



Guidance for the preparation of ESTR products – land classification scheme

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**Canadian Biodiversity: Ecosystem Status and Trends 2010
Technical Thematic Report No. 3
Published by the Canadian Councils of Resource Ministers**

¹ Ecosystems and Biodiversity Priorities, Environment Canada

Library and Archives Canada Cataloguing in Publication

Guidance for the preparation of ESTR products – land classification scheme.

Issued also in French under title:

Schéma de classification des terres pour le Rapport sur l'état et les tendances des écosystèmes.

Electronic monograph in PDF format.

ISBN 978-1-100-20257-0

Cat. no.: En14-43/3-2012E-PDF

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This report should be cited as:

Frisk, J. 2011. Guidance for the preparation of ESTR products – land classification scheme. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report No. 3. Canadian Councils of Resource Ministers. Ottawa, ON. iv + 34 p.
<http://www.biodivcanada.ca/default.asp?lang=En&n=137E1147-1>

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PREFACE

The Canadian Councils of Resource Ministers developed a Biodiversity Outcomes Framework¹ in 2006 to focus conservation and restoration actions under the *Canadian Biodiversity Strategy*.² *Canadian Biodiversity: Ecosystem Status and Trends 2010*³ was a first report under this framework. It assesses progress towards the framework's goal of "Healthy and Diverse Ecosystems" and the two desired conservation outcomes: i) productive, resilient, diverse ecosystems with the capacity to recover and adapt; and ii) damaged ecosystems restored.

The 22 recurring key findings that are presented in *Canadian Biodiversity: Ecosystem Status and Trends 2010* emerged from synthesis and analysis of technical reports prepared as part of this project. Over 500 experts participated in the writing and review of these foundation documents. This report, *Guidance for the preparation of ESTR products – Land classification scheme*, is one of three background papers prepared to assist the Ecosystem Status and Trends Report (ESTR) Steering Committee in developing a framework and providing guidance for the project. This report was prepared in 2008 and the information presented in it has not been updated except to put into context with the final ESTR reports.

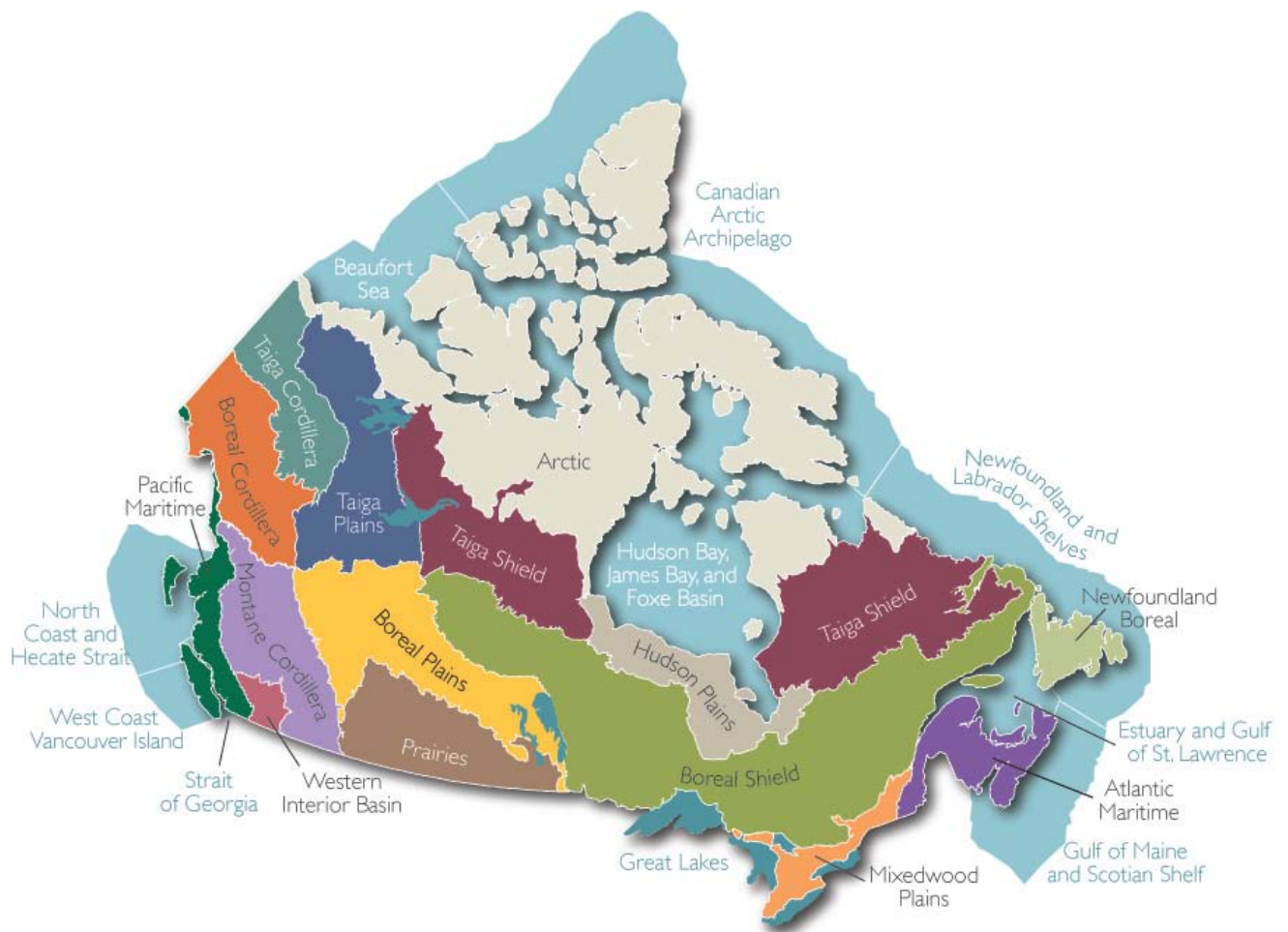
¹ Environment Canada. 2006. Biodiversity outcomes framework for Canada. Canadian Councils of Resource Ministers. Ottawa, ON. 8 p. <http://www.biodivcanada.ca/default.asp?lang=En&n=F14D37B9-1>

² Federal-Provincial-Territorial Biodiversity Working Group. 1995. Canadian biodiversity strategy: Canada's response to the Convention on Biological Diversity. Environment Canada, Biodiversity Convention Office. Ottawa, ON. 86 p. <http://www.biodivcanada.ca/default.asp?lang=En&n=560ED58E-1>

³ Federal, Provincial and Territorial Governments of Canada. 2010. Canadian biodiversity: ecosystem status and trends 2010. Canadian Councils of Resource Ministers. Ottawa, ON. vi + 142 p. <http://www.biodivcanada.ca/default.asp?lang=En&n=83A35E06-1>

Ecological Classification System – Ecozones⁺

A slightly modified version of the Terrestrial Ecozones of Canada, described in the *National Ecological Framework for Canada*,⁴ provided the ecosystem-based units for all reports related to this project. Modifications from the original framework include: adjustments to terrestrial boundaries to reflect improvements from ground-truthing exercises; the combination of three Arctic ecozones into one; the use of two ecoprovinces – Western Interior Basin and Newfoundland Boreal; the addition of nine marine ecosystem-based units; and, the addition of the Great Lakes as a unit. This modified classification system is referred to as “ecozones” throughout these reports to avoid confusion with the more familiar “ecozones” of the original framework.⁵



⁴ Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch. Ottawa/Hull, ON. 125 p. Report and national map at 1:7 500 000 scale.

⁵ Rankin, R., Austin, M. and Rice, J. 2011. Ecological classification system for the ecosystem status and trends report. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report No. 1. Canadian Councils of Resource Ministers. Ottawa, ON. <http://www.biodivcanada.ca/default.asp?lang=En&n=137E1147-1>

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INTRODUCTION

During the preparation of the Ecosystem Status and Trends (ESTR) Technical Ecozone⁶ Reports it became clear that some guidance was required for terminology to be used when discussing land cover in order to ensure consistency and comparability across reports. This paper provides that guidance by presenting a land cover classification scheme for ESTR which considers both land cover classifications used in national data analyzed specifically for ESTR and other common relevant land cover classifications. Because it is not always possible to change how data is presented and because data is not always available for all classifications, use of the scheme recommended in this paper is not absolute in ESTR technical reports.

The terms ‘classification scheme’, ‘classification standard’, and ‘classification system’ are often used interchangeably, and in this paper ‘classification scheme’ will be used.

The purpose of this paper is to:

- (1) provide a clearly defined set of land cover terminology as guidance for preparing ESTR technical reports; and
- (2) describe the terminology used when discussing land cover in seven analyses using land cover data that were carried out for ESTR, and to show how they correspond with the land classification proposed for ESTR in this paper.

LAND COVER TERMINOLOGY USED IN NATIONAL ANALYSES PREPARED FOR ESTR

Seven analyses of national land cover data were carried out to provide information for ESTR (Table 1) and must therefore be taken into account in the development of a consistent land cover terminology for use in ESTR technical reports. These land cover analyses have legends⁶ which are based on one of two different land cover classification schemes⁷, the Federal Geographic Data Committee – National Vegetation Classification Standard (FGDC-NVCS) (Grossman et al., 1998) or the National Forest Inventory (NFI) Land Cover Classification Scheme (National Forest Inventory, 2004), or have been developed specifically for the analysis for ESTR. Land cover information provided for ESTR comes from one of two sources: the Canadian Centre for Remote Sensing analyzed by TerreVista Earth Imaging (see Ahern et al., 2011 for final report); or the NFI. Data from these two sources are collected differently, with data from Canadian Centre for Remote Sensing obtained from satellite imagery and data from the NFI from aerial photography and field plots. These sources provide data at different resolutions; however this is not

⁶A classification legend is a list of classes usually (but not always) derived from a classification scheme for a particular product. Only those classes relevant to a particular project are included (Wulder & Trisalyn 2003).

necessarily an issue if the classification schemes used are hierarchical and crosswalk easily. The difference in resolution of the data is reflected in the level of classification.

Table 1. Description of the national land cover analyses prepared for ESTR.

Analysis #	Title	Description
1	Land cover change in Canada, 1985-2005	Coarse resolution (1 km) land cover and land cover change analysis for 1985, 1990, 1995, 2000, and 2005 based on data from Advanced Very High Resolution Radiometer (AVHRR) sensors. This analysis is included in the ESTR technical thematic report by Ahern et al., (2011).
2	Land cover in Canada, 2005 ⁸	A 250 m resolution map of Canada for the year 2005 based on data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor, analyzed by ecozone ⁺ .
3	Arctic Canada land cover, circa 2000	Two medium resolution (250 m) maps of land cover in the Arctic Ecozone ⁺ circa 2000 based on Landsat satellite data. This analysis is included in the ESTR technical thematic report by Ahern et al., (2011).
4	Land Cover Change in the Peace Athabasca Delta ⁸	Medium resolution land cover change analysis in the Peace-Athabasca Delta based on Landsat data. Changes were analysed from 1975 to 1992, and from 1992 to 1999.
5	Golden Horseshoe and lower Fraser Valley urban case studies	Medium resolution land cover change analysis in two areas (the lower Fraser Valley in the Pacific Maritime Ecozone ⁺ of British Columbia and the Golden Horseshoe in the Mixedwood Plains Ecozone ⁺) based on landsat data. These case studies focus on increases in urban area between 1970, 1990, and 2005/2007. These analyses are included in the ESTR technical thematic report by Ahern et al., (2011).
6	Rangeland Case Study ⁸	Medium resolution land cover change analysis (with a focus on rangeland) based on landsat data for an area of the mixed grass prairie in southeastern Alberta and southwestern Saskatchewan between 1972, 1989, and 2001.
7	NFI Land Cover	Land cover and other forest information from the NFI for each ecozone ⁺ . This information is based on a combination of systematic field surveys and aerial photographs carried out by the Provinces and Territories collected through standardized procedures and compiled for the National Forest Inventory.

⁷ A classification scheme is a tool designed for the classification of a given object (i.e. polygon). It usually takes the form of a decision tree with classification levels (Wulder & Trisalyn 2003)

⁸ This analysis was not used in ESTR, but the classification scheme still played a role in the development of the ESTR land classification scheme presented in this report.

Analysis 1: Land Cover Change

The Land Cover Change analysis uses a coarse 12-class legend, which is a condensed version of the 31-class legend developed by the Canadian Centre for Remote Sensing for their 1995 land cover map of Canada (Cihlar et al., 1999 cited in Latifovic and Pouliot, 2005). The classes are:

1. Conifer forest
2. Deciduous forest
3. Mixed forest
4. Disturbance (Fire)
5. Shrubland
6. Grassland
7. Low vegetation and barren
8. Cropland
9. Cropland/woodland
10. Urban and built-up
11. Water
12. Snow/ice

As this is a coarse legend, it is easy to crosswalk with other legends. Note that in the technical thematic report for ESTR on remote sensing (Ahern et al., 2011), classes 1, 2, and 3 were combined and named “Forest”, class 4 was renamed “Fire Scars”, class 7 was renamed “Low Vegetation and Barren” and classes 8 and 9 were combined and named “Agricultural Land”.

Analysis 2: 2005 Land Cover⁹

The 2005 Land Cover analysis is based on data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. The land cover map was first published by the Canadian Centre for Remote Sensing (2008) and only minor modifications were made for ESTR. The land cover legend consists of 39 classes and is derived from the FGDC-NVCS (Grossman et al., 1998).

The FGDC-NVCS is hierarchical consisting of nine levels primarily based on vegetation (Table 2) with classification categories designed to be mutually exclusive. Revisions to the classification scheme accepted in 1997 had been proposed and were under review at the time of writing of this report (Peet, 2007). The legend used for the 2005 Land Cover analysis had not been finalized at the time this report was written, therefore the specific classes were not used in the determination of a land classification scheme for ESTR. Legends used for other analyses based on the FGDC-NVCS classification scheme were, however, used for reference.

⁹ This analysis was not used in ESTR, but the classification scheme presented here still played a role in the development of the ESTR land classification scheme.

Table 2. FGDC-NVCS classification hierarchy.

	Level	Definition
	Division	Separates earth cover into either vegetated or non-vegetated categories
	Order	Refines the Vegetated Division by dominant life form (tree, shrub, dwarf shrub, herbaceous, or non-vascular).
Physiognomic Levels (Based on life form, cover, structure, leaf type of the vegetation)	Class	Defined by the relative percent canopy cover of the tree, shrub, dwarf shrub, herb, and nonvascular life form in the uppermost strata during the peak of the growing season.
	Subclass	Determined by the predominant leaf phenology of woody plants and the leaf type and periodicity of herbaceous plants.
	Group	Defined by a combination of factors relating to climate, leaf morphology and leaf phenology.
	Subgroup	Separates Natural/Semi-natural types from the Planted/Cultivated types.
	Formation	Identifies ecological groupings of vegetation units with broadly defined environmental (for example, hydrology) and additional physiognomic factors.
Floristic Levels (Derived from field data)	Alliance	A physiognomically uniform group of Associations sharing one or more diagnostic (dominant, differential, indicator, or character) species which, as a rule, are found in the uppermost stratum of the vegetation.
	Association	A physiognomically uniform group of vegetation stands that share one or more diagnostic (dominant, differential, indicator, or character) overstory and understory species. These elements occur as repeatable patterns of assemblages across the landscape, and are generally found under similar habitat conditions. The Association refers to existing vegetation, not a potential vegetation type.

Source: adapted from the Federal Geographic Data Committee (1997)

Analysis 3: Arctic Canada Vegetation Cover

The Arctic Canada vegetation cover legend is also based on the FGDC-NVCS classification scheme (see Table 2). The legend includes the following classes:

1. Tussock graminoid tundra
2. Wet sedge
3. Moist to dry non-tussock graminoid/dwarf shrub tundra
4. Dry graminoid prostrate dwarf shrub tundra
5. Low shrub
6. Tall shrub
7. Prostrate dwarf shrub
8. Sparsely vegetated bedrock
9. Sparsely vegetated till colluvium
10. Bare soil with croptogam crust - frost boils
11. Wetlands
12. Barren
13. Snow and/or Ice

Analysis 4: Land Cover Change in the Peace Athabasca Delta¹⁰

Due to the complexity of the vegetation and wetland patterns in the Peace Athabasca Delta, this case study uses a coarse classification legend which directly corresponds to the Land Cover Change analysis (see Analysis 1 on page 3) with the exclusion of the cropland, cropland/woodland, urban and built-up, and snow/ice categories as these classes are not present in the Peace Athabasca Delta. The 'water' class is further divided into dark water, turbid water, and aquatic vegetation. Dark water can be interpreted as flowing water, while turbid water can be interpreted as stagnant water. The classes are:

1. Conifer forest
2. Deciduous forest
3. Mixed forest
4. Recent fire
5. Shrubland
6. Grassland
7. Low vegetation and barren
8. Dark water
9. Turbid water
10. Aquatic vegetation

Wetlands are classified in more detail in the NFI data (see Analysis 7 on page 6). The Canadian Wetland Classification Scheme (National Wetlands Working Group, 1997) is discussed on page 8 and is compared with the NFI classification of wetlands on page 6.

Analysis 5: Two Urban Case Studies

Two urban case studies were conducted for the Lower Fraser Valley in British Columbia and the Golden Horseshoe in Ontario. Landsat data for these areas was visually classified under a coarse classification legend created specifically for this analysis. The classes used are:

1. Urban or barren
2. Forest or shrub
3. Agriculture
4. Grassland
5. Wetland
6. Open water
7. Snow or ice

¹⁰ This analysis was not used in ESTR, but the classification scheme presented here still played a role in the development of the ESTR land classification scheme.

Analysis 6: Rangelands Case Study¹¹

The Rangelands case study is also based on Landsat data which has been visually classified. Visual classification in this case was preferred because subtle differences in colour, shape, texture, and context used to classify an area may be overlooked by spectral or spectral/spatial classification. The classes used in this analysis are:

1. Rangeland
2. Dryland agriculture
3. Irrigated agriculture
4. Urban areas
5. Water

Analysis 7: National Forest Inventory Land Cover

Land cover information provided by the NFI uses the NFI land cover classification scheme based on the British Columbia Land Cover Classification Scheme (BC Ministry of Sustainable Resource Management, 2002) and designed to be compatible with other classification schemes. Like the FGDC-NVCS, this scheme is hierarchical with mutually exclusive categories, and is based on existing vegetation. The NFI data are based on vegetation structure and not individual species. For a breakdown of the NFI hierarchy, see Appendix 1. In the NFI classification scheme, each area is classified by landscape position (either wetland, upland, or alpine). It is the only scheme used in national ESTR land cover analyses that categorizes Wetland Types (see page 8 for a description of 'Wetland Class', 'Wetland Form' and 'Wetland Type'). Distinctions among wetlands classified by the NFI data can be made by vegetation and land cover type which correspond directly with the Wetland Types of the Canadian Wetland Classification (Table 3). The NFI does not distinguish explicitly between Wetland Classes (such as Fen or Bog), however. Table 4 compares the two classification systems at this more refined level.

¹¹ This analysis was not used in ESTR, but the classification scheme presented here still played a role in the development of the ESTR land classification scheme.

Table 3. Comparison of Wetland Types of the Canadian Wetland Classification and NFI wetland classes.

Canadian Wetland Classification System Types	NFI Wetland Classes
Treed – Coniferous	Treed – Coniferous
Treed – Hardwood	Treed – Broadleaf
Treed – Mixed	Treed – Mixed
Shrub – Low (0.1-0.5m)	Shrub – Low (<2 m)
Shrub – Tall (>1.5 m)	Shrub – Tall (>2 m)
Shrub – Mixed	N/A
Graminoid – Grass	Herb – Graminoid
Graminoid – Low Rush	Herb – Graminoid
Graminoid – Tall Rush	Herb – Graminoid
Graminoid – Reed	Herb – Graminoid
Graminoid – Sedge	Herb – Graminoid
Lichen	Bryoid – Lichen
Moss	Bryoid – Moss
Floating Aquatic	N/A
Submerged Aquatic	N/A
Non-Vegetated	Non-Vegetated

Table 4. Comparison of Wetland Classes of the Canadian Wetland Classification and NFI wetland classes.

Canadian Wetland Classification System Classes	NFI Wetland Classes
Bog (<i>Peatland</i>)	Treed Wetland Shrub Wetland Bryoid Wetland
Fen (<i>Peatland</i>)	Herb: Graminoid Wetland Shrub Wetland
Swamp (<i>Peatland or Mineral Wetland</i>)	Treed Wetland Shrub Wetland
Marsh (<i>Mineral Wetland</i>)	Herb: Graminoid Wetland Herb: Forb Wetland Shrub Wetland
Shallow Water (<i>Mineral Wetland</i>)	N/A

Note that the NFI does not distinguish between peatlands and mineral wetlands.

OTHER LAND COVER/VEGETATION CLASSIFICATIONS

This section outlines other national classification schemes or legends that were not used directly in national land cover analyses produced for ESTR but are still relevant for consideration in an overall land cover classification scheme for use in ESTR reports.

Canadian Wetland Classification System

The Canadian Wetland Classification System (National Wetlands Working Group, 1997) has three levels:

1. **Wetland Class:** distinguished based on “properties of the wetland that reflect the overall genetic origin of the wetland and the nature of the environment” (Bog, Fen, Swamp, Marsh, or Shallow Water).
2. **Wetland Form:** “Subdivisions of each class based on surface morphology, surface pattern, water type, and morphology characteristics of underlying mineral soil” (for example, Blanket Bog, Basin Bog, Collapse Scar Bog).
3. **Wetland Type:** “Subdivisions of Wetland Form and Subform based on the physiognomic characteristics of the vegetation communities” (for example, Forb, Graminoid). Wetland types can apply to more than one class.

As discussed above, wetlands in the NFI can be differentiated by land cover and vegetation type which corresponds directly with the third level of the Wetland Classification System (Wetland Type, Table 3); however, differentiation between Wetland Classes and Forms is not always possible for NFI data (Table 4). Wetland Classes may correspond to a number of NFI wetland polygons. Generally, the Canadian Wetland Classification System classifies wetlands in finer detail than is necessary for the purposes of ESTR.

Canadian National Vegetation Classification

The Canadian component of the International Vegetation Classification, the Canadian National Vegetation Classification was launched in 1998. Development of the Canadian National Vegetation Classification system is ongoing and is based on the revised version of the FGDC-NVCS (which was not yet implemented in the U.S. at the time of writing this paper). At the time of writing, work was completed on defining the broadest level classification and was ongoing at the association level for forests and woodlands through the Canadian Forest Ecosystem Classification of the Canadian Forest Service (see Table 5). The divisions within the rest of the hierarchy had not been determined and formalized.

Table 5. Status of categorization for the Canadian National Vegetation Classification hierarchy.

Level	Status of Categorization
Upper Levels (based primarily on physiognomy)	
Formation Class	Predefined in to 5 growth form units: mesomorphic , xeromorphic, cryomorphic , lithomorphic, and hydromorphic
Formation Subclass	Not categorized at time of writing
Formation	Not categorized at time of writing
Mid levels (based on both floristics and physiognomy)	
Division	Not categorized at time of writing
Macrogroup	Not categorized at time of writing
Group	Not categorized at time of writing
Lower levels (based primarily on floristics)	
Alliance	Not categorized at time of writing
Association	Work underway categorizing forest and woodland associations through the Canadian Forest Ecosystem Classification

Source: Baldwin (2008, pers. comm.). For current information, go to <http://cnvc-cnvc.ca/>

National Land and Water Information Service

The National Land and Water Information Service (NLWIS) is an internet-service being developed by Agriculture and Agri-Food Canada in close collaboration with other federal departments, provincial, territorial and municipal governments, producer and industry groups, and academic institutions to provide easy access to agri-environmental information, including land use, soil, water, climate, and biodiversity (Agriculture and Agri-food Canada, 2008). At the time of writing, NLWIS has completed Phase 1 of 4, and was due to be complete in 2009.¹²

Land cover classes provided through NLWIS for agricultural land for the year 2000 were:

1. Water bodies
2. Exposed land
3. Developed or built-up land
4. Shrubland
5. Wetland
6. Native grassland
7. Annual crops
8. Perennial cropland and pasture
9. Coniferous forest
10. Deciduous forest
11. Mixed forest

¹² NLWIS was completed in March 2009 and has turned into an ongoing service known as Agri-Geomatics. See <http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1227209183756&lang=eng> for more information.

Earth Observation for Sustainable Development of Forests

The Earth Observation for Sustainable Development (EOSD) of Forests is a Canadian Forest Services project in partnership with the Canadian Space Agency aimed at mapping Canada's forested land cover using satellite imagery. A map of the land cover of Canada's forested ecozones (all except for the three arctic ecozones, the prairies, and the mixedwood plains) circa 2000 has been produced based on landsat data as part of this project (Wulder et al., 2008). The legend used for the EOSD was developed to work with the NFI Land Cover Classification Scheme (see page 6), and is considered a closed legend which aims to be applicable throughout Canada for a breadth of different land cover products (Wulder and Nelson, 2003).

Millennium Ecosystem Assessment

In Volume 1 of The Millennium Ecosystem Assessment (2005), ten reporting units are used. These units are referred to as "systems" as opposed to "ecosystems" and they are:

1. Marine
2. Coastal
3. Inland water
4. Forest and woodland
5. Dryland
6. Island
7. Mountain
8. Polar
9. Cultivated
10. Urban

LAND USE CLASSIFICATION SCHEME FOR ESTR

The proposed classification scheme for ESTR (Figure 1) takes into account the analyses that were provided nationally, as well as other relevant national and international classification schemes. The first level of classification follows the categories used in the Millennium Ecosystem Assessment with the exception of "Island". The Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005) defines Islands as "Small Island Developing States" which is not an ecological classification and thus not recommended for use in ESTR. Further breakdown has been designed to meet the needs of ESTR.

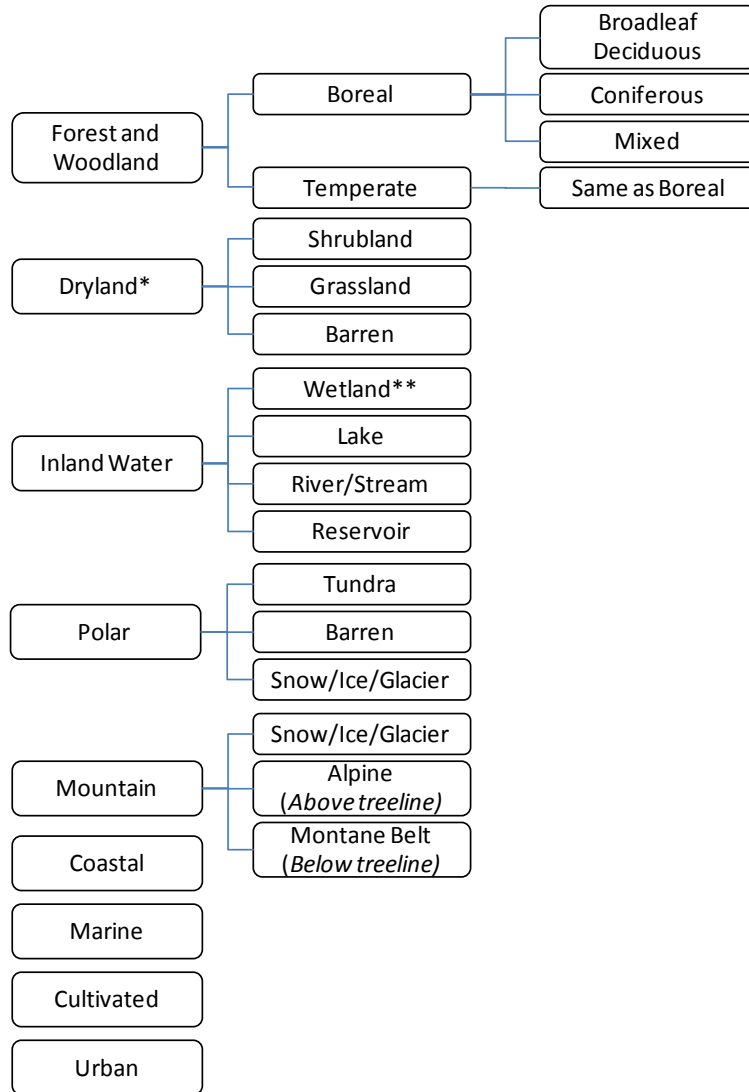


Figure 1. Proposed ecological land classification scheme for use in ESTR.

*Polar Drylands are covered within Polar Tundra

**Wetlands may occur within other classes and will be covered in detail as a whole (i.e. as a subclass of Inland Waters), not dispersed amongst the various classes they occur in.

The incorporation of national data with defined classification schemes into ESTR technical reports creates a need for a clear description of how these systems crosswalk with the proposed ESTR land cover terminology. Table 6 describes how they fit.

Table 6. Description of the proposed land use classification scheme terminology and crosswalk to land use analyses discussed in this paper.

Term	Definition	What's Included	National Analyses that Crosswalk*	National Analyses that do not Crosswalk*
<p>1. Forest and woodland</p> <p><i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Lands dominated by trees. Specifically, areas where tree crown density is greater than approximately 10%.</p> <p><i>Note that while the Millennium Ecosystem Assessment uses >40% crown cover as the boundary for classifying forests, >10% crown cover is used in several MEA analyses.</i></p>	<p>Forests and Woodlands (typically defined as 10-25% tree crown density)</p>	<p>1 – Tree crown density > 10% 2 – Tree crown density > 25% (“Tree Dominated”) 4 – Tree crown density % not specified 7 – “Treed”</p>	<p>3 – Not present in this case study 5 – Tree crown density % not specified, forest and shrubland combined into “Forest or Shrub” 6 – Not present in this case study</p>
<p>1.1. Boreal</p>	<p>This includes forests within the Boreal zone, as defined by Brandt (2009).</p>	<p>Taiga (northern Boreal forest), montane forests</p>		<p>1,2,4,7 – Only defines forests by dominant tree type 3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>
<p>1.1.1. Broadleaf Deciduous</p>	<p>Deciduous (seasonal shedding of foliage) trees are dominant (> 75% of total tree basal area. May also be referred to as “Broadleaf” or “Hardwood”).</p> <p>Note: Basal area is defined as “the area of the circle formed by the cross-section of a tree taken 1.3 m above the ground” (BC Ministry of Forests and Range, 2005).</p>	<p>Broadleaf, hardwood</p>	<p>1– Deciduous trees make up > 80 % of the total tree basal area 2 4 – % of deciduous trees not specified 7 – “Broadleaf”</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>

<p>1.1.2. Coniferous</p>	<p>Coniferous (trees classified botanically as Coniferae; cone-bearing trees having needle or scale-like leaves, usually evergreen (National Forest Inventory, 2004)) trees are dominant (>75% of total tree basal area). May also be referred to as “Evergreen” (though evergreen trees are not necessarily coniferous), “Needle-leaf” or “Softwood”.</p>	<p>Evergreen, needle-leaf, softwood</p>	<p>1 – Coniferous trees make up > 80 % of the total tree basal area 2 – (“Evergreen Needleleaf”) 4 – % of coniferous trees not specified 7</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>
<p>1.1.3. Mixed</p>	<p>Mixture of deciduous and coniferous trees where neither tree type is dominant (make up >75% of the total tree basal area).</p>		<p>1 – Neither coniferous nor deciduous trees make up > 80 % of the total tree basal area 2 4 – % not specified 7</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>
<p>1.2. Temperate</p>	<p>Forests that are located between the tropics and the polar regions and have moderate climates with distinct seasons of alternating long, warm summers and short, cold winters (Federal Geographic Data Committee, Vegetation Subcommittee, 1997). These are forests that lie outside of the Boreal zone in Canada, as defined by Brandt (2009).</p>	<p>Acadian forests, montane forests</p>		<p>1,2,4,7 – Only defines forests by dominant tree type 3 – Not present in this case study 5 – Combines forest and shrubland, does not define any further 6 – Not present in this case study</p>

<p>1.2.1. Broadleaf Deciduous</p>	<p>Deciduous (seasonal shedding of foliage) trees are dominant (> 75% of total tree basal area). May also be referred to as “Broadleaf” or “Hardwood”.</p> <p>Note: Basal area is defined as “the area of the circle formed by the cross-section of a tree taken 1.3 m above the ground” (BC Ministry of Forests and Range, 2005).</p>	<p>Broadleaf, hardwood</p>	<p>1 – Deciduous trees make up > 80 % of the total tree basal area 2 4 – % of deciduous trees not specified 7 – “Broadleaf”</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>
<p>1.2.2. Coniferous</p>	<p>Coniferous (trees classified botanically as Coniferae; cone-bearing trees having needle or scale-like leaves, usually evergreen (National Forest Inventory, 2004)) trees are dominant (>75% of total tree basal area). May also be referred to as “Evergreen” (though evergreen trees are not necessarily coniferous), “Needle-leaf” or “Softwood”.</p>	<p>Evergreen, needle-leaf, softwood</p>	<p>1 – Coniferous trees make up > 80 % of the total tree basal area 2 – (“Evergreen Needleleaf”) 4 – % of coniferous trees not specified 7</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>
<p>1.2.3. Mixed</p>	<p>Mixture of deciduous and coniferous trees where neither tree type is dominant (make up >75% of the total tree basal area).</p>		<p>1 – Neither coniferous nor deciduous trees make up > 80 % of the total tree basal area 2 4 – % not specified 7</p>	<p>3 – Not present in this case study 5 – Combines forests and shrubland, does not define any further 6 – Not present in this case study</p>

<p>2. Dryland</p> <p><i>As defined in the Millennium Ecosystem Assessment(2005)</i></p>	<p>Lands where plant production is limited by water availability.</p> <p>Specifically, areas where tree growth is limited by water availability (tree crown density <10%). In the Millennium Ecosystem Assessment (2005), drylands are defined more specifically as lands where annual precipitation is < 2/3 of potential evaporation including sub-humid, semi-arid, arid, and hyper-arid (as defined by the Convention to Combat Desertification). Specific aridity indexes are not required for the ESTR.</p>	<p>Shrublands, grasslands, semi-deserts and true deserts.</p> <p>Note: Cultivated lands may also meet the Dryland criteria, however these are discussed under "Cultivated"</p>		<p>1,2,3,4,5,6,7 – Not defined in this way</p>
<p>2.1. Shrubland</p>	<p>A given vegetated area (>10% ground cover by vegetation) is considered Shrubland if shrubs compose either: ≥ 10% of ground cover; OR > 1/3 of the total vegetation cover</p>	<p>Heathlands, alpine shrublands, etc.</p> <p>Note that this includes Shrublands which occur on various landforms e.g. sand dunes/hills, eskers, mountains etc. as well as areas considered as "Parkland" or "Woodland" using other terminology if the total tree basal area < 10% and shrub cover meets the stated criteria.</p>	<p>2 – "High-Low Shrub Dominated" % Ground cover required not specified. 3 – "Low Shrub" (<40cm; >25%cover); Tall shrub (>40cm; >25% cover); "Prostrate dwarf shrub" (>50% vegetation cover) 4 – % Ground cover required not specified. 7</p>	<p>1 – Shrubs compose > 40% of ground cover 5 – Included with Forest under "Forest or Shrub" 6 – Not included in this case study.</p>

<p>2.2. Grassland</p>	<p>Grass-dominated areas where few or no trees grow. For the purposes of ESTR, this is a vegetated area (>10% ground cover by vegetation) that does not meet the criteria of either a forest or a shrubland where graminoids make up > 50% of the vegetation cover with forbs dominating the rest of the vegetation.</p>	<p>Mixed grasslands, Fescue grasslands, Tallgrass Prairie, Bunchgrass grasslands, Shrub-Steppe grasslands, alpine grasslands, rangelands etc. Note that this includes Grasslands which occur on various landforms e.g. sand dunes/hills, eskers, mountains etc. as well as areas considered “Woodland” or “Parkland” using other terminology which do not meet the forest or Shrubland classification criteria and graminoids make up >50% of the vegetation cover.</p>	<p>1 – % Herb vegetation required not defined. 2 – % Herb vegetation required not defined (“Herb Dominated”). 4 – % Herb vegetation required not defined. 5 – % Herb vegetation required not defined. 6 – “Rangeland” % Herb vegetation required not defined. 7</p>	<p>3 – included within Tundra classes: Tussock Graminoid Tundra; Moist to dry non-tussock Graminoid/dwarf shrub tundra; and Dry Graminoid prostrate dwarf shrub tundra</p>
<p>2.3 Barren</p>	<p>Dryland regions with limited vegetation. Specifically, these are Drylands which do not meet the criteria of a Shrubland or Grassland.</p>	<p>This class can be present on various land forms e.g. sand dunes/hills, salt flats, eskers, moraines, rocky cliffs, exposed bedrock etc.</p>	<p>1,4 – “Low vegetation and barren”</p>	<p>2 – “Sparse Vegetation” (though not necessarily Dryland) 3 – Not included within this study (Arctic barrens covered within the Polar land classes) 5 – “Urban or barren” 6 – Not present in this case study 7 – “Non-Vegetated” (though not necessarily Dryland)</p>

<p>3. Inland Water <i>As defined in the Millennium Ecosystem Assessment(2005)</i></p>	<p>Permanent water bodies inland from the coastal zone, and areas whose ecology and use are dominated by the permanent, seasonal, or intermittent occurrence of flooded conditions.</p>	<p>Includes rivers, lakes, floodplains, reservoirs, and wetlands; also includes inland saline systems.</p>		<p>3</p>
<p>3.1. Wetland</p>	<p>Terrain affected by water table at, near or above the land surface (< 2m deep) which is saturated for sufficient time to promote wetland or aquatic processes (National Wetlands Working Group, 1997).</p>	<p>Peatlands (e.g. bogs, fens and some swamps), mineral wetlands (e.g. marshes, some swamps, shallow water < 2m deep), mudflats/tidal flats and deltas (areas of accumulated sediment deposits located at the mouth of a river)</p>	<p>2, 3, 4, 5, 7</p>	<p>1 – Wetlands are included within other classes (mostly within “Shrubland” and “Grassland” classes) 6 – Not present in this case study</p>
<p>3.2. Lake</p>	<p>A naturally occurring static body of inland water (> 2m deep).</p>	<p>Freshwater and saline lakes</p>	<p>7</p>	<p>1 – Does not break down further than “Water” 2 – Does not break down further than “Mixes of water and land” 3 4 – breaks water down instead by “Turbid water”, “Dark water” and “Aquatic vegetation” 5 – Only defines “Open Water” 6 – Does not break down further than “Water”</p>

<p>3.3. River/Stream</p>	<p>“A watercourse formed when water flows between continuous, definable banks. Flow may be intermittent or perennial, but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that have definable banks are not” (National Forest Inventory, 2004).</p>	<p>Rivers, streams and associated floodplains</p>	<p>7</p>	<p>1 – Does not break down further than “Water” 2 – Does not break down further than “Mixes of water and land” 3 4 – breaks water down instead by “Turbid water”, “Dark water” and “Aquatic vegetation” 5 – Only defines “Open Water” 6 – Does not break down further than “Water”</p>
<p>3.4. Reservoir</p>	<p>“An artificial basin affected by impoundment of water behind a human fabricated structure such as a dam, berm, dyke, or wall” (National Forest Inventory, 2004).</p>		<p>7</p>	<p>1 – Does not break down from “Water” 2 – Does not break down from “Mixes of water and land” 3 4 – breaks water down by “Turbid water”, “Dark water” and “Aquatic vegetation” only 5 – Only defines “Open Water” 6 – Does not break down from “Water”</p>

<p>4. Polar</p> <p><i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>High-latitude systems frozen for most of the year.</p> <p>For the purposes of ESTR, this is defined as the region from the North Pole south to the tree line, and is therefore equivalent to the Arctic Ecozone⁺. It is important to note, however, that in reality the tree line is a transition area that is best described as a band. The boundary for the Arctic Ecozone⁺ has been delineated with the best information available, however there may still be some discrepancies as to the best location for this line.</p>	<p>Ice caps, areas underlain by continuous permafrost, tundra, polar deserts, and polar coastal areas</p>	<p>3</p>	<p>1,2,7 – Not defined in this way 4,5,6 – Not included in these case studies</p>
<p>4.1. Tundra</p> <p><i>As defined in the Millennium Ecosystem Assessment(2005)</i></p>	<p>Treeless regions within the Arctic Ecozone⁺ which contain nearly continuous plant cover. Specifically, contains >50% ground cover (otherwise classified as “Barren”).</p> <p>Due to discrepancies in the exact location of the northern tree line, some areas of Tundra may exist in the northern portions of the Taiga Plains, Taiga Shield and Hudson Plains Ecozones⁺.</p>	<p>Polar grasslands (i.e. Graminoid Tundra), prostrate and erect shrub Tundra’s</p> <p>This class can be present on various land forms e.g. dunes, salt flats, eskers, moraines, rocky cliffs, etc.</p>	<p>3 – Broken down further into: Tussock Graminoid Tundra; Moist to dry non-tussock Graminoid/dwarf shrub tundra; and Dry Graminoid prostrate dwarf shrub tundra</p>	<p>1 – Not broken down further than ‘Shrubland’. May also be included under “Low Vegetation and Barren.” 2 – Not broken down further than “High-Low Shrub Dominated” 4 – Not broken down further than ‘Shrubland’ 5 – Not broken down further than “Forest or Shrub” 6 – Not included in this case study 7 – “Shrubland” not broken down this way (only by Alpine, Wetland or Upland)</p>

<p>4.2. Barren <i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Treeless regions within the Arctic Ecozone⁺ which contain < 50% plant cover. Vegetation present is primarily herbs, lichens, mosses and liverworts.</p>	<p>Polar deserts, areas of exposed bedrock etc. This class can be present on various land forms e.g. dunes, eskers, moraines, rocky cliffs, exposed bedrock etc.</p>	<p>3</p>	<p>1 – Polar barrens not separate 2 – Polar barrens not separate 4 – not included in this case study 5 – Polar barrens not separate 6 – Not present in this case study 7 – Polar barrens not separate</p>
<p>4.3. Snow/Ice/Glacier</p>	<p>Mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction, snow or ice that is not part of a glacier but is found during the summer months on the landscape.</p>	<p>Glaciers, perennial snow cover</p>	<p>3</p>	<p>1 – Polar ice not separate 2 – Polar ice not separate 4 – not included in this case study 5 – Polar ice not separate 6 – Not present in this case study 7 – Polar ice not separate</p>
<p>5. Mountain <i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Steep and high lands. As defined by Mountain Watch using criteria based on elevation alone, and at lower elevations on a combination of elevation, slope, and local elevation range. Specifically, classified as mountain if: elevation > 2500m elevation 1500-2500m and slope > 2° elevation 1000-1499m and slope > 5° or local elevation range (7 km radius) is > 300m</p>	<p>Rocky Mountains, Appalachian Mountains, Laurentian Mountains, Torngat Mountains etc.</p>		<p>1, 2, 3, 4, 5, 6, 7</p>

	elevation 300-1000m and local elevation range >300m isolated inner basins and plateaus less than 25 km ² extent that are surrounded by mountains			
5.1. Snow/Ice/Glacier <i>(or Nival Belt as it is called in the Millennium Ecosystem Assessment (2005))</i>	Mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction. On a mountain, this perennial snow/ice is found in the Nival Belt (the terrain above the snow-line which is defined as the lowest elevation where snow is commonly present all year round).	Glaciers, perennial snow cover		1, 2, 3, 4, 5, 6, 7
5.2. Alpine Zone	Treeless region (i.e. above the treeline) on a mountain between the natural climatic forest limit and the snow line. Refers strictly to a temperature-driven treeless high-altitude life zone. May also be referred to as Alpine Tundra.	Note: Alpine grasslands and shrublands will be covered under Grasslands and Shrublands, not within Mountains.	7	1, 2, 3, 4, 5, 6
5.3. Montane Belt	The region of a mountain which extends from the lower mountain limit to the upper thermal limit of forest (i.e. below the treeline) irrespective of whether forest is present or not. Note that information was not organized in this manner for ESTR (i.e. forests which occur in the Montane belt are not separated from forests which occur in the adjacent non-mountain regions) and so there will be limited information reported on the Montane belt.	Note: Montane Grasslands and Shrublands will be covered under Grasslands and Shrublands, not within Mountains.		1, 2, 3, 4, 5, 6, 7

<p>6. Coastal</p> <p><i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Interface between ocean and land, extending seawards to about the middle of the continental shelf and inland to include all areas strongly influenced by the proximity to the ocean.</p> <p>Specifically, this encompasses the area between 50 metres below mean sea level to 50 metres above the high tide level or extending landward to a distance 100 kilometres from shore.</p> <p>Note that the coastal zone may be covered by both terrestrial and marine ecozones⁺ chapters, depending on the particular issue.</p>	<p>Reefs, intertidal zones, archipelago's estuaries, coastal dunes, coastal aquaculture and seagrass communities.</p> <p>Note that coastal wetlands (e.g. estuaries and mudflats/tidal flats) are covered within Wetlands (contrary to the Millennium Ecosystem Assessment where they were discussed under Coastal).</p>		<p>1, 2, 3, 4, 5, 6, 7</p>
<p>7. Marine</p> <p><i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Areas of ocean where the water is deeper than 50 metres.</p> <p>Note that part of the coastal region (where water is < 50m deep and/or within 100 km of the shore) will be covered in the appropriate marine ecozones⁺ chapters.</p>			<p>1, 2, 3, 4, 5, 6, 7</p>
<p>8. Cultivated</p> <p><i>As defined in the Millennium Ecosystem Assessment (2005)</i></p>	<p>Lands dominated by domesticated plant species, used for and substantially changed by crop, agroforestry, or aquaculture production.</p> <p>Specifically, areas in which at least 30% of the landscape comes under cultivation in any particular year.</p>	<p>Orchards, agroforestry, feedlots, etc.</p> <p>Note that coastal aquaculture will be included within Coastal.</p>	<p>1 – Broken down further into: Cropland; and Cropland-woodland 2 – Broken down further into ‘High’, ‘Medium’ and ‘Low Biomass Cropland’ 5 6 – Broken down further into: Dryland agriculture; and Irrigated agriculture</p>	<p>3 – Not included in this case study 4 – Not included in this case study 7 – Cultivated land not distinguished from natural land</p>

9. Urban <i>As defined in the Millennium Ecosystem Assessment (2005</i>	Built environments with a high human density. Specifically, known human settlements with a population of 5,000 or more, with boundaries delineated by observing persistent night-time lights or by inferring areal extent in the cases where such observations are absent.	Human settlements with ≥ 5000 inhabitants	1 – Urban and Built 2 – Urban and Built 6 – Urban Areas 7 – Urban and Built	3 – Not included in this case study 4 – Not included in this case study 5 – Urban or Barren
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*Numbers in these columns correspond with the Analysis numbers on Table 1.

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Glossary

Aridity Index	Ratio of mean annual precipitation to mean annual potential evapotranspiration
% Cover/Crown Density	“The percentage of a given area covered by the vertical projection of the aerial parts of plants of one or more species (Federal Geographic Data Committee, Vegetation Subcommittee, 1997).”
Basal area	“The area of the circle formed by the cross-section of a tree take 1.3 m above the ground (BC Ministry of Forests and Range, 2005).”
Broadleaf	“Trees classified botanically as Angiospermae in the subclass Dicotyledoneae; commonly referred to as deciduous or hardwoods” (National Forest Inventory, 2004)
Bryoids	“Bryoids are defined as bryophytes (mosses, liverworts and hornworts) and lichens (foliose or fruticose; not crustose)” (National Forest Inventory, 2004)
Coniferous	“Trees classified botanically as Coniferae; cone-bearing trees having needles or scale-like leaves, usually evergreen; commonly referred to as conifer or softwoods” (National Forest Inventory, 2004)
Deciduous	Vegetation which loses its foliage seasonally.
Forbs	“Herbaceous plants other than graminoids, including ferns, club mosses, and horsetails.” (National Forest Inventory, 2004)
Graminoids	“Herbaceous plants with long, narrow leaves characterized by linear venation; including grasses, sedges, rushes, and other related species” (National Forest Inventory, 2004).
Herbs	“Vascular plants without a woody stem, including ferns, fern allies, grasses, and grass-like plants.” (National Forest Inventory, 2004)
Shrub	“Woody perennial plants, both evergreen and deciduous, that have a relatively low growth habit, and are generally multi-stemmed, rather than having one bole. They differ from a tree by their low stature (generally < 10 m) and non-treelike form” (National Forest Inventory, 2004).
Tundra	A treeless area where growth is hindered by low temperatures and short growing seasons.

APPENDIX

Appendix 1. NFI Land Classification Scheme (National Forest Inventory, 2004).

Class	Definition and Classification Criteria
1. Vegetated	Total cover of trees, shrubs, herbs and bryoids (other than crustose lichens) covers at least 5% of the total surface area of the polygon.
1.1. Treed	≥ 10% of the polygon area, by crown cover, consists of tree species of any size.
1.1.1. Wetland	(From Fraser et al. (1995) cited in the National Forest Inventory (2004)): Land having the water table at, near or above the soil surface, or which is saturated for a long enough period of time to promote wetland or aquatic processes. These wetland processes are indicated by the presence of Organic or Gleysolic soils and hydrophytic vegetation.
1.1.1.1. Coniferous	Trees classified botanically as Coniferae; cone-bearing trees having needles or scale-like leaves, usually evergreen. These species are commonly referred to as conifer or softwoods.
1.1.1.2. Broadleaf	Trees classified botanically as Angiospermae in the subclass Dicotyledoneae. These species are commonly referred to as deciduous or hardwoods.
1.1.1.3. Mixed	The polygon is classified as Mixed when neither coniferous nor broadleaf trees account for 75% or more of the total tree basal area
1.1.2. Upland	A broad class that includes all non-wetland ecosystems that range from very xeric to hygric soil moisture regimes
1.1.2.1. Coniferous	Trees classified botanically as Coniferae; cone-bearing trees having needles or scale-like leaves, usually evergreen. These species are commonly referred to as conifer or softwoods.
1.1.2.2. Broadleaf	Trees classified botanically as Angiospermae in the subclass Dicotyledoneae. These species are commonly referred to as deciduous or hardwoods.
1.1.2.3. Mixed	The polygon is classified as Mixed when neither coniferous nor broadleaf trees account for 75% or more of the total tree basal area
1.1.3. Alpine	Treeless (for practical purposes < 1% tree cover can be included with the Alpine category), with alpine vegetation dominated by shrubs, herbs, graminoids, bryoids, and lichens. Rock, ice, and snow dominate much of the Alpine. Alpine does not typically include the parkland and krummholz forest types. Alpine is a classification level of Non-Treed areas above the tree line only.
1.1.3.1. Coniferous	Trees classified botanically as Coniferae; cone-bearing trees having needles or scale-like leaves, usually evergreen. These species are commonly referred to as conifer or softwoods.
1.1.3.2. Broadleaf	Trees classified botanically as Angiospermae in the subclass Dicotyledoneae. These species are commonly referred to as deciduous

	or hardwoods.
1.1.3.3. Mixed	The polygon is classified as Mixed when neither coniferous nor broadleaved trees account for 75% or more of the total tree basal area
1.2. Non-treed	< 10% of the polygon area consists of tree species of any size (by crown cover).
1.2.1. Wetland	See vegetated-treed
1.2.1.1. Shrubs	For a polygon to be classed as Shrub, it must have a minimum of 10% ground cover of shrubs, or shrubs must constitute >1/3 of the total vegetation cover. Shrubs are defined as woody perennial plants, both evergreen and deciduous, that have a relatively low growth habit, and are generally multi-stemmed, rather than having one bole. They differ from a tree by their low stature (generally < 10m) and non-treelike form.
1.2.1.2. Herbs	If a polygon does not meet the definition of a shrub, then it can be classed as Herb if it has a minimum of 20% ground cover of herbs, or herbs constitute > 1/3 of total vegetation cover. Herbs are defined as vascular plants without a woody stem, including ferns, fern allies, grasses, and grass-like plants
1.2.1.2.1. Graminoids	A Herb polygon is further classified as Graminoid if graminoids account for >50% of the herb cover. Graminoids are defined as herbaceous plants with long, narrow leaf characterized by linear venation; including grasses, sedges, rushes and other related species.
1.2.1.2.2. Forbs	A Herb polygon is further classified as Forb if forbs account for >50% of the herb cover. Forbs are defined as herbaceous plants other than graminoids, including ferns, club mosses, and horsetails.
1.2.1.3. Bryoids	If a Non-treed polygon does not meet the definition of Shrub or Herb, then it can be classed as Bryoid if it has >50% of the vegetation cover in bryoids, and herb and shrub cover must each constitute < 20%. Bryoids are defined as bryophytes (mosses, liverworts and hornworts) and lichens (foliose or fruticose; not crustose).
1.2.2. Upland	See vegetated-treed
1.2.2.1. Shrubs	For a polygon to be classed as Shrub, it must have a minimum of 10% ground cover of shrubs, or shrubs must constitute >1/3 of the total vegetation cover. Shrubs are defined as woody perennial plants, both evergreen and deciduous, that have a relatively low growth habit, and are generally multi-stemmed, rather than having one bole. They differ from a tree by their low stature (generally < 10m) and non-treelike form.
1.2.2.2. Herbs	If a polygon does not meet the definition of a shrub, then it can be classed as Herb if it has a minimum of 20% ground cover of herbs, or herbs constitute > 1/3 of total vegetation cover. Herbs are defined as vascular plants without a woody stem, including ferns, fern allies, grasses, and grass-like plants
1.2.2.2.1. Graminoids	A Herb polygon is further classified as Graminoid if graminoids account for >50% of the herb cover. Graminoids are defined as herbaceous plants with long, narrow leaf characterized by linear venation; including grasses, sedges, rushes and other related species.

1.2.2.2. Forbs	A Herb polygon is further classified as Forb if forbs account for >50% of the herb cover. Forbs are defined as herbaceous plants other than graminoids, including ferns, club mosses, and horsetails.
1.2.2.3. Bryoids	If a Non-treed polygon does not meet the definition of Shrub or Herb, then it can be classed as Bryoid if it has >50% of the vegetation cover in bryoids, and herb and shrub cover must each constitute < 20%. Bryoids are defined as bryophytes (mosses, liverworts and hornworts) and lichens (foliose or fruticose; not crustose).
1.2.3. Alpine	See vegetated-treed
1.2.3.1. Shrubs	For a polygon to be classed as Shrub, it must have a minimum of 10% ground cover of shrubs, or shrubs must constitute >1/3 of the total vegetation cover. Shrubs are defined as woody perennial plants, both evergreen and deciduous, that have a relatively low growth habit, and are generally multi-stemmed, rather than having one bole. They differ from a tree by their low stature (generally < 10m) and non-treelike form.
1.2.3.2. Herbs	If a polygon does not meet the definition of a shrub, then it can be classed as Herb if it has a minimum of 20% ground cover of herbs, or herbs constitute > 1/3 of total vegetation cover. Herbs are defined as vascular plants without a woody stem, including ferns, fern allies, grasses, and grass-like plants
1.2.3.2.1. Graminoids	A Herb polygon is further classified as Graminoid if graminoids account for >50% of the herb cover. Graminoids are defined as herbaceous plants with long, narrow leaf characterized by linear venation; including grasses, sedges, rushes and other related species.
1.2.3.2.2. Forbs	A Herb polygon is further classified as Forb if forbs account for >50% of the herb cover. Forbs are defined as herbaceous plants other than graminoids, including ferns, club mosses, and horsetails.
1.2.3.3. Bryoids	If a Non-treed polygon does not meet the definition of Shrub or Herb, then it can be classed as Bryoid if it has >50% of the vegetation cover in bryoids, and herb and shrub cover must each constitute < 20%. Bryoids are defined as bryophytes (mosses, liverworts and hornworts) and lichens (foliose or fruticose; not crustose).
2. Non-vegetated	Total cover of trees, shrubs, herbs and bryoids is <5% of the total surface area of the polygon. Bodies of water are to be classified as Non-Vegetated.
2.1. Land	>50% of the polygon is occupied by land.
2.1.1. Wetland	See vegetated-treed
2.1.1.1. Snow/Ice	
2.1.1.1.1. Glacier	A mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction.
2.1.1.1.2. Snow cover	Snow or ice that is not part of a glacier, but is found during summer months on the landscape.
2.1.1.2. Rock/Rubble	
2.1.1.2.1. Bedrock	Unfragmented, consolidated rock contiguous with the underlying material.

2.1.1.2.2. Rubble, Talus, Blockfield	Fragmented rock, broken away from bedrock surface and moved to present place by gravity or ice.
2.1.1.2.3. Rubbly Mine Spoils	Discarded overburden or waste rock moved to extract ore during a mining operation.
2.1.1.2.4. Lava Bed	Area where molten rock has flowed from volcano or fissure and cooled and solidified to form rock.
2.1.1.3. Exposed Land	
2.1.1.3.1. River Sediments	Silt, gravel, and sand bars associated with former river channels and present river edges
2.1.1.3.2. Exposed Soil	Any exposed soil not covered by the other categories, such as areas of recent disturbance including mud slides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way or cultivated fields, where vegetation cover is < 5%
2.1.1.3.3. Pond or Lake Sediments	Exposed sediments related to dried-up lakes or ponds
2.1.1.3.4. Reservoir Margin	Land exposed by a drained or fluctuating reservoir It is found above "normal" water levels and may consist of a range of substrates including gravel, cobbles, fine sediments, or bedrock.
2.1.1.3.5. Beach	An area with sorted sediments reworked in recent time by wave actions. It may be formed at the edge of fresh or salt water bodies.
2.1.1.3.6. Landing	A compacted area adjacent to a road used for sorting and loading logs
2.1.1.3.7. Burned Area	Land showing evidence of recent burning, either natural or prescribed. Vegetation of < 5% crown cover is present at the time of polygon description.
2.1.1.3.8. Road Surface	An area cleared and compacted for the purpose of transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be classified as non-vegetated.
2.1.1.3.9. Mudflat Sediment	Flat plain-like areas associated with lakes, ponds, rivers, or streams, dominated by fine-textured sediments. They can be associated with freshwater or estuarine sources.
2.1.1.3.10. Cutbank	Part of a road corridor created upslope of the road surface by excavation into the hillside. "Natural" forces may also create Cutbanks.
2.1.1.3.11. Moraine	An area of debris transported and deposited by a glacier.
2.1.1.3.12. Gravel or Borrow Pit	An area exposed through the removal of sand and gravel.
2.1.1.3.13. Tailings	An area containing the solid waste material produced by the mining and milling of ore.
2.1.1.3.14. Railway Surface	A roadbed with fixed rails, may contain single or multiple rail lines.
2.1.1.3.15. Buildings and Parking	Buildings and parking: buildings and associated developments such as roads and parking areas.
2.1.1.3.16. Airport	A permanently paved or graveled area, and associated buildings and parking, use by airplanes.
2.1.1.3.17. Open pit Mine	An exposed area use to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.
2.1.1.3.18. Other	None of the other exposed land categories can be reliably chosen.

2.1.2. Upland	See vegetated-treed
2.1.2.1. Snow/Ice	
2.1.2.1.1. Glacier	A mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction.
2.1.2.1.2. Snow cover	Snow or ice that is not part of a glacier, but is found during summer months on the landscape.
2.1.2.2. Rock/Rubble	
2.1.2.2.1. Bedrock	Unfragmented, consolidated rock contiguous with the underlying material.
2.1.2.2.2. Rubble, Talus, Blockfield	Fragmented rock, broken away from bedrock surfaces and moved into its present position by gravity or ice.
2.1.2.2.3. Rubbly Mine Spoils	Discarded overburden or waste rock moved to extract ore during a mining operation.
2.1.2.2.4. Lava Bed	An area where molten rock has flowed from a volcano or fissure and cooled and solidified to form rock.
2.1.2.3. Exposed Land	
2.1.2.3.1. River Sediments	Silt, gravel, and sand bars associated with former river channels and present river edges
2.1.2.3.2. Exposed Soil	Any exposed soil not covered by the other categories, such as areas of recent disturbance including mud slides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way or cultivated fields, where vegetation cover is < 5%
2.1.2.3.3. Pond or Lake Sediments	Exposed sediments related to dried-up lakes or ponds
2.1.2.3.4. Reservoir Margin	Land exposed by a drained or fluctuating reservoir It is found above "normal" water levels and may consist of a range of substrates including gravel, cobbles, fine sediments, or bedrock.
2.1.2.3.5. Beach	An area with sorted sediments reworked in recent time by wave actions. It may be formed at the edge of fresh or salt water bodies.
2.1.2.3.6. Landing	A compacted area adjacent to a road used for sorting and loading logs
2.1.2.3.7. Burned Area	Land showing evidence of recent burning, either natural or prescribed. Vegetation of < 5% crown cover is present at the time of polygon description.
2.1.2.3.8. Road Surface	An area cleared and compacted for the purpose of transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be classified as non-vegetated.
2.1.2.3.9. Mudflat Sediment	Flat plain-like areas associated with lakes, ponds, rivers, or streams, dominated by fine-textured sediments. They can be associated with freshwater or estuarine sources.
2.1.2.3.10. Cutbank	Part of a road corridor created upslope of the road surface by excavation into the hillside. "Natural" forces may also create Cutbanks.
2.1.2.3.11. Moraine	An area of debris transported and deposited by a glacier.
2.1.2.3.12. Gravel or Borrow Pit	An area exposed through the removal of sand and gravel.
2.1.2.3.13. Tailings	An area containing the solid waste material produced by the mining and milling of ore.
2.1.2.3.14. Railway	A roadbed with fixed rails, may contain single or multiple rail lines.

Surface	
2.1.2.3.15. Buildings and Parking	Buildings and parking: buildings and associated developments such as roads and parking areas.
2.1.2.3.16. Airport	A permanently paved or graveled area, and associated buildings and parking, use by airplanes.
2.1.2.3.17. Open pit Mine	An exposed area use to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.
2.1.2.3.18. Other	None of the other exposed land categories can be reliably chosen.
2.1.3. Alpine	See vegetated-treed
2.1.3.1. Snow/Ice	
2.1.3.1.1. Glacier	A mass of perennial snow and ice with definite lateral limits, typically flowing in a particular direction.
2.1.3.1.2. Snow cover	Snow or ice that is not part of a glacier, but is found during summer months on the landscape.
2.1.3.2. Rock/Rubble	
2.1.3.2.1. Bedrock	Unfragmented, consolidated rock contiguous with the underlying material.
2.1.3.2.2. Rubble, Talus, Blockfield	Fragmented rock, broken away from bedrock surfaces and moved into its present position by gravity or ice.
2.1.3.2.3. Rubbly Mine Spoils	Discarded overburden or waste rock moved to extract ore during a mining operation.
2.1.3.2.4. Lava Bed	Area where molten rock has flowed from volcano or fissure and cooled and solidified to form rock.
2.1.3.3. Exposed Land	
2.1.3.3.1. River Sediments	Silt, gravel, and sand bars associated with former river channels and present river edges
2.1.3.3.2. Exposed Soil	Any exposed soil not covered by the other categories, such as areas of recent disturbance including mud slides, debris torrents, avalanches, or disturbances such as pipeline rights-of-way or cultivated fields, where vegetation cover is < 5%
2.1.3.3.3. Pond or Lake Sediments	Exposed sediments related to dried-up lakes or ponds
2.1.3.3.4. Reservoir Margin	Land exposed by a drained or fluctuating reservoir It is found above "normal" water levels and may consist of a range of substrates including gravel, cobbles, fine sediments, or bedrock.
2.1.3.3.5. Beach	An area with sorted sediments reworked in recent time by wave actions. It may be formed at the edge of fresh or salt water bodies.
2.1.3.3.6. Landing	A compacted area adjacent to a road used for sorting and loading logs
2.1.3.3.7. Burned Area	Land showing evidence of recent burning, either natural or prescribed. Vegetation of < 5% crown cover is present at the time of polygon description.
2.1.3.3.8. Road Surface	An area cleared and compacted for the purpose of transporting goods and services by vehicles. Older roads that are used infrequently or not at all may cease to be classified as non-vegetated.
2.1.3.3.9. Mudflat Sediment	Flat plain-like areas associated with lakes, ponds, rivers, or streams, dominated by fine-textured sediments. They can be associated with

	freshwater or estuarine sources.
2.1.3.3.10. Cutbank	Part of a road corridor created upslope of the road surface by excavation into the hillside. "Natural" forces may also create Cutbanks.
2.1.3.3.11. Moraine	An area of debris transported and deposited by a glacier.
2.1.3.3.12. Gravel or Borrow Pit	An area exposed through the removal of sand and gravel.
2.1.3.3.13. Tailings	An area containing the solid waste material produced by the mining and milling of ore.
2.1.3.3.14. Railway Surface	A roadbed with fixed rails, may contain single or multiple rail lines.
2.1.3.3.15. Buildings and Parking	Buildings and parking: buildings and associated developments such as roads and parking areas.
2.1.3.3.16. Airport	A permanently paved or graveled area, and associated buildings and parking, use by airplanes.
2.1.3.3.17. Open pit Mine	An exposed area use to extract ore during a mining operation. This may contain associated buildings and any tailing produced by the mining and milling process.
2.1.3.3.18. Other	None of the other exposed land categories can be reliably chosen.
2.2 Water	
2.2.1. Wetland	See vegetated-treed
2.2.1.1. Lake	A naturally occurring static body of water more > 2m deep in some portion. The boundary for the lake is the natural high water mark.
2.2.1.2. Reservoir	An artificial basin affected by impoundment of water behind a human fabricated structure such as a dam, berm, dyke, or wall.
2.2.1.3. River/Stream	A watercourse formed when water flows between continuous, definable banks. Flow may be intermittent or perennial, but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that have definable banks are not.
2.2.1.4. Salt Water	A naturally occurring body of water containing salt or generally considered to be salty.
2.2.2. Upland	See vegetated-treed
2.2.2.1. Lake	A naturally occurring static body of water more > 2m deep in some portion. The boundary for the lake is the natural high water mark.
2.2.2.2. Reservoir	An artificial basin affected by impoundment of water behind a human fabricated structure such as a dam, berm, dyke, or wall.
2.2.2.3. River/Stream	A watercourse formed when water flows between continuous, definable banks. Flow may be intermittent or perennial, but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that have definable banks are not.
2.2.2.4. Salt Water	A naturally occurring body of water containing salt or generally considered to be salty.
2.2.3. Alpine	See vegetated-treed
2.2.3.1. Lake	A naturally occurring static body of water more > 2m deep in some portion. The boundary for the lake is the natural high water mark.
2.2.3.2. Reservoir	An artificial basin affected by impoundment of water behind a human

	fabricated structure such as a dam, berm, dyke, or wall.
2.2.3.3. River/Stream	A watercourse formed when water flows between continuous, definable banks. Flow may be intermittent or perennial, but does not include ephemeral flow where a channel with no definable banks is present. Gravel bars are part of a stream, while islands within a stream that have definable banks are not.
2.2.3.4. Salt Water	A naturally occurring body of water containing salt or generally considered to be salty.

Each polygon class of the NFI Land Cover Classification Scheme is also defined by its density class which is defined below.

Dense	Tree, shrub, or herb cover is between 61% and 100% crown closure for the polygon.
Closed	This density class is strictly for Bryoid polygons where the cover of bryoids is >50% of the polygon.
Open	Tree, shrub, or herb cover is between 26% and 60% crown closure for the polygon. For Bryoid polygons, the cover of bryoids ≤ 50% of the total polygon.
Sparse	Tree cover is between 10% and 25% crown closure for treed polygons or cover is between 20-25% for shrub or herb cover polygons.