Canadian National Vegetation Classification:

Status report of units described in Canada [draft]

Faber-Langendoen, D., K. Snow, and M. Lee

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NatureServe. 2022. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of May 3, 2022.

NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, a national program in Canada (NatureServe Canada) and Conservation Data Centres (CDC) in Canada. Ecologists from the following organizations have contributed the development of the CNVC classification, which at broad scales contains types that cover North America and beyond.:

United States

Central NatureServe Office, Arlington, VA; Eastern Regional Office, Boston, MA; Midwestern Regional Office, Minneapolis, MN; Southeastern Regional Office, Durham, NC; Western Regional Office, Boulder, CO; Alabama Natural Heritage Program, Montgomery AL; Alaska Natural Heritage Program, Anchorage, AK; Arizona Heritage Data Management Center, Phoenix AZ; Arkansas Natural Heritage Commission Little Rock, AR; Blue Ridge Parkway, Asheville, NC; California Natural Heritage Program, Sacramento, CA; Colorado Natural Heritage Program, Fort Collins, CO; Connecticut Natural Diversity Database, Hartford, CT; Delaware Natural Heritage Program, Smyrna, DE; District of Columbia Natural Heritage Program/National Capital Region Conservation Data Center, Washington DC; Florida Natural Areas Inventory, Tallahassee, FL; Georgia Natural Heritage Program, Social Circle, GA; Great Smoky Mountains National Park, Gatlinburg, TN; Gulf Islands National Seashore, Gulf Breeze, FL; Hawaii Natural Heritage Program, Honolulu, Hawaii; Idaho Conservation Data Center, Boise, ID; Illinois Natural Heritage Division/Illinois Natural Heritage Database Program, Springfield, IL; Indiana Natural Heritage Data Center, Indianapolis, IN; Iowa Natural Areas Inventory, Des Moines, IA; Kansas Natural Heritage Inventory, Lawrence, KS; Kentucky Natural Heritage Program, Frankfort, KY; Louisiana Natural Heritage Program, Baton Rouge, LA; Maine Natural Areas Program, Augusta, ME; Mammoth Cave National Park, Mammoth Cave, KY; Maryland Wildlife & Heritage Division, Annapolis, MD; Massachusetts Natural Heritage & Endangered Species Program, Westborough, MA; Michigan Natural Features Inventory, Lansing, MI; Minnesota Natural Heritage & Nongame Research and Minnesota County Biological Survey, St. Paul, MN; Mississippi Natural Heritage Program, Jackson, MI; Missouri Natural Heritage Database, Jefferson City, MO; Montana Natural Heritage Program, Helena, MT; National Forest in North Carolina, Asheville, NC; National Forests in Florida, Tallahassee, FL; National Park Service, Southeastern Regional Office, Atlanta, GA; Navajo Natural Heritage Program, Window Rock, AZ; Nebraska Natural Heritage Program, Lincoln, NE; Nevada Natural Heritage Program, Carson City, NV; New Hampshire Natural Heritage Inventory, Concord, NH; New Jersey Natural Heritage Program, Trenton, NJ; New Mexico Natural Heritage Program, Albuquerque , NM; New York Natural Heritage Program, Latham, NY; North Carolina Natural Heritage Program, Raleigh, NC; North Dakota Natural Heritage Inventory, Bismarck, ND; Ohio Natural Heritage Database, Columbus, OH; Oklahoma Natural Heritage Inventory, Norman, OK; Oregon Natural Heritage Program, Portland, OR; Pennsylvania Natural Diversity Inventory, PA; Rhode Island Natural Heritage Program, Providence, RI; South Carolina Heritage Trust, Columbia, SC; South Dakota Natural Heritage Data Base, Pierre, SD; Tennessee Division of Natural Heritage, Nashville, TN; Tennessee Valley Authority Heritage Program, Norris, TN; Texas Conservation Data Center, San Antonio, TX; Utah Natural Heritage Program, Salt Lake City, UT; Vermont Nongame & Natural Heritage Program, Waterbury, VT; Virginia Division of Natural Heritage, Richmond, VA; Washington Natural Heritage Program, Olympia, WA; West Virginia Natural Heritage Program, Elkins, WV; Wisconsin Natural Heritage Program, Madison, WI; Wyoming Natural Diversity Database, Laramie, WY

Canada

Alberta Natural Heritage Information Centre, Edmonton, AB, Canada; Atlantic Canada Conservation Data Centre, Sackville, New Brunswick, Canada; British Columbia Conservation Data Centre, Victoria, BC, Canada; Manitoba Conservation Data Centre. Winnipeg, MB, Canada; Ontario Natural Heritage Information Centre, Peterborough, ON, Canada; Quebec Conservation Data Centre, Quebec, QC, Canada; Saskatchewan Conservation Data Centre, Regina, SK, Canada; Yukon Conservation Data Centre, Yukon, Canada

NatureServe also has partnered with many International and United States Federal and State organizations, which have also contributed significantly to the development of the International Vegetation Classification. Partners include the following The Nature Conservancy; Provincial Forest Ecosystem Classification Groups in Canada; Canadian Forest Service; Parks Canada; United States Forest Service; National GAP Analysis Program; United States National Park Service; United States Fish and Wildlife Service; United States Geological Survey; United States Department of Defense; Ecological Society of America; Environmental Protection Agency; Natural Resource Conservation Services; United States Department of Energy; and the Tennessee Valley Authority. Many individual state organizations and people from academic institutions have also contributed to the development of this classification.

EXECUTIVE SUMMARY

Introduction

The primary purpose of the Canadian National Vegetation Classification[1] (CNVC) is to provide a consistent, systematic, and authoritative classification and description of Canadian ecosystems, based on vegetation patterns in the context of ecological processes. A set of principles, methods, and peer review procedures have been published to support the work, guided by the CNVC Technical Committee and provincial and territorial experts. Support for the CNVC has come from provincial, territorial, and federal governments, primarily in the form of in-kind contributions (e.g., staff time). Financial support over the course of the multi-decades long project was provided primarily by Natural Resources Canada - Canadian Forest Service and more recently by Environment and Climate Change Canada and NatureServe Canada.

At this time, publications of types have been completed for much of the boreal forest and pacific coastal forest types. However, the CNVC remains incomplete for many vegetation types in Canada, limiting its ability to provide an authoritative classification. To help advance development of the CNVC, we first provide background on the CNVC, then develop a methodology and provide results for a synopsis of all types reported in Canada, and which are available for peer review. This peer review is the next and critical step in completing the CNVC and would entail a national effort led by the provincial and territorial governments. Confirming resourcing for such a multi-year project remains a priority of the provincial and territorial CNVC Technical Committee members.

Background

As background, the CNVC, together with the U.S. National Vegetation Classification and the International Vegetation Classification (IVC), uses the eight-level EcoVeg hierarchical structure that was developed by an international group of scientists from the western hemisphere. Generally, the CNVC Technical Committee has interpreted the hierarchy levels in the same way as does the USNVC, and the CNVC has adopted all types in the upper four levels that occur in Canada. For the bottom four levels, the Technical Committee has emphasized the ecological context for Canadian vegetation conditions.

Methods

In this report, we continue to follow the principles and methods of the CNVC. Our methodology emphasizes synthesizing existing scientific knowledge for the Macrogroup to Association levels of the CNVC hierarchy, but with a particular focus on the Group, Alliance, and Association levels, as these are the most incomplete. Much of the information for this synthesis exists in prototype form for the CNVC, in part through previous collaborations with federal and provincial-territorial agencies, Conservation Data Centres (CDCs), USNVC and IVC partners, and others. Only units that have already been described and documented through these partnerships are provided as provisional types to be considered for addition to the CNVC. We limit our reporting of such units as they have compiled in the NatureServe Biotics classification database.

Results

Total Count

The total count of Canadian vegetation types based on a synthesis of confirmed and accepted types is provided in the table below. Counts by jurisdiction are also provided. No changes were made to types

[1] http://cnvc-cnvc.ca/

in the top four levels of the hierarchy.

Level	Level Name	Confirmed and Provisional types
Level 1	Class	6
Level 2	Subclass	8
Level 3	Formation	20
Level 4	Division	38
Level 5	Macrogroup	97
Level 6	Group	242
Level 7	Alliance	613
Level 8	Association	1379

Macrogroup

In addition to the 76 Macrogroups that were previously confirmed or provisionally accepted for the CNVC, we added 25 more, of which 11 are Ruderal (invasive naturalized or weedy native) macrogroups that were not previously listed because the focus was on natural types. An additional 6 are marginal, 3 are a result of splits to two existing CNVC macrogroups, 4 are provisional splits of two existing macrogroups, and 1 is a new provisional type.

Groups, Alliances, Associations

We list 242 Groups, 613 Alliances, and 1379 Associations for Canada. Apart from those from boreal or Vancouverian forests (see Chapman et al. 2020), all are provisional and require peer review.

Descriptions

A set of descriptions are provided for all Canadian vegetation types, organized by the CNVC hierarchy (Appendix B). These descriptions were generated from the NatureServe Biotics database. Not shown are the provincial/territorial types that help form the basis for these units, but this information is available in the database. Global ranks (G-ranks) are provided, where available, for Groups and for Associations. Although many of these units are provisional in Canada, we provide the ranks to highlight the potential at-risk status of these units, should they be confirmed.

This report includes many provisional, as well as accepted, types. As noted in our Methods section, **all provisional types are flagged as such in the description.** This is because, although they are well documented, their concepts have not been fully vetted by experts across Canada.

Discussion

In this report we catalog a large number of Associations, Alliances, and Groups from the USNVC and IVC that are listed as present in Canada. Many of these units have already received some review from Canadian partners, but have not been formally confirmed by a process overseen by the CNVC Committee. Our goal is to provide enough information to indicate how we are describing the range of variation in vegetation patterns at multiple scales.

The process of peer review for the large number of units is a large undertaking. A draft workplan is provided, and we will work with the CNVC Committee to develop a formal workplan and budget that would be required to complete this work.

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ACKNOWLEDGEMENTS

We acknowledge the longstanding contribution of many participants in the Canadian National Vegetation Classification (CNVC), since its inception in 2000. The partners involved its development consisted of representatives from all active provincial/ territorial ecological classification programs, some provincial/ territorial/ regional conservation data centres (CDCs), NatureServe (US) and NatureServe Canada, and two federal government agencies (NRCan – CFS and Parks Canada). From 2000 – 2017 the effort was led by Natural Resources Canada, Canadian Forest Service, under the direction of Ken Baldwin. Baldwin et al. (2019, Table 1) provides a list of participants who contributed during those years, including the main partner organizations and their primary representatives who have contributed to the work. In addition, the CNVC Technical Committee has overseen governance of the CNVC. The Technical Committee comprised individuals with expertise in ecological classification from across Canada and successfully guided CNVC development through 2018. The CNVC Technical Committee has continued to guide CNVC development, and is currently co-chaired by Nadele Flynn, (Yukon Government) and Don Faber-Langendoen (NatureServe).

In 2018, NatureServe Canada assumed primary responsibility for maintaining the CNVC, and we thank Patrick Henry, Executive Director for his ongoing support. We thank Charles Francis at Environment Climate Change Canada (ECCC) for his support and ECCC's financial support to advance components of the CNVC during recent fiscal years

The work contained in this publication represents a synthesis of a vast and extensive set of vegetation ecology experts, too many to catalogue here on an individual basis. We acknowledge the authorship of all CNVC types and provisional types reported for Canada within each of the descriptions.

This report is a first draft of a status report on Canada's vegetation that we intend to have peer reviewed throughout Canada. We look forward to the contributions from many experts across the provinces and territories.

INTRODUCTION

The primary purpose of the Canadian National Vegetation Classification is to provide a consistent, systematic, and authoritative classification and description of Canadian ecosystems, based on vegetation patterns in the context of ecological processes. The CNVC is an important tool for coordinating the exchange of ecological information among multiple user groups to support research and land management activities, including a) serving as a standardized ecological framework and language, b) providing ecologically meaningful units for reporting, c) supporting monitoring and predicting change, d) informing ecosystem-based management, and e) assisting in conservation planning. For example, the CNVC can serve as a standard for describing the vegetation of ecological units of the Canadian Terrestrial Ecological Framework, especially for ecozones and ecoregions, and ultimately for ecodistricts. It can also integrate information from the provinces and territories on distribution, conservation status, and management practices. However, despite rigorous publications of boreal forest and pacific coastal forest types, at this time the CNVC remains incomplete for many vegetation types in Canada, limiting its ability to provide an authoritative classification.

Development of the CNVC[2] began in 2000, guided by a CNVC Technical Committee (hereafter "Committee"), with close partnership from key vegetation ecologists in the jurisdictions. The Committee adopted an 8-level hierarchy based on the EcoVeg approach, which was developed by an international team that included members of the Committee (Faber-Langendoen 2014). It has continued to review units of the International Vegetation Classification (IVC) and U.S. National Vegetation Classification (Faber-Langendoen et al. 2018, Baldwin et al. 2019) for their applicability in Canada, making it feasible to exchange information at both national and international levels. The shared hierarchy approach means that provincial and territorial partners can view their units in both a national and international context.

Development of a full CNVC has not yet been within reach, partly because the approach for its development at the lower 3 levels required a plot-based "analytical approach." The plot-analytic approach was valuable in helping interpret relationships between the standard CNVC unit and its territorial unit counterparts, but it was both time-consuming and limited to Canadian types that had plot data. For that reason, a complimentary "synthetic approach" is implemented here, in which all existing information on Canadian vegetation is compiled from existing types already listed in the USNVC and IVC.

Here we provide a background on the principles and methods of the CNVC, including description of the plot-analytical approach and the complementary approach based on other information sources (the synthetic approach). We then combine the information available from both approaches to provide a first draft approximation of all vegetation types in Canada at all 8 levels of the hierarchy. Our goal is to make the CNVC operational within a 3-year period for various applications and continue to refine it as new information comes in.

BACKGROUND

Because the purpose of this report is to build on the existing work already accomplished by the CNVC Technical Committee under the leadership of NRCAN Canadian Forest Service from 2000-2018, we provide an extensive background on its development during that time period. The text for this background is largely taken from Baldwin et al. (2019).

Classification Principles

The Committee was led by Natural Resources Canada - Canadian Forest Service (CFS) staff from 2000-2017, who worked with the Committee to complete a publication on the overall guiding principles for the CNVC (Baldwin et al. 2019). Those principles were developed in conjunction with the USNVC and IVC (Faber-Langendoen et al. 2018). Core principles are as follows (Baldwin et al. 2019):

The CNVC uses the primary EcoVeg principles for natural vegetation classification (i.e., Faber-Langendoen et al. 2014; 2018), which are re-stated briefly below with modifications for Canadian application. The core principles of the CNVC are as follows:

1. Types define and describe existing natural mature vegetation in relation to ecological processes.
2. Types are defined by vegetation characteristics and can be characterized by their physiognomy (i.e., dominant growth form and stand structure), diagnostic and dominant species, and overall floristic composition.
3. Types are based on the highest quality information available. In the best case, quantitative ecological plot data collected for classification purposes are employed. In

[2] http://cnvc-cnvc.ca/index.cfm

the absence of such data, other information sources (e.g., incomplete plot data, literature sources, etc.) are used.

4. The hierarchical organization within the classification is based on ecological and biogeographical relationships expressed by the types. Types at different levels of the hierarchy use consistent diagnostic criteria within levels, but emphasize different criteria between levels.
5. Although the CNVC describes vegetation using nationally standardized criteria and nomenclature, it integrates with provincial/ territorial and regional classifications where possible and the integrity of antecedent subnational classification units is maintained.
6. Types are intended to be revised and expanded as new information and type concepts become available.

The CNVC has not treated cultural or ruderal vegetation (though the EcoVeg approach includes both).

Hierarchy Structure

The CNVC, together with the USNVC, uses the eight-level EcoVeg hierarchical structure that was developed by an international group of scientists from the western hemisphere (Faber-Langendoen et al. 2014). Generally, the CNVC Technical Committee has interpreted the hierarchy levels in the same way as does the USNVC, and the CNVC has adopted all types in the upper four levels that occur in Canada. For the bottom four levels, the Technical Committee has emphasized the ecological context for Canadian vegetation conditions (for a comparison of USNVC and CNVC interpretive approaches, see Faber-Langendoen et al. 2018, Supplement S3). Table 1 provides the CNVC definitions for each level of the hierarchy, with examples. Distinctions made between zonal and azonal vegetation at Macrogroup, Group, and Alliance levels.

Table 1. Definitions for vegetation types for the 8 levels of the CNVC hierarchy. Definitions on zonal sites differs somewhat from azonal sites. Zonal sites reflect regional-scale vegetation patterns, including successional trends, that are primarily attributable to climate influences, such as latitudinal, elevational, and continentality gradients. Azonal sites and types reflect vegetation patterns that are primarily attributable to site-scale environmental factors, such as edaphic or disturbance conditions (from Baldwin et al. 2019).

Natural Hierarchy		Definition	Example
Upper	L1 – Formation Class	A vegetation type defined by broad combinations of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.	**Scientific Name:** Mesomorphic Shrub & Herb Vegetation **Colloquial Name:** Shrub & Vegetation
	L2 – Formation Subclass	A vegetation type defined by a combination of general dominant and diagnostic growth forms that reflect global mega- or macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.	**Scientific Name:** Temperate & Boreal Shrub & Herb Vegetation **Colloquial Name:** Temperate & Boreal Grassland & Shrubland
	L3 – Formation	A vegetation type defined by combinations of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	**Scientific Name:** Temperate Shrub & Herb Vegetation **Colloquial Name:** Temperate Grassland & Shrubland
Mid	L4 – Division	A vegetation type defined by combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	**Scientific Name:** *Andropogon – Stipa – Bouteloua* Grassland & Shrubland **Colloquial Name:** Central North American Grassland & Shrubland
	L5 – Macrogroup	**CNVC AZONAL :** A vegetation type defined by moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic difference in composition and sub-continental to regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	**Scientific Name:** *Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans* Grassland & Shrubland **Colloquial Name:** Central Lowlands Tallgrass Prairie
		CNVC: ZONAL A regionally distinct subset of plant species composition, abundance and/or dominance, representing primary regional climatic gradients as reflected in vegetation patterns on circum-mesic ("zonal") sites.	**Colloquial Name:** Central Lowlands Tallgrass Prairie
	L6 – Group	**CNVC: AZONAL:** A vegetation type defined by a relatively narrow set of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Scientific Name: *Andropogon gerardii – Heterostipa spartea – Muhlenbergia richardsonis* Grassland **Colloquial Name:** Northern Tallgrass Prairie
		CNVC: ZONAL: An aggregation of Alliances within the regional vegetation defined by a Macrogroup (or subtype), with consistency in dominant and/or diagnostic species. Groups describe regionally generalized vegetation patterns attributable to ecological drivers such as edaphic or geological conditions within the Macrogroup (subtype), successional relationships within the Macrogroup (subtype), etc.	Scientific Name: *Andropogon gerardii – Heterostipa spartea – Muhlenbergia richardsonis* Grassland **Colloquial Name:** Northern Tallgrass Prairie
Lower	L7 – Alliance	**CNVC ZONAL:** A vegetation type defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation. Alliances reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	**Scientific Name:** *Andropogon gerardii – Sporobolus heterolepis – Muhlenbergia richardsonis* Northern Grassland **Colloquial Name:** Northern Mesic Tallgrass Prairie

		CNVC AZONAL : An aggregation of Associations, with consistency in dominant and/or diagnostic species, describing regionally repeating vegetation patterns at the local to sub-regional scale. Alliances are created by grouping Associations that are ecologically "related" into more generalized ecological types (e.g., successionally related Associations on similar edaphic conditions can be aggregated into more generalized Alliances).	Not yet developed for CNVC
	L8 – Association	**CNVC ZONAL and AZONAL:** A plant community type with consistency of species dominance and overall floristic composition, having a clearly interpretable ecological context in terms of site-scale climate, substrate and/or hydrology conditions, moisture/nutrient factors and disturbance regimes, as expressed by diagnostic indicator species.	**Scientific Name:** *Andropogon gerardii – Heterostipa spartea - Sporobolus heterolepis* Grassland **Colloquial Name:** Northern Mesic Big Bluestem Prairie

The upper three levels of the hierarchy, Formation Class, Formation Subclass, and Formation, use dominant and diagnostic growth forms as criteria to reflect environmental gradients at global to continental scales. The Division level uses dominant and diagnostic growth forms, as well as broad sets of diagnostic species, that reflect continental-scale biogeography and environmental factors.

At the fifth level of the hierarchy (**Macrogroup**), and at group and alliance levels, types are defined as either **zonal** or **azonal** types (Table 1). Zonal Macrogroups reflect regionally distinct subset of plant species composition, abundance and/or dominance, representing primary regional climatic gradients as reflected in vegetation patterns on circum-mesic ("zonal") sites. Conversely azonal Macrogroups are defined by moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic difference in composition and sub-continental to regional mesoclimate, geology, substrates, hydrology, and disturbance regimes. Regardless of zonality, Macrogroups reflect sub-continental to regional vegetation patterns and ecological processes. The Macrogroup level is the broadest level at which the CNVC describes the characteristics of types expressed in the Canadian part of their range.

The lowest three levels of the hierarchy, **Group**, **Alliance**, and **Association**, use species dominance, diagnostic indicator value, and overall floristic compositional similarity to describe zonal and azonal vegetation conditions that reflect site-scale environmental gradients. In the CNVC, Alliances and Groups are first- and second-order aggregates of Associations, respectively (i.e., Associations must be developed first). The Association (level 8) is the lowestl unit of the CNVC (Table 2). An Association describes a plant community with consistent species dominance and overall floristic composition. Each Association has a clearly interpretable ecological context in terms of site-scale climate, substrate and/or hydrologic conditions and seral status or disturbance regime, as expressed by a diagnostic combination of indicator species.

The CNVC permits subtypes for Macrogroups, Groups, Alliances, and Associations but so far has only used them at the Macrogroup and Association levels. Subtypes describe vegetation conditions that are not distinct enough to be recognized as formal types at their respective levels. CNVC Macrogroup subtypes are commonly used for upland Macrogroups to distinguish vegetation patterns that represent secondary gradients of regional climate or biogeography. Association subtypes ("subAssociations") describe consistent patterns of species occurrence or dominance that are not sufficiently significant for Association level distinctions. Table 2 summarizes the interpretive guidelines for developing CNVC types (or subtypes) at the Macrogroup, Group, Alliance, and Association levels. Consistent scaling of macrogroup, group,

and alliance concepts between Canada and international partners (USNVC and IVC) is an ongoing task.

Table 2. Interpretive guidelines for CNVC hierarchy levels from Macrogroup to Association. Bold text indicates criteria emphasized at each level. [adapted from Baldwin et al. 2019). (see Faber-Langendoen et al. 2014, 2018). Macrogroup subtype is an optional level available for zonal types.

Hierarchy Level	Biogeography / Floristics	Diagnostic Species	Physiognomy	Climate	Disturbance Regime / Succession	Edaphic / Geology / Hydrology
Macrogroup	**Sub-continental to regional**	**Sub-continental to regional subsets of species composition, abundance and/or dominance**	Broadly uniform; **differences distinguish Macrogroups** (e.g., forest vs woodland; mixedgrass vs tallgrass)	**Sub- continental to regional gradients distinguish Macrogroups**	Broadly consistent; indicative of regional climate (e.g., fire regime)	Broad range
Macrogroup subtype [zonal]	***subregional***	*Subregional subsets of species composition, abundance and/or dominance*	*Broadly uniform*	***subregional gradients (e.g., continentality, elevation, latitude) distinguish subtypes***	*Broadly consistent;* ***variation can distinguish subtypes*** *(e.g., maritime vs. continental fire regimes)*	*Broad range*
Group	**Subregional to local**	**Stand-level dominant and/or diagnostic species**	Generally uniform; **subregional or local variation can distinguish Groups** (e.g., dry woodlands vs mesic forests)	**local climate gradients (e.g., coastal) can distinguish Groups**	Typically consistent; may aggregate successionally related Alliances	**Moderate range; slightly broader than Alliances**
Alliance	**Subregional to local**	**Stand-level dominant and/or diagnostic species**	Uniform; **dominant growth form differences (e.g., conifer vs broadleaved) may distinguish Alliances**	Consistent local climate	Consistent; may aggregate successionally related Associations	**Narrow range slightly broader than Associations**
Association	**Local**	**Stand-level dominant and diagnostic species**	Uniform	Consistent site-scale climate; may have microclimatic interpretation	Consistent; **may have disturbance or successional relationships to other Associations**	**Narrow range; indicative of locally significant site factors**

Methods for Development of CNVC Types

CNVC types have been confirmed at all eight levels of the hierarchy (Baldwin et al. 2019, Chapman et al. 2020), most completely for Boreal forests and Vancouverian (Pacific Coastal) rainforests. Three types of methods were used, one for levels 1 -4, (top down synthetic approach), the second for Macrogroup development, the third for levels 6- 8 (bottom up plot analytical approach).

Type Development Levels 1 – 4 (Formation Class to Division)

Types at global and continental scales (i.e., the upper four levels of the hierarchy) were developed by the USNVC (see Faber-Langendoen et al. 2012, 2014; USNVC 2017) and were accepted by the CNVC Technical Committee. Thus Levels 1 – 4 are the same as the USNVC.

Type Development Levels 5 – 8 (Macrogroup to Association)

Within the lower four hierarchy levels, CNVC types have been defined using methodologies developed by the Technical Committee for the CNVC. Methods of type development have varied according to the hierarchy level (Table 2) and the quality of source information available. These data have been subsequently summarized to provide type descriptions.

Development of CNVC types for Levels 5 – 8 has followed three fundamental principles:

1. Types are based on the highest quality source information available; namely, wherever possible, type concepts are based on high quality ground plot data covering the range of the type's geographic and environmental variation (within Canada).
2. Wherever possible, types are developed by correlating existing provincial/ territorial/ regional types that meet CNVC conceptual standards; and
3. Types are confirmed through review and consensus by a bioregional expert panel.

Natural Resources Canada – Canadian Forest Service (NRCan – CFS) has led the development of types, including developing and maintaining CNVC databases, conducting analyses and proposing initial type concepts, as well as sponsoring, organizing and leading expert meetings. NRCan – CFS has assigned CNVC codes and names, led the development and production of factsheets, and developed and maintained the CNVC website.

Source of Information

Each CNVC type is based on the best available source information. The order of preference for source information is as follows:

1. High quality ecological plot data collected for classification purposes that includes the following attributes: description of floristic composition/ abundance/ dominance and vegetation structure; habitat description (including abiotic environmental factors and ecological process drivers); geo- coordinates and eco-regional distribution; metadata for primary data sources.
2. Ground plot data suitable for empirical analysis but with only limited attributes (e.g., data from a portion of the type's range, or qualitative descriptions of vegetation and/or environmental attributes).
3. Published types developed from empirical ground plot data that have quantitative data summaries, but lack specific details of plot data (i.e., numerical data summaries may be available, but not individual plot data).
4. Published types developed from partial ground plot data or qualitative information sources, or types with descriptions that lack quantitative data summaries.

Expert Review

Expert review is an integral part of CNVC type development. Throughout the development of all types, a review process has been used to ensure consistency of approach in applying classification criteria. The review process serves to:

1. Confirm the ecological integrity of types across their Canadian range, based on regional and local knowledge of plant community species composition and structure within the context of habitat and ecological process relationships;
2. Confirm the ecological equivalency of antecedent subnational units that are proposed to be aggregated within CNVC types;
3. Maximize the expertise that is applied to the developmental phase of the CNVC.

Bioregional review panels are created, as necessary, to review types. These panels require individuals with expertise in regional and local ecology, as well as an understanding of the broader standards and structure of the CNVC, to ensure consistency in the development of types. Review panels are listed for each published CNVC type under the "Concept Authors" field (Appendix 2).

Data Collation, Standardization, and Management

To date, the largest component of CNVC data has been the forest plot data collected by provincial/ territorial ecological classification programs. In some regions, data have also been supplied by NRCan – CFS and conservation data centres (Table 1). Jurisdictional data have been used with permissions from authors and jurisdictional authorities under the auspices of data-use agreements; data ownership is retained by the originating authors/ jurisdictions. Details of the Data Collation, Standardization, and use of VPro software for plot data management are fully described in Baldwin et al. (2019).

Analysis and Confirmation of Types

Analytical methods were selected to match the hierarchy level and the best available source information (i.e., exploratory numerical methods such as cluster analysis and ordination). The general analysis process for types at all levels can be outlined as follows:

1. Identify a "core" type concept using the diagnostic criteria emphasized at a specific hierarchy level (Table 3); concept proposals are developed using existing published classifications, expert opinion, data summaries, etc.;
2. Utilize the highest quality source information available to explore and refine the type concept;
3. Submit the proposed type to expert review by a panel of ecologists with bioregional expertise in the vegetation condition being considered (Table 1);
4. Iterate steps 1 to 3 until the type is confirmed by consensus of the expert review panel;
5. When the type is confirmed, prepare a type description complete with summary data from its constituent plots (where available).

Type Development Level 5: Macrogroup

A comprehensive list of all Macrogroups for Canada was published in Baldwin et al. (2019), using two information sources – plot data or other sources.

Macrogroup Development from Plot Data

Where high quality ecological plot data were available, they were used to develop Macrogroups and subtypes. Macrogroup and subtype development was led by NRCan – CFS staff, in consultation with provincial/ territorial experts, and ultimately reviewed by members of the Technical Committee with expertise in the vegetation condition under consideration. For further details, see Baldwin et al. (2019).

Macrogroup Development from Other Information Sources

In the absence of plot data, Macrogroups were developed by expert evaluation of core concepts against CNVC Macrogroup criteria, using other sources of information. In some cases, existing types in the USNVC or Canadian bioclimatic classifications have been confirmed as CNVC Macrogroups (e.g., CM332 [Great Plains Rough Fescue Prairie]). In other cases, types have been proposed from the USNVC or literature review and provisionally accepted for the CNVC pending evaluation of suitable plot data (e.g., M109 [Western North American Freshwater Aquatic Vegetation]).

The list of Macrogroups developed up to 2017 was provided in Baldwin et al. (2019, Appendix 1), Macrogroups have been confirmed for all zonal vegetation in Canada and provisionally accepted by the Technical Committee for most azonal conditions. The CNVC links well with the USNVC at the levels of Macrogroup, though certain zonal conditions are treated somewhat differently in the temperate zone.

CNVC often invokes Macrogroup subtypes to reflect vegetation patterns attributable to subregional bioclimatic or biogeographic variation. In many cases, subtypes facilitate harmonization with the USNVC (at either Macrogroup or Group scale), while allowing for recognition of existing Canadian bioclimatic divisions within the broader concept of a Macrogroup. Protocols used to propose and confirm subtypes are similar to those for Macrogroups, but subtypes are only developed if they are supported by plot data.

Type Development Levels 6 – 8: Group to Association

CNVC type development initially focused on Associations, then proceeded to Alliances and Groups, and later Macrogroups (but see above for Macrogroup development). Association development began in two areas of the country's forests, the Pacific coast and the boreal. Pacific coast Associations (described in the CNVC as "Vancouverian"; relevant types include all those in Divisions D192 [Vancouverian Forest & Woodland] and D193 [Vancouverian Flooded & Swamp Forest]) emerged from a collaborative international exercise to develop International Associations by correlating British Columbia coastal forest types with Associations from Washington and Oregon. The boreal region (relevant types include all those in Divisions D014 [North American Boreal Forest & Woodland] and D016 [North American Boreal Flooded & Swamp Forest]) was of particular interest to the Technical Committee, as this region occurs across Canada and has required coordination among all jurisdictions.

Alliances and Groups were treated as first and second-order, respectively, aggregations of Associations. Associations are aggregated based on the ecological criteria of Table 2. These criteria differ somewhat for upland conditions that include zonal vegetation (e.g., those in D192 and D014) and azonal conditions (e.g., D193 and D016).

Associations

Association development has been a priority for the Technical Committee from the outset. The decision was made early in the project to build these types from previously classified provincial/ territorial/ regional "plant community" types, to enhance the relevance and utility of the newly formed national Associations by maintaining links with the subnational classifications. All Associations confirmed to date have been developed from high quality ecological plot data Although no Associations have so far been developed using other sources of information, the Technical Committee has proposed methods for doing so, also described below (Section "Suggested Protocol For Association Development From Other Information Sources").

Association Development from Jurisdictional Types Using Plot Data

Ecosystem classification plot data from various jurisdictions were collated and standardized as described previously. Association analyses then consisted of comparisons/ correlations between antecedent jurisdictional "plant community" types ("site units") using VPro data summaries. The details of this process, and of the jurisdictional types, are described in Baldwin et al. (2019, Appendix 5). The goal of the analyses was to group ecologically equivalent and floristically similar jurisdictional types into conceptual CNVC Associations. The analyses were based on the jurisdictional type summaries, i.e., not on primary analysis of individual plot data, and the integrity of jurisdictional types was not modified by the CNVC correlation analysis. Further details on the Association development process with high quality plot data are provided in Baldwin et al. (2019), along with guidance for aggregatio of Associations into Alliances and Groups.

Suggested Protocol for Association Development from Other Information Sources

In the absence of high quality ecological plot data, other information sources can be utilized to create Associations. Development of Associations from lower quality information should follow the same general principles outlined at the beginning of the Type Development Levels 5 – 8 (Macrogroup to Association) section, except all assessment and evaluation steps for the proposed Associations should be by expert opinion in the absence of data summaries. Under these circumstances, it is imperative that specialists with expertise in the vegetation condition under consideration are consulted, especially to obtain knowledge of variability across the geographic range of the Association. An efficient way of consulting a group of specialists with expertise in different aspects of the subject (e.g., knowledge from different provinces/ territories) is to convene expert workshops. Some principles for this type of analysis are as follows:

1. Emphasis should be placed on Associations that are known to recur across the landscape in a consistent manner and in recognizable and uniform habitats or site conditions;
2. Information should be compiled into a standardized table structure designed to facilitate comparison between similar types;
3. Information should be compiled into the CNVC factsheet format, completing as many fields of the template as possible;
4. All source reports/ publications with similar types should be referenced in the factsheet;
5. Where information is very limited, Associations should be accepted provisionally, pending evaluation with additional data.

CNVC Type Names and Codes

Nomenclatural Guidelines and Codes for naming CNVC vegetation types are provided in Baldwin et al. (2019).

Summary of Hierarchy and Type Development 2000-2018

Organizational Structure: The CNVC is maintained by the CNVC Committee, which maintains a process for ongoing development, peer review and improvement. Development of the classification relies on partnerships with provincial and territorial governments for regional ecological expertise and data, and the CNVC benefits from international collaborations through comparisons with other national vegetation classifications. Oversight/funding Support for the CNVC has primarily come from Natural Resources Canada – Canadian Forest Service, as well as from NatureServe Canada

Principles, Methods, Status: The principles, methods, and status of the CNVC are published in Baldwin et al (2019). The CNVC, together with the USNVC, uses the eight-level EcoVeg hierarchical structure that was developed by an international group of scientists from the western hemisphere (Faber-Langendoen et al. 2014). Generally, the CNVC Technical Committee has interpreted the hierarchy levels in the same way as does the USNVC.

Levels 1 – 4 Formation Class to Division: The CNVC has adopted all types from the USNVC in the upper four levels that occur in Canada.

Protocols Level 5 – 8 Macrogroup to Association: Development of types for Levels 5 – 8 preferentially rely on plot data, but where they are absent or insufficient, protocols are provided to guide use from other information sources.

Level 5: Macrogroup: As of 2018, 76 Macrogroups had been confirmed or provisionally accepted for the CNVC (Baldwin et al. 2019, Appendix 1). In the large majority of cases, the CNVC has provisionally accepted the USNVC Macrogroup as an equivalent unit for Canada. In a few cases where USNVC Macrogroups did not meet CNVC criteria, they were not accepted. Instead, new CNVC types were developed either by adapting the concept of the USNVC Macrogroup to better fit the CNVC criteria and/or Canadian vegetation, or by data analysis, including the aggregation of lower level CNVC types (Appendix 6). All Macrogroup subtypes are unique to the CNVC since the USNVC does not currently recognize this hierarchy level.

Level 6 – 8: Group – Association: A catalogue of all Associations to 2018 is provided in Baldwin et al (Appendix 2). Alliances and Groups have been developed by aggregating these Associations. Associations, Alliances and Groups were developed for boreal divisions (D014 North American Boreal Forest & Woodland and D016 North American Boreal Flooded & Swamp Forest) and for Vancouverian divisions (D192 Vancouverian Forest & Woodland and D193 Vancouverian Flooded & Swamp Forest.

CNVC Products and Websites

The primary products of the CNVC are the classification hierarchy and factsheets of confirmed types. CNVC classification products and supporting documentation are available on the CNVC website (**cnvc-cnvc.ca**) as well as on the Natural Resources Canada, Canadian Forest Service Publications site (**cfs.nrcan.gc.ca/publications**). The CNVC website (**cnvc-cnvc.ca**) includes background information about the CNVC, a glossary of terms, botanical standards, links to other ecological classifications, and all CNVC publications, including factsheets. The website is currently

the only place where the CNVC hierarchy is maintained, including the English and French names for all types. The goal is to update the website as new types are developed or as names of types change (e.g., because of botanical nomenclatural changes). At present, factsheets are available for some Associations and Macrogroups (Appendices 1 and 2).

A secondary product of the CNVC is the map and accompanying report of **Vegetation Zones of Canada: A Biogeoclimatic Perspective** (Baldwin et al. 2019), also available on the website.

METHODS

In this report, we continue to follow the principles and methods of the CNVC, as outlined in the Background section (above). Our methodology in this report emphasizes synthesizing existing scientific knowledge across all eight levels of the CNVC hierarchy, but with the strongest focus on the Group, Alliance, and Association levels, where the units are most incomplete. The synthesis was guided by the principles of the CNVC and EcoVeg approach, and the criteria for each of the levels (See Table 1 and 2 above).

Much of the information for this synthesis exists in prototype form for parts of the CNVC, in part through previous collaborations with the International Vegetation Classification (Faber-Langendoen et al. 2018), including with provincial and territorial classifications that have been crosswalked to the IVC. As with past CNVC development, our methods are tailored to the various levels of the CNVC.

Development of Level 1 – 4: Formation to Division

We retain all the level 1 -4 units included in Baldwin et al. (2019), in which the method used was to adopt the levels provided by the USNVC and IVC.

Development of Level 5: Macrogroup

We developed Macrogroups by building on the work of Baldwin et al. (2019, Appendix 1). That report listed 76 Macrogroups that had been confirmed or provisionally accepted for the CNVC. Preferentially any new Macrogroups would be based on the plot data (the preferred methodology), but in the absence of plot data, we relied on the second methodology provided by Baldwin et al. (2019). That methodology was described as "Macrogroup development from other Information Sources;" namely, that Macrogroups are developed by expert evaluation of core concepts against CNVC Macrogroup criteria, using other sources of information. In all cases, additional Macrogroups added to the CNVC were based on existing descriptions from the USNVC, in which Macrogroups have been described and contain component Groups, Alliances, and Associations that have been reported for Canada.

Development of Level 6 – 8: Group, Alliance, Association

As with Macrogroups, our methods for developing Group, Alliance, and Association rely on Baldwin et al. (2019) protocol for development "Suggested Protocol For Association Development From Other Information Sources." Our development is limited to two steps:

1. Prior publication of types: Only units already described and documented from prior projects in Canada or for types shared with the USNVC are here provided as provisional types to be considered for addition to the CNVC (e.g., Diamond and Smeins 1988, Catling and Brownell 1995, Greenall 1996, Schneider et al. 1997, Lee et al. 1998, Reschke et al. 1998, Cadrin et al. 2018, Comer et al. 2018, Neufeld et al. 2018, Hoagland and Faber-Langendoen 2021). Thus, for

all types, there is supporting literature, and sometimes even plot data, albeit as published in the literature, rather than through analyses by the CNVC Committee.

2. Availability in NatureServe Biotics database. Much of the published information on Canadian vegetation types, from step 1 above, has been compiled in Biotics through partnerships with Canadian agencies, including through Conservation Data Centres (CDCs) that are part of the NatureServe Network. These types have been included in the IVC. For this initial synthesis, we rely on a list and set of descriptions for all such types reported in Canada.

Because this is an initial synthesis of a large body of information available in Canada, and because our major focus is on development of Group and Alliance level concepts, we include detailed descriptions of those two levels, and only briefly describe other levels. For the Association level, we only provide a listing and brief characterization within the Alliance unit that it is placed in. However, the Biotics database contains full descriptions for all levels, and these descriptions will be made available for peer review.

Descriptions and Data Management of Vegetation Types

Narrative Descriptions

The CNVC website (cnvc-cnvc.ca) provides the standard template for describing CNVC types. We have included as many fields in the NatureServe Biotics database as was needed for this synopsis, which only includes some of the fields that fully describe the type. Our goal is to provide enough information to indicate how we are describing the range of variation in vegetation patterns at multiple scales. A fuller set of fields are available for CNVC types and for IVC types shared with Canada. We will continue to work on enhancing Biotics so it can fully manage the CNVC information.

Plot Summaries

A powerful feature of the CNVC descriptions is the plot-based tabular summaries. It will take an additional data management process to compile those summaries into the Biotics Database. In addition, we would like the plot data to be fully accessible to the public, to allow for transparency and ongoing refinement to the types.

Provincial and Territorial Units

All units listed here, as with confirmed CNVC and USNVC units, are directly tied to jurisdictional units that have contributed to the vegetation type concept. In this report, we do not directly show those relationships in the description, but we will provide an Appendix that captures our current knowledge of those jurisdictional units. In addition, we will emphasize jurisdictional relationships at the Alliance level.

Conservation Status Assessment

NatureServe and our Network assess the conservation status of species and ecosystems to evaluate the risk that a given species will go extinct or a given ecosystem will collapse. For species, we assess full species and subspecific units. For ecosystems, ranking is conducted at multiple levels, from regional to local types; that is, Group, Alliance, and Association We have developed a rigorous, consistent, and repeatable method for evaluating and documenting the relative imperilment of both species and ecosystems based on the best available science (Master et al. 2012, Faber-Langendoen et al 2012). Using a 5-point scale from critically imperiled (1) to secure (5), we evaluate data and published studies to assign conservation status ranks at three geographic scales: global, national, and subnational. We call these Global, National, and Subnational Ranks (or “G-Ranks,” N-Ranks” and “S-Ranks”). Definitions for NatureServe's Conservation Status Ranks on NatureServe Explorer can be found at https://explorer.natureserve.org/AboutTheData/Statuses

Currently, G-ranks have been developed for Groups and for Associations. Although many of the units listed in this report are provisional in Canada, we provide the ranks to highlight the potential at-risk status of these units, should they be confirmed.

Peer Review and Provisional Status

Many of the groups and alliances listed in this report are provisional. **All provisional types are flagged as such in the description.** This is because, although they are well documented, their concepts have not been fully vetted by experts across Canada. These provisional types are open to peer review through collaboration with the CNVC Committee. At this time, our focus is on the Group and Alliance levels, and their linkage to provincial and territorial units and to currently described Associations. We will be developing a peer review process in the coming months (Appendix A).

RESULTS

Summary Across Levels

The total count of Canadian vegetation types based on a synthesis of confirmed and accepted types is provided in Table 3. No changes were made to types in the top four levels of the hierarchy, so this count is the same as for Baldwin et al. (2019).

Table 3. Count of Canadian vegetation types using the CNVC hierarchy. Types include both confirmed and provisional types.

Level	Level Name	Confirmed and Provisional types
Level 1	Class	6
Level 2	Subclass	8
Level 3	Formation	20
Level 4	Division	38
Level 5	Macrogroup	97
Level 6	Group	242
Level 7	Alliance	613
Level 8	Association	1379

Macrogroup

There are 97 macrogroups in this report, as compared to the 76 Macrogroups that were confirmed or provisionally accepted for the CNVC in Baldwin et al. (2019, Appendix 1). The additional 25 are shown in Table 4. Although at first this may appear to be a large additional set, 11 are Ruderal macrogroups (naturalized invasive vegetation or weedy native vegetation often found on abandoned farmland or other human-disturbed areas). These types were not listed in Baldwin et al. (2019) as the focus of that work was on natural vegetation types. Of the 14 that are new natural macrogroup types, 6 are added because there are a few associations that are marginally present in Canada from south of the border. These include two are marginal from the Central Midwest that extend into the prairie-woodland region of southwest Ontario (M884, M012), two are wetland macrogroups that are marginal in the Arid West of

British Columbia (M036, M888), two are coastal marsh types that are marginal along the Maritime Atlantic Coast (M067, M068). Of the remaining 8 types, four are a result of splitting two existing CNVC macrogroups to facilitate integration of IVC groups and alliances (CM014-1 and CM014-2, CM742a and CM742b), one is a distinct sandy grassland type in the Great Plains (M052), one is a new boreal cliff macrogroup (M895) that is the result of separating the boreal cliffs from 2 existing temperate macrogroups (M111 and M887), and two are new western North American montane (M893) and boreal (M894) wetland macrogroups (M894) (Table 4). Thus, of the 25 new macrogroups, 11 are ruderal, 6 are marginal, 3 are a result of splits to two existing CNVC macrogroups, 4 are provisional splits of two existing macrogroups, and 1 is a new provisional type.

Table 4. List of 25 new macrogroups not previously reported for Canada in Baldwin et al. (2019). Note that 11 are Ruderal macrogroups (in italics). These were not previously listed because the focus was on natural types. Explanations for the additional macrogroups is provided in the notes, including those that marginal to Canada from the United States, those resulting from proposed splits to existing CNVC macrogroups, and a new macrogroup.

Macrogroup	Macrogroup Name	Note
CM742a	Warm Eastern Canadian Temperate Deciduous Forest	split from CM742
M882	Central Midwest Mesic Forest	marginal
M012	Central Midwest Oak Forest, Woodland & Savanna	Marginal
CM014-2	Eastern North American Temperate Hardwood-Conifer Forest - Mesic	split from CM014
CM742b	Cool Eastern Canadian Temperate Deciduous Forest	split from CM742
CM014-1	Eastern North American Temperate Hardwood-Conifer Forest - Dry	split from CM014
M013	*Eastern North American Ruderal Forest*	*Ruderal*
M405	*Vancouverian Ruderal Forest*	*Ruderal*
M302	*Eastern North American Ruderal Flooded & Swamp Forest*	*Ruderal*
M036	Western Arid Lowland Riparian Forest	Marginal
M052	Great Plains Sand Grassland & Shrubland	New
M498	*Great Plains Ruderal Grassland & Shrubland*	*Ruderal*
M123	*Eastern North American Ruderal Grassland & Shrubland*	*Ruderal*
M493	*Western North American Ruderal Grassland & Shrubland*	*Ruderal*
M511	*North Pacific Coastal Ruderal Grassland & Shrubland*	*Ruderal*
M888	Arid West Interior Freshwater Marsh	Marginal
M893	Western North American Montane Marsh, Wet Meadow & Shrubland	split from M075
M301	*Western North American Ruderal Marsh, Wet Meadow & Shrubland*	*Ruderal*
M303	*Eastern-Southeastern North American Ruderal Marsh, Wet Meadow & Shrubland*	*Ruderal*
M067	Atlantic & Gulf Coastal Plain Wet Prairie & Marsh	marginal
M066	Atlantic & Gulf Coastal Fresh-Oligohaline Tidal Marsh	marginal
M894	North American Boreal Marsh, Wet Meadow & Shrubland	split from M075
M499	*Western North American Cool Semi-Desert Ruderal Scrub & Grassland*	*Ruderal*
M401	*North American Temperate Ruderal Aquatic Vegetation*	*Ruderal*
M895	North American Boreal Cliff, Scree & Rock Vegetation	split of boreal from temperate cliff

Groups and Alliances

We list 242 Groups and 613 Alliances for Canada (Table 3). Apart from those from boreal or Vancouverian forests (see Chapman et al. 2020), all are provisional and require peer review.

Associations

We list 1379 Associations for Canada (Table 3). As with the Groups and Alliances, apart from the boreal or Vancouverian forest associations listed in Chapman et al. (2020), all are provisional and require peer review.

Jurisdictional Summary

A summary of the counts of accepted and provisional types for each jurisdiction is shown in Table 5.

Table 5. Count of provisional and accepted vegetation types in each jurisdiction, listed using the lower 5 levels of the CNVC. Territories are first shown, from West to East, followed by the provinces, from west to east. Newfoundland and Labrador are shown both separately and together, and the Maritimes are also shown as a unit.

Level	Level Name	YT	NT	NU	BC	AB	SK	MB	ON	QC	NF	LB	NF+ LB	NB	PE	NS	Mari-times (NB,PEI, NS)
Level 4	Division	10	8	9	19	19	13	16	17	19	14	12	20	15	11	13	15
Level 5	Macrogroup	19	14	13	43	38	33	38	41	43	19	22	30	27	16	26	28
Level 6	Group	49	27	22	95	72	50	76	81	94	29	39	52	41	20	43	45
Level 7	Alliance	95	48	47	203	123	79	137	163	170	21	43	53	45	9	38	52
Level 8	Association	6	2	2	327	198	73	154	303	86	6	5	58	56	6	29	64
	Total	179	99	93	687	450	248	421	606	413	89	121	214	185	63	150	205

Descriptions of Vegetation Types

A set of descriptions are provided for all Canadian vegetation types, organized by the CNVC hierarchy (Appendix B). These descriptions were generated from the NatureServe Biotics database.
Not shown are the provincial/territorial types that help form the basis for these units, but this information is available in the database.

Detailed descriptions are provided for the Group and Alliance levels. For the Association level, we only provide a listing and brief characterization within the Alliance unit that it is placed in. Global ranks (G-ranks) are provided, where available, for Groups and for Associations. Although many of these units are provisional in Canada, we provide the ranks to highlight the potential at-risk status of these units, should they be confirmed.

This report includes many provisional types. As noted in our Methods section, **all provisional types are flagged as such in the description.** This is because, although they are well documented, their concepts have not been fully vetted by experts across Canada.

DISCUSSION

Development of units for all levels of the CNVC

In this report we catalog a large number of Associations, Alliances, and Groups from the USNVC and IVC that are listed as present in Canada. Many of these units have already received some review from Canadian partners, but have not been formally confirmed by a process overseen by the CNVC Committee. Our goal is to provide enough information to indicate how we are describing the range of variation in vegetation patterns at multiple scales. Most critical is a jurisdiction review, and for that reason, we will work with the jurisdictions to show how these units are tied to jurisdictional units that have contributed to the type concept, or how types can be improved through better linkages to jurisdictional units. In this report, we do not directly show those relationships in the description, but we can provide that information for review. Our goal is to emphasize jurisdictional relationships at the Alliance level, as we will propose that this be the primary base standard unit across Canada.

Conservation Status Assessment

In this report we provide G-ranks for Groups and for Associations. Although many of these units are provisional in Canada, we provide the ranks to highlight the potential at-risk status of these units, should they be confirmed. In addition, various conservation applications, such as the Key Biodiversity Areas (KBA) process could choose to focus on these units as a primary area for peer review.

Peer Review

The process of peer review for the large number of units is a large undertaking. We will work with the CNVC Committee to develop such a process. See Appendix A for a draft workplan that is being considered for the CNVC.

Application Of CNVC For Ecological Land Classification

The CNVC has many potential applications. One such application that can be highlighted is in conjuction with the Canadian Terrestrial Ecological Framework (CTEF), for which a scoping document has been written to help develop the framework (Wright et al. 2022). To be successful, standardized attributes are needed in the four main classes of biophysical descriptors: climate, physiography, hydrology, and biota (vegetation and faunal assemblages). A standard set of CNVC types at various level of the CTEF framework could help standardize the conepts of these levels (Table 6). Having standardized units would facilitate cross-border reconciliation of eco-level lines and clarify distinctions among units in the CTEF hierarchy.

Table 6. Examples of attributes used to describe the ecological units of the CTEF (adapted from Table 1, Ecological Stratification Working Group 1996); vegetation column updated using the Canadian National Vegetation Classification terminology. See Wright et al. (2022) for further details.

Level of Generalization Map Scale*	Geomorphology	Soils**	Vegetation***	Climate
Ecozone 1:7.5M	Physiographic or macro landforms	Soil order Group(s)	Broad physiognomic types (formation, Macrogroups)	Macro-climate
Ecoregion 1:5 M to 1:2 M	Large-order landforms or assemblages of regional landforms	Great Groups or Associations thereof	Group(s) across landforms	Meso or small order macro-climate
EcoDistrict 1:3M to 1:1M	Regional landforms or assemblages thereof	SubGroups or Associations thereof	Alliances along topo-edaphic gradients	Meso or large order microclimate

*Map scales should not be taken too restrictively, as they vary with settings and objectives. M = Million
**Terminology according to Agriculture Canada Expert Committee of Soil Survey (1987)
***Terminology according to Canadian National Vegetation Classification (Faber-Langendoen *et al.* 2018, Baldwin *et al.* 2019).

To illustrate use of the CNVC types as part of the CTEF framework, we show how the CNVC *Group* level can be used to characterize the vegetation attribute at the ecoregion level using the ECOREGION: 159 MIXED GRASSLAND (1996) (Figure 8). The description is the same text as the vegetation description provided in the 1996 CTEF publication, but the vegetation description is supplemented with vegetation units of the CNVC system.

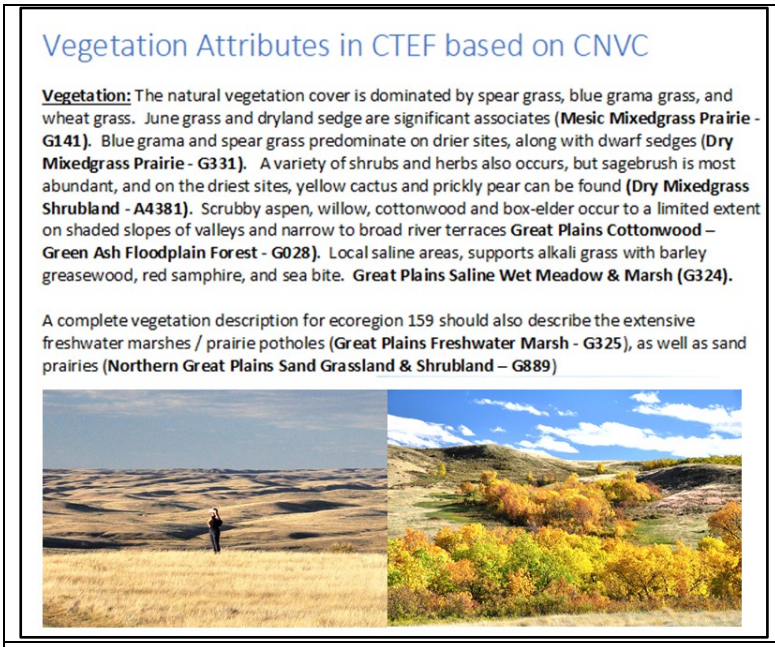

Figure 1. Illustration of how the CNVC can be used to describe vegetation for Ecoregion: 159 Mixed Grassland (Ecological Stratification Working Group 1996). Left photo is a view from the West Block of Grasslands National Park, SK; the right photo is of a prairie coulee near Rockglen, SK. Both photos used with permission from Robert A. Wright.

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APPENDICES

APPENDIX A: A 3-YEAR WORKPLAN FOR THE CNVC, first approximation

Outline

A. Identify the National CNVC Working Group.

B. Assess the level of completeness for all existing information compiled for Canadian Macrogroups, Groups, Alliances, and Associations and for P/T units.

C. Conduct a thorough peer review process to evaluate each provisional Group and Alliance, in conjunction with P/T units.

D. Write descriptions for each Macrogroup, Group, Alliance, and where feasible, Associations.

E. Work with NatureServe NatureServe Data Management Team to compile descriptions.

F. Identify and work closely with partners seeking to apply the CNVC, including for mapping applications.

Details

A. **Identify the National CNVC Working Group.** Identify the provincial-territorial, national, and international experts, including lead contractors, required to form an effective CNVC National Working Group, with P/T teams. The group will be charged to follow the methodology identified here.
B. **Assess the level of completeness for all existing information compiled for Canadian Macrogroups, Groups, Alliances, and Associations and for P/T units:**
    a. In phase 1, a comprehensive report on Canadian vegetation was compiled. In that report there are 263 Groups and 591 Alliances listed for Canada, but 25 Groups and 111 Alliances are tentative. The working group will do an initial assessment to determine how complete the synthesis of information is in that report and to identify additional sources.
    b. The Working Group will identify a comprehensive provisional set of Groups and Alliances and if possible, a set of provisional and confirmed Associations (the latter from boreal and pacific coastal forests). Provisional and confirmed Macrogroups are already available from Baldwin et al. (2019).
    c. In addition, all P/T vegetation classifications that are maintained by the jurisdictions will be compiled and put in a database ready format compatible with CNVC database formats.
C. **Conduct a thorough peer review process to evaluate each provisional Group and Alliance, in conjunction with P/T units.** The peer review process will be coordinated by the National Working Group, with participation from P/T ecologists, who will focus on the linkage of their classifications to the provisional CNVC Association and Alliance units. The National Working Group will:

a. Facilitate the linkage of all P/T units to at least the provisional Alliance level (if not Association), and compile notes on problematic types.
b. Hold working sessions with P/T and other experts to resolve problems with the provisional units.
c. Generate a revised set of provisional Groups, Alliances, and where feasible, Associations.

D. Write descriptions for each Macrogroup, Group, Alliance, and where feasible, Associations.

a. Use the standard CNVC template to describe each of the units, coordinated with the Data Management Committee that manages the CNVC in NatureServe Biotics to ensure that data are formatted for upload into the database. The template includes, at minimum, Concept Summary, Classification Comments, Physiognomy/Structure, Floristics, Environment, Dynamics, Geographic Range, State/Province/Territory, Global Rank (Conservation status), and, depending on collaboration with the Canadian Terrestrial Ecological Framework, distribution by ecozone, ecoregion, and provincial ecodistrict) (see Appendix B).
b. As part of the write-up, rate the confidence level of the unit, based on level of documentation, i.e., High Confidence, (well documented, including from plot data), Medium Confidence (moderately well documented), Low Confidence (type is good, but description is limited), or Provisional (further documentation needed). It may also be possible that some units could be modified (split, merge), or rejected.
c. Within the description, note the availability of plot data that could be used to refine the concept in a later plot-analytic or modular approach.
d. Distribute descriptions for final review from P/T, national, and international experts.
e. Finalize descriptions for Data Management Team.

E. Work with NatureServe Network Data Management Team to compile descriptions. The National Working Group will:

a. Send all descriptions to the Data Management Team (DMT).
b. Work closely with the DMT to address any issues or errors in the description.
c. Post descriptions on the CNVC website, the Government of Canada Open Data portal and make available on NatureServe Explorer.

F. **Identify and work closely with partners seeking to apply the CNVC, including for mapping applications.** Current users of the CNVC include the Key Biodiversity Areas (KBA) team, NatureServe Canada and the CDCs, and others to be identified as the project proceeds. The National Working Group will reach out to all partners early in the process to identify their needs and determine how to best make the products available to them.

a. A particular need is to identify opportunities to provide maps of CNVC units, at least down to the Group level. Opportunities include:
    i. Circum-Arctic Vegetation Map (CAVM) team to provide maps of CNVC Group level units in the Arctic (Raynolds et al. 2019).
    ii. Circum-Boreal Vegetation Map (CBVM) teams to assess opportunities for maps of CNVC Group level. Currently the Alaska - Yukon map may be the only readily available map (Jorgenson and Meidinger 2015).
    iii. Temperate Canada. Ecological Systems map for temperate Canada. (Comer et al. 2020).
    iv. P/T maps. Vegetation maps may be available for all or parts of various P/T.
b. Demonstration maps may be possible as part of this project, or provide the basis for a proposed workplan for a comprehensive CNVC vegetation map of Canada.

APPENDIX B. DESCRIPTION OF VEGETATION UNITS IN CANADA ORGANIZED BY THE CNVC HIERARCHY.

[See separate document]