- Moderate veg.type	Moderate -Severe: veg. type	Severe: soil moist. slope veg.type	Moderate -Severe: soil moist. veg.type
M_5	$\frac{M^{T}v}{R}$	Moderate -Severe: slope erosion veg.type	Moderate -Severe: slope erosion	Moderate -Severe: slope erosion veg.type	Severe: slope	Severe: slope veg.type	Severe: slope	Severe: slope veg.type	Moderate -Severe: slope veg.type	Severe: slope erosion veg.type
O_1	$\frac{Ob/Ov - S}{Rm}$	Severe: slope erosion veg.type	Moderate -Severe: slope erosion veg.type	Moderate -Severe: erosion veg.type	Moderate -Severe: slope veg.type	Severe: veg.type	Moderate slope veg.type	Severe: veg.type	Moderate: slope veg.type	Severe: slope erosion veg.type
O_2	$\frac{Oh - S}{Rh}$	Moderate -Severe: soil moist. veg.type	Moderate -Severe: soil moist. veg.type	Moderate -Severe: soil moist. veg.type	Moderate slope	Moderate -Severe: slope veg.type	Moderate slope :	Moderate -Severe: slope veg.type	Severe: soil moist. slope veg.type	Moderate -Severe: soil moist. erosion veg.type
O_3	O^{F}1	Severe: soil moist. flooding veg.type	Severe: soil moist. flooding	Severe: soil moist. flooding	Slight -Moderate: veg.type	Moderate veg.type	Slight: veg.type	Severe: slope	Severe: soil moist. slope veg.type	Severe: soil moist. flooding
O_4	O^{F}1 - S	Severe: soil moist. flooding veg.type	Severe: soil moist. flooding veg.type	Severe: soil moist. flooding veg.type	Slight -Moderate: veg.type	Severe: veg.type	Slight: veg.type	Severe: slope veg.type	Severe: soil moist. slope	Severe: soil moist. flooding veg.type
O_5	O^{S}1	Severe: soil moist. flooding veg.type	Severe: soil moist. flooding veg.type	Severe: soil moist. flooding	Moderate: veg.type	Moderate veg.type	Slight- Moderate veg.type	Severe: slope veg.type	Severe: soil moist. slope veg.type	Severe: soil moist. flooding veg.type
O_6	O^{F}m - S	Severe: soil moist. flooding erosion	Moderate -Severe: soil moist. flooding erosion	Severe: soil moist. flooding erosion	Slight -Moderate: veg.type	Severe: veg.type	Slight: veg.type	Severe: slope veg.type	Severe: soil moist. slope	Severe: soil moist. aspect flooding erosion
O_7	$\frac{O^{R}v - N}{Rh}$	Severe: slope erosion veg.type	Moderate -Severe: erosion veg.type	Moderate erosion	Severe: slope	Severe: slope veg.type	Severe: slope	Severe: veg.type	Severe: slope veg.type	Severe: slope erosion
R_1	Rh - C(N)	Severe: slope veg.type	Moderate: veg.type	Moderate -Severe: veg.type	Moderate: slope veg.type	Severe: veg.type	Slight- Moderate slope veg.type	Moderate -Severe: slope veg.type	Moderate: slope	Severe: veg.type
R_2	Rr - C(N)	Severe: slope veg.type	Moderate: aspect veg.type	Moderate veg.type	Slight -Moderate: slope veg.type	Severe: veg.type	Slight- Moderate slope veg.type	Moderate -Severe: veg.type	Severe: slope aspect veg.type	Severe: veg.type

1. Refer to Section 3.3 - "Site Requirements for Selected Recreation Activities", for definitions of suitability ratings, as well as a discussion pertaining to the ecological (biophysical) locational criteria specific to each of the nine selected recreational activities. The indicated suitability ratings were derived on the basis of soil moisture regime and drainage, slope, aspect, flood hazard, erosion hazard and vegetation type (via Biogeoclimatic Zones), with the most limiting factors being indicated below each of the generalized suitability ratings.
2. Abbreviations for Land Systems represent: C - colluvial, F - fluvial (alluvial), M - morainal, O - organic and R - bedrock. *Refer to Min. of the Envir. (1978).
3. Terrain Units were identified, classified and mapped using the Terrain Classification System approach to land classification as developed by the Min. of the Envir. (1978).

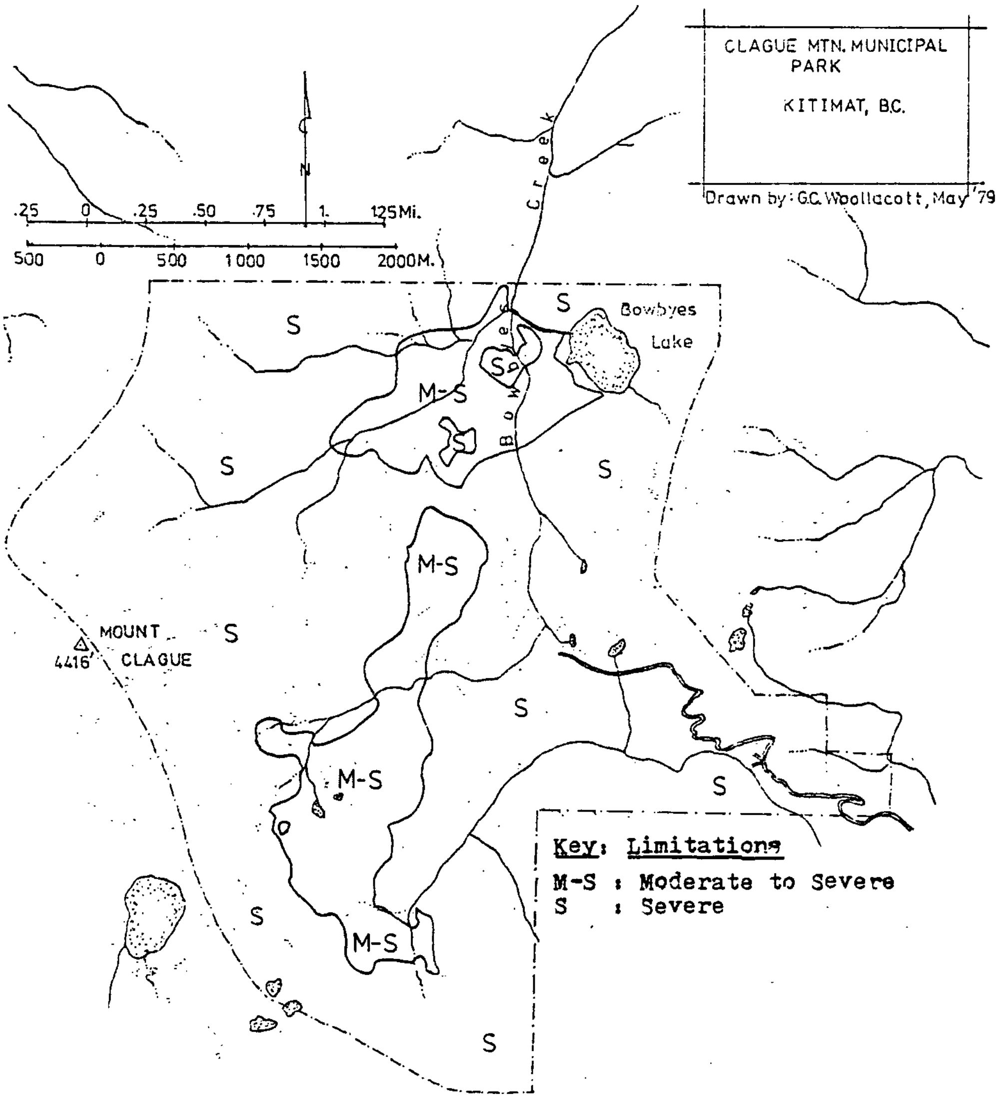


Fig.18. Generalized Suitability Map for Campgrounds

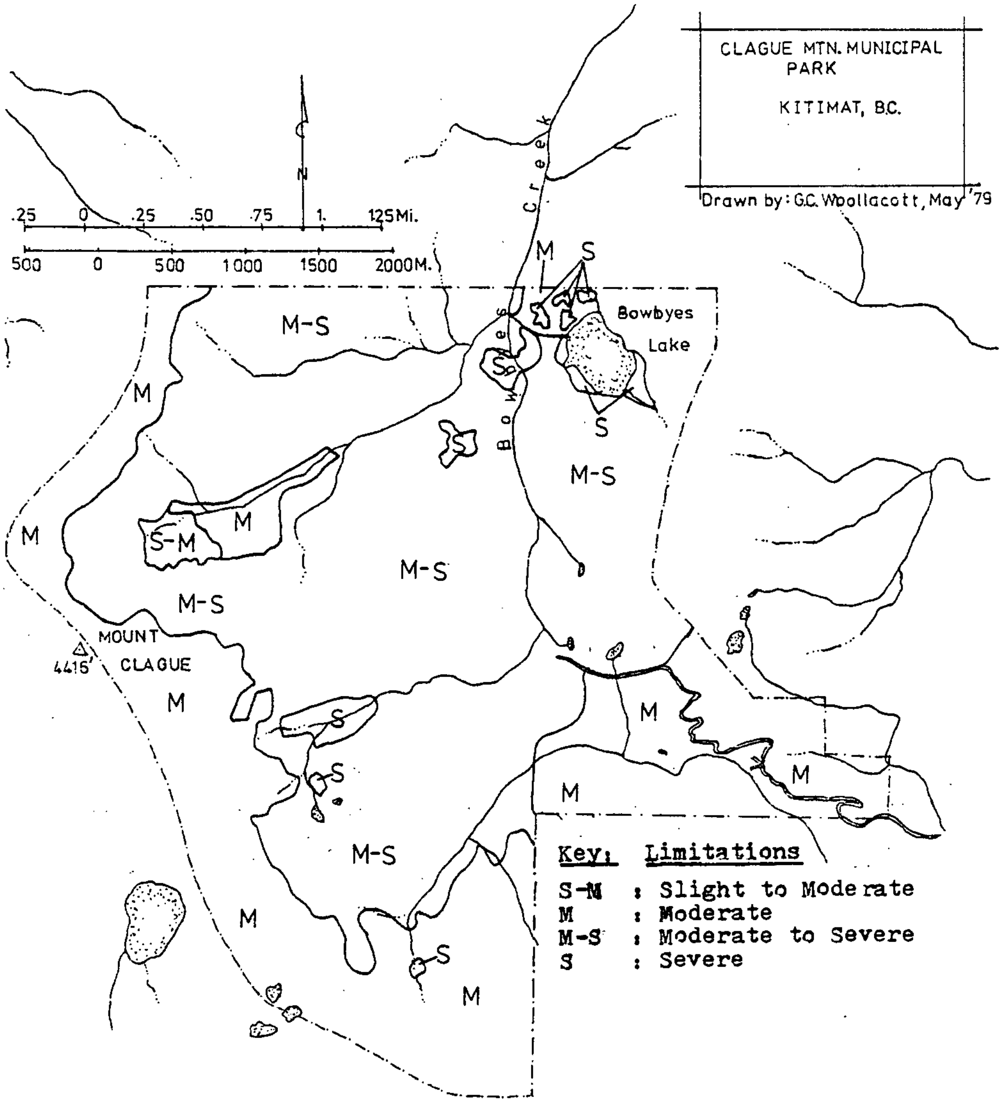


Fig.19. Generalized Suitability Map for Hiking Trails (Summer Use)

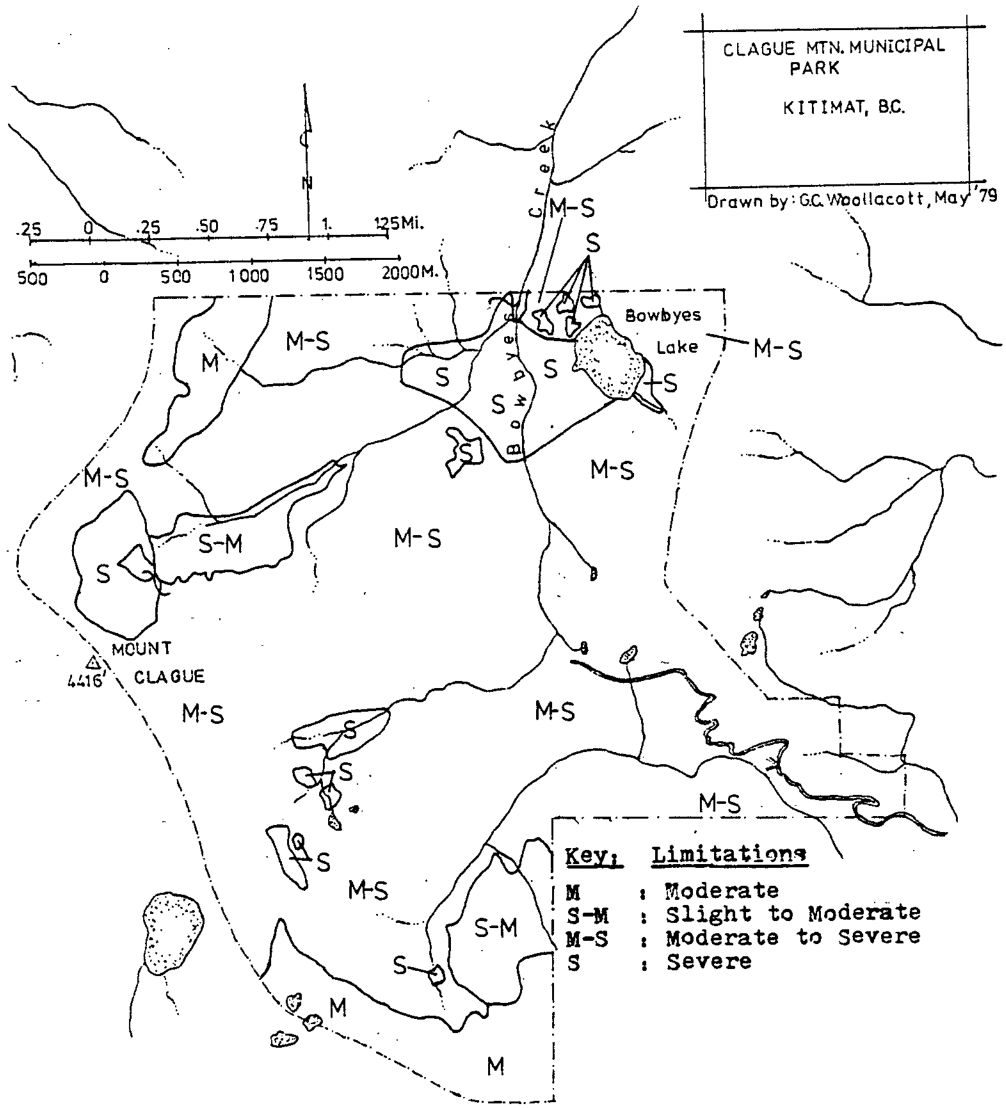


Fig.20. Generalized Suitability Map for Downhill Skiing

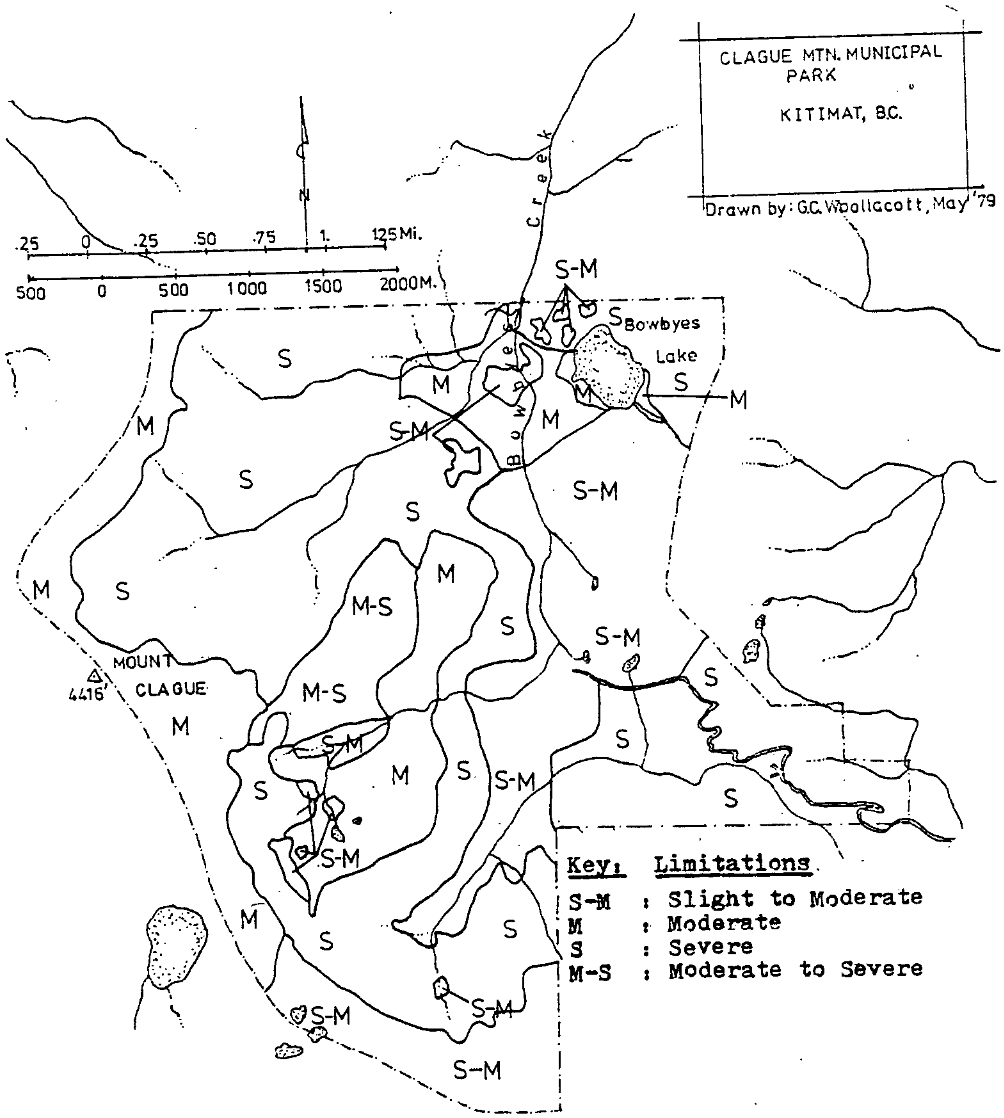


Fig.21. Generalized Suitability Map for Cross-Country Skiing

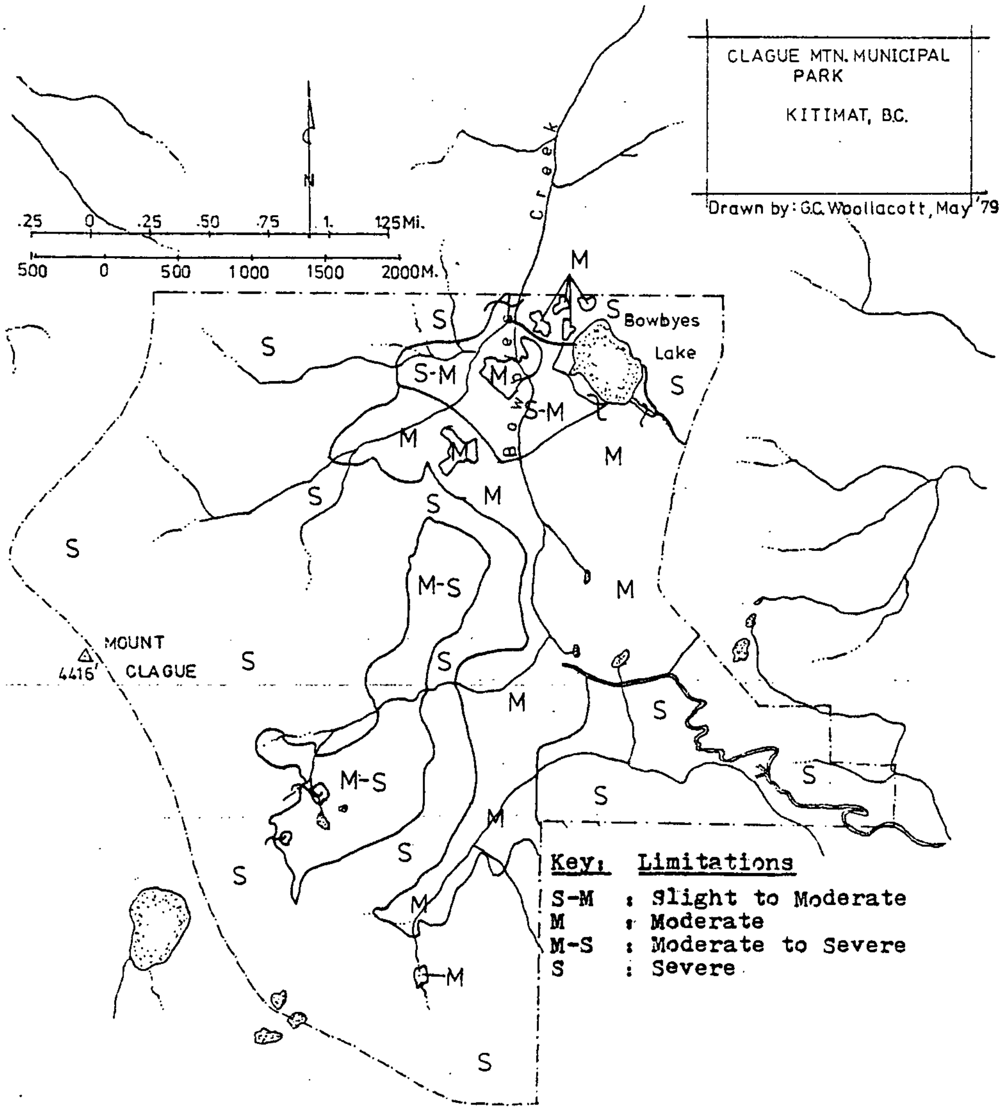


Fig.22. Generalized Suitability Map for Snowmobiling

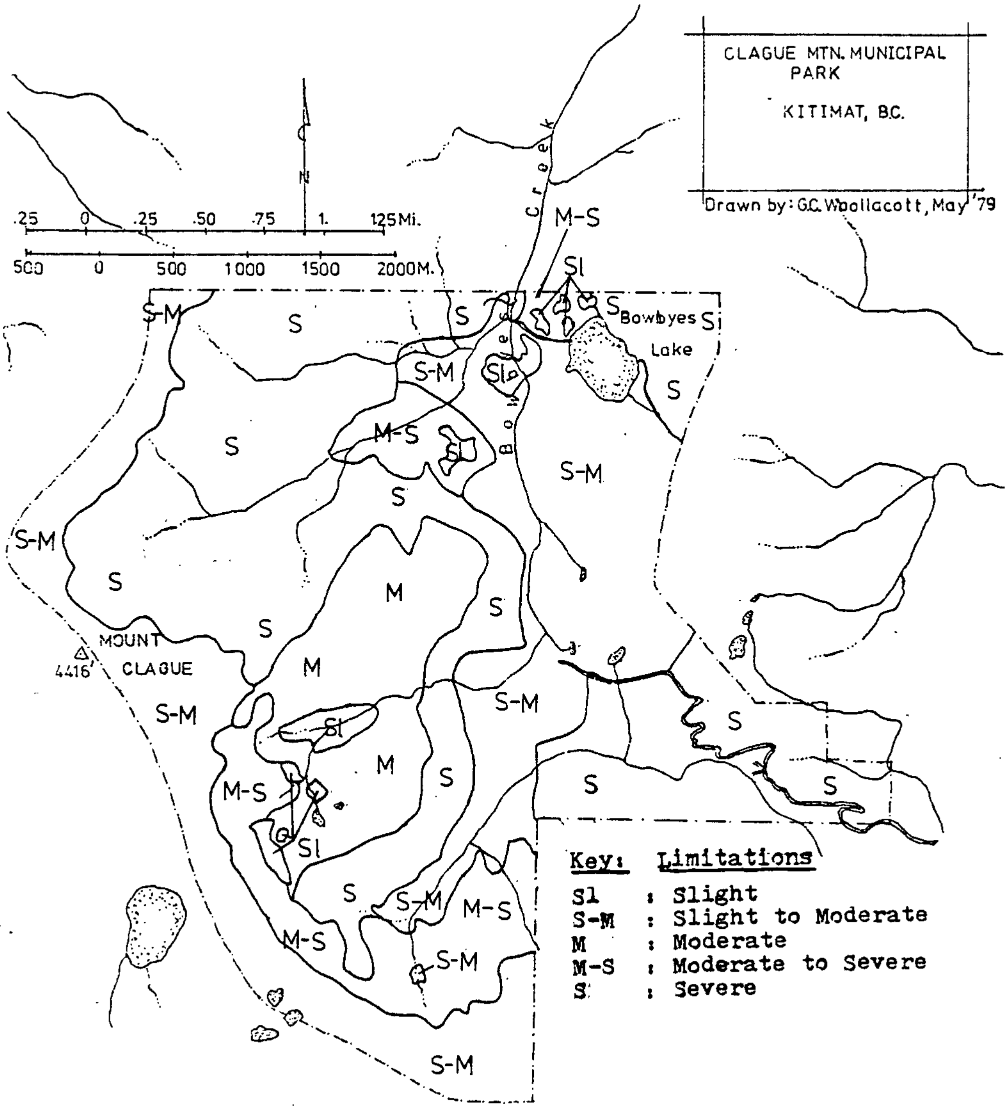


Fig.23. Generalized Suitability Map for Snowshoeing

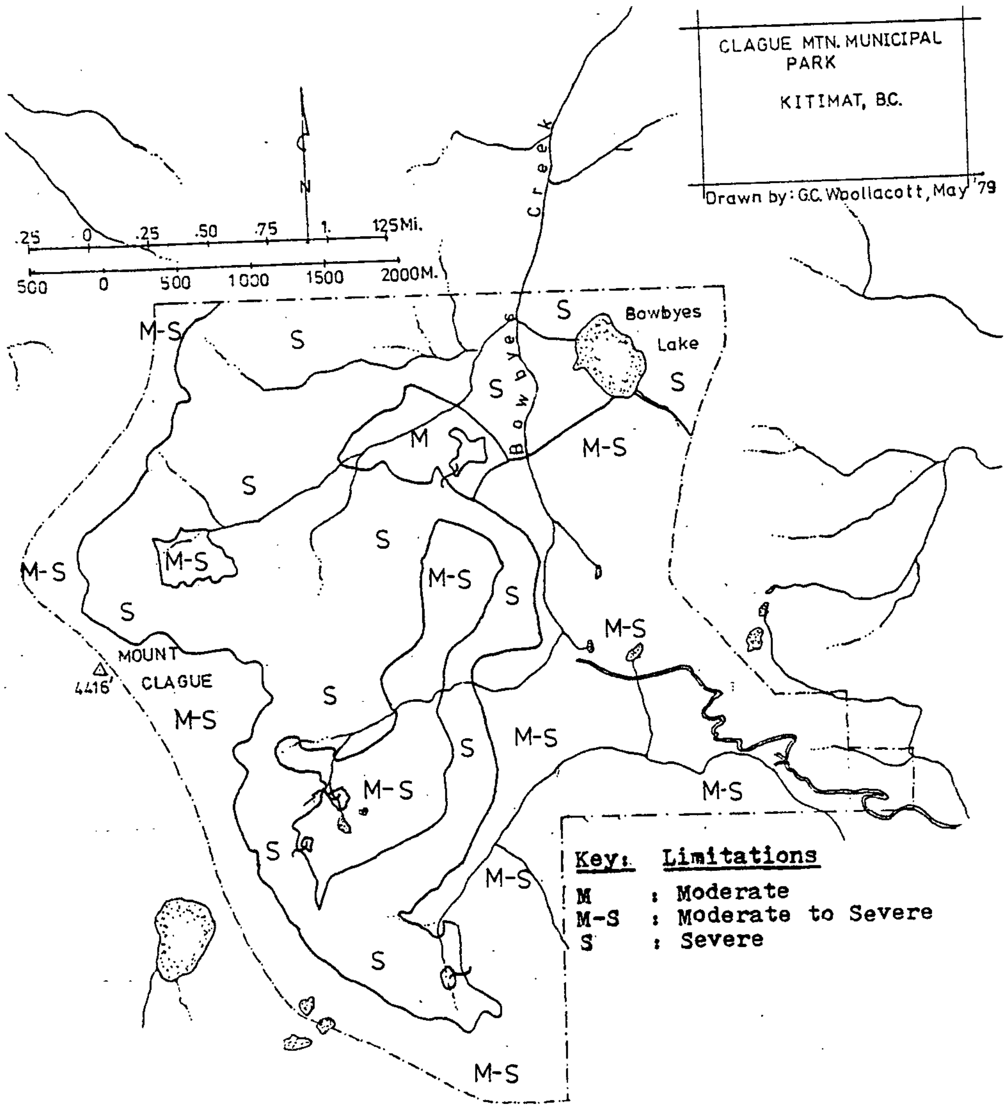


Fig. 24. Generalized Suitability Map for Tobogganing

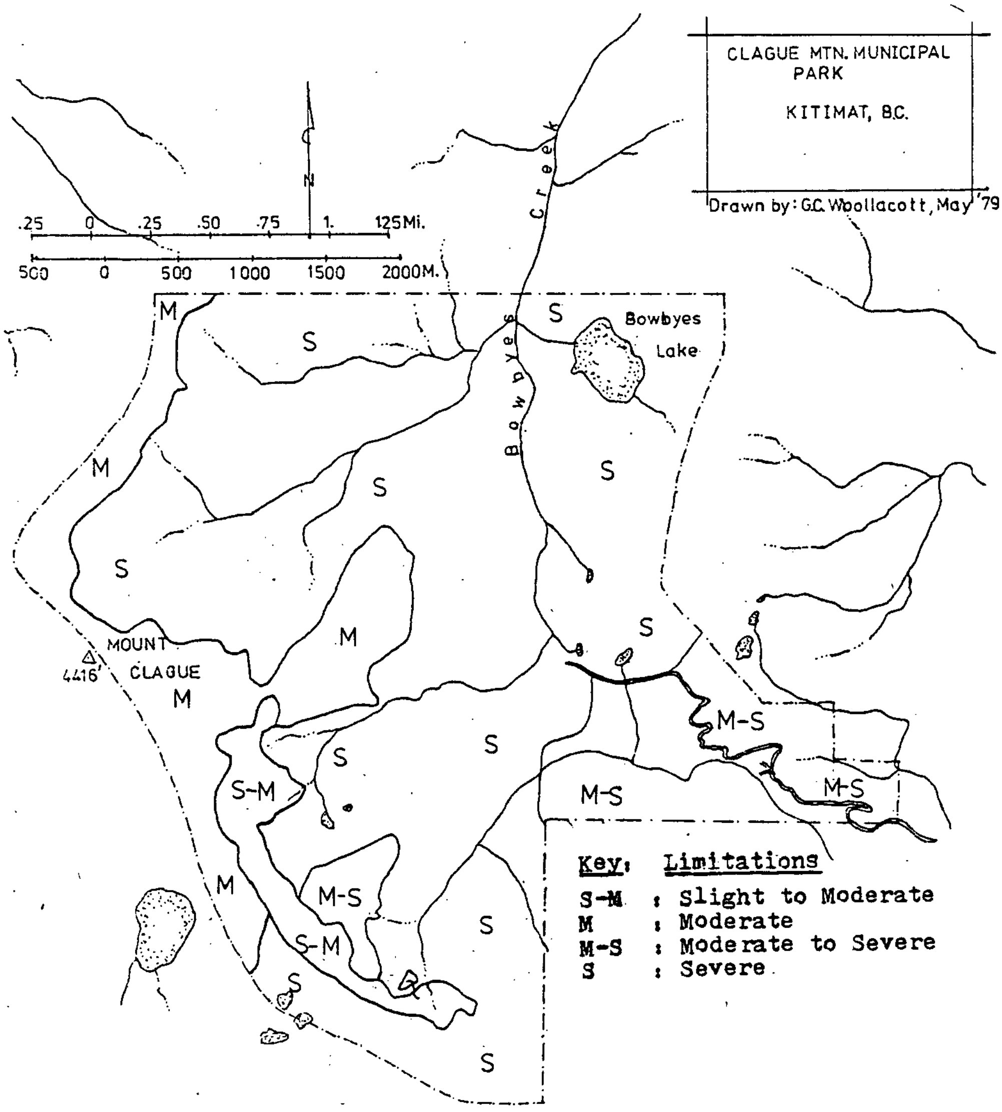


Fig. 25. Generalized Suitability Map for Mountain Climbing: Mountaineering

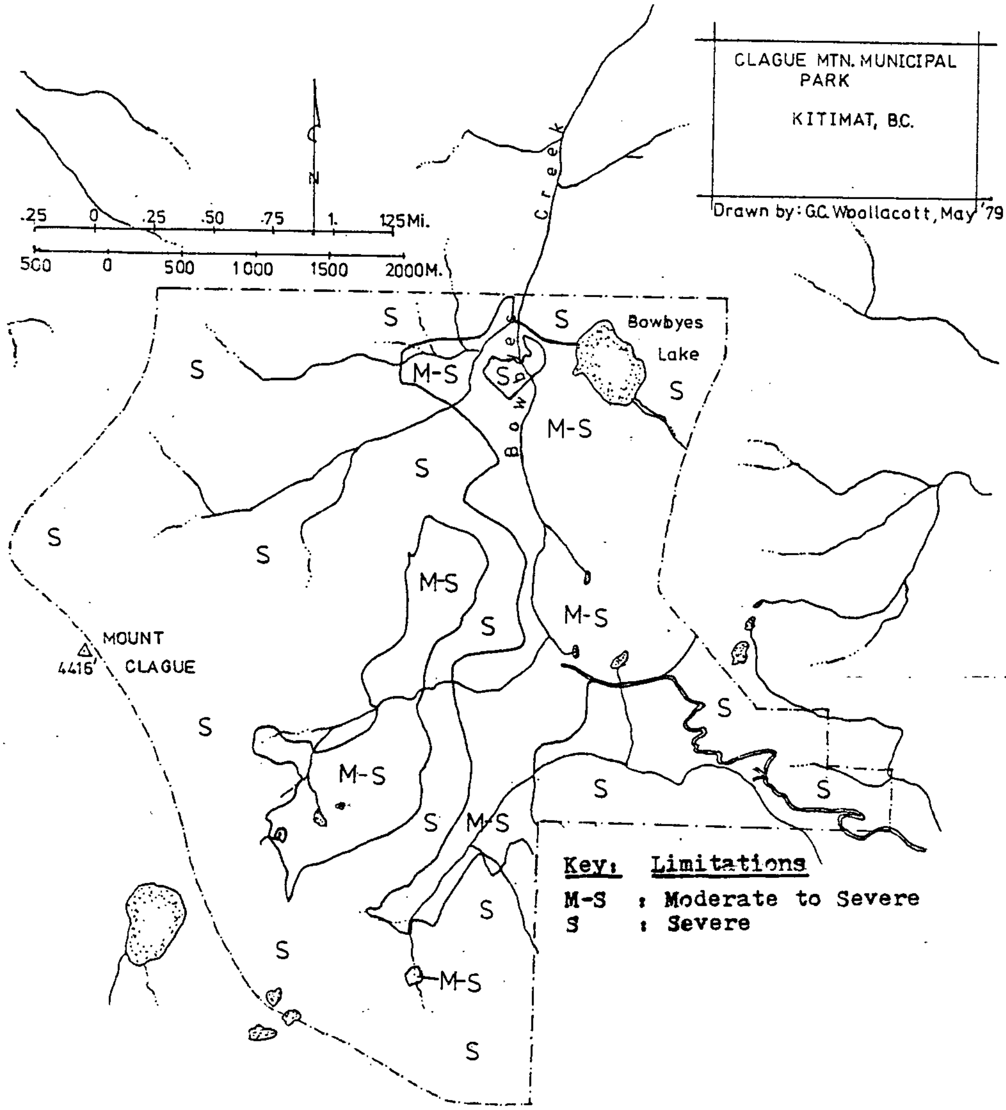


Fig.26. Generalized Suitability Map for Picnicking/Day Use

maps, landform units of identical suitability rating, for a given recreational activity, were aggregated in an attempt to provide a practical final product that readily conveys the findings of the suitability analysis and facilitates ease of future application, e.g. land use and site development planning. Refer to Appendix VII for photographs which are representative of each of the delineated landform units. Unfortunately, photographs illustrating the $F^{A}a - E$ (fluvial), $M^{I}bh$ (morainal), $\frac{M^{I}v}{R}$ (morainal) and $\frac{O^{B}v - N}{Rh}$ (organic) landform units are not available for inclusion in Appendix VII. Water bodies, in the form of lakes and small ponds, were also identified but not rated as to their suitability and/or capability to attract and sustain recreational activities.

5.0 SUMMARY AND RECOMMENDATIONS

On the basis of the preceeding recreation suitability analysis it was found that:

1. Camping (intensive) is best suited to five landform units, i.e., F4, F5, M2, M5 and O2, which are located southwest of Bowbyes Lake and in the subalpine areas adjacent to the Main Meadow area.
2. Hiking (summer) is suited to most areas of the park being severely limited in areas of subalpine meadow (Main Meadow area), as well as the lower elevation marshlands adjacent to Bowbyes Lake.
3. Downhill skiing is classified as having a poor to

moderate suitability rating for most landform units, with severe limitations (poor suitability) for this activity existing in areas with excessively steep slopes, e.g. Cl, areas that are level and subject to flooding and have high water tables, i.e., fluvial landform adjacent to Bowbyes Lake, and in high elevation subalpine meadows.

4. Cross-country skiing is best suited to landform units that are level to rolling and characterized by open to somewhat scattered vegetation types that pose minimal limitations to movement on the ground, such units being adjacent to Bowbyes Lake, the Main Meadow area and, if snow conditions are right, the high elevation bedrock landform units.

5. Snowmobiling is best suited to the mid-elevation level to gently sloping morainal landforms and the fluvial landforms south and southwest of Bowbyes Lake. All other landform units are moderately to severely limiting for snowmobiling due predominantly to the existence of steep slopes or specific vegetation types. Due to the limited space suitable for recreational development within the park, it is imperative that snowmobiling be adequately integrated into the overall land use planning and development of the park, so as to minimize user conflicts and the impacts of snowmobiling upon the plant and animal communities contained within the park.

6. Snowshoeing is best suited to areas of low slope gradient and areas characterized by vegetation which does not hinder movement. Such areas include the landform units situated adjacent to Bowbyes Lake, those within the sub-alpine meadow areas and those found in the higher elevation bedrock areas of the park. If the latter area proves to be too exposed and/or lacks sufficient snow cover, snowshoeing should be restricted to lower elevation areas of moderate to good suitability, i.e., of moderate to slight limitation for snowshoeing.
7. Tobogganning is best suited to the lower elevation glacio-fluvial landform unit on the east side of the park, the area of hummocky morainal deposition found south of Bowbyes Lake, and the level to gently sloping glacio-fluvial fan situated southwest of Bowbyes Lake. Although the suitability analysis indicated that the high elevation bedrock areas, i.e., Rr-C(N) and Rh-C(N), were of moderate to poor suitability for tobogganning, access into these areas and problems with excessive exposure to winds and direct sunlight warrants that greater consideration be given to lower elevation landform units exhibiting more favourable site characteristics. Areas of steep terrain, dense vegetation and/or subject to flooding or high water tables pose severe limitations for this recreational activity. Toboggan runs should be planned and developed in conjunction with other winter-

based recreational activities.

8. Mountain climbing (mountaineering) is best suited to the most westerly fringe of the park, in areas of exposed bedrock and steep cliffs typical of the colluvial landform units found within the park.
9. Picnicking and day use activities are best suited to the level to gently sloping morainal (M4) and fluvial (F5) landform units found immediately west and south of Bowbyes Lake, as well as the 02 organic landform unit adjacent to the Main Meadow area. Prior to developing these areas for picnicking and day use activities it is stressed that more indepth studies by undertaken pertaining to the soils, climate, hydrology, and wildlife communities characteristic of these areas. It should be noted that the generalized suitability map drawn up for picnicking and day use activities corresponds very closely to that established for campgrounds, hence these two activities should be considered together in any future park planning and development.

The following recommendations are based on ground reconnaissance of the park and the findings of the recreation suitability analysis:

1. It is essential that, in anticipation of the increased demand for recreational opportunities in the Kitimat-Terrace area, the existing access road to the park and the trail network within the park be upgraded. Upon

examination of the existing trail system it was found that: areas of extensive blowdown seriously hindered movement along the trail, the "forest of snags" first encountered as one enters the park from the east, poses a serious threat to the safety of park users, and there is a need to relocate certain segments of the trail in an effort to avoid areas of high water table, e.g. peat bogs, specific vegetation types, and excessively steep slopes subject to erosion. If trail relocation is deemed inappropriate, time and monies should be spent to build structures suitable to minimize the impact of man upon the plant and animal communities found within the park. In addition, it was found that no system of trail signs existed within the park. Trail signs located at trail heads and along trail routes are invaluable for providing the user public with information pertaining to specific trail features, points of interest, access, length, location of route, degree of difficulty and time to traverse.

2. It is recommended that the "forest of snags" be either felled and bucked, i.e., cut into short sections, completely or, at the very least, selectively cut down and bucked over a sixty metre wide swath on either side of the trail, for the length of trail running within this "forest of snags".

3. It is recommended that conflicts between mechanized and

non-mechanized trail activities should be dealt with by formally designating separate trails and areas for snowmobiles, trail bikes, A.T.V.'s, hiking, cross-country skiing, snowshoeing, and other activities which may lead to user conflicts. Management techniques must be implemented to resolve conflicts arising between or amongst non-compatible recreational uses.

4. It is recommended that user groups, local resource extraction and manufacturing industries, municipal and regional governments, and all other interested citizens be involved in the overall planning, development, management and maintenance of this rather beautiful, yet sadly neglected park that is situated at the "doorstep" of Kitimat.

5. It is recommended that in the planning and execution of forest extraction activities by Eurocan Pulp and Paper Co. Ltd. north of the Bowbyes Lake area, every attempt be made to insure that the natural integrity and general sense of "wilderness" be maintained in this, as yet, untouched portion of the park.

6. It is recommended that the Corporation of the District of Kitimat become more involved in the overall management and planning of Clague Mountain Park, by way of enforcement of the established regulations governing park use, upgrading and maintenance of access roads and the existing trail network, and allotment of time and monies

to facilitate a detailed inventory and analysis of the ecological (biophysical) attributes of the park, as well as the determination of the current and anticipated recreation demand on the park.

7. It is recommended that the findings and general suitability ratings of this recreation suitability analysis be used to assist in any future recreation planning and development within the park. The results of this study would be of use in the preliminary stages of park planning and development. If more detailed, site-specific information is required, it is recommended that more indepth studies be initiated.

The approach presented in this thesis is not new. The amalgamation of activity-specific ecologically significant criteria into condensed tables represents summaries not frequently found in the literature. This approach represents one of several approaches that will facilitate a systematic assessment of land units' capabilities to support selected recreation activities. Others include the Canada Land Inventory and the B.C. Resource Analysis Branch approaches to recreation capability assessment.

This approach should be used in conjunction with traditional "on-site" assessments made by experienced field personnel. It is believed the approach presented in this thesis will aid in the identification of potential problem areas, i.e., ecological, social and/or economic, early in the planning stages. As the planned costs associated with facility development increase there will be an ever increasing need to use better, more sophisticated interpretative "tools", this approach being one of them. In conclusion the author believes the approach to recreational site-suitability analysis presented in this thesis is suited for undertaking reconnaissance level inventories and analyses of the recreational capabilities of areas in the Coast Mountain region of B.C.

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APPENDIX I

Resource Analysis Branch, Min. of the Environment,
Data Collection Form

SITE DESCRIPTION FORM

№ 2089 -79

Tentative Veg. Name ________________

N.B.

This form not to be copied; refer to definitions manual for all terms used   PAGE ________ OF ________
Parameters which must be filled in are circled; an attempt should be made to fill in all other parameters.

1. Project identificaton ____________________ 2. Plot number ____________________

3. Date (Y/M/D) ________ 4. NTS Sheet ____________ 5. Latitude ____ ° ' " ∓

6. Longitude ____ ° ' " ∓ 7. Location ____________________

8. Photo number and Co-ord. flight line ________ photo no. ________ X ________ Y ________

9. Aspect ________ ° 10. Slope ________ percent 11. Elevation ________ metres

12. Terrain classification

	Texture	Genetic Material	Super. Mod.	Surface Exp.	Mod. Proc.
SITE					
Map Unit					

13. Physiographic Region ____________________

14. Zone/Subzone ____________
classification system ________

15. Landscape Type ____________
classification system ________

16. Vegetation Type ____________
classification system ________

17. Soil Classification ____________
phase ________
year ________
family tex. ________

18. Plot representing ____________________

19. Site position macro
a. apex
b. face
c. upper slope
d. middle slope
e. lower slope
f. valley floor
g. plain

20. Site position meso
a. crest
b. upper slope
c. middle slope
d. lower slope
e. toe
f. depression
g. level

21. Site surface shape
a. concave
b. convex
c. straight

22. Microtopography
a. smooth
b. slightly mounded
c. moderately mounded
d. strongly mounded
e. severly mounded
f. extremely mounded
g. ultra mounded

23. Slope length ____________ m 24. Up-Slope length ____________ m

25. Site position diagram (refer to data form no. ____________)

photo roll no. ____
photo no. ____
Direction ⟷

scale |________| 1 = ________

26. Exposure type
a. wind
b. insolation
c. frost
d. cold air drainage
e. saltspray
f. atmospheric toxicity
g. not applicable
h. other ____________

27. Ecological Moisture Regime
a. very xeric
b. xeric
c. subxeric
d. submesic
e. mesic
f. subhygric
g. hygric
h. subhydric
i. hydric

28. Nutrient Regime
a. oligotrophic
b. submesotrophic
c. mesotrophic
d. permesotrophic
e. eutrophic
f. hypereutrophic

29. Soil Moisture Subclass
a. xeric
b. arid
c. subarid
d. semiarid
e. subhumid
f. humid
g. perhumid
h. subaquic
i. aquic
j. peraquic

30. Soil Temperature Class
a. extremely cold
b. very cold
c. cold
d. cool
e. mild

31. Soil drainage
a. very rapidly
b. rapidly
c. well
d. mod. well
e. imperfectly
f. poorly
g. very poorly

32. Perviousness
a. rapidly
b. moderately
c. slowly

33. Free Water
a. present
b. absent

34. Flood hazard
a. frequent and irregular
b. frequent
c. may be expected
d. rare
e. no hazard

35. Depth to (cm) (circle - if absent)
a. water table ______ -
b. rooting (effective) ______ -
c. root restricting layer ______ -
d. frozen layer ______ -
e. bedrock ______ -
f. carbonate ______ -
g. salinity ______ -

36. Bedrock type (listed in order of dominance)
______ | ______ | ______

37. Bedrock structure ______

38. Coarse fragment lithology
a. type (in order of dominance)
______ | ______ | ______
b. mixed
c. none

39. Successional Status
Present Stage: PS, YS, MS, OS, YC, YEC
YCC, MC, MCC, MEC, DC, NV
Expected climax ______
Rate of succession
a. slow
b. moderate
c. fast

40. Cause of Stand Establishment
______
______
______

41. Veg. Plot Dim. ______ (metres)

42. Humus Form Class. ______
______
______

43. Surface Substrate

SUBSTRATE	% COVER
Organic Matter	
Decaying Wood	
Bedrock	
Cobbles and Stones	
Mineral Soil	
Water	
Total	100%

44. Profile Status
a. modal
b. variant
c. taxadjunct
d. undecided

45. Profile Deviation
a. solum thickness
b. colour
c. texture
d. drainage
e. other ______
f. none

46. Soil Mapping Unit
a. series
b. family
c. associate
d. association
e. catena
f. complex
g. land system
h. land type
i. other

47. Soil name ______

48. Associated soil ______

49. Profile No. ______

50. Project Coordinator ______

51. Agency ______

Notes on Site Description
______
______
______
______

52. Type of Soil Sample
A. Sampled
1. Chemical
a. full
b. partial
2. Physical
a. full
b. partial
B. No Sample

53. Veg. Sampling Tech.
______
______

MENSURATION / WILDLIFE DESCRIPTION FORM

				-		

PAGE ________ OF ________

PROJECT I.D. ______________________ PLOT NO. ______________________

SURVEYOR ______________________

11	12	13	14	15	16
PROJECT			PLOT NO.		
		A			

MAIN PLOT SIZE					SUB - PLOT SIZE				
27–52									
HECTARES	OR	B.A.F.	F/H	D.B.H. LIMIT	HECTARES	OR	B.A.F.	F/H	D.B.H. LIMIT
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1	TREE NO. (25–26)	TOTAL HEIGHT (Metres) (27–29)	SPECIES (30–31)	D.B.H. (Centimetres) (32–35)	TREE CLASS (36)	PATH. REMARKS: CONK (37)	BLIND CONK (38)	SCAR (39)	FORK or CROOK (40)	FROST CRACK (41)	MISTLETOE (42)	ROTTEN BR. (43)	D or B TOP (44)	CROWN CLASS
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TREE CLASS	
1	Residual
2	Subject
3	Dead Potential
4	Dead Useless
5	Veteran

PATH CODE	
1	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]
6	[illegible]
7	[illegible]

CROWN CLASS (C/C)	
1	DOMINANT
2	CO-DOMINANT
3	INTERMEDIATE
4	SUPPRESSED

11	12	13	14	15	16
PROJECT			PLOT NO.		
		B			

MAIN PLOT SIZE					SUB - PLOT SIZE				
27–52									
HECTARES	OR	B.A.F.	F/H	D.B.H. LIMIT	HECTARES	OR	B.A.F.	F/H	D.B.H. LIMIT
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1	TREE NO. (25–26)	TOTAL HEIGHT (Metres) (27–29)	SPECIES (30–31)	D.B.H. (Centimetres) (32–35)	TREE CLASS (36)	PATH. REMARKS: CONK (37)	BLIND CONK (38)	SCAR (39)	FORK or CROOK (40)	FROST CRACK (41)	MISTLETOE (42)	ROTTEN BR. (43)	D or B TOP (44)	CROWN CLASS
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3	TREE NO.	TOTAL HEIGHT	SPEC.	D.B.H.	C/C	TOTAL AGE	AGE CALCULATIONS: COUNT. AGE	B.H.	COR.	SUP.	HEIGHT CALCULATIONS: TOP	BOT.	TOTAL	S.D.	SLOPE	H.D.	HT.	COR.
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UNGULATE PELLET GROUP COUNTS

UNGULATE SPECIES	QUADRAT				
	1	2	3	4	5

Sightings ______________________________

Tracks ______________________________

Scats ______________________________

Wildlife Rating ______________________________

Season of use ______________________________

Domestic Range Condition: 1. Excellent 2. Good 3. Fair 4. Poor

Miscellaneous Comments on Wildlife and Domestic Range Characteristics:

General Miscellaneous Comments:

VEGETATION DESCRIPTION FORM

				-		

PROJECT I.D. ______________ PLOT NO. ______________ PAGE ______ OF ______

SURVEYOR ______________

FLORISTIC LIST specify entries here	STRATUM											NOTES				
	Veteran	A1 Dominant Trees	A2 Main Canopy	A3 Trees	Total Trees	B1 Tall Shrubs	B2 Low Shrubs	Total Shrubs	C Herbs	D Mosses, Liv., Seedlings	All Strata					
Height of top of strata(m)																
Number of dead snags																
Total percentage cover of each layer																
SPECIES LIST																

Comments on Vegetation Characteristics

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FLORISTIC LIST	Veteran	A1 Dominant Trees	A2 Main Canopy	A3 Trees	Total Trees	B1 Tall Shrubs	B2 Low Shrubs	Total Shrubs	C Herbs	D Mosses, Liv, Seedlings	All Strata	NOTES				

SOIL DESCRIPTION FORM

PROJECT I.D. ________ PLOT NO. ________ PAGE ____ OF ____

SURVEYOR ________

HORIZON DESIG.	DEPTH THICKNESS CM			HORIZON BOUNDARY		COARSE FRAGMENT DESCRIPTION							FIELD TEXTURE	STRUCTURE								MST. D 1 M 2 W 3	CONSIST.				SOIL TEMP. °C
							Gravel <7.5cm		Cobbles 7.5-25cm		Stones >25cm			PRIMARY				SECONDARY									
		MIN	MAX	Dist.	Form	% by vol	%	type	%	type	%	type		GRADE	CLASS	KIND	KIND MOD.	GRADE	CLASS	KIND	KIND MOD.		dry	moist	wet	plast.	

HORIZON DESIG.	COLOUR 1		COLOUR 2		MOTTLES						ROOTS 1				ROOTS 2				PH		NOTES
					AB. F C M	SI. F M C	CO. F D P	COLOUR		BOUND. DIST. S C D	Ab. V F P A	Size V F Me C	Ori V H O R	Dist IN EX MTX	Ab. V F P A	Size V F Me C	Ori V H O R	Dist IN EX MTX			
	aspect		aspect					aspect											reaction	method	

HORIZON DESIG.	PORES Ab.	Size	Ori	Dist	Cont	Mor	Type	HOR. POR.	CLAY FILMS Freq	Thi	Loc	EFFERVESC. Deg.	Reag.	SECONDARY CARBONATE DESCRIPTION Cont	Ab.	Size	Shape Str.	Spo	Consist. Moist	Dry	SAL	CONCRETIONS Kind	Ab.	Size	Loc	Shape	Colour Aspect		CEMENT. Agent	Degree	Extent	LAB SAMPLE NO.
	V F P A	V F M C	V H O R	IN EX MTX	CO DC	S D C	V I T	S M H	F C M CS	TN MTK TK VTK		VW W M S			F C M	F M C	V H R	R O I	Moist	Dry	W M S		F C M	F M C		S O I P	Aspect		Agent	Degree	Extent	

HORIZON DESIG.	ORGANIC MATERIAL DESCRIPTION Material Composition Kind	Kind	Decom	Woody Material Hard	Vol. %	Pyro. Index	von Post Scale
	1	2		S SH H VH			

General Comments on Soil Characteristics

SCHEMATIC SOIL PROFILE

DEPTH (cm)

10 — 0 — 25 — 50 — 75 — 100

APPENDIX II

Tables of :

1. Characteristics of the Coastal Western Hemlock, Mountain Hemlock and Alpine Biogeoclimatic Zones of British Columbia.
2. Summaries of the characteristic species of each of these three zones.
3. Suitability ratings of the plant associations of each of these three zones for recreation.

Table 1a : Characteristics of the Coastal Western Hemlock (CWH) Biogeoclimatic Zone[1].

Macroclimate:	- mainly Cfb and the mildest Dfb (Koppen) - an equable (marine) mesothermal (or the mildest microthermal) humid to rainy climate with slight to moderate snow cover.	
	Annual snowfall	: 5 - 295 in (12.7 - 750 cm)
	Annual total precipitation	: 65 - 262 in (165 - 665 cm)
	Precipitation proportion as snow	: .9 - 38.%
	Seasonal occurance in % of total precipitation	: South: wet-winter (30 - 45%) dry-summer (7 - 15%) North: wet-autumn (30 - 40%) dry-summer (11 - 15%)
	Mean annual temperature	: 41 - 49°F (5 - 9°C)
	Number of months:	
	above 50°F (10°C)	: 4 - 6
	below 32°F (0°C)	: 0 - 3 (-4)
	Number of frost-free days	: 120 - 250 (-275) days
Altitude: (British Columbia)	North	: 0 - 1000 ft (0 - 300 m) A.S.L.
	South	: 0 - 3000 ft (0 - 900 m) on windward side : 1500 - 3500 ft (450 - 1050 m) on leeward side
Soils:	Prevailing pedogenic processes	: mor formation, podzolization, gleization, kaolinization, high moor formation, solodization and very weak laterization.
	Zonal soils (mesic sites):	
	Dry Subzone (CWH_a)	: Orthic Ortstein or Humo-Ferric or Ferro-Humic Podzols.
	Wet Subzone (CWH_b)	: Orthic Humic Podzols
	Soil Orders, Great Groups and Parent Materials[2]	: Podzolic - Humo-Ferric Podzol: colluvium, marine - Ferro-Humic Podzol: sandy fluvial, morainal, & fluvial : Gleysolic - Humic Gleysol: marine & fluvial : Regosolic - Regosol: marine & fluvial : Organic - Mesisol: organic - Folisol: organic
Vegetation:	Dominant trees	: Western hemlock, Western red cedar with Douglas fir in Dry Subzone (CWH_a) or Amabilis fir in Wet Subzone (CWH_b).
	Zonal community & soil:	
	Dry Subzone	: Western Hemlock Assoc. on Ortstein Podzols.
	Wet Subzone	: Amabilis Fir - Western Hemlock Assoc. on Humic Podzols.
	Common plant species of each plant association for each subzone3.	: *refer to following "Summary of the Characteristic Species of the Coastal Western Hemlock Zone Plant Associations".

1. Source: Krajina(1969).
2. Source: Cotie et al(1978), Gimbarzevsky(1972), Valentine(1976) and Valentine et al(1978).
3. Source: The U.B.C. Forest Club(1971), Krajina(1959) and Krajina(1969).

Table 1b : Characteristics of the Mountain Hemlock (MH) Biogeoclimatic Zone[1].

Macroclimate:	- mainly Dfc (Koppen) - a microthermal subcontinental (subalpine) humid climate with heavy snow cover.	
	Annual snowfall	: 110 - 800 in (279 - 2032 cm)
	Annual total precipitation	: 87 - 170 in (221 - 432 cm)
	Precipitation proportion as snow	: 20. - 70.%
	Seasonal occurance in % of total precipitation	: South: wet-winter (30 - 40%) dry-spring or summer (10 - 15%) North: wet-autumn (30 -35%) dry-summer (10 - 15%)
	Mean annual temperature	: $38 - 44^{\circ}F$ ($3 - 7^{\circ}C$)
	Number of months: above $50^{\circ}F$ ($10^{\circ}C$) below $32^{\circ}F$ ($0^{\circ}C$)	 : 2 - 3 (-4) : 1 - 6
	Number of frost-free days	: 40 - 120 days
Altitude: (British Columbia)	North South	: 1000 - 2500 ft (305 - 762 m) (A.S.L.) : 3000 - 5000 ft (900 - 1500 m) on windward side : 3600 - 6000 ft (1100 - 1800 m) on leeward side
Soils:	Prevailing pedogenic processes	: mor formation, gleziation, podzolization, high mor formation and kaolinization.
	Zonal soils (mesic sites)	: Humic Podzols (remain unfrozen during winter months)
	Soil Orders, Great Groups & Parent Materials[2].	: Podzolic - Ferro-Humic Podzol: colluvium, fluvial, & morainal : Regosolic - Regosol: colluvium : Organic - Mesisol: organic - Fibrisol: organic (northeastern & coastal B.C.) - Humisol: organic (coastal B.C.) - Folisol: organic (coast B.C. mountains)
Vegetation:	Dominant trees	: Mountain hemlock, yellow cedar and Amabilis fir
	Zonal community & soil:	
	Forest Subzone (MH_a)	: Amabilis Fir-Mountain Hemlock Assoc. on Humic Podzols.
	Parkland Subzone (MH_b)	: Mountain Hemlock-Mountain Bilberry Assoc. on Humic Podzols.
	Common plant species of each plant association for each subzone[3]	: *refer to following "Summary of the Characteristic Species of the Mountain Hemlock Parkland and Forest Subzone Plant Associations".

1. Source: Krajina(1969).
2. Source: Cotie et al(1978), Gimbarzevsky(1972), Valentine(1976), and Valentine et al(1978).
3. Source: Brooke et al(1969), Eekman(1976), The U.B.C. Forest Club(1971), Krajina(1959), and Krajina(1969).

Table 1c : Characteristics of the Alpine Zone (AT)[1].

Macroclimate:	- ET (Koppen) - classified as alpine tundra with annual total precipitation being quite variable, but often characterized by heavy snow cover.	
	Annual snowfall	: 209 - 770 in (531 - 1955 cm)
	Annual total precipitation	: 28 - 110 in (70 - 280 cm)
	Precipitation proportion as snow	: 72 - 74%
	Seasonal occurrance (relative rating)	: West: wet-winter, dry summer East: wet-summer, dry-autumn or spring
	Mean annual temperature	: 25 - 29°F (-4 - -1.5°C)
	Number of months:	
	above 50°F (10°C)	: Nil.
	below 32°F (0°C)	: 7 - 8 (9)
	Number of frost-free days	: less than 25 days/year, however frost may occur any day especially in elevations over 10,000 ft (3,000 m).
Altitude: (British Columbia)	Southwest	: Greater than 5000 ft (1500 m) on windward side.
	"	: Greater than 6000 ft (1800 m) on leeward side.
	Southeast	: Greater than 7500 ft (2250 m).
	Northwest	: Greater than 3000 ft (900 m).
	Northeast	: Greater than 5500 ft (1650 m).

Table 1c : Characteristics of the Alpine Zone (AT)[1.] (continued)

Soils:	Prevailing pedogenic processes:	Skeletal disintegration, gleiziation, and podzolization.
	Zonal soils (mesic sites):	
	Coastal areas	: Alpine Dystric Brunisols to Mini Podzols.
	Interior areas	: Alpine Brunisols.
	Soil Orders, Great Groups, & Parent Materials[2.]	: Regosloic - Regosol: colluvium & bedrock. - Humic Regosol: colluvium & bedrock. : Podzolic - Ferro-Humic Podzol: colluvium & fluvial. - Humo-Ferric Podzol (in krummholz zone especially): :colluvium & fluvial. :Crysolic - Turbic Crysol: colluvium. - Static Crysol: " - Organic Crysol: " : Organic - Folisol: organic & colluvium. : Gleysolic - Humic-Gleysol: organic.
Vegetation:	Dominant trees	: Most subalpine tree species occur in scrub patches (krummholz) near lower limits of alpine areas throughout British Columbia. Trees tend not to grow well in this Zone, being scattered, straggling, prostrate, and krummholz in form.
	Zonal community and soil	: Heathers (Cassiope & Phyllodoce species) and Empetrum nigrum on Alpine Rendzinas, Podozols and Ranker soils.
	Common plant species of each Plant association of the Alpine Zone[3.]	: *refer to following "Summary of the Characteristic Species of the Alpine Zone (AT) Plant Associations".

1. Source: Krajina(1969).
2. Source: Cotie et al(1978), Gimbarzevsky(1972), Valentine(1976), and Valentine et al(1978).
3. Source: The U.B.C. Forest Club(1971), Krajina(1959), & Krajina(1969).

Table 2a : Summary of the Characteristic Species of the Coastal Western Hemlock Zone (CWH) Plant Associations[1.]

Association	ESG[2.]	Characteristic Species	Common Name
Pseudotsugo-Gaultheretum shallon	2,3	Gautheria shallon (a)	Salal
		Pseudotsuga menziesii (d)	Douglas fir
		Tsuga peterophylla (d)	Western hemlock
		Thuja plicata (oc)	Western red cedar (occasional)
		Mahonia nervosa (a)	Oregon grape
Tsugetum heterophyllae	2,3	Tsuga heterophylla (d)	W. hemlock
		Pseudotsuga menziesii (d)	D.fir
		Thuja plicata (oc)	W. red cedar (occasional)
		Plagiothecium undulatum (a)	Step moss
		Eurhynchium oreganum (of)	Moss species. No common name.
		Mahonia nervosa (a)	Oregon grape
Thujo-Polystichetum munitum	4,5,6 & 2,3 (oc)	Polystichum munitum	Sword fern
		Thuja plicata (d)	W. red cedar
		Pseudotsuga menziesii (of)	D.fir
		Tsuga heterophylla (of)	W. hemlock
Tsugo-Gaultheretum shallon	2,3	Gaultheria shallon (a)	Salal
		Tsuga heterophylla (d)	W. hemlock
		Thuja plicata (of)	W. red cedar
		Pseudotsuga menziesii (oc)	D.fir
		Vaccinium alaskaense (of)	Alaska blueberry ("blueberry")
		Rhytidiopsis robusta (of)	Moss species. No common name.
		Chamaecyparis nootkatensis (oc)	Yellow cedar
		Pleurozium schreberi (a)	Moss species. No common name.
Tsugo-Abietetum amabilis	3,4 & 6,7 (oc)	Abies amabilis (d)	Amabilis fir or Pacific silver fir
		Tsuga heterophylla (d)	W. hemlock
		Gaultheria shallon (oc)	Salal
		Vaccinium alaskaense (of)	Alaska blueberry
		Rhytidiopsis robusta (	Moss species. No common name.
		Clintonia uniflora (of)	Queen's cup
		Plagiothecium undulatum (of)	Step moss
Tsugo-Struthiopteretum spicant	3,4,5,7,8,9 & 2,6 (oc)	Struthiopteretum spicant (a)	Deer fern
		Tsuga heterophylla (d)	W. hemlock
		Abies amabilis (oc)	Amabilis fir
		Streptopus amplexifolius (a)	Twisted stalk
		Vaccinum alaskaense	Alaska blueberry
		Rhytidiopsis robusta	Moss species. No common name.

Table 2a : Summary of the Characteristic Species of the Coastal Western Hemlock Zone (CWH) Plant Associations[1.] (continued)

Association	ESG[2.]	Characteristic Species	Common Name
Lysichito-Vaccinietum alaskaense	4,5,8,10	Vaccinium alaskaense (a)	Alaska blueberry
		Lysichiton kamtschatcense (a)	Skunk cabbage
		Thuja plicata (d)	W. red cedar
		Tsuga heterophylla (d)	W. hemlock
Copto-Lysichetum kamtschatcense	5,10,11 & 8 (oc)	L. kamtschatcense (a)	Skunk cabbage
		Coptis asplenifolia (a)	Spleenwort-leaved goldthread
		Thuja plicata (d)	W. red cedar
		Tsuga heterophylla (d)	W. hemlock
		Pinus contorta (oc)	Lodgepole pine
		Coptis trifoliata (a)	Three-leaved goldthread
		Vaccinium alaskaense (of)	Alaska blueberry
		Ribes bracteosun (of)	Stink current
		Pinus monticola (of)	Western white pine
Thujo-Oplopanicetum horridus	4,5,8,10,12	Oplopanx horridus (a)	Devil's club
		Thuja plicata (d)	W. red cedar
		Tsuga heterophylla (d)	W. hemlock
		Vaccinium alaskaense	Alaska blueberry
Populo-Loniceretum involucratae	5,13,14	Loniceretum involucrata (a)	Black twinberry
		L. utahensis (a)	Red twinberry
		Populus trichocarpa (d)	Black cottonwoood
		Alnus rubra	Red alder
Piceo-Oplopanicetum horridus	4,5,13 & 6,8 (oc)	Oplopanx horridus	Devil's club
		Picea sitchensis (of,d)	Sitka spruce
		Populus trichocarpa (d)	Black cottonwood
		Acer macrophyllum (of,d)	Bigleaf maple
		Alnus rubra (oc)	Red alder
		Ribes bracteosun (oc)	Stink current
		Polystichum andersonii (a)	Anderson's holly-fern
Piceo-Symphoricaroetum$_o$ albus	4,13 & 6 (oc)	Symphoricaros albus (a)	Snowberry
		(= S. rivularis)	"
		Populus trichocarpa (d)	Black cottonwood
		Picea sitchensis (of)	Sitka spruce
		Acer macrophyllum (of)	Bigleaf maple
		Alnus rubra (oc)	Red alder
		Acer circinatum (oc)	Vine maple

1. Source: The U.B.C. Forest Club(1971).
2. Ecological Species Groups, Coastal Western Hemlock Zone - *refer to The U.B.C. Forest Club (1971), pp.216-217.
3. Abbreviations following the species names : a = abundant, d = dominant, oc = occasional and of = often.

Table 2b : Summary of the Characteristic Species of the Mountain Hemlock Zone (MH) Plant Associations, Forest Subzone (MH_a)[1.]

Association	ESG[2.]	Characteristic Species[3.]	Common Names
Cladothamno-Tsugetum mertensianae (C-Tm)	1,2,3,4,5,6	Tsuga mertensiana (c,d)	Mountain hemlock
		Chamaecyparis nootkatensis (c,d)	Yellow cedar
		Abies amabilis	Amabilis fir or Pacific silver fir
		Cladothamnus pyrolaeflorus (c,d,s)	Copper bush
		Vaccinium membranaceum (c,d)	Mountain huckleberry
		V. alaskaense (c,d)	Alaska blueberry (huckleberry)
		Menziesia ferruginea (c)	False azalea
		Phyllodoce empetriformis (c)	Red heather
Abieto-Tsugetum mertensianae (A-Tm)	4,5,6,7,8	Tsuga mertensiana (c,d)	Mountain hemlock
		Abies amabilis	Amabilis fir
		Vaccinium alaskaense (c,d)	Alaska blueberry
		V. membranaceum (c)	Mountain huckleberry
		Menziesia ferruginea (c)	False azalea
Streptopo-Abietetum amabilis (S-Aa)	5,6,7,8,9 & 10 (oc)	Abies amabilis	Amabilis fir
		Tsuga mertensiana (c,d)	Mountain hemlock
		Vaccinium alaskaense (c,d)	Alaska blueberry
		Streptopus roseus (c)	Twisted stalk
		Rubus pedatus (c,d)	Trailing rubus
Oplopanaco-Thujetum plicatae (O-Tp)	4,6,7,9,10,11, 12	Tsuga heterophylla (c,d)	Western hemlock
		Abies amabilis (c,d)	Amabilis fir
		Oplopanax horridus (c,d,s)	Devil's club
		Vaccinium alaskaense (c,d)	Alaska blueberry
		Athyrium filex-femina (c,d,s)	Lady fern
		Gymnocarpium dryopteris (c,d)	Oak fern
		Streptopus roseus (c)	Twisted stalk
		Tiarella unifoliata (c)	Foam flower
Lysichito-Chamaecyparetum nootkatensis (L-Cn)	5,6,7,10,11, 13 & 4,8,9 (oc)	Abies amabilis (c,d)	Amabilis fir
		Tsuga heterophylla(c,d)	W. hemlock
		Chamaecyparis nootkatensis (c,d)	Yellow cedar
		Tsuga mertensiana (c)	Mountain hemlock
		Vaccinium alaskaense (c,d)	Alaska blueberry
		Lysichitum americanum (c,d,s)	Skunk cabbage
		Rubus pedatus (c)	Trailing rubus
		Clintonia uniflora (c)	Queen's cup
Eriophoro-Sphagetum (E-S)	N/A	Carex aquatilis (d)	Water sedge
		Eriophorum augustifolium (d,s)	Cotton grass or narrow-leaf cotton sedge
		Drepanocladus aduncus(d)	Moss species. No common name.
		Sphagnum Spp. (d)	Peat Mosses.

1. Source: Brooke et al(1969).
2. Source: The U.B.C. Forest Club(1971). Ecological Species Groups, Mountain Hemlock Zone by Forest Subzone (MH_a). Not all of the associations have corresponding ESGs due to the limitations of the Forestry Handbook published by the Forest Club(1971).
3. Abbreviations following the species names represent - c = common, d = dominant and s = selective species.

Table 2b : Summary of the Characteristic Species of the Mountain Hemlock Zone (MH) Plant Associations, Parkland Subzone (MH_b)[1]

Association	ESG[2]	Characteristic Species[3]	Common Name
Vaccinio-Tsugetum mertensianae (V-Tm)	N/A[4]	Tsuga mertensiana (c,d)	Mountain hemlock
		Abies amabilis (c,d)	Amabilis fir
		Vaccinium membranaceum (c,d)	Mountain huckleberry
		Rhododendron albiflorum (d,s)	White rhododendron
		Vaccinium deliciosum (c,d)	Blueleaf huckleberry
Leptarrheno-Calthetum leptosepalae (L-Cl)	N/A	Leptarrhena pyrolifolia (c,d,s)	Leptarrhena
		Caltha leptosepala (c,d,s)	White marsh marigold
		Erigeron peregrinus (c,d,s)	Mountain daisy
		Parnassia fimbriata (c,d,s)	Fringed grass of Parnassus
		Equisetum palustre (d,s)	Horsetail
Phyllodoco-Cassiopetum mertensianae (P-Cm)	N/A	Phyllodoce empetriformis (c,d)	Red heather
		Cassiope mertensiana (c,d)	White moss heather
		Luetkea pectinata (c)	Meadow spirea or partridge foot
		Vaccinium deliciosum (c,d)	Blueleaf huckleberry
Nano-Tsugetum mertensianae (N-Tm)	N/A	Tsuga mertensiana (c,d)	Mountain hemlock
		Phyllodoce empetriformis (c,d)	Red heather
		Cassiope mertensiana (c,d)	White moss heather
		Luetkea pectinata (c,d)	Meadow spirea or partridge foot
		Vaccinum deliciosum (c)	Blueleaf huckleberry
Vaccinetum deliciosi (Vd)	N/A	Vaccinim deliciosum (c,d)	Blueleaf huckleberry
		Phyllodoce empetriformis (c,d)	Red heather
		Cassiope mertensiana (c,d)	White moss heather
		Luetkea pectinata (c)	Meadow spirea or partridge foot
Saxifragetum tolmiei (St)	N/A	Saxifraga tolmiei (a,d,s)	Tolmie saxifrage
		Marsupella brevissima (a,d)	Common name unknown.
Caricetum nigricantis (Cn)	N/A	Polytrichum norvegicum (a,d,s)	Hair cap moss
		Carex nigricans (a,d)	Black alpine sedge

1. Source: Brooke et al (1969).
2. Source: The U.B.C. Forest Club (1971). Ecological Species Groups, Mountain Hemlock Zone by Forest and Parkland Subzones. Not all plant associations listed have ESGs due to limitations of the Forestry Handbook published by The U.B.C. Forest Club (1971).
3. Abbreviations following the species names represent - c = common, d = dominant, and s = selective species.

Table 2c : Summary of the Characteristic Species of the Alpine Zone (AT) Plant Associations[1.]

Group	Association	Characteristic Species[2.]	Common Name
Snow Patch[3.]	Gymnomitrieto-Polytrichetum norvegici	Polytrichum norvegicum (B,IV,3)	Hair cap moss
		Gymnomitrium varians (B,V,3-4)	Moss Species
		Pohlia drummondii (V,I,5)	Moss Species
	Caricetum nigricantis	Carex nigricans (H,V,3)	Black alpine sedge
		Polytrchum norvegicum (B,IV,3)	Hair cap moss
	Sibbaldietum procumbentis	Sibbaldia procumbens (H,V,3)	Creeping sibbaldia
		Antennareia alpina (H,IV,2)	Alpine pussytoes
		Polytrichum piliferum (B,V,2)	Common name unknown.
Chomophytic[4.]	Caricetum spectabilis	Carex spectabilis (H,V,3)	Showy sedge
		Lupinus arcticus (H,V,2)	Arctic lupine
		Agoseris aurantiaca (H,I,3-4)	Orange false dandelion
	Luetkeetum pectinatae	Luetkea pectinata (H,V,2)	Meadow spirea or partridge foot
		Hieracium gracile (H,V,2-3)	Slender hawkweed
	Anaphaleto-Lupinetum arctici	Lupinus arcticus (H,V,4)	Arctic lupine
		Anaphalis margaritacea (H,III,5)	Common pearly everlasting
		Carex spectabilis (H,V,2)	Showy sedge
Alpine Meadow[5.]	Mimuleto-Epilobietum latifolii	Mimulus lewisii (H,III,5)	Lewis's monkeyflower
		Epilobium latifolium (H,V,3)	Broad-leaved willow herb
		Leptarrhena amplexifolia (H,III,5)	Common name unknown.
		Mimulus tilingii (H,I,5)	Large mountain monkeyflower
		Saxifraga arguta (H,II,5) (= S. odontoloma)	Stream saxifrage " "
		Marchantia polymorpha (B,III,5)	Common name unknown.
		Scapania undulata (B,IV,5)	" " " .
		Philonotis fontana (B,V,5)	" " " .
	Valerianetum sitchensis	Valeriana sitchensis (H,V,3)	Sitka valerian
		Lupinus arcticus (H,V,2)	Arctic lupine
		Carex spectabilis (H,V,2)	Showy sedge
Rupicolous[6.]	Junipereto-Perstemonetum menziesii	Juniperus communis (S,V,3-4)	Common juniper
		Perstemon menziesii (S,V,4-5) (= P. Davidsonii var. menziesii)	Davidson's perstemon " "
		Festuca brachyphylla (H,III,3-4)	Alpine fescue
		Phyllodoce glanduliflora (S,IV,2)	Cream mountain heather
	Silenetum acaulis	Silene acaulis (H,-,-)[7.]	Moss campion
		Saxifraga bronchialis (H,-,-)	Prickly saxifrage
		S. ferruginea (H,-,-)	Alaska saxifrage
Alpine Heather[8.]	Phyllodoco-Cassiopetum mertensianae	Phyllodoce empetriformis (S,V,3)	Red mountain heather
		P. glanduliformis (S,II,3)	Cream mountain heather

Table 2c : Summary of the Characteristic Species of the Alpine Zone (AT) Plant Associations[1.] (continued)

Group	Association	Characteristic Species[2.]	Common Name
		Cassiope mertensiana (S,V,3)	Whitemoss heather
Krummholz[9.]	Abieto-Chamaecyparetum nootkatensis	Abies lasiocarpa (T,V,5)	Alpine fir
		Chamaecyparis nootkatensis (T,II,5)	Yellow cedar
		Juniperus communis (S,V,3-4)	Common juniper
		Rhytidiopsis robusta (B,V,5)	Common name unknown.
Bog Peat[10.]		Sphagnum capillaceum (B,-,-)[7.]	Common name unknown.
		S. plumulosum (B,-,-)	" " " .
		S. compactum (B,-,-)	" " " .

1. Source: Archer(1963). Based on Associations within the Alpine (AT) Biogeoclimatic Zone (Krajina,1969).
2. Abbreviations following the species names - (plant community, presence, fidelity)
   i) Plant communities - B = bryophytes, H = herbs, S = shrubs, and T = trees.
   ii) Presence - measure of occurance of species throughout a number of plots.
   I = 1 - 20%, II = 21 - 40%, III = 41 - 60 %, IV = 61 - 80%, and V = 81 - 100%
   iii) Fidelity - indication of characteristic species or combination of species in defined floral communities.

1 = Accidentals: strange species, or intruders or relicts of a preceding community.
2 = Companions: indifferent species found in many communities without pronounced affinities.
3 = Preferential species present in several communities more or less abundantly but predominately or with better vitality in one certain community.
4 = Selective species: found frequently in more than one community, but also, though rarely, in other communities.
5 = Exclusive species: confined completely or almost completely to one community.

3. Snow Patch Group - well adapted plant communities that exist in localities which are under the influence of prolonged snow pack.
4. Chomophytic Group - plant communities which form pioneer groups colonizing the fragmented rocks of the boulder and fell-fields (talus slopes).
5. Alpine Meadow Group - hydrophytic plant communities (forbs and sedges) which grow on sites with abundant seepage water,characterized by a high base status.
6. Rupicolus Group - plant communities characteristic of rock walls, rock pavements and rock ridges; being established in the cracks of rocks or on accumulations of fine debris in pockets and depressions.
7. No indication of presence or fidelity factors due to insufficient data.
8. Alpine Heather Group - plant communities dominated by Cassiope mertensiana, Phyllodoce empetreformis and P. glanduliflora in areas typified by progressive podzolization and accumulation of organic matter.
9. Krummoholz Group - plant communities characteristic of steep terrain and rock outcrops where snow is melted by the end of June or the beginning of July.
10. Bog Peat Group - bog peat plant communities characteristic of small depressions which are saturated by melting snow water.

Table 3a : Suitability Ratings[1.] of Plant Associations for Recreation: Coastal Western Hemlock Zone (CWH)[2.]

Plant Associations	Camping	Trails[3.]	Snowmobiling	Tobogganning	Downhill Skiing	Picnicking/ Day Use	Mountain Climbing: Mountaineering
Pseudotsugo-Gaultheretum shallon	m	ns	m	m	m	m	m
Tsugetum-heterophallae	ns	ns	ns	ns	m	ns	s
Thujo-Polystichetum munitum	s	s	m	m	s	s	s
TsugoAbietetum amabilis	s	m	s	m	m	s	s
Tsugo-Gaultheretum - shallon	m	m	s	m	m	s	s
Tsugo-Struthiopteretum spicant	s	s	m	m	s	s	s
Lysichito-Vaccinietum alaskaense	s	s	s	s	s	s	s
Copto-Lysichetum kamtschatcense	s	s	s	s	s	s	s
Thujo-Oplópanicetum horridus	s	s	s	s	s	s	s
Populo-Loniceretum involueratae	m	ns	ns	s	s	ns	s
Piceo-Oplopanicetum horridus	m	s	s	s	s	s	s
Piceo-Symphoricaroetum albus	ns	ns	ns	s	s	ns	s
Pseudotsugo-Cladonietum pacificae	m	ns	s	s	s	m	m

1. Abbreviations used: ns = none to slight, m = moderate and s = severe limitations for specified recreational use. Suitability ratings were derived by the author using an interpretive approach similar to that proposed by Eekman(1976). Interpretation of the plant associations in relation to the site requirements and standards for the selected recreational activities, is the basis upon which the suitability ratings were derived.
2. Source: The U.B.C. Forest Club(1971), pp.200 - 287 inclusive.
3. Trails include summer use hiking trails and winter use cross-country ski and snowshoe trails.

Table 3b : Suitability Ratings[1.] of Plant Associations for Recreation: Mountain Hemlock Zone (MH)[2.]

Plant Associations	Camping 1.	Trails 2. & 3.	Snowmobiling	Tobogganning	Downhill Skiing	Picnicking/ Day Use 2.	Mountain Climbing: Mountaineering	
Vaccinio-Tsugetum mertensianae	ns	ns	s	m	ns	ns	m	
Leptarrheno-Calthetum leptosepalae	s	s	s	s	s	s	s	
Phyllodoco-Cassiopetum mertensianae	m	m	s	s	m	m	m	MH_b [4.]
Nano-Tsugetum mertensianae	m	m	s	s	m	m	m	
Vaccinietum deliciosi	m	m	s	s	m	m	m	
Saxifragetum tolmiei	s	m	s	s	s	s	m	
Caricetum nigricantis	s	s	s	s	s	s	s	
Cladothamno-Tsugetum mertensianae	m	ns	s	s	m	m	s	
Abieto-Tsugetum mertensianae	m	ns	ns	ns	ns	m	s	
Streptopo-Abietetum amabilis	s	m	s	s	m	s	s	MH_a [4.]
Oplopanaco-Thujetum plicatae	s	s	s	s	s	s	s	
Lysichito-Chamaecyparetum nootkatensis	s	s	s	s	s	s	s	
Eriophoro-Sphagnetum	s	s	s	s	s	s	s	

1. Abbreviations used: ns = none to slight, m = moderate, and s = severe limitations for specified recreational use. Suitability ratings were derived by the author using an interpretive approach similar to that proposed by Eekman(1976). Interpretation of the plant associations in relation to the site requirementsand standards for the selected recreational activities, is the basis upon which the suitability ratings were derived.
2. Source: Camping, Trails, and Picnicking/Day Use categories were taken from Eekman(1976).
3. Trails include summer use hiking trails and winter use cross-country ski and snowshoe trails.
4. Abbreviations used: MH_a = Mountain Hemlock,Forest Subzone and MH_b = Mountain Hemlock,Parkland Subzone.

Table 3c : Suitability Ratings[1.] of Plant Associations for Recreation: Alpine Zone (AT)[2.]

Plant Associations	Camping	Trails[3.]	Snowmobiling	Tobogganing	Downhill Skiing	Picnicking/ Day Use	Mountain Climbing: Mountaineering
Gymnomitrieto-Polytrichetum norvegici	s	s	s	s	s	s	s
Caricetum nigricantis	s	s	s	s	s	s	s
Sibbaldietum procumbentis	s	s	s	s	s	s	s
Caricetum spectabilis	s	m	s	s	m	s	m
Luetkeetum pectinatae	s	m	s	s	m	s	m
Anaphaleto-Lupinetum arctici	s	ns	m	s	s	m	s
Mimuleto-Epilobietum latifolii	s	s	m	m	m	s	s
Valerianetum sitchensis	s	m	s	s	m	s	m
Junipereto-Penstemonetum menziesii	s	m	s	s	s	s	ns
Silenetum acaulis	s	m	s	s	s	s	m
Phyllodoco-Cassiopetum mertensianae	s	m	s	s	s	s	m
Abieto-Chamaecyparetum nootkatensis	s	m	s	s	s	s	ns
Bog Peat - Sphagnum Assoc	s	ns	s	s	s	s	ns

1. Abbreviations used: ns = none to slight, m = moderate, and s = severe limitations for selected recreational activities. Suitability ratings were derived by the author using an interpretiveapproach similar to that proposed by Eekman(1976). Interpretations of the plant associations in relation to the site requirements and standards for the selected recreational activities, is the basis upon which the suitability ratings were derived.
2. Associations used for the Alpine Zone (AT) are those established by Archer(1963) in the Garibaldi Park area of southwestern British Columbia.
3. Trails include summer use hiking trails and winter use cross-country ski and snowshoe trails.

APPENDIX III

Summary of Criteria for the Climatic Suitability for Recreation Classification (*after Bennett (1977))

Appendix III

SUMMARY OF CRITERIA FOR THE CLIMATIC SUITABILITY FOR RECREATION CLASSIFICATION

Ranking	1 - most suitable to 5 - least suitable	
Seasons	S - summer	June - August
	T - transition	April, May, September, October
	W - winter	December - February
Limiting Factors	h - too warm	
	k - too cold	
	p - precipitation	

1. TEMPERATURE - by activity level

T(max) = maximum temperature
T(mean) = mean temperature

a) Land Active

summer/transition		winter	
class	T(max)	class	T(mean)
4h	>28°C	4h	>0°C
3h	24-28	3h	0 to -4
2h	20-24	2h	-4 to -8
1	16-20	1	-8 to -12
2k	12-16	2k	-12 to -16
3k	8-12	3k	-16 to -20
4k	<8	4k	<-20

b) Land Passive

summer/transition

class	T(max)
3h	$>28^{o}C$
2h	24-28
1	20-24
2k	16-20
3k	12-16
4k	8-12
5k	<8

winter

class	T(mean)
2h	$>0^{o}C$
1	0 to -4
2k	-4 to -8
3k	-8 to -12
4k	-12 to -16
5k	<-16

c) Aquatic Passive

summer/transition

class	T(max)
2h	$>28^{o}C$
1	24-28
2k	20-24
3k	16-20
4k	12-16
5k	<12

2. PRECIPITATION

N = number of days per season with measurable precipitation

P = total seasonal precipitation

R = precipitation index

$$R = N + 4\frac{P}{N} \qquad \text{when P is in millimetres}$$

$$R = N + \frac{100P}{N} \qquad \text{when P is in inches}$$

class	Summer R	Transition R	Winter R
1	<40	<40	<40
2	40-50	40-60	40-65
3	50-60	60-80	65-90
4	60-70	80-100	90-115
5	>70	>100	>115

3. WIND

V = wind index

S = mean wind speed in dominant direction

%C = frequency of calms in per cent

$$V = KS - \%C$$

K = 1 if S is in miles per hour

K = 2.24 if S is in metres per second

class	V
1	<5
2	5-10
3	10-15
4	15-20
5	>20

4. SUNSHINE

%S = mean hours of bright sunshine expressed as a percentage of maximum possible sunshine duration.

class	%S
1	>50%
2	40-50
3	30-40
4	20-30
5	<20

Source : Bennett (1977)

APPENDIX IV

Detailed description of Clague Mountain Trail
(*after Blix (1977))

Clague Mountain Trail [KT2]

GENERAL AREA:
Kitimat-Terrace, near Kitlmat

MAPS REQUIRED:
103I/2W Kitimat (1:50,000)
103I/2E Kitimat (1:50,000)
103I Terrace (1:250,000)

TRAIL DESCRIPTION:

About 4½ miles from the start of the trail at elevation 100 ft. to Clague Mountain, elevation 4400 ft. A well defined trail all the way, but extremely muddy in sections. The first mile or so is a logging road and the next ½ mile is a cat road that goes through a slashed area. This was originally cleared for a skihill, but never used. The slashing is very steep with a gain in elevation of about 1000 ft. in a ½ mile. The trail then flattens out for a short distance and traverses a marshy area. After skirting around a small lake, it immediately climbs steeply a couple of hundred feet to another marshy, gently sloping area. At the top of this slope, the trail enters a distinct valley. The elevation at this point is approximately 2000 ft. and the distance from the starting point about 2 miles.

The most used summer route continues more or less westerly, and climbs steeply up beside a creek (true right bank). At the top of this slope, the trail emerges into an open gently sloping valley, at elevation 2700 ft., which is about timberline near the coast. From there after crossing the creek, the trail gradually climbs up onto a ridge to the right (north) and follows this to the summit. A higher summit (4500 ft.) is reached by following the ridge as it continues northwesterly for about a mile.

A more pleasant and far easier winter route can be found by bearing left (southwest) up the valley instead of taking the steep summer route straight ahead. This route follows the valley up, gradually climbing and bearing right (north). Where this route eventually climbs out of the valley, the timber is quite open and poses no problem for skiers. After emerging from the valley, bear left and follow a subsidiary spur in a westerly direction up onto the main, southeasterly ridge of Claque Mountain and follow it to the summit.

Allow 4-5 hours from the start of the trail to the summit, and 2-3 hours down.

DIRECTIONS:

After crossing the Kitimat River bridge on Hwy 25 (Haisla Blvd.), continue straight on to Enterprise Ave. then turn right (north) and drive along Enterprise which shortly turns left (west) and crosses the CN tracks. Just beyond, at the intersection with the logging road, turn right again and continue along the logging road in a northerly direction for just under a mile. Where the logging road makes a distinct right turn, turn left onto a side road. This side road is fine for about a mile which is where the cat road starts off straight ahead up the slashed area.

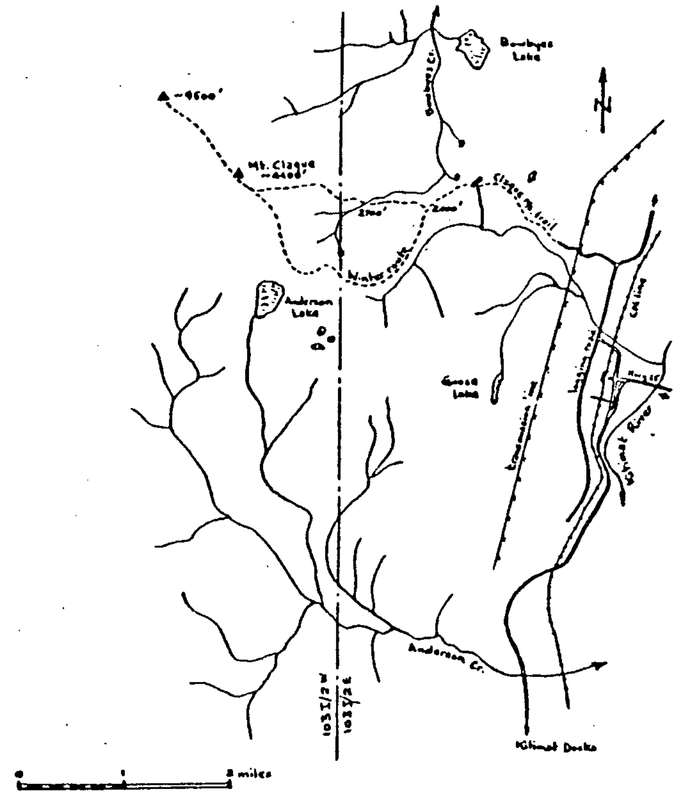
COMMENTS:

This trail gives very convenient access to alpine country for anyone living in or visiting Kitimat. It is a steep, muddy and somewhat unattractive route for the first couple of miles, but beyond that there are good views and pleasant alpine terrain. Once above timberline, there is easy access to a considerable area of good hiking and ski touring country.

As far as skiing is concerned, the problem is getting up and down the steep portion at the start. Except under extremely good snow conditions, most people will find it easiest to carry their skis both up and down this section.

It is recommended that this trail be used only when the wind is from the north; otherwise the fumes from the smelter and pulpmill detract significantly from one's enjoyment.

Young children and even older ones without previous hiking experience generally do not find this trail enjoyable due to steep muddy parts.



CLAGUE MOUNTAIN TRAIL [KT2]

APPENDIX V

Clague Mountain Park Regulations

CLAGUE MT. MUNICIPAL PARK - REGULATIONS

BACKGROUND

THE CLAGUE MOUNTAIN AREA WAS LEASED FROM THE CROWN IN 1963 ON A 21 YEAR LEASE AT AN ANNUAL RENT OF $185.50*. (SEE ATTACHED SKETCH.)

PURPOSE

THE PURPOSE OF THIS REPORT IS TO SUGGEST CERTAIN REGULATIONS TO CONTROL THE USE OF THE PARK IN RESPECT TO VARIOUS ACTIVITIES SUCH AS TIMBER CUTTING, CABIN BUILDING, DISPOSAL OF REFUSE FIRE PREVENTION, PROHIBITION OF HUNTING, ETC.

RECOMMENDATIONS

THAT THE DRAFT REGULATIONS ATTACHED TO AND FORMING A PART OF THIS REPORT BE CONSIDERED FOR ADOPTION.

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* THE RENT IS SUBJECT TO REVIEW AFTER A PERIOD OF FIVE YEARS.

PLANNING DEPARTMENT,
REPORT NO. 6501,
JANUARY, 1965.

THE CORPORATION OF THE DISTRICT OF KITIMAT

BY-LAW ______

A BYLAW to establish regulations for Clague Mountain Park.

WHEREAS it is intended that the land known as Clague Mountain Park as leased from the Crown under the terms of the "Park and Recreation Land Lease Bylaw No. 1, 1963, be established as a municipal park.

AND WHEREAS it is intended that Clague Mountain Park be preserved and used as a wilderness reserve.

AND WHEREAS it is intended that Clague Mountain Park remain a recreational area to be enjoyed by hikers, skiers and campers.

AND WHEREAS it is considered that regulations should be established to ensure the continued enjoyment of Clague Mountain Park for recreational purposes.

NOW THEREFORE the Council of the Corporation of the District of Kitimat, in open meeting assembled, amends the Kitimat Municipal Code by enacting the following:

1. This Bylaw may be cited as the "Clague Mountain Park Regulations Bylaw No.1, 1965".

2. Part XI is amended by adding the following Division 2 :-

Division 2 - Municipal Parks

Subdivision 1 - Clague Mountain Park

Interpretation

3. 11,210 Within this subdivision "Park" means the area described within the Park and Recreation Land Lease Bylaw No. 1; 1963.

Designation

4. 11,211 The area as described in the lease executed between the Municipality and the Crown and as described within the Park and Recreation Land Lease Bylaw No.1, 1963 is hereby designated as a Municipal Park.

Permitted Uses

5. 11,212 The following uses only shall be permitted within the Park:

(a) Skiing (b) Hiking (c) Recreation camping other than camping in trailers. (d) Activities normally associated with wilderness recreation with the exception of hunting. (e) Temporary concessions operated in conjunction with the permitted uses (a), (b), (c) or (d).

Permitted Structures

6. 11,213 No structure is permitted within the Park other than structures which are used or intended to be used in conjunction with the uses permitted under Section 11,212.

Permits Required for Structures and for Timber Cutting

7. 11,214 No person shall construct or occupy any structure for which a permit is required without obtaining a permit, and no person shall occupy, use, or continue to occupy or use any structure which was constructed prior to the coming into force of these regulations without obtaining a permit.

8. 11,215 (i) Park use permits are required for the erection or use of the following structures:

(a) Any cabin, outhouse or shed.
(b) Any structure used in conjunction with a concession.
(c) Any structure erected in conjunction with the operation of a ski tow.

(ii) No person shall cut any green timber for personal use without obtaining a timber cutting permit and paying stumpage charges as determined by the Crown.

Condition of Issuance of Permits

9. 11,216 (i) Any permit for a concession shall be temporary only and in no case shall it be valid for more than twelve months from the date of issue, but may be renewed.

(ii) No person shall lease, rent or charge a toll within the park unless such person has obtained a Park Use Permit in which such lease, rent or toll is authorized.

(iii) No park use permit issued for a concession shall be transferable.

(iv) The Authority Having Jurisdiction may impose conditions upon the issuance of any permit to control the location of any use or structure for which a permit is issued, to control the area from which trees may be cut by permit holders, and to ensure that adequate standards of safety and health are observed.

Application for Permits

10. 11,217 An application for a permit shall be in writing, and shall include:

(a) The name and address of the applicant.

(b) A full description of the proposed use.

(c) The date upon which the proposed use is to commence.

(d) The date upon which the proposed use is to terminate.

(e) The approximate location of the proposed use within the park and details of any structures which are proposed to be built.

(f) Where the proposed use is a concession full details of proposed prices and admission fees, tolls or charges.

(g) Any other information which the Authority Having Jurisdiction may require.

Grounds for Refusal

11. 11,218 The Authority Having Jurisdiction may refuse to grant a permit for the following reasons:

If the location of the proposed structure or use will:

(a) Interfere with the use of existing or proposed roads, ski slopes or trails.

(b) Be likely to cause pollution of any lake or stream.

(c) Be in any way detrimental to the full enjoyment of any part of the park by the public.

Cancellation of Permits

12. 11,219 The Authority Having Jurisdiction may cancel any permit if the person to whom the permit was issued has:

(a) Failed to use the permit for the prupose for which it was issued within 6 months of the date of issue.

(b) Failed to comply with the conditions of the permit.

(c) Failed to comply with the regulations of this division.

Disposal of Improvements

13. 11,220 (i) Where a permit has expired or been cancelled any cabins or other improvements which have been constructed under the permit shall, within 60 days of the date of expiration or cancellation of the permit, be removed from the park or disposed of to the satisfaction of the Authority Having Jurisdiction.

(ii) Where a permit holder has failed to remove or dispose of improvements to the satisfaction of the Authority Having Jurisdiction, within 60 days of the date of termination of his permit, the improvements shall be forfeited and shall become municipal property, and the Authority Having Jurisdiction may order that they be disposed of in any way that he thinks is suitable.

Appeal to Council

14. 11,221 Any applicant or holder of a Park Use Permit may appeal to Council any decision by the Authority Having Jurisdiction pertaining to the refusal of a permit, the cancellation of a permit, the imposing of conditions upon the issuance of a permit, or the designation of areas where tree cutting is prohibited.

Fees

15. 11,230 The following annual fees shall be paid to the Authority Having Jurisdiction:

(a) Any concession $100.00

(b) Any cabin together with one outhouse used in conjunction with it . . . . $ 10.00

(c) Any other structure for which a permit is required. . $ 10.00

Disposal of Sewage and Garbage

16. 11,235 (i) No person shall throw, place, discharge, or otherwise deposit any substance, matter, or thing in or near any watercourse or body of water, in the park, where such action might reasonably be expected to result in the pollution of water in the park.

(ii) All sewage, refuse, garbage, waste paper, cans, bottles, or any other debris or discarded material shall be buried or destroyed.

(iii) All outhouses must be located at least 25 ft. from any habitable building and have a pit 3 feet in depth or more. When abandoned the pit shall be filled with earth to original ground level and when in use it shall chemically treated or covered with soil daily.

Tree Protection

17. 11,238 (i) No person shall take any timber from the park.

(ii) No person shall cut any green timber except for firewood or for constructing a structure for which timber cutting permit has been obtained as authorized under Sec. 11215 (ii).

(iii) Notwithstanding Subsection (ii) of this section, no person shall cut trees from any part of the park which may be designated by the Authority Having Jurisdiction as an area where the cutting of trees would interfere with the enjoyment of the park by the public.

Fire Regulations

18. 11,240 (i) Except in an approved cabin stove or in a portable camp stove no person shall start a fire anywhere in the Park for any purpose without obtaining a permit from the Fire Department

(ii) No person, having started a fire for cooking or any other purpose, shall leave it without completely extinguishing it.

(iii) No person shall discard any lighted cigar, cigarette, match or any other burning substance anywhere within the park.

(iv) All indoor stoves must be provided with spark catchers and all heating equipment shall be subject to the approval of the Fire Department.

Roads and Parking

19. 11,242 No person shall park any vehicle on any existing or proposed road within the park in such a way as to obstruct the free passage of vehicles in either direction on any such road.

Firearms and Explosives

20. 11,244 No person other than an employee of the Provincial Fish and Game Department on duty, or a Police Officer on duty shall at any time have in possession within the park any firearm, gun, air gun, air rifle, air pistol, spring gun or explosive.

BY-LAW NO. ________ 6.

Game Protection

21. 11,246 (i) No person shall molest, pursue, hunt, shoot, trap, wound, capture, destroy, or in any manner interfere with or attempt to interfere with any animal or bird within the Park.

(ii) No person shall have any dead bird or animal in his possession within the Park.

22. This Bylaw shall take effect and come into force and be binding on all persons as from the date of adoption.

DONE AND PASSED by the Municipal Council this ________________ day of ____________________ 1965.

RECONSIDERED AND finally adopted by the Municipal Council of the Corporation of the District of Kitimat this ________________ day of ____________________ 1965.

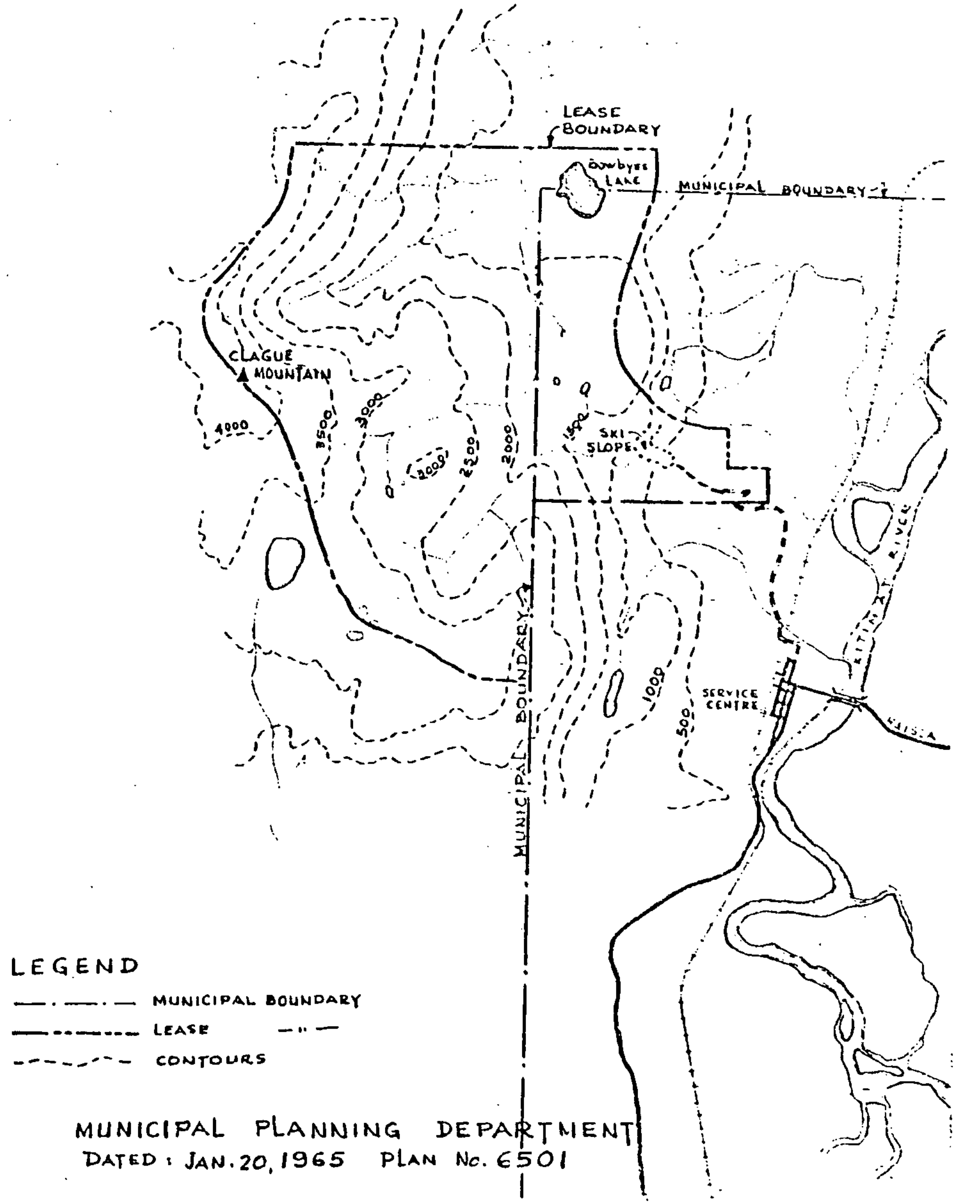
Reeve

Clerk

CERTIFIED a true and correct copy of Bylaw No. ______________ passed by the Municipal Council of the Corporation of the District of Kitimat on the ____________________ day of ____________________ 1965.

Clerk of the Corporation of the District of Kitimat.

CLAGUE MOUNTAIN LEASE



APPENDIX VI

Characteristic plant species of Clague Mountain Park, Kitimat, British Columbia

<u>Note</u>: The Biogeoclimatic Zone and Terrain Unit in which each of the photographs was taken are indicated.

Sorbus sitchensis - Sitka Mountain Ash

Location : Coastal Western Hemlock Zone (Wet Subzone)

$F^{G}bs$ - V terrain unit

Vaccinium ovalifolium - Tall Blue Huckleberry
or Oval Leaf Whortleberry
Location : Coastal Western Hemlock Zone (Wet Subzone)
$F^{G}bs$ - V terrain unit

Vaccinium parvifolium - Red Huckleberry

Location : Coastal Western Hemlock Zone (Wet Subzone)

$F^{G}bs$ - V terrain unit

Cornus canadensis - Bunchberry or Pigeon Berry

Location : Coastal Western Hemlock Zone (Wet Subzone)

$F^{G}bs$ - V terrain unit

Oplopanx horridus - Devil's Club

Location : Coastal Western Hemlock Zone (Wet Subzone)

$F^{G}bs$ - V terrain unit

Senecio triangularis - Giant Ragwort

Location : Mountain Hemlock Zone (Forest Subzone)
$M^{I}bs$ - V terrain unit

Veratum eschocholtzii (V. viride) - Indian Hellebore

Location : Mountain Hemlock Zone (Forest Subzone)

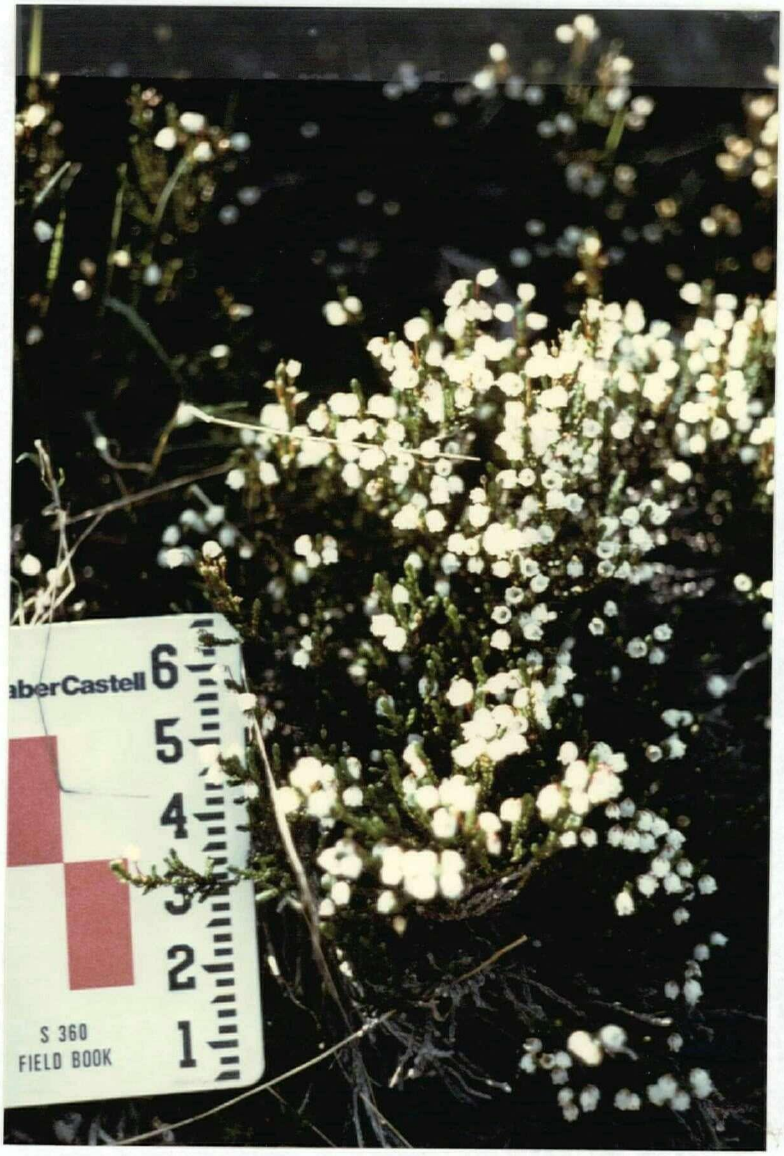
$M^{I}bs$ - V terrain unit

Spirea douglasii - Hardhack or Steeple Bush
or Douglas Spirea
Location : Coastal Western Hemlock Zone (Wet Subzone)
$F^{A}r$ - E terrain unit
(just west of Bowbyes Lake)

Castilleja augustifolia - Indian Paintbrush
or Painted Cup

Location : Mountain Hemlock Zone (Parkland Subzone)
$O^{F}l$ - S terrain unit
(adjacent to Main Meadow area of park)

Mimulus Lewisii - Red Monkey Flower
or Lewis Monkey Flower
Location : Mountain Hemlock Zone (Parkland Subzone)
$O^{F}1$ - S terrain unit
(adjacent to Main Meadow area of park)



Cassiope mertensiana - White Moss Heather

Location : Mountain Hemlock Zone (Parkland Subzone)

$\frac{\text{Oh - S}}{\text{Rh}}$ terrain unit

Saxifraga tolmiei - Alpine Saxifrage

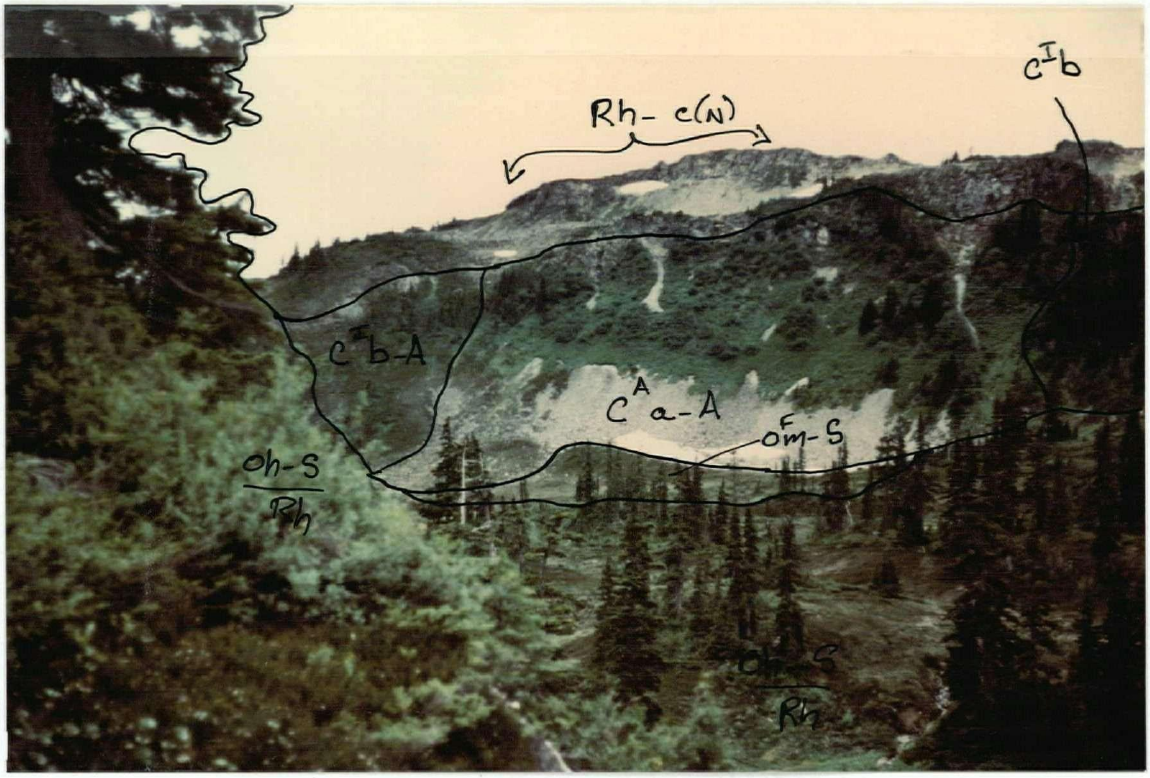
Location : Alpine Zone

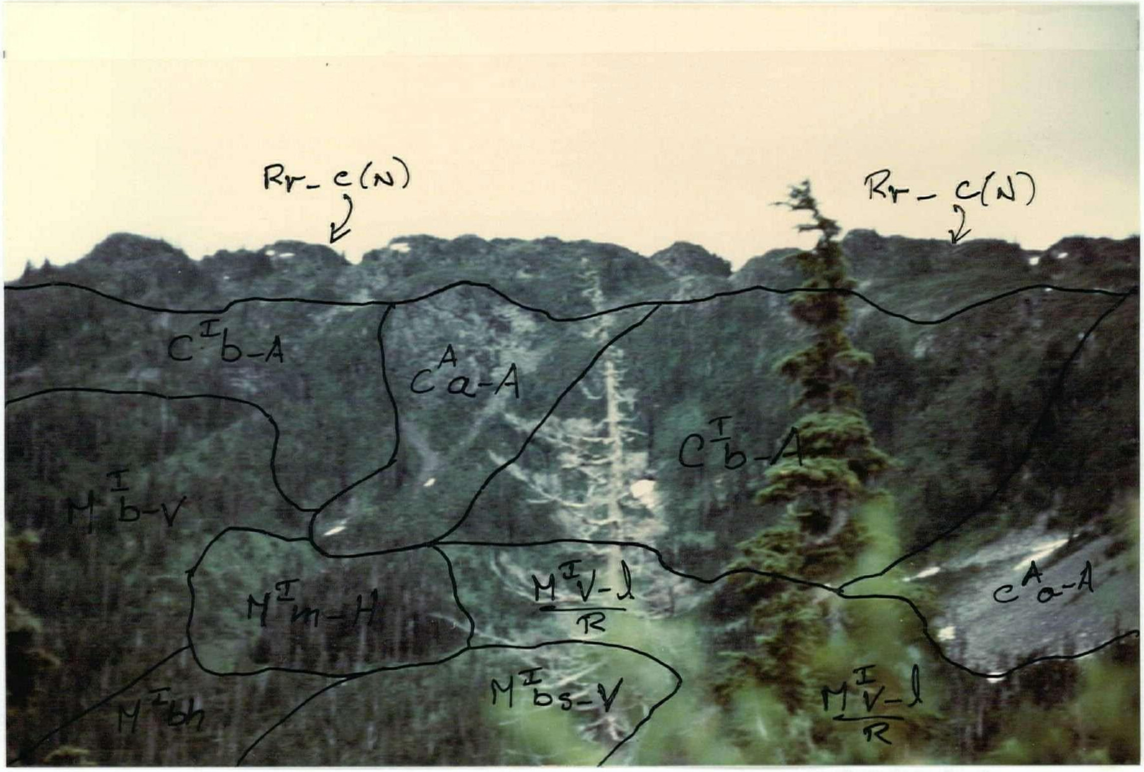
Rh - C(N) terrain unit

(near top of Clague Mountain)

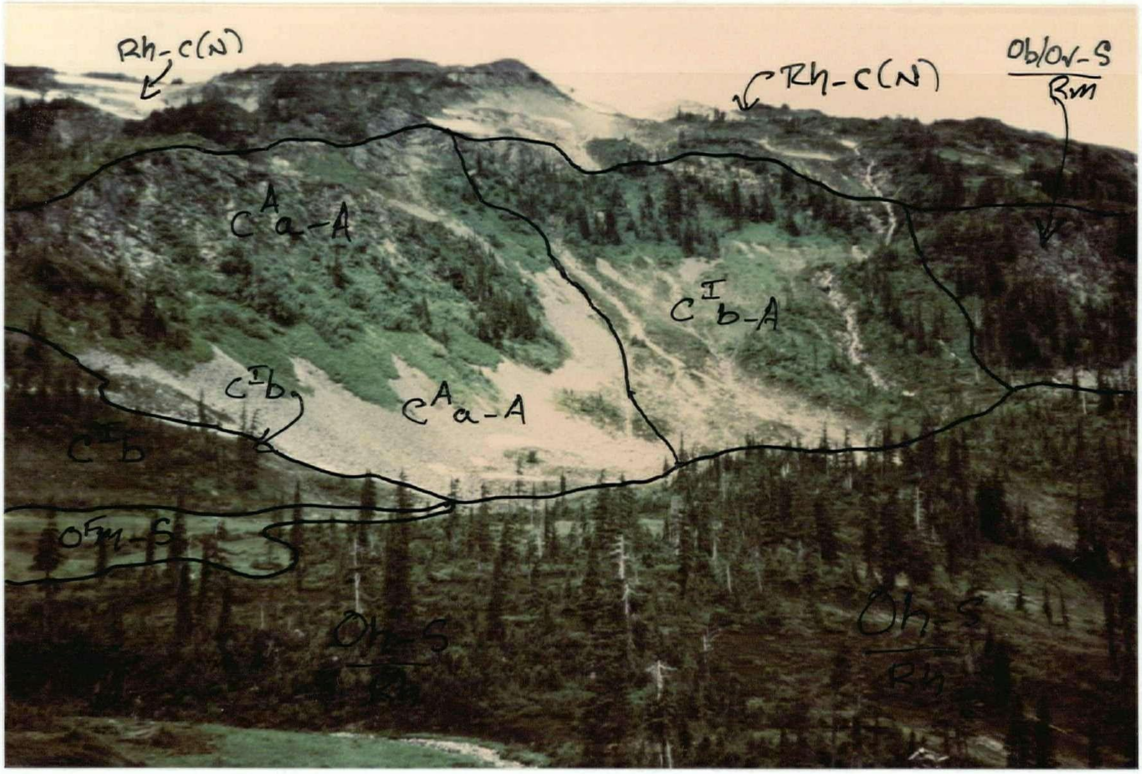
APPENDIX VII

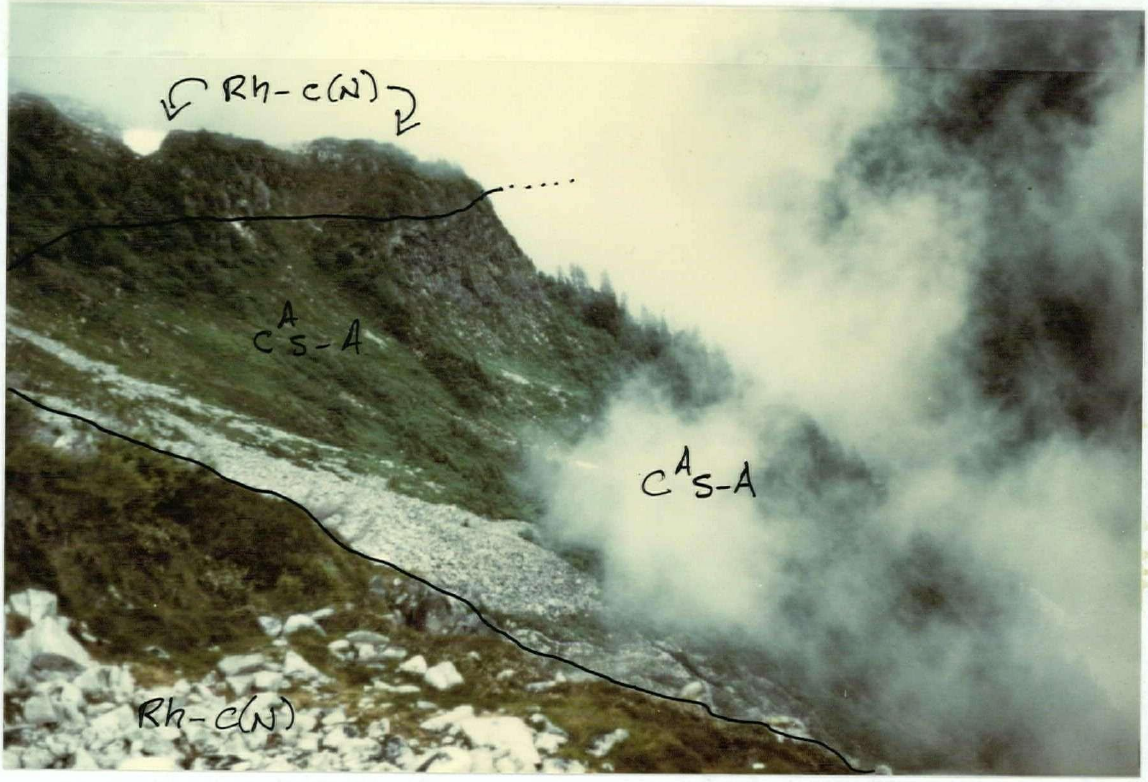
Photographs Showing Delineated Terrain Units

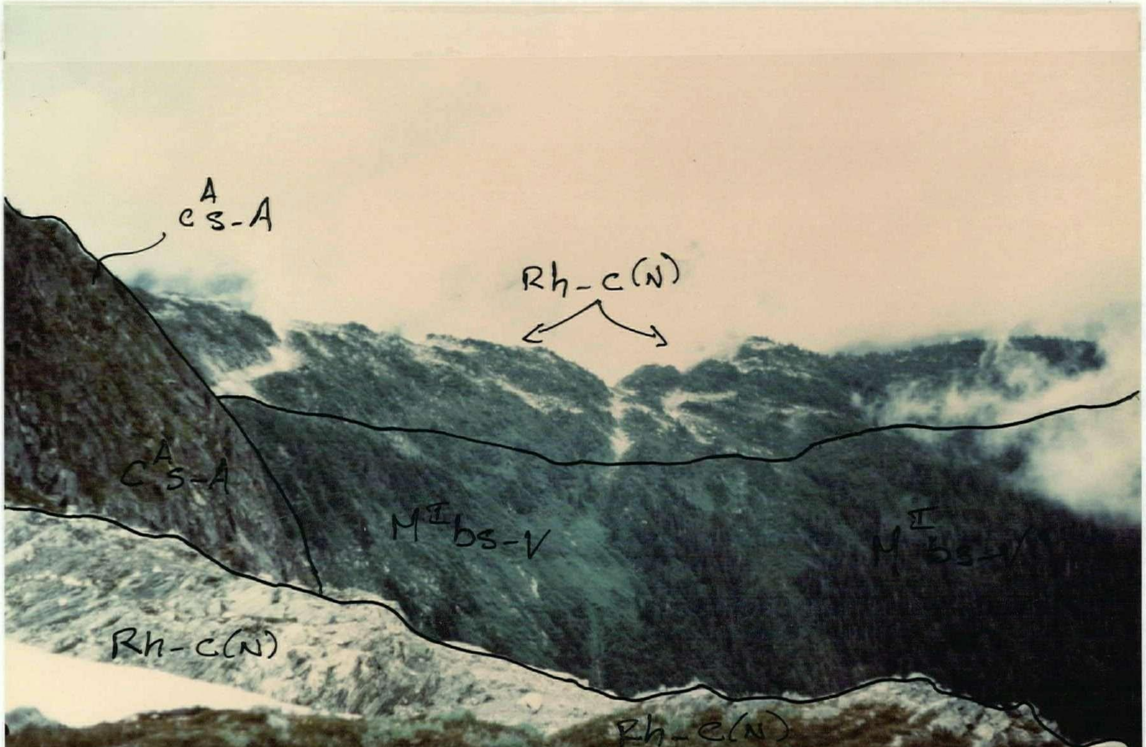

Rh- c(N)
$C^{I}b$
$C^{I}b$-A
$C^{A}a$-A
$O^{F}m$-S
Oh-S / Rh
Oh-S / Rh

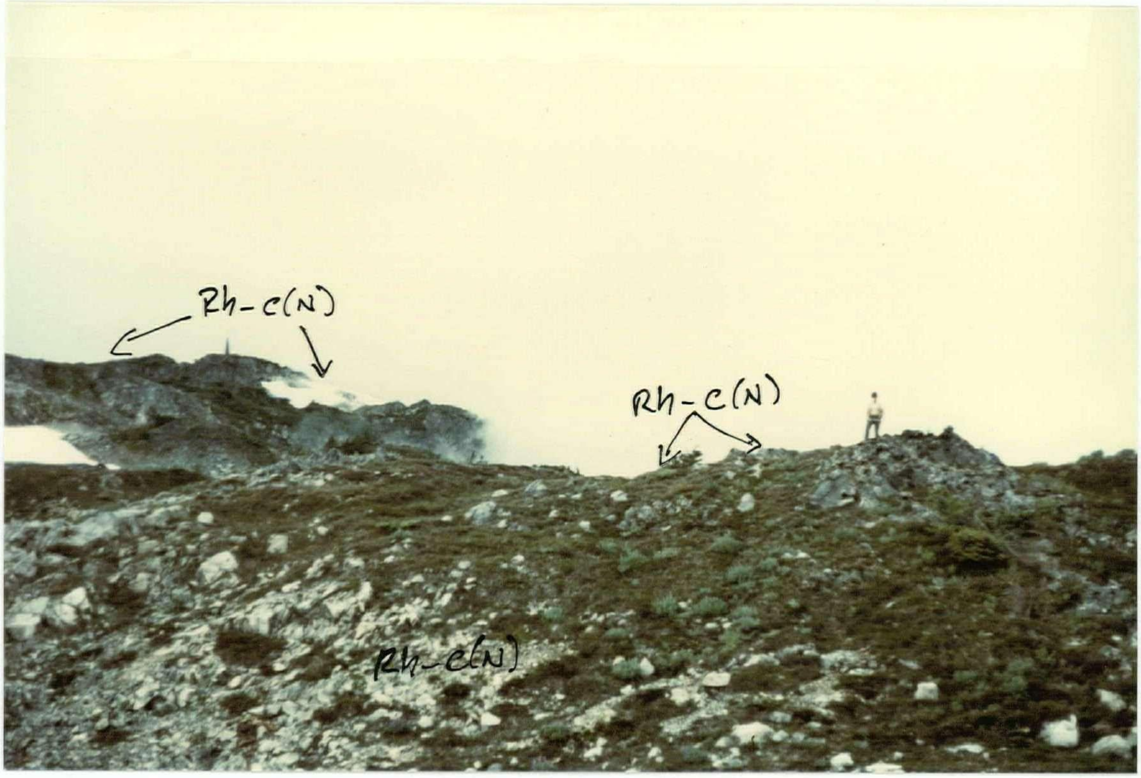

Rr- c(N)
Rr- c(N)
$C^{I}b$-A
$C^{A}a$-A
$C^{I}b$-A
$M^{I}b$-V
$M^{I}m$-H
$M^{I}V$-l / R
$C^{A}a$-A
$M^{I}bh$
$M^{I}bs$-V
$M^{I}V$-l / R

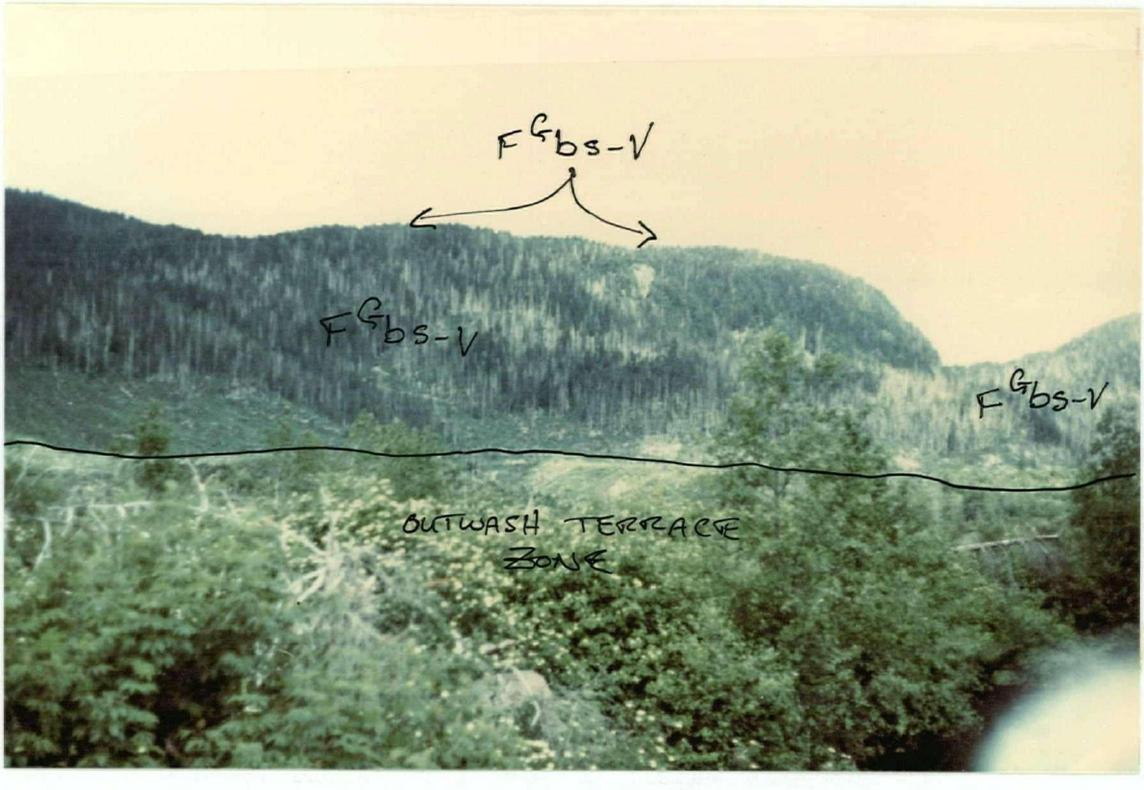

Rh-C(N)
Rh-C(N)
$C^{I}b$
$C^{A}a$-A
$C^{I}b$
$O^{F}m$-S
Oh-S / Rh
Oh-S / Rh

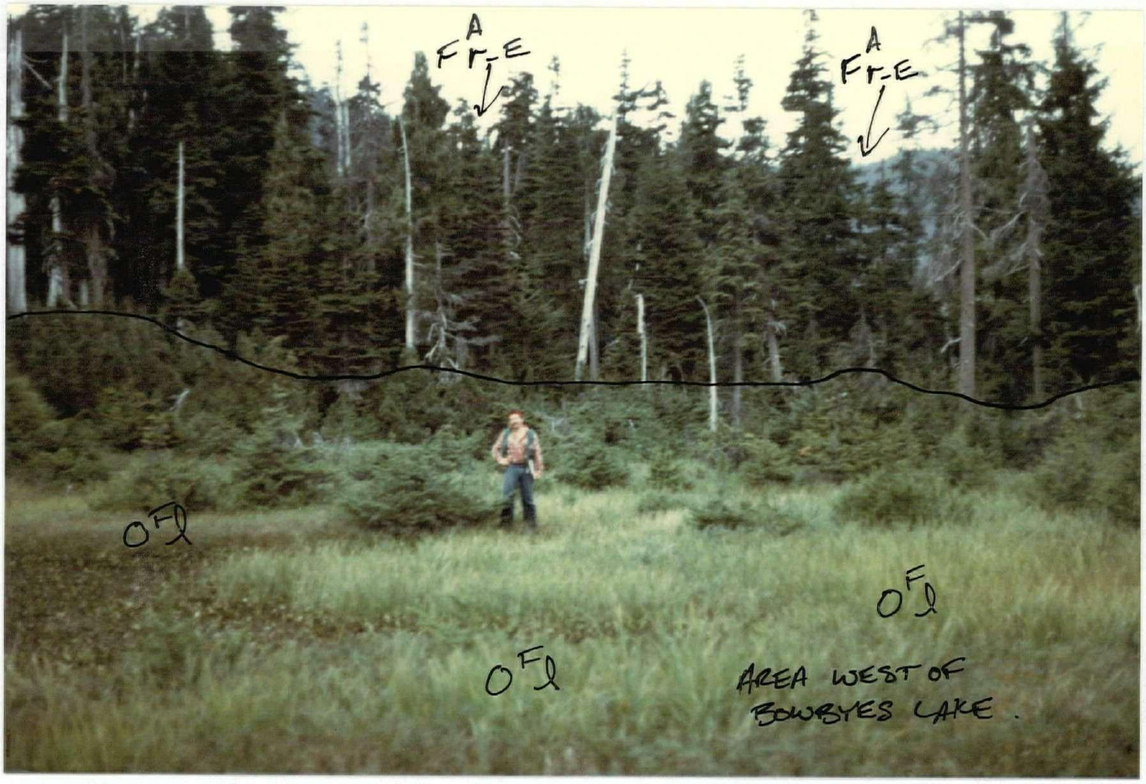

Rh-C(N)
Rh-C(N)
Ob/Or-S / Rm
$C^{A}a$-A
$C^{I}b$-A
$C^{I}b$
$C^{A}a$-A
$C^{I}b$
$O^{F}m$-S
Oh-S
Oh-S / Rh

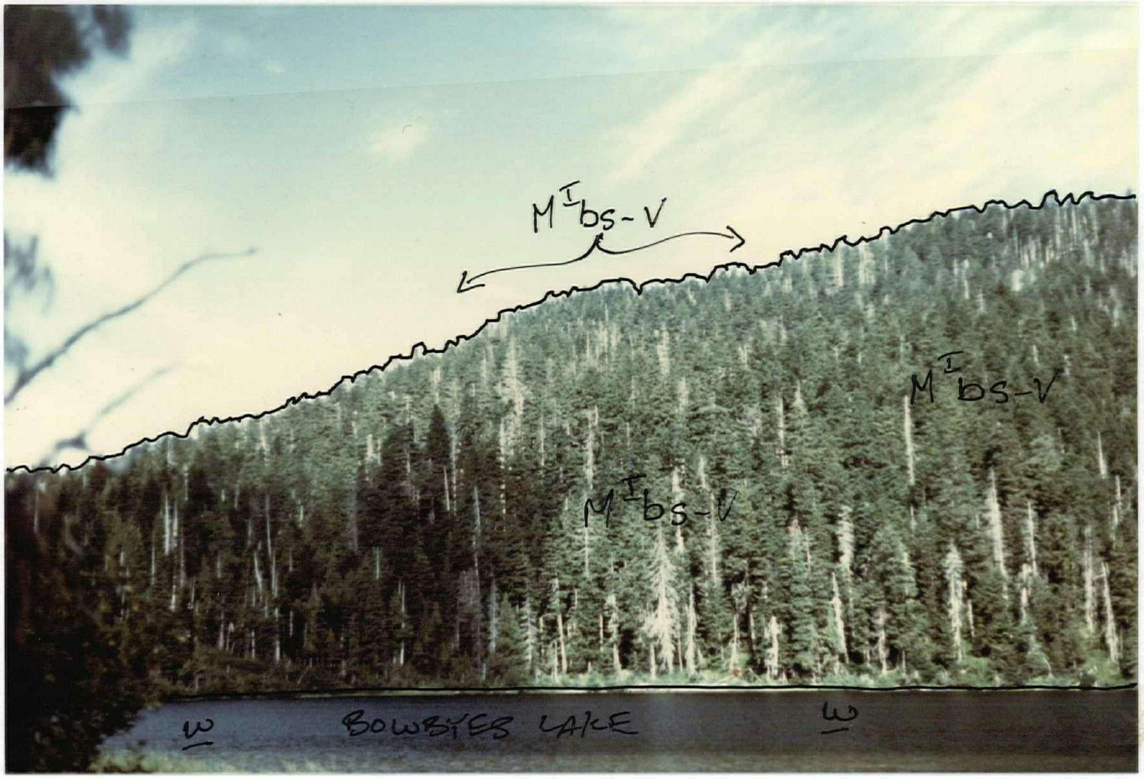

Rh-c(N)
C^A_S-A
C^A_S-A
Rh-c(N)

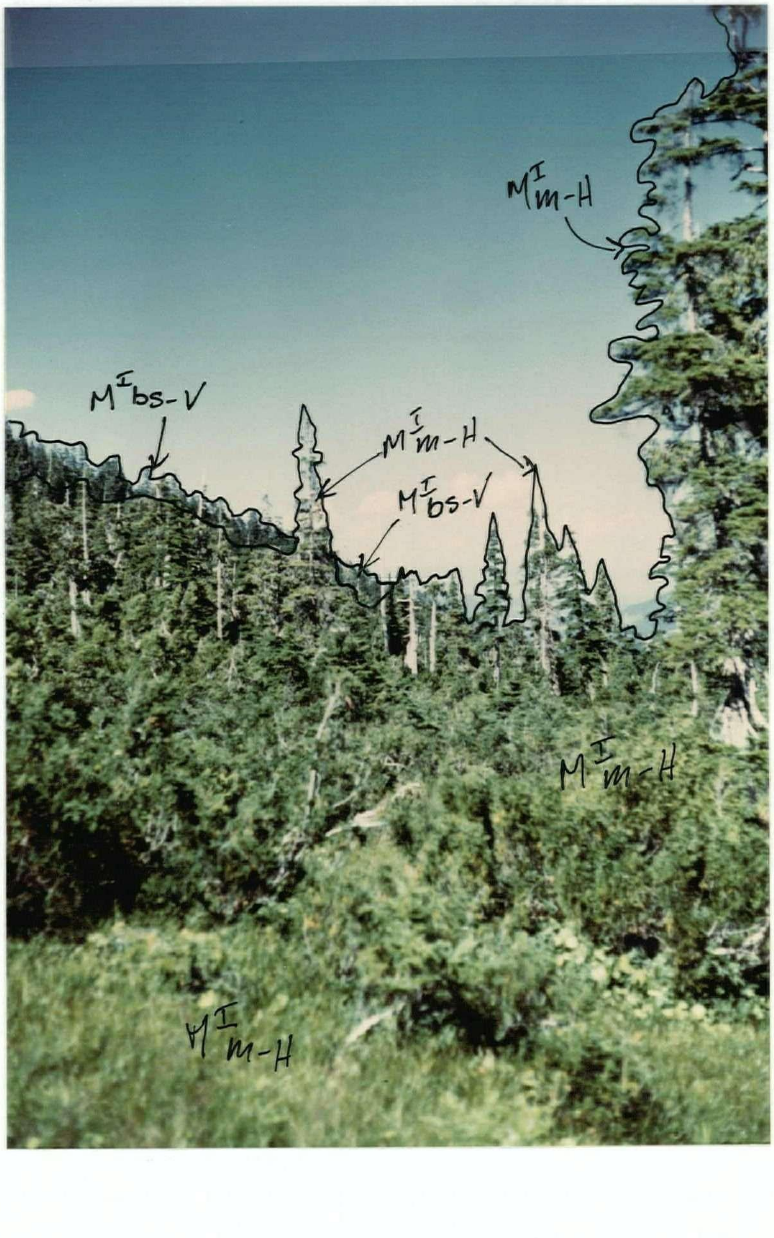

C^A_S-A
Rh-c(N)
C^A_S-A
M^{II}_{bs}-V
M^{II}_{bs}-V
Rh-c(N)
Rh-c(N)

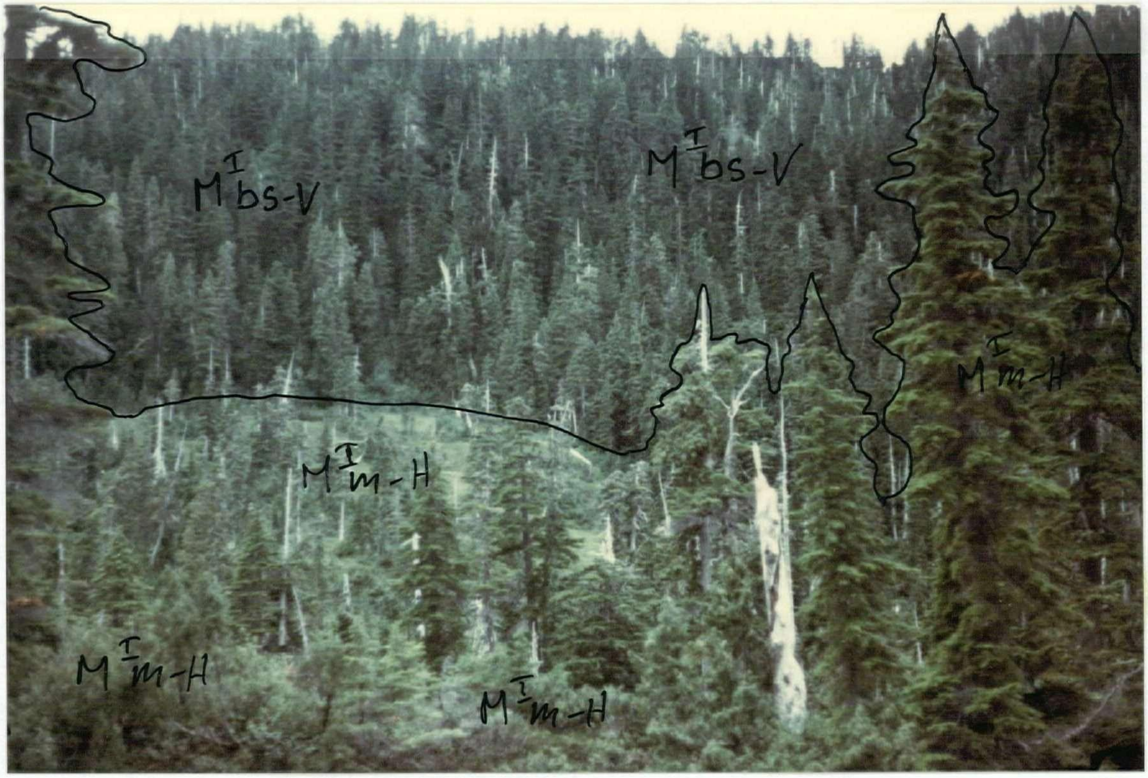

Rh-c(N)
Rh-c(N)
Rh-c(N)

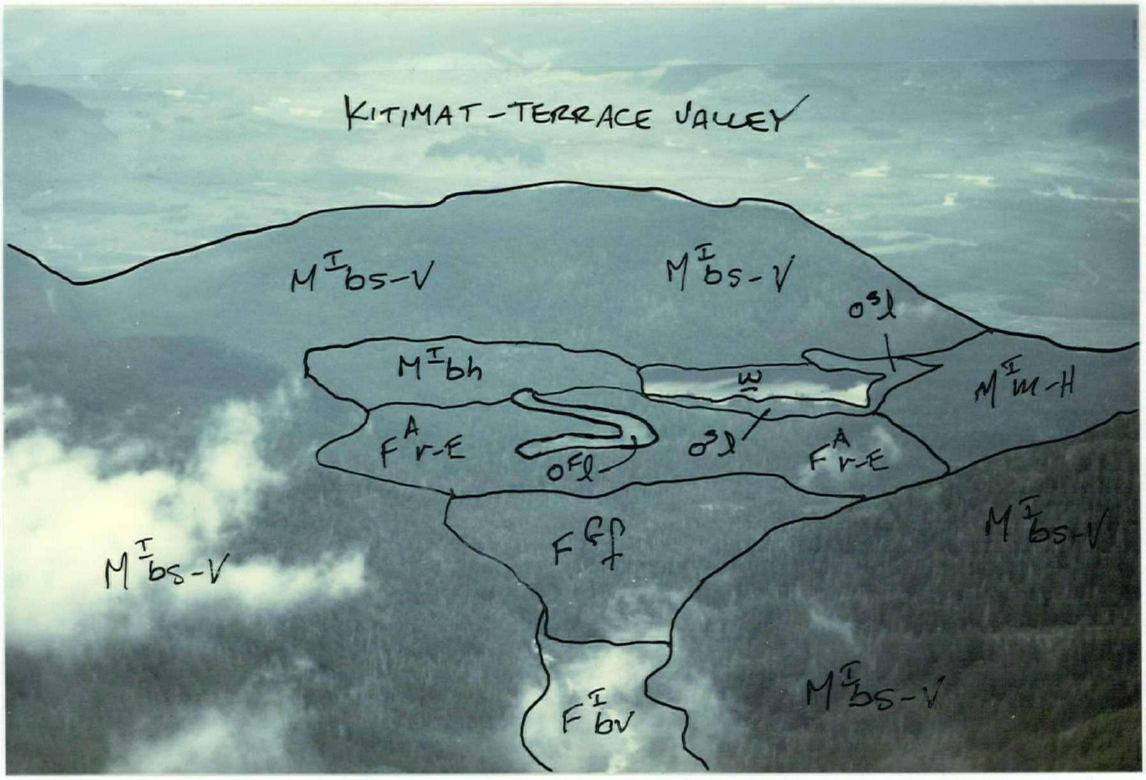

$F^{G}bs-V$
$F^{G}bs-V$
$F^{G}bs-V$
OUTWASH TERRACE
ZONE

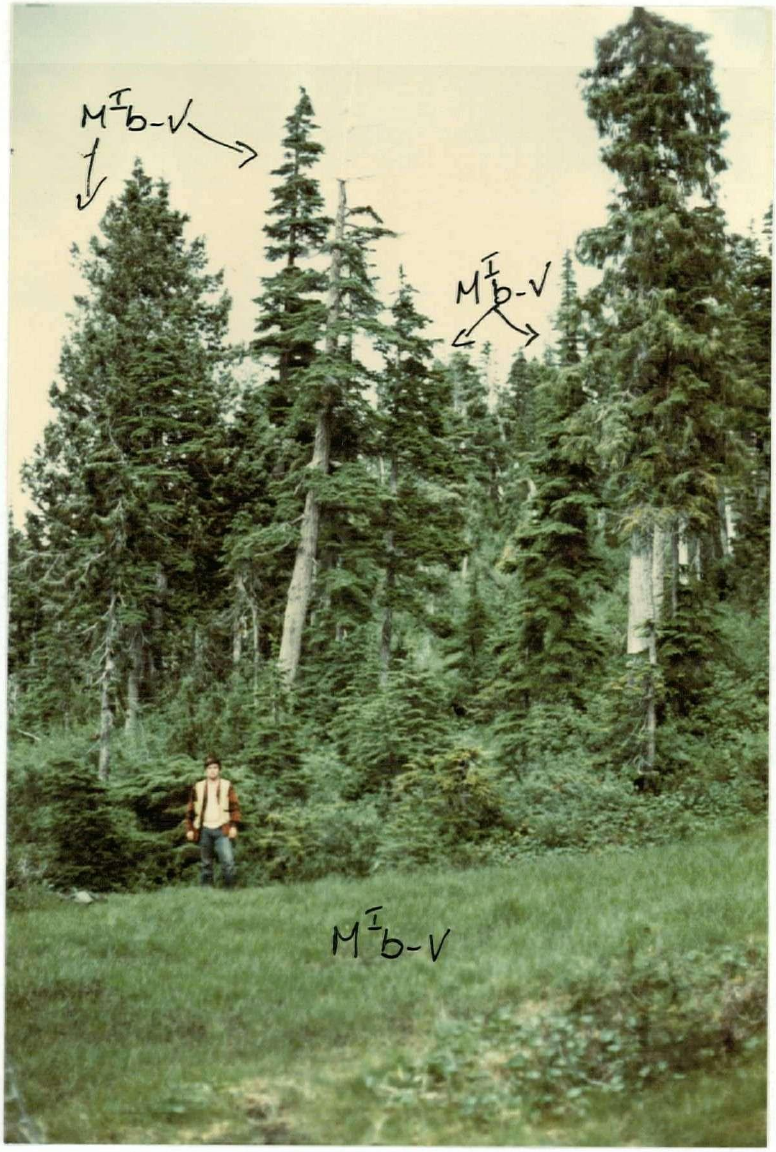

$F^{A}r-E$
$F^{A}r-E$
$O^{F}l$
$O^{F}l$
$O^{F}l$
AREA WEST OF
BOWBYES LAKE.

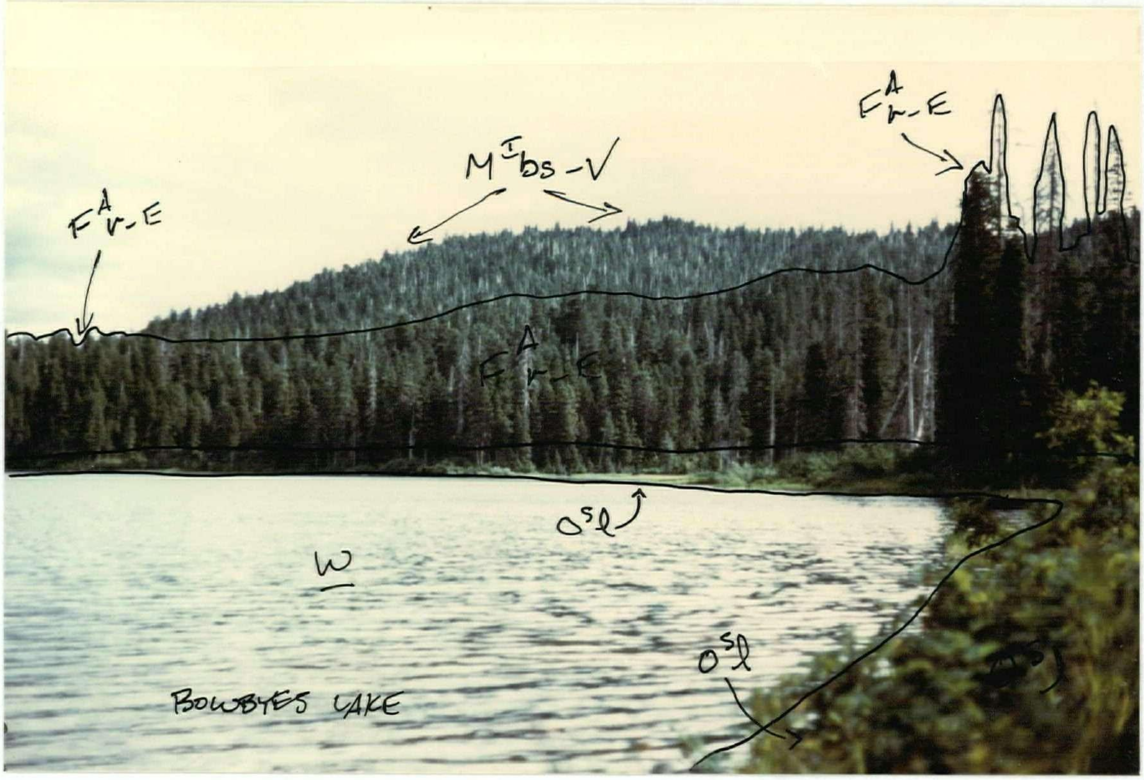

$M^{I}bs-V$
$M^{I}bs-V$
$M^{I}bs-V$
w
BOWBYES LAKE
w

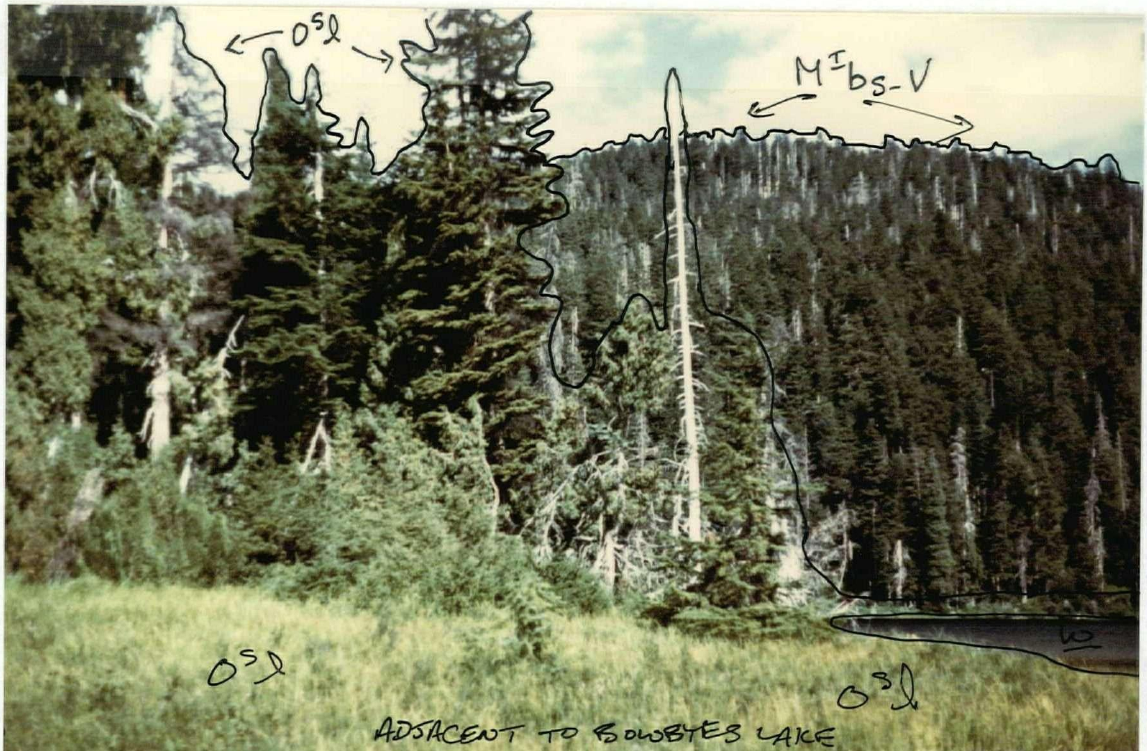

$M^{I}m$-H
$M^{I}bs$-V
$M^{I}m$-H
$M^{I}bs$-V
$M^{I}m$-H
$M^{I}m$-H

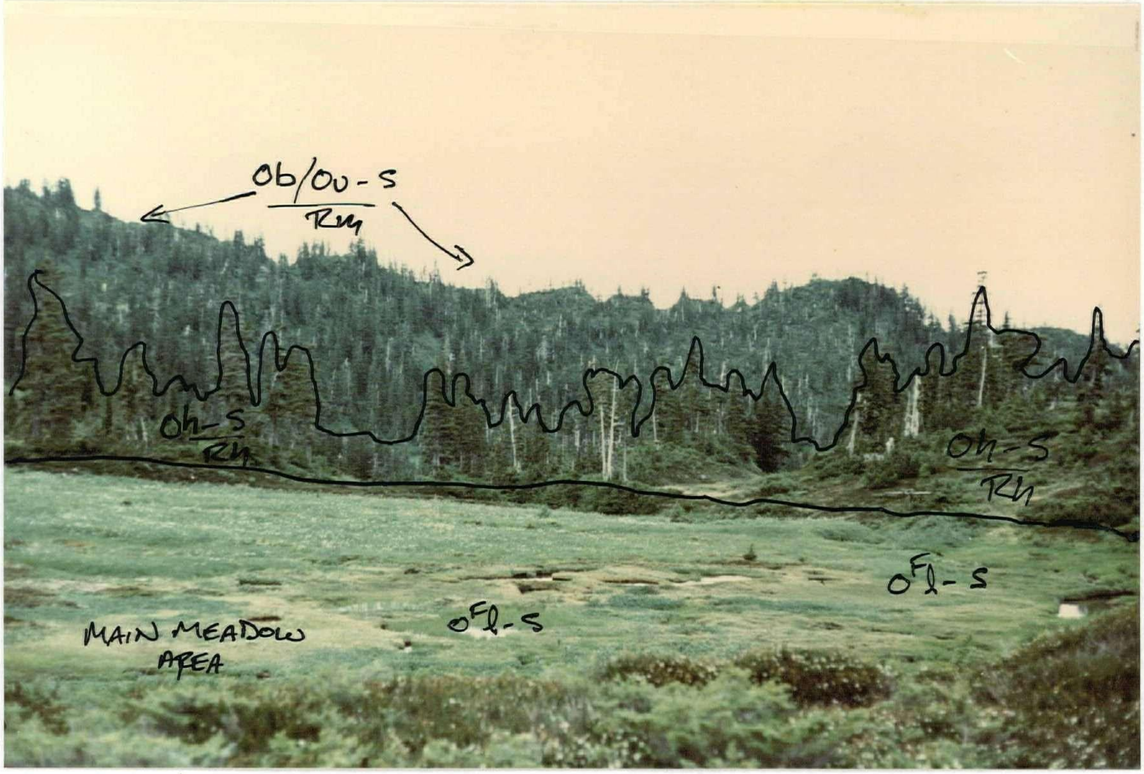

$M^{I}bs$-V
$M^{I}bs$-V
$M^{I}m$-H
$M^{I}m$-H
$M^{I}m$-H
$M^{I}m$-H

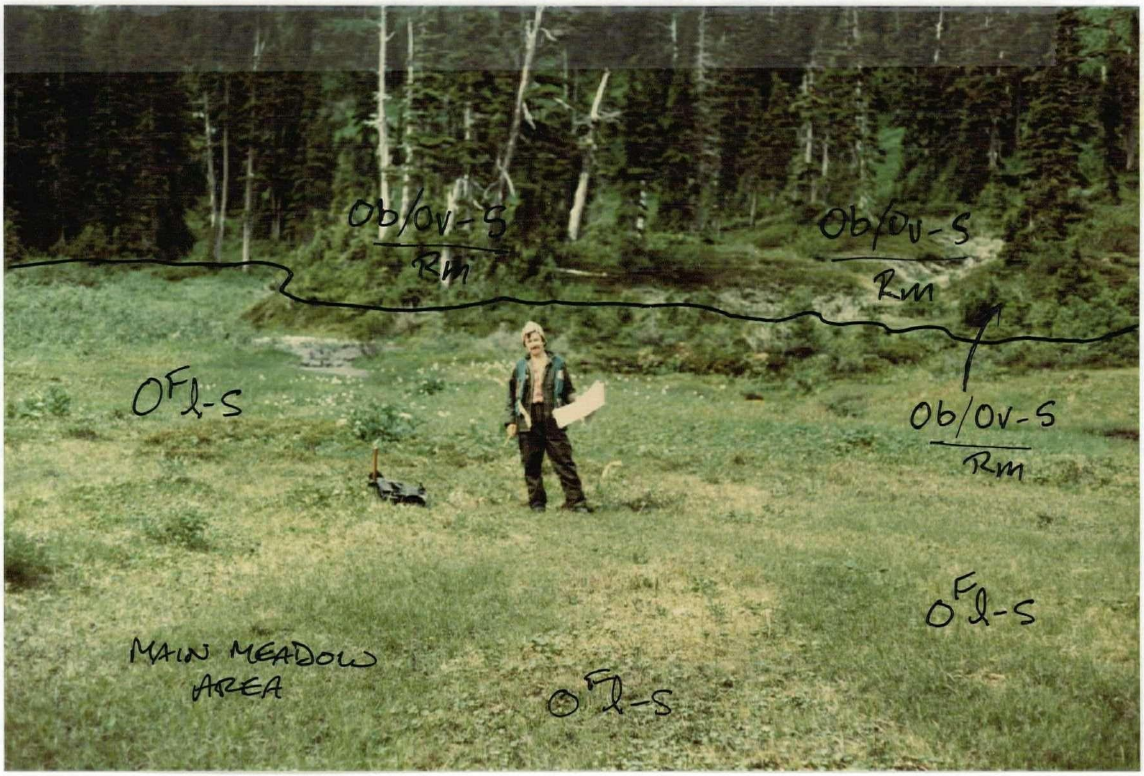

KITIMAT-TERRACE VALLEY
$M^{I}bs$-V
$M^{I}bs$-V
$O^{s}l$
$M^{I}bh$
w
$M^{I}m$-H
$F^{A}r$-E
$O^{s}l$
$F^{A}r$-E
$O^{F}l$
$M^{I}bs$-V
F^{gf}
$M^{I}bs$-V
$M^{I}bs$-V
$F^{I}bv$


$M^{I}b$-V
$M^{I}b$-V
$M^{I}b$-V


F^{A}_{r-E}
$M^{I}bs-V$
F^{A}_{r-E}
F^{A}_{r-E}
$O^{s}l$
W
$O^{s}l$
$O^{s}l$
BOWBYES LAKE


$O^{s}l$
$M^{I}bs-V$
$O^{s}l$
W
$O^{s}l$
ADJACENT TO BOWBYES LAKE


Ob/Ov-S
Rm
Oh-S
Rm
Oh-S
Rm
OFl-S
OFl-S
MAIN MEADOW
AREA


Ob/Ov-S
Rm
Ob/Ov-S
Rm
OFl-S
Ob/Ov-S
Rm
OFl-S
MAIN MEADOW
AREA
OFl-S


Oh-S
Rh
Oh-S
Rh
Oh-S
Rh
Oh-S
Rh

APPENDIX VIII

Terrain Classification Guide

TERRAIN CLASSIFICATION

Texture:

	SIZE / ROUNDNESS	mm 256	64	2	.062	.0039	
SPECIFIC	ROUNDED	b BOULDERY	k COBBLY	p PEBBLY			
SPECIFIC	ROUND OR ANGULAR				SANDY s	SILTY z	CLAYEY c
COMMON	ROUNDED	g GRAVELLY					
COMMON						f FINES	
COMMON	ANGULAR	a BLOCKY	r RUBBLY				

ORGANIC: e-fibric m - mesic h - humic

Genetic Material
- Anthropogenic--A
- Colluvial------C
- Eolian---------E
- Fluvial--------F
- Ice------------I
- Lacustrine-----L
- Morainal-------M
- Organic--------O
- Bedrock--------R
- Saprolite------S
- Volcanic-------V
- Marine---------W

Superscript Modifier
- Clastic
  - Glacial---G
- Organic
  - Bog-------B
  - Fen-------F
  - Swamp-----S
- Process
  - Active----A
  - Inactive--I

Surface Expression
- Apron----------a
- Blanket--------b
- Fan------------f
- Hummocky-------h
- Subdued--------m
- Level----------l
- Ridged---------r
- Steep----------s
- Terraced-------t
- Veneer---------v

Modifying Process
- Avalanched--------A
- Bevelled----------B
- Cryoturbated------C
- Deflated----------D
- Eroded------------E
- Failing-----------F
- Kettled-----------H
- Karst modified----K
- Nivated-----------N
- Piping------------P
- Soliflucted-------S
- Gullied-----------V
- Washed------------W

e.g. $gF^{G}t$-V
Rs-A

APPENDIX IX

Definitions and Potential Frost Action Ratings for Major Third Level Divisions of the Unified Soil Classification System

Definitions and potential frost action ratings for major third level divisions of the Unified Soil Classification System :

Soil Division & Definition	Potential Frost Action
GW - well graded gravels or gravel-sand mixtures, little or no fines	- none to very slight
GP - poorly graded gravels or gravel-sand mixtures, little or no fines	- none to very slight
GM - silty gravels, gravel-sand-silt mixtures	- slight to medium
GC - clayey gravels, gravel-sand-silt mixtures	- slight to medium
SW - well graded sands or gravelly sands, little or no fines	- none to very slight
SP - poorly graded sands or gravelly sands little or no fines	- none to very slight
SM - silty sands, sand-silt mixtures	- slight to high
SC - clayey sands, sand-clay mixtures	- slight to high
ML - inorganic silts and very fine sands, rock flour, silt or clayey fine sand or clayey silts with slight plasticity	- medium to very high
CL - inorganic clays or low to medium plasticity, gravelly clays, sandy clays, silty clays and lean clays	- medium to high
OL - organic silts and organic silt-clays of low plasticity	- medium to high
MH - inorganic silts, micaceous or diatomaceous fine sandy or silty soils elastic silts	- medium to very high
CH - inorganic clays of high plasticity, fat clays	- medium
OH - organic clays of medium to high plasticity, organic silts	- medium
PL - peat or other highly organic soils	- slight

Source: Way (1973)