Standard and Procedures for Integration of Terrestrial Ecosystem Mapping (TEM) and Vegetation Resources Inventory (VRI) in British Columbia

Prepared by the
Ministry of Sustainable Resource Management
Terrestrial Information Branch
for the Resources Inventory Committee

February 12, 2002

Version 1.0

Published by the
Resources Inventory Committee

National Library of Canada Cataloguing in Publication Data

Main entry under title:

Standard and procedures for integration of Terrestrial Ecosystem Mapping (TEM) and Vegetation Resources Inventory (VRI) in British Columbia. -- Version 1.0

Also available on the Internet.

Includes bibliographical references: p.

ISBN 0-7726-4737-2

1. Environmental mapping - Standards - British Columbia. 2. Ecological mapping - Standards - British Columbia.
3. Ecological surveys – Standards - British Columbia.
4. Vegetation mapping - Standards - British Columbia.
5. Vegetation surveys – Standards – British Columbia.
I. Resources Inventory Committee (Canada) II. British Columbia. Terrestrial Information Branch.

QH541.15.S95S73 2002 577.'022'3 C2002-960061-8

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Acknowledgments

The Resources Inventory Committee consists of representatives from various ministries and agencies of the Canadian and the British Columbia governments. 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

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Preface

British Columbia's unique situation presents both challenges and opportunities for the definition, collection and integration of natural resource information. Factors such as biophysical and climatic diversity, high forest productivity, relatively recent disturbance history and the simple ownership and governance have all contributed to the development and advanced state of a number of resource inventories.

Cooperative efforts in data definition and point data collection (for example, *Describing Ecosystems in the Field* and *Procedures for Environmental Monitoring in Range and Wildlife Habitats*) have facilitated data sharing across agencies for decades. More recently, through the efforts of the Resources Inventory Committee (RIC), clarification of roles and responsibilities has reduced redundancies and further focused efforts. Interdisciplinary inventory design teams have contributed to a broad, common level of understanding, and increased knowledge of natural system dynamics, particularly in the areas of terrain, soils, ecosystems, wildlife and vegetation.

Recent government restructuring has brought together most elements of inventory, data management and land use planning into the Ministry of Sustainable Resource Management (MSRM). This sets the stage for another major leap forward in inventory integration. Melding Terrestrial Ecosystem Mapping (TEM) and the photo interpretation phase of the Vegetation Resources Inventory (VRI) is a logical first step. There are similarities in both the scale and resolution; similarities in the process; many specialists have knowledge and experience in both; and while they are somewhat complementary, there are redundancies between these two inventories.

There is potential for integration of the two inventories at four levels:

1. in the design of mapping, field methods and standards for collecting the information;
2. during project implementation where both types of inventory information could be gathered at the same time and place;
3. where one type of inventory already exists, build on it to more cost-effectively achieve the objectives of the other inventory type; and
4. in reducing the complexity of supporting information systems by combining the components into a single system.

The benefits of successfully integrating TEM and VRI include better information for planning, monitoring and resource allocation, as well as improved efficiency, and data currency. Continuous improvement in our understanding of the function of complex natural systems and of the impact of resource management on a wide spectrum of resource values will contribute to sustainable resource management.

1. Introduction

Defensible resource management decisions in diverse and productive landscapes require detailed information of known reliability. The establishment of standardized inventory methods has been generally accepted in British Columbia as a means of ensuring that all stakeholders in resource use decisions can understand and have confidence in the information that is used in making these decisions.

The opportunity now exists to more efficiently address the increasing need for vegetation and ecosystem mapping information. This is the result of advances in information technology, and an increasing focus on ecosystem information needed to support land and resource use planning decisions (such as Land and Resource Management Planning (LRMP) and Timber Supply Review (TSR)). This inventory information is also a key input to forest certification processes where sustainable resource management must be demonstrated to ensure access to world markets for British Columbia's resource sectors.

The interpretation of timber, wildlife and biodiversity values for Sustainable Forest Management (SFM) and Forest Development Planning (FDP) may be based on a combination of TEM and VRI. Where both of these inventories are to be undertaken coincidentally, a single delineation process can be the basis for identification of polygon attributes.

This document provides the standards for mapping and data capture for project areas where both TEM and VRI data are to be collected using a common polygon based on both the TEM and VRI delineation standards. This collection standard does not preclude the collection of only TEM or VRI inventory data. It also does not preclude the collection of additional data over and above that collected for TEM or VRI to satisfy local data analysis needs.

In the short term, integration of the supporting information systems will not be considered within this standard.

2. Polygon Delineation

Polygon delineation for an integrated TEM/VRI is based on a combination of the methods described in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* and the *Vegetation Resources Inventory Photo Interpretation Procedures*. The integrated method is further defined below.

Definition

Delineation is the process used to divide the landscape into uniform polygons according to defined criteria. Polygon delineation is based on both TEM and VRI features that are observable on mid-scale aerial photography (see Table 2.1).

Purpose

The objective is to delineate distinctly recognizable and relatively uniform vegetation and ecological (site series and terrain) features, which provide logical units for the estimation of attributes. In many cases, the polygon will be a complex of more than one vegetated and/or non-vegetated ecosystem. The intent of the TEM/VRI procedure is that one set of polygons will be used as the basis for both VRI and TEM attributes (including bioterrain attributes).

Delineation Procedure

The photo interpreter normally proceeds from the general to the specific during the delineation process. The order in which delineation is accomplished will vary from individual to individual so the following steps are provided as an example that may be modified as required.

The photo interpreter will use vegetation characteristics (including the B.C. Land Cover Classification Scheme) and ecological features to guide the process of delineating polygons. The primary types of attributes that are interpreted for each polygon that drive the delineation process are:

- ecological attributes, including ecosection, biogeoclimatic units, site series, hard terrain boundaries (floodplains, fans, wetlands, ridgetops, distinct surficial material), topography (major breaks in aspect, slope, slope position), and moisture regime or soil drainage;
- B.C. Land Cover Classification Scheme criteria;
- vegetation attributes;
- mensurational attributes.

Table 2.1 summarizes various delineation features, their characteristics that are observable on air photos, and the applicable attribute.

Table 2.1 - Criteria for delineating TEM/VRI map units on aerial photographs

Criteria	Observable Feature/Photo Characteristic[1]	Applicable Mapped Attribute
Topography		
Landscape position and shape	Shape, three dimensional characteristics	Site series, site modifier, soil drainage, elevation
Aspect	Shape, three dimensional characteristics, direction	Site series, site modifier
Slope	Shape, three dimensional characteristics	Site series, site modifier, soil drainage
Drainage pattern	Shape, pattern, three dimensional characteristics	Site series, site modifier, soil drainage
Terrain		
Type (and texture) of surficial material	Mode of deposition, material source, position, patterns, shape, landscape evolution	Inferred terrain texture, genetic material, qualifiers, subtype, site series, site modifier, soil drainage
Surface expression	Shape, position, landscape evolution	Surface expression, site series, site modifier, soil drainage
Geomorphological process	Patterns, shape, tone, colour, source areas, runout zones, vegetation	Geomorphological process, qualifiers, subtype, site series, site modifier
Soils		
Soil drainage	Tone, drainage patterns, topography	Soil drainage, site series, site modifier
Soil depth	Colour, tone, texture, topography	Soil drainage, site series, site modifier
Vegetation		
Tree species composition	Tone, texture, colour, size, shape, shadow	Site series, structural stage (seral community type), species composition
Understory or non-forested vegetation composition or characteristics	Tone, texture, colour	Site series, structural stage (seral community type), shrub, herb and bryoid cover, some biogeoclimatic units
Canopy characteristics (including crown closure)	Tone, texture, colour, shape, shadow, size, pattern (open, closed, layered, clumpy)	Site series, structural stage (seral community type), age, basal area
Height of stand (relative productivity)	Texture, size, pattern, tone, density	Site series, structural stage (seral community type), height, estimated site index
Gradients/Patterns		
Relationship to other map units	Pattern, juxtaposition, size, edges	Various
Adjacent map units	Pattern, juxtaposition, shape, edges	Various
Polygon shape and orientation	Pattern, juxtaposition, shape, edges, direction	Various

[1] Refer to *Vegetation Resources Inventory Photo Interpretation Procedures Manual* (RIC) for more information on interpreting physical and biological attributes from aerial photographs.

The expertise of three disciplines is required to ensure the accurate delineation and assignment of attributes to a polygon. A vegetation interpreter, a surficial geologist and an ecologist must work together throughout the delineation process. The most efficient and consistent method of delineation may be to select one of the experts to perform the majority of the delineations. Mapping projects should start with the experts typing a few stereo pairs of air photographs together to ensure that the polygons delineated will meet the requirements of each discipline. Preliminary photos, complete with attributes, can be provided to quality control individuals for review and to ensure that the final mapping will be acceptable. The selected individual can then complete the delineation and the other experts can suggest modifications when completing their attributes.

Polygon delineation will follow the procedures outlined in the *TEM Standards* and the *VRI Photo Interpretation Standards*. It is important to note the following three items:

1. Digitally capture water features (lakes, double line rivers) from the TRIM topographic base. As in TEM, vegetated ecosystems that are found within a TRIM water feature can be delineated and attributed if they are of sufficient size.
2. Areas within silvicultural opening boundaries will be delineated and attributed as per TEM standards. Standard procedure is to use the external boundary from existing inventory/silviculture files and not re-delineate the boundary. Polygons delineated for TEM within openings need not be interpreted for VRI. A polygon number and the opening number may be entered as attributes for the VRI portion of the database. Silviculture specific information need not be entered in the VRI database unless specifically requested.
3. Delineate the Alpine Tundra biogeoclimatic zone and the subalpine parkland subzone before completing the TEM/VRI delineation.

After fieldwork, ecosection and biogeoclimatic zonation for other biogeoclimatic units will be added. This Biogeoclimatic unit mapping can be completed manually or through large-scale modelling of biogeoclimatic units using the methods outlined in *A Method for Large-scale Biogeoclimatic Mapping in British Columbia* (Eng and Meidinger, 1999).

3. Identification of Polygon Attributes

Polygon attributes for the integrated TEM/VRI polygons will include all of the attributes that are required for TEM and VRI, except as noted below.

Definition

Identification is the process of interpreting and recording the attributes of the delineated map unit or polygon.

Purpose

To characterize or estimate the type, quantity or proportion, and spatial distribution of vegetation and ecological parameters that provides the basis for resource interpretations.

3.1 Terrestrial Ecosystem Mapping Polygon Attributes

All core TEM polygon attributes are required for integrated TEM/VRI. Site modifier and structural stage attributes can be modelled; however, the final attributes must be provided in the data captured by polygon for each component.

3.2 Vegetation Resources Inventory Polygon Attributes

The following VRI polygon attributes are not to be provided in integrated TEM/VRI:

1. All Ecology attributes including surface expression, modifying process, site position meso, alpine designation, soil nutrient regime, data source; and
2. All Land Classification component information including Land Cover Component #1, 2 and 3, Land Cover #1, 2, and 3 Percent Coverage, LCC #1, 2 and 3 Soil Moisture Regime, and Other Land Cover Components and Percent Coverage.

Information required to automatically populate Level 3 of the B.C. Land Cover Classification Code (wetland, upland or alpine designator) is not available when using the integrated TEM/VRI procedures. The contractor/proponent will be required to manually enter Levels 3, 4 and 5 of the Code before submitting the final data to the Province for acceptance and approval.

3.3 Requirements for Mapper Expertise

The expertise of three disciplines is required for integrated TEM/VRI mapping in order to delineate and attribute TEM/VRI polygons: a certified TEM mapper, a terrain specialist experienced in surficial geology mapping, and a certified VRI photo interpreter. One individual may have more than one expertise.

4. Spatial Data Capture

Introduction

Currently, digital deliverables for TEM/VRI projects are not integrated. While there can be efficiencies found at the digital capture stage, the contractor will be required to submit deliverables that meet each inventory's existing standards independently. The following is a summary of deliverables that will be required by each of TEM and VRI.

4.1 Terrestrial Ecosystem Mapping Digital Deliverables

Below is a list of the final spatial TEM digital products required for each project in order for it to be placed in the Provincial TEM data warehouse. These files should be burned to a single CD or zipped into a single file to be uploaded onto:

ftp://ftp.env.gov.bc.ca/pub/incoming/

Deliverables should meet the following standards, unless otherwise specified in the integrated TEM/VRI standards:

Standards For Terrestrial Ecosystem Mapping – Digital Data Capture In British Columbia, Version 3.0. April, 2000. RIC, Ecosystems Working Group.

1. Two ARC/INFO single digit precision export files – one containing the TEM polygon information and one containing the sample points (plot locations). See pages 37 to 47 of the above standards document.

   (e.g.: <TEM_coverage_name >.e00) – tECP_Project.e00)

   (e.g.: <TEM_coverage_name >.e00) – tECI_Project.e00)

   Export files must be created with the 'NONE' compression option (produces readable ASCII).

   The completed project spatial data file must include the entire project boundary, terrain and TEM features along with the required spatial attributes (see below for attribute database requirements).

2. A set of final TEM map plot files generated from Arc/Info with polygon labels in Hewlett Packard Raster Transfer Language for each mapsheet within the project area. See pages 48 to 53 of the above standards document.

   (e.g.: <mapsheet>.rtl)

4.2 Vegetation Resources Inventory Digital Deliverables

Any data captured or updated outside the INCOSADA system is referred to as RedLine Data. External agencies such as Contractors, Major Forest Licensees or other Government agencies that wish to exchange data with the Province do not have access to the full INCOSADA system for management of provincial corporate data and therefore must use INCOSADA RedLine Data to exchange information.

This process would be used when an entire map tile and VEG.MDB has been updated by a contractor. In this case, the new IGDS tile/MDB file pair will replace (update) the previous version of the data. Currently, the MSRM staff generates the spatial/attribute linkage (FIDs and Feature Link Table) and performs the QC/QA process. The IGDS tile must meet the INCOSADA Red Line standards as defined in the document entitled *INCOSADA Spatial Data Standards, Standard Positional Spatial Data Types and their Representation in IGDS Format*, Version 1.1, available at http://www.for.gov.bc.ca/isb/incosada/technical_info/positional_spatial_data_standards/Posstd.htm.

The MDB file must meet the VEG data model standards and be accompanied with a VEGCHK report file with no errors. The process is as follows:

1. Replace the existing tile/file with the new RedLine files (named appropriately in the update directory).
2. Execute FIDGEN to generate FID linkages and Feature Link Table.
3. Execute Vegetation QC (spatial) Script.
4. Execute Validate and VDYP processes from VEGCAP.
5. Execute Vegetation QA process to seal the tile/file.
6. Check sealed pair into IODM.

5. Digital Data Capture of Polygon Attributes

Tools for data capture and validation of the integrated TEM/VRI have not yet been developed. The existing TEM and VRI based data capture and validation tools will be modified and used. Use of these modified tools is not mandatory, but data must be provided to the MSRM standard. This will allow the data to be loaded into the TEM or VRI validations and then stored within the corporate data warehouse.

5.1 Terrestrial Ecosystem Mapping Attributes

The following are required:

1. Attribute database (containing both ecosystem and terrain attributes).

   The only file format acceptable by the Ministry for non-spatial data is a comma separated value (CSV) file. These files must be produced from a successful run through the Data Capture Application.

   (e.g.: <scale designator>_<project name>.csv) - t_lignum.csv)

   (e.g.: <scale designator><polygon>_<project name>.csv) - tecp_lignum.csv)

   (e.g.: <scale designator><user defined>_<project name>.csv) - tusr_lignum.csv)

2. Map legend.

   To be recorded as associated Word, RTF, or text file with a maximum of 8 characters in the name and it must have a 3 character extension. See Section 5.0 of the Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC, 1998) for further explanation and examples of what should be included in a TEM Map Legend.

   (e.g.: <project name_ML>.doc) – lignumML.doc)

   (e.g.: <project name_ML>.txt) – lignumML.txt)

3. VENUS database.

   This includes field data from both Full plots and GIFs, and an Excel spreadsheet containing field data from visual checks.

   (e.g.: <project name_V>.mdb) – lignum_V.mdb)

   (e.g.: <project name_Vis>.xls) – lignmVis.xls)

4. Expanded legend and final report.

   These items may be separate Word documents or they may be combined in one report. Ensure that all appendices are attached. All figures and photos should either be embedded and saved in the document or included as separate files if they are linked in the document. Portable Document Files (PDF) are also acceptable formats for submitting final reports for warehousing.

(e.g.: <project name_EL>.doc) – lignum_EL.doc)

(e.g.: <project name_EL>.pdf) – lignum_EL.pdf)

In addition to the digital files listed above, the following hard copy items are also required before projects can be placed into the data warehouse:

1. Original or copies of Field Plot Cards (full plots and GIFs).
2. Original or good quality photocopies of pre-typed air photos.

5.2 Vegetation Resources Inventory Attributes

Data capture standards for the VRI attributes within the integrated TEM/VRI are integrated within the INCOSADA model. For Attribute Data, the RedLine Data will consist of MS Access MDB format files as defined in the Vegetation Inventory Data Model (MDB) Document.

Inventory data is loaded to an ACCESS MDB and validated using the VEGCAPS software.

References

Eng and Meidinger. A Method for Large-scale Biogeoclimatic Mapping in British Columbia. 1999. B.C. Ministry of Forests.

INCOSADA Spatial Data Standards, Standard Positional Spatial Data Types and their Representation in IGDS Format, Version 1.1.

RIC Ecosystems Working Group. Standard For Terrestrial Ecosystem Mapping In British Columbia.

RIC Ecosystems Working Group. Standard For Terrestrial Ecosystem Mapping (TEM) – Digital Data Capture In British Columbia.

Resources Inventory Committee. Vegetation Resources Inventory Photo Interpretation Procedures.