Voucher Specimen Collection, Preparation, Identification and Storage Protocol: Plants & Fungi

Standards for Components of British Columbia's Biodiversity No. 4b

Prepared by
Ministry of Environment, Lands and Parks
Resources Inventory Branch
for the Terrestrial Ecosystems Task Force
Resources Inventory Committee

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Preface

This manual presents standard protocols for collecting plant and fungi vouchers in British Columbia (animal vouchers are covered in manual No. 4a). The manual was compiled by the Elements Working Group of the Terrestrial Ecosystems Task Force, under the auspices of the Resources Inventory Committee (RIC). The objectives of the working group are to develop inventory methods that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species component of biodiversity.

This manual is part of the Standards for Components of British Columbia's Biodiversity (CBCB) series. The series includes an introductory manual (*Species Inventory Fundamentals No. 1*) which describes the history and objectives of RIC, and outlines the general process of conducting a species inventory according to RIC standards, including selection of inventory intensity, sampling design, sampling techniques, and statistical analysis. The *Species Inventory Fundamentals* manual provides important background information and should be thoroughly reviewed before commencing with a RIC wildlife inventory. RIC standards are also available for vertebrate taxonomy (No. 2), animal capture and handling (No. 3), and radio-telemetry (No. 5). Field personnel should be thoroughly familiar with these standards before engaging in field inventories which involve any of these activities. The rest of the series is comprised of standard protocols designed specifically for groups of species with similar inventory requirements.

Standard data forms are required for all RIC species inventory. Survey-specific data forms accompany most manuals while general wildlife inventory forms are available in *Species Inventory Fundamentals No. 1 [Forms]*. This is important to ensure compatibility with provincial data systems, as all information must eventually be included in the Species Inventory Datasystem (SPI). For more information about SPI and data forms, visit the Species Inventory Homepage at: http://www.elp.gov.bc.ca/rib/wis/spi/

It is recognized that development of standard methods is necessarily an ongoing process. The CBCB manuals are expected to evolve and improve very quickly over their initial years of use. Field testing is a vital component of this process and feedback is essential. Comments and suggestions can be forwarded to the Elements Working Group by contacting:

Species Inventory Unit
Wildlife Inventory Section, Resource Inventory Branch
Ministry of Environment, Lands & Parks
P.O. Box 9344, Station Prov Govt
Victoria, BC V8W 9M1
Tel: (250) 387 9765

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The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments as well as from First Nations peoples. 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”.

For further information about the Resources Inventory Committee and its various Task Forces, please access the Resources Inventory Committee Website at:
http://www.for.gov.bc.ca/ric

Terrestrial Ecosystems Task Force

All decisions regarding protocols and standards are the responsibility of the Resources Inventory Committee. The following people made substantial contributions to various sections of this manual: Introduction - Rob Cannings, Andrew Harcombe, Leah Westereng; Vascular and Non-vascular Plants - George Douglas with comments by Joan Kerik, John Pinder-Moss, Richard Hebda; and Fungi - Brenda Callan with comments by Adolf Ceska. Helpful comments were submitted by Peter Newroth and Del Meidenger.

Background information and protocols presented in this version are partly based on the unpublished draft government report, *Manual for Voucher Specimen Collection, Preparation, Identification and Storage Protocol for Inventories in British Columbia*, prepared for the Resources Inventory Committee by M.G. Shepard and M. Lambert. Assistance for this draft manual was appreciated from the following people listed. Brenda Callan provided a synopsis of protocol for fungi voucher specimens that was most useful in the preparation of this report. Stan Orchard (herpetology) and Adolf Ceska (vascular plants) made valuable suggestions on the specimen preparation sections. Julie Oliveira gave us information on preserving marine algae. Rob Cannings and Trudy Chatwin provided direction on the preparation of this manual, and Phil Lambert was a constant source of helpful comments throughout the project.

This manual was edited to its final form by Leah Westereng.

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1. Introduction

The Resources Inventory Committee (RIC) of British Columbia has a mandate to develop standardized procedures for inventory for provincial resources. Interest in, and demand for, information from biological inventory and research is at a high level for several important reasons. The documentation of biological diversity including the distribution and abundance of organisms (much of which is unknown), is considered a vital ethical and management task. Inventory information is critical to the requirements of Forest Renewal British Columbia (FRBC) and the Forest Practices Code that it supports, Protected Area Strategies, land-use planning, and management issues in general.

Museum collections of biological specimens are the fundamental reference material that documents the province's biological diversity. Such collections are essential for research in the science of systematics, which embraces classification, taxonomy, evolutionary relationships and evolutionary processes. Conserving biological diversity and ecological integrity in British Columbia is intimately connected to taxonomic knowledge. It is impossible to carry our biological inventories of threatened ecosystems such as coastal old-growth forests, southern interior grasslands or freshwater ponds and rivers, without being able to identify and name the distinctive and ecologically critical organisms that are present. Without such inventories of "name-able" organisms people cannot communicate, values of areas cannot be assessed, necessary research cannot be done, and management and protection plans cannot be developed. Natural history museums have the responsibility to develop well-documented field collections; to preserve them; to study them and to publish the results of research; to make them available for examination or loan; to serve as repositories for specimens and associated data; and to provide expert information on taxonomy, identification and distribution (Miller and Nagorsen 1992).

Because of the increased demand for biological information it is imperative that collection standards be established and accuracy in identification be encouraged. This manual presents a standard protocol for voucher specimens, a subset of inventory collections designed to ensure the reliability of the inventory.

During ecological, environmental and taxonomic studies, as well as basic species inventory, biological specimens are often collected and identified. These identifications are used in subsequent analyses and reports to come to certain conclusions. If these identifications are incorrect, false conclusions can be made. If results of future studies disagree with those of the initial study, the initial results can be verified only if representative specimens are available for reexamination. The information contained in these specimens is irreplaceable because we cannot go back in time and resample. Thus, it is imperative that in any inventory or study whose conclusions depend on the identification of biological specimens, provisions are made for the deposition of voucher specimens, preferably in a recognized museum with facilities for maintenance of biological collections (Green and Lambert 1994).

Voucher specimens are defined, and their importance is noted, by Miller and Nagorsen (1992). They "... are representative specimens that are collected in biological field surveys and research, and that are preserved to permit independent verification of results and to allow further study. The term "specimen" covers diverse materials such as photographs and tape recordings, but usually refers to more traditional preparations like skins, skulls, pressed

plants or dead animals in preserving fluids... Many kinds of animals and plants that are of interest in environmental impact studies or biological surveys can only be reliably identified when they have been preserved as specimens. Without such voucher specimens it is impossible to independently verify an investigator's claims, it is impossible to re-evaluate the species present in a sample in light of changing knowledge and taxonomic revisions, and it is impossible to reliably make historical comparisons or true ecological changes over time due to environmental effects such as pollution or climate change".

Specific voucher collections (i.e. collections of one biological group from one project) are stored as discrete units for a designated time period. This allows easy access for verification of identifications or additional taxonomic examination. After the designated time has elapsed, museum curators select appropriate specimens from the voucher collection for permanent accessioning into the main reference (research) collections. These latter collections are arranged taxonomically. Therefore, in addition to the primary reasons for making voucher collections, any government supported inventory offers the opportunity for the growth and improvement of the provincial collection.

The voucher specimens, as part of the main collection, then become invaluable for other research such as studies on seasonal occurrence, distribution and biogeography, life history, and taxonomy. Biologists also have an ethical obligation to use fully any plants and animals that they collect, particularly if the species are uncommon or if they are from areas that are subsequently altered by human activity (Miller and Nagorsen 1992).

Responsibilities of museums are to provide curatorial, legal and technical advice on collecting, preserving, documenting and depositing voucher specimens. Arrangements with museums for training field investigators and for accepting voucher specimens should be planned early in a project so that training needs can be met and logistical considerations can be addressed. Museums must maintain voucher specimens in good condition and make them and their data readily accessible. Field investigators and collectors are responsible for properly sampling, preserving and documenting specimens as outlined in relevant protocols and for ensuring that satisfactory samples of collections are deposited in museums after a project is completed. Investigators should cross reference voucher specimens in all reports and publications.

This document should be considered a dynamic document as procedures and techniques change and improve. Note that this manual presents standard protocols for collecting plant and fungi vouchers only. Information on collecting and preparing animal vouchers is covered in manual No. 4a.

1.1 Ethical Considerations

General considerations

Investigators have an obligation to identify and assess the consequences of their research activities on wild animals, populations and the environment. Whenever possible, action should be taken to avoid, alleviate or minimize any adverse effects. Research activities should include the collection of adequate samples to ensure valid research results, yet be balanced to minimize adverse effects. Investigators should always weigh potential gain in knowledge against the negative consequences of disturbance. Although short-term

detrimental effects may result from research activities, research can ultimately yield long-term positive effects for the affected population.

Investigators must also take into account that the sounds, the behaviours and the simple presence of humans as they approach and move closer to sensitive areas may elicit a response from animals. In addition, species that are not under study may be disturbed.

1.2 Compliance with Laws and Regulations

- Permits are required to collect within protected areas (e.g., parks).
- Investigators must obtain and comply with all permits required for the collection of any species (plants or animals).
- Investigators must be familiar with the current provincial list of threatened and endangered species put out by the Conservation Data Centre (CDC), (B.C. Ministry of Environment Lands and Parks 1999), and must comply with all rules and regulations pertaining to these.
- Applications must be made well in advance of the sampling dates to allow adequate time for processing. Failure to obtain permits can result in seizure of gear and penalties.
- **Note:** if a permit can not be obtained to collect a certain specimen, do not collect it (even if it is a recommended voucher requirement).

1.2.1 Protected Areas

Depending on where the inventory survey takes place, one or more of the following may be required to access an area or to collect vouchers:

- Wildlife Sanctuary permit (written permission to be obtained from the Ministry of Environment, Lands and Parks' Regional Manager)
- Provincial Parks permit (contact the Resource Officer in the Park District of interest)
- National Parks permit (phone the office of the national park of interest)
- permission to work on First Nations or private property

Two acts of legislation forbid collection in provincial parks and ecological reserves: The Park Act (Section 8, Park and Recreation Area Regulations, O.C. 867/90, Division 6, Section 32(1)) and the Ecological Reserve Act (Ecological Reserves Regulations, 335/75, Section 1).

The Park Act and Ecological Reserve Act both provide the legislation which clearly prohibits the collection and removal of all natural resources within the parks and ecological reserves. Violators are subject to prosecution under the terms of the regulations (fines) and the judgments held before the courts for charges submitted.

Collection and research may only occur under the authority granted and outlined in a Park Use Permit, Recreation Area Permit or Ecological Use Permit. Permits are issued by the various Park District offices through the province, upon application and review by District staff. The Resource Officer is normally the lead coordinator in reviewing and issuing new permits involving collection and research.

1.2.2 Protected Plants

Note that the collection of some species of plants is restricted by law such as in the Trillium Dogwood Act of 1979. This Act covers three species: *Trillium ovatum*, Dogwood and *Rhododendron macrophyllum*.

1.2.3 Wildlife

Wildlife for which a possession permit from a Regional Manager or Wildlife Branch Director is required is that which is described in the Wildlife Act. Possession permits are issued pursuant to Section 19 of the WILDLIFE ACT, and BC Regulation 337/82, section 1(l). The authority for capture of wildlife comes under section 1(c) of the same regulation.

There is no prescribed application form for wildlife possession permits at this time. Written request for possession permits must be made to the Ministry of Environment, Lands and Parks' (MELP) Regional Manager. Requests for possession permits must provide the necessary details as to collectors' names, sampling period, locations to be sampled, gear types to be used, general purpose of the inventory, species, description, number, location of storage/display, and responsible institution/agency (who will be collecting what, where, when, why and how). Reference should be made to authority (permit) under which the wildlife was collected. Note: If wildlife (dead or alive) is to be exported out of British Columbia, a "BC Wildlife Export Permit for Live Wildlife (or Dead Wildlife, Parts or Derivatives)" must be obtained. Application forms are available from Regional Managers or the Wildlife Branch Director. Wildlife permits cover terrestrial vertebrates as well as sea otters, but do not include migratory birds.

1.3 Health Hazards

Inventory personnel must be aware of health hazards associated with working with wild animals and chemicals used for preserving specimens. Ford and Tesch (1993) discuss some of these concerns. Although it is beyond the scope of this manual to cover these health hazards, below are some common sense precautions:

- familiarize yourself with the disease hazards in the area and the animals that carry them
- inquire about needed vaccinations
- take care to avoid being bitten or scratched by wild animals
- know how to clean up spills and treat for any chemicals that you use
- wear protective gear and disinfect equipment as needed
- immediately wash and treat cuts

1.4 Special Training

All personnel including project managers, crew leaders and any other persons who are independently collecting data on a provincially-funded species inventory project must have successfully completed the training course "Introduction to Wildlife Inventory" that is based on the *Species Inventory Fundamentals* manual (No. 1). This course, along with other species inventory courses, are offered through the British Columbia Forestry Continuing Studies Network (FCSN).

2. Protocol Overview

This section describes the recommended protocol from design of the project with respect to collecting vouchers through to incorporation of vouchers into museum collections.

2.1 Office Procedures

This stage involves determining what specimens are to be collected, how they are to be prepared and the cost. The following are recommended:

- Obtain information regarding what species to expect in inventory area using sources such as literature, government biologists (e.g., Wildlife Branch, Royal BC Museum), university biologists, non-government museums and naturalists groups.
- Contact appropriate museum staff to discuss what collection priorities should be made, as well as the latest in collection and field preparation techniques.
- Obtain necessary permissions for collecting and access (see section 1.2).
- Make cost estimates (including staff time and expenses) for field collections, collection and preparation materials, transport of specimens, storage costs, and identification of specimens.
- Obtain all necessary collection and preparation equipment before departing.
- Make arrangements for transporting hazardous materials and specimens (see section 2.5).
- Keep in contact with appropriate museum to arrange timing of delivery of prepared specimens (see section 2.6).

2.2 Voucher Requirements by Taxonomic Group

If vouchers need be collected, the type of voucher to collect and the number of vouchers to be collected, depend on many things. If whole specimen vouchers are to be collected, one must consider 1) the efficiency that one can collect the species and prepare them; 2) feasibility of taxonomic identification with regard to available exports and published keys; 3) if the taxonomic group to be collected can act as an indicator that can be related to management; and 4) if the collections can be made available in a reasonable length of time to create useful data (body of knowledge).

Collection of rare species may endanger the population - do not collect if this situation is likely. Do not collect more specimens than can be reasonably handled. To document the presence of a species, it is generally accepted that one specimen of each species is adequate. However, for taxa that are difficult to identify, additional specimens may be needed.

It is impossible to generalize as to how many specimens should be collected. See *Voucher Requirements*, sections 3.1 and 4.1, for detailed recommendations. Inventory personnel must also discuss this issue with museum curators prior to field work.

2.3 Preparation and Care of Specimens

2.3.1 Photo Documentation

Photographs taken to provide documentation for species identification should be taken with a macro or close-up lens, and they should show features used for identification and scale of the photo. Photographs should be submitted with the pertinent raw data. It may be necessary to take more than one picture of one specimen from different angles.

Ensure that slides or prints are kept in appropriate protective sleeves. They should be returned to the photographer once species identification has been verified or arrangements made for them to be kept as part of a permanent species record.

2.3.2 Whole Specimens

After specimens are collected, special care is needed to ensure that they will arrive at the museum in excellent condition. In general, to avoid decomposition, specimens should be prepared as soon as possible after collection, if not already done in the field (see taxon specific sections). Permissible time will vary with temperature and humidity conditions, however do not delay.

Note: Specimens may not be accepted by the museum if they are not prepared properly (as outlined in relevant protocols).

2.4 Data Needs

The value of a voucher specimen relies on and can be greatly enhanced by accurate and detailed data gathered at the time of collection. This section provides general guidelines and recommended data to be recorded along with voucher specimens. See appropriate taxa group for specifics.

2.4.1 Field Notebook

Waterproof notebooks and indelible ink pens are recommended for use in the field. Although notebook set up depends on personal preference, legibility and clarity of entries are critical. These must be unambiguous so that other people can read and understand what is written. It is crucial that general data such as habitat and date, be associated with the appropriate specimens. It is recommended that the date and location be written at the top of each page, and when either changes, broad dividing lines be used to distinguish such changes. Avoid abbreviations, if they are used a key must be included in the field notebook or permanently attached to it. Also, if ditto marks are used then the information must be exactly the same.

2.4.2 Field Labels

Field labels should be written on waterproof paper (anonymous (undated) recommends Permafibre) in India ink or pencil. Labels and inks should be tested in water prior to going into the field. For specimens that are housed in containers, the labels should be placed inside, not on the outside.

2.4.3 General Data Requirements

Voucher data must be recorded in the field (preferably in a waterproof surveyors notebook or field forms). The order of notebook entries should approximate the label format being used for ease in label preparation and duplications, especially when label preparation will be done by someone other than the collector.

The absolute minimum voucher data that must be included is the field collection number, the date and a detailed location. Without these, specimens are virtually useless.

For details, see the specific section on Data Needs for plants (3.2) and for fungi (4.2).

Note: Specimens may not be accepted by the museum if they are not labelled properly. Specimens without the associated minimum data required can make a valuable voucher virtually useless.

2.4.4 Identification of Specimens

Specimens will need to be identified and all data verified. A useful reference for species identification experts is *Directory of Experts in the Identification of BC Species*, compiled by H. Nadel (1996). This technical working paper (WP19) can be viewed online at: http://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp19.htm or it can be ordered through Queen's Printers of Victoria (stock number: 7655000058) via their internet homepage: http://www.publications.gov.bc.ca/ by searching under the Ministry of Forests.

2.5 Transportation of Specimens

Specimens should be stored and transported carefully to ensure that they remain in excellent condition. This may involve attention to such details as light conditions, dust, humidity, temperature, packing of containers, and transport of dangerous goods.

2.6 Deposition Policy

2.6.1 Museum Accessioning

Museums must know in advance when to expect a collection and the size of the collection so that they can be ready to process the incoming specimens. Museum staff and inventory personnel should be in frequent contact to ensure the most efficient handling of specimens. A copy of any written reports and field notes associated with the voucher specimens should accompany the collection.

The recommended repository for plants is the Royal BC Museum. The mandate of this institution includes "to collect, preserve and research the natural history of British Columbia" and has the required expertise to oversee the storage and management of biological collections and their related data.

The recommended repository for fungi is the Pacific Forestry Centre.

The University of British Columbia may also be used as a repository for some of the taxa considered in this manual if the Royal BC Museum or Pacific Forestry Centre does not need or want to store them.

Royal BC Museum	**Pacific Forestry Centre**	**University of BC**
Chief, Natural History Collections, 675 Belleville Street, PO Box 9815 Stn Prov Gov't Victoria, BC V8W 9W2	DAVFP, Forest Pathology Herbarium 506 West Burnside Road, Victoria, BC V8Z 1M5	Herbarium Director, 6270 University Blvd., Vancouver, BC V6T 1Z4

Note: Specimens may not be accepted by these repositories if they are not collected, prepared, labelled and contained properly (as set out in this manual and as per other specifications required by the collection manager), or if sufficient funds have not been allotted to cover the cost of storing and maintaining them.

2.6.2 Museum Curation

The Royal BC Museum can provide curation services for voucher specimens. Specimen "curation" includes a) receipt of specimen and data, issue of Temporary Receipt Form; b) preservation of specimen; c) notification of Curator for designation of specimen; d) accession of specimen, notification to donor of accession number and designation; e) preparation of specimen, label(s) attached to all pieces; f) specimens stored in collection; g) full data on a computerized database.

The following curation rates are given as a guideline for estimating the cost of incorporating voucher specimens into the collections at the Royal BC Museum. Rates will vary with expertise of staff, complexity of identification, etc.

Curation Rates Per 6.5 Hours

- Vascular Plants: 20 - 25 specimens
- Non-Vascular Plants: 20 - 30 specimens
- Fungi: 20 - 30 specimens (assuming samples are already identified and heat-killed)

2.6.3 Museum Storage

Only voucher specimens collected to the standards outlined herein will be stored at the Royal BC Museum. Such storage will be for a minimum period of five years or such time as is negotiated between the collecting agency and the Royal BC Museum. Beyond this "voucher storage period" some specimens may become part of the Royal BC Museum's permanent collection.

Storage of specimens at the Pacific Forestry Centre and the University of British Columbia should be discussed on a project-by-project basis.

2.7 Material Specifications and Collection Costs

2.7.1 Material Specifications

As emphasized in the previous sections, specimens must be collected, prepared, labelled and contained properly to be accepted by the museum. For each taxon group you will find a

section that describes the specific equipment required for preparing and storing specimens. It is very important that specified materials are used as this will ensure that specimens arrive at the museum in the appropriate form and will prevent re-doing specimens which wastes both time and money.

2.7.2 Costs

At first glance, it may seem a simple matter to deal with specimens from an inventory project. However, collection costs include not only the actual cost of collecting a specimen in the field, but the costs associated with preparing, storing and maintaining the collection. All these elements must be considered when making a budget. Please see sections 3.5 and 4.5 for more details.

Note:

- The museum may not accept specimens if sufficient funds have not been allotted to cover the cost of storing and maintaining them.
- Costs given in this document are estimates only (as of spring 1999).

3. Vascular and Non-vascular Plants

3.1 Voucher Requirements

An essential part of any vegetation study is the collection and identification of plants. Even though the objectives of some studies may not be dependent on the identification of all species present, the collection of voucher specimens will indirectly benefit many other ecological or botanical studies.

The voucher specimen requirement could make such studies much more cost effective. For example, in the past, during investigations of wildlife habitat, the identification of various species of sedges (*Carex*) and willows (*Salix*) were taken only to the generic level. This lack of data at the species or subspecific level often requires a future researcher, interested in similar research or the same geographic area, to repeat a major part of the study. Excessive costs to return to an area may even prohibit further study.

Although it takes additional time to collect plants in a study area, the data from such collections could prove extremely valuable for many workers. Researchers, using this data, will be able to document our knowledge of the ecology of plants in British Columbia much better than can be done at the present time.

Summary

The procedures necessary for conducting ecological or floristical inventories are presented in detail in the following sections. The summary below is provided as an overview of this process:

1. Every vegetation study should collect voucher material of all but the common plant species in their study area.
2. Every voucher specimen must be collected and processed according to the standards set forth in this inventory manual.
3. Every voucher specimen must, after competent identification, be deposited in either the Royal British Columbia Museum or the University of British Columbia Herbaria.
4. The success of a botanical study will be entirely dependent on the expertise of the botanist. A large number of previous studies have been less than adequate due, not only to poorly qualified botanists, but also to the naiveté of the project leader with respect to minimum project requirements.

Diversity Inventory - General Plant and Cryptogamic Collections

Collections should be made of all plant species except the most common occurring species in a vegetation study plot. In addition, a survey and collection of other species occurring in the immediate vicinity, especially those on different habitats, should be made. This will allow researchers to prepare a floristic list of all species in their study area.

Directed Taxa Inventory - Rare Plant Collections

If the number of individual plants at a site are limited, care should be taken in obtaining voucher collections. Common sense should prevail. In the case of plants on the Ministry of Environment, Lands and Parks Red or Blue lists, it is essential to obtain material and data for the Conservation Data Centre (CDC). It is usually possible to remove the necessary leaf or flower from a single plant without harming the plant. In most small populations, a knowledgeable botanist will be able to make collections of the upper parts without harming the future life of the plant. This is especially true with most monocotyledons and pteridophytes and many dicotyledons. In the case of annuals, flowers or fruits should be taken only when a sufficient seed supply for the next season is ensured.

In the cases where a single individual plant is found that is very rare, a photograph is acceptable. It is important to refer to the CDC's rare and endangered species tracking lists.

Inventory of Rare Plants

If a project requires the inventory of rare plants, the general inventory approach described above will usually be inadequate. A rare plant study will often require a habitat-specific approach. In areas of good access the use of air photos and ground transport will suffice. In some cases, the most cost-efficient logistics may include the use of a helicopter. A skilled botanist can often assess and locate habitats from the air over lengthy corridors or large areas then revisit them after the air reconnaissance. Most of the rare plants in BC occur in relatively small, recognizable habitat units thus the use of either random sampling plots or transects is not appropriate. The habitat-specific approach requires adequate preparation and should include the following:

1. Obtaining the services of a highly qualified botanist familiar with the rare plants of the subject area. This is a not an easy task - there are probably less than 20 qualified individuals in BC that have the expertise to conduct an efficient and productive rare vascular plant survey. Qualified bryologists and lichenologists are even fewer in numbers. Most rare plant surveys fail without a competent botanist.
2. The acquisition of the most current BC CDC tracking list for the area. The CDC will also provide specific site locations, habitat data and other pertinent information for rare plants of the area. The botanist will also be familiar with the major reference material (e.g., *Moss Flora of the Pacific Northwest, The Lichens of BC, The Vascular Plants of BC, The Illustrated Flora of BC, Vascular Plants of the Pacific Northwest,* etc.) available.
3. The acquisition of topographic maps and air photographs of the area are also essential. The botanist will have sufficient air photo interpretation skills to identify potential rare plant habitat. Most rare plants are easily found when the botanist is familiar with a rare plants' habitat.
4. Knowledge of the plant's phenology, for both the species and the area in question, in order to plan survey date(s). In BC peak flowering times may vary from January to August. For many habitats, both an early season/late season survey should be planned. Phenological information is available from both the literature and herbaria collections. Local naturalists may also be helpful in this respect.

3.1.2 Vascular Plants - Specifications

For a regular collection, enough material should be collected to cover two 39.5 x 29.5 cm herbaria sheets. (The extra material is sometimes necessary when the specimen is sent to an expert for identification or if extra material is needed for a regional herbarium.) Roots should be included, where convenient, and various tools, such as knives or trowels, are helpful when digging specimens. When digging up a specimen, however, care should be taken to leave the remaining plants as undisturbed as possible. Specimens larger than a herbarium sheet must be cut or, preferably, folded. Flowers or seeds (or other plant parts) are often necessary for identification but this knowledge, which is often specific to particular families or genera, usually comes with experience.

When plant specimens are collected they must be protected from wilting, and drying until such time as they are put into a plant press. Plant material should be placed in a plastic bag with the air expressed and then kept in a refrigerator, or the coolest place possible, until the material can be dried. The samples will keep for three to five days if kept cool.

If a plant is too bulky or too heavy to collect in its entirety e.g., large herbs, shrubs, trees, then parts critical for identification must be collected instead e.g., for trees a branchlet with leaves and flowers or fruits may do; but for large herbs, in addition to leaves and flowers, the root or a piece of it should be collected. Dirt should be removed from the plants, especially from the roots, e.g., wash in a stream if available.

3.1.3 Non-vascular Plants - Specifications

If the plants are growing on a soil substrate they should be lifted, cleaned and placed in a small paper bag. Plastic bags should not be used as the specimens will mold quickly.

Enough material should be collected to fill two herbaria envelopes (packets (10 x 15 cm) that are made from acid-free paper). The extra material is sometimes necessary when the specimen is sent to an expert for identification or if extra material is needed for a regional herbarium.

3.2 Data Needs

There are minimum standards for data recording which render the collected specimen more valuable than one for which little data is recorded. A specimen with little recorded data may be of little value to science and/or resource management. If a collected plant specimen is accompanied by adequate data and is subsequently made a part of a permanent collection, it can provide valuable information to taxonomists, ecologists, geographers, resource users and resource managers for the next several hundred years; plant collecting is not for today alone!

Data must be recorded in a field notebook or on a proper dataform (see below).

3.2.1 Field Notebook

All data recorded for a collected plant should be recorded in a permanent notebook. Data recorded in a permanent notebook is not readily lost or subsequently altered; it is the permanent evidence associated with a plant collection. Data from the notebook will be transcribed onto an herbarium label for attachment to an herbarium sheet (for those plants

becoming part of the permanent collection); even for those voucher specimens temporarily held, the data notebook provides information about the specimen(s) and - if used in court proceedings - as evidence. For each specimen collected the collector's name and field collection number is recorded in this notebook.

3.2.2 Field Form

Many projects that involve collecting plants are field sampling surveys where the site and vegetation data from the vegetation plot are recorded on Ecosystem Field Forms (FS882) or Vegetation Resource Inventory Forms. The site and vegetation data from the plot becomes the information for the label. When field forms are used, it is not necessary to record the plot information in a field notebook.

When forms are used, it is most time-efficient to number the plants collected on each plot and simply write them directly onto the form. The numbering format is 'plot number – specimen number'. The plot number is a pre-assigned number that is written on the field form or often pre-typed on the form. The two-digit number specific to the plant is written after the species name in the vegetation list (e.g., *Alisma gramineum* -01). For example, if using an Ecosystem Field Form with an assigned plot number of 9900123, then the full reference for the first two plants collected would be 9900123-01 and 9900123-02. For Vegetation Resource Inventory Forms, the plot number will have one extra digit, then the dash and two-digit specimen number. This creates unique numbers for each specimen.

Note that these unique plot–specimen numbers are not the same as the plant collection numbers that will appear on the prepared collection labels! Once the plot data has been digitally entered, a unique collector and collector's number will be created that is linked to this initial 10 or 11 digit plot–specimen number (e.g., 9900123-01 may now be linked and referred to as *Penny 73*). This newly assigned label will become the collector's number that will be used on the plant label.

3.2.3 Plant Labels

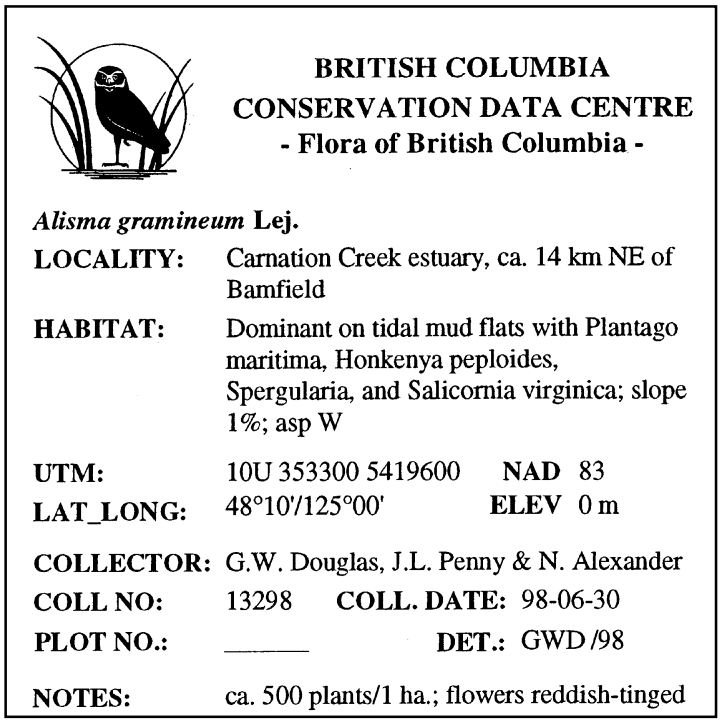
Labels are the most important part of a plant collection (Figure 1). The essential items, (listed in section 3.2.5), can greatly increase the value of the collection for a variety of users. The order of notebook entries should approximate the label format for ease in label preparation and duplications, especially for label preparation by someone other than the collector. Plant labels must accompany voucher specimens. Labels should be a size so that six fit onto an 8 ½ x 11 inch sheet of paper (approximate label dimensions: 8 x 10.5 cm, or 3 x 4 inches)[1].

3.2.4 Rare Plants

For conservation purposes, a complete rare plant Field Observation Form should be completed when a rare plant has been found (Figure 2). This will create a record in the CDC data base that is retrievable for a number of different users. Much of the information

[1] The BC Conservation Data Centre can provide an electronic template that ensures proper label format, as well as suggest software that is cabable of efficiently producing labels.

contained in the collection label will also appear on this form. Data on the size of the plant population for the particular sample (both in area and numbers) is especially valuable, particularly for conservation rank and resurvey purposes.



BRITISH COLUMBIA
CONSERVATION DATA CENTRE
- Flora of British Columbia -

***Alisma gramineum* Lej.**

LOCALITY:	Carnation Creek estuary, ca. 14 km NE of Bamfield		
HABITAT:	Dominant on tidal mud flats with Plantago maritima, Honkenya peploides, Spergularia, and Salicornia virginica; slope 1%; asp W		
UTM:	10U 353300 5419600	**NAD**	83
LAT_LONG:	48°10'/125°00'	**ELEV**	0 m
COLLECTOR:	G.W. Douglas, J.L. Penny & N. Alexander		
COLL NO:	13298	**COLL. DATE:**	98-06-30
PLOT NO.:	_____	**DET.:**	GWD /98
NOTES:	ca. 500 plants/1 ha.; flowers reddish-tinged		

Figure 1. Example of a BC Conservation Data Centre collection label (actual size).

B.C. Conservation Data Centre
FIELD SURVEY FORM (PLANTS)

Note: Complete only for species on CDC tracking list. Please fill out as many fields as you can, but precise locality and population data are especially important pieces of information.

EO: Create _____
Update _____
EO #: _____
DONE: _____
New Site (Y/N)___

Taxon _____
Name of surveyor_____
Address & phone # _____

Specimen Collection # & Herbarium (*Please make a collection; in most cases, a collection is necessary to verify identification*)_____ **Was a photo taken? _____**

Survey Date (*Month/Day/year*):_____ **1st visit, or repeat visit to this site**_____

Population Data (*Size, extent in m², vigor, # of plants flowering, fruiting, mature/juvenile)*_____
_____
_____

Location (*Please be as precise as possible, preferably to within 100 m; include directions to site & photocopies of 1:50,000 topographic maps (if possible, but any maps are welcome*)
_____
_____
_____

UTM grid reference (*from blue grid on 1:50,000 NTS map*): **MAP SHEET#** _____

(*Please note what the North American Datum (NAD) designation is, found below the contour interval scale on NTS map, 27 or 83; a GPS unit can be set to either NAD designation; CDC Mapping uses NAD 83 data*)

ZONE (e.g., 10U) ____ ___ **EASTING** ___ ___ ___ ___ **NORTHING** ___ ___ ___ ___ ___ **NAD** ____
Did you use a GPS unit to determine this UTM point? Y / N Precision of point (+/- metres) ____

Habitat *(Please include dominant plants and identify plant communities, a general description of area including land forms/use)* _____
_____
_____
_____
_____

Elevation _____ metres feet (*circle one*) **Slope** _____ **Aspect** _____
(Please do not use elev. from GPS unit)

Notes (*habitat threats, land ownership, development plans, disturbance adjacent to sites, presence of exotic species, etc*.)
_____
_____
_____

Please return forms to: CDC, Ministry of Environment, Lands, & Parks, Resources Inventory Branch, Wildlife Inventory Section, P.O. Box 9344 Station Provincial Government, Victoria BC V8W 9M1 (fax: 250-387-2733) **THANK YOU!**

Figure 2. BC Conservation Data Centre Field Observation Form.

3.2.5 Data to be Collected

Below is a list of the minimum data to be collected for label preparation[1] .

Specimen Name

- On the label, record the identity of the specimen that has been verified in a suitable reference work or in a herbarium (if the specimen belongs to a taxonomically difficult group). The taxonomic authority should also be written, i.e., *Ranunculus repens* Linnaeus. Taxonomy and nomenclature should follow *The Vascular Plants of BC or The Illustrated Flora of BC* (when the latter becomes available) for vascular plants, *The Lichens of BC* for foliose and squamulose lichens, and the most recent North American checklists produced by *The Bryologist* for the remaining lichens and all bryophytes.
- If a photo was taken of the plant, record this in the field notebook.

Detailed Location (Locality)

- This should include: reference to a landmark near the collection site, the elevation, a UTM[2] and the latitude/longitude. The UTM is used for later identification of the precise sampling site by the Conservation Data Centre (CDC) and is also required for mapping purposes for those using GIS (Geographical information Systems). If the UTM is provided, a less detailed description of the locality is necessary, however, the latitude/longitude is still required to aid those users outside of BC who may not have access to BC 1:50,000 maps. References to human-made landmarks should be avoided as these are often subject to change.
- Geographical site names provide information which supports the given UTM or latitude/longitude and provides other information which may lead a subsequent researcher back to the collection site.
- Altitude or elevation above sea level must be recorded in meters (specify, if recorded in feet). This may be done from a topographical map or obtained from a properly calibrated altimeter.

Habitat

- e.g., landform, moisture regime, aspect, slope, vegetative composition. The latter is especially important. Knowledge of the dominant/co-dominant species often reveals a wealth of information concerning the ecology of the site. This data is invaluable for future retrieval of ecological and conservation data.

Collector's name

- Record first name, initials and surname.

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[2]If using 1:50,000 maps for the establishment of Universal Transverse Mercator Grid (UTM) coordinates, the instructions for their establishment appear in the margins of all 1:50,000 maps. Most of the latter map editions use North American Datum (NAD) 27 or 1927. Global Positioning Satellite (GPS) units have the option of using a multiple of different NAD settings, including NAD 83, the BC Government standard. All new surveys and maps will use this. The CDC also uses NAD 83 to map element occurrences. The CDC converts NAD 27 data to NAD 83 data when necessary.

Collector's number

- This is extremely important since it will identify the collection in future databases, scientific papers and conservation reports.
- A unique field collection label should be assigned to each specimen.
  - A lifetime system is recommended rather than labels for each project or year. A label may look like "*Penny 73*" where the collector and number are unambiguous.
  - The use of consecutive numbers is best.
  - In the case of extra, inconspicuous bryophytes and lichens, which may only appear during identification under the microscope in the herbarium, these should be given additional lower case letters. These are added to the number (i.e., 264a, 264b, etc.). These become unique collections but the labels will be nearly identical.
- For each collected specimen this assigned number after the collector's name, must be written:
  1. in the permanent field notebook. Note that in the case of voucher collections made during RIC approved field sampling surveys that use field forms, it is the plot-specimen number that must be written on the form. This initial plot-specimen number will later be linked to a corresponding collection number that must be used on the plant label (see section 3.2.2);
  2. on the sheet of folded newsprint used to enclose the plant specimen;
  3. and on the completed plant label.

Collection date

- Format is YYYY/MM/DD.

Plot number

- This refers to the plot number that is pre-assigned to a vegetation plot when field sampling surveys are being conducted using Ecosystem Field Forms (FS882) or Vegetation Resource Inventory Forms. This number is often pre-typed on the form.
- The plot number need only be recorded on the plant label if the collector desires to link a particular plant specimen back to the sample plot from which is was collected.

Determiner

- Name of the person who identifies the specimen in the laboratory is recorded on the plant label. The date (at minimum the year) the identification was made is also required.

Notes

Record comments that may be of importance here. For example:

- Flower colour, as it often fades upon drying.
- Unusual phenomena, e.g., "many rye plants in the population sampled had their spikelets infected with smut".
- For marine algae it is useful to document tide level (upper, middle, or low intertidal or subtidal), exposure to sea, currents and type of substrate data.

3.3 Preparation and Care of Specimens

Preparation techniques are listed under the following categories: vascular plants; aquatic plants; and non-vascular plants (sections 3.3.1, 3.3.2, and 3.3.3, respectively).

3.3.1 Vascular Plants

The preparation protocol listed below must be taken as soon as possible after collection, preferably the same day.

Preparing the specimens

1. Remove plants from plastic collection bags.
2. Wash roots of specimens.

   Before placing succulent plants in the plant press they may have to be scalded or briefly boiled in water in order to kill them; the method used depends on the specimen thickness.

3. Complete specimen documentation in the field notebook, ensuring that a unique reference number is assigned to each specimen.

Pressing the specimens

Materials needed are:

- 2 pieces of plywood 46 x 31 cm (can be solid plywood or wood grid)
- raw newsprint, approximately 60 x 44 cm which are folded in half to be used as collection sheets
- 10 - 30 sheets of cardboard, cut the same size, with blotting paper attached (about the same size as a standard herbarium sheet (39.5 x 29.5 cm)). Corrugations must all run through the width of the cardboard sheet.
- 2 belts or ropes, used to tighten the press

The set-up:

The collection sheets, with the plant samples inside, are inserted between the cardboard sheets. These cardboard sheets are necessary for protection of the plant specimens, as a spacer in building up the plant press and, especially, as a means for ventilating water vapour exiting the plants in the drying process and for conducting heat internally. The cardboard sheets are in turn held between the outer plywood pieces (like a multi-layered sandwich!). The belts, or ropes, are then used to tighten the entire "package", pressing the samples.

4. Fold the collection sheets (raw newsprint) in half. Place plants inside the folded sheets, on one half, with the field collection number written on both the inside and outside right hand lower corner.

5. Ensure to lay out each plant specimen in its final form on the folded newsprint sheet. The final form is the way it should be when it is fastened to an herbarium sheet, i.e., in a manner in which it may be most readily identified. This may involve inverting some of the leaves, portions of fronds, fruits, flowers, etc., so that if the plant becomes rigid or brittle when dried and is subsequently fixed to an herbarium sheet, the characters necessary for identification may still be viewed.

Plants must be pressed in such a way that one side (the bottom side i.e., the side to be set onto an herbarium sheet) becomes flattened and the other side retains a reasonable amount of three-dimensional characters. Thin sheets of foam may be used on bulky specimens (optional method, see below).

The flattened side is necessary so that the plant is readily set onto and fastened to the herbarium sheet. For the side of the specimen which will be primarily viewed for identification, the three dimensional structure of flowers, fruits, leaves, etc. help facilitate identification and gives an artifact that at least retains some of its natural structure.

Note that plants must also be prepared for pressing so that they fit onto a standard herbarium sheet with room for a herbarium label while leaving a border of about 2.5 cm.

6. Cover the specimen with the second half of the folded newsprint sheet.

7. Insert the collection sheets, with the plant samples inside, between two cardboard sheets.

   If foam is used for pressing (optional):

   - Cover the folded newsprint sheet containing the plant for protection against crushing by a sheet of open cell foam rubber (polyurethane foam) appropriate to the plant's thickness (1.25 - 2.5 cm). Throughout the pressing process this will allow the upper side of the plant to retain some of its three-dimensional characteristics. It will also, along with the other foam rubber sheets in the press, press outward against the press straps, thereby reducing the frequency with which the press straps need to be tightened during the drying process.
   - Place the collection sheets, with the plant samples inside, and foam rubber on top between two cardboard sheets.

8. Place these packages between the two outer plywood pieces (the plant press). Add more packages until a reasonable height. Fasten two straps around the press and tighten to press the plants. The straps will need to be tightened as the plants dry (Figure 2).

Drying the specimens

9. Plants must be protected from fungal growth until the drying process is over. Begin the drying process of plant specimens immediately after the plants are placed in the plant press and pressure applied.

   If the air temperatures are high and the relative humidity low, then all that is necessary to dry the plant specimens well is to place the plant press where it will receive some natural ventilation, and tighten the press straps each day (they loosen when the plants inside dry and shrink).

   If conditions are such that little or no natural drying occurs (e.g., cool temperatures, high relative humidity), then a heat source must be applied (see dryer construction below). In all cases ventilation of the plant press is important in order to remove water vapour arising from the plant specimens, and especially to vent water vapour from the corrugations of the cardboard. The newsprint can be changed as well, but care must be taken to ensure that the label information is transferred at the same time.

The body of the dryer consists of an open-ended plywood (Figure 3) or wooden box (with or without a bottom) measuring 46 cm long, 35-60 cm wide and at least 30 cm high. To allow for proper air circulation, the dryer should have a small air vent cut near the base (or should be raised slightly off the ground, if the bottom of the dryer is absent). A 100 watt bulb is placed in the bottom of the dryer (on an aluminium pie plate or fire resistant pad). The press is placed on edge, length-wise, across the dryer's open top, with cardboard placed alongside to block air spaces. This will cause the warm air within the dryer to be forced through the press. Depending on the turgidity of the plant samples, the collection sheets will dry in 24 - 48 hours.

Figure 3. Plant press with cardboard and collection sheets.

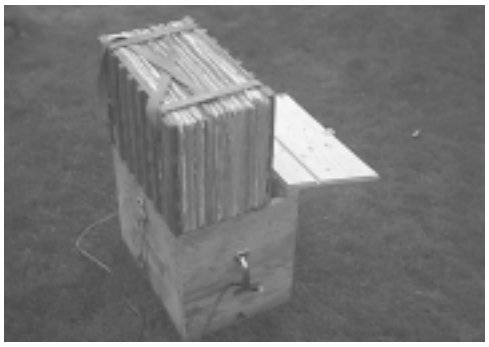

Figure 4. Plant drier with plant press set up.

Preserving the specimens

10. After drying, vascular plant specimens must be handled with care to avoid breakage or other damage, as they may become fragile or brittle when dried. Transport specimens to the appropriate herbarium (see section 3.4).

3.3.2 Aquatic Plants

Preparation of aquatic plants generally follows the techniques listed above, modified as detailed below.

- For plants that are stiff, erect and emergent and those that do not clump together when they are taken from the water, lay the plant on a piece of card stock with a high rag content (95%) so the paper does not scrunch up during the drying process. Field data can be written on this paper in the lower right hand corner where they will later be covered by the permanent herbarium label.

- For plants that clump together or are flaccid, write field data on a piece of the high rag content paper stock before the paper is wet. Put the paper into a container (a photographic tray works well, so does a bathtub). Float plants, then slowly lift the bottom of the card stock out of the water at the root end. Arrange and spread the plant as you continue. The plant will stay in place once it is out of the water. Let the excess water drain off. Lay a piece of heavy blotting paper over the specimens to help the plant dry quickly. Slip this package into a folded newspaper sheet. Put a piece of corrugated cardboard on either side of the newspaper and continue to build up a press load.

3.3.3 Non-vascular Plants

Bryophytes

- Collect specimens directly into paper bags on which field collection numbers, substratum and location can be written.
- Remove surplus soil from the specimen before it is dried. Some larger specimens can be washed but this may pose a problem with some hepatics where sporophytes could be seriously damaged.
- Aquatic bryophytes often have considerable extraneous matter attached to them. Carefully rinse them without injuring the specimen before drying.
- Some genera (e.g., *Sphagnum)* should have excess water extracted before bagging and air-drying. Do this by carefully squeezing (or pressing) it out between the hands. Take caution not to break the brittle stems of some bryophytes.
- When specimens are to be dried, tease them loose from each other, flatten out and expose in a newspaper packet to air dry. When bryophytes are being dried they should not be placed under great pressure. Some of the critical morphologic features are often destroyed and sporophytes ruptured when placed under pressure.
- Make bryophyte specimens so that they fit into a 10 x 15 cm packet, if possible without damaging the specimen. The packet can be enlarged to fit larger specimens.
- The packets can be stored upright in a shoe box. Pack the packets in the box so you can easily insert two fingers between the packets and the end of the box so the specimens will not be crushed.
- Field collection number and field data can be written directly on the packet.

Lichens

- Collect lichens directly into paper bags on which field collection numbers, substratum and location can be written.
- Some bulky lichens (e.g., *Peltigera*) will need moistening, then light pressing, as they are drying.
- Dry lichens thoroughly as soon as they are brought back to base camp. Specimens may be spread out to dry using any available gentle heat source. If there is no heat source available, spread out the specimens in a warm, well-ventilated place until they are completely dry.
- Once dry, place lichens in packets. The packets can be stored upright in a shoe box. Pack the packets in the box so you can easily insert two fingers between the packets and the end of the box so the specimens will not be crushed.
- Field collection number and field data can be written directly on the packet.

Marine Algae

- Dried specimens maintain their natural colour better than liquid preserved specimens.
- Small specimens may be partially dried in the sun but should be placed between sheets of newsprint for further drying.
- Large specimens may be partly dried in the sun and when they are about the consistency of leather they should be rolled up and placed in a box for further drying.
- Specimens can be rehydrated later and arranged on sheets of paper for permanent storage.
- Paper with a rag content of 95% is recommended to prevent wrinkling during the drying process.
- Some seaweed stick well to paper, many do not (this knowledge is acquired by experience). Those that do not can be dried between sheets of newsprint separated by blotters and when dry, mounted directly on herbarium paper with waterproof glue.
- Float small, delicate specimen in a tray large enough to hold the mounting paper. Arrange specimens with forceps at the same time as the paper is being raised out of the water. Write field notes on the mounting paper before it is submerged.
- Assemble a package similar to aquatic plants to be placed in the press: place the sheet of mounting paper on a sheet of blotting paper, then place a sheet of cheesecloth or J-cloth over the specimen and cover by another sheet of blotting paper. Place a number of these packages of specimens in the press and dry slowly. Keep the specimens under pressure but be careful not to crush them. Change the blotters at approximately 12 hour intervals until the plants are dried thoroughly.
- Once dried, store the specimens flat in folders and keep in the dark to preserve their colour.
- It is useful to document tide level (upper, middle, or low intertidal or subtidal), exposure to sea, currents and type of substrate data.

3.4 Museum Accessioning

- After competent identification, every plant voucher specimen must be deposited in either the Royal BC Museum or the University of British Columbia Vascular Plant Herbaria (and other herbaria if extra material is available).
- Plant vouchers will be accepted only if they are properly pressed and dried on collection sheets with the accompanying labels.
- If the plant voucher(s) becomes part of the herbarium's permanent collection, it will be mounted on a standard herbarium sheet. (There are exceptions to this standard such as in the case of collecting large conifer cones or other plant parts that simply cannot be adapted to fit on standard herbarium sheets or stored in standard herbarium cabinets.) Generally, the Royal BC Museum will mount the specimens onto acid-free herbarium sheets as required.

Royal BC Museum Contacts:
Joan Kerik, Botany and Fossil Collections Manager
Phone (250) 387-2924 Fax (250) 387-0534 Email jkerik@rbml01.rbcm.gov.bc.ca

John Pinder-Moss, Botany and Mineral Collections Manager
Phone (250) 387-2918 Fax (250) 387-0534 Email jpindermoss@rbml01.rbcm.gov.bc.ca

UBC Herbarium Contacts:
Dr. Fred Ganders, Herbarium Director
Phone (604) 822-5862 Email ganders@unixg.ubc.ca

Olivia Lee, Herbarium Curator
Phone (604) 822-3344 Email olivia@interchange.ubc.ca

3.5 Materials and Costs

If the plant voucher(s) becomes part of a herbarium's permanent collection, they will need to be mounted on standard herbarium sheets. If the collection is only needed for a short time and it is not necessary for the specimens to be mounted, only storage at the desired herbarium may be required. Cost will depend on the specific requirements of each collection, and the storage and/or preparation fees applied by individual herbariums. Below is information on preparation and storage costs for the Royal BC Museum.

3.5.1 Royal BC Museum

The costs for preparing (mounting the specimens onto herbarium sheets as required), maintaining and storage of plant voucher specimens at the Royal BC Museum have been estimated. This estimate does not include the costs of collection, identification or drying of the specimens that normally occurs before submission, extraordinary conservation measures, or security, etc.; it does include the capital costs of building construction and the amortized costs of such things as asbestos removal; also included are the costs of heat, light, property taxes, etc. As the total costs contain components for salaries, materials and the purchasing of storage cabinets they may be expected to rise with inflation; also they may be modified based on future cost experience.

Table 1. Initial plant preparation costs (per herbarium sheet).

Item	Amount
Materials	0.50
Labour	5.19
Subtotal	$5.69

Table 2. Maintenance costs for a 5 year period per herbarium sheet.

Item	Amount	Amount per 5 years
Materials	0.05	0.25
Labour	0.39	1.95
Cabinet space		1.00
Other: building, asbestos removal, heat, light, taxes, rent, etc.	0.51	2.55
Subtotal		5.75
Total		$11.44

Other Services and Costs

In future it is anticipated that the Royal BC Museum may provide a "random identification check" service for incoming voucher specimens whereby 10% of the specimens would be checked by the museum staff for accuracy of identification. This would be "on request" by the depositing agency. Fees for this have not yet been set, but, based on Lee *et al*., (1982), a cost of between $5.00 and $6.00 per specimen may be appropriate.

The Royal BC Museum may also provide plant dryer services for incoming collections from other agencies; the cost of this is not as yet established.

3.6 References

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4. Fungi

4.1 Voucher Requirements

Diversity Inventory

Collect and process one of each type of macrofungal fruitbodies within a study area.

4.2 Data Needs

The Collaborator Collection Slip should be completed and submitted with the specimen (Figure 4). If possible, a literature reference for the species description should be included in the space provided, if the identifier is not a taxonomic authority, or if the reference is obscure. Additional field notes (space at the bottom of the slip, and additional data, sketches, or photographs may be submitted along with the form) are essential for agarics and other fleshy fungi whose appearances change dramatically after drying. Temporary color changes to fleshy fungi after bruising or wounding should also be noted, as these often disappear after heat treatment. Spore prints of agarics should also be included. Habitat notes are also useful.

The following is the minimum voucher data that must be included:

- **Field Collection Number:** A unique field label should be assigned to each specimen. A lifetime system is recommended rather than labels for each project or year. A label may look like "Shepard 2094" where the collector and number are unambiguous.
- **Collection Date:** Format for dates is YYYY/MM/DD. Note that four digits are used for the year.
- **Detailed Location:** It is important that the place of collection can be precisely located in the future. Include country, province, city, and gazetted location name. Location must include latitude and longitude or Universal Transverse Mercator (UTM) coordinates (use NAD83 when using a GPS or a 1:50,000 map), as precisely as can be calculated, plus a brief written description, noting elevation, as well as direction and distance from a conspicuous landmark.
- **Recommended Additional Data:** Many aspects of the specimen and its environment may be useful to record. Check with curators for suggestions to enhance the value of specimens.
  - **Collector name:** It is important to note the collector’s name. This acknowledges this person and is useful when details need to be tracked should data be misplaced or additional information desired.
  - **Habitat:** Basic descriptions of the collection area should be made in as much detail as is practical. Aspects that may be useful include vegetation, associated flora and fauna, altitude, cover, depth of collection, substrate, pH, salinity, nutrient load, and light conditions.
  - **Collection method:** The method used to collect the specimen.
  - **Mode of Acquisition:** How the museum acquired each specimen (gift, etc.).

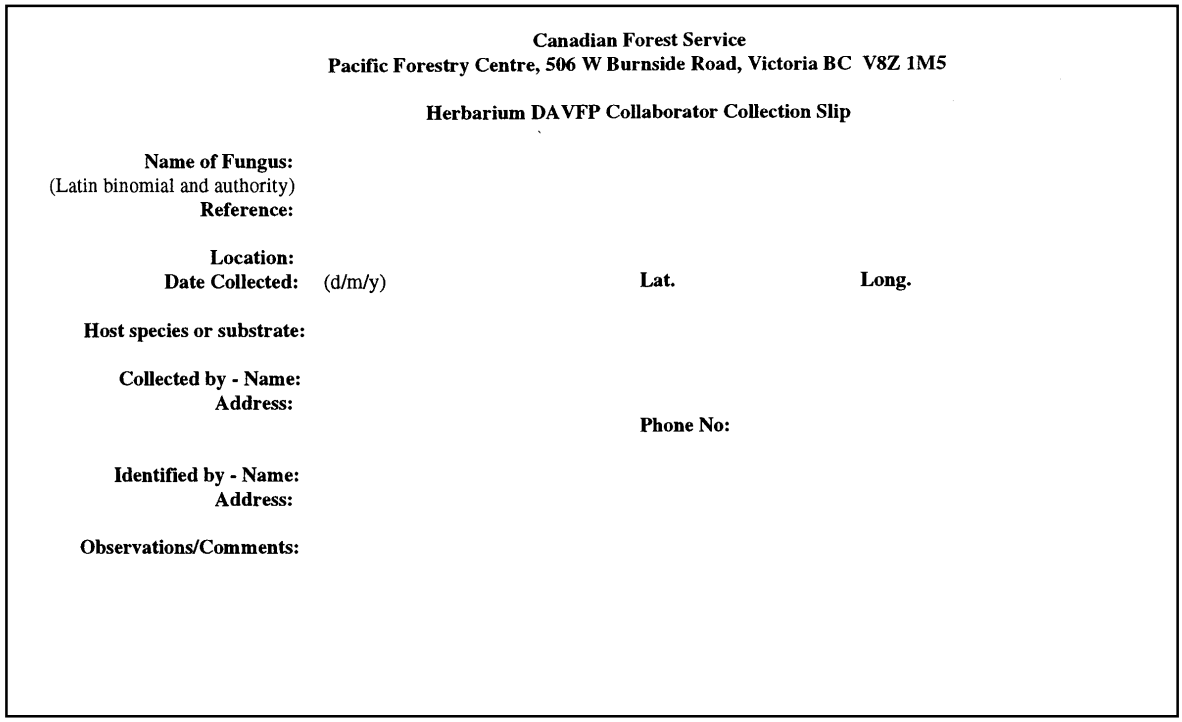

Figure 5. Collaborator collection slip.

4.3 Preparation and Care of Specimens

4.3.1 Photo Documentation

For photography consider the following: tripod, flash, shutter release, reflectors, umbrella (to protect the camera), water spray bottle (to freshen or clean specimens in situ), scales (mm and cm). See also section 2.3.1.

4.3.2 Whole Specimens

For more complete collecting and preserving procedures see Callan (1998) and the species manual by RIC (1997), *Inventory Methods for Macrofungi* (No. 41) sections entitled Field Equipment, Field Procedures, Processing Spores, Recording Data on Fresh Specimens, and Preserving Herbarium Specimens.

Preparation and submission specifics given below can be found on the Pacific Forestry Centre's website at http://www.pfc.cfs.nrcan.gc.ca/. Its Forest Pathology Herbarium abbreviation is DAVFP (Department of Agriculture, Victoria, Forest Pathology). DAVFP information is under the heading "Forest Biodiversity". You can contact the Forest Pathology Herbarium's curator Dr. Brenda E. Callan or the technician Ms. Analie Fernando by phone at (250) 363-0684.

General preparation protocol to meet criteria for specimen accession can be found in section 4.4. Below fungi collection protocols are provided according to type of specimen.

A) Foliar Disease:

- Cut one or more lengths of branch or stem, ca. 20 cm long, with diseased foliage attached. Include a second cutting with healthy foliage, for comparison.
- Include flowers or fruit if identity of plant is unknown.
- If collection is made in spring or early summer, pathogen fruiting bodies on current year growth may be immature. Search for overwintered foliage in ground litter or branch crotches, and include some, either pressed or wrapped in a paper bag, with the fresh sample.
- Do not moisten specimen. This encourages growth of contaminants.
- Do not seal specimen in plastic bags or wrap. This encourages growth of contaminants. It is better to let the material dry.
- Press the freshly-cut specimen between folded sheets of dry newspaper. If specimens are too dense and bushy to press, place in bottom of large paper bag, fold bag over, and tape shut.

B) Stem or branch canker (<10 cm diameter):

- Sample should include both living and dead host tissue, if possible, because the pathogen is most active in dying tissue (i.e. be sure to cut stem or branch a few centimeters below the visible edge of the canker).
- Saw or clip a ca. 20 cm long section from a cankered area of branch or stem.
- Pack sample in newspaper (not plastic), or roll it inside a large paper bag.

C) Stem or branch canker (>10 cm diameter):

- If tree is to be felled, or if it is possible to remove a large branch: cut a 10-20 cm long section of canker, preferably at the lower edge of the canker, where there is the greatest likelihood of living tissue.
- If tree cannot be felled, use a hammer and chisel, knife, or axe to cut out a ca. 10x10 cm square section of bark from the edge of the canker.
- If fruiting bodies are visible on other parts of the canker, remove a similar-sized portion from this area, too.

- Wrap sample in newspaper (not plastic).

D) Wood decay samples:

- Look for conks, mushrooms or other fruiting bodies which might be associated with the decay.
- Break off, or cut out conk, wrap in newspaper, and if it is not fragile, include in package with decay sample. If mushrooms are observed, collect and process as described below in Section G.
- Do not include large pieces of substrate in the same bag with fragile fruiting bodies. Large clumps of substrate either soil the fruiting bodies, or smashes the fungus to pieces in transit.
- Document the type of wood decay (brown cubical, white rot, laminated decay, white pocket rot).
- To collect a sample of wood decay, cut into wood near the conk or point of breakage, using an axe or chainsaw. Ideally, wood sample should contain symptoms of advanced decay, incipient decay, and sound wood. These conditions are found near the edge of the decay column. Wood sample should be at least 15 x 15 x 15 cm; large enough to split with an axe.
- Do not send in increment cores, or small chips. These are too small to culture or identify. Avoid areas with insect activity, and weathered, exposed wood. Samples made from these areas are contaminated with bacteria and molds.
- Wrap sample in newspaper (not plastic).

E) Standing dead or dying tree with suspected root disease:

- Sample from a dying or recently dead tree in the stand. These trees are often found in the middle of a root disease center, with old dead trees in the centre, and symptomless trees at the edge.
- Samples should be made from ground-level areas of the butt of the tree where there are visible signs (mushrooms, conks) or visible symptoms (heavy pitch exudation, cracked bark at butt of tree). Use an axe, polaski, or chain saw, and proper safety techniques, either falling the tree or removing from a standing tree a chunk of the outer part of the butt, 20 x 20 x 10 cm, important: leave bark intact on sample.
- If no root disease symptoms or signs are apparent on the butt of the tree, and examination of above-ground cambium reveals no evidence of root diseases (stains, decay, or mycelial fans), excavate the roots at the base of the tree, looking for pitching, stains, decay, or mycelial fans, and obtain a sample as described above. If the root is <10 cm diameter, cut out a 20 cm long, whole section of root, bark intact.
- Wrap sample in newspaper (not plastic).
- NOTE: Long-dead, standing trees are generally colonized with saprophytic decay fungi. These fungi often produce mycelial fans or decay columns which extend several meters up the trunk of a dead tree, and are sometimes confused with pathogenic fungi. Care should be taken to excavate down the butt and along roots of the tree, until signs of pathogen activity, such as pitching, or stunted, callused roots, are encountered. Samples should be taken from these areas.

F) Blowdown with decay - how and where to sample:

- Try to determine host species, at least to hardwood vs. conifer. If the tree is too old to identify, make note of other tree species in the vicinity.
- Note: fungi fruiting on dead, long-down trees are often not the same ones responsible for tree failure.
- If stem has failed, cut into wood near conk or point of breakage. Sample wood as described in Section D.
- If roots have failed, check for root decay and sample from decayed roots, either those remaining in the ground or larger roots in the exposed root plate (See Section E).
- Wrap sample in newspaper (not plastic).

G) Fungi fruiting on soil or duff:

- Dig the fruiting body out of the substrate with a knife. Make sure that the entire fruiting body is collected, as some fungi have large, below-ground structures.
- If the mushroom is on wood, also follow instructions for collecting a wood decay sample (See Section D).
- If possible, collect several fruiting bodies, especially if a number of them are at different levels of maturity.
- Temporary in-field packaging. These fungi are fragile and must be individually wrapped or packaged for transportation. Pack the fungus in a paper bag (never plastic) or, wrap in wax paper. Roll the wax paper in a cylinder around the mushroom, then twist each end like you would a candy wrapper. Because waxed paper tends to collapse in pouring rain and smaller specimens either become crushed by larger or heavier specimens, or water logged, aluminum foil is now preferred in temperate climates. Aluminum foil forms a ridged protectant, retains moisture, protects specimens from heavy rain, and does not stick to viscid pilei.
- Carry mushrooms in a rigid container so that they do not get squashed. For small fleshy fungi (mushrooms, cup fungi, coral fungi) small plastic tackle boxes with many compartments, or pill vials or film canisters may be used. For bulk collecting a reinforced backpack or carrying basket is recommended.
- Process the specimens the same day they are collected, using the following guideline:
    - Obtain a Spore Print. Mushroom identifications depend on spore colour. A spore print is very helpful, but may only be obtained while the specimen is very fresh. To make a spore print, cut the stalk off a mature mushroom and place the cap gill-side down on a piece of paper. If you suspect the spores might be white (check the stalk or the ground underneath), use colored paper. Cover the cap with a drinking glass or bowl if it is a very dry day. Consider making the spore print outside if the mushroom was collected on a cold day; as it might stop sporulating when warmed up to room temperature inside. Spore prints appear in several hours or overnight. Protect the spore print between cardboard before shipping.
    - Air-Dry, or Heat-Dry the Sample. Most unpreserved fungi turn to mush during the few days it takes to send a sample by mail to an expert. Specimens should be dried before shipping. Small, fragile specimens under dry conditions may be air-dried in opened paper bags or wax paper in a warm, dry room for a day or two. Large fungi should be quickly dried using a portable dehydrator (such as those sold for drying food), otherwise they will decay and/or become infested with maggots As a last resort, with careful and constant monitoring, a conventional oven may be used, if

turned to the lowest setting with specimens on the highest possible rack with the door open. Alternatively, use the warming drawer below the oven, left partially open while the oven is in use. Ideally, drying temperatures should be around 50 C.

- Pack dried specimens in rigid containers, or in zip-locked plastic bags packed in a box filled with foam chips. Dried specimens are very fragile.

4.4 Museum Accessioning

Collaborators should first contact the Pacific Forestry Centre's Forest Pathology Herbarium DAVFP (Department of Agriculture, Victoria, Forest Pathology) curator prior to sending specimens. After proper preparation and competent identification, fungi voucher specimens should be sent to the DAVFP. The contact for the DAVFP is Dr. Brenda Callan, a research scientist - mycologist.

Pacific Forestry Centre Contacts: Curator: Dr. Brenda E. Callan
Technician: Ms. Analie Fernando
Phone: (250) 363-0684

General protocol to meet criteria for specimen accession

Proper preparation, preservation, and inclusion of essential field data is necessary before the specimen will be accepted by DAVFP. Specimens must fulfill the minimum requirements given below.

1) Pressing(if foliar sample) and sizing specimens for standard box or packet sizes

Unlike vascular plant herbaria, specimens and specimen packets in DAVFP are not mounted on sheets, but are placed in boxes or folded paper packets which are specially sized to fit in the cabinet drawers. Therefore, specimens should be prepared in such a way that they fit into the dimensions specified below for boxes and paper packets. Very large, valuable specimens occasionally take up all or most of an entire drawer (8x volume of the largest box), but collections this size are rarely accepted, and must be of extraordinary merit to be retained.

Fleshy or woody specimens, such as agarics, polypores and fungi fruiting on wood are stored in boxes which are sized to fit in the cabinet drawers (see 4.5 Materials and Costs for box measurements).

Foliar samples should first be pressed between newspaper or blotting paper (plant presses are used for parasites on leaves and other vegetation), and then cut so that they may easily fit into paper packets, which are sized 18.5 x 11.5 cm. For large specimens cut to fit standard box sizes.

2) Heat-killing specimens

Small specimens should be placed in a dryer for several days at temperatures at or above 50^0C, in open bags or in plant presses. If the specimen is very large and woody, it should remain in the dryer for several weeks. DAVFP has dryers which are available for treatment of specimens prior to accession.

3) Inclusion of proper collection data

Complete a Collaborator Collection Slip and submit it with the specimen (see section 2.4 Data Needs).

Note: The herbarium accepts identification requests on a limited basis. If collections are from the Victoria area, please contact the herbarium directly prior to sending samples. Outside the Victoria area, contact: 1) Regional Pathologist, BC Ministry of Forests, for disease collection slips, and a referral, or 2) Herbarium, Pacific Forestry Centre.

The herbarium does not have unlimited resources to house collections. Thus, it is essential that the herbarium be contacted at the onset of a project to discuss requirements and any associated costs there might be to the project.

4.5 Materials and Costs

At present there are no set costs for storage of specimens at the DAVFP. It is necessary to check what costs if any, there will be to the project for identification or housing of the specimens. This should be done before field work is started.

Specimens and specimen packets are placed in boxes or folded paper packets which are specially sized to fit in the cabinet drawers. Measurements are in centimeters; width x length x height.

Table 3. Materials used for storing fungi specimens.

Item	Size (cm)	Details
Small Box	7 x 9 x 6	32 fill one drawer
Mid-sized Box	7 x 18 x 6	16 fill one drawer
Large Box	15 x 18.5 x 6	8 fill one drawer
Paper Packets	11.5 x 18.5	

4.6 References

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Glossary

BIODIVERSITY: Jargon for biological diversity: “the variety of life forms, the ecological roles they perform, and the genetic diversity they contain” (Wilcox, B.A. 1984 cited in Murphy, D.D. 1988. Challenges to biological diversity in urban areas. Pages 71-76 in Wilson, E.O. and F.M. Peter, Eds. 1988. Biodiversity. National Academy Press, Washington, DC. 519 pp.).

BLUE LIST: Taxa listed as BLUE are sensitive or vulnerable; indigenous (native) species that are not immediately threatened but are particularly at risk for reasons including low or declining numbers, a restricted distribution, or occurrence at the fringe of their global range. Population viability is a concern as shown by significant current or predicted downward trends in abundance or habitat suitability.

CBCB (Components of B.C.’s Biodiversity) Manuals: Wildlife species inventory manuals that have been/are under development for approximately 36 different taxonomic groups in British Columbia; in addition, six supporting manuals.

CDC (CONSERVATION DATA CENTER): The B.C.’s Conservation Data Centre is a program of the Resources Inventory Branch of the Ministry of Environment, Lands and Parks. The CDC systematically collects information on the rare and endangered plants, animals and plant associations in the province. This information is compiled and maintained in a computerized database which provides a centralized, objective source of information on the status, locations and level of protection of these rare organisms and ecosystems. Their goal is to assist in preserving the biodiversity of the province by providing accurate information on rare species and plant associations. See http://www.elp.gov.bc.ca/rib/wis/cdc/

CHIN: Canadian Heritage Information Network.

CWS: Canadian Wildlife Service.

DAVFP: Department of Agriculture, Victoria, Forest Pathology. The name of the Forest Pathology Herbarium at the Pacific Forestry Centre.

DFO: Department of Fisheries and Ocean.

EWG (Elements Working Group): A group of individuals that are part of the Terrestrial Ecosystems Task Force (one of 7 under the auspices of RIC) which is specifically concerned with inventory of the province’s wildlife species. The EWG is mandated to provide standard inventory methods to deliver reliable, comparable data on the living “elements” of BC’s ecosystems. To meet this objective, the EWG is developing the CBCB series, a suite of manuals containing standard methods for wildlife inventory that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species populations.

FCSN: Forest Continuing Studies Network.

INVENTORY: The process of gathering field data on wildlife distribution, numbers and/or composition. This includes traditional wildlife range determination and habitat association

inventories. It also encompasses *population monitoring* which is the process of detecting a demographic (e.g., growth rate, recruitment and mortality rates) or distribution changes in a population from repeated inventories and relating these changes to either natural processes (e.g., winter severity, predation) or human-related activities (e.g., animal harvesting, mining, forestry, hydro-development, urban development, etc.). Population monitoring may include the development and use of population models that integrate existing demographic information (including harvest) on a species. Within the species manuals, *inventory* also includes, *species statusing* which is the process of compiling general (overview) information on the historical and current abundance and distribution of a species, its habitat requirements, rate of population change, and limiting factors. Species statusing enables prioritization of animal inventories and population monitoring. All of these activities are included under the term *inventory*.

MELP: Ministry of Environment, Lands and Parks.

OBSERVATION: The detection of a species or sign of a species during an inventory survey. Observations are collected on visits to a design component on a specific date at a specific time. Each observation must be georeferenced, either in itself or simply by association with a specific, georeferenced design component. Each observation will also include numerous types of information, such as species, sex, age class, activity, and morphometric information.

POPULATION: A group of organisms of the same species occupying a particular space at a particular time.

PRESENCE/NOT DETECTED (POSSIBLE): A survey intensity that verifies that a species is present in an area or states that it was not detected (thus not likely to be in the area, but still a possibility).

PROJECT: A species inventory project is the inventory of one or more species over one or more years. It has a georeferenced boundary location, to which other data, such as a project team, funding source, and start/end date are linked. Each project may also be composed of a number of surveys.

RBCM: Abbreviation for the Royal British Columbia Museum.

RED LIST: Taxa listed as RED are candidates for designation as Endangered or Threatened. Endangered species are any indigenous (native) species threatened with imminent extinction or extirpation throughout all or a significant portion of their range in British Columbia. Threatened species are any indigenous taxa that are likely to become endangered in British Columbia, if factors affecting their vulnerability are not reversed.

RELATIVE ABUNDANCE: The number of organisms at one location or time relative to the number of organisms at another location or time. Generally reported as an index of abundance.

RIC (Resources Inventory Committee): RIC was established in 1991, with the primary task of establishing data collection standards for effective land management. This process involves evaluating data collection methods at different levels of detail and making recommendations for standardized protocols based on cost-effectiveness, co-operative data

collection, broad application of results and long term relevance. RIC is comprised of seven task forces: Terrestrial, Aquatic, Coastal/Marine, Land Use, Atmospheric, Earth Sciences, and Cultural. Each task force consists of representatives from various ministries and agencies of the Federal and BC governments and First Nations. The objective of RIC is to develop a common set of standards and procedures for the provincial resources inventories. [See http://www.for.gov.bc.ca/ric/]

SPECIMEN: In this manual the term specimen includes diverse materials such as photographs and tape recordings, but usually refers to more traditional preparations like skins, skulls, pressed plants or dead animals in preserving fluids.

SPI: Abbreviation for 'Species Inventory'; generally used in reference to the Species Inventory Datasystem and its components.

STUDY AREA: A discrete area within a project boundary in which sampling actually takes place. Study areas should be delineated to logically group samples together, generally based on habitat or population stratification and/or logistical concerns.

SURVEY: The application of one RIC method to one taxonomic group for one season.

TERRESTRIAL ECOSYSTEMS TASK FORCE: One of the 7 tasks forces under the auspices of the Resources Inventory Committee (RIC). Their goal is to develop a set of standards for inventory for the entire range of terrestrial species and ecosystems in British Columbia.

VOUCHER (SPECIMEN): Representative specimen that are collected in biological field surveys and research, and are preserved to permit independent verification of results and to allow further study. Specimen in this manual includes diverse materials such as photographs and tape recordings, but usually refers to more traditional preparations like skins, skulls, pressed plants or dead animals in preserving fluids.

YELLOW-LIST: Includes any native species which is not red- or blue-listed.

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