RIC Report 007
Discussion Document

INVENTORY OF EXISTING BIOLOGICAL DIVERSITY DATABASES FOR BRITISH COLUMBIA

FOR

THE BIODIVERSITY INVENTORY TASK FORCE OF THE RESOURCES INVENTORY COMMITTEE

BY

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Preamble

This report is submitted to the Resources Inventory Committee (RIC) by the Biodiversity Inventory Task Force.

The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments. First Nations peoples are represented in the Committee. RIC objectives are to develop a common set of standards and procedures for the provincial resources inventories, as recommended by the Forest Resources Commission in its report *The Future of Our Forests*.

To achieve its objectives, the Resources Inventory Committee has set up several task forces, including the Biodiversity Inventory Task Force.

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Summary

Objectives and scope

This project was intended to develop a database of existing biological diversity inventories (or databases) for B.C. Specifically we collected basic information on existing inventories and evaluated them for reliability, accessibility, completeness and state of maintenance. We also identified major gaps.

Biodiversity inventories *per se* have not yet been developed in B.C. The elements of biodiversity considered to be priorities for this study were, in decreasing order: mammals, birds, reptiles, amphibians, and vascular plants; rare plant communities; invertebrates; and non-vascular plants. Freshwater flora and fauna were Included, with the exception of fish. Regional ecosystems, and databases dealing specifically with species status, were also considered.

Other Task Force groups were contacted to try to minimise overlap. Potential areas of overlap are briefly discussed in the report. Greatest overlap occurs with the Wildlife Habitat and Range Task Force. Fisheries, Water and Watersheds, and Recreation, Tourism and Culture Task Force groups may also have covered a few of the same databases.

Subject areas of relevance to biodiversity not specifically covered within this study include historical studies of biodiversity, ethnobiology, palaeoecology, marine biodiversity, and microbial diversity.

Status of this inventory

The inventory of existing databases is still incomplete. As might be expected, the great range of potential databases of relevance simply reflects the enormous scope of the topic. To date, forms have been completed for 44 databases; these will be entered into a database program. A list of databases documented to date, and lists of incomplete enquiries, are provided as appendix v to this report. Table 1 in the report briefly summarises the main databases by element of biodiversity.

Each main element of biodiversity is considered in turn in the report. The main databases for each element are listed, followed by a brief discussion of the sources and any general comments on availability, reliability and so on.

Problems with existing information sources

The level of effort directed at collecting plant and animal species and data, both across the province and across different taxa, has been very inconsistent. In general, there have been few planned, systematic surveys. Collections of most groups have been sporadic, and most surveys and collections are strongly influenced by physical accessibility of the landbase (i.e., much more data exists for areas near roads). Methodologies vary enormously and are rarely standardised, and identifications of specimens vary in reliability. Sampling inequalities make it almost impossible to properly assess the status of a large number of species and groups.

Basic taxonomic and distribution data are frequently lacking even for some of the more conspicuous elements. The relatively well documented taxa, in terms of distribution, include the larger mammals, particularly the ungulates, some of the more conspicuous bird groups, including diurnal birds of prey and the game birds. However, even amongst these better known elements, population data and knowledge of their ecology and habitat relationships is often inadequate for management planning.

With other groups, knowledge even of basic distributions, as well-as of habitat relationships and life histories, is almost entirely lacking for some members. This would apply particularly to groups such as the shrews, moles, bats, other small mammals, certain bird groups, amphibians, and some of the snakes.

Information on the invertebrates is even more fragmentary, and is almost non-existent for some groups, including the soil fauna. Aquatic invertebrates are also extremely poorly documented in the province.

As with the vertebrates, the best known invertebrate species are those that are of commercial interest, such as forest pests. This is also true for the non-vascular plants. Other than for forest and agricultural pests, the non-vascular plants are an exceptionally poorly documented group, despite the fact that they play critical roles in ecosystem functioning. Overall, we have little understanding of ecological functions and processes.

Vascular plants, are, by comparison, well documented in herbaria and there are many large collections. Even with this group however we have a poor understanding of the distribution of many species. For those apparently rare species in particular, there is often inadequate information to properly assess their status.

Level of inventory effort has varied greatly across the province. For example, relatively intensive efforts to sample vertebrates and habitats in the southern Okanagan is reflected in the more detailed knowledge we have for that area for many species and habitats. However, for terrestrial insects, for example, about 80% of the samples at the RBCM are from southern Vancouver Island and the lower mainland (and most of this is old material). The rest of the province is largely unknown for insects. Information from the north is generally lacking across all taxonomic groups.

A large accumulation of data on ecosystems is available from the various ecosystem mapping programmes. However, the main provincial and national vegetation/ecosystem classification systems are not fully integrated or correlated, resulting in loss of information between the systems. The systems have also not been specifically designed with biodiversity considerations in mind. Because the classifications are based on diagnostic characteristics, rare elements are inevitably overlooked.

Information management for existing inventories is also generally inadequate. Many important collections are not computerized at all; few are fully computerized and/or catalogued. Consequently, much existing data is rendered effectively inaccessible to most potential users. Although most major institutions are gradually remedying this, an enormous backlog of data is the rule rather than the exception. Geographical coding of the data is also a problem, and few of the databases permit sorting by, 1br example, drainage basin. A need for improved communication between the diverse institutions is also apparent. Despite coordinating databases such as CHIN, information remains highly fragmented.

Recommendations

1. More information is needed on distributions and habitat requirements for rare, threatened and endangered species (and subspecies).

2. We need better support documentation on life histories and ecology to determine critical habitats and minimum viable populations. Species and subspecies unique in Canada to B.C. should be priorities.

3. More systematic sampling across the province is necessary to provide baseline biological diversity inventories in advance of development.

4. Basic species inventories and ecological data are particularly needed for lichens, fungi, soil and freshwater invertebrates, and the lesser known vertebrate groups.

5. There is a need to better correlate the existing ecosystem classifications to provide a more adequate basis for examining biodiversity.

6. Attention must be given to scale of inventory. For example, "hot spots" of biodiversity may require a larger scale than areas of relatively low biodiversity.

7. There should be attempts to incorporate agricultural, suburban and even urban habitats into any ecosystem inventory.

8. Database management must be improved, and should be made more compatible between different institutions.

9. More research is needed on ecosystem functions and processes.

10. A national or even international database of biodiversity sources is recommended.

11. We suggest a matrix to examine existing and proposed inventories of the different Task Force groups be developed at the Mesachie Lake workshop.

12. An overall co-ordinating biodiversity group should direct inventory and synthesize information.

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LIST OF ACRONYMS USED IN THIS REPORT

BEC	Biogeoclimatic Ecosystem Classification
BIG	Biodiversity Inventory Group (Task Force)
CANSIS	Canadian Soils Information System
CDC	Conservation Data Centre
CHIN	Canadian Heritage Information Network
CLBRI	Centre for Land and Biological Research Institute
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DAO	Department of Agriculture, Ottawa
DFO	Department of Fisheries and Oceans
ELC	Ecological (Biophysical) Land Classification
FBCN	Federation of B.C. Naturalists
FHIIP	Fish Habitat Inventory and Information Program
FRDA	Forest Resource Development Agreement
GIS	Geographic Information System
IBP	International Biological Programme
IMPACT	Initial Monitoring Program for Animal Conflicts with Transportation
IUCN	International Union for the Conservation of Nature
IWIFR	Integrated Wildlife Intensive Forestry Research
LII	Land Information Infrastructure
MOAFF	Ministry of Agriculture, Fisheries and Food
MOELP	Ministry of Environment, Lands and Parks
MOF	Ministry of Forests
MOTH	Ministry of Transportation and Highways
OSRIS	Oil Spill Response Information System
RBCM	Royal British Columbia Museum
RIC	Resource Inventory Committee
SIS	Stream Information System
SSDB	Summary Statistics Database
TFL	Tree Farm Licence
UBC	University of British Columbia
UIDB	Ungulate Inventory Database
UVIC	University of Victoria
WCWC	Western Canada Wilderness Committee

1. Introduction

1.1 Project Objectives

The objectives of this project are to:

1. Develop an inventory of existing biological diversity inventories (or databases) pertinent to British Columbia.

2. Establish a database containing selected data for the existing inventories.

3. Evaluate existing inventories where possible in terms of reliability and accessibility, completeness, and present maintenance.

4. Identify and discuss any major gaps in existing inventory.

5. Participate in Biodiversity Inventory Group (BIG) meetings, and the Resources Inventory Committee (RIC) workshop at Mesachie Lake.

The full terms of reference for this project are included as appendix i.

1.2 Definitions

The following definitions were provided to the consultants by the Biodiversity Inventory Group.

Biological Diversity:

The full variety of life, including genes, species, and ecosystems, plus ecological and evolutionary processes.

Inventory:

verb – the process of collection of materials, data, or information;
noun – the resulting collection.

Data:

Information or materials, including photos, sightings, physical remains, specimens, written records, and quantitative data.

1.3 Scope of project

Although many aspects of biological diversity have individually been the focus of research and management efforts in B.C., the concept of overall "biodiversity" has only relatively recently

emerged in the province. It has gained rapidly increasing attention over the past couple of years. Consequently, biodiversity inventories per se have not yet been developed in B.C., and few, if any, efforts have been made to address the subject in its entirety. Numerous inventories exist, however, which address certain components of this subject. For this project, therefore, we have focused on documenting existing databases which may provide pertinent information for current and future biodiversity initiatives.

Because of the enormous scope of the subject, and the very limited time available, "elements" relevant to biodiversity studies were priorised by the Biodiversity Inventory Group. Priorities to be considered were, in decreasing order:

mammals, birds, reptiles, amphibians, and vascular plants
rare plant communities
invertebrates
non-vascular plants

Freshwater flora and fauna, with the exception of freshwater fish, were to be included in the scope. Marine ecosystems, including nearshore habitats, were not included because of time constraints (see section 3.4 for further discussion). In addition, we also included regional ecosystems – i.e. the interpreted ecosystems that are the basic components of the various provincial and federal ecological classification systems – for example the Biogeoclimatic Ecosystem Classification (BEC). We also felt that any databases relating specifically to the status of species (plant or animal) should be included as this information is often essential in biodiversity studies in assessing the relative significance of particular species or populations.

A number of important subjects were excluded from specific consideration. These subject areas are discussed in Section 3.

2. Methods

We drew up a list of potential key databases, and of contacts, for further information. This was progressively developed as new information was obtained. Contacts were interviewed primarily by telephone. In a few cases the agency concerned was visited directly. A full list of people contacted during this process is provided in appendix ii. Not all individuals contacted provided details on specific databases. Many provided more general information, impressions and views on the state of biodiversity inventory in the province, and suggested avenues/databases for further investigation.

Because of the broad scope of the subject it was apparent there may be considerable overlap with several other groups. Several task force chairs or co-chairs, and in some cases consultants and other task force members, were contacted to identify areas of potential duplication of effort, and also to discuss potential links between the different resource areas. In particular, inventories and information sources in the other resource areas which may be of value in biodiversity studies were discussed.

A form was produced (and subsequently modified) to standardise collection of key information on the existing inventories (appendix iii). Data collected will be entered into a database program

compatible with Dbase IV. Where noted, comments on linkages between existing databases were made on the forms.

The Land Information Infrastructure Repository (LII) format was obtained after initiation of our inventory, and we briefly reviewed our database for compatibility with that system. It was too late to set up a fully compatible database, and collect all the information required by the LII. However, about 80% of the fieldnames used in our database were directly synonymous with fields used by the LII, and it would not be too difficult to convert the information into a directly compatible format at a later date if desired. Some additional details however would be required – we did not for example collect as much detail on the hardware and software components. Conversely, we also collected information on a number of areas considered important for biodiversity but which are not required by LII.

Copies of data forms, database attributes, and other pertinent supporting materials were requested where applicable. These will be submitted with the database.

3. Subject Areas not Specifically Addressed in This Study

As with the subject matter itself, the potential information sources are numerous and diverse. So numerous, in fact, it is often difficult to know where to start. Obviously, which information sources are pertinent depends entirely on the nature and scope of the biodiversity project in question. For some aspects of biodiversity we simply did not have sufficient time to fully survey even the key information sources. The following sections briefly identify some of the areas where biodiversity overlaps with other task force subjects. Also mentioned are subject areas we consider relevant in biodiversity studies, but for which we did not have time to investigate the databases.

3.1 Overlap with other Task Force groups

Wildlife Habitat and Range

The greatest area of overlap with other task force groups was with the Wildlife Habitat and Range group. This group are essentially concerned with inventorying ecosystems, and have apparently covered such sources as the wildlife and biophysical habitat inventory/mapping, wildlife capability/suitability mapping, and the estuary mapping programs of the Ministry of Environment. These inventories were consequently excluded from our investigations. The wildlife and vegetation data collected during these ecosystem inventories constitute an important source of data, particularly on wildlife populations and diversity (see wildlife form in Luttmerding *et al.* 1990). We have included this information source in our database on existing inventories. We assumed however that any other specifically habitat-oriented data sources, such as the Wildlife Habitat Handbooks for the Southern Interior Ecoprovince, would be noted by the Habitat and Range group. Although inventorying ecosystems, this group was not specifically covering databases such as the Ministry of Forests (MOF) Biogeoclimatic Ecosystem Classification (other than where it relates directly to the biophysical mapping), so we added the Regional Ecosystems element to our list.

Fisheries

Agencies responsible for managing the freshwater fish resource include the Federal Department of Fisheries and Oceans (DFO), and the provincial Ministry of Environment, Lands and Parks (MOELP) Fisheries Branch. A number of standard inventories exist and have been documented by the Fisheries Task Force. Areas of potential interest from a biodiversity perspective include information on fish species and different genetic stocks where known, and also information on freshwater invertebrate communities and aquatic flora of wetlands, lakes, rivers, and streams, plus the adjacent riparian vegetation and associated invertebrates. Relevant information on potential "pest" species may also be included in some databases -e.g. data on herons, mergansers, river otters and so on. The latter may be included in some of the Ministry of Agriculture, Fisheries and Food (MOAFF) databases (dealing with freshwater aquaculture). We have not had time to explore this avenue further at this stage.

Databases we thought might contain considerable information on aquatic and riparian invertebrates (the Fish Habitat Inventory and Information Program (FHlIP), the MOELP stream and lake databases, and the Stream Information System (SISI) in fact appear to offer little information on these groups of organisms. Information on the presence of individual coarse fish species, when noted, and more detailed information on game species (perhaps including in some cases information on different genetic stocks) are the key pieces of data obtainable from these sources. Absences of coarse fish species means little however, as they are not systematically inventoried, each programme has a number of inherent sampling biases, and the reliability of the information for non-game fish is likely to vary considerable depending upon the expertise of the individual sampler. The Conservation Data Centre (CDC) is including information on rare fish, and other important sources of information on the rare and endangered species include specialists at the Royal British Columbia Museum (RBCM – Alex Peden), and at the University of British Columbia (UBC -Don McPhail). Forestry companies also often have quite detailed fisheries information for their Tree Farm Licences (TFL's), although again information on other freshwater biota is likely to be lacking.

Water and Watersheds

A number of databases developed for water management may contain pertinent information for biodiversity studies. Kevin Ronneseth (consulting to the Water and Watersheds Task Force) provided a list of inventories he has documented which collect some form of biological information (see appendix iv). It is likely that the information in many of these databases is very peripheral. A few, however, may be potentially valuable data sources, depending on the focus of the study. For example, pollution studies and monitoring may have yielded detailed information on freshwater invertebrate communities. We have detailed the Aquatic Plant Database (Dr. P. Warrington) as it is pertinent to our subject. The Biological Database (Bruce Holms) may also yield valuable data for biodiversity; we have not investigated this inventory yet.

Several databases have been set up on "wilderness watersheds" which May be of interest to both subject areas to some degree. The information available is documented in Moore (1991). The Western Canada Wilderness Committee (WCWC) is apparently developing a database of contiguous wilderness areas based on watersheds, although information is not yet available.

Recreation, Tourism and Culture

The MOF recreation inventory database contains limited information of relevance for biodiversity (although there is some, for example, on vegetation types). The MOELP Wildlife Viewing program is likely to be pertinent for both subject areas. We did not document this program directly, but an inventory exists at least in the form of a considerable number of Wildlife Viewing Plan reports.

A wide range of plant and animal species have been utilised by native peoples, and ethnobiological studies are likely to have relevance both to the tourism, recreation and culture group, the archaeology sub-group, and the biodiversity group.

The Canadian Heritage Information Network (CHIN) has probably been inventoried by this group. However, we have also documented it here (see section 4.2). It has considerable potential for biodiversity studies.

Climate

We did not directly contact this Task Force, as we felt that overlap, in terms of documenting existing inventory, was rather unlikely. Climate of course is a major factor in all the ecological processes shaping biodiversity, and has a critical influence on community composition, and on species distributions and abundance. There are certainly some areas of research – for example, studies on the likely influence of global warming on past and future diversity, where linkages between databases may occur. However, the inventorying of climatic data (through a large existing network of climate stations) does not involve the recording of biological components of the ecosystems,

Timber

We also did not contact this group. However, the information available from the MOF timber inventory can have relevance for biodiversity studies. For example, data can be analyzed to determine relative occurrences of different forest types, different age forests, and so on. Information an the spatial dispersion and arrangements of these forest types is also highly relevant, however we are uncertain how much information can be gleaned from the timber inventory on this subject. For example, the range of polygon sizes can presumably be determined quite readily, but this may say little regarding the actual shape of the polygon (e.g. is it long and narrow, almost circular etc.), nor the spatial relationship of a given forest type to other polygons of the same kind. Both pieces of information would be important in studies of landscape diversity, or in planning management to maintain/enhance biodiversity. The main value of the timber inventory from a biodiversity perspective is that it is relatively complete for the province. With careful interpretation it can yield valuable information on ecosystems, and may function in the short term as a substitute for ecosystem inventories, particularly where inventory funding is scarce and good timber inventory already exists.

Soils

Generally there appears to be little overlap between task forces, as the soils group are not specifically considering the biological component of the soil system. Thus we have given brief consideration to this aspect of biodiversity in our review of databases. The linkages however between the subject areas, including the influence of the biotic component of the soils on the-physical aspects, are numerous and important. Berch (1992) points out that Klinka *et al.* (1981) have recognized the contribution of fungi and fauna to the development of humus forms. In their humus classification system the mull and mor humus types are distinguished on the basis of the biological component of the system – i.e whether decomposition is driven predominantly by fungi or invertebrates.

The archaeology sub-committee of this task force were not directly contacted, but it seems likely that there may be a number of links, as discussed below.

3.2 Historical studies of biodiversity

Biodiversity studies which would involve a significant historical and archaeological component would doubtless find an important repository of information in many archaeological museums

and collections (e.g. in universities, and various archives). Coverage is likely to exist largely for those species which have been regularly utilised by native peoples for food and artifacts. These may be appropriate sources for studies, for example, examining historical distributions of particular vertebrate or marine invertebrate species.

3.3 Evolutionary perspectives

For a perspective over geological time, museums and universities with research interests and collections in palaeoecology (in addition to current collections) are also important sources of material. Again, however, we did not specifically cover this topic. Some potential key database sources are: The Tyrell Museum of Palaeontology; the Palaeobiology Department of the Smithsonian Institute in Washington, which has a large collection of Burgess Shale fossils (including considerable material from B.C.); the Canadian Museum of Nature; archaeology departments in the B.C. universities and elsewhere.

3.4 Marine biodiversity, including the intertidal zone

Another important aspect of biodiversity which we did not specifically cover is the marine environment, including the intertidal zone, and also the interactions between the marine and terrestrial components of coastal ecosystems. Dr. E.L. Bousfield in 1955, collecting for the National Museum of Canada, surmised the Canadian Pacific Shore fauna to be "exceedingly rich in numbers of species and individuals. . .three or more times that of comparable shores of the Canadian Atlantic Coast" (cited by Dr. W. Austin in Radcliffe *et al*. 1991).

An important information source for coastal information in future is likely to be the Oil Spill Response Information System (OSRIS). This database has readily accessible computerised information available on all aspects of the coastal resource, including shore zone mapping, and data on biological aspects such as marine birds and mammals, fish etc. We have not specifically incorporated details in our database compilation as Don Howes is on the Fisheries Task Force and it is assumed this database will be covered in more detail there. A major limitation at the present time however is that existing geographical cover is very restricted. To date only 4% of the B.C. coast has been fully inventoried and entered into the database. The possibilities of utilising this database to store biodiversity data for the coast should be explored further.

For studies involving a marine component along the remaining 96% of the coast, other sources must be explored. These may include for example various maps from Maps B.C., the Coastal Resources Folio, collections at the RBCM, Environment Canada coastal mapping, studies on marine mammals from DFO, the Vancouver Aquarium, reports from B.C. Parks and Ecological reserves, and multifarious other sources which we have not had sufficient time to document.

3.5 Microbial Diversity

We have to draw a line somewhere. We have not attempted to tackle this subject at all – partly a reflection of the priorities set by BIG, but it also reflects the state of data and collections. There are apparently no microbe collections in museums!

4. Status of Existing Inventory by Subject Area

The following sections are intended to give an overview of "where we are today" in ter ms of inventory of elements of biodiversity. Each section briefly discusses key database sources for each subject area, followed by general comments. These comments may refer to the relative strengths or merits of certain databases, degree of knowledge of particular taxonomic groups, evenness or representativeness of sampling, or any other aspects of the information sources which we felt may be of interest. The comments are drawn from our observations from this present project, but we have also directly drawn from previous studies we have undertaken (Radcliffe *et al*. 1991, 1992, and Radcliffe [ed.] 1991) where relevant. The key databases surveyed so far are summarised by element of biodiversity in Table 1.

4.1 Inventory of Biodiversity Inventories (this project)

Main sources

At the present time our survey of databases is incomplete. Contacts have been initiated with most major collections and databases of plant, animal and invertebrate material. Many of these databases have been documented on our forms and are completed – these are listed in Appendix V. Other enquiries are still pending. Many of these are likely to be unproductive, or lead to relatively minor sources, but a few potentially significant sources are still undocumented. A list of partially completed avenues of enquiry, and ones still unexplored to date, is also included in Appendix V. There will not be sufficient time to complete enquiries for all sources within the time frame of this project.

Table 1. Summary of existing inventories, by element

Mammals	Birds	Reptiles and Amphibians
Canadian Museum of Nature (Handbook of Canadian Mammals) Royal British Columbia Museum - collection, accessions catalogue, database. publications CHIN Parks Canada B.C. Parks National History Museum of the Smithsonian Intl.? Ungulate Inventory Database (minor) Summary Statistics Database (mlnor) Aerial surveys (winter flights) IMPACT Furbearer database Cowan Vertebrate Museum CDC Vertebrates by subzone; Habitat requirements for listed species; Breeding habitats of forest-dwelling vertebrates; several boodiverally compilations COSEWIC Provincial Status lists Biophysical habitat mapping (wildlife data) Wildlife Habitat Handbooks TSA, TFL, LRUP plans Others (crown corps. MEMPR, private orgs. etc.)	Canadian Museum of Nature & publications Royal British Columbia Museum (sight record cards, nest record cards. Christmas Bird counts, ornithology collection, specimen database, publications) Cowan Vertebrate Museum, UBC Coastal Waterbird Survey Parks Canada B.C. Parks CHIN Summary Statistics Database (minimal – game birds only) Cowan Vertebrate Museum CWS databases – bird diversity studies, migratory birds Ducks Unlimited databases CDC COSEWIC Biophysical habitat mapping (wildlife data) Wildlife Habitat Handbooks TSA. TFL. LRUP plans Others (crown corps. MEMPR, private orgs. etc.) Provincial status lists	Canadian Museum of Nature Royal British Columbia Museum CHIN CDC IUCN Task Fame on declining amphibian populations Universities ? Wildlife Habitat Handbooks COSEWIC Provincial status lists

Freshwater fish	Invertebrates	Vascular Plants, Rare Plants
CDC RBCM UBC ? Others ?	CLBRI – Canadian National Insect Collection Spencer Entomological Museum, UBC Pacific Forest Research Centre RBCM – Entomology collection Canadian Museum of Nature (small collection)	CLBRI – DAO Herbarium Ecological Reserves Parts Canada (CANSIS) B.C. Parks CDC Fraser Lowland Wetland Inventory Canadian Museum of Nature (including Plants at Risk database) RBCM & native plant garden UBC herbarium University of Washington Herbarium Flora B.C. Program Van Dusen Botanical Garden (native plant collection) Aquatic Plant database MOF Regional Herbaria WCWC; Heritage Tree register
Non-Vascular Plants	**Ecosystems, Rare Plant Communities**	**Ecosystem and Evolutionary Processes**
CLBRI – Mycological herbarium Pacific Forest Research Centre – Forest Insect and Disease Survey MOF Inventory – decay and breakage plots UBC herbarium RBCM – small collection UVIC – small collection	Ecological Reserves Parks Canada – ELC system B.C. Parks BEC Biophysical habitat mapping Natural landscapes database Fraser Lowlands Wetland Inventory CDC Plants at Risk database	Universities. museum research?? Pacific Forest Research Centre

A number of potential sources turned out to have little data of relevance (e.g. the Agricultural Land Commission, Simon Fraser University). Sources likely to be very pertinent and for which enquiries need to be completed include the Pacific Forest Research Institute (partial) and the MOF regional herbaria (only Cariboo Region surveyed to date).

Comments

Our coverage of subject areas has been influenced not only by priorities set by BIG, but doubtless also by our own knowledge and biases. For example, plant data and collections are relatively well documented because we are relatively familiar with key information sources, and individual herbaria have been contacted specifically. Invertebrate material however is beyond our realm of expertise, and has largely been covered within the context of large institutions, with comprehensive collections or databases. Also, herbaria tend to have independent existences, collections of invertebrates generally do not.

The volume of material also influences the degree of documentation we have made. For example, insect collections tend to be huge, and consequently are often not entered into computer databases. There are far fewer species of macrophytes and vertebrates, hence, they tend to be documented in more detail.

There has also been no consistency in our depth of cover. For example, small, linked databases, such as those currently being completed for the MOELP/MOF by Victoria Stevens, may each receive an entry, while massive institutions may, at this stage, have received only a single entry. In other words, information on these large institutions (e.g. the Canadian Museum of Nature; the Smithsonian Institute) is very general. In reality a separate entry should probably be made for each main database and collection in the individual departments of relevance (in some cases individual departments have been surveyed, but only a single form is completed for the institution). In practice there has not been sufficient time to do this. As these organisations are hierarchical in structure, we should perhaps establish bounds on this. We have tended to go further down the hierarchy for B.C. based organisations (e.g. the RBCM), completing forms for some individual departments or collections.

4.2 Multiple aspects of biodiversity

Main Sources

A number of key sources exist which have considerable information on all vertebrate groups, vascular plants, and in some cases on invertebrates, plant communities, and non-vascular plants. These sources essentially include all the main museums. Many of the major museums are linked to the Canadian Heritage Information Network (CHIN) and much of the information based on the numerous different collections can be accessed via this system.

The Canadian Museum of Nature in Ottawa has a very large collection divided phylogenetically and hierarchically into numerous disciplines. Representation of B.C. material varies from one discipline to another. The museum employs some of the leading taxonomists in Canada. The strengths of the collection include lichens, some invertebrates, identification services, and "a

good window into the past." Weaknesses include only partial entry of data into a computer database (especially molluscs, being redone); only partial cataloguing of the collection; relatively weaker expertise for aquatic invertebrates, soil microorganisms, and lower plants; and underbudgeting. The museum encompasses the Biological Survey of Canada (mainly terrestrial arthropods) and the Zooarchaeological Identification Centre (for historical biodiversity). The museum also houses the Canadian Centre for Biodiversity, and collection data is entered in an in-house database tentatively called Biodiv. Not all of the museum's data has been entered yet. The museum is also linked to the CHIN (Canadian Heritage Information Network) database. Some key publication series include the Syllogeus series, Publications in Zoology, and Publications in Botany series (not published lately), and a new periodical "Canadian Biodiversity."

The Royal British Columbia Museum has both specimen collections and a number of computerised databases specific to certain taxonomic groups. Some of the individual databases – particularly for vertebrates – have been documented individually in our inventory. Collections include materials from regions adjacent to B.C. The Museum has a Handbook series and an Occasional Papers series, both with many pertinent topics for biodiversity projects. The database is linked with CHIN.

The Natural History Museum of the Smithsonian Institute in Washington, DC. is a national museum mandated by the U.S. Congress. It is probably the largest museum complex in the world. The Natural History Museum alone holds about 120 million specimens, including material from B.C. There is a fairly up-to-date computer database. The museum is so vast that the data fields of this survey are not very meaningful at the scale of the whole museum. As well as the museum's own experts, scientists from various U.S. government agencies are tenants at the museum. There is a congressionally-funded biodiversity program for South America. We do not know what material of biodiversity relevance might have been collected in B.C. A variety of publications are produced, including the Smithsonian contributions to Botany, Smithsonian Contributions to Marine Science, and so on.

The Centre for Land and Biological Research Institute (CLBRI), Agriculture Canada, Ottawa, houses at least two separate herbaria – the Department of Agriculture, Ottawa (DAO) herbarium and the Mycological herbarium, as well as the Canadian National Insect collection. These are discussed in sections 4.5, 4.6, and 4.4 respectively. A list is published each year summarizing all CLBRI research (Research Branch Report).

Local museum collections have not been inventoried in this project but can often provide excellent cover for specific areas or for specific taxonomic groups. These collections may be held by local government, special interest groups or even individuals.

Some of the more comprehensive inventories covering specific geographical areas are those undertaken for Parks Canada. The province is endowed with 6 National Parks; Yoho, Glacier, Revelstoke, Kootenay, Pacific Rim, and South Moresby. It also has borders in common with adjacent National Parks (in Alberta, the Yukon, and in Montana and Alaska). As such, a considerable body of information on the wildlife and vegetation exists – particularly for the southern interior portion of the province (where four of our six National Parks are located). Ecological (Biophysical) Land Classification (ELC) has been carried out for most of these parks (see section for more details). Inventory of the most recent, South Moresby, is currently underway. There is also a Chilco Heritage Trail for which some biological inventory may be

available. Further details on vertebrate wildlife in the Parks are entered in the Warden Wildlife Observation Records.

B.C. Parks inventories also frequently cover many aspects of diversity. In the past, Provincial Parks have maintained no centralised database of information applicable to biodiversity studies. A wide range of studies and reports, including maps, species lists and so on, have been undertaken in parks however, and are available through the Parks library in Victoria, or regionally. Parks has also been undertaking biophysical habitat mapping projects for some parks in conjunction with the Wildlife Branch. Recently, a new system has been implemented in the Southern Interior Region, to attempt to systematise and make available the collection of random resource – related observations made in B.C. Parks. This is the B.C. Parks Field Observation Card System, and it is intended to eventually implement this throughout the province. About 1000 records exist to date. Parks have also recently obtained a GIS system, and eventually it should be possible to produce maps of any resource records. This system however is still immature. There is apparently also a database being established to maintain information from Park Use Permits granted for research in B.C. Parks. We have not documented this database.

The Ecological Reserves Program of the MOELP administers 130 ecological reserves in B.C. under a legislative mandate for protection, research, and education. It does not maintain a specimen collection. Data consists of ecological information collected on IBP (International Biological Program) forms. These are predominantly vegetation – oriented, with information on rare plants and plant communities, but vertebrate information is sometimes included. There is currently no computer database, however the information should eventually all be available through the CDC.

The goal of the Conservation Data Centre for B.C. is to handle data related to the conservation of biological diversity. It will maintain an inventory of key elements of biodiversity, including rare vertebrates, rare vascular plants and rare plant communities. Heritage trees and freshwater fish are included in the scope of cover, as are marine vertebrates. Invertebrates, however, are not being included at the present time. Considerable supporting data will be entered in the system. A number of other databases will eventually be directly linked with the CDC. The CDC also contains details of the status of the various plants and animals entered in the system, and will help establish protection priorities. The CDC will also maintain information on land ownership, on protected areas, sources of additional information, and documentation of key individuals and institutions.

The Centre for Conservation Biology at UBC (part of the Faculty of Forestry) is another very recent development. It is intended to act as a co-ordinating agency on biodiversity research. It will also be linked with the CDC.

There have also been a few attempts to compile information on many (in no cases all) aspects of biological diversity in the province. These include "Biodiversity of the Prince Rupert Forest Region" (Radcliffe *et al.* 1991) which includes a compilation of information on ecosystems, rare plants, terrestrial vertebrates, and a very limited assessment of information on invertebrates and non-vascular plants. A similar project of more limited scope "Biodiversity of the Nelson Forest Region – selected elements" has also been undertaken (Radcliffe and Porter 1992). The information compiled is in computerised format.

For assessing international status of both vertebrates and plants, COSEWIC produces regular status listings. The IUCN doubtless also maintain databases on particular species and species groups. We have not completed documentation of these information sources.

Many forestry companies, mining companies and so on maintain their own map-based inventories, which often includes information on a variety of resources, including wildlife. This is a requirement for TFL holders. A summary list of TFL non-timber resource inventories is provided in the British Columbia Forest Resources Commission Report on the Current Status of Forest Resource Inventories of British Columbia (Background Papers, Volume 7). Larger individual companies may also initiate and participate in wildlife, vegetation and biodiversity projects. For example MacMillan Bloedel currently maintain databases for two ongoing research studies being done in conjunction with the Canadian Wildlife Service (Bryant, 1992 and Eckert *et al*. nd).

Doubtless for the plants and the vertebrates in particular there are numerous small site-specific inventories which have been done by a variety of public and private groups, including municipalities and naturalist groups. There was insufficient time to track down all possible sources however. Also, with these other sources there is generally no standardisation in approach, methodology and so on. This makes it difficult to assess for reliability, although in some cases it is unquestionably very high and should not be ignored. There may also be information available from biosphere projects and a variety of other sources we have not yet documented.

Comments

Museums are the primary reference source for biodiversity studies, and supply the type specimens by which we measure other specimens. Museums provide unparalleled opportunities for research into evolutionary processes; much less opportunity for research in functional ecological processes.

A common theme among the museums is chronic under-funding and lack of staff. This has often resulted not only in inadequate collecting, but in an enormous backlog of unidentified specimens. Where systems are gradually being computerised, a huge backlog of unentered data seems to be the rule rather than the exception, often rendering much of the information inaccessible. Also, as collecting in the past was generally unsystematic, and ecological data collected was inadequate, the value of early collections is often severely limited. Poor labelling and errors in identification can further compound this problem. Identification errors occur more frequently in some institutions, or particular collections, than others. Nevertheless, the museums are an extremely valuable source of primary materials and provide the reference point for identifying species and determining nomenclature, for taxonomic studies, studies on evolutionary mechanisms, for determining geographic distributions and variation, for producing distribution maps, and for numerous studies from an historical perspective, including changes in diversity over time.

The inventories undertaken for the Federal Parks may come the closest to "biodiversity inventories" of any undertaken so far, and provide an excellent source of what should be fairly high quality, reliable information. Although many of the projects are quite out-of-date, having been undertaken in the 1970's (prior to the development of the Canadian Vegetation Classification System), there is nevertheless considerable information which is still valid,

available for the National Parks. Apart from site-specific records, general information on wildlife range/habitats given in the ELC reports appears to generally be derived from Cowan and Guiguet (1965). Most of the inventories have little or no information on reptiles and amphibians, let alone invertebrate species.

The ELC projects are generally most readily accessible in report form, through a public library system, although all the data is stored on computer in the Canadian Soils Information System (CANSIS) system in Ottawa. Additional wildlife information (which has been recorded since the initial studies) from the Warden Wildlife Observation Records is also available in print-out from the CANSIS system if requested through a Federal Parks office. It is subject to approval of the Chief Park Warden.

In recent years the individual National Park offices are turning to microcomputers, and many Parks have not been sending information in to the central archives in Ottawa. The system appears to be undergoing a process of decentralization. Individual Parks may also be maintaining some databases independently, including the more recent data from the Warden Wildlife Observation Records. Consequently the database in Ottawa is receiving less use, and less updating. The most up-to-date information is therefore likely to be available only from the individual parks.

In the Provincial Parks, no standardised methodologies for either vegetation or wildlife sampling programs that have been employed in the past. Information is therefore of variable quality and is often relatively difficult to access, as it is not computerised. The lack of standardisation limits the utility of the data for broader studies. Coverage however is highly variable through the province, methodologies – for both vegetation and wildlife – have not been standardised across the province in any way, and inventories are not entered into any organised database.

Compiled inventories are produced from a range of data sources, and generally contain information of variable reliability. Often there is no way to assess the reliability of the different pieces of information contained within the database. Much of the data may be based on best guesses, but are not necessarily based in hard fact. These compilations can provide valuable information for a particular area, ecosystem etc., but there is also considerable potential for misuse of the information.

The Conservation Data Centre should eventually prove to be an invaluable source of information, but is at the present time an immature system. It will contain both compiled and observational data. So far most species records have not been entered. It is accessible to the public, but in practice accessibility may be limited by availability of staff time. Potential users of, for example, the tracking lists that the CDC produce, need to fully understand the criteria for incorporating a species on the list, so there is no danger the information will be taken out of context.

4.3 Vertebrates

Main sources

All of the main -museums contain -some vertebrate specimens from B.C. with associated data. The RBCM is of course an extremely important data source. A number of vertebrate collections and databases have been individually documented for our database. The Cowan Vertebrate Museum at U.B.C. is also a potentially useful data source. The collection includes about 15,000 bird and 15,000 mammal specimens, but many are from northwestern Mexico. In addition are some databases of provincial scope which contain selected information on terrestrial vertebrates. Databases on vertebrate species occurrence by subzone, on habitat requirements for listed species, and on breeding habitats of forest-dwelling vertebrates, are currently being completed for the MOELP and MOF. All three list species on the basis of the BEC zones or subzones.

Many of the Wildlife Branch (MOELP) databases contain information on the vertebrates. The database on Scientific and English names of the Vertebrates of B.C. established by Cannings and Harcombe (1990) provides listings of all vertebrate species in the province and sets a standard for nomenclature, including standardised codes for every vertebrate species. Biophysical habitat mapping projects (recently developed to incorporate a wide range of species, rather than just ungulates or grizzly bears) and the Wildlife Habitat Handbooks for the Southern Interior Ecoprovince are important databases we have not specifically documented. Existing information on particular species and species groups is often summarised in the Regional Wildlife Management Plans, and also in individual species management plans produced by the Wildlife Branch. Other MOELP databases are noted below under specific taxonomic classes.

The MOF also maintains data on vertebrate wildlife. The Integrated Wildlife Intensive Forestry Research (IWIFR) program may contain some useful data, although it has been strongly oriented to ungulatet/forestry interactions, and is geared to habitat information. The program did however produce a number of problem analyses on other vertebrate groups (reptiles and amphibians, birds, and non-game mammals) for Vancouver Island, and there may have been databases set up in conjunction with these problem analyses. We have not completed our enquiries on the IWIFR program. The MOF research station at Red Rock appears to have little in the way of information pertinent for biodiversity studies at present. A wide range of forestry plans (Timber Supply Area plans, Local Resource Use Plans and soon) may also yield some useful data. Individual companies holding TFL's also maintain a variety of map-based inventories. Non-timber resource inventories for all the TFL's in the province are listed in the Forest Resources Commission (1990). We have not individually inventoried these databases. The Forest Resource Development Agreement (FRDA) program may also have established a number of databases which may contain information of value in biodiversity studies; we have not yet documented this potential source.

For assessing the status of vertebrates at a provincial level, the Wildlife Branch maintain a listing of species coded Red, Blue, Yellow and Green, indicating status. Details of criteria and the most recent published version is available in the document "Managing Wildlife to 2001: A Discussion Paper" (Wildlife Branch, 1991). However, these lists are currently undergoing review.

Substantial changes may be expected in the near future. Presumably the updated database will be held at the Wildlife Branch. The Red and Blue listed species are being tracked by the CDC.

Federal Parks ELC reports contain vertebrate information, and also all wildlife data stored in the CANSIS system in Ottawa.

Comments

The methods used to inventory the vertebrates vary greatly both across taxonomic groups and geographically. What is appropriate in one part of the province may not be possible in another. Methodologies have frequently lacked standardisation, and data collection has often been inadequate, even for its intended purpose. Storage and retrieval of the data has been – and often continues to be – woefully inadequate.

4.3.1 Amphibians and Reptiles

Main Sources

The **RBCM** maintains a herpetological collection, and has published a couple of useful handbooks: Green and Campbell (1984) and Gregory and Campbell (1984). A literature review of amphibians and reptiles is available as a report which documents all locality records from the literature and record cards, and locates them on maps (Orchard 1984). The IUCN Task Force on declining amphibian populations is inventorying both amphibians and reptiles, and is potentially an important data source. At the present time however it is just being initiated. Universities with active herpetological research programs, such as the University of Victoria (UVIC) may also maintain small collections, and no doubt have a number of small databases associated with individual research projects.

Comments

The herpetological collection at the RBCM contains about 5000 specimens. However, only about 800 to 900 have been identified and given accession numbers to date (these will eventually be entered into the CHIN system, but have not been as yet). This collection has been poorly maintained and many specimens are unidentifiable. The specimens which have been verified so far are mainly the salamanders. The reptiles and more particularly the amphibians, remain generally the least known of the terrestrial vertebrates. For the amphibians, remarkably little is known even of the distribution of many species, let alone their ecological relationships.

4.3.2 Birds

Main Sources

Nest record cards for the birds of B.C. are maintained by the RBCM and the Canadian Wildlife Service (CWS) at Qualicum. This scheme is organised by the Federation of B.C. Naturalists (FBCN), and maintains nesting records, located on NT map grids, for all breeding bird species in B.C. Some 200,000 nest record cards exist at the present time. Only the passerines are currently being computerised. Records are published annually in the BC Naturalist. A similar system for sight record cards compiles information on all the reported bird sightings in the province. These are now being computerised. Christmas bird counts are similarly organised by the FBCN, with results held by the RBCM and the CWS.

The **RBCM** also maintains an ornithology collection with over 24,000 specimens; most are from B.C.. The collection dates back to 1835. There is an associated specimen database which includes a variety of ecological data. This system is fully computerised. Specimens are listed in an accessions catalogue, and data is entered into CHIN. The museum has a range of publications in association with the various bird databases. A recent and relatively comprehensive publication, the Birds of British Columbia (Campbell *et al.* 1989), is an excellent and easily accessible information source, but the third volume, covering the passerines, has not yet been published. Another excellent RBCM publication, but restricted in geographical scope, is the Birds of the Okanagan Valley, British Columbia (Cannings *et al.* 1987).

The **Canadian Museum of Nature** produced the book "The Birds of Canada" (Godfrey 1966) which is also a useful reference.

The **Cowan Vertebrate Museum** at UBC holds some 15,000 bird specimens and associated record cards (although many are form northwestern Mexico).

The **Coastal Waterbird Survey** data is held by the Wildlife Branch in Victoria. This collected waterbird inventory over time for coastal B.C. The survey was in effect form 1967 through to the mid 1980's, but is no longer continued. The area covered extended from Race Rocks to Pears Island. The data is stored on manual record cards only, and may provide some useful information on specific areas. The Wildlife Branch also conduct specific surveys for certain bird species. For example, Bald Eagle nest surveys are routinely conducted along parts of the coast, often in conjunction with industry. The different Regions may also conduct various inventories of their own. The MOELP also conduct a Gyrfalcon Survey on an ongoing basis (carried out through the Regions, but co-ordinated from Victoria), and a Peregrine Falcon survey is also conducted periodically (approx. every five years).

The **Canadian Wildlife Service** often has valuable bird information on specific areas, or species. However, as there is no centralised database, numerous small databases tend to reside with individual researchers, and the various research projects must be identified before data sources can be accessed. A list of all the official reports is available from Ottawa. The CWS, in conjunction with MacMillan Bloedel, is conducting studies of bird diversity in various forest stands on Vancouver Island (Bryant, 1992 and Eckert *et al*. nd.). It is likely that there are a number of individual research projects scattered across the province which may yield valuable

information on specific areas/topics. The main office in Ottawa maintains a publication list which list all the reports produced from the various research projects. Although CWS has an office in Delta, a number of researchers operate separate offices in B.C. Activities in the northern part of the Province are undertaken by the Yukon CWS office.

Ducks Unlimited is also a potentially important source of information, primarily for waterfowl. We have not completed our enquiries however.

Comments

As for most wildlife groups, survey methodologies have varied widely and there has been little standardization between researchers or across the province (although there are, however, fairly well standardised methodologies available). Because of the relatively high interest in this class, however, many bird groups are much better documented than most other vertebrates. A large body of information (in the form of nesting records, sight records, and Christmas Bird counts) has been amassed from the input of a large number of amateur naturalists.

Bird groups which are relatively well documented include, for example, the diurnal raptors and the game birds (particularly the waterfowl). Even within these groups, however, there are of course species which, by virtue of their secretive habits, rarity, cryptic coloration and so on, are poorly known. Groups of birds which are the most poorly documented across the province are generally those which are difficult to identify in the field, for example some of the sparrows, some warblers, and *Empidonax flycatchers*, and those that are difficult to observe, including many of the small, skulking passerines. Shorebirds, although often very difficult to identify, may be better documented because of a relatively high level of effort directed toward them by the CWS (which is responsible for migratory species) and other interest groups. However, even for those species which are relatively well known, generally very little is understood about their habitat requirements and ecological relationships.

4.3.3 Mammals

Main Sources

The Canadian Museum of Nature maintains an important reference collection, and publishes the Handbook of Canadian Mammals series (Zyll de Jong 1983, 1985). The RBCM maintains a collection of approximately 18,000 mammal specimens and an associated database and accessions catalogue. Nagorsen (1990) provides a taxonomic reference for the mammals of B.C. and updates the mammal listing in Cannings and Harcombe (1990). The museum handbook published by Cowan and Guiguet (1965) remains the single most useful mammal reference for the province at the present time. The Cowan Vertebrate Museum at UBC holds some 15,000 mammal specimens and associated record cards. Many of these however are for northwest Mexico.

MOELP databases include the Summary Statistics Database (SSDB), which provides summary statistics for big game species (and limited. information for a few game birds). The database incorporates data from compulsory reporting (for big game animals), from guide outfitter

summaries, hunter sample questionnaires, limited entry hunting, problem wildlife reports, and tooth returns. The Ungulate Inventory Database (UIDB) is a source of information on ungulate populations. The database maintaining information on road and rail mortalities (initial Monitoring Program for Animal Conflicts with Transportation, or IMPACT) also contains information primarily on the large mammals. This incorporates information from the Ministry of Transport and Highways (MOTH) roadkill database and other sources. Big Game Range Maps are also maintained by the Wildlife Branch for 11 species of game animal. These provide information on the distribution and relative abundance of the different species included. Aerial Survey data, primarily of winter flights, is maintained in a map-based database. This is a substantial database built up over the last 30 years, and covering most of the province. Information is primarily available for ungulates, although in recent years some other species have been included. Flights are usually on a once only basis, and the information is used for developing ungulate capability maps. The information from these flights is not incorporated in the UIDB.

A furbearer database, based on trapline information, is also maintained by the MOE. This incorporates current and historical data on fur harvests and trader information. This can be a useful source of information, particularly for the more remote areas where other surveys have not been undertaken. However, only a limited range of species are recorded, and because the data is from harvests there are many biases which limit the utility of the data. Various surveys and several species management plans have been undertaken for the furbearers.

There are also a considerable number of databases associated with specific research programs, generally focused on individual species, such as the coastal and Flathead grizzly research projects, and the IWIFR program. Potentially important sources which we have not yet researched include the various inventories and research projects undertaken in association with a wide range of major developments, including some of the individual highways projects (no centralized database is held by MOTH other than the roadkill database, but a number of research projects have been carried out), B.C. Hydro developments, and various mining developments.

Comments

MOELP wildlife habitat mapping and, more recently, biophysical habitat mapping, are among the more reliable sources of mammal information. However, until relatively recently the inventory programme was largely confined to the game animals, particularly the ungulates.

The SSDB and the UIDB are some of the more developed databases, with standardisation of methodologies (including planned population inventories) and relatively good data storage and retrieval. They provide quick, easy access to game harvest and population data respectively, and are perhaps the best developed wildlife databases maintained by the Wildlife Branch. Even so, the ungulate inventory is generally inadequate at an operational scale for most regions of the province. The SSDB and UIDB provide examples of relatively well-developed databases, However, they are generally of peripheral value in biodiversity studies. In general, population inventories often lack formal criteria, manpower and funding. The SSDB, the UIDB, and IMPACT have very limited applicability for biodiversity studies.

Overall, information on the larger mammals managed as game includes a fairly good knowledge of range and less knowledge of populations and trends. For those intensively studied and

monitored ungulates, knowledge of habitat requirements and relationships is often quite detailed. Ecological relationships for most however, including, for example, predator-prey relationships, are generally poorly known.

For the furbearers, range information can be expected to be reasonably good, although information on habits and habitats of many of the furbearers is quite poor. Often, information has to be extrapolated on the basis of data from elsewhere (including the U.S.A.). The completeness of coverage of trapline data may vary spatially and temporally depending upon trapper effort and reporting. It does serve to give some limited information on a range of different species.

For the small mammals in general, and the bats and shrews in particular, even information on current range is often highly questionable. Knowledge of these groups is fragmentary. Knowledge of habitat use for these animals is often, at best, an educated guess, and for many species is effectively unknown. For many of them, almost nothing is known of their life histories, habits, or habitats in B.C.

Information on lesser known groups is often anecdotal and out-of date. Many data sources are in turn based substantially on a couple of references – Banfield (1974), and more particularly Cowan and Guiguet (1965). Ranges for species may have changed since publication, and our knowledge of the taxonomy/systematics of some of the small mammal groups has also changed. Nevertheless the latter reference in particular is still one of the best sources of information on B.C. mammals, despite being substantially out-of-date.

4.4 Invertebrates

Main Sources

The principal insect collections include the National Insect Collection at the Centre for Land and Biological Resources Research Institute (CLBRI – previously the Biosystematics Research Institute), Agriculture Canada, in Ottawa; the Spencer Entomological Museum of the Department of Zoology at the University of British Columbia; the collection of the Pacific Forest Research Centre (Forestry Canada) in Victoria; and the collection of the Royal British Columbia Museum in Victoria. In addition, the Canadian Museum of Nature in Ottawa has started an insect collection which is still small.

The National Insect Collection at the CLBRI has about 15 million insect specimens, including a significant amount of material from British Columbia. Most of the insects known to occur in Canada are represented. The collection also includes spiders (a large collection) and mites. The collections are well maintained and are accessible by species, but not by geographical area. There is no catalogue.

The Spencer Entomological Museum in the Zoology Department at the University of British Columbia has about 600,000 insect specimens, mostly from southern British Columbia. Phytophagous and parasitic tree-living insects are represented, but not soil and litter insects. The museum collection now includes the substantial Stace-Smith beetle collection from the Creston area, but these specimens are scattered in the general collection. Habitat information is generally

lacking. There is no feasible way to pull out the specimens by geographical region. The collection is not computerized.

The Pacific Forest Research Centre insect collection was started in 1949, and now includes 65,000 to 70,000 specimens representing about 6,500 to 7,000 species. The emphasis is on forest insects: there are a lot of defoliators, bark beetles, parasitic wasps and flies. The collection also includes a few spiders. It is difficult to pull out information by forest region, as the records are tracked by species. The Pacific Forest Research Centre maintains the Forest Insect and Disease Survey for British Columbia, which is described under non-vascular plants (Section 4.6).

The Canadian Museum of Nature insect collection is only about four years old. The collection has a research focus and has been acquired mostly by donation. British Columbia is not as well represented as other regions of Canada and the rest of the world. The collection is about 99% beetles, especially phytophagous beetles. There is no catalogue. The Canadian Museum of Nature has collections of other major taxa of invertebrates, including crustaceans, molluscs and annelids. The crustacean collection includes material from northwestern Canada and Alaska. There are no terrestrial isopods (crustaceans) catalogued from southeastern B.C., though there are some uncatalogued specimens from the province. Freshwater isopods of southeastern B.C. are surveyed in an unpublished document.[1] The museum's mollusc collection includes freshwater and terrestrial molluscs, but. there is little material from western Canada. The mollusc catalogue is currently being reorganized, as a new computer system is being implemented. The annelid collection includes some from certain parts of B.C. There is not much terrestrial material generally from northwestern B.C, and probably little freshwater material outside of the above taxa (note: marine material is better represented). A new computer cataloguing system is being installed which would allow accessing data by geographical references.

The Royal British Columbia Museum has a collection of terrestrial and aquatic invertebrates. Cover of the different groups is highly variable. Marine invertebrates are relatively well documented, although the amount of material identified varies considerably between groups, depending on the availability of expertise. Crustaceans, echinoderms, polychaetes, molluscs, sea anemones and nudibranchs have all been identified by specialists, but for many other groups there is considerable unidentified material. Some of the terrestrial insect groups have also been well documented, particularly the *Odonata*, *Lepidoptera* and *Afilidae* (robber flies). Other terrestrial invertebrates in the collection include some *Isopoda* (pill bugs) and *Gastropoda*. Freshwater invertebrates only became the focus of surveys a few years ago, and consequently are poorly represented in the museum. To date, most material has been collected from the dry interior portion of the province, although there is some material for the north, from the mid 1970's. Even with the relatively recent material, many specimens need to be identified. For example, almost none of the oligochaetes; have been identified so far. The material is organized by collecting location and is not yet fully computerized.

[1] Chengalath, R. 1980. A survey of the littoral *Cladocera* of Canada. Unpublished manuscnpt.

Comments

The museum collections are mostly not computerized as yet and all are organized by species, so it is tedious to determine which specimens are from a particular geographical or administrative region. At the RBCM, probably half of the material in Entomology has not been identified to species level.

Overall, little is known for most invertebrates. Insects and spiders have been fairly well collected in southeastern B.C., partly because of the presence of several National Parks in the area. Even so, the taxonomy and distributions of most invertebrate groups of even the better surveyed portions of the province are poorly known. Basic data is often lacking and what exists is difficult to access for a particular administrative region.

Among the better-known arthropod taxa in B.C. are dragonflies, mosquitoes, deer flies, horseflies, pest species of beetles, butterflies, and spiders. With the exception of forest pests, moths are poorly known. Even for the better known groups, however, knowledge is so fragmentary that it is often impossible to assess their true status (Cannings 1990). The Lepidoptera of the southeastern interior specifically have been well collected by Jon Shepard.

Taxa and distributions in British Columbia of dragonflies and mosquitoes have been described in publications of the British Columbia Provincial Museum (now the Royal British Columbia Museum).[2] The Biosystematics Research Institute (Ottawa) has published a selection of handbooks on insects, including distribution maps.[3]. The same agency has published a checklist of beetles for each province.[4] A series of annotated checklists of some insect groups and water mites of B.C. has been published in the journal *Syesis*.[5] The National Museum of Natural Sciences (now the Canadian Museum of Nature) publishes a multi-volume generic list, reference list, and set of species synopses of aquatic (freshwater and marine) invertebrates of Canada.[6]

There is no good estimate of the number of insect species in British Columbia. Cannings (1990) suggests 35,000 for the province as a whole, of which about 15,000 have been found so far. On Vancouver Island, for example, a survey of the Brooks peninsula revealed 519 terrestrial invertebrates in 190 families, of which 31 were undescribed species and 34 were previously unknown in Canada (Cannings 1990). The same author reports that 90 of 100 gall midges collected in Sooke were new to science. Fungus flies may represent a significant component of biodiversity, yet they are poorly known (Jon Shepard, pers. comm.)

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[2] *Handbooks No.35 and 4l*, respectively. British Columbia Provincial Museum (Royal British Columbia Museum), Victoria.

[3] *Insects and Arachnids of Canada and Alaska*, parts 1-16. Agriculture Canada. Queen's Printer, Ottawa.

[4] Bousquet (ed.) 1991. *Checklist of Beetles of Canada and Alaska*. Agriculture Canada. Oueen's Printer, Ottawa.

[5] *Syesis* 8:305-310, 311-315, 333-348 (1976); 9:143-161 (1977); 10:31-48 (1977); 11:117-133 (1979); 16:71-83 (1984).

[6] Bibliographia Invertebratorum Aquaticorum Canadensium, volumes 1-. National Museum of Natural Sciences. National Museums of Canada, Ottawa.

Soil invertebrates are also poorly known. Within British Columbia, the numbers of known genera of soil invertebrate groups are as follows:[7]

Group	No. of Genera		Group	No. of Genera
Protozoa	100		Tardigrada	5
Rotifera	4		Myriapoda	7
Nematoda	11		Crustacea	4
Annelida	8		Arachnida	113
Gastropoda	5		Hexapoda	50

Fauna must be extracted from the soil to permit identification, yet efficiency of extraction even for the more mobile animals ranges from 50% to 80% (Berch 1992). Consequently, much of the soil fauna remains unknown.

4.5 Vascular Plants, including Rare Plants and Rare Plant Communities

Main Sources

Although there are several databases of plant communities or ecosystem types we have not encountered any databases specific to rare plant communities as such – with the single exception of the CDC. Rare plant communities are included within the plant community databases or files (e.g. in the Ecological Reserves Program files, BEG, and the Fraser Lowland Wetland Inventory).

Herbaria are a significant information source. The Index Herbariorum (Holmgren *et al.* 1981) details all registered herbaria in the world. There are many herbaria outside of Canada with important collections of B.C. materials. For example, some early plant collections from B.C. are held at the British Museum, at Kew, and in the Edinburgh and Gray Herbaria. We have not been able to inventory such sources for this project. Boivin (1980) has surveyed the Canadian Herbaria. Important databases for B.C are held at the Canadian Museum of Nature, the DAO Herbarium, the RBCM, the UBC Herbarium, and the University of Washington Herbarium. Ceska (1985) discusses the major manuals for the B.C. vascular flora.

The DAO Herbarium is Canada's principal herbarium, with about 900,000 specimens and many taxonomic experts employed. Several floras and other plant guides for different parts of Canada have been published. the herbarium has the objective of gathering the best possible plant collection of biodiversity research, including cultivated and native plants. The Flora of the Queen Charlotte Islands (Calder and Taylor 1968) is a product of this herbarium. Other potentially useful publications include Poisonous Plants of Canada, and Flora of the Northwest Territories. Various monographs have also been published.

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[7] Valin Marshall (biodivelsity symposium presentation, Victoria, 1991)

The Flora British Columbia Program (U.B.C.) is the database of 3,137 vascular plant taxa occurring in B.C. which was published in Vascular Plants of British Columbia by Roy L. Taylor and Bruce MacBryde. The database is currently inactive and more or less inaccessible. The files are in dead storage somewhere in the U.B.C. computing centre. The database could be reactivated if it could be found.

The UBC Herbarium houses over 220,000 vascular plant specimens and about 500,000 altogether. Specimens mainly date from the 1940's. Type collections however are mainly in Ottawa at the Canadian Museum of Nature, or are at the Royal B.C. Museum. Data is submitted to CHIN periodically. The museum has published monographs on a number of vascular plant families, see Ceska (1985) for a listing.

Van Dusen Botanical Garden (funded by the municipality)- does have a collection of Western North American native plants, although representation of some habitats is weak. There is also a Canadian Heritage Garden of ornamental and food plants that have been developed in Canada.

The Aquatic Plant Database housed at the MOELP is a potentially valuable source for biodiversity studies involving freshwater plant communities. This database apparently incorporates all known records of aquatic macrophytes from every herbarium in B.C.

For standardising plant names, the Plant List of Accepted Nomenclature, Taxonomy and Symbols is an important source (by U.S. Federal Agencies). It covers all of North America, including Canada. Also has information on the status of plants in the U.S. (may be useful, for example for species which just range into B.C.). It is not however accessible to the public as yet.

Plants At Risk is a database at the Canadian Museum of Nature which lists Canadian rare and endangered vascular plants. It has around 600 records. This information is used to update the COSEWIC lists. One objective is to relate species distributions to post-glacial history. It is not publicly available. The Syllogeus series include issues on rare vascular plant species by province/territory. Syllogeus No. 59 covers the B.C. rare plants.

The MOF maintain a number of Regional Herbaria (Kamloops, Cariboo, Prince George, Prince Rupert) which are potentially important sources for biodiversity studies, although these collections may be weak for some non-forested ecosystems. The Cariboo herbarium is weak on deep-water aquatics, bryophytes; and lichens.

The Western Canada Wilderness Committee (WCWC) maintain a small Heritage Tree Register, a database to record the largest and tallest trees recorded in B.C.

Comments

As individual herbaria were contacted directly, this subject area is relatively well surveyed compared to the others.

The CDC records for rare plants are extremely useful, and occurrences of rare plant populations are individually documented. However, only a relatively small number of rare species have been fully documented in the CDC system. For example, only 24 rare plant taxa for the Nelson Forest Region have been entered, although there are a total of about 157 species of rare vascular plant known for the Region.

George Douglas (pers. comm. early 1992) estimates the CDC list may be only 10-15% complete for known element occurrences.

Douglas has been personally checking identifications from many of the herbaria collections on which the CDC information is based. He has indicated considerable variation in the reliability of herbaria sources. In some cases – particularly for the more difficult groups (Poaceae, Cyperaceae, Brassicaceae, and Fabaceae), and for certain herbaria – many mis-identifications have been found. Data being entered into the CDC system has been verified by Douglas and can be expected to be of high reliability. However, some of the herbaria collections need to be regarded with caution.

Overall, the Southern Interior and the lower mainland coast, and lower Vancouver Island, have probably been relatively well sampled for rare plants compared to other parts of the province. Nevertheless, the discovery of rare plants is an ongoing process even in some of the better known portions of the province. An under-representation of rare plants in the north of the province may simply reflect the relatively low sampling intensity in the north, or may reflect a smaller flora.

Coverage of rare plant collections is, inevitably, somewhat biased to favour sites alongside roads and in recreational areas, including for example alpine areas. More systematic sampling across all habitat types is desirable. As the southern regions are relatively well sampled however, bias from access-oriented sampling is probably less than for much of B.C.

4.6 Non-vascular plants

Main Sources

The Pacific Forest Research Centre maintains the Forest Insect and Disease Survey for British Columbia. This is part of a national data base consisting of collection records going back to the 19th century. British Columbia records (more than 600,000) comprise about 45% of the total. The data include over 6000 insects and about 3300 diseases. Decay fungi, mycorrhizal fungi, and mushrooms are included, as are beneficial insects, pest insects, and predators. The data are coded by host species, location, and date, and are retrievable by UTM grid (10-krn cell size) or by drainage divisions: thus one could retrieve records for pest A on host B in years C, and by compiling drainage divisions one could obtain information for a particular forest or wildlife management region. The data base incorporates the biogeoclimatic zone map; the Centre hopes to produce tables relating the distribution of organisms to biogeoclimatic zones. The Centre also maintains a collection of about 33,000 fungus specimens comprising over 3000 species, especially forest disease species. The collection records for these are included in the national data base.

The MOF Inventory Branch maintains a large data base of decay and breakage plots in each forest region. Generally, however, the pathogens are not identified, so this resource is of limited usefulness as a source of knowledge of fungi in the region.

The best collection of B.C. lichens is probably the one in the University of British Columbia Herbarium, which is computerized. The collection is indexed by genus and species and filed by

geographical area, which for B.C. specimens is the whole province. To find out which specimens have been collected in any given Region would therefore require checking every B.C. collection record, which would be impractical. Records could, however, be pulled out by specific collecting locations within the region.

The Royal British Columbia Museum has a small lichen collection consisting mostly of duplicates of specimens contained in the University of British Columbia Herbarium. There is a small collection of fungi and lichens at the University of Victoria which is probably not significant for the purposes of this survey.

There was at one time a synoptic collection of fungi from the region at the now-defunct Notre Dame University. This collection has apparently been neglected and is now in the custody of Selkirk College (Jon Shepard, pers. comm.).

The CLBRI houses the National Mycological Herbarium. 10,000 strains are in culture to preserve genetic diversity. Dead specimens number some 275,0000. This museum holds historically important information. this is the main mycological collection in Canada. It concentrates on taxonomy, and provides services to other Federal Departments. It has an agricultural focus.

Comments

Except for some commercially important species, little information is available concerning the taxonomy or distributions of fungi for the province. There has been no ecological inventory of fungi per se in B.C., and there are no very complete species lists. The situation is likely to be worst in the northern parts of the province, which have generally been poorly sampled. Lack of data makes it generally impossible to adequately assess the status of different species.

The best-known fungi are the tree pathogens, especially rusts and smuts. Lack of data makes it generally impossible to adequately assess the status of different fungal species. Moreover, such collection information as exists is seldom coded in a manner which would allow records for a particular administrative region to be pulled out, though this information may be readily available for particular collecting locations or for the province as a whole.

About 340 species of gilled fungi have been identified in British Columbia under 410 names; the total number of species may be around 2000. Hypogeous fungi such as truffles are almost unreported in British Columbia, but there are probably many species. Fungi of all kinds may number over 10,000 species in the province.

Lichens, considered here as fungi, may number around 1000 species; the latest inventory of lichens and allied fungi lists 1013 species in 205 genera (Goward 1990). There-has been relatively little collecting of lichens in the Nelson Forest Region, but Trevor Goward hopes to collect lichens systematically in old growth forests of southeastern B.C. in the near future (T. Goward pers. comm.).

The fungal tree pathogens have been better studied. The Pacific Forest Research Centre in Victoria produces Regional Reports on tree pathogens and has published a book of distribution maps of common tree diseases (mainly fungal) in B.C.[8]

Mycorrhizal fungus species are present but it is not known which ones are important. It is thought that perhaps half of the mushroom species are mycorrhizal.

Pine mushrooms are a locally significant resource of considerable commercial value. The MOF has undertaken a review of the pine mushroom industry in B.C. which has not been made public. Scoff Redhead of the Biosystematics Research Institute has written an unpublished article on the pine mushroom industry.

Numerous popular guides and technical references to the mushrooms of British Columbia, Canada, and North America have been published. A checklist of the lichens has been published[9] by the Canadian Museum of Nature (formerly the National Museum of Natural Sciences).

Knowledge of microorganisms is extremely poor. Berch (1992) points out that most soil fungi cannot be isolated from the soil. Only some 20% of microorganisms in natural communities can be cultured.

4.7 Regional Ecosystems

Main Sources

The databases we located which specifically deal with ecosystems include the Ministry of Forests Biogeoclimatic Ecosystem Classification system (BEC); the Federal Parks Ecological (Biophysical) Land Classification program (ELC); and the Provincial Environment Biophysical Habitat Mapping program (this program has been covered by the Wildlife Habitat and Range Task Force).

The Fraser Lowlands Wetland Inventory database has been established at the CWS office in Delta; this is based on the National Wetlands Classification System. This is a new database of Fraser Lowlands wetlands, including wetland locations, sizes, classes represented and condition. It consists of a DBASE file and GIS-generated maps. There is an intention to maintain the database to keep it current. It is not directly linked with any other databases. It is anticipated that a report will be, produced out of this program in about a years time. A similar project has recently been initiated for the Comox Valley.

B.C. Parks Planning and Conservation Services have a Natural Landscapes database with 59 regional landscape areas entered, based on terrain, vegetation, climate etc. The objective is to establish a framework for a park system which fully represents distinct environmental

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[8] Wood, C. 1986. *Distribution maps of common tree diseases in British Columbia.* Information Report BCX 281. Pacific Forest Research Centre Victoria.

[9] *Syllogeus* 61 (1987). National Museums of Canada, Ottawa.

differences. The Ecological Reserves Program IBP forms also often contain information on ecosystems.

Comments

The MOF BEC Program has not yet been entered in our database. We have been requested to call back in mid-May as the data setup is currently being changed and better information will be available at that time. This system is used extensively by the MOF, while the biophysical habitat classification is used mainly by the MOE. Both systems have amassed a wealth of information. Yet interpreting this in terms of biodiversity is fraught with difficulties. These systems need to be correlated for a broader perspective.

The Federal ELC program has operated since the 1970's and in B.C. has only been applied in National Parks. In South Moresby the provincial biophysical mapping system has been directly combined with the Federal ELC system. In earlier projects this was not done (primarily as the provincial system was not in place when the other parks were mapped). However, as the underlying principals are essentially the same, the units should show high correlation, and it should not be difficult to interpret the ELC units for the other parks in terms of the provincial system.

The MOF BEC system is based on fundamentally different principles than the biophysical, and is not likely to directly correlate, other than for point-source data. However, we consider correlation of the units from all three systems largely possible, although there may be some areas where difficulties emerge. Correlation of the more distinctive communities – i.e. very dry or very wet types, for example, is likely to be very high. Correlation between the mesic units however may be much less clear. At the present time, differences between the systems make much of the existing information on wildlife/habitat relationships of very limited value for users from the other systems. For example, much excellent and highly pertinent information (for biodiversity) for the Federal Parks exists, yet is essentially lost to the Ministry of Forests, which is generally responsible for management of the lands adjacent to the Park boundaries.

All three systems are user-oriented, and representation of biological diversity within any one of them is incomplete. Non-wildlife, non-green plant components of biodiversity are essentially overlooked, at least by the provincial systems. BEC is often incomplete or imprecise regarding ecosystems of low commercial value. Diverse wetland types tend often to be grouped together in one site series. Fens may be amalgamated with marshes, swamps or bogs. Some non-forested vegetation types have been omitted form the classification. The representation of seral ecosystems within BEC is not yet consistent.

Within the BEC, seral ecosystems have often been sampled inadequately, or not at all. Wildlife Habitat Classes usually do not correspond directly to BEC site series/associations, although there are exceptions. Typically, a forested habitat class can include several site series, and possibly site associations, while a wetland site association may include more than one Wildlife Habitat Class. Several of the habitat classes have no specific counterparts within BEC.

Within BEC, apparent differences in ecosystem diversity can partly reflect different levels of effort. Sampling intensity is likely lower in zones with limited access (e.g. the Mountain

Hemlock zone). Individual mapping preferences will also influence apparent diversity (lumpers versus splitters).

5. General Comments and Recommendations

5-1 Completeness, major data gaps

Inventory of databases

The main collections of the major, well-known institutions are easy to cover, but there are many important small collections and databases that are not widely known. These may be uncovered more or less by accident when a contact volunteers some peripheral information. Some of these (e.g. the RBCM Native Plant Garden) are housed within larger institutions whose spokesperson may either not know about them or not realize they are significant for purposes of this survey and thus not mention them. Others are held by numerous individual researchers based at various academic institutions, or have been developed by individual special interest groups. In addition, there are numerous large institutions outside the country that house significant B.C. Material. Inevitably, many of the smaller resources, and many of those housed outside of B.C., cannot be fully documented in this brief survey. Considerably more investigation and documentation would be required to complete the inventory to this level. A list of incomplete contacts/sources is provided in appendix v. It is recommended that these sources be pursued to complete the inventory of existing databases, which could then be held by the CDC and could be made available to other users.

Taxonomic cove

Level of effort directed at collecting both across the province, and across different taxa, has been very inconsistent.

The outstanding impression is the overall lack of the most basic taxonomic and distribution data. Although there are some large and excellent collections of biodiversity data in Canada, representation of specific taxa may be scanty for B.C. (e.g. molluscs, annelids). Particularly for the lesser known groups of plant and animal, collection has been sporadic and is influenced by accessibility. Relatively few planned, systematic surveys have been done.

The relatively well-documented taxa have been mentioned in preceding sections. Information on invertebrate and microbial populations, and on fungi and lichens, is extremely fragmentary and often almost non-existent, other than for groups of commercial interest such as tree pathogens. Some broad groups which particularly require further study include: lichens (important as ungulate browse); soil invertebrates (important as decomposers); aquatic invertebrates (prey for fish and birds); wood rot fungi; mycorrhizal fungi; and (not to be forgotten) those fungi and invertebrates having no obvious commercial importance. Specific taxa mentioned by some of our contacts include: land snails, freshwater molluscs, terrestrial isopods, leaf miners, fungus flies, earthworms, and Discomycetes.

Large gaps exist even in the knowledge base for vertebrates. Information on species distributions is often fragmentary, varying geographically and across different taxa. For some vertebrate groups (notably bats, shrews and several other small mammals, passerines, amphibians) even basic distributional information is lacking. The Pygmy Shrew, the Least Chipmunk, the Red-

tailed Chipmunk, the Collared Pika, and the Least Weasel are just a few examples of the poorly known small mammals. Studies of the ecology of these species is also necessary. For some of the small mammals and birds, the systematics need review.

There is a need for more systematic collection and more accurate identification of rare plants in the province. Continued efforts to determine the distribution and habitat relationships of rare, threatened and endangered species in all taxonomic groups is also required.

Knowledge of genetic diversity is probably almost non-existent for most species, with the exception of commercial vascular plants.

Geographical cover

Distribution of sampling for most groups is affected by proximity to population centres and access. This is most pronounced in the more remote portions of the province. Clusters of rare plants along the Alaska and Haines highways in the northwest, for example, doubtless indicate accessibility more than any genuine concentrations of rare species. Sampling inequalities make it almost impossible to adequately assess the distribution and status of numerous species and species groups, whether rare plant, lichen, invertebrate or small mammal. For example, Straley (1990) points out that it is very difficult to assess how common or rare many of the plants in the northern parts of the province are because of the limited fieldwork. Information for the larger, highly visible mammals is generally much better.

In addition to increased efforts to study vulnerable species, there is a need for more systematic sampling across all parts of the province. However, as the less sampled, more remote areas are generally under less imminent threat of development, priorities must continue to focus on those species and habitats in closer proximity to population centres. Nevertheless, an effort to develop baseline biological diversity inventories throughout the province would improve our ability to assess the status of many of the species and habitats of concern in advance of development.

Apparent diversity of ecosystems may also be influenced by sampling intensity. For example, the BWBS subzone in northwestern B.C. appear to be more diverse, in terms of wildlife, than the SWB subzone in that area. This may however be partly an artifact of recording effort as several studies and collections made in the extreme northwestern corner have provided many more vertebrate records than occur for the SWB. Non-commercial ecosystem units, most extensive in the north, have received relatively little effort in terms of ecosystem classification.

Ecological cover (ecological processes, habitat, relationships, etc.)

A general impression from our survey is the need for studies of ecosystem function. Land management practices, including forest pest management, fire management, timber harvesting practices, tree species selection, and so on probably have major biodiversity implications which may not be understood (or even imagined) because of the lack of basic species inventory data and the correspondingly weak level of understanding of ecosystem relationships and processes. Managing for biodiversity will require comparative studies of ecosystem processes in ecosystems under different management regimes, including no management.

For wildlife, in addition to distributional and population information, knowledge of habitat requirements, as well as of details of reproductive capability, dispersal ability, and versatility (or sensitivity) are prerequisite to managing diversity. For example, for bats, information on roosting, maternal, and Wintering colonies is needed. The ability of certain species to recover from impacts, and to recognise areas, is also important information, necessary to determine the minimum viable population for a given species. Ideally, a detailed review should be compiled for every species on the provincial red, blue and yellow lists, giving range details, listing specific localities, data sources, and, summarising biological and ecological information. Species which occur in Canada only within B.C. should in particular be targeted for research and inventory. Amphibians should be high among the priorities for research.

Although the BEC, the ELC and the Biophysical habitat mapping programs have amassed a wealth of information, interpreting it for biodiversity is fraught with difficulties. Provincial and national vegetation/ecosystem classification systems are not integrated or correlated. There seems to be no drive by their managers to integrate these systems, presumably because the systems capably do the job for which they are intended. But if management of biodiversity is an objective, then it is desirable to integrate or correlate these systems in some manner.

Also, these systems are not designed to pick up on rare elements, a critical component in biodiversity considerations. These ecosystem mapping approaches are founded on the bas is of the most commonly occurring, or diagnostic, elements of communities. Small, rare ecosystems and species are likely to be entirely overlooked. Obviously, scale of inventory is a significant consideration here. For example, biophysical habitat mapping at 1:250,000 scale may give an indication of landscape level diversity, but will entirely miss many smaller scale habitats, such as talus slopes, limestone outcrops etc. which do so much to introduce diversity into the landscape. It is likely that many important habitats will only be delineated at a scale of 1:20,000 or greater. For areas thought to be real "hot spots" for biodiversity, an even larger mapping scale may be more appropriate.

The classification systems discussed focus on natural ecosystems, and relatively little, or no, attention is paid to agricultural and urban habitats. However, agriculture and urbanisation have very significant impacts on biodiversity – both directly on the developed lands, and also on adjacent areas. Much can be done in both agricultural and urban environments to ameliorate impacts on native biodiversity. Classification systems and inventories for biodiversity should automatically incorporate these habitats as part of the system.

Along with more data, better data management, and better integration of existing classification systems, is the need for higher quality data. Collection records should include comprehensive ecological information as well as geographical coordinates. Efforts to identify species at risk need to be continued.

5.2 Accessibility

Another major impression is the inadequacy of information management (catalogues, computerized databases) for existing specimen collections. The lack of computerization of some important collections (e.g. the Spencer Entomological Museum at U.B.C., the National Insect Collection of Agriculture Canada) effectively restricts access. Where cataloguing is inadequate,

there is no practical way to compile a species inventory of existing data in the collection for a particular geographical region or habitat type. This problem is being remedied somewhat as major institutions (e.g. the Canadian Museum of Nature) computerize their data. However, there still exists provincially and nationally an enormous backlog of data, scattered among numerous institutions, needing to be entered into computer data bases.

Records are often coded in a manner which limits their utility. For example, fungi collections rarely allow for a particular administrative region to be pulled out. Records can however generally be accessed by a specific location, or for the province as a whole.

Database systems should incorporate a geographical map base of ecological and administrative units. At present only the Forest Insect and Disease Survey data base permits accessing of data by biogeoclimatic zone or drainage basin.

A standardised, computer-based system for compiling basic distributional and ecological data on vertebrates, accessible to all potential user groups, needs to be developed. This needs to include cross-referencing not only to the BEC system but also to the Ecoregion/ecosection and wildlife habitat classes in use by the MOELP. It should also be compatible with the system utilised by the CDC.

For greatest usefulness, a national data base along the lines of the Forest Insect and Disease Survey system may be appropriate.

5.3 Reliability and Maintenance

Collections vary considerably in reliability. For example, mis-identifications occur in some of the existing plant collections upon which the rare plants information for B.C. is based. These are particularly common amongst certain difficult taxa. For rare vascular plants, the CDC is attempting to systematically verify all the rare plant identifications for the province. It is likely there are also many mis-identifications of the invertebrates, and perhaps for some of the more difficult vertebrate species also.

In compiled databases, the distinction between primary data (actual records) and hypothesised information is important. This distinction needs to be clearly made in my databases being established for collecting information on biodiversity. There is considerable danger that otherwise data will be misinterpreted, or incorrectly used. Without making this distinction it is also impossible to establish the reliability of different pieces of information.

Maintenance of databases is also highly variable. Although some programs are regularly updated, most are updated only on an ad hoc basis, or in some cases not at all. Actual specimen collections can of course be destroyed by lack of maintenance, and collections held in small institutions or by private individuals in particular may be left to deteriorate following the demise of the collector.

5.4 General Comments

Some institutions have a mandate which imposes a relatively narrow focus on their operations, or their managers interpret their mandate that way. For example, the Department of Agriculture herbarium is Canada's major repository of plant biodiversity data but has a conservatively agricultural orientation. Closer to home the MOF's Ecosystem Classification Program has collected plot data mainly from forested ecosystems. These information resources are thus not developed as well as they could be. Separate, parallel collections and databases for comprehensive biodiversity research would be impractical. It is desirable to find methods to permit the existing. developed information resources to operate in a less narrow, more comprehensive manner.

Lack of funding was a common theme, particularly from contacts at major federal institutions. Some contacts suggested the collecting and study of biodiversity material does not have a high priority with funding agencies, and that biodiversity surveys and research seem to have a much higher priority with some foreign governments than with our own. Lack of funding results in barely adequate staffing, very slow data upgrading, and cutting back or elimination of collecting expeditions.

Reorganization is also a common theme. Several major institutions or agencies (e.g. Canadian Museum of Nature, Parks Canada, CLBRI) are being reorganized. Sometimes individuals in such organizations are unsure of the institutional hierarchy, or even of their own position within it. Contacts in the same organization will sometimes give conflicting information. Reorganization is so common perhaps it is a fundamental function of bureaucratic structures? Presumably such restructuring may serve administrative purposes, but is generally unlikely to further the cause of research.

There is an overall lack of linkage between the diverse institutional information sources. Some effort has been made to overcome this through databases such as CHIN, but information remains fragmented. Individual researchers toil in relative obscurity. Moreover, individuals hold invaluable information on data sources and contacts, but individuals change jobs and retire, taking their knowledge with them and leading to fragmentation and loss of information.

5.5 Recommendations

Continued efforts are needed to determine the distributions and habitat needs of the rare, threatened and endangered species (and where applicable, subspecies) of all taxa. Efforts are also required to improve identification of difficult taxonomic groups.

Better documentation of life histories and ecology is also necessary to permit the determination of critical habitats, and minimum viable populations. This process should begin with detailed status reviews of all vertebrate species on the red and blue lists (rare fish species should be included), and of rare plant and invertebrate species (NB some status reports for vertebrates are already underway). Those species or subspecies unique to B.C., or that occur in Canada only in B.C., should be priorities. These reports should summarise existing knowledge on distribution, list specific locations, give data sources, and summarise biological and ecological information.

At the same time, we need more systematic sampling across the province to provide a baseline biological diversity inventory permitting the status of species and habitats to be determined in advance of development. Priorities must still lie however with those species and habitats which are under most imminent threat.

Basic species inventories are particularly needed for lichens, fungi, soil and freshwater invertebrates, and the lesser known vertebrate groups. Future collections and surveys should include comprehensive ecological data as well as geographic co-ordinates. Better information on the genetic variation within the different taxonomic groups is also needed.

In order to manage biodiversity we need to correlate or integrate existing ecosystem classifications to provide a more adequate basis for examining biodiversity. A matrix combining site association information with seral stages and wildlife habitat units may provide a more adequate framework for biodiversity.

The scale of inventory must be carefully considered. For biodiversity, it is likely many important habitats may only be delineated at a scale of 1:20,000 or greater. Suspected "hot spots" of biodiversity need to be priorised, and mapped at a sufficiently detailed scale to account for these small habitats/ecosystems.

More attention should be given to incorporating agricultural and urban habitats into any ecosystem inventory for biodiversity.

A glaring need for improved database management exists throughout. Computerised information banks are needed to access data and compile -inventories. Digitised geographical map bases of ecological and administrative units are prerequisite. A database along the lines of the Forest Disease and Insect Survey database may be appropriate. Better compatibility of databases between different institutions needs to be achieved.

More research is required on ecosystem function, including studies on the implications of land management practices for biodiversity. Comparative studies under a range of different management regimes is required. Experimental forest may offer good opportunities for developing this research.

A national or even international database of biodiversity sources would be a valuable resource which could act as a network for posting of information, including tracking who is doing what and where, the status of existing databases and collections, and so on. A network along these lines would make a survey such as this largely unnecessary. In the meantime, a continuation of this project to complete documentation at least of all the major sources is recommended. The database could be housed by the CDC and should be made available to other interested groups/agencies.

It is also recommended that a matrix to examine existing and proposed inventories of the different Task Force groups be developed at the Mesachie Lake workshop to further explore overlap between groups. Once biodiversity inventory needs have been defined, this should facilitate the allocation of inventory responsibilities to other groups. An over-all co-ordinating group for biodiversity is recommended, which would direct supplementary activities needed to collect data which does not readily fit into the other groups, and to synthesise biodiversity information from the other inventories.

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Table 2. Proposed matrix to examine existing overlap and biodiversity inventory needs

Level	Timber	Range, Wildlife	Water. Watersheds	Soils	Fisheries	Climate	Agriculture?
Province							
Region/ subregion	TSA, TFL inventories (fisheries data, wildlife data, old-growth data)	Biophysical habitat maps @ 1:250,000 Wildlife Habitat Handbooks					
Local	LRUP's etc.	Biophysical habitat maps estuarine habitat maps					
Point source?							
Data sources for bio-diversity			pollution studies? water quality monitoring? wilderness watersheds aquatic plant database	humus classifications - fungi/invertebra the data?	fish species genetic stocks freshwater invertebrates? aquatic flora riparian communities? marine mammals fisheries "pests"		pest species - invertebrates, vertebrates, noxious weeds

Appendix I – Terms of Reference

Terms of Reference For an Inventory of Biodiversity Inventcrf I)ata Bases

1. Consult interactively with the Biodiversity Task Force of the, Resource Inventory Committee, to develop a listing of the major inventories and appropriate contact people that should be included in an inventory of biodiversity inventories, A very preliminary listing is attached to give some idea of the scope of sources. This will help prevent excessive overlap with activities of other Task Force, Priorities of groups of elements to be considered, in decreasing order, are:

    a) mammals, birds, reptiles, amphibians, vascular plants

    b) rare plant communities

    c) invertebrates

    d) nonvascular plants

2. Compile a database, using DBase IV software (or some approved, fully compatible; software), that summarises a selected set of data (see Schedule C) on those major inventories; containing information on the selected elements of the biological diversity of British Columbia. This database should be checked with the CLISP group to ensure compatibility with developing government standards.

3. Add subjective evaluation of reliability, accessibility, completeness, and present maintenance of each database to the summary database.

4. Whenever possible, Include a copy of the data form and any manuals that may define attributes that are used in each database and describe the sampling methodology in greater detail.

5. Provide a written report, in both electronic WordPerfect format and a paper copy, that summarises the sources contacted, major gaps in the inventory (e.g. most invertebrates other than butterflies were not included) and any other information or comments that will clarify or explain the findings.

6. Attend all Biodiversity Task Force meetings, held every second or third week, to provide updates on progress, be involved in discussion of problem areas, and receive instructions (if necessary) on modifications to products.

7. Attend a two-day workshop on May 27 and 28, 1992, at Mesachie Lake, to participate with co-chairs of the Biodiversity Task Force in combining information with other Task Forces and in shaping further direction of needs for resource inventories.

Appendix II. People Contacted

Contact	Area	Phone	Agency	Location	Topic
Abbott. Harry			Parks Canada	Yoho NP	Parks inventories
Apt, Kamil		387-8481	MOF (Landscape Inventory)	Victoria	Tourism and recreation Inventory
Aston. Mona		888-5729	Federation of B.C. Naturalists		Lands for Nature Project
Bellamy, Raymond	613	992-3333	CHIN	Ottawa	CHIN
Benson, Patricia	403	2924519	Parks Canada	Calgary	ELC database
Bradley, Tom		226-7222	Silva Ecosystem Consultants		old-growth inventory
Buckingham, Angola			MOTH	Victoria	MOTH roadkill database
Cadrin, Carmen		356-0928			CDC Victoria ecosystem Inventories
Cannlngs, Sid		366-9798	CDC	Victoria	Cowan Vertebrate Museum – UBC
Chanway, Chris			UBC	Vancouver	soil fauna
Cayouette, Jacques	613	996-1665	CLBRI (Ag Can) – DAO Herbarium	Ottawa	DAO Herbarium
Chutter, Myke		387-9797	MOE	Victoria	Gyrfalcon, Peregrine surveys
Cosgrove, Jim		3873544	RBCM	Victoria	RBCM
Coupe, Ray		398-4406	MOF - Cariboo Region	Williams Lake	Cariboo Regional Herbarium
Dawe, Neil		752-9611	CWS		Nesting records for B.C.
Demarchl, Dennis		387-9772	MOE	Victoria	Coastal Waterbird Census, Describing Ecosystems in the Field (Wildlife Form)
Dobson, Ross	204	983-3113	Parks Canada. Pralre &	Whitehorse	Info. on Park Inventories
Dodd, Chris		387-9763	MOE	Victoria	info on COSEWIC, (contact Bill Munro)
Downey, Alex		266-7194	Van Dusen Botanical Garden	Vancouver	Van Dusen Botanical Garden
Doyle, Isobel		387-7756			MOTH Victoria MOTH databases,
Gage. Sarah	206	543-1682	U of W Herbarium	Seattle, WA	U of W Herbarium
Ginns, Jim	613	996-1665	CLBRI (Ag Can) - Mycological Herbarium	Ottawa	Mycological Herbarium
Gourlie, Diane	403	292-4571	Parks Canada	Calgary	ELC database
Greene, Gordon		356-8242	RBCM	Victoria	marine and freshwater Invertebrates
Guppy, Chris		356-8242	RBCM	Victoria	Entomology collection
Haber, Erich	613	990-6452	Canadian Museum of Nature	Ottawa	Plants at Risk (PLANTSAR)
Haley, Paul		387-9771	MOE	Victoria	Biometrics SSDB
Hamilton, Tony		387-9761	MOE – Research and Development	Victoria	Bear management areas-digitized
Harcombe. Andrew		387-9798	MOELP, BIG	Victoria	CDC, Habitat handbooks, contacts
Harney, Tom	202	357-2458	Smithson. Inst. – Natural History Museum	Washington DC	Natural History Museum
Hatler, Dave		846-9172	Wildlife Research and Consulting,	Smithers, B.C	ongoing survey Info on large mammal species, Spatzizi
Hatler, Ian		387-9792	MOELP Wildlife Branch	Victoria	IMPACT, UIDB
Howes, Don		387-9300	MOELP	Victoria	Oil spill response Information system
Jingforth. Kirk		3874601	B.C. Parks	Victoria	Parks inventories
Johnson, Jacklyn		822-5724	UBC – Faculty of Forestry	Vancouver	Centre for Conservation Biology (contact Fred Bunnell)

Kazmerik, Brian	204	477-1760	Ducks Unlimited		Ducks Unlimited databases
Lee, Olivia		822-3344	University of B.C. Herbarium	Vancouver	University of B.C. Herbarium
Lewis. Peter		387-9553	RIC Fisheries	Victoria	fisheries overlap, biodiversity Information
Lindsay, Dave		246-9332	Fletcher Challenge	Crofton	TFL inventory
Luttmerding, Herb		387-9657	MOELP Integrated Management	Victoria	soil inventories
Mattison, Jim		387-1112	MOELP. Hydrology Branch	Victoria	watershed Inventories
McAllister, Don	613	990-8819	Canadian Museum of Nature	Ottawa	BIODIV; Canadian Museum of Nature
McLaughlin. Ron		755-3500	MacMillan Bloedel	Nanaimo	Breeding Bird Communities/ Biodiversity studies
McLellan,Bruce		963-9651	MOF-Biologist- Red Rock Research Station	Prince George	MOF biodiversity Inventories
McLeod, Lance		666-3567	CWS-Data Manager	Vancouver	CWS databases
Millar, Judy		929-1291	B.C. Parks.	Vancouver	park inventories
Murtha, Mike		565-6270	B.C. Parks, Northern	Prince George	park resource information
Norris, Gary		387-9560	Fisheries Branch	Victoria	information in fisheries databases pertinent for biodiversity
Nyberg, Brian		387-3144	MOF, Research	Victoria	IWIFR, contacts
Orchard, Stan		386-7510	Independent		Victoria amphibian, reptile data sources
Pendergast, Bruce		387-9770	MOE, RIC wildlife/range	Victoria	habitat inventory
Peterson, Scott	301	504-8175	USDA Soil Conservation Service	Beltsville, MD	PLANTS database
Peterson, Les		387-3177	MOF-Research	Victoria	IWIFR projects
Richardson, John		2914475	SFU-Biology Dept.	Vancouver	no data bases at SFU
Roemer. Hans		3874649	MOELP – Ecological Reserves Program	Victoria	Ecological Reserves
Ronneseth, Kevin		3854020	Capstan Group, Victoria	Victoria	watershed Inventories
Runka, Gary		433-6540	consulting to wildlife/range	Vancouver	overlap, landscape range group Inventory
Scheer, Bob		8284501	BC Parks, Southern Interior	Karnloops	Parks inventories
Schieck, Jim		381-1692	SFU (post doc)	Victoria	vertebrate/parks area lists
Simmons, Rik		755-2483	B.C. Parks	Parksville	Parks inventories
Stewart, Andy			MOELP	Victoria	Aerial flights – map base
Stoltman, Randy		683-8220	WCWC	Vancouver	record tree registry
Straley, Gerald		8224779	UBC Botanical Garden	Vancouver	Flora British Columbia
Taylor, Elizabeth		356-8791		Victoria	RBCM-Collectlon Systems and Development Co-ordinator Mammal Collection# Mammals Data System# Bird
Ward. Peggy		666-0143	Canadian Wildlife Service	Delta	Fraser Lowland Wetland Inventory
Warrington, Pat		387-9513	MOELP - Water Quality Unit	Victoria	Aquatic Plant Database; WIB Herbarium

Appendix III. Example of Data Form

INVENTORY NAME: Fraser Lowland Wetland Inventory ACRONYM:

RECORD INITIATED: 92/04/25 LAST UPDATE:

LOCATION: Canadian Wildlife Service, 5421 Robertson Rd., Delta, B.C.

MAILING ADDRESS: P.O. Box 340, Delta, B.C. V4K 3Y3

MAIN CONTACT:
POSITION: Ecosystem Mapping
NAME: Peggy Ward
PHONE: 666-0143

ALTERNATE:
POSITION: Ecosystem Evaluation
NAME: Kathleen Moore
PHONE: 666-0143

INFORMATION SOURCE (if not main contact):

MAIN INVENTORY LOCATION (PLUS CONTACT):

INVENTORY OBJECTIVES: To answer the following questions:
1) Where are the remaining wetlands in the Fraser Lowland?
2) What size are they? 3) What wetland classes do they represent? 4) What state are they in?

DATA SET TYPE:
Voucher: Observational: ✓ Compiled: ✓ Other:

COMMENT:

CLASS OF ELEMENT:

Vertebrates:	Vascular plants:	Rare plant communities: ✓
reptile	Non-vascular plants:	Plant communities: ✓
amphibian	Invertebrates:	Rare plants:
bird	Other: ~~includes rare wetland types~~	
mammal		

COMMENT:

SIZE OF DATABASE: 398 Wetland Units (records) x 52 fields + memo fields. 388 KB.

PERIOD COVERED: 1988, 1989, 1990

GEOGRAPHICAL COVER: International: Canada: B.C.
Regional: ✓ Local:

COMMENT: Fraser River lowlands

RECORD TYPE:

Manual: record cards: photos: reports:
data forms: maps: tables:
other (specify):

COMMENTS:

Electronic: ✓ hardware: PC software: dBASE III
spatial: type: GIS-generated maps
non-spatial: type: descriptions, classifications, locations, status

COMMENTS:

INVENTORY NAME: Fraser Lowland Wetland Inventory

INDEXED BY:
All fields
Place name ✓
Drainage ✓
Administrative unit ✓
Genus/Species
UTM coordinates ✓
Physiographic unit ✓
Other (specify) wetland type, vegetation type
Host
Mapsheet No.
Lats & longs

COMMENTS:

DATA SCALE:
Provincial:
Regional: ✓
Sub-regional:
Local:
Variable:
Map scales: 1:50,000
(index maps at 1:125,000)

DATA COLLECTED: wetland size, location, CWCS classification, vegetation type, degree of disturbance, etc.

SURVEY DESIGN:
unplanned:
planned: ✓
methodology: subjective

COMMENTS:

SUPPORTING DOCUMENT: Yes: ✓ No: Sources documentation: Canadian Wetland Classification System

MAINTENANCE: intention to update

RELIABILITY: fair – the classification system is broad – information is good at its own level

COSTS\CHARGES:
Survey costs: mostly in-house; 2 contracts were let for about $ 30,000
Identification costs: n/a
Information costs: specific queries could cost contractor's fees, but generally there are no user fees – the database and GIS will be available free

ACCESSIBILITY: high

KEY PUBLICATIONS: Ward, P., K. Moore & R. Kistritz. [redacted]. 1989.
Wetlands of the Fraser Lowland. An Inventory.
and - same - - - - - - - - A Summary Report.
both publ. by CWS, and in press.

GENERAL COMMENTS:
Database not linked at present to any other, but files will be linked to GIS.
Status of all wetland units in the Fraser Lowland is intended in about a year.
A similar project for the Comox Valley has just started.

Appendix IV. Water/watersheds and biodiversity – possible overlaps

Survey Name	Access Name	Access Address	Access City	Access Postal	Access Phone	Access Fax
B.J. Zebarth	B.J. Zebarth, Aq Can Station	P0 Box 1000	Agassiz BC	V0M 1A0	796-2221	796-2221
Barry A. Willoughby	Public Health Protection Branch		Victoria BC		387-2686	356-8850
Beniot Godin	Bryan Kelso	224 W. Esplanade	N. Vancouver BC	V7M 3H7	666-5193	666-6858
Bruce Holms	G. Bruce Holms	765 Broughton St. 3rd Floor	Victoria Bc	V8V 1X5	387-9508	356-8298
C. Baldazzi	Cris Baldazzi	224 W. Esplanade	N. Vancouver BC	V7M 3H7	666-8007	666-3325
C. Robinson	C. Robinson	224 W. Esplanade	N. Vancouver BC	V7M 3H7	666-3858	666-3325
Colin McKean	Colin McKean	765 Broughton St., 3rd Floor	Victoria BC	V8V 1X5	387-9511	356-8298
Dr. P. Warrington	Dr. P. Warrinqton	765 Broughton Street	Victoria BC	V8V 1X4	387-9513	356-8298
Fred Mah	Fred Mah	224 W. Esplanade, 4th floor	N. Vancouver BC		666-8000	666-6713
Harvey Sasaki	H. Sasaki	Financial Development Branch	Victoria BC		356-1828	
John R. Wigmore	John R. Wigmore	765 Broughton St. 3rd Floor	Victoria BC	V8V 1X5	387-6341	356-8298
Nellie Peppin	Nellie Peppin	777 Broughton Street	Victoria BC		387-9962	356-7197
Rick Nordin	Rick Nordin	765 Broughton Street	Victoria BC	V8V 1X4	387-9517	356-8298
Rodney D. Zimmerman1	Rod Zimmerman	765 Broughton St, 4th Floor	Victoria 8C	V8V 1X5	387-9496	356-5496
Rodney D. Zimmerman3	Mike Wei	765 Broughton St, 4th Floor	Victoria BC	V8V 1X5	356-5062	356-5496
Rodney D. Zimmerman4	Rod Zimmerman	765 Broughton St, 4th Floor	Victoria 8C	V8V 1X5	387-9464	356-5496
Rodney D. Zimmerman5	Rod Zimmerman	765 Broughton St. 4th Floor	Victoria BC	V8V 1X5	387-9464	356-5496
Rodney D. Zimmerman6	Rod Zimmerman	765 Brougbton St, 4th Floor	Victoria HC	V8V 1X5	387-9464	356-5496
Stewart Irwin	Stewart Irwin	479 Island Highway	Victoria BC	V9B 1H7	478-1715	474-4012

Survey Name	Inventory	Category	Parameters:	Metric
B.J. Zebarth	Research an Efficnet Use of Nitrogem in Agriculture			Vol/mov/time/phys/chem/bio
Barry A. Willoughby	Water Sample Analysis Computer System (WASCS)			Loc/time/own/phys/chem/bio
Beniot Godin	Project File and Freshwater Database (FWD)	Surface	stream; lake	Vol/mov/avail/phys/chem/bio
Bruce Holms	Biological Database	Surface	bio & taxonomic data	Time/own/taxonomy, presence/absense, bio
C. Baldazzi	Dioxin Survey 1988-89	surface	stream/river, take, reservoir	Phys/chem/bio
C. Robinson	Surface Water Data	Atmospheric/Surface	Rain, stream, lake, reservoir	Vol/mov/loc/time/avail/own/phys/chem
Colin McKean	Fish/Sediment Lake Database	Surface	Lake, sediment, lake morpholog	Vol/loc/phys/chem/bio
Cris Baldazzi	Contaminants Survey in Columbia River	Surface	stream/river, lake/reservoir	Phys/chem/bio
Dr. P. Warrington	Aquatic Plant Life			Vol/loc/bio
Fred Mah	Environmental Quality objectives: Water Ecosystem	Surface/Groundwater	stream;lake;res/groundwater	Phys/chem/bio
Harvey Sasaki	ARDSA Projects			Vol/mov/loc/time/avail/own/phys/bio
John R. Wigmore	Water Utility Database			Vol/loc/avail/own/phys/bio
Nellie Peppin	SEAM			Vol/loc/avail/own/phys/chem/bio
Rick Nordin	SEAM	Surface	stream, take, reservoir	Phys/chem/bio
Rodney D. Zimmerman1	CGDS (Computerized Groundwater Database System)			
Rodney D. Zimmerman3	Observation Well Network			Vol/mov/loc/avail/own/phys/chem/bio
Rodney D. Zimmerman4	Water Well Records Files			Vol/mov/loc/avail/own/phys/chem/bio
Rodney D. Zimmerman5	Water Quality Check Program Data			Phys/chem/bio
Rodney D. Zimmerman6	Groundwater Section NTS Files			Vol/mov/loc/time/avail/own/phys/chem
Stewart Irwin	Greater Victoria Water District	Atmospheric/surface	rain/stream, reservoir	Vol/mov/time/phys/chem/bio

Appendix V

a. Completed database enquiries

Aerial Survey Database (widlife data - mainly winter flights)
Aquatic Plant Database
BC *Listed" species
BC Terestrial Vertebrate Species
BC Parks Field Observation System
Biodiversity in old-growth and managed forests, Western Vancouver Island
BIODOV database (Canadian Museum of Nature)
Breeding Birds in Managed. Riparian and Old-growth Forests. Northeast Vancouver Island
Breeding Habitat of the Forest Dwelling Vertebrates of BC
Canadian Heritage Information Network
Canadian Museum of Nature - General
Coastal Waterbird Survey Data
Conservation Data Centre
Cowan Vertebrate Museum
DAO Herbarium Natural History Museum - Smithsonian Institute
Describing Ecosystems in the field - Wildlife Data
Ecological Land Classification (Federal Parks)
Flora B.C. Progmmme (c/o UBC)
Fraser Lowland Wetland Inventory
Furbearer database
Initial Monitoring Program for Animal Conflicts with transportation
IUCN Task Force on Declining Amphibian Populations
Literature Review of Amphibians and Reptiles
MOF Cariboo Regional Herbarium
National Mycological Herbarium
Plant List of Accepted Nomenclature, Taxonomy and Wymbols
Plants at risk (Canadian Museum of Nature, Ottawa)
RBCM - General
RBCM - Entomology collection and database
RBCM/CWS - Nest Record Cards
RBCM - Sight Record Cards
RBCM - Ornithology Collection
RBCM - Ornithology specimen database
RBCM - Mammal collection
RBCM Mammal collection database
RBCM Herpetological Collection - Accession Catalogue for Amphibians and Reptiles
Record Tree Registry (WCWC)
Summary Statistics Database
UBC Herbarium
Ungulate Inventory Database
University of Washington Herbarium
Van Dusen Botanical Garden

b. Incomplete enquiries

The following contacts/databases are either incomplete (i.e. enquiries have been initiated but further data is in the mail, a database exists but we need to re-contact the organization for further details, etc.). or have they are believed to have a database or other pertinent information. but have not yet been contacted.

Agriculture Canada - Pests & Diseases (call librarian), Vancouver, 224-4355
B.C. Hydro, Vancouver, 663-2212
CIN - Conservation Information Network
CLBRI (Ag Can) - Canadian National Insect Collection, Ottawa, 613-996-1665, P.T. Dang, 613-996-1665, Milton Campbell, 613-996-1665
Dogwood Project - BC Museums Association
Ecological Land Surveys Ltd. (re CVCS), Edmonton, 403-474-5376
EnvCan - Environment Canada, Ottawa, 613-997-2800
ErryCan - Environment Canada (librarian), Vancouver, Andrew. 666-5914
Federation of B.C. Naturalists, Vancouver, 737-3057
Geological Survey of Canada, Vancouver, 666-0529
Greater Vancouver Regional District Parks, Burnaby, 432-6350
Grist Mill (re preservation of variety of crop plants), Keremeos, 499-2888
Inland Waters Canada, N. Van, 666-6711
MOAFF, Victoria, Tony Kluge; aquaculture - Michael Coon
MOELP (re fish tissue. sediment samples databases), Victoria, Colin McKeon
MOELP (re SEAM - lake bottorn sampling), Victoria, Bruce Holms, 387-9508
MOF - re BEC, Victoria, Del Meidinger, 387-6688, Shirley Mah, 356-2180
MOF - Kamloops Regional Herbarium, Kamloops, 374-7741, Fraser Russell
MOF - Nelson Regional Herbarium, Nelson, 354-6200
MOF - Prince George Regional Herbarium, Prince George, 565-6100, Craig Delong
MOF - Prince Rupert Regional Herbarium, Smithers, 847-7500, Sandra Thompson
MOF - regional protection sections?
MOF - Vancouver Regional Herbarium (if exists), Burnaby, 660-7500, Fred Nuszdorfer, 660-7529
MOH - B.C. Ministry of Health, Victoria
MOTH - Environmental Services, Victoria
N. Amer. Wetlands Conservation Council (re CWCS), Ottawa, Clayton Rubec. 613-228-2601
Oregon State U. (re soil ecology), Andrew Moldenke
PFRC – Forest Insect & Disease Survey, Victoria, 363-0600; (fungi – Brenda Callan, 363-0744; insects – Les Humble,363-0644, inverts – Allan van Sickle, 363-0674; soil inverts - Valin Marshall, 363-0663; CV&WCS - 363-0600. Ed Oswald, 387-0687; CVCS - 363-0600, John Senyk, 388-0688
Public Works Canada, Vancouver, 666-3103
RBCM - Rare Plant Garden, Victoria, Richard Hebda
ROM - Royal Ontario Museum, Toronto, 416-586-5549, Joe Mandarino, 416-586-8044
SFU - Simon Fraser University, Burnaby, 291-3111
Smithson Inst. - NHM - Botany Dept, Washington, DC, Laurence Skog, 202-357-2534; Entomology Dept. - Ronald McGinley, 202-357-2834; Invertebrate Zoology Dept. – Brian Kensley, 202-357-2030; Vertebrate Zoology Dept – Spencer Entomological Museum, Vancouver, 822-3682, Geoff Scudder
U of Michigan - Herbarium, Ann Arbor, MI, 313-764-2407, Tony Reznicek, 313-764-5544
U of Wash. - Burke Museum (Zoology Dept., inverts.), Seattle, WA, 206-543-5590. Rod Crawford, 206-543-9853

UBC - Hort Line, Vancouver, 822-5858
UBC Dept. of Soil Science (re fungi. mycorrhizae), Vancouver, Shannon Berch, 822-3716
MOE – Victoria, Doyle, Dan,356-0244
MOE - Nanaimo, Quadra Is. biodiversity study, Kim Brunt, 758-3951
IWIFR - Black-tailed Deer
McNay, Scott, 367-6711, MOF-Research
Cannings, Dick, 8224665, UBC (Dept. of Zoology), Cowen Vertebrate Museum
MOE – Surrey, Dave Dunbar. 584-8822
Weldwood of Canada – Prince George
Friis, Laura, 387-9755. MOE, non game species info
Munro, Bill, 387-9764, MOE, COSEWIC; Peregrine and Gyrfalcon surveys
Lemmon, Moira, 666-0143, CWS-Delta
Wielgus, Rob, 822-5724, UBC-Faculty of Forestry
Sullivan,Tom, UBC
Fred Bunnell, Alton Harestad
MOE – Cranbrook, Rob Ned, riparian areas; TRIM mapbase
MOE – Victoria, Todd Manning, Wildlife Trees
Ros Pojar - bird diversity/aspen stands
Laura Darling, Trudi Chatwin, MOE Victoria
GAP analysis, V1 - Marvin Eng
Sierra Club
FRDA program
BC Hydro
MEMPR
RBCM - Dave Nagorsen
Lertzman, Ken SFU
Earthlife Canada foundation; Conservation International; Ecotrust - wilderness inventory for coast; Kitlope study; others?
BC Parks - PUP database for research permits - Mona Holly, 387-4559