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Ecological Reserve System Plan

Draft

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INTRODUCTION

In 1971, British Columbia assumed a national leadership role by passing the Ecological Reserves Act — the first legislation of its kind in Canada aimed exclusively at protecting special and representative elements in the natural environment.

The Act outlines five broad reasons for establishing ecological reserves. These reasons reflect the scientific, educational and ethical values to our society of ensuring that the natural diversity of animals, plants and their communities is preserved. Simply stated, they are permanent sanctuaries established in the province to:

- Serve as benchmarks for long-term scientific research and educational use;
- Preserve representative examples of plant and animal communities;
- Serve as examples of habitats recovering from modifications caused by human activity;
- Protect rare and endangered plants and animals in their natural habitat; and,
- Preserve unique or rare zoological, botanical or geological phenomena.

Of the 123 reserves selected and designated since 1971, most protect ecosytems representing the biogeoclimatic classification system compiled by Dr. Vladimir J. Krajina. This divides the province into 14 major zones and numerous subzones based on dominant vegetation, terrain, soils and climatic factors such as elevation, marine influence and latitude. Reserves exemplifying these zones and subzones range from Tranquille, near Kamloops, containing ponderosa pine and sagebrush plant communities, to Mount Tuam, on Saltspring Island, a mixed forest of douglas-fir and arbutus. Other reserves protect outstanding or rare/endangered features and, by their very nature, were selected in a less systematic fashion. These include Raspberry Harbour, on Williston Lake, which preserves a stand of high-

quality lodgepole pines for use in forest research, and Haley Lake, near Nanaimo, which protects the endangered Vancouver Island marmot.

Ecological reserves are not the only means for conserving and protecting the natural environment. The ecological reserves system is one important component in the larger, more generalized network of nature conservation lands and regulations which, in turn, can also contribute towards satisfying the objectives of the ecological reserves system. The provincial parks system, for instance, has a dual mandate to provide a balance between conservation and offering recreation opportunities to the public. But ecological reserves comprise a vital, specialized system. They are the *only* conservation mechanism dedicated solely to ensuring that representative and special elements of the natural ecosystems are retained for their own self-perpetuation, as benchmarks and gene pools for scientific research, and for educational benefits. Considering this role, the system of ecological reserves can be viewed as a bastion for ecological preservation and knowledge. In essence, it is an environmental insurance program.

As it now stands, the B.C. system of ecological reserves is far from complete. If it is to meet the purposes stated in the Act, additional reserves are required to represent the ecosystems of the province and protect outstanding and rare features or species. The system is not representative of the entire province at present because establishing reserves has been easier in places where land-use conflicts are few, such as marine and alpine areas, and more difficult in places where land use is intensive. In addition, more emphasis must be given to the increasing role ecological reserves play in research and education.

The time has come to evaluate the present system of ecological reserves and develop a strategy for its orderly completion. The process necessary to meet this objective is referred to as the B.C. Ecological Reserve System Plan — an action plan for the systematic selection, designation and management of ecological reserves in a manner consistent with the goals and objectives of the Ecological Reserves Act. The following steps outline how this system plan will be implemented.

a. **Develop system policies.**
The goals and objectives of the Ecological Reserves Program are identified, along with areas where the program overlaps other conservation legislation.

b. **Develop a system design.**
This technical policy document defines the range of natural features in a complete system of ecological reserves, and contains technical classifications and lists detailing all natural features to be included.

c. **Develop evaluation policies and procedures.**
This establishes technical/policy criteria for the documentation, selection, evaluation and designation of candidate ecological reserves.

d. **Assess the existing system of reserves.**
This procedure involves comparison between the natural feature elements listed in the detailed system design and those now contained in existing and proposed reserves; identification of gaps; and development of a priorized "shopping list" of additional features and reserves required to complete the system.

e. **Complete the ecological reserve system.**
Suitable candidate reserves to fill the gaps identified in the system design are selected and evaluated. Administrative referral of ecological reserve proposals and/or designation by Order-in-Council follows.

f. **Develop management policies.**
These outline how ecological reserves should be managed to ensure they are adequately protected and serve their intended purposes.

g. **Develop administrative policies and procedures**
This policy statement outlines the timing and individual actions necessary to select, evaluate, designate and manage ecological reserves.

h. **Assess implications of the system plan.**
The impacts of creating the new reserves required to complete the system are identified and evaluated.

The objectives of this report are to address the first three steps on this list. They are:

- To develop system policies for the Ecological Reserves Program, based on the Ecological Reserves legislation and taking other conservation legislation into account;

- To delineate a comprehensive system design that lists the types of natural features which should be included in a system of ecological reserves;

- To develop a detailed system design for the selection of terrestrial natural features; and

- To develop some policies and procedures for the documentation, selection, evaluation and priorization of candidate ecological reserves.

SYSTEM POLICIES

INTRODUCTION

The Ecological Reserves System is defined as a network of individual land and water units set aside for preservation of representative, rare, threatened or endangered ecological values under the authority of the Ecological Reserves Act of British Columbia.

The purpose of the system plan, of which this policy document is a component, is to guide the orderly implementation of the Ecological Reserves Act. The aim of this policy document, along with supporting technical documentation, is to accomplish that goal. In this way, the array of ecological reserves set aside or sought after will comprise a *system*, wherein the individual reserves contribute to a greater whole that satisfies the broad societal need to protect ecological diversity and other special elements of nature.

SYSTEM POLICY BACKGROUND

The System Planning and Policy Framework

System policies are based directly on the intent of the statute, which is the source of the legal and conceptual principles of the system. As such, they comprise the initial step in system planning. A system plan describes and charts a logical progression from legislative mandate, through policies, selection criteria, priorities, evaluation of existing and candidate sites, to acquisition of new reserves and finally completion of the system. The function of system policies is to clarify and focus the implementation of the five broad purposes for reserves stated in the Act. By serving as the governing rules, system policies provide direction and order to the process of completing the system of ecological reserves.

There are two general categories of system policies. One of these is a special policy stream consisting of *goals and objectives*. These are elaborations and clarifications of the five purposes identified in the Act. By stating *what* must be accomplished, they express the mission of the ecological reserves system.

The second category consists of *supporting system policies*. These provide additional clarification and instruction as to how the system ought to be developed and how the goals and objectives ought to be implemented. These supporting policies include: viability; categories of reserves; integration with the nature conservation network; and a process for completing the system.

The Function of Goals and Objectives

Goals and objectives are institutional targets against which progress can be measured. The Ecological Reserves System can be viewed as a system of geographically distinct land and water units, with each unit contributing in specific ways to achieving the overall system goals and objectives.

Goals express the *long-range mission* for the administering agency (Ministry of Parks) in terms of meeting the purposes identified by the statute. Therefore, goal statements for the ecological reserves system derive directly from the purposes stated in the Act. They point the administering agency at long range, generalized destinations.

The function of system objectives is to serve as either more specific steps toward or as components of a given system goal. By applying a specific strategy or method, each objective is independently achievable. Also, the series of objectives can be arranged in the most appropriate sequence for the agency to direct its attentions. System objectives tend to be medium term, achievable steps toward the broader goals. However, regardless of their own complexity or time frame, objectives must directly lead the agency toward accomplishing its goals.

Viability

In setting aside ecological reserves, it is fundamentally important that there is a reasonable certainty of long-term viability for the values they are intended to protect. Viability is a central concept because it refers to both the long-term workability or feasibility of reserves in achieving their intended objectives, as well as the success of the living elements contained by reserves. Since the basic tenet of the Ecological Reserves Act is to protect ecological diversity and special natural phenomena, it is imperative that a reasonable certainty of long-term ecological

viability exists for every site or area set aside. In the context of ecological reserves, viability refers to the undisturbed continuation of the natural conditions, characteristics and processes for which each reserve is established. While there cannot be an absolute guarantee of viability, reserves can be selected and geographically defined to maximize the likelihood of their long-term freedom from environmental impacts or degradation.

In completing the system, there are several important considerations toward ensuring this viability. The primary consideration is the strength of the institutional arrangement under which a particular reserve is designated. The Ecological Reserves Act absolutely excludes the influence of other legislation within established reserves, thus enhancing the likelihood of viability. Other legislation aimed at nature conservation that may be compared to this statute varies in the degree of exclusion of potentially disruptive activities.

The following interdependent factors modify viability:

- natural characteristics of each ecological feature;
- conflict/compatibility of adjacent land uses;
- fragility of the particular ecological values;
- security of buffer zones;
- size of reserve;
- boundary configuration; and,
- rarity of particular elements.

Where there are adjacent land uses of a scale or type that could significantly impact ecological characteristics, depending upon the fragility of those characteristics, there is a need for a larger reserve, for buffer zones, or for boundaries that afford greater protection. Replication of ecological characteristics, within a given reserve or by geographically distinct reserves, is another means of enhancing the likelihood of the viability of the ecological values.

Once a reserve is selected and established, management strategies may be applied to increase or maintain the viability of that site.

Categories of Reserves

The Act states that ecological reserves serve a variety of purposes. As a component of a system, each reserve plays a distinct role in regard to protection of representative natural ecosystems, protection of rare or outstanding ecological values or natural phenomena, and suitability to scientific and educational uses. Moreover, reserves vary widely in terms of the fragility of the elements they are intended to protect, and in their relationship to adjacent land uses and designations.

Given this variety, it is important for system policies to provide a general framework or guide for subsequent management and administration of reserves. This is the purpose of categorization. A simple set of distinct categories, each defined in terms of basic management and administrative strategy, is a basic tool for organizing and explaining the system.

Integration with the Nature Conservation Network

While the Ecological Reserves Act is unique in purpose and mandate, a number of other statutes are also oriented to related aspects of nature conservation.

Evaluating the ecological reserves system in the context of other nature conservation mandates and associated programs assists in defining and focusing the system, in terms of both its own purposes and the broader interests to society of nature conservation. As well, awareness of the conservation roles of other land designation and regulatory mechanisms can help to coordinate efforts among the administering agencies, thus maximizing individual and joint effectiveness.

For example, other legislation often helps the ecological reserves system to accomplish its objectives. Since the conservation mandates of other agencies have the ability to protect certain representative or special environments or ecological values, this may influence the selection of new sites for ecological reserve status, the determination of priorities, the need for or ability to obtain suitable buffer areas and other system considerations.

Table 1 is intended to highlight the main purposes and ecological conservation implications of the various key federal and provincial statutes concerned with the

protection of natural environments, phenomena, biota and habitats. It is evident from this simple analysis that our society depends upon a spectrum of institutional arrangements to protect natural values. The ecological reserves system is just one important part of a larger network of designations and regulatory mechanisms aimed at nature conservation.

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A Process for Completing the System

System planning is founded on the idea of proceeding logically toward the completion of a system defined by goals. Due to the nature of the approval process for creating new ecological reserves, or any other form of land designation, it is possible to move only a limited number of candidate reserve areas toward formal establishment within any given time frame. Completion of the system in an orderly and logical fashion involves determining system priorities, identifying candidate areas to meet objectives, and evaluating these candidates to determine which is most suitable. It must be emphasized, though, that this is an idealized process. In practice, decisions may depart considerably from this standard.

The priorities of the system are determined by the relative importance of the objectives and their associated sub-objectives (i.e. desired natural elements, ecosystems, phenomena, etc.) This can be judged by considering criteria that examine the urgency of the issue.

Once the most appropriate sequence of objectives and sub-objectives has been determined, the next step is to identify suitable candidate areas for each sub-objective in its turn. This can be accomplished using the purely scientific criteria of the particular ecological characteristics sought. Identifying representative ecosystems in this manner is relatively straightforward. However, it is arguable whether unique and rare sites can be systematically identified. Except in cases where sites of significance are already known, it is more likely that such special sites will be discovered by chance. But to recognize such rare or unique occurrences, it is necessary to understand what is being sought, in terms of distinguishing criteria.

The third system planning step is evaluation of candidate areas. For each sub-objective, the candidates for addition to the system must be evaluated against a standard set of relative criteria. This process will determine their suitability or, if there are several alternative candidates, the most suitable area or areas to fulfill the particular system sub-objective and enter the approval process leading to designation.

SYSTEM GOALS AND OBJECTIVES

Goal 1: Representation and Protection of Natural Ecological Diversity

Goal Statement: The Ecological Reserve System will ensure that the natural ecological diversity of British Columbia is sustained through the protection of areas that contain viable, undisturbed, representative samples of British Columbia ecosystems.

Objectives:

Terrestrial and Freshwater Ecosystems:
To ensure that at least two viable, representative examples of each of the terrestrial and freshwater ecosystems of the biogeoclimatic zones and subzones typical of British Columbia's natural environment, are protected in Ecological Reserves or within comparable conservation designations.

Marine Biotic Zones and Subzones:
To ensure that at least two representative examples of each of the major biotic zones and subzones of British Columbia's inner and outer coasts are protected in Ecological Reserves or in comparable conservation designations, and by supportive regulations under pertinent federal and provincial legislation that is concerned with the marine environment.

Goal 2: Protection of Rare, Threatened or Endangered Biota in Natural Habitats

Goal Statement: The Ecological Reserve System will ensure that selected viable occurrences and special habitats of rare, threatened or endangered species or populations of native plants and animals are protected from disturbance from all forms of human use and occupation.

Objectives:

Native Terrestrial and Freshwater Plant Species:
To ensure that at least two viable occurrences of each of the most rare, threatened or endangered native species and/or populations of terrestrial, wetland and freshwater plants are protected in Ecological Reserves, within comparable conservation designations or, if these are not achievable, by formal agreements with landowners.

Native Terrestrial and Freshwater Animal Species:
To ensure that at least two viable occurrences of each rare, threatened or endangered native species and/or populations of terrestrial, wetland and freshwater animals and their critical habitats are protected in Ecological Reserves, within comparable conservation designations or, if these are not achievable, by formal agreements with landowners.

Native Marine Flora:
To ensure that at least two viable occurrences of each rare, threatened or endangered native species and/or populations of marine flora are protected in Ecological Reserves or in comparable conservation designations, and by supportive regulations under pertinent federal and provincial legislation concerned with the marine environment.

Native Marine Fauna:
To ensure that at least two viable occurrences of each rare, threatened or endangered native species and/or populations of marine fauna and their critical habitats are protected in Ecological Reserves or within comparable conservation designations, and by supportive regulations under pertinent federal and provincial legislation concerned with the marine environment.

Goal 3: Protection of Examples of Unique or Rare Natural Features

Goal Statement: The Ecological Reserve System will ensure that exceptional examples of botanical, zoological, geological, paleontological and other natural phenomena highly sensitive to human impact, are adequately protected where they are found throughout the Province from disturbance from all forms of human use and occupation.

Objectives:

Terrestrial and Freshwater Native Botanical Features:
To ensure that one or more exceptional examples of each type of terrestrial, wetland and freshwater botanical phenomena (communities, associations, particular specimens), that are highly sensitive to human impacts, are adequately protected in Ecological Reserves in comparable conservation designations or, if these are not achievable, by formal agreements with landowners.

Terrestrial and Freshwater Native Zoological Features:
To ensure that one or more exceptional examples of each type of terrestrial, wetland and freshwater zoological phenomena (eg. breeding or other concentrations, sites of unusual diversity, sites of unusual behaviour of scientific interest), that are highly sensitive to human impacts, are adequately protected in Ecological Reserves, in comparable conservation designations or, if these are not achievable, by formal agreement with landowners.

Marine Botanical and Zoological Features:
To ensure that one or more exceptional examples of each type of marine botanical and zoological phenomena (eg. communities, associations, breeding or other concentrations, sites of unusual diversity, sites of unusual behaviour of scientific interest), that are highly sensitive to human impacts, are adequately protected in Ecological Reserves or in comparable conservation designations, and by supportive regulations under pertinent federal and provincial legislation.

Geological, Paleontological and Other Physical Features:
To ensure that one or more outstanding examples of each type of terrestrial and marine geological, paleontological or other physical features, that are of scientific interest and are highly sensitive to human impact, are adequately protected in Ecological Reserves, in comparable conservation designations or, if these are not achievable, by formal agreement with landowners.

Goal 4: Protection of Examples of Human-Modified Ecosystems

Goal Statement: The Ecological Reserve System will ensure that selected examples of human-modified ecosystems are set aside for the purpose of facilitating long-term, controlled research and educational programs regarding the impacts of certain activities and practices on ecosystems, the self-recovery of these ecosystems and techniques aimed at enhancing the recovery of these ecosystems.

Objective:

Reserves for Studying Ecosystem Recovery:
To establish Ecological Reserves at the request of recognized nature research institutions and agencies that propose to engage in long term monitoring and evaluation of the impacts of and recovery from human-induced disturbance to a given ecosystem, such as logging, cultivation, intensive grazing, human-caused fire, reservoir inundation, quarrying, mining and mine waste disposal, liquid and solid waste disposal and introduction of exotic species.

Goal 5: Scientific Research and Educational Study of the Natural Environment

Goal Statement: The Ecological Reserve System will ensure that representative natural ecosystems, rare or endangered native species and habitats, outstanding examples of natural phenomena and human-modified ecosystems are available for scientific research and educational study, to the extent that these activities are not detrimental to the resources being protected.

Objectives:

Creating a Scientifically Based System:
To establish a system of ecological reserves based upon scientific values and principles with regard to the protection and study of the natural environment.

Fostering Research and Study of Nature:
To foster institutionally supported, low-impact research and study of natural phenomena and processes, genetic diversity, benchmark conditions, recovery of human-modified ecosystems.

Fostering Public Opportunities for Nature Study:
To establish and manage a selection of Ecological Reserves capable of sustaining low levels of non-consumptive nature study and educational activities, in order to foster public awareness and understanding of ecological values and appreciation for the benefits of Ecological Reserves.

SUPPORTING SYSTEM POLICIES

Long-Term Viability of Ecological Reserves

General Policy:

All ecological reserves, as well as other designations deemed to be comparable for the purpose of accomplishing objectives of the ecological reserves system, must be selected and bounded in a manner that maximizes the likelihood of the long-term viability of the ecological values intended for protection.

Policy Guidelines:

(a) Size: Every reserve should be of such a size that it can sustain a viable sample of or afford adequate protection for the natural features over an indefinite period of time. Size requirements for ecological reserves vary widely with (a) the minimum area in which a particular ecological feature can be sampled in its entirety, and (b) the minimum area in which the longer-term survival of a feature is guaranteed. A system of small reserves may be chosen to better cover a given diversity, but such a system will be wasteful due to the larger total edge effect incurred in it. Therefore, the size of each ecological reserve must be determined by the minimum viable sizes applicable to the reserve's mix of features. Furthermore, size should be larger than this minimum in those cases where an equivalent increase in diversity can be accomplished by such enlargement.

(b) Boundaries: Ideally, boundaries should be recognizable and functional; by their configuration, they should provide protection for the ecological values contained. Therefore, wherever possible, the boundaries of ecological reserves and equivalent designations should reflect the configuration of ecological values (approximated by contours or major botanical distinctions), heights of land, watersheds, shorelines and other natural demarcations. The particular natural boundaries selected will depend upon the ecological values being encompassed. Boundaries coinciding with natural boundaries are also more easily marked in the field and are easier to recognize.

(c) Buffer Areas: To help ensure long-term viability, buffer areas surrounding sites of ecological significance are always desirable. The relative need for buffer areas encircling ecological reserves and equivalent designations is inversely related to the size and the boundary sufficiency of the reserve. On the other hand, the need for buffer areas is directly related to the fragility of the particular ecological values and the impact potential from adjacent land uses.

For instance, where an existing or proposed ecological reserve area is adjacent to high-impact land uses and activities, and where its size and boundary configuration are insufficient, as described above, then it is imperative that a buffer zone be created to reduce the anticipated impacts of the adjacent land use. Such a buffer should encompass an area that meets the size and boundary guidelines.

For highly fragile reserves or reserve components, buffer areas essential to the viability of the features to be protected should be part of the reserve itself. In all other cases, buffers may be of two types: adjacent areas where disruptive activities are excluded or adjacent areas where disruptive activities are modified. Of these, the first is superior but may only be achievable if the surrounding land use is a type of nature conservation designation.

(d) Replication: By including more than one occurrence of each particular ecosystem, element or phenomenon in the ecological reserve system, there is a greater certainty of the survival of the particular ecological values. The relative need for replication of the protection of ecological values is directly related to the fragility of these values, to the needs for research (comparative), to the proximity of high impact land uses, and to the adequacy of the size and configuration of a given ecological reserve. Ideally, it is desirable to replicate protection of all types of occurrences. The ability to achieve this will be modified by the likelihood of obtaining replicas of unique or rare occurrences, the feasibility of obtaining ecological protection in the context of other land-use demands, and the relative priority of replication in relation to satisfying all system objectives by at least single occurrences.

There are two types of replication: inclusion of multiple occurrences within one larger designation, and inclusion of similar occurrences in geographically separate designations.

The advantage of the first type of replication is a likelihood of greater ecological viability. Advantages of geographically separate replications are a smaller probability of losing the occurrence to natural catastrophes, in particular to fire, and the likelihood of sampling subtle geographical variations of the feature.

Occurrences of ecological values of a rare or an outstanding nature, being located more or less at random, should be protected wherever they are found. This means that it is appropriate to include such occurrences in at least two geographically separate ecological reserves or comparable designations.

Management Categories of Ecological Reserves

General Policy:

Ecological reserves and proposals for ecological reserve status will be categorized for management purposes as "Special Ecological Reserves", "Representative Ecological Reserves", or "Nature Study Ecological Reserves". These differentiations will be based upon their relative fragility, their rarity, their representativeness, their degree of current replication and their value for active research or educational programs. Each of these three categories corresponds to specific objectives of the Ecological Reserves System and may, accordingly, require different management approaches.

Policy Guidelines:

The following definitions of these three reserve categories are preliminary and general in nature. These definitions will be embellished and further refined in association with the development of comprehensive management policies for the ecological reserve system as well as specific management plans for individual ecological reserves.

(a) Special Ecological Reserve: This category includes those reserves which protect rare, threatened, endangered or exceptional features or species. By their very nature, these reserves normally protect very specific features and may have a low biological diversity. These features usually occupy small areas and, due to their special features, may attract public attention. Therefore, due to fragility, public access may be denied in such reserves, and research and educational activities may also be restricted. The specific management requirements of each of these reserves will be identified in their associated management plans.

(b) Representative Ecological Reserve: This category includes those reserves that, by their nature, are usually relatively large and may include a relatively high biological diversity. These reserves are fairly resilient in general, although they tend not to attract much public attention. Management actions in such reserves will normally be minimal. Research and educational activities will be allowed if they are not detrimental to the resources being protected. Zoning in relation to permitted uses and ecological fragility may be considered in the larger reserves. The specific management requirements of each of these reserves will be identified in their associated management plans.

(c) Nature Study Ecological Reserve: This category includes those reserves which offer high research and educational values and are, therefore, managed to maintain these values. The research or educational potential of a given reserve may result from its location (eg. proximity to a research facility or major population), or be a function of the type of natural features it protects. Both representative and special reserves may be categorized as "nature study" reserves and be intensively managed to serve such a function, provided that the resources contained are not imperilled by these activities. Many "nature study" reserves will be either human-modified sites or replications of representative or special sites. The specific management requirements of each of these reserves will be identified in their associated management plans.

Integration with the Nature Conservation Network

General Policy:

The Ecological Reserve System will be completed and managed as a discrete nature conservation strategy, with appropriate consideration given to the contributions of compatible, equivalent or superseding designations and regulations that may contribute to or strongly influence the accomplishment of the objectives of the system. Recognition of the comparable conservation roles of other agencies and the role that private lands may contribute means that completion of the ecological reserve system objectives involves the employment of cooperative strategies. While ecological reserves will form the core of the system, other designations will also participate in completing the system, and to this extent, the ecological reserves program will play a vital coordinating role in achieving satisfactory protection of the diverse ecological values of British Columbia.

Policy Guidelines:

(a) Comparable Protection: Several designations in other conservation-oriented legislation offer a level of protection similar or comparable to specific aspects of the ecological reserve system. To minimize unnecessary redundancies in completing the ecological reserve system, comparable designation systems will be examined and considered for equivalency in relation to the ecological objectives pursued.

In considering comparability, it is recognized that no other type of designation is equal to ecological reserves with regard to the purposes and exclusiveness of the Ecological Reserves Act. Some management techniques in comparable areas may not be appropriate to the preservation of all ecological values. Therefore, it is important that each specific instance of comparability be closely examined in conjunction with the ecological value of interest. Furthermore, it will be necessary to obtain recognition or agreement from the authorities responsible for a given comparable area that the particular ecological feature will be protected in a manner consistent with the objectives of the Ecological Reserves System.

A data-base registry will be developed to identify and assist in monitoring areas that protect values significant to the Ecological Reserve System.

Designations	Ecological Objectives
National Wildlife Area	Protection of rare, endangered or outstanding fauna populations and habitat.
Creston Valley, W.M.A.	Protection of outstanding waterfowl habitat and related aquatic habitats.
Migratory Bird Sanctuary	Protection of outstanding migratory bird habitat.
National Parks	Protection of representative natural ecosystems in wilderness zones.
National Park Reserves	Protection of representative natural ecosystems in wilderness zones.
Class A Parks, Cat.#1,2,6	Protection of representative natural ecosystems, provided there are suitable zoning and management controls.
Nature Conservancy Areas	Protection of representative natural ecosystems.
Wildlife Sanctuaries	Protection of specific outstanding or rare wildlife populations or habitats.

(b) Preferred Source Areas: Several designations established under other conservation-oriented legislation may include elements of significance to the ecological reserve system. In specific instances, these designations may not offer a level of long-term protection satisfactory to the specific objectives for ecological reserves. But these designations are preferred source areas for ecological reserves because they could act as buffers for enclosed ecological reserves. Internal ecological reserves may be accepted as contributing to the overall conservation value of the surrounding designations. In most instances, re-designation of such specific sites and

areas, wholly or in part under the Ecological Reserves Act, requires the agreement and cooperation of the responsible agency. Specific cases of the following designations will be examined, with the cooperation of the associated agency, as possible sources of and buffers for ecological reserves. A data-base registry will be developed to identify and assist in monitoring such sites.

Designations	Ecological Objectives
Wilderness Conservancy	Source of and buffer for ecological reserves of special and representative characteristics.
Wilderness Areas	(same as above)
Greenbelt Land	(same as above)
Map Reserve	Interim protection from alienation for ecological reserve proposals.
Wildlife Management Reserves	Source of and buffer for ecological reserves, especially concerning threatened or outstanding wildlife habitats.
Class A Park, all categories	Source of and buffer for ecological reserves of special or representative characteristics.
Nature Conservancy Area	Source of and buffer for reserves protecting rare, threatened or outstanding ecological values.
Recreation Areas	(same as Class A Parks)
Regional Park	(same as above)
Wildlife Sanctuary	Source of and buffer for reserves requiring strictest protection for rare, threatened or outstanding ecological values.

Wildlife Management Area	Source of and buffer for reserves oriented to special or representative wildlife habitats.
Water Supply Districts	Sources of and buffers for reserves in forest ecosystems of south coastal British Columbia.

(c) Inter-agency and Landowner Agreements: Private land ownership and some statutes bestow rights or mandates which equal or supersede the authority of the Ecological Reserves Act. Achieving ecological reserve status may be difficult when significant ecological values are identified on private lands that cannot be acquired, in instances of jurisdictions that supersede the Ecological Reserves Act (such as federal territory), or in designations which may predate and preclude establishment of ecological reserves (such as under other exclusive legislation), .

In these situations, cooperative agreements will be sought to achieve the objectives of the Ecological Reserve System. Inter-agency agreement is required when other designations are deemed comparable for ecological protection. A data-base registry will be maintained for candidate sites, agreements sought and agreements in place.

Situation	Agreement Sought
Private/Leased Lands	Purchase; failing this, acquire option to purchase and/or seek landowner cooperation to protect ecological values of parcel.
Conservation Foundations	Purchase; failing this, seek foundation cooperation to protect ecological values.
National Wildlife Area	Formal recognition of identified values.

Creston Valley W.M.A.	Ecological Reserve designation; if not possible, then seek formal recognition of identified sites through zoning and other management practices.
Migratory Bird Sanctuary	(same as above)
Provincial Park/Rec. Area	(same as above)
National Park	Formal recognition of identified sites and areas of significance through zoning and other management practices.
National Park Reserve	(same as National Park)
Nature Conservancy Areas	(same as Provincial Park)
Wildlife Sanctuaries	(same as Provincial Park)
Water Districts (legislated)	Formal recognition of the protection of the identified site(s) from development and use.
Wildlife Act Regulations	Compatible regulations in buffer areas surrounding reserves intended to protect special animal habitats.
Fisheries Act Regulations	Compatible regulations within marine reserves and in buffer areas surrounding such reserves intended to protect special or representative animal habitats.
Canada Shipping Act Regulations	Compatible regulations within and surrounding marine reserves of all types.

Process, Priorities and Criteria for Completing the Ecological Reserve System

General Policy:

Using the system planning process, the Ecological Reserve System will be expanded toward completion in an orderly manner. The desired or ideal process involves accomplishing objectives according to their priority, identifying candidate areas according to the ecological specifications of the sub-objectives, and evaluation of the candidates according to an array of scientific, functional and logistical criteria.

Policy Guidelines:

(a) Priorization of Objectives and Sub-Objectives: Ordinal scale rankings (e.g. 1, 2, 3) representing low to high relative significance can be assigned, weighted according to importance, and tallied to separate the objectives and sub-objectives (i.e. specific elements required to meet objectives) into priority categories. Each of the following factors must be considered from the perspective of urgency:

- degree that the objective is already satisfied in an existing reserve;
- degree that the objective is already satisfied in a reasonably comparable conservation designation;
- degree to which sites that would satisfy the objective may be threatened by uses or development that would significantly alter or impair their ecological values;
- degree of rarity or scarcity of sites that would satisfy the objective; and,
- degree of fragility of sites that would satisfy the objective.

Based upon consideration of the above factors, system objectives and sub-objectives can be arranged sequentially in the most appropriate of the

following three categories, which are themselves presented in priorized sequence:

- those that should have immediate attention due to endangerment or imperilment of known sites, elements or representative environments;

- those that involve representative environments or exceptional or rare phenomena that are not presently satisfactorily protected but are not likely to be immediately threatened; and

- those that involve representative environments or exceptional or rare phenomena that are already reasonably protected by the Ecological Reserves System or another conservation designation or regulation.

(b) Selection and Evaluation of Candidates: All candidate areas, whether identified by systematic or other means, must qualify on fundamentally scientific grounds satisfying one or more sub-objectives of the system plan. This initial screening is as simple or as complex as the technical specifications of the sub-objectives.

Once the candidates for satisfying a given sub-objective have been identified, they must be evaluated to determine which, if any, should be advanced as formal proposals for designation. This evaluation will be based upon the following ecological, suitability, and logistical criteria:

- rarity or uniqueness of the elements contained;

- representativeness of the elements contained;

- ecological diversity of site, with special consideration given to faunal populations;

- fragility or sensitivity to impact;

- degree of imperilment from human activities;

- degree of naturalness, which is the relative freedom from human-caused disturbance or change;

- likelihood of long-term ecological viability, considering the expectation of achieving adequate size, boundary configuration, buffers and internal replication of values;

- scientific suitability for research and study, considering accessibility, sensitivity and viability;

- educational suitability, considering accessibility and sensitivity;

- administrative suitability, considering present land status (existing equivalent designation, preferred source area, vacant crown land, resource-dedicated crown or private land); and,

- potential for use conflicts, considering impact potential and management feasibility.

POLICIES AND PROCEDURES FOR DOCUMENTATION, SELECTION, EVALUATION AND PRIORIZATION OF RESERVE PROPOSALS

ECOLOGICAL RESERVE DOCUMENTATION

Documentation of proposed ecological reserves serves several purposes. First and foremost, it provides the basic description of what the reserve would contain. Proper documentation allows the Ministry of Parks to judge whether or not the proposal fills system needs and is worthy of designation as a reserve. Secondly, if and when the proposal results in a reserve, this documentation becomes part of the data base which enables researchers, educators and land managers to select a reserve for their purposes or to make appropriate management decisions for it.

It is proposed that the first level of documentation be applicable to all potential reserves, whether representative or special (Appendix 1). For all reserves, information is needed on location, size, access, land status, adjacent land uses and purpose of the reserve. Purpose is based on system goals and overall design criteria, and determines what kind of detailed documentation is needed. This may vary considerably between proposals intended to protect representative ecosystems and those to protect rare or unique features.

Representative Ecosystems

The following general sequence of events is recommended for describing reserves intended to protect representative ecosystems.

Office Preparation

1) Acquire air photos, topographic maps and soil-landform maps (if available) for the candidate area.

2) Examine air photos and map vegetation types.

3) Examine topographic maps and plan most efficient traverse through the area depending on vegetation distribution and access.

4) Assemble plant association data (from Ministry of Forests data bank) for the particular ecoregion subzone or subzone variant in which the candidate reserve occurs. This would include identification tools (provided by Ministry of Forests) such as:

   (a) Table of dominant and subdominant plants expected to occur in each layer or strata of each plant association;

   (b) Key to plant associations; and,

   (c) Edatopic grid of plant associations.

Field Work

1) Sample vegetation at sites along a preplanned traverse. These sample site will vary according to association size and variability encountered in the field. Recommended field sampling procedures are described in Appendix 2. Field data may be recorded in a notebook or other format normally used by the proponent. However, information provided to the Ecological Reserves program must be on forms which allow evaluation of the degree to which the proposed area is representative of the Ecoregion subzone or subzone variant in which it occurs.

2) Identify plant associations, estimate their areal extent and use this information to refine a vegetation map (with use of air photos).

3) Record any representative animals encountered.

4) Identify basic ecological characteristics of each plant association in the field (e.g. soil type; landform; moisture regime).

Office Work

1) Using field data, identify the site associations which occur in the candidate reserve.

2) Evaluate the candidate reserve based on the predetermined system design plan. For representative reserves, the candidate area must have a sufficient number of site associations representing the particular ecoregion subzone or subzone variant in which it is located.

3) After acceptance of the reserve, all data should be entered into the data bank.

Rare Biota and Outstanding Natural Phenomena

These kinds of features vary so much that standard forms are not sufficient for their documentation. Detailed description of environmental conditions within the proposed boundaries is less important than description of the target feature itself, including threats to its continued existence and its protected status elsewhere in B.C. Proponents of these kinds of reserves should provide documentation which meets the requirements listed in Appendix 3 and Appendix 4.

CRITERIA FOR THE SELECTION OF A RESERVE PROPOSAL

The landscape of British Columbia is physically and biotically complex and partially modified by humans. Within this mosaic, some sites are more suitable than others as candidates for ecological reserves. Persons proposing sites as ecological reserves should consider the following criteria in order to arrive at a proposal which has as many desirable characteristics as possible.

1. Needs of the Ecological Reserves System

Proposals should meet one or more of the following goals:

a) Representation and protection of natural ecological diversity;
b) Protection of rare biota in natural habitats;
c) Protection of unique or rare natural features; and,
d) Protection of examples of human-modified ecosystems.

To meet these goals, certain kinds of general and detailed features have been defined as desirable targets for the ecological reserves system. The proposer of a new reserve should be familiar with the kinds of representative ecosystems and special features which are thought to be worthy of Ecological Reserve designation, and the extent to which they are already included in the system. The Ministry of Parks publication, "Guide to Ecological Reserves In British Columbia", is useful for assessing what the system already contains. There is no point in proposing features which do not meet system goals, or which do meet goals but are already protected.

It has not been possible to list in detail all the kinds of special or unique features which may be deserving of ecological reserve status. Some undoubtedly remain to be discovered, while the scientific importance of others may not yet have been recognized. Persons wishing to propose ecological reserve status for sites containing rare/unique features of unknown scientific/educational significance should seek advice from Ecological Reserves Program staff at an early stage.

2. Size of Proposed Reserves

A proposed reserve should include enough land area to ensure long-term protection of its major feature or features. Inclusion of land in excess of that need should be avoided. The minimum acceptable size varies greatly and depends on the kind of feature or features to be protected.

In general, the size of reserves should be large enough that the outer part of the reserve provides a buffer against the effects of adjacent land uses. Though it may be possible to negotiate agreements with adjacent land users that will reduce external impacts, this approach requires much on-going time and effort and cannot be relied upon to provide the required protection. As well, attempts by the Ecological Reserves Program to control land use in areas surrounding reserves are opposed by many land owners or users and can jeopardize the acquisition of reserve lands. It is better, therefore, that buffer land be part of the reserve itself.

a) Forested representative ecosystems

Reserves should be large enough so that any portion around the perimeter that is influenced by forest clearing to the reserve boundary is a relatively small proportion of the total reserve. Assuming a 100-metre zone could be affected by windfall, light penetration etc., a circular reserve would need to be over 100 hectares if 70% of it is to be unaffected. Representative forested reserves should contain as many as possible of the plant communities or site associations that occur in the subzone being represented. Fewer large reserves will be easier to protect and manage than many small ones. In most cases, it is impractical to propose representative reserves that are large enough to

contain viable populations of the larger and/or more mobile fauna. Reserves 500 hectares or larger should contain viable resident populations of small and medium-sized mammals and most resident birds, as well as viable breeding populations of migrant birds.

b) **Non-forested representative ecosystems**

Land areas as small as 10-to-100 hectares may be sufficient for long-term protection of grassland, alpine and wetland vegetation. However, much larger tracts are needed if viable populations of most vertebrate animals characteristic of these ecosystems are to be maintained. This may be practical in alpine areas, but probably not so in the case of grasslands and wetlands, except for small species such as mice or amphibians. Plant communities vary greatly over short distances in the alpine zone. Here, as in the case of forested ecosystems, a few large reserves is a more practical approach than many small ones.

c) **Rare vascular plants**

Reserves meant only to serve this function can be quite small, although the size needed will vary with total population size and distribution pattern of the rare species. Reserves as small as three hectares may be adequate.

d) **Rare vertebrate animals**

The minimum land area needed to preserve viable animal populations varies tremendously from species to species. For any targeted species, information on seasonal migrations, home-range size and population density should be reviewed before an appropriate reserve size is recommended.

e) **Other features**

The size of reserves needed for other features will be as variable as the features themselves. Small reserves will suffice for local geological features; somewhat larger sizes are needed for unusual tree stands; and still larger ones are required for some zoological phenomena.

3. Boundary Design

The shape of a reserve should afford maximum protection to its major feature or features. Narrow, elongate shapes are usually least effective. Where possible, boundaries should follow natural features such as heights of land or rivers. Roads may serve this purpose if the right-of-way is legally surveyed and unlikely to change, and if the presence of the road does not affect ecosystems in the reserve. The most desirable approach for representative forested reserves is to enclose an entire watershed.

4. Naturalness and Diversity

Sites that are proposed to protect natural features (Goals 1 through 3) should be inspected to ensure that human-caused impacts have not occurred, or at least that the most natural alternative is selected. Such influences may not be obvious. They include control of river regimes by upstream dams; pollutants from nearby industrial plants; or predator control on adjacent lands.

As a general rule, sites having a high level of ecological diversity are preferable to those with lesser diversity. This promotes the preservation of the most species, communities and ecosystems per unit area of land in the ecological reserve system. A 100-hectare reserve containing five site associations is preferable to a 100-hectare reserve enclosing only one such association.

5. Avoidance of Outside Influences

Where alternatives are available, proposals should be sited in areas where surrounding land uses are least likely to affect reserve lands or require management actions to protect the reserve. Since most representative reserves in British Columbia will be on forested land, and most forested land has been or will be logged, the effects of logging and of silvicultural practices carried out on adjacent lands are difficult to avoid. As noted earlier, large reserves are less subject to impacts from adjacent land uses than are small ones. Also, inclusion of entire watersheds in such reserves helps to minimize these impacts. Placement of reserves within or adjacent to

Provincial Parks or other protected forestland will also reduce the influence of adjacent land uses on them.

Where possible, locations with free-roaming livestock should be avoided because grazing may adversely affect the vegetation which the reserve is intended to protect. Grazed areas may require fencing which is expensive, must be maintained and interferes with natural movements of wildlife.

Sites which are likely to receive heavy and potentially damaging public recreational use are also best avoided if possible. Small reserves adjacent to towns or subdivisions are vulnerable to mountain bikes, motorcycles, depredations by cats and dogs, littering, fires and general vandalism. Control of such impacts through fencing or other means is expensive, never-ending and not always completely effective.

Populations of wide-ranging animals are difficult to maintain in ecological reserves because they are hunted or trapped when they move outside the reserve or because critical adjacent habitats are destroyed. Where maintenance of large mammal populations is important, consideration should be given to placement of reserves adjacent to Provincial or National Parks, Recreation Areas, Wildlife Management Areas or other conservation lands. This will ensure that the largest block of land possible is available for wide-ranging species.

6. Minimizing Long-Term Management Needs

This is achieved by choosing sites where the influence of adjacent land uses will be minimal (Point 5 above).

7. Avoiding Land-Use Conflicts

Where options are available, reserve proposals should be sited in areas where other values and previous commitments are least. This will reduce the impact of establishing reserves on other users and keep land purchase or compensation costs to a minimum. Conflicts are normally least if reserves are established on uncommitted Crown Land or Nature Conservancies in

Provincial Parks. A variety of Crown Land commitments such as Tree Farm Licences, Grazing Leases and Mineral Claims may complicate land acquisition and result in higher costs for ecological reserve acquisition. Where possible, locations having high forest, mineral or other values should be avoided.

8. Suitability for Research and Education

A major purpose of all ecological reserves is to provide an opportunity for research education. Where alternative sites are available to preserve certain features of research/educational interest and all other factors are equal, a site with reasonable access from major population centres and research institutions should be proposed.

EVALUATION OF RESERVE PROPOSALS

The major concern here is whether or not the *kind of feature* proposed is needed by the Ecological Reserve system. In future, it is expected that searches for new reserve locations will be based on the system plan, and that proponents will, for the most part, be proposing features and sites which are needed and meet system goals.

When evaluating reserve proposals, whether already on file or new submissions, the following questions should be asked:

1) Does preservation of the proposed feature meet one or more of the system goals?

2) Is the targeted feature or features included in one of the overall-design and detailed-design categories?

3) Is continued existence of the feature or features threatened in B.C.?

4) Is the feature in demand for research/educational purposes?

5) Does the feature lack protection in other reserves in the province?

A format for carrying out the above assessment is included as Appendix 5 (Part 1). If all of the above questions are answered in the affirmative, then the feature is not only a worthy target for preservation, but is needed to complete the Ecological Reserves system.

The next stage is to determine whether the *specific site* which has been proposed will serve its intended purpose, or if more than one site is being evaluated, which will serve the purpose best. This requires consideration of the specific location of the proposal, its size, land tenure, surrounding land use, impact of land withdrawal, on-going management needs and related factors. A format for carrying out this evaluation is included as Appendix 5 (Part 2). If only a single proposal is being evaluated to meet a particular purpose, but it rates highly favourably for all criteria, then it is probable that additional sites will not have to be sought.

If two or more proposals which could meet the same need are being evaluated, the one which rates the most highly will normally be chosen for acquisition. Important considerations in the *comparison of competing proposals* are the following:

1. Viability

Viability should be rated as High, Moderate or Low, based on:

a) size (largest is most viable);
b) sensitivity of feature (least sensitive is most viable); and,
c) kind and severity of surrounding land use (least severe is most viable).

2. Socio-Economic Impact

This should be rated as High, Moderate or Low, based on the number of users and amount of activity displaced. Exact amounts are not needed as long as the proposals can be ranked as having more or less impact when compared to each other.

3. Ease of Land Acquisition

Land acquisition may involve varying amounts of negotiating time and effort, and varying land cost. This is not simply a matter of tenure. Crown land having previous commitments may be difficult to obtain, while private land is sometimes easy and even inexpensive to acquire. Ease of acquisition should also be rated as High, Moderate or Low.

4. On-going Management Effort

This should consider demands made on the areas as a result of public interest in the preserved feature, as well as protection from surrounding impacts such as grazing. Exact costs need not be predicted. Anticipated levels of on-going management effort can be rated as High, Moderate, Low or Nil.

PRIORITIES FOR ACTION

Priorities for acquisition of representative areas and for special features should be considered separately. For example, it is not realistic to compare a reserve to protect ecosystems representative of a particular subzone in a Biogeoclimatic Zone with a reserve to protect a rare plant or animal.

The relative priority of *competing proposals* which would meet the same need would be established by means of the previous evaluation process and is not considered here.

Representative Ecosystems

The most important factors for priorization of representative reserve proposals are:

1) The extent of current protection received by ecosystems in the particular subzone; and,
2) Threats to or rate of loss of natural ecosystems in the subzone.

Ecosystems which are well represented in Nature Conservancy Areas, National Parks or other secure designations should receive lower priority than those which are not. Ecosystems which are representative of productive forest zones which are rapidly being logged should receive priority over those which are of little importance for commercial use.

A rating system for priorizing the need for action toward acquisition of representative ecosystems is given in Appendix 6.

Rare Biota and Outstanding Natural Phenomena

Considerations for priorizing the need to acquire these features are generally the same as for representative ecosystems. If they currently have little or no protection, and if their habitats are disappearing rapidly, then priority for attention is high. Scientific and/or educational importance are other factors which should be considered. This recognizes the inherent uniqueness of the feature and results in those features which are most rare/unique receiving the highest priority for action.

A rating system for priorizing the need for action toward acquisition of special features is given in Appendix 6.

SYSTEM DESIGN FRAMEWORK

INTRODUCTION

The system design attempts to describe all general categories and individual elements that should ultimately be included in a complete system of ecological reserves in British Columbia. General categories include such items as forest ecosystems, grasslands or rare/endangered animals. Individual elements are more specific. Examples are an ecosystem representative of the dry subzone of the Coastal Western Hemlock Biogeoclimatic Zone, or a rare animal such as the Vancouver Island marmot.

The Ecological Reserves Act and goals provide considerable breadth of scope for inclusion of features in the system. A major purpose of this system design is to establish bounds between what is worthy of ecological reserve status and what is not. This is accomplished by means of classification schemes which proceed from the general to the particular, with the objective of arriving at a finite number of features which should be included in ecological reserves.

Every effort has been made to develop a design that is logical and is understandable to non-scientists. However, it must be appreciated that at the level of detailed design, many features can only be described in technical terms.
The classification schemes adapted for system-design purposes should ensure an optimal distribution of representative reserves across the province, and establishment of special reserves for those features most worthy of protection in locations where they are most needed. In developing this design, an objective has been to define features which can easily be identified on maps or air photos, or through field inspection. This is not always possible when dealing with little known, rare or endangered plants or animals. Where possible, the design uses classification schemes that are compatible with those used by other government agencies, and which apply to the whole province.

COMPREHENSIVE DESIGN

Kinds of Features

Natural versus Modified Features

The Ecological Reserves Act and system goals recognize the need to establish reserves which contain both natural features and human-modified environments. The first-order subdivision should be into these two categories.

Natural Features

The Act and system goals plainly identify the need to preserve two basic kinds of natural features, those which are *representative* and those which are *rare/unique* or otherwise noteworthy. These are proposed as the two major categories of natural features.

> **Representative natural features:** These will normally be complete *ecosystems* (the biota *and* its physical environment in a defined geographic area) which are representative of ecological zones into which the province is divided. This stems from Sec. 2(b) of the Act, which states that its purpose is to preserve "*areas that are representative examples of natural ecosystems* ...".
>
> Because of differences in government jurisdiction, availability of descriptive information and fundamental classification schemes, representative ecosystems should be divided into *marine* and *terrestrial* components. Largely for legal/jurisdictional reasons, the logical boundary between these is the high tide line.

The terrestrial category includes wetland and freshwater ecosystems. Terrestrial ecosystem reserves will normally contain representative vegetation and fauna on representative landforms/soils. Representative terrestrial reserves will preserve ecosystems characterized by various forest communities and by non-forest vegetation such as grasslands, alpine communities and wetlands. Based on the existing, larger, representative reserves, many are expected to contain streams, ponds, lakes and wetlands which are typical of the ecological zone which the reserve is intended to represent.

Representative marine reserves will also encompass physical substrates, oceanic conditions and biota which are typical of the marine zone in which they are located.

Rare and unique natural features: Both the Act and the system goals suggest that this category be logically divided into *species* of plants and animals (including taxonomically defensible sub-species or varieties), and other rare or unique natural *features or phenomena*, both biotic and geological. This distinction should be applied both in the terrestrial and marine environments.

1) **Rare biota:** The E.R. Act refers specifically to *"rare or endangered native plants and animals"*. This can be interpreted to include other commonly used descriptors such as "threatened", and to encompass not only the species level of taxonomy, but also any scientifically defensible sub-specific taxa. The purpose of reserves in this category would be to protect taxonomic elements such as species, but in so doing complete ecosystems might be involved. Taxa included in this category would be selected from lists prepared by scientifically credible individuals or agencies.

The category of Rare Biota is most logically subdivided into *marine* and *terrestrial* species, and these in turn into *plants* and *animals*. While mphasis is expected to be on vascular plants and vertebrate animals, lower plants and invertebrate animals are not excluded.

2) **Rare/unique features or phenomena:** This category is based on Sec. 2(e) of the Act which states that a purpose of the Act is to reserve areas that contain "... *unique and rare examples of botanical, zoological or geological phenomena*". This category is broad, difficult to define and one in which the distinction between what is rare and what is representative may be difficult.

In terms of taxonomic breadth, it is clear that no component of the natural environment is excluded.

Biotic features in this category could include both populations and various assemblages. At the population level, examples would include breeding concentrations of species which are not officially endangered (e.g. seabirds), tree stands of superior growth or hardiness, or unusual habitat relationships. Plant or animal communities/associations which are outstanding in terms of diversity, or are of rare occurrence, would also be included.

Geological features would include both outstanding examples of otherwise widespread phenomena (e.g. the most outstanding example of an esker) and features which are of rare occurrence in the province.

Human-Modified Features

For human-modified features, the major intent of the Act appears to be to establish reserves which will allow long-term study of the recovery of disturbed ecosystems. However, it is also desirable to study sites where pollutants or effluents may be causing gradual long-term change to natural ecosystems.

General Types of Features Which Should be Included

A. Natural Features

Representative Ecological Systems

Terrestrial/Freshwater:

— Forested Ecosystems

— Non-Forested Ecosystems
  a) Alpine-Subalpine
  b) Grassland
  c) Wetland
  d) Freshwater (streams, lakes, ponds)
  e) Other

Marine:

— Inner Coast

— Outer Coast

Rare or Unique Features

Terrestrial/Freshwater:

— Plant/Animal Species or Subspecific Taxa
  a) Plants
  b) Animals

— Communities, Associations and Phenomena
  a) Botanical Features
  b) Zoological Features
  c) Geological Features
  d) Combinations of Above

Marine:

— Plant/Animal Species or Subspecific Taxa
  a) Plants
  b) Animals

— Communities, Associations and Phenomena
  a) Botanical Features
  b) Zoological Features
  c) Geological Features
  d) Combinations of Above

B. Human-Modified Features

Recovering from Former Disturbance

Terrestrial/Freshwater

Marine

Subject to On-going Human-Caused Influences

Terrestrial/Freshwater

Marine

DETAILED SYSTEM DESIGN FOR TERRESTRIAL NATURAL FEATURES

INTRODUCTION

Some general objectives of the system design process were discussed previously. With respect to the detailed components of such a design, the major objective is to subdivide selected general categories to arrive at lists of natural features which should ultimately be given Ecological Reserves status. This applies to both representative ecosystems and rare/unique features. Marine environment and freshwater features other than wetlands are omitted from consideration because inventory information is incomplete.

Categories in the comprehensive design section which have been selected for detailed treatment are the following:

1. Representative terrestrial ecosystems
    - Forested lands
    - Alpine-subalpine lands
    - Grasslands
    - Wetlands

2. Rare or unique terrestrial features
    - Rare species/subspecies
        - — Vascular plants
        - — Vertebrate animals
    - Outstanding features and phenomena
        - — Botanical
        - — Zoological
        - — Geological

Scientifically accepted classification schemes and criteria are used where possible to subdivide the above categories into smaller units, thus generating lists of ecosystems and features that should be included in a complete system of ecological reserves in B.C. Several problems place limits on the finality of this process. Major among these is the fact that many rare or unique features have not yet been identified or have been only superficially described. Secondly, even the most widely accepted ecological classification schemes are frequently revised and are the subject of considerable debate. Finally, there is considerable disagreement about what constitutes a rare or unique feature, especially the latter.

In British Columbia, semi-quantitative criteria have been established to assess degrees of rarity or endangeredness of the better-known biota (vascular plants and terrestrial vertebrates), but lesser known organisms and geological features have not been subjected to this kind of analysis. Features which may be termed unique or outstanding occur on a graduated scale, and scientific criteria are often of limited use in differentiating between them. In the final analysis, designation of such features as being worthy of ecological reserve status is largely a value judgment.

REPRESENTATIVE TERRESTRIAL ECOSYSTEMS

Introduction

Ecosystems consist of the combination of climate, landforms, soils, vegetation and animals found in any particular location. Ecosystems can be described in terms of functions like nutrient cycling and energy flow, or structure, such as dominant plants and type of soil. Structure is the only concern for purposes of classification. For convenience, ecosystems are usually defined by description of their most obvious feature — plant cover. This description includes the dominant species of tree, shrub, herb and moss/lichen layer, if present.

In a province as diverse as British Columbia, ecosystems vary tremendously from place to place, even over short distances. Differences in elevation, in wetness or dryness of the soil, in slope steepness and exposure, in soil nutrients, and many other factors contribute to this diversity. This makes the task of reserving lands that are "representative examples of natural ecosystems" (Sec. 2b, Ecological

Reserves Act) a challenging one. Since everything is representative of the place where it occurs in an undisturbed landscape, how many reserves are needed and how should they be distributed across the province?

The following discussions incorporate the results of a one-day workshop that was convened on February 23, 1989, to obtain a classification scheme which would provide the best framework for selection of a system of representative ecological reserves. Participants were invited who had expertise in at least one ecosystem component (climate; landform; soils; vegetation; fauna), who had province-wide experience with classification schemes and mapping programs in their discipline, and who were to some extent familiar with the Ecological Reserves Program (Appendix 1).

Achieving province-wide distribution

The first step in the process of distributing reserves across B.C. is to divide the province into regions that are environmentally different from each other. These are divided still further to eliminate any pronounced environmental variation within the regions, especially those caused by climatic differences. The resulting map units should be fairly uniform internally in climate, landform, soils, vegetation and fauna, but each unit should be significantly different from all others. Ideally, it should be possible to delineate one or more ecological reserves within each map unit which are typical or representative of the entire unit.

The map units will theoretically be largest where environmental conditions are fairly constant over large areas, such as the Interior and Alberta Plateaus. They will be smallest where the landscape is most complex, such as is mountainous areas (particularly in southern B.C.) where both elevational and rain-shadow influences cause rapid climatic change over short distances. These kinds of regional variation are the reason for dividing the province into ecological units of one kind or another. The objective is to achieve *stratified* sampling, by means of ecological reserves, of province-wide ecological diversity. Otherwise, the province could be divided into 100 or 200 blocks of equal size, with a reserve in each block.

In theory, a variety of environmental factors could be used to divide the B.C. landscape into suitable strata or map units, including patterns of climate, landform, surficial deposits, soils, vegetation, or a combination of these. In practice, however, these options are reduced because of the need to have information which: 1). is already available in map form; 2). has been produced at an appropriate scale; and, 3). covers the entire province. These criteria are not met for all of the above environmental factors. Consideration must also be given to which components of the environment are most meaningful for ecological reserve system planning.

Ecological suitability of classification schemes

Ecosystems are comprised of three main structural components: climate, physical substrates, and biota. A classification system for ecological reserve purposes should be based on one or more of these. To assess which is most important and how these factors can be integrated into a classification scheme, it is worthwhile to look at cause and effect relationships. For purposes of this exercise, the important physical factor is landform and the important biotic factor is vegetation.

If B.C. was perfectly flat, there would still be some climatic variation associated with latitude (coldest in the north) and maritime-versus-continental influences. But the major climatic variations in the province — alternating wet and dry belts from west to east, and increasingly cooler climates at higher elevations — result from topography. Therefore, topography is the major determinant of regional climatic variation. Vegetation patterns are primarily an expression of climate and indirectly an expression of landform. Examples are the occurrence of cedar and hemlock in wet belts and grassland in dry interior valleys, and the elevational banding of vegetation.

Since ecosystems are recognized and defined primarily on the basis of their vegetation, and landform and climate are fundamental determinants of plant distribution, these factors should be incorporated into a classification system for ecological-reserve purposes.

Landforms alone would not provide an adequate basis for achieving optimal distribution of representative ecological reserves. This is because landform

classifications do not normally divide mountain ranges into east and west slopes or into low, middle and high-elevation components. Climate and vegetation can vary markedly in such situations. Detailed climatic mapping, assuming it is available, would provide a good basis for ecological stratification of B.C. But even within small areas with uniform climate, plant cover may vary due to different soil parent materials or other factors. Integration of climate and landform (e.g. Demarchi 1988) theoretically provides a better system than either considered alone. Ultimately, vegetation patterns provide the best basis for ecological stratification of B.C. because they reflect the combined effect of landform and climate.

Existing land conservation system plans in British Columbia

Existing plans designed to distribute conservation areas across B.C. in a systematic way include those of the Canadian Parks Service (National Parks) and BC Parks.

The Canadian Parks Service has divided Canada into 39 "natural regions", eight of which occur in B.C. (Falkner and Carruthers, 1974). Those in B.C. are primarily landform units, such as the Pacific Coast Mountains, Strait of Georgia Lowlands and Rocky Mountains. Some consideration of climate is introduced through division of the Interior Plateau into southern dry and northern cool regions. However, being a national system, this classification does not divide B.C. into small enough units to serve planning purposes for the ecological reserves system.

BC Parks system planning (Ministry of Parks, 1988) is based on division of B.C. into 59 Landscapes. The boundaries of these landscapes were defined by using: Holland's and Mathews' analyses of physiography; Demarchi's Ecoregion work; and other environmental characteristics, including biogeoclimatic and topographic patterns. If used directly to achieve ecological reserve representation, this system would suffer from the previously-discussed limitations which apply to any classification based entirely on landforms. On the other hand, since it is logical to include landforms somewhere in a classification scheme for ecological reserves, system plans for ecological reserves and provincial parks will have fundamental similarity. A provincial park objective has been to select park

sites having landscapes with high scenic and outdoor recreation values and which "look different" to the casual observer. Being less constrained by scientific considerations than is the case for ecological reserves, a landform-based design is probably suitable for achieving province-wide distribution of provincial parks, but not of ecological reserves.

Information availability

Most province-wide mapping of environmental and resource information is only available as single sheets of scale 1:2,000,000 to 1:6,000,000. These provide a provincial overview and may be suitable for the upper level of a classification scheme, but are not detailed enough for ecological-reserve purposes. Much local and regional mapping has been produced at 1:250,000 to 1:50,000 and even more detailed scales, but is not available province-wide. It is generally felt that mapping at least at scale 1:500,000 is needed to depict the level of ecological variability which should be accounted for in a system of representative ecological reserves.

1). Climate

Specialized mapping, such as climatic capability for agriculture, is available for portions of the province. Although climatic data are available for many stations in the province, province-wide mapping of climatic regimes is available at only a very general level (Marsh 1985).

2). Landform

The physiographic classification of B.C. by Holland (1976) is very logical and has been widely adopted. It is a hierarchical scheme in which the province is divided into increasingly smaller landform units. There are four or five levels, depending on location, although each level was not given a formal name. Province-wide mapping is only available at a scale of about 1:2,000,000. This divides B.C. into about 85 map units. Holland's map units have been more finely divided in a few regions, such as the East Kootenay (Ryder 1981), but this has not been systematically attempted for the whole province.

3). Climate and Landform combined (Ecoregions)

Demarchi (1988) has developed an hierarchical scheme of "Ecoregions" designed to fit into a North American ecoregion system, encompass both the marine and terrestrial environment, and provide an upper level framework for regional biophysical mapping of wildlife habitats in B.C. It is based entirely on climate and landform (Figure 1; Table 2).

This includes landform units and names which are generally based on Holland (1976) and climatic regimes outlined by Marsh (1985). Physiographic units are subdivided to recognize climatic variation within them. For example, Holland's Vancouver Island Mountains physiographic unit is divided into windward and leeward areas, and his Rocky Mountains unit into northern, central and southern sections, to recognize climatic variability. But even the smallest units in this scheme (Ecosections) may have considerable internal variation in climate and vegetation due to variations in elevation. Elevational banding may result in the occurrence of four or more Biogeoclimatic Zones within a single Ecosection.

The ecoregion scheme is felt to be useful for wildlife-management planning at a regional level (Demarchi 1987). The map units are large enough to accommodate migratory big-game species which may seasonally occupy habitats over a wide elevational range. Province-wide mapping is available to 1:2,000,000 scale (Demarchi 1988). Regional mapping at 1:500,000 scale has also been produced (Fenger et al 1987 a; 1987 b). The regional maps also delineate Biogeoclimatic Subzones.

4). Vegetation

Mapped province-wide classifications are primarily based on distribution of trees. They include Rowe's (1972) Forest Regions, and the system of Biogeoclimatic Zones developed by Krajina (1965).

The Forest Region classification is part of a national system, and mapping was only produced at 1:6,000,000 scale. Non-forested lands are not included. This classification is not useful for ecological reserve planning.

The Biogeoclimatic Zone system initiated by Krajina has been adopted and refined by the B.C. Ministry of Forests and is widely used by that ministry for management purposes (e.g. Klinka et al 1984). Twelve of the 14 zones currently recognized in B.C. are named after their dominant climax tree species, the other two (Alpine Tundra and Bunchgrass Zones) are largely treeless. Detailed studies of plant communities and environmental relationships have been carried out in most of the forested zones by students of Dr. Krajina (e.g. Brooke et al 1970) and by Ministry of Forests researches (e.g. Pojar et al 1984). Some forested zones, especially in northern B.C., as well as the non-forested zones, are less well known.

Biogeoclimatic units or categories commonly used and mapped by the Ministry of Forests are the zone, subzone and variant.

Table 2. Terrestrial ecoregions in British Columbia, from Demarchi (1987) [1]

Level In Hierarchy	Name of Unit	No. of Units	Environmental Parameter on Which This Level is Based in B.C.
1.	Ecodomain	4	Climate (global patterns)
2.	Ecodivision	7	Continental patterns of climate and physiography
3.	Ecoprovince	10	Sub-continental (national) level patterns of climate and physiography
4.	Ecoregion	30	Provincial level patterns of climate and physiography
5.	Ecosections	78	Minor physiographic differences and macro-climatic subregions of significance for sub-provincial planning

1. excluding marine regions

INSERT MAP (FIGURE 1) HERE

Subzones are the basic unit of biogeoclimatic classification, and the first to be recognized in the classification process. A subzone is characterized by a distinct climatic climax forest association which, in turn, is made up of unique sequences of geographically related ecosystems. These sequences are influenced by one kind of regional climate.

The biogeoclimatic term "Variant" is used to describe variation within subzones[1]. According to Pojar *et al* 1984, variants "... reflect further differences in regional climate, and are generally recognized for areas that are drier, wetter, snowier, warmer or colder than other areas in the subzone. These climatic differences result in corresponding differences in vegetation, soil and ecosystem productivity."

Subzones with similar climatic characteristics and zonal ecosystems are grouped into Biogeoclimatic Zones. A biogeoclimatic zone is defined as a large geographic area with a broadly homogenous mesoclimate. According to Pojar *et al* 1984, a biogeoclimatic zone "... has characteristic webs of energy flow and nutrient cycling, and typical patterns of vegetation and soil". Zones also have characteristic soil-forming processes and one or more typical, climax species of tree, shrub, herb and/or moss.

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1. Theoretically, variation at the subzone level is maintained at approximately equivalent levels by further subdivision into variants when the variation is recognizable and mappable. Subzone variation is recognized by the occurrence of different plant associations or sub-associations. Some subzones have no variants, while others have several.

The Biogeoclimatic Zone system is useful because it demonstrates how climate, landform and soils interact to produce regional variations in plant communities. Province-wide mapping of zones is available on a single sheet at 1:2,000,000 scale (Ministry of Forests 1988). Regional maps which delineate zones, subzones and in, some cases, variants have been produced for the whole province at scales of 1:500,000 or 1:600,000. Some are available in published form (Nuszdorfer et al 1985; Ministry of Forests 1985), others only as working drafts. One limitation is that subzone/variant mapping does not include the Bunchgrass and Alpine Tundra Zones.

Selection of appropriate scheme for each type of landscape component

Background information, especially mapping, differs in the level of detail available for each of the kinds of representative terrestrial ecosystems selected for detailed treatment (Forested lands; Alpine/subalpine lands; Grasslands; Wetlands). The most detailed province-wide mapping (in the form of Biogeoclimatic Subzones/variants) is available for forested lands. Alpine Tundra and Bunchgrass Zones currently lack such mapping. Wetlands do not occur as a zone but rather as small discrete units scattered across the province, and require individual attention. As a result, each of the above general kinds of ecosystems must be treated differently in planning ecological reserve distribution.

1). Forested land

Theoretical advantages and practical limitations of potential classification approaches were previously discussed. For achieving optimal distribution of representative forest ecosystems at the provincial level, the use of Biogeoclimatic Subzone/variant mapping is the best, and virtually only, possible approach. About 80 subzones/variants are currently recognized.

In mountainous areas (most of the province) subzones occur as narrow elevational bands or valley-bottom ribbons, discontinuously distributed over considerable latitudinal distance. To accommodate variations in ecosystem structure found throughout the range of subzones or variants, particularly in the case of the fauna, workshop participants felt that a higher level

landform/climate-based classification should be superimposed on the subzones/variants.

Since Demarchi (1988) has integrated climate and landform into his ecoregion scheme, a workshop consensus was that this would provide a rational basis for the first level of a classification scheme for ecological reserves. The fourth level of his five-part hierarchy, the Ecoregion[1], was selected for this purpose. There are 26 ecoregions in the province (Figure 1).

This results in a two-level hierarchy in which the first level (Ecoregions) is based on climate and landform, and the second level (Biogeoclimatic Subzones/variants) is based on regional vegetation. Since some subzones and variants occur in more than one Ecoregion, the number of map units requiring representation is increased to about 120 (Table 2). It is assumed that if new Ecological Reserves are of adequate size (more than 500 hectares) and sufficiently diverse with respect to vegetation, then forested regions in the province should be adequately represented by one in each Ecoregion. In cases where small watersheds are enclosed by representative reserves, more than one subzone or variant will be included. In addition, a number of extremely large ecological reserves (or their equivalent) made possible through use of suitable areas in other conservation areas (e.g., Provincial Parks, National Parks), will also help achieve the diversity required in some of the ecoregions.

The use of Ecoregions together with Biogeoclimatic Subzones/variants serves to recognize regional biogeographic variations which may be unrelated to climate. For example, the wet subzone of the Coastal Western Hemlock Biogeoclimatic Zone occurs on the entire B.C. coast. Despite similar climate and climax tree species, these areas have quite different zoogeographic and phytogeographic histories and hence different animal and plant communities. Thus, a single reserve would not represent this subzone.

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1. It should be noted that the term "Ecoregion" is used both to name this classification system and to identify the fourth level within it.

Table 3. Classification scheme for various landscape components in B.C.

Landscape Component	Hierarchy Level	Classification Scheme	No. of Map Units	Estimated No. of Elements	Estimated No. of Reserves Required
Forest	1	Ecoregions	26		
	2	Biogeoclimatic subzones or variants	ca. 120		ca. 120
	3	Site associations[1]		ca. 400-500	
Alpine/ Subalpine	1	Ecoregions (modification of)	12		12
	2	Plant associations		ca. 150-200	
Grasslands	1	Biogeoclimatic Zones	1		
		Ecosections	3		ca. 3-44
		Plant associations		ca. 8	
Wetlands	1	Classes (5) (within ecoregions)	26		
		Forms	60-70		250
		Types			
		Plant associations		500-1500	

1 Groups of similar plant associations (Ministry of Forests).

2). Alpine/subalpine lands

All alpine habitats in B.C. have commonly been lumped into a single Biogeoclimatic zone (Ministry of Forests, 1988). In actual fact, the alpine zone is probably not a Biogeoclimatic Zone in the same sense as the forested zones, but subdivision of it into one or more zones or subzones has not been systematically attempted. It will likely be some time before alpine ecosystems are described in sufficient detail to allow broad areas of similarity or dissimilarity to be mapped. For purposes of selection of representative alpine ecological reserves, it is proposed that the ecoregion system, or some modification of that system, be applied. In 1980, G.W.

Douglas, working with the Ecological Reserves Unit, proposed a classification system that divided the province into 14 regions. These regions were based essentially on physiography. More recently, Douglas has worked with the Ministry of Forests and Ministry of Environment on further alpine/subalpine classification studies. Although the latter classification system has yet to be finalized, it would appear that the newer system will fit closely to Douglas' 1980 system with some modification resulting from the recent work of Demarchi (1988). Approximately 12 alpine/subalpine regions will be recognized for the present (Table 2), and these will form the basis for an MoF report on the Alpine Tundra Biogeoclimatic Zone in B.C.

3). Grasslands

The Bunchgrass Biogeoclimatic Zone is presently being mapped with respect to subzones[1]. Two subzones, each with two variants, will be recognized. In theory, three or four representative reserves would be sufficient for grassland representation in the Bunchgrass Zone (Table 2). In reality, land-use problems and the lack of suitable undisturbed sites may require a higher number of small reserves. Transitional small-scale grasslands that would need representation also occur in six other biogeoclimatic zones, but are most extensive in the Ponderosa Pine Zone and in the Interior Douglas-fir Zone.

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1. Only preliminary information in presently available from the Ministry of Forests for the Bunchgrass Biogeoclimatic Zone. A final published report will be available by April 1, 1991, although sufficient data, at least with respect to plant associations, should be available for ecological reserve use by December 31, 1989 (A. Nicholson, pers. comm.).

4). Wetlands

The previous categories of forest land, grassland and alpine land occur as broad zones and are more or less mutually exclusive. Wetlands, however, are usually small discrete units found scattered across the above landscapes. Similar wetlands may occur in widely separated parts of the province, and different wetland types may occur in close proximity. Although wetlands have been classified and the forms and types which occur in B.C. are generally known, they have not been mapped or studied on a province-wide basis. Such mapping would require individual description of virtually every wetland, and is unlikely to be undertaken. Therefore, there is no basis for pre-determining the location of wetland reserves on a province-wide scale.

A variety of wetlands already occur in established Ecological Reserves and additional wetlands would also certainly be included in most new representative reserves. The best approach for achieving wetland representation will be to inventory the kinds of wetlands present in all representative ecosystem reserves, then establish individual reserves for any desired types which are not already included.

Assessing Variability Within Ecoregion/Subzone Map Units

The previous section has dealt with the general problem of how many representative Ecological Reserves are needed (aside from considerations of replication) and how they should be distributed across the province. More detailed information on ecosystem variation within Ecoregion/Subzone map units is also needed for the following inter-related reasons:

1). optimal siting of a reserve within the map unit;

2). determination of whether more than one reserve may be needed to represent the map unit; and,

3). assessment of reserve proposals for their adequacy to represent the map unit.

This more detailed assessment may be thought of as a third level in the Ecoregion/Subzone classification scheme (Table 2).

Forested land

Assessment of ecological variation within Ecoregion/Subzone map units is best approached by identifying representative vegetation. This third level, essentially a working level in the field, is represented by site associations within each ecoregion subzone or subzone variant. The Ministry of Forests is currently completing its documentation of provincial site associations. They estimate there will be a total of 400-500 site associations derived from 2000-2400 plant associations sampled and identified in the field. The floristic expressions of the site associations may be considered an indication of the combined influence of all environmental and ecologically significant factors. Requiring coverage of all site associations in ecological reserves is at present the only scientifically sound and feasible way to accomplish adequate representation of the existing ecological diversity within subzones or variants. None of the other parameters (i.e. soils, surficial deposits, landforms, moisture-nutrient gradients, animal communities, etc.) would provide the same degree of integration, and the use of most of them would not be feasible because existing inventories are lacking. The latter parameters are usually reflected by the vegetation while the converse is not always true.

An example of how the Ecoregion-Subzone classification scheme would work has been prepared for the Fraser Basin Ecoregion in east-central B.C.[1]. Ten subzones or subzone variants, each with five to 10 plant associations, occur in this ecoregion (see Appendix 4). These plant associations (81 in total) belong to 49 different site associations. Thus, if each ecological reserve, in each ecoregion subzone or subzone variant, contained four or five site associations, it is likely that the reserve would adequately represent the forest vegetation for that particular subzone or subzone variant. Since there are a number of smaller unique or research 'type' reserves already established in some of these ecoregion subzones or subzone variants, then these reserves would also add to the overall site association inventory for that area.

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1. Four additional subzones or subzone variants are excluded from consideration in this ecoregion since they are marginal and represent less than 5% of the area.

In some ecoregions, it might be appropriate to omit one or more of the subzones or subzone variants from consideration for ecological reserves due to adequate representation in adjacent ecoregions. A potential example of this situation in the Fraser Basin Ecoregion occurs with the two variants of the Sub-boreal spruce wet cool subzone (see Appendix 4). These two variants do not contain any site associations not already found in the other eight subzones or subzone variants. A final check for this type of overlap must await further testing once the complete classification scheme at this level is in place.

Alpine/subalpine lands

Alpine regions are extremely complex. Climatic variation, from frigid icefields to sheltered shales at timberline, is much greater than within any forested Biogeoclimatic Zone. Slope steepness, slope orientation and soil development show extreme variations over short distances, and a large number of plant associations occur (Table 2). As with forested areas, the degree of ecosystem variation is best expressed by the number of plant associations that are present. Research studies have described such associations in a few B.C. locations, but a complete list of alpine associations has not been compiled. This should not be a major impediment or optimal location of a reserve within each of the 12 to 14 map units requiring representation. Physical conditions and plant communities vary so greatly within short distances that a strategically located reserve of moderate size should capture most associations. Review of air photos in the office would allow a small number of potential reserve sites to be selected, based on physiographic factors. Brief field checks would then determine which of these contained the greatest variety of associations. An important consideration would be that sufficient elevational range and a variety of slope orientations are included.

Grasslands

An approach using air-photo interpretation of soil parent materials for preliminary identification of potential reserve sites, followed by field inspection to determine if known plant associations are present, is also recommended for the Grassland Biogeoclimatic Zone. However, optimal siting of reserves within the four projected Subzone variants is complicated

because of fragmentation by human use and because remaining tracts are almost entirely grazed, resulting in a mosaic of seral stands. A large reserve in each Subzone variant would probably capture most associations, but large reserves probably cannot be achieved. The number of reserves needed to obtain complete representation must take land tenure and use into account and cannot be accurately estimated at this time.

Wetlands

The Canadian Wetland Classification System, recently developed by Environment Canada, is appropriate for determining the kinds of wetlands which should be included in the Ecological Reserves system. Although wetland data are still relatively sparse, the Ministry of Forests has conducted detailed studies in several regions generally using the Canadian Wetland Classification system.

The system contains three hierarchical levels:

1. Classes - Five are recognized: bogs, fens, marshes, swamps and shallow water.
2. Forms - Seventy forms are recognized for Canada. Not all of these occur in B.C.
3. Types - These are classified according to vegetation physiognomy. The actual working level for a wetland classification will be most practical at the 'form' level (Table 2). The 'type' level would prove impractical for ecological reserves purposes since it is based on vegetative physiognomy, and it will be many years before the hundreds of different wetland plant associations are documented.

Summary of recommended classification schemes

Recommended schemes for classifying B.C. into ecological units requiring reserve representation and for assessing ecological variation within those units are summarized in Table 2. The estimated number of reserves required for forest, grassland and alpine representation is based on one-per-map unit. It is felt that only in extreme cases would more than one-per-map unit be needed. On the other hand, where reserves enclosing watersheds have considerable elevational range, several Subzones/variants may be included in a single reserve. This approach will significantly reduce the total number of reserves needed to achieve province-wide representation. It is estimated that about 50 kinds (forms) of wetlands should receive ecological reserve protection. Many if not all of those will be included within other representative reserves. Even where reserves are designated strictly for wetland ecosystem representation, it may be possible to include several forms within a single reserve. Therefore, the number of reserves required strictly for wetlands cannot be determined at this time, but should be relatively small.

Roemer (1984) stated that an aim of the Ecological Reserves Program was to "... secure examples of *all* ecosystem cells in each biogeoclimatic zone ...". Rigid adherence to this principle could result in the need for several reserves per map unit, and considerable field investigation to determine the location and extent of ecosystems or site associations in each map unit. A more reasonable objective would be to concentrate on including average or zonal (i.e. representative) conditions while attempting at the same time to capture a reasonable amount of associated diversity.

Testing the recommended scheme: Fraser Basin Ecoregion

Nine Ecological Reserves (#36, 38, 41, 71, 72, 73, 82, 84 and 86) were tested against the detailed system classifications developed during this study. All of the reserves are located within the Fraser Basin Ecoregion. This ecoregion, with its eleven subzones or variants, was chosen as a test case for representative terrestrial vegetation.

It is immediately apparent that a true test of the detailed system classification for representative terrestrial vegetation must, in many cases, await an adequate survey

of established representative reserves. Some reserves, although relatively large, lack sufficiently detailed vegetation data. For example, information on E.R. #38 (Takla Lake) briefly outlines dominant trees species, but gives no indication of understorey dominants or area covered by climax/seral associations.

It appears that five of the reserves qualify as rare or unique reserves, while four (#36, 38, 41 and 84) have potential as representative reserves. Ecological Reserve #84, although somewhat small, has satisfactory representation for its subzone variant. Ecological Reserves #36 and 41, because of their relatively large size, also are likely to be well qualified, but only resurveys would confirm this. Ecological Reserve #38 may have potential but, in addition to its relatively small size, may be more qualified as a unique reserve.

In addition to a paucity of vegetation data, there is very little pedological data and virtually nothing on geological/geomorphological features included in each Ecological Reserve report. The latter information is necessary, not only to provide more accurate classification within the system, but to adequately assess other ecological reserve needs (unique features, etc.) as well as providing preliminary data for future researchers.

ECOLOGICAL RESERVES TESTED

Ecological Reserve #36 (Mackinnon Esker) - 4662 ha

System Design Location
- Fraser Basin Ecoregion
  - Sub-boreal Spruce moist cool subzone (SBSmk)
    - Variant 1 (SBSmk1)
  - Engelmann Spruce-Subalpine Fir moist cold subzone (ESSFmc)

Associations Present
1. Picea - Vaccinium (mem) - Pleurozinium
2. Pinus - Vaccinium (myr) - Arctostaphylos - Cladina
3. Pinus - Vaccinium (caes) - Arctostaphylos - Cladina
4. Picea (glau) - Abies - Gymnocarpium - Oplopanax
5. Picea (eng) - Abies - Rhododendron (albi)
6. Seven other shrub and herb associations

Rare Plants, Animals and Landform Types Present - No rare plants or animals are identified. The reserve itself, in part, represents an exceptional esker.

Discussion

Three out of nine associations listed by MoF for this subzone variant are included in this reserve. An addition ESSF subzone association is also included. There is no indication how thoroughly this large reserve was surveyed. Thus, it is possible that there are more associations present.

Ecological Reserve #38 (Takla Lake) - 263 ha

System Design Location
- Fraser Basin Ecoregion
  - Sub-boreal Spruce wet cool subzone (SBSwk)
    - Variant 3 (SBSwk3)

Associations Present
1. Pseudotsuga
2. Picea - Pseudotsuga
3. Pinus - Pseudotsuga
4. Picea (glau) - Picea (engel)

Rare Plants, Animals and Land Form Types Present - None

Discussion

Documentation of this reserve, at least with respect to the composition of dominant plant associations, is virtually absent. To enable a comparison with MoF associations studied in this subzone variant, a complete resurvey would have to be conducted.

Ecological Reserve #41 (Tacheeda Lakes) - 1709 ha

System Design Location
- Fraser Basin Ecoregion
  - Sub-boreal spruce wet cool subzone (SBSwk)
    - Variant 1 (SBSwk1)
  - Engelmann Spruce-Subalpine Fir moist cold subzone (ESSFmc)

Associations Present
1. Picea - Abies - Gymnocarpium - Opopanax
2. Picea - Abies - Gymnocarpium - Ptilium
3. Picea - Vaccinium (mem) - Pleurozium
4. Picea (eng) - Abies - Rhododendron
5. Picea (eng x glau) - Oplopanax
6. Eight other shrub and herb associations

Rare Plants, Animals and Landform Types Present - None

Discussion

Three of ten SBSwk1 association types listed by MoF are included in this reserve. In addition, two ESSFmc associations out of a total of eight, are also included.

Ecological Reserve #71 (Blackwater Creek) - 223 ha

System Design Location
- Fraser Basin Ecoregion
  - Sub-boreal Spruce moist cool subzone (SBSmk)
    - Variant 2 (SBSmk2)

Associations Present

1. Pinus - Viccinium (caes) - Arctostaphylos - Cladina
2. Picea - Vaccinium (memb) - Pleurozium
3. Picea mariana - Cornus - Sphagnum
4. Picea mariana - Betula (pum) - Sphagnum
5. Four additional shrub and herb wetland associations

Rare Plants, Animals and Landform Types Present - None

Discussion

It is likely that only two or three of the above associations are among the six listed for this subzone variant by MoF. There is no indication in the E.R. report on how the reserve is divided into upland forest or bogs.

Ecological Reserve #72 (Nechako River) - 138 ha

System Design Location

Fraser Basin Ecoregion

Sub-boreal Spruce dry warm subzone (SBSdw)

Variant 1 (SBSdw1)

Associations Present

1. Picea glauca x engel - Vacc (caes, vitis)
2. Picea glauca x engel - Lonicera - Plagiomnium
3. Pinus - Picea - Pseudotsuga - Arctostaphylos - Cornus
4. Larix - Picea marianum - Sphagnum
5. Larix - Picea marianum - Sphagnum
6. Carex aquatilis - Menyanthes

Rare Plants, Animals and Landform Types - None

Discussion

It is likely that at least two, and possibly three, of the above associations are among the nine listed for this subzone variant by MoF. It is extremely difficult to compare the very sparse data provided by Ecological Reserve surveyors with the material provided by MoF. Since the purpose of this reserve was to protect a rare and unique Larix (tamarack) stand, it probably should not be included as a representative reserve.

Ecological Reserve #73 (Torkelsen Lake) - 161 ha

System Design Location

Fraser Basin Ecoregion
Sub-boreal Spruce moist cold subzone (SBSmc)
Variant 2 (SBSmc2)

Associations Present

1. Abies - Picea glauca x engel - Vaccinium - Pleurozium
2. Abies - Picea glauca - P. mariana - Petasites - Aulucomium
3. Picea glauca - P. mariana - Sphagnum
4. Alnus - Salix (glauca, barclayi) - Sphagnum

Rare Plants, Animals and Landform Types - None

Discussion

None of the climax associations listed for SBSmc2 occur in E.R. #73. This reserve would have to be treated as a rare or unique wetland reserve under the system design.

Ecological Reserve #82 (Cinema Bog) - 100 ha

System Design Location

Fraser Basin Ecoregion
Sub-boreal Spruce dry warm subzone (SBdw)
Variant 1 (SBSdw1)

Associations Present
Five shrub and herb wetland associations listed

Rare Plants, Animals or Landform Types Listed - None

Discussion

None of the climax associations listed for SBSdw1 occur in E.R. #82. This reserve would have to be treated as a rare or unique wetland reserve under the system design.

Ecological Reserve #84 (Aleza Lake) - 283 ha

System Design Location
Fraser Basin Location
Sub-boreal Spruce wet cool subzone (SBSwk)
Variant 1 (SBSwk1)

Associations Present

1. Picea glauca - Vaccinium (memb), Clintonia - Ptilium, Pleurozium
2. Picea mariana - Betula (pum)
3. Picea glauca, Pinus (cont) - Pseudotsuga - Chimophila, Goodyera - Pleurozium
4. Picea glauca, Abies - Gymnocarpium - Ptilium
5. Picea glauca, Abies - Oplopanax, Gymnocarpium

Rare Plants, Animals or Landform Types Listed - None

Discussion

It would appear that at least four of the above associations are among the ten listed for this subzone variant by MoF. It is quite possible that a more thorough survey, using MoF methodology, might result in additional associations. Further surveys might also show that a slight increase in size could add several associations and fulfill the requirements for a representative ecological reserve in this subzone variant.

Ecological Reserve #86 (Bednesti Lake) - 121 ha

System Design Location
Fraser Basin Ecoregion
Sub-boreal Spruce dry warm subzone (SBSdw)
Variant 3 (SBSdw3)

Associations Present

1. Picea mariana - Sphagnum
2. Picea glauca - Picea mariana
3. Larix - Betula pumila
4. Larix - Picea mariana
5. Several other wetland shrub and herb associations

Rare Plants, Animals or Landform Types Listed - None

Discussion

None of the climax associations listed for SBSdw3 occur in E.R. #86. This reserve would have to be treated as a rare or unique wetland reserve under the system design.

RARE, THREATENED OR ENDANGERED SPECIES

Native Vascular plants

Introduction and methodology

Rare, threatened and endangered native plants are of particular concern to ecological reserve planning. Recent botanical studies have identified 61 vascular plant species belonging to the above category. An additional 504 rare species and seven endemic (but not rare) species are included in a separate report. Some of these may become of concern to ecological reserves when their exact status becomes known.

A rare plant, for purposes of this document, is defined as one that has a small population or number of populations in the province. It may be restricted to a small geographical area or it may occur sparsely over a wider area. These would include most of the R1's and some of the R2's of Straley *et al.* (1985).

The rare gymnosperms and dicotyledons listed were identified by Douglas *et al.* (1989) while the rare pteridophytes and monocotyledons were taken from Straley *et al.* (1985).

The list of 61 vascular plants consists of plants that are either rare and endemic to B.C. (and possibly immediately adjacent states or provinces), rare with their habitat presently endangered in B.C., or rare with their habitat threatened/vulnerable.

List of rare, threatened or endangered plants to be protected in B.C. Ecological Reserves

Adiantum capillus-veneris L.
Adiantum pedatum L. var. *subpumilum* Wagner & Boydston
Arnica louiseana Farr
Asplenium adulterinum Milde
Aster curtus Cronq.
Aster paucicapitalus (B.L. Robins) B.L. Robins
Astragalus mutzotinensis Rouss
Azolla mexicana Presl.
Basamorhiza deltoidea Nutt.
Boisduvalia stricta (Gray) Greene
Calochortus lyallii J. Baker
Camissonia andina (Nutt.) Raven
Castilleja levisecta Greenm.
Centaurium exaltatum (Griseb.) Wight ex. Piper
Cephalanthera austinae (Gray) Heller
Corydalis scouleri Hook.
Crassula erecta (H.&A.) Berger (*Tillaea erecta* H.&A.)
Douglasia montana Gray
Downingia elegans (Dougl. ex. Lindl.) Torr.
Elmera racemosa (S. Wats.) Rydb.
Epipactis gigantea Dougl. ex Hook.
Erigeron leibergii Piper
Erigeron salishii G.W. Dougl. & Packer
Erigonum strictum Benth.
Eriogonum pyrolaefolium Hook. ex. Murr. var. *coryphaecum* T.&G.
Euonymus occidentalis Nutt. ex. Torr.
Githopsis specularioides Nutt.
Hydrophyllum tenuipes Heller
Lewisia tweedyi (Gray) B.L. Robins in Gray
Limnanthes macounii Trel.
Liparis loeselii (L.) L.C. Rich.
Lotus formosissimus Greene
Lotus pinnatus
Lupinus lepidus Dougl. ex. Lindl. (*L. minimus* Dougl. ex. Hook.)
Meconella oregona Nutt. in T.&G.
Microseris bigelovii (A. Gray) Schultz - Bip.
Microseris lindleyi (D.C.) A. Gray
Mimulus dentatus Nutt ex. Benth. in DC.
Ophioglossum vulgatum

Orthocarpus bracteosus Benth.
Orthocarpus castillejoides Benth.
Orthocarpus faucibarbatus Gray ssp. *albidus* Keck
Phlox speciosa Pursh
Plagiobothrys figuratus (Piper) I.M. Johnst. ex. M.E. Peck
Polygala senega L.
Polystichum lemmonii Underw.
Polystichum scopulinum
Ranunculus alismaefolius Geyer ex. Benth. var. *alismaefolius*
Ranunculus californicus Benth.
Ranunculus lobbii (Hiern) Gray
Salix setchelliana
Sanicula arctopoides H.&A.
Sanicula bipinnatifida Dougl. ex. Hook.
Sidalcea hendersonii S. Wats.
Silene scouleri (Estw.) C.L. Hitche. & Maguire ssp. grandis (Eastw.) C.L. Hitche. & Maguire
Sporobolus airoides (Torr.) Torr.
Talinium okanogannse English
Thelypteris nevadensis (J.B. Baker) Clute ex. Manton
Trillium ovatum Pursh. f. *Hibbersonii* Tayl. & Szczawinkski
Triteleia howellii (S. Wats.) Greene
Woodwardia fimbriata J.E. Smith ex. Rees

Native Vertebrate Animals

Introduction and methodology

It is anticipated that the system of representative terrestrial reserves will also include animal communities which are representative of the ecological zones in which those reserves occur. Those reserves should be numerous and widespread enough to sample the range of vertebrate and invertebrate diversity which occurs in British Columbia. Some will also contain habitat of importance for rare or endangered species. However, it is an objective of the Ecological Reserves program to establish reserves to specifically meet the needs of rare and endangered animals.

Many birds and mammals, both common and rare, undertake extensive seasonal migrations. It is not possible to enclose the year-round habitats of viable populations of such species within reserves of reasonable size. Movements in and out of reserves by common species, like moose and ducks, need not be of great concern to the Ecological Reserves Program. In the case of mobile rare or endangered species, the program objective, as already pursued in the case of some seabirds, should be to preserve critical seasonal habitats, such as breeding sites, important feeding areas or winter range.

Designation for rare or endangered status

The vertebrate groups considered here are amphibians, reptiles, birds and mammals. Fish are excluded because of less complete knowledge of their status. The taxonomic level of concern is primarily the species, although well-defined sub-species may also be included[1]. Species included are those which have been listed as rare, threatened or endangered and/or are of management concern because of their population status, in a *provincial* context. However, this includes those B.C. species which are imperilled nationally or globally.

The B.C. Wildlife Branch has established semi-quantitative criteria for assessment of the rare/endangered status of B.C. vertebrates (Table 3). These have evolved, after several years of testing, from criteria presented in the Ministry of Environment's preliminary plan for the designation of threatened and endangered species in B.C. (Munro and Low 1979). The six criteria allow a numerical score to be derived for species for which sufficient documentation is available.

Specialists in the Wildlife Branch and Royal B.C. Museum have applied the criteria to B.C. vertebrates to develop lists of rare/endangered species. This includes a "red list" (species with 36 or more points) and a "blue list" (all species with 30-35 points plus selected species with fewer than 30 points). These lists are given in Appendix 5. In order to be consistent with Ministry of Environment practices, it is recommended that the Wildlife Branch criteria and lists be used as a preliminary basis for assessment of species needing ecological reserve protection.

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1. For brevity, the term species will apply to both species and sub-species.

Table 4. Criteria used to assess rare/endangered status of B.C. vertebrate animals (draft material, B.C. Wildlife Branch)

Criteria	Numerical Scores				
	12	9	6	3	0
1. Abundance # of individuals breeding in B.C. Examples:	VERY LOW 100 Burrowing Owl Spotted Bat	LOW 500 Vancouver Island Marmot White Pelican	LIMITED 1000 Badger	MODERATE 5000 Cougar California Bighorn	COMMON
2. Distribution Examples:	VERY RESTRICTED (1 ecoregion) Townsend Mole Sea otter	RESTRICTED (1 ecoprovince or 2 ecoregions) Gyrfalcon Rattlesnake	LOCALIZED (2 ecoprovinces or 4 ecoregions) Western Grebe Mountain Beaver	GENERAL BUT LOCALIZED (narrow niches, clustered distribution) Eared Grebe	WIDESPREAD
3. Habitat Integrity Confined to habitat currently occupied and includes all environmental threats. Examples:	SEVERELY THREATENED (> 50% of habitat liable to be destroyed in 10 years) Marbled Murrelet	THREATENED (> 10% of habitat liable to be destroyed in 10 years) Ancient Murrelet	DETERIORATING (major long term degradation/ alienation) Grizzly Bear Bald eagle	AT RISK (degradation likely within 10 years) Fisher	NOT AT RISK
4. Population Trend (In B.C. over at least 3 generations or 3 cycles) Examples:	BELOW MINIMUM VIABLE POPULATION Burrowing Owl White-tailed Jackrabbit	RAPIDLY DECREASING (> 10-% per generation or cycle) Marbled Murrelet?	SLOW DOWNWARD TREND	STABLE (± 5% per generation or cycle) White Pelican	INCREASING
5. Reproductive Potential Average annual no. of young per female over life of female. Examples:	VERY LOW < 1 Grizzly Bear Marbled Murrelet	LOW 1 - 2 Ancient Murrelet Thinhorn Sheep	LIMITED 2 - 3 Marten Osprey	MODERATE 3 - 4 Beaver Prairie Falcon	HIGH
6. National and International Status Done at species level only Examples:	UNIQUE (Total world population in B.C. or endangered everywhere) Vancouver Island Marmot	MAJOR (> 20% of world's population in B.C. and rare elsewhere OR only Canadian population and rare elsewhere) Keen's myotis Spotted bat	SHARED (> 50% of world's population in B.C., common elsewhere) Barrow's Goldeneye Thinhorn Sheep	UNIQUE IN CANADA (Only Canadian population, common elsewhere OR > 25% of world's population in B.C.) Flammulated Owl Harlequin Duck	COMMON

For ecological reserve purposes, the Appendix 5 list can be reduced by elimination of species which fit the following criteria:

a). Game species which are relatively widespread and managed for hunting.

This includes elk, caribou and mountain goats. It is assumed that if a species is abundant enough to allow sport hunting, it is not in need of ecological reserve protection.

b). Species not amenable to ecological reserve protection.

This includes species which are so widespread that a reserve could protect no more than a single breeding pair and would, thus, be of little value for species preservation (e.g. anatum peregrine falcon), and those for which key habitats cannot be identified (e.g. the bats).

c). Species already protected another type of reserve.

This includes species for which the only known B.C. populations are in reserves, such as the white pelican (White Pelican Provincial Park), Forster's tern (Creston Valley Wildlife Management Area), Horned puffin (E.R.'s 95 and 96) and Thick-billed murre (E.R. 13), plus those having a substantial proportion of their B.C. population in protected areas (several species of seabirds).

List of vertebrate animals to be protected in B.C. Ecological Reserves

The resulting species list is presented below. It includes species having populations which occur year-round in restricted areas, species which are resident in B.C. but have large home ranges and species which migrate seasonally to and from the province. The fact that species may be wide-ranging is not felt to preclude them from consideration. Ecological reserves can contribute greatly to species conservation by protecting seasonally used habitats of critical importance.

Species	Feasible Ecological Reserve Program Objective
1. High Priority *	
Burrowing owl	Nesting habitat of a few breeding pairs
Canyon wren	Year-round habitat of a small population
Common poorwill	Nesting habitat of a few breeding pairs
Flammulated owl	Nesting habitat of a few breeding pairs
Marbled murrelet	Nesting habitat of a few breeding pairs
Spotted owl	Year-round habitat of a small population
Cascade golden-mantled ground squirrel	Year-round habitat of a viable population
White-tailed jack rabbit	Year-round habitat of a small population
Wood bison	A critical seasonal habitat
2. Moderate Priority **	
Arctic tern	One or more breeding colonies
Great blue heron	One or more breeding colonies
White-throated swift	One or more breeding colonies
Arctic loon	Habitat of several breeding pairs
Lesser golden plover	Habitat of a few breeding pairs
Purple martin	Natural habitat of a few breeding pairs
Wandering tattler	Habitat of a few breeding pairs
Sandhill Crane	Habitat of a few breeding pairs
Dall sheep	Year-round range of one herd
Nuttal's cottontail	Year-round habitat of a small population
Townsend's mole	Year-round habitat of a viable population
Collared pika	Year-round habitat of a viable population
Great Basin pocket mouse	Year-round habitat of a viable population
Grizzly bear	One or more critical seasonal habitat
Marsh shrew	Year-round habitat of a viable population
Pacific jumping mouse	Year-round habitat of a viable population
Shrew mole	Year-round habitat of a viable population
Western harvest mouse	Year-round habitat of a viable population
Clouded salamander	Year-round habitat of a viable population
Coeur d'Alene salamander	Year-round habitat of a viable population
Pacific giant salamander	Year-round habitat of a viable population
Tiger salamander	Year-round habitat of a viable population
Western rattlesnake	Year-round habitat of a viable population

* Species receiving 36 or more points based on criteria in Table 3.

** Species receiving 30-35 points, plus a few selected species with less than 30 points.

RARE OR UNIQUE FEATURES AND PHENOMENA

Botanical Features

There are numerous botanical habitats and unique phenomena that are outstanding and worthy of ecological reserve status. A list of some examples of these follows:

Geological habitat types and their plants:

- — Limestone floras
- — Serpentine or ultratramafic outcrop floras
- — Special quartize and other alpine scree floras
- — Coastal and interior sand dune floras
- — Hydrological types and their plants

Hot springs floras

- — Alkaline/saline floras
- — Unique wetland floras
- — Vernal pool floras (especially in southwest B.C.)

Other unique features

- — Plants at the extremes of their ranges
- — Plants of unique sizes (e.g. trees)
- — Fragile populations (e.g. E.R. #113, Honeymoon Bay)
- — Endemics or widely disjunct species
- — Unique mass displays (e.g. E.R. #88, Skwahah)

Zoological Features

The two major criteria which have been used to develop preliminary lists of worthy zoological phenomena are rarity and sensitivity. Features targeted for ecological reserve protection should be one-of-a-kind with respect to the province or large regions within it, and should be sensitive and/or vulnerable to human-caused impacts.

Exceptional Populations

This category is established in order to provide protection for those populations which have unique characteristics, but have not been given a formal sub-specific taxonomic designation and are, therefore, not included on lists of rare or endangered "species". Relatively few phenomena of this kind are expected to occur, however, some probably remain to be discovered.
Examples could include:

— unusual colour phases;
— populations having exceptional growth rates or size;
— populations in zones of hybridization;
— genetically pure stocks.

Unique Concentrations of Animals

Animals of a single species, or of different species having similar habitat requirements, may temporarily concentrate in a restricted area for purposes of breeding, wintering, feeding or social interactions. Some of these concentrations are unique in a provincial context, and most are sensitive to human disturbance. Where animal concentrations are of fairly widespread occurrence, e.g. in the case of spawning salmon or wintering ungulates, only the most outstanding and/or vulnerable examples should be considered for reserve status.
Examples include the following:

1. Breeding concentrations:
   — rutting caribou (e.g. Spatsizi area)
   — seabird colonies
   — inland colonial bird sites
   — fish spawning sites (anadromous and freshwater species)
   — wetlands with exceptional amphibian concentrations

2. Wintering concentrations:
   — wintering ungulates (e.g. Premier Ridge)
   — wintering waterfowl (e.g. snow geese in Fraser Delta)
   — bat caves
   — snake hibernacula

Unique Environmental Relationships

By definition, phenomena such as these are not frequently encountered, but outstanding examples should receive reserve status as they become known. This category is meant to include sites where animals utilize a kind of habitat that is atypical, or use typical habitat in an unusual way. These occurrences should be virtually one-of-a-kind in a provincial context.

Typical examples include ground-nesting bald eagles (Triangle Island), tree-nesting peregrine falcons (Byers/ Conroy Islands), and rubbing beaches used by killer whales (Robson Bight). These examples are in established ecological reserves, but additional examples involving other species undoubtedly occur.

Scientific Benchmark Sites

These are locations where basic faunal research has been carried out and where it is important to be able to make repeat observations over the long-term future. Examples include habitats where type specimens of several taxa of insects have been collected and from which additional specimens (e.g. paratypes) may be needed in the future, or sites where long-term studies of animal populations (e.g. cyclic fluctuations) are being undertaken.

Geological Features

Introduction and methodology

Geological elements of terrestrial ecosystems are by nature essentially inanimate features and, hence, distinct from other elements such as fauna and flora. As a consequence, geological elements often do not fit well in ecological classification schemes such as the 'site association' proposed for the Ecological Reserves System Plan. However, it is recognized that soil and landform attributes are vital components of terrestrial ecosystems in regard to their biological functioning. In addition, there are geological features which are unique to B.C. as well as those which are fragile and may require active protection measures.

Landform and geological features are, therefore, viewed as three types:

Category 1. Common or widespread soil and landform characteristics which, while vital to ecosystem functioning are neither rare, fragile or endangered.

Category 2. Geological features which have high scientific or educational value, but which are not easily destroyed and are not rare.

Category 3. Geological features which are unique in B.C. and can be easily destroyed by land use activity.

For the purposes of Ecological Reserves, only Category 3 elements should be considered as possible candidates for assigning priority for protection. Category 2 elements should be considered only as worthwhile additions to Ecological Reserves which are established to protect other elements in order to add to the reserve's natural diversity and scientific interest. Category 1 elements should not be considered for Ecological Reserve protection.

The following sections describe a generalized landform classification system from which elements are chosen for the purposes of categorization as representative features (Category 2) or rare and unique features (Category 3).

Generalized landform classification

The following generalized system of landform classification is presented as a means of categorizing specific landform and geologic processes for use in determining candidates for Ecological Reserve status and for reviewing existing reserves in regard to the type of coverage presently in place.

This preliminary system has been developed with the following points in mind:

1. The landform elements must be identifiable within existing classification/mapping systems in the Province to aid in use and communication (e.g. Terrain Classification System);

2. The system must subdivide elements that represent distinctive geological phenomena related to the physiography of the Province;

3. The system must be capable of delimiting unique examples of geological phenomena as well as specific examples of representative ecosystems; and

4. The system must be hierarchical to aid in data storage and manipulation (e.g. computer storage/retrieval).

The following material describes the proposed classification system:

1. Unconsolidated

Depositional

Glacial	— Eskers — Drumlins — Kames and Kettles — Terraces — Terminal/Lateral/End Moraines
Fluvial	— Fans — Terraces — Floodplains (channel forms)
Gravity	— Fans/Talus — Landslide Debris (large blockfields)
Wind	— Dunes (various types)
Marine	— Beaches — Raised Marine Platforms (inactive) — Lagoons — Spits

Erosional

Glacial	— Hanging Valley — Outwash Channels — Glacial Outburst Flood

Fluvial/Gravity — Erosional Gulleys (debris torrents, flows)
— Hoodoos
— River Canyons

Wind

Marine

Sea Cliffs

2. Bedrock

Depositional (recent geologic features)

Volcanic Flows
Volcanos (cones)
Chemical Precipitation (travertine)
Mineral Springs

Erosional

Glacial (cirque/tarn, horn, rock drumlin, striations)
Wind Sculpted
Chemical Alteration (karst)
Marine/Fluvial Sculpting
River Canyons
Waterfalls

Mineralization

Gemstones (garnets, jade, rhodonite, etc.)
Base Metals (copper, lead, zinc, etc.)
Precious Metals (gold, silver, platinum)

Structure

Faulting
Folding

Fossilization

3. Glaciers

Rock Glacier (Active/Relict)

Active Ice Glacier

4. Pedological

Chemical

Podzolization
Salinization

Biological

Soil Fauna
Soil Flora

Paleosols

Permafrost

Thaw Features (thermokarst)
Relict Ice

Periglacial

Solifluction Lobes
Nivation Hollows
Stone Polygons
Snow Avalanching

5. Anthropological

Mine Workings

Petroglyphs

List of geological features to be included in B.C. Ecological Reserves
The following geologic elements have been extracted from those listed in the previous section for the purpose of exemplifying elements which may be worthy of protection. The list limits itself to Category 2 and 3 elements only, since it is expected that Category 1 elements will be captured in Ecological Reserves established for other reasons.

At the present time, it is recommended that only Category 3 elements be assigned priority for selection by Ecological Reserves for protection purposes.

Category	Geological Description	Priority for Acquisition	Examples (only selected examples given)
3	BEDROCK (Fragile Locations)		
	— Mineralization	Moderate	Gemstones in the Likely/ Horsefly area of the Cariboo
	— Fossilization	High	Princeton/Tulameen area
	— Structure (folding/ faulting	Moderate	Active tectonic features (e.g. faults) Rocky Mountains
	PEDOLOGICAL (Fragile Locations)		
	— Paleosols (intact pollen record)	High	Bogs in the Coastal Douglas Fir Zone
2	BEDROCK		
	— Volcano Flows and Cones		Telegraph Creek area in Northwest B.C.
	UNCONSOLIDATED - Depositional		
	— Esker		Fort St. James area
	— Drumlin		Prince George area
	— Kames and Kettles		Okanagan area
	— Dunes		Kootenay/Columbia River Valley

UNCONSOLIDATED - Erosional	
— Glacial Outwash Channels	Northwest B.C.; Stikine River Drainage
— Hoodoos	Columbia River Valley
PEDOLOGICAL	
— Periglacial - Patterned Ground	Cariboo Mountains

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Appendix 1. Workshop Organization and Participants

Participants were provided in advance with background materials and an agenda. The workshop was structured primarily as a morning orientation and information exchange and an afternoon problem-solving exercise (Appendix 2).

For the afternoon session, participants were divided into two teams, each of which debated the merits of a previously prepared list of possible classification schemes (Appendix 3). The objective was for each group to independently select a classification scheme which they felt would best serve the interests of the Ecological Reserves Program. Late in the afternoon, the two groups re-convened to compare and discuss their recommendations.

Workshop Participants

Don Blood (Chairman)	D. Blood and Associates Ltd. 5771 Kerry Lane Nanaimo, B.C. V9T 5N5
George Douglas (Secretary)	Douglas Ecological Consultants 6200 North Road, R. R. #2 Duncan, B.C. V9L 1N9
Hans Roemer	Ministry of Parks Planning and Ecological Reserves 400 Seymour Place Victoria, B.C. V8V 1X5
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Adolf Ceska	Royal B.C. Museum Botany Division 675 Belleville Street Victoria, B.C. V8V 1X4
Terry Lewis	6149 Burns Street Burnaby, B.C. V5H 1X3
Bill Munn	Ministry of Parks Planning and Ecological Reserves 4000 Seymour Place Victoria, B.C. V8V 1X5

Appendix 2. Agenda for workshop on ecological land classification schemes useful for selection of representative ecological reserves.

Morning Session

1. 9:00 a.m. Introductory remarks - D. Blood

2. The Ecological Reserves system planning process - L. Goulet

3. Present problems with respect to achieving E.R. representation - H. Roemer

4. Completeness, detail and availability of information and mapping in B.C. (various participants).
   a. Climate
   b. Landform/Surficial Deposits/Soils
   c. Vegetation
      — Biogeoclimatic Zones/Subzones/Variants
      — Forest Communities
      — Grasslands
      — Alpine
      — Wetlands
      — Other Vegetation Types

5. What is the most meaningful classification hierarchy for E.R. purposes; how many levels; which factor should be dominant?

6. Other considerations, e.g., practical size of smallest working unit in the system.

Afternoon Session

1. 1:00 p.m. Criteria for comparing possible classification approaches in B.C. - D. Blood

2. 1:30 p.m. Break into two groups, each of which will debate and list the pros and cons of approaches given in Attachment 5.

3. Each group to priorize the list of classification approaches.

4. 4:00 p.m. Comparison of approach(es) recommended by each group.

5. Resolution of differences, if any, and recommendation of first and second priority approaches.

Appendix 3: Possible approaches for classification of B.C. into units which will provide a basis for selection of representative ecological reserves.

A. Approaches based on climate and physiography (Ecoregion system)
   - Level 1: Major climatic regions (Ecodomains; ecodivisions)
   - Level 2: Physiographic regions (Ecoprovinces; ecoregions)
   - Level 3: Ecosections (78 in B.C.)

B. Approaches based on physiography
   1. Provincial Park System
      - Level 1: Natural regions (16, based on Holland)
      - Level 2: Regional landscapes (52, based on Holland)
   2. Physiographic/Biogeographic Approach
      - Level 1: Involves the slight modification of 52 physiographic landscapes in province to accommodate the boundaries of the usually consistent biogeoclimatic zones they contain. Consists of 52+ landscapes
      - Level 2: Fixed catalogue of elements to be defined for each landscape.

C. Approaches based on Biogeoclimatic Zones
   1. Biogeoclimatic Zone/Ecosystem Classification Approach
      This is the approach which has been used by the Ecological Reserves Program so far.
      - Level 1: Biogeoclimatic zones (13 in province)
      - Level 2: Complete list of all ecosystems in each zone, in terms of tree-shrub-herb-moss community names.
   2. Strict Biogeoclimatic Zone Classification Approach
      - Level 1: Biogeoclimatic zones (13)
      - Level 2: Biogeoclimatic subzones (60 to 100)
      - Level 3: Fixed catalogue of elements to be defined in each subzone.
   3. Biogeoclimatic/Geographic Approach
      - Level 1: Biogeoclimatic zones (13)
      - Level 2: Each zone is divided in geographic areas. Possibly 80+ for the province.
      - Level 3: Fixed catalogue of elements to be defined in each geographical area.

D. Various combinations of above.

Appendix 4. List of Plant Associations for Representative Terrestrial Vegetation in the Fraser Basin Ecoregion[1]

FRASER BASIN ECOREGION[2]

Sub-boreal spruce dry warm subzone (SBSdw)

Variant 1 (SBSdw1)

Associations[3]:

1. SBSdw1: Pinus - Cladonia - Polytrichum
2. SBSdw1: Pseudotsuga - Symphorocarpos - Pleurozium
3. SBSdw1: Pinus - Calamagrostis - Pleurozium; Vaccinium
4. SBSdw1: Pseudotsuga - Picea - Oryzopsis; Pseudotsuga
5. SBSdw1: Pseudotsuga - Picea - Calamagrostis; Paxistima
6. SBSdw1: Pseudotsuga - Picea - Rubus; Corylus
7. SBSdw1: Picea - Lonicera - Petasites; - Ribes
8. SBSdw1: Picea - Lonicera - Gymnocarpium; Viburnum
9. SBSdw1: Picea - Equisetum - Aulacomnium; typicum

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1. Data provided by Ministry of Forests, Victoria.

2. Four additional subzones or variants (SBSmk2, SBSvk, ICHvk and ESSF1) are excluded from this list since they are not typical of the Fraser Basin Ecoregion and represent less than 5% of the area.

3. A total of 49 different associations are identified for the Fraser Basin Ecoregion. Association numbers in parentheses indicate associations belonging to the same site association.

Variant 2 (SBSdw2)

Associations:

10. SBSdw2: Pseudotsuga - Juniperis - Pleurozium
11. SBSdw2: Pinus - Calamagrostis - Pleurozium; Vaccinium (myr)
12. SBSdw2: Pseudotsuga - Juniperus - Pleurozium
13. SBSdw2: Pinus - Arctostaphylos - Pleurozium
14. SBSdw2: Pseudotsuga - Picea - Rhytidiacelphus
(5) SBSdw2: Pseudotsuga - Picea - Calamagrostis; Vaccinium (myr)
15. SBSdw2: Pinus - Picea (mariana) - Pleurozium

16. SBSdw2: Picea - Lonicera
17. SBSdw2: Picea - Oplopanax - Athyrium; Ptilium
18. SBSdw2: Picea - Equisetum; Cornus

Variant 3 (SBSdw3)

Associations:

19. SBSdw3: Pseudotsuga - Juniperis - Pleurozium
20. SBSdw3: Pinus - Pleurozium - Cladina; Orthilia
(4) SBSdw3: Pseudotsuga - Picea - Cladina; Pseudotsuga
(15) SBSdw3: Pinus - Picea (mariana) - Pleurozium
(5) SBSdw3: Pseudotsuga - Picea - Calamagrostis; Petasites
(16) SBSdw3: Picea - Lonicera
21. SBSdw3: Picea - Gymnocarpium; Arnica
(9) SBSdw3: Picea - Equisetum - Aulacomnium; typicum
22. SBSdw3: Picea - Spiraea (douglassii); Vaccinium (caespitosu)

<u>Sub-boreal spruce moist warm subzone</u> (SBSmw)

Associations:

23. SBSmw: Pseudotsuga - Abies - Vaccinium (membrandaceum)
24. SBSmw: Pseudotsuga - Picea - Ptilium
25. SBSmw: Pseudotsuga - Picea - Paxistima

26. SBSmw: Pinus - Vaccinium (mem) - Vaccinium (myr)
(21) SBSmw: Picea - Gymnocarpium; Streptopus
(8) SBSmw: Picea - Lonicera - Gymnocarpium; Viburnum
27. SBSmw: Picea - Oplopanax; Rubus (parviflorus)
(18) SBSmw: Picea - Equisetum; Cornus

Sub-boreal spruce moist hot subzone (SBSmh)

Associations:

(13) SBSmh: Pinus - Arctostaphylos - Pleurozium
28. SBSmh: Pseudotsuga - Picea - Paxistima
(6) SBSmh: Pseudotsuga - Picea - Rubus; Corylus
29. SBSmh: Picea - Butela - Oplopanax; Populus (bal)
30. SBSmh: Picea - Matteuccia

Sub-boreal spruce moist cold subzone (SBSmc)

Variant 2

Associations:

31. SBSmc2: Pinus - Vaccinium (membranaceum) - Cladonia
32. SBSmc2: Picea - Vaccinium; typicum
33. SBSmc2: Picea (mar) - Vaccinium (mem) - Petasites; Lycopodium
34. SBSmc2: Picea - Vaccinium; Vaccinium (caespitosum)
35. SBSmc2: Picea - Lonicera - Petasites; Ribes
(21) SBSmc2: Picea - Gymnocarpium; Arnica
(8) SBSmc2: Picea - Lonicera - Gymnocarpium; Viburnum
(27) SBSmc2: Picea - Oploparax; Rubus (parviflorus)
(9) SBSmc2: Picea - Equisteum - Aulacomnium; typicum
(18) SBSmc2: Picea - Equisteum; Rubus

Sub-boreal spruce moist cool subzone (SBSmk)

Variant 1

Associations:

(31) SBSmk1: Pinus - Vaccinium (membranaceum) - Cladonia; Hylocomium
(20) SBSmk1: Pinus - Pleurozium - Cladina; Vaccinium

(myr)

39. SBSmk1: Picea - Spiraea (bet) - Pleurozium; Lathyrus (nevadensium)
40. SBSmk1: Picea - Spiraea (betulafolia) - Pleurozium; Arctostaphylos
41. SBSmk1: Picea - Lonicera - Petasites; Ribes
(18) SBSmk1: Picea - Equisteum; Cornus

Engelmann spruce-subalpine fir moist cold subzone (ESSFmc)

Associations:

42. ESSFmc: Abies - Juniperus - Cladina; Vaccinium (caesp)
43. ESSFmc: Abies - Vaccinium - Dicranum (fusc); Barbilophozia
44. ESSFmc: Abies - Vaccinium - Dicranum (fusc); Vaccinium (caes)
45. ESSFmc: Abies - Vaccinium (mem) - Empetrum
46. ESSFmc: Abies - Gymnocarpium - Dicranum
47. ESSFmc: Abies - Oplopanax - Athyrium; typicum
48. ESSFmc: Abies - Equisetum - Drepanocladus; Mnium
49. ESSFmc: Abies - Equisetum - Aulocomium; Hylocomium

Sub-boreal spruce wet cool subzone (SBSwk)

Variant 1 (SBSwk1)

Associations:

(31) SBSwk1: Pinus - Vaccinium (membranaceum) - Cladina
(26) SBSwk1: Pinus - Vaccinium (mem) - Vaccinium (myr)
(21) SBSwk1: Picea - Gymnocarpium; Streptopus
(24) SBSwk1: Pseudotsuga - Picea - Ptilium
(36) SBSwk1: Picea - Vaccinium - Viburnum; Rubus (parviflorus)
(27) SBSwk1: Picea - Oplopanax; Rubus (parviflorus)
(8) SBSwk1: Picea - Lonicera - Gymnocarpium; Viburnum
(17) SBSwk1: Picea - Oplopanax - Athyrium; Equisetum
(18) SBSwk1: Picea - Equisetum; Rubus
(22) SBSwk1: Picea - Spiraea (douglassii); Picea (miriana)

Variant 2 (SBSwk2)

Associations:

(36) SBSwk3: Picea - Vaccinium - Viburnum; Rubus (parviflorus)
(6) SBSwk3: Pseudotsuga - Picea - Rubus; Lathyrus (nevadensis)
(35) SBSwk3: Picea - Lonicera - Petasites; Ribes
(21) SBSwk3: Picea - Gymnocarpium; Arnica
(27) SBSwk3: Picea - Oplopanax; Rubus (parviflorus)
(18) SBSwk3: Picea - Equisetum; Rubus

Appendix 5 List of rare, threatened or endangered vertebrates in British Columbia[1]

Red List[2]		Blue List[3]	
	BIRDS		
(c)	Amer. white pelican		Category A
(b)	Anatum peregrine falcon	(c)	Ancient murrelet
	Burrowing owl		Arctic tern
	Canyon wren		Great blue heron
	Common poorwill		White-throated swift
	Flammulated owl		Category B
(c)	Forster's tern		Arctic loon
(c)	Horned puffin	(c)	Fork-tailed storm petrel
(b)	Marbled murrelet	(c)	Leach's storm-petrel
(c)	Prairie falcon		Lesser golden plover
	Spotted owl		Purple martin
(c)	Thick-billed murre		Wandering tattler
			Category C
		(c)	Cassin's auklet
		(c)	Common murre
		(c)	Rhinoceros auklet
			Sandhill crane
		(c)	Tufted puffin
	MAMMALS		
	Cascade golden-mantled ground squirrel		Category A
(b)	Fringed myotis		Dall sheep
(b)	Keen's myotis	(b)	Red bat
(b)	Pallid bat	(a)	Roosevelt elk
(c)	Sea otter		Category B
(b)	Spotted bat		Nuttal's cottontail
(b)	Townsend's big-eared bat		Plains bison
(c)	Vancouver Island marmot		Townsend's mole
(b)	Western small-footed myotis		Category C
	White-tailed jack rabbit	(a)	Caribou
	Wood bison		Collared pika
			Great Basin pocket mouse

	Grizzly bear
	Marsh shrew
(a)	Mountain goat
(b)	Northern long-eared myotis
	Pacific jumping mouse
(a)	Rocky mountain elk
	Shrew mole
	Western harvest mouse

AMPHIBIANS

N/A	<u>Category A</u>
	Clouded salamander
	<u>Category B</u>
	Coeur d'Alene salamander
	Pacific giant salamander
	Tiger salamander
	<u>Category C</u>
	N/A

REPTILES

	<u>Category A</u>
	N/A
	<u>Category B</u>
(b)	Night snake
	Western rattlesnake
	<u>Category C</u>
	N/A

---

1. Draft information provided by BC Wildlife Branch. Assignment to lists is based on criteria in Table 3.

2. Species with 36 or more points.

3. Category A = Species with 30-35 points and no criterion ranked "12".
   Category B = Species with 30-35 points, including one or more "12" rating.
   Category C = Species with less than 30 points, but receiving a rating of "12" for abundance, distribution, reproductive potential status <u>OR</u> a rating of 9 or more for habitat integrity or population trend.

   (c) = species already having completed or partial protection.
   (a) = hunted game species.
   (b) = species not amenable to Ecological Reserve Program.

Appendix 6* Contents of a documentation form for proposed ecological reserves

FORM CONTENTS	EXPLANATORY GUIDE CONTENTS
1. Proposal Number _____	To be assigned by ER staff.
2. Tentative name of proposal _____	Name must refer to a named map feature.
3. Surveyor(s) _____ _____	Name(s) and affiliation and/or address(es).
4. Date of Survey _____	
5. Proposer(s), if different _____	
6. Date of Proposal _____	
7. Proposed as representative for recurrent features/ecosystems	) If mix, indicate both.)
8. Proposed as unique or rare occurrence	)
9. Location _____ _____	Relative to nearest well-known settlement or geographical feature.

10. Size (hectares) _____

Elaborate on separate sheet or map if there is a high-priority portion or a core/buffer situation.

11. Elevation range (from-to,metres)

_____

12. Latitude/Longitude

_____

Average lat/long if under 5,000 ha.; otherwise give range from-to.

13. Attach 8.5 x 11-inch map(s)

Draw boundary on copy of 1:50,000 map. Attach separate sketch if needed.

14. Legal description of "metes and bounds" description

If not legally surveyed, append metes and bounds description.

_____
_____
_____

15. Land status

_____

16. Geographic setting

Macro-scale, e.g. "Rocky Mountain Trench".

_____

17. Landscape position

Micro-scale, e.g. "comprising foot of slope and floodplain of Fraser River".

_____

_____

18.	General vegetation cover _____	Eg., 1/2 forest, 1/4 bog, 1/4 grassland (compare #20).
19.	List of important landscape elements in proposal area _____ _____	List landforms that are not obvious from your map, e.g. "mosaic of drumlins and flat outwash plain".
20.	List of plant community types and estimated proportion of total proposal area covered by each List of types attached Detailed data sheet for each type attached (use corresponding numbering)	Attach documentation of average complete species combination for each. Designate dominant species or provide complete sample plot descriptions with cover estimates
21.	List soil types Separate sheet attached OR List all soil parent materials (sheet attached) for each plant community type with corresponding numbering	Subgroup level of Canadian System of Soil Class., or outwash, alluvium, till mantle, t.veneer, rock, organic, lacustrine etc.

22. List of mammals

Separate sheet attached

_____

23. List of birds

Separate sheet attached

_____

Minimum information for each species should include number of individuals, whether sighted (s) or presence inferred (i) from signs (tracks, droppings, evidence of feeding, etc.), and any information that will suggest whether the animal is resident or transient in the proposal area (e.g. nesting, territorial behaviour).

24. List of other fauna

Separate sheet attached

_____

_____

List and/or description of rare or unique features in ...

25. ... FLORA

None present
Separate sheet attached

_____

_____

26. ... FAUNA

None present
Separate sheet attached

_____

_____

27. ... OTHER

None present
Separate sheet attached

_____

28. Type of shoreline(s) and substrate of shoreline(s)

Distinguish ocean, river, lake if several; type: cliff, beach, bank etc. substrate: rock, sand, mud, gravel, boulder, peat etc.

None present
Separate sheet attached

_____
_____

29. Human history and disturbance

Possible histories: cultivation, grazing, drainage

_____
_____

30. Natural stand or site history

Eg., indications of fire, flooding, landslide etc.

_____
_____

31. Suggested purpose of proposed reserve

_____
_____

32. Proposer's view of area's significance

Separate sheet attached

_____

33. Why was this locality chosen over alternative ones (if any)?

_____
_____

34. How does present proposal relate to other proposed or established conservation areas?

Additional replication, complementary, first example?

_____
_____

35. Surrounding land uses

Present _____

Anticipated _____

36. N.T.S. map reference numbers (1:50,000) _____

37. Biogeoclimatic subzone or variant abbreviation

Use up-to-date Forest Ministry designation of the most detailed mapped unit.

_____

38. Forest cover map reference numbers

_____

39. Air photo numbers

_____

_____

40. Other references and additional notes

Separate sheet attached

_____

_____

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* prepared by Dr. H. Roemer, Ministry of Parks

Appendix 7 Recommended vegetation sampling procedures for proposed reresentative reserves

The system design plan for representative ecological reserves is based on a detailed knowledge of plant associations. Thus, it is important that acquisition of data be both complete and efficient. Collection of data is probably best achieved by use of a rapid reconnaissance technique such as that used by Douglas (1974) in the southwestern Yukon. This relatively rapid sampling technique, a modification of the method used by Franklin et al (1970) for the U.S. Forest Service in the western U.S., makes it possible to quantitatively sample a larger number of stands and include a greater degree of variability than more standard methods would allow.

Sample sites are selected on the basis of recognition of relatively homogeneous populations of various combinations of recurring species throughout the area. Transitional, heterogeneous or disturbed sites should be avoided. If a plant association is rare, then sampling should be limited (as few as three sites), whereas, if the association covers a large area or is variable, then more sites should be sampled.

Quantitative data is collected at each site using a circular plot about 15 m in diameter. Plots are established by arranging two 15-metre tapes to form the coordinates of a circle, the boundary of which is then visually estimated. This plot size is large enough to obtain information on the successional status of the forested stands. Forest structure data is obtained by tallying the number of trees (by species) and estimating the average diameter at breast height (DBH), and height of the overstory, intermediate and sampling tree strata at each site. The ages of several of the larger trees in each plot are recorded using an increment borer. Crown cover, using the methods and cover classes of (0-5, 5-25, 25-50, 50-75, 75-95, 95-100%) of Daubenmire (1959), is estimated for overstory and intermediate trees, samplings, shrubs, all other vascular plants and terricolous lichens, mosses and hepatics. These estimates are aided by the four quadrants outlined by the tapes. Midpoints of the six cover classes are then used in calculating average percentage cover of all taxa tallied in an association. Aspect, percentage slope, elevation, landform and other site characteristics are also recorded at each site.

Appendix 8 Detailed Information requirements (Proposals for Rare/Endangered Species)

Provide as much detail as possible on the following topics:

1. Common and scientific names of the taxon or taxa.

2. Validity of the taxon. Who described it? Is it widely accepted?

3. Distribution of the species, over its total range and in B.C. Include range maps and literature citations where available.

4. Abundance of the species in B.C. Give probable population size in B.C., in various regions and inside the proposed ecological reserve.

5. Habitat requirements of the species (seasonal for animals).

6. Information on home range, movements and population density relative to size of the proposed ecological reserve(animals only).

7. Conservation status in B.C.: Is habitat for this species protected elsewhere in B.C.? If so, where at? Estimate the proportion of the B.C. population that has protected status and kind of reserves involved.

8. Why is the land in the proposed ecological reserve of particular importance for this species?

9. Threats to habitat of this species in B.C.: What kinds of land use threaten the continued existence of this species? At what rate is habitat being lost? Will land use surrounding the ERP threaten survival of the species inside it? If so, within what time frame?

10. Any other documentation and titles of relevant literature.

Appendix 9 Detailed Information Requirements (Proposals for Outstanding Botanical, Zoological or Geological phenomena)

Provide as much detail as possible on the following topics:

1. Description of the feature and its environmental setting. Provide colour photos where appropriate.

2. Review other known occurrences of this feature in B.C., including locations and extent. Does this feature have protection elsewhere in B.C.? If so, where and to what extent?

3. Compare the uniqueness and scientific/educational importance of the feature within the proposed ecological reserve with other occurrences in B.C., if any.

4. Describe threats to the continued existence of the feature in B.C.

5. Describe threats to the continued existence of the feature at the location of this proposed ecological reserve in the absence of protection. Include kinds of threats and urgency for protection.

6. Describe potential impacts of surrounding land uses on the feature at this site if reserve status is achieved.

Appendix 10 Evaluation Criteria — Part 1

A. WHICH GOAL AND OBJECTIVE DOES THE PROPOSAL MEET? (Check one or more):

1. Representation and Protection of Natural Ecological Diversity

— Terrestrial and Freshwater Ecosystems _____
— Marine Biotic Zones and Subzones _____

2. Protection of Rare, Threatened or Endangered Biota in Natural Habitats

— Native Terrestrial and Freshwater Plant Species _____
— Native Terrestrial and Freshwater Animal Species _____
— Native Marine Flora _____
— Native Marine Fauna _____

3. Protection of Examples of Unique or Rare Natural Features

— Terrestrial and Freshwater Native Botanical Features _____
— Terrestrial and Freshwater Native Zoological Features _____
— Marine Botanical and Zoological Features _____
— Geological, Paleontological and Other Physical Features _____

4. Protection of Examples of Human-Modified Ecosystems

— Long-Term Study of Ecosystem Recovery _____

5. Scientific Research and Educational Study of the Natural Environment

Scientific Study _____
Institutional Research _____
Public Nature Study _____

B. WHAT FEATURE(S) OR ELEMENTS DOES THE PROPOSED ECOLOGICAL RESERVE CONTAIN?

1 Representative

— Terrestrial and Freshwater:

_____

— Marine: _____

2. Rare, Threatened or Endangered Biota

— Terrestrial and Freshwater Plants:

_____

_____

— Terrestrial and Freshwater Animals:

_____

_____

— Marine Flora: _____

_____

— Marine Fauna: _____

3. Unique or Rare Natural Features

— Terrestrial and Freshwater Plants:

_____

_____

— Terrestrial and Freshwater Animals:

_____

_____

— Marine Plants and Animals:

_____

_____

— Geological: _____

4. Human-Modified Ecosystems

— Ecosystem Recovery:

_____

5. Scientific Research and Education Study

— Scientific Study:_____

— Institutional Research:

_____

— Public Nature Study:

_____

C. IS THE CONTINUED EXISTENCE OF THE FEATURE THREATENED?

Short Term (0-10 years)		Long Term (10-100+ years)	
— High Threat	_____	— High Threat	_____
— Moderate Threat	_____	— Moderate Threat	_____
— Low/Nil Threat	_____	— Low/Nil Threat	_____

What is the nature of the threat?

_____

D. IS THE FEATURE IN DEMAND FOR RESEARCH/SCIENTIFIC EDUCATION PURPOSES?

Present Demand		Anticipated Feature Demand	
— High	_____	— High	_____
— Moderate	_____	— Moderate	_____
— Low	_____	— Low	_____

What is the nature of the demand?

_____

E. IS THE FEATURE ADEQUATELY PRESERVED ELSEWHERE?

— Unknown; Further documentation needed. _____

— Probably _____Location _____

Agency _____

— Definitely _____Location _____

Agency _____

Appendix 10 Evaluation Criteria — Part 2

1. LOCATION OF THIS PROPOSAL RELATIVE TO DISTRIBUTION/ABUNDANCE OF THE TARGET FEATURE:

— the best possible location _____
— suitable, but not the only possible location _____
— poor location; better sites are available elsewhere _____

Basis for this evaluation:

— documentation provided by proponent _____
— other (give source)

_____

2. SIZE OF THE RESERVE PROPOSAL (LAND AREA) RELATIVE TO LONG-TERM PRESERVATION OF THE TARGETED FEATURE:

— large enough _____
— marginal _____
— too small _____

3. BOUNDARY CONFIGURATION RELATIVE TO DISTRIBUTION OF TARGETED FEATURE:

— suitable _____
— marginal _____
— unsuitable _____

4. PROBABLE IMPACT OF ADJACENT LAND USES ON INTEGRITY OF THE RESERVE AND ON CONTINUED EXISTENCE OF THE TARGET FEATURE:

Short Term (0-10 yrs.)		Long Term (0-100+ yrs.)	
High	_____	High	_____
Moderate	_____	Moderate	_____
Low/Nil	_____	Low/Nil	_____

5. FEASIBILITY OF CONTROL OF POTENTIALLY HARMFUL LAND USES ADJACENT TO THIS RESERVE:

High _____ Moderate _____ Low _____

6. SUITABILITY OF THE SITE FOR RESEARCH AND EDUCATIONAL USE:

High _____ Moderate _____ Low _____

7. EFFECT OF LAND TENURE ON ATTAINABILITY OF RESERVE:

— uncommitted Crown Land _____

— committed Crown Land (TFL; TL; Grazing Lease etc.)

Describe:

_____

— private land _____

Current Use:

_____

8. SOCIO-ECONOMIC IMPACT OF LAND WITHDRAWAL:

— what current uses would have to be foregone?

Describe:

_____

— no. of users of various kinds affected?

Describe:

_____

economic impact on various users:

Describe:

_____

9. ON-GOING MANAGEMENT EFFORT NEEDED TO ENSURE RESERVE INTEGRITY (patrols, signing; fencing; public education, etc.):

High _____ Moderate _____ Low _____ Nil _____

10. ESTIMATED COST OF ACQUIRING RESERVE $_____

Appendix 11 Criteria for Establishment of Priorities for completing the Ecological Reserve System

1. Representative Ecosystems

(a) Current need:

High	(4)	Subzone has no representation.
Moderate	(3)	< 25% of site associations in the subzone are protected
Low	(2)	25-75% of site associations in the subzone are protected.
Very Low	(1)	75-95% of site associations in the subzone are protected.

(b) Threats to continued existence:

High	(4)	Remaining natural sites in this subzone will mostly be disturbed in the next 10 years.
Moderate	(3)	Considerable area in the subzone will remain in a natural state for the next 25 years.
Low	(2)	Considerable area in the subzone will remain in a natural state for the next 50-75 years.
Very Low	(1)	Considerable area in the subzone will never be disturbed (i.e. subzones in MH and SWB).

Current Need

Threat	High	Moderate	Low	Very Low
High	8	7	6	5
Moderate	7	6	5	4
Low	6	5	4	3
Very Low	5	4	3	2

2. Rare/Unique species and phenomena

(a) Current need

High	(4)	Feature is not currently protected (in an E.R. or Park).
Moderate	(3)	Feature has marginal protection, but insufficient for long-term viability.
Low	(2)	Feature has fair protection, but additional protected area desirable.
Very Low	(1)	Feature is already quite well protected.

(b) Threats to continued existence

High	(4)	Feature likely to be completely lost in next 10 years.
Moderate	(3)	Options for protecting the feature or habitat should be open for next 25 years.
Low	(2)	Options for protecting the feature or habitat should be open for next 50 years.
Very Low	(1)	Some habitat should remain available more or less indefinitely.

(c) Scientific/Educational Importance

High	(4)	Species in categories of greatest rarity/ endangeredness (R1 plants; vertebrates with 36 or more points on Wildlife Branch rating). Botanical, zoological or geological phenomena that are not only very rare in B.C., but also virtually unknown elsewhere.

Moderate	(3)	Species in secondary categories of rarity/ endangeredness (R2 plants, vertebrates with 30-35 points). Phenomena which are quite rare in B.C. (occur in up to 2 or 3 locations), but may be common outside B.C.
Low	(2)	Species of less concern than in the above two categories. Phenomena which are unusual or outstanding, but not of great rarity.
Very Low	(1)	Phenomena having little scientific/educational importance.