The EcoVeg approach in the Americas: U.S., Canadian and International Vegetation Classifications

Don Faber-Langendoen*, Ken Baldwin, Robert K. Peet, Del Meidinger, Este Muldavin, Todd Keeler-Wolf & Carmen Josse

Abstract

The purpose of the EcoVeg classification approach is to describe the diversity of terrestrial ecosystems across the globe and inform decisions about conservation and resource management. The approach provides the scientific basis for the U.S. National Vegetation Classification, Canadian National Vegetation Classification and NatureServe’s International Vegetation Classification, and has encouraged international and national collaborations elsewhere in the Americas. The approach is global, but most advanced in the western hemisphere, especially the U.S. and Canada. EcoVeg provides a consistent thematic framework to support extensive vegetation mapping across the U.S. and Latin America. The approach provides an 8-level hierarchy for natural types, with three upper (formation) levels, three mid (physiognomic-biogeographic-floristic) levels and 2 lower (floristic) levels, and a separate 8-level hierarchy for cultural types. Types are maintained through a review board to ensure consistent definition. All protocols use the best available scientific information, including plot data and secondary sources. Preferred plot sizes typically range from 0.01 to 0.1 ha (to 1.0 ha in tropical vegetation). Plot data include full species lists by strata with cover values, and supporting environmental and site data. The classification approach meets the need for a dynamic, 8-level catalog of types for all existing vegetation. The open, peer-review model allows for ongoing improvement by ecologists, while always providing comprehensive versions for users. Use of the best available scientific information ensures that the legacy of previous classification efforts is fully incorporated. Limitations include somewhat complicated names for types, limited availability of comprehensive plot data sets, and sparse testing beyond the Americas and Africa. The conservation or at-risk status of macrogroups, groups and associations are evaluated using both the IUCN Red List of Ecosystems and NatureServe Conservation Status Assessment protocols.

Keywords: biogeography; cultural vegetation; ecosystem; floristics; growth form; natural vegetation; ruderal vegetation; novel ecosystem; vegetation type; ecological classification.

Nomenclature: Scientific names in the text follow Flora North America (1997–2016), but see additional details in the section on Preparation of Plot data.

Abbreviations: CNVC = Canadian National Vegetation Classification; IVC = International Vegetation Classification; USNVC = United States National Vegetation Classification.

Submitted: 8 October 2016; first decision: 11 December 2016; accepted: 27 February 2017

Co-ordinating Editor: John Hunter

Introduction

The implications of global change for biodiversity, ecological processes and ecosystem services are profound, even as historic natural systems are replaced by novel and cultural ecosystems. A paramount need for assessing these alterations is an ecosystem classification based on vegetation that builds on the scientific and practical legacies of previous approaches, is operable at multiple thematic, spatial and temporal scales of resolution, is flexible yet rigorous in the data sources used to develop and revise vegetation types, and maintains an authoritative, peer-reviewed and dynamic set of types available to all users, thereby facilitating its use by a wide variety of practition-
ers. The EcoVeg approach was developed to address these needs (Faber-Langendoen et al. 2014). Its development started in the early 2000s through a collaboration among ecologists in federal, state and provincial government agencies, non-profit organizations and academic institutions in the U.S., Canada and Latin America. It now provides the scientific basis for the U.S. National Vegetation Classification (USNVC), Canadian National Vegetation Classification (CNVC), and NatureServe’s International Vegetation Classification (IVC), and it has supported national and continental classifications elsewhere in the Americas and beyond. Here we summarize the USNVC, CNVC and IVC as developed to date, and make recommendations for the implementation of the EcoVeg approach to address the multiple challenges of maintaining the resilience and adaptive capacity of natural ecosystems in the face of rapid environmental change.

The EcoVeg approach

Purpose

The primary purpose of the EcoVeg approach is to provide a consistent, systematic, and authoritative description and classification of ecosystems, based primarily on vegetation patterns and their relationships with ecological, biogeographic, dynamic, and human processes. Classifications based on this approach play an important role, not only in applied research, but also in coordinating information on vegetation across multiple agencies, partners, and land ownerships to support management. These classifications describe vegetation types from multiple sources of data (e.g., secondary literature, as well as primary plot data), and are used to establish baseline knowledge of ecosystems (e.g., complete inventories, documentation of the diversity of ecosystems), and inform assessment, monitoring and mapping programs. Furthermore, the data gathered to support the classifications (including field plot descriptions, inventories, and mapping) provides place-based information critical to the conservation, management and restoration of ecosystems across the world.

Scope

The USNVC and IVC classify all existing vegetation, both cultural and natural, from global to local scales, using standardized criteria and terminology. The mandate of the CNVC is to classify the natural and semi-natural vegetation of Canada. In the U.S., aquatic vegetation may be integrated with other factors as part of classification standards for freshwater lake and river (Cowardin et al. 1979) or marine (Coastal and Marine Ecological Classification Standard) ecosystems (FGDC 2012).

History

The USNVC arose in the middle 1990s when conservation, academic and government agency personnel recognized that the application of many disparate classification systems for describing the same natural resources was hindering achievement of applied research, conservation and land-management goals. Among U.S. agencies, the need was particularly urgent at the federal level, because multiple federal agencies manage extensive lands across multiple states (Fig. 1). The United States government created the Federal Geographic Data Committee (FGDC) with various subcommittees to formulate national standards that would ensure greater efficiency and inter-agency communication; one such subcommittee was established for vegetation. The charges to the FGDC Vegetation Subcommittee (which included representatives from federal government agencies, NatureServe, and the Ecological Society of America) were to: 1) define and adopt standards for vegetation data collection and analysis, 2) facilitate inter-agency collaboration and product consistency, 3) foster accuracy, consistency, and clarity in the structure, labelling, definition and application of a systematic vegetation classification for the U.S., 4) establish a national set of standards for classifying existing vegetation, 5) develop minimum metadata requirements, and 6) collaborate between state, federal and international efforts. In 1994, nearly simultaneously with establishment of the FGDC vegetation subcommittee, a partnership was developed in the form of the Vegetation Panel of the Ecological Society of America (ESA). The Panel included representatives of the academic community, government agencies and NatureServe, all of whom shared a common vision for development of a widely applicable vegetation classification for the country. Among the most significant products of the collaboration between the Panel and FGDC was the creation of formal FGDC standards for the USNVC (FGDC 2008 Jennings et al. 2009). The FGDC Vegetation Subcommittee and the ESA Panel continue to collaborate, with FGDC overseeing standards and implementation, and the Panel providing guidance, as well as a peer-review process for revisions (Franklin et al. 2012).

The CNVC was launched in 2000 as an inter-jurisdictional (i.e., subnational provinces and territories) initiative to provide a standardized vegetation classification for Canada. In 2008 the CNVC Technical Committee opted to test the newly developed hierarchical standard of the USNVC (FGDC 2008) as an organizing framework for the Canadian classification. Over time, it was decided that the USNVC hierarchy (with some modifications) would be adopted for the CNVC, in part to facilitate communication of ecological information with neighboring U.S. jurisdictions. The CNVC partnership comprises approximately 20 international, federal, pro-
vincial, territorial governmental and non-governmental agencies who have contributed data, expertise and/or money towards the development of the CNVC. Most subnational jurisdictions in Canada have hierarchical ecological classifications, at least for forests (e.g., BECWeb 2016; McLaughlan et al. 2010; MRNQ 2002+; OMNR 2009), that are applied in land and natural resource management within their boundaries. These classifications are consistent within each jurisdiction, but they do not communicate across borders. The goal of the CNVC is to provide a national, ecologically sound classification of Canadian vegetation that crosswalks existing provincial/territorial classifications between jurisdictions using standardized principles, definitions and nomenclature. All provincial/territorial classifications have a plant community level that approximates the association-level of the EcoVeg hierarchy. This is the level at which the subnational classifications are crosswalked within the CNVC structure. In many cases, the recently confirmed national protocols of the CNVC inform development or revision of subnational classifications (e.g., Environment Yukon 2016; Uhlig et al. 2016).

The IVC was developed by NatureServe and partners, in conjunction with the USNVC, to help conserve and manage ecosystems in states, provinces and countries in the Americas that are part of the Natural Heritage Network (Fig. 2) (Grossman et al. 1998). Initially, the IVC and USNVC adopted the existing international structure of UNESCO (1973) for their classifications. Initial applications of the UNESCO-based hierarchy in the U.S. were challenged by the lack of “mid-scale” units in its hierarchical structure, leading in part to development of alternative classifications for use in ecosystem inventory (Comer et al. 2003; Josse et al. 2003). When the USNVC partners agreed in 2003 to undertake a revision to the USNVC, an international approach was reconfirmed, reflecting the goals of incorporating global classification concepts and avoiding artificial differences resulting from national perspectives. The emphasis was on the natural structuring of vegetation world-wide, relying on the

![Federal land ownership in the United States. A major driver of support for the USNVC as a federal standard (FGDC 2008) was the need for sharing information on vegetation across land managed by federal agencies. See also Table 2.](image-url)
combined physiognomic-structural, floristic and ecological components of vegetation. To this end, the partners agreed to form a Hierarchy Revisions Working Group (HRWG) sponsored by FGDC. The work of the HRWG progressed in two phases. In the first phase, from 2003–2008, the HRWG provided input for revision of the US-NVC standard (FGDC 2008) and development of the CNVC standard. In the second phase, from 2010–2013, the HRWG formulated the EcoVeg approach (Faber-Langendoen et al. 2014) and produced global descriptions for all formation types (Faber-Langendoen et al. 2016).

Fig. 2. NatureServe and its Network of Member Programs across the Americas (as of Sept 1, 2016). The EcoVeg approach was partly driven by the need for NatureServe and the Network to have consistent biodiversity classifications (green = jurisdiction is a member program, white = currently not a member program). Currently, the ecosystem classifications include the International Vegetation Classification (which covers all of the Americas and beyond), as well as national classifications, especially the U.S. National Vegetation Classification and the Canadian National Vegetation Classification. NatureServe is currently working to make these classifications available in database format to all member programs.
EcoVeg approach in the Americas

Achievements

The EcoVeg approach builds on the traditional physiognomic-floristic-ecological classifications that have been developed over many years (e.g., Rübel 1930 in Shimwell 1971; Whittaker 1962; Beard 1973; Borhidi 1991; Brown et al. 1998). These perspectives also share a central philosophy with floristic-ecological approaches, such as the Braun-Blanquet approach (Becking 1957; Westhoff & van der Maarel 1973; Dengler et al. 2008), and the biogeoclimatic approach (Pojar et al. 1987); namely, that vegetation types should be constructed in the context of ecological, dynamic, and biogeographic considerations. The EcoVeg approach integrates these considerations for all vegetation types at multiple thematic scales.

The most important objectives and achievements of the EcoVeg approach, working through the CNVC, USNVC, and IVC, are the following:

- Define and describe the full range of existing vegetation patterns, including both cultural (planted and dominated by human processes) and natural (spontaneously formed and dominated by ecological processes), using standardized criteria and terminology.
- Define and describe vegetation types at multiple thematic scales, from broad formations (biomes) to fine-scale associations (biotopes).
- Guide inventory and mapping of vegetation and ecosystem patterns within and across ecological sites, landscapes and ecoregions. In combination with the NatureServe Terrestrial Ecological Systems classification (Comer et al. 2003; Josse et al. 2003), the EcoVeg approach has provided maps of types at the group or macrogroup level and above for the U.S., South America, Africa, and parts of Canada. The geographic distribution of all major grassland divisions around the globe is now available (Dixon et al. 2014). Many of North America’s most significant natural areas (National, State, Provincial, or Regional parks, wildlife refuges, etc.) are mapped using the alliance or association levels (e.g., see http://science.nature.nps.gov/im/inventory/veg/products.cfm). The CNVC underlines a new map of vegetation zones for Canada (CNVC 2016a).
- Support the documentation of conservation status and trends of vegetation and ecosystems (e.g., trends in extent, trends in condition). The at-risk status of macrogroups and terrestrial ecological systems in the western Hemisphere is being assessed as part of the IUCN red list of ecosystems effort (Keith et al. 2013; Comer et al. in prep), and complements the global and state/provincial assessments of at-risk associations in the U.S. (e.g., Grossman et al. 1998; Gawler & Cutko 2010; Marriott et al. 2016) and Canada (e.g. Henson & Bakowsky 2014; B.C. Conservation Data Centre 2016). Macrogroups are one suggested level of ecosystem type when assessing threatened ecosystems for inclusion in the new Key Biodiversity Areas Standard (IUCN 2016).
- Facilitate the interpretation of long-term change in vegetation, by providing vegetation types defined by both growth forms (formations) and by large biogeographic scales of species patterns (division, macrogroup) that can be traced historically in the paleoecological record (Delcourt & Delcourt 1987; Barnosky et al. 2017).
- Provide a structure to monitor real-time ecosystem responses to invasive species, land use, and climate change.
- Synthesize ecological knowledge at various spatial and thematic scales to inform sustainable development.
- Rely on a well-structured peer review process that facilitates ongoing improvement of subnational, national and international classifications. The outcome is a set of dynamic classifications that are made available on a regular basis to meet emerging research and management needs.
- Facilitate compilation of plot data in standardized formats for future analysis (e.g. Peet et al. 2012).
- Provide frameworks for national or subnational classifications.

Applications of the approach

Scope

The USNVC covers all natural and cultural vegetation types found in the U.S., including the states and territories. Types are described based on their range-wide characteristics. In the lower 48 states, known natural types across all eight hierarchical levels have been described, largely through an extended literature synthesis, but with ongoing updates as plot data analyses are completed (Table 1); however, ruderal types are not well developed. In Alaska, Hawaii, and the Caribbean, types have been developed to the group level, but alliances and associations are largely incomplete or not yet peer reviewed. Throughout the U.S., cultural types at mid and lower levels are not well defined and largely undescribed.

The long-term goal for the CNVC is to develop a classification for all the natural and semi-natural vegetation in Canada. Currently, the upper levels of the hierarchy characterize all vegetation in Canada, but the focus to date at the lower levels has been on forested vegetation. The classification of boreal forests at all hierarchical levels is mostly complete, based on extensive plot data over most of Canada. Considerable progress has been achieved in classification of temperate forests, particularly in western Canada. Regional gaps exist in the forest classification data, particularly in northern Canada. Thematic data gaps are significant for non-treed vegetation that has not been the subject of formal classification programs by the
provinces and territories. Methods for confirming types that are not derived from primary plot data have not been developed yet. Table 1 provides a summary of the types presently confirmed for Canada.

The IVC is global in scope for all natural and cultural vegetation types, but cultural types have only been described for the top three formation levels (Faber-Langendoen et al. 2016). Global descriptions are also complete for the top three natural formation levels (Faber-Langendoen et al. 2016). Descriptions are complete for natural divisions and macrogroups for a number of continents, including North America, South America, and Africa. The IVC hierarchy was used to integrate classification concepts across the African continent for subsequent application to ecosystem mapping (Sayre et al. 2013). In South America, concepts for group types are approximated through a crosswalk to the closely related “terrestrial ecological system” types developed by NatureServe (terrestrial ecological systems are mid-scale types based on aggregating associations using spatial-ecological relationships (Josse et al. 2003; Table 1)). Alliance and association descriptions are only available for North America where they are largely complete (for natural types) across the lower 48 states of the U.S. and partly complete in Canada (but still in the process of harmonization with the CNVC for temperate forest and non-forested types).

Subnational, national and international collaboration

The CNVC and USNVC are national implementations of the EcoVeg approach, which overlap with the IVC. The EcoVeg approach is also broadly compatible with the Braun-Blanquet approach at the four mid and lower levels of the hierarchy, with the association and alliance concepts being relatively similar, especially for the US-NVC.

Within the U.S. and Canada, the national classifications have been developed as part of a strong collaboration with subnational state and provincial/territorial partners. Some states and provinces have directly, or through similar approaches, published a subset of the national classifications, or derivatives thereof, for their jurisdiction, at either the association or the alliance level (e.g., Hoagland 2000; Sawyer et al. 2009; Gawler & Cutko 2010; Schafale 2012; Uhlig et al. 2016; among others).

Examples of applications

Applications of the EcoVeg approach are now well developed, especially in the U.S. (Franklin et al. 2015) and Canada, but increasingly across the Americas (Table 2). There is now a broad suite of inventory, monitoring, and ecological assessment programs that have integrated EcoVeg and associated classifications into their work flow from the lowest to the highest levels of the hierarchy.
Supporting infrastructure and peer review

USNVC

The USNVC is supported by an array of partnerships, acting through the Federal Geographic Data Committee Vegetation Subcommittee (http://fgdc.gov), which is chaired by the U.S. Forest Service. Through the Subcommittee, the federal agencies and non-federal partners (NatureServe and the ESA’s Vegetation Classification Panel) formalized standards for vegetation classification in 2008 (FGDC 2008; Peet 2008; Faber-Langendoen et al. 2009; Jennings et al. 2009), and continue to support plans that include priorities for development of classification con-

To support the USNVC, a public vegetation-plot database (VegBank; http://vegbank.org) was launched in 2004 (Peet et al. 2012). Although the primary purpose of archiving these records is to document the classification and facilitate its revision and improvement, this resource also allows scientists to address ecological questions from micro- to macro-scales. Examples of regional analyses based on plots now readily accessible in VegBank include xeric longleaf pine (Pinus palustris) association and alliance types from Virginia to Florida (Palmquist et al. 2015), Great Lakes alvar vegetation (Reschke et al. 1998), and species occurrence data across the Western Hemisphere (BIEN 2016).

The USNVC can be updated through a peer-review process administered by the Ecological Society of America’s NVC Review Board (and authorized by the FGDC Vegetation Subcommittee), with changes published in annual editions of an on-line USNVC Proceedings (Franklin et al. 2012). This review process functions in two ways: (1) it establishes a minimum effort, including quality and spatial extent of data, required for proposing new vegetation types or significantly revising extant ones, and (2) it precludes an explosion of site-specific, potentially overlapping vegetation types, as all changes are reviewed in light of already established types (e.g., Matthews et al. 2011). The fundamental goal of the process is to allow for dynamic changes to the classification, while providing an authoritative version for users (USNVC 2016).

CNVC

The CNVC has partnerships with all provinces and territories. The CNVC Technical Committee oversees the development of standards employed in data analysis and confirmation of vegetation types. Peer review meetings of regional experts are used to assess proposed types and to confirm or revise them. The classification, with supporting information, is available on the CNVC website (CNVC 2016b, http://cnvc-cnvc.ca). All plot data, supporting species taxonomy, and crosswalks to published provincial ecological classifications are compiled and maintained by Natural Resources Canada (NRCan). A standardized national database compiled from provincial/territorial plot data is maintained by NRCan, using the VPro data management tool (MacKenzie & Klassen 2009). However, individual data belong to the respective jurisdictions and are only available through specific data requests to the data owners.

IVC

NatureServe maintains the IVC, working in collaboration with international partners, such as International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF), and with national partners especially the USNVC and CNVC, as well as the Bolivian NVC (Navarro 2011) and Ecuadorian NVC (Ministerio del Ambiente 2013), among others. A future goal is to establish a formal international review panel that would oversee collaboration around a few key international and continental classifications. NatureServe staff maintains the IVC content, and shares the data with 82 member programs (U.S. states, Canadian provinces and territories, and a number of Latin American countries). Information on the North American IVC is available on the web at http://natureserve.org/explorer.

Main features of the EcoVeg approach

Principles

The EcoVeg approach contains nine core principles, briefly summarized here (see Faber-Langendoen et al. 2014 for more details):

1. The classification is based on existing vegetation types, defined as the plant cover—including floristic composition and abundance and vegetation structure—documented at a specific location and time, under specified ecological conditions, and preferably described at an optimal time during the growing season.
2. Vegetation types are characterized by full floristic and growth form (physiognomic) composition, which together express ecological and biogeographical relations.
3. Vegetation characteristics can be described as a function of both natural and cultural (or anthropogenic) processes.
4. Characterizing and describing vegetation types is best accomplished using plot data, including both floristic and environmental site data, collected and compiled using systematic protocols and survey techniques.
5. Vegetation types can be defined using a number of differentiating criteria, including diagnostic, constant and dominant species, dominant and diagnostic growth forms, and compositional similarity (Fig. 3). The most useful criteria are those that express environmental and biogeographical relationships that clearly distinguish types. These criteria should be defined for application in the field or lab so that recognizable field characteristics are provided to ensure consistent identification using keys and other tools. Types are defined both extensively (e.g., a full list of types is developed within each level of the hierarchy, a list of plots is attributed to each type, range maps are provided, etc.) and intensively (e.g., concise differentiating criteria are
provided for each type, including diagnostic and dominant species, growth forms, environmental site factors and biogeography) (Whittaker 1962, 1973).

6. Classification and field recognition of vegetation types creates a conceptual framework of vegetation pattern and process that provides a foundation for multiple applications (e.g., vegetation mapping, monitoring, modeling).

7. Differentiating criteria for vegetation types can be arranged hierarchically, from upper levels primarily based on general growth forms, to middle levels based on specific growth forms and floristics that include suites of general and regional combinations of characteristic species, to lower levels based primarily on regional to local floristics. At all levels, existing vegetation provides the primary criteria for definitions and descriptions within the hierarchy, but the hierarchical organization may be based on the ecological and biogeographical relations expressed by the vegetation.

8. An integrated hierarchy of vegetation types is best established by considering each level as both independent and inter-connected in a nested relationship; that is, criteria selected to differentiate levels in the hierarchy are sufficient to define and distinguish types of a particular level, thereby preventing it from being arbitrarily defined by the level immediately above or below in the hierarchy. Thus, the EcoVeg approach is both "top-down" and "bottom-up." This occasionally leads to some tension about how to nest types where the top- and bottom-driven methods intersect, but the dual approach provides for a more synthetic development of the system than would otherwise be the case.

9. The classification is maintained through a coordinating body that oversees the recognition and integration of new and revised vegetation types through a peer-review process. The goal is that at any one time there will be one standard set of recognized types that represents the current best understanding of the universe of ecosystems, based on vegetation variation.

Fig. 3. Vegetation classification criteria for the USNVC. The diagram portrays the five vegetation criteria used to classify vegetation at all levels of the USNVC hierarchy (from FGDC 2008). These criteria are arranged from the most fine-scaled on the left to the most broad-scaled on the right. The five criteria are derived from stand attributes or plot data (inside oval) and reflect the ecological context (outside oval) of the stand or plot. The ecological context includes environmental factors and biogeography considered at multiple scales, as well as natural and human disturbance regimes.
**Consistent classification sections**

Two basic dichotomies guide the overall hierarchy; namely, the distinction between a) vegetated and non-vegetated, and b) natural and cultural. Within the natural we recognize a third, softer distinction between somewhat anthropogenic (we use the term “ruderal”) and “near-natural” vegetation.

**Vegetated and non-vegetated**

All terrestrial areas are classified as vegetated that have ≥ 1% surface coverage by live vascular and/or non-vascular plant species, including wetland and aquatic vegetation (rooted emergent, rooted submergent and floating aquatic vegetation).

**Natural and cultural vegetation**

Natural (including ruderal) vegetation is composed predominantly of spontaneously growing sets of plant species with composition shaped by both abiotic (site) and biotic processes; these are vegetation types whose species composition is primarily determined by non-human ecological processes (Küchler 1969; Westhoff & van der Maarel 1973; van der Maarel 2005). Although natural vegetation is variously impacted by human activities (e.g., logging, livestock grazing, fire, introduced pathogens and exotic species), it retains a distinctive set of spontaneous vegetation and ecological characteristics (Westhoff & van der Maarel 1973; Di Gregorio & Jansen 1996). It includes both near-natural (vegetation largely shaped by natural processes) and ruderal vegetation (vegetation shaped more strongly by anthropogenic processes, in combination with natural processes).

There is growing interest in weedy (including relatively ephemeral or episodic) and invasive vegetation types, along with those with no apparent historical natural analogs (the “novel” or “emerging” ecosystems of Hobbs et al. 2006; Morse et al. 2014). We refer to this vegetation as ruderal; that is “vegetation found on human-disturbed sites that may not have apparent recent historical natural analogs, and whose current composition and structure is not a function of continuous cultivation by humans and includes a broadly distinctive characteristic species combination, whether tree, shrub or herb dominated. The vegetation is often composed of invasive species, whether exotic or native, that have expanded in extent and abundance due to the human disturbances” (from Faber-Langendoen et al. 2014; see also Ellenberg 1988). For example, on abandoned farmlands in eastern North America, an old-field vegetation type is found that contains a mix of weedy native shrubs (e.g., Cornus foemina Mill.), exotic shrubs (e.g., Rhamnus cathartica L. and Lonicera spp.) and weedy forbs. It has no analog in the surrounding historic native forest vegetation of the region because of the underlying novel, human-driven disturbance represented by intensive agriculture.

Cultural vegetation possesses a distinctive structure and composition that is determined by the response to human intervention (cultural vegetation sensu stricto Küchler 1969; Di Gregorio & Jansen 1996). Characteristics of various types of cultural vegetation include: 1) regularly spaced herbaceous vegetation with substantial cover of bare soil for significant periods of the year (usually determined by tillage, chemical treatment, or agricultural flooding), 2) vegetation consisting of highly-manipulated growth forms or structures rarely found under natural plant development (usually determined by mechanical pruning, mowing, clipping, etc.), and 3) vegetation composed of species not native to the area that have been intentionally introduced to the site by humans and that would not persist without active management by humans (e.g., golf courses, plantations, arboreta).

**Classification protocols for natural vegetation**

**General protocols**

**Vegetation plots**

In general, for the EcoVeg approach, plot records can be obtained by conducting field surveys, collected through a variety of inventories, or by drawing them from available vegetation-plot databases (Dengler et al. 2011; http://www.givd.info/). Given the comprehensive global and national scope of the classifications, the option of analyses at one or more hierarchy levels, and the wide variety of data sets available, the sampling (and re-sampling) designs will necessarily combine elements of different approaches (Peet & Roberts 2013). A fundamental concern is the need to ensure comprehensiveness of the sample (i.e., that the selected plot records encompass the range of vegetation and ecological variation within the scope of the classification).

**Preparation of plot data**

We encourage plot data sets where the spatial grid is largely constrained from 100 m² to 1000 m² (with allowances for extended sizes in highly-diverse tropical vegetation, e.g., Neldner & Butler 2008). Smaller plot sizes typically represent “within-community variation.” Where multiple small plots are used within a stand (e.g., multiple 1 m² or 10 m² quadrats), we recommend aggregating them within a homogeneous area into a larger “exploded” plot,
because the combined plot data are more accurate for determining diagnostic, constant and dominant species of a stand, even though species richness per unit area can only be approximated. We also encourage consistent plot sizes across structural types (e.g., forests and grasslands), using nested plot designs if needed, such as 100 m² modules within a 0.1 ha plot design (e.g., Shmida 1984; Peet et al. 1998).

Floristic, growth-form, and structural data should be gathered using a minimal set of strata in order to provide both compositional and vertical profiles of the vegetation. Recommended cover-abundance scales for both growth forms and species are provided in the FGDC standard (2008) and Jennings et al. (2009), with the minimum requirement of being able to nest within the Braun-Blanquet scale (Jennings et al. 2009). All vascular plants, including both overstory and understory species, should be included and used in analyses. To ensure long-term data comparison, plant names should follow a stated taxonomic standard. Flora of North America can, when completed, provide a standard across both the U.S. and Canada. Currently, in the U.S., USDA PLANTS (http://plants.usda.gov/) is the most common nomenclatural standard. In Canada, standard species nomenclature for vascular plants (including English and French vernacular names) follows VASCAN (http://data.canadensys.net/vascan/search); for bryophytes follows Flora of North America volumes 27, 28 & 29 (http://www.mobot.org/plantscience/bfna/); and for lichens follows Esslinger (https://www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm). The CNVC website provides the standardized names for all species in its database. For the IVC, current nomenclural standards include The Plant List (http://www.thepantlist.org/) and Tropicos (http://www.tropicos.org/).

### Grouping plot records

With respect to grouping plot records, it is not possible to provide quantitative guidance, given the diversity of practitioners and vegetation types across the Americas. Rather, we provide broad, contextual guidelines; namely, that consideration be given at the outset to growth form and structural (formation) criteria (e.g., forest type analyses should emphasize plots meeting the requirements for “Forest & Woodland” criteria). However, this is not intended to preclude analyses that include a wider range of structural variation in order to test the conceptual boundaries between classes, such as between grasslands and shrublands or bogs and acidic forest swamps.

### Evaluation of vegetation types

When evaluating the grouping of plot records into types, the process may vary when working at formation levels versus lower levels (Tables 3 and 4). For mid and lower

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### Table 3. Interpretive guidelines for vegetation and ecology criteria, for upper formation levels. The division level is included for comparison. Simplified from Faber-Langendoen et al. (2014). See also Table 4.

<table>
<thead>
<tr>
<th>Level</th>
<th>Growth Forms</th>
<th>Ecological Factors – Climate, Disturbance and Edaphic/Hydrology</th>
<th>Biogeography – Floristics/ Diagnostic species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formation</td>
<td>Broad combinations of dominant general growth forms and specific growth forms. Overlapping general growth forms</td>
<td>basic moisture, temperature, and/or substrate or aquatic conditions</td>
<td>--</td>
</tr>
<tr>
<td>Subclass</td>
<td>Combinations of general and specific dominant and diagnostic growth forms.</td>
<td>global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions</td>
<td>--</td>
</tr>
<tr>
<td>Formation</td>
<td>Combinations of dominant and diagnostic growth forms.</td>
<td>global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions</td>
<td>--</td>
</tr>
<tr>
<td>Division</td>
<td>Broadly uniform sets of growth forms and canopy closure</td>
<td>Climate: continental macroclimate separates formations by continental or major inter-continental climatic patterns. Edaphic/Hydrology: Broad range of conditions consistent with continental expression of formation</td>
<td>Large scale, continental biogeography with largely non-overlapping floristics. One or more sets of strongly diagnostic (character) species; species have high fidelity but variable constancy</td>
</tr>
</tbody>
</table>
Table 4. Interpretive guidelines for vegetation and ecology criteria, from division to association. These are “typical” criteria, and the role of factors may differ for some types (from Faber-Langendoen et al. 2014). See also Table 3 and Supplement S1.

<table>
<thead>
<tr>
<th>Level</th>
<th>Biogeography/Floristics</th>
<th>Diagnostic Species</th>
<th>Growth Forms</th>
<th>Climate</th>
<th>Disturbance regime/Succession</th>
<th>Edaphic/Hydrology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division</td>
<td>Large scale, continental, biogeography with largely non-overlapping floristics</td>
<td>One or more sets of strongly diagnostic species</td>
<td>Broadly uniform sets of growth forms and canopy closure</td>
<td>Continental macroclimate</td>
<td>Variable range of disturbance regimes consistent with formation</td>
<td>Broad range of conditions consistent with formation</td>
</tr>
<tr>
<td>Macro-group</td>
<td>Sub-continental to regional ecological gradient segment, reflected by sets of strongly diagnostic species; overall composition very distinct from other types</td>
<td>Multiple sets of strong diagnostic species, including many strong differential and character species. Constant species become more important; at least 25% constancy expected</td>
<td>Broadly uniform sets of growth forms and canopy closure - may be specific growth form variants that support floristic patterns</td>
<td>Sub-continental mesoclimates - indicative of primary regional gradients in vegetation</td>
<td>Broadly consistent, but variable disturbance regimes indicative of subcontinental climate</td>
<td>Broad range of conditions, sometimes reflective of broad topo-edaphic interactions with climate</td>
</tr>
<tr>
<td>Group</td>
<td>Regional ecological gradient segment (often broadly topo-edaphic) reflected by a set of moderately diagnostic species (at least a few species ranges fully contained); overall composition broadly distinct from other types</td>
<td>A set of moderately strong diagnostic species, preferably with one or more strong differentials or character species. Constancy of at least 25% expected for some species</td>
<td>Moderately uniform growth forms and canopy closure</td>
<td>Regional meso-climate - could indicate secondary regional gradients</td>
<td>Moderately consistent disturbance regime; may incorporate successional stages that are otherwise floristically similar</td>
<td>Moderate range of variation in specific topo-edaphic or hydrologic conditions</td>
</tr>
<tr>
<td>Alliance</td>
<td>Regional to sub-regional gradient segment (often more narrowly topo-edaphic or biogeographic), reflected by at least several moderate diagnostic species, including from the dominant strata; overall composition moderately distinct from other types</td>
<td>Several or more moderate diagnostic species, preferably including at least one strong differential (character species may be absent). Constant species more important for defining type, with at least 40% constancy expected</td>
<td>Moderately uniform growth forms and canopy closure, at least in the dominant layer</td>
<td>Regional to sub-regional topo-edaphic factors, sometimes reflective of biogeography and climate</td>
<td>Moderately specific disturbance regime - may group successionaly related associations</td>
<td>Moderately specific edaphic or hydrologic conditions</td>
</tr>
<tr>
<td>Association</td>
<td>Subregional to local ecological gradient segment reflected in several diagnostic species, including differential species and constant dominants across strata; overall composition not well separated from other types</td>
<td>At least a few diagnostic species, preferably including at least one moderate differential. Constancy 40–60% for a suite of species</td>
<td>Strongly uniform growth forms, in both dominant and other layers and degree of canopy closure</td>
<td>Climate rarely a driver; rather a narrow range of topo-edaphically related influences</td>
<td>Narrow range of disturbance regime - may have disturbance or successional relationships to other local associations</td>
<td>Narrow range of edaphic or hydrologic conditions, indicative of locally significant factors</td>
</tr>
</tbody>
</table>
levels, a two-step process is often used (sometimes referred to as internal and external evaluation criteria). In the first step, the primary vegetation attributes of growth form, structure and floristics are used to evaluate the appropriateness of the vegetation types. In the second step, ecological (including biogeographic, environmental and dynamic) attributes are used to evaluate the type. The two-step process may be iterative, whereby the strength of both vegetation and ecological attributes are used to evaluate the type. For the upper levels, ecological criteria may play a more primary role (Fig. 4). Patterns of vegetation can also be related to major vegetation regions, such as comparing the plot distribution of the boreal forest macrogroup to the boreal ecoregion or zone. The comparison helps highlight the boreal-like conditions found outside the major boreal zone (Fig. 5).

Characterization of vegetation types

Characterization is a critical step in the classification process, as it provides the end-user with the important information about a type. For the CNVC, USNVC, and IVC, a standard template is used to describe each type (FGDC 2008; Jennings et al. 2009; http://cnvc-cnvc.ca/). These templates include a concept summary (abstract), physiognomy, floristics (including synoptic table, where available), environment, dynamics, geographic range, ecoregional distributions, classification comments, synonymy and relevant literature. The CNVC template contains more plot-based summary fields than the USNVC or IVC, reflecting the extensive plot data available for the forest types that are currently being described.

Additional information is added to complement the characterization of vegetation types for particular applications. Examples include assessments of degree of conservation significance (e.g., NatureServe’s G (global), N (national), or S (state) ranks for conservation status (Master et al. 2012)), protection status, species’ habitat suitability, recommendations for management, and photos or graphics.

Assignment rules

Assignment rules for near-natural vegetation

Assignment rules are largely guided by a number of constraining criteria, including growth forms and structure, floristics, environmental and biogeographical variables (Faber-Langendoen et al. 2014). Vegetation variables are primary, but the ecological context of the vegetation is emphasized throughout (cf., Mueller-Dombois & Ellenberg 1974). Briefly, the EcoVeg approach uses the following criteria (Fig. 3):

**Assignment rules for near-natural vegetation**

Assignment rules for near-natural vegetation

Assignment rules are largely guided by a number of constraining criteria, including growth forms and structure, floristics, environmental and biogeographical variables (Faber-Langendoen et al. 2014). Vegetation variables are primary, but the ecological context of the vegetation is emphasized throughout (cf., Mueller-Dombois & Ellenberg 1974). Briefly, the EcoVeg approach uses the following criteria (Fig. 3):
Fig. 5. Map of plots assigned to the “Eastern North American Boreal Forest Macrogroup” (M495). The grey shaded area represents the boreal zone according to “Vegetation Zones of Canada (CNVC 2016).” Photo by W.J. Meades (used with permission).
be used to assess the degree of compositional similarity (Mueller-Dombois & Ellenberg 1974; Peet & Roberts 2013). At middle scales of vegetation pattern (division, macrogroup, group), where plots increasingly lack overlap in species composition but occupy similar ecological and biogeographical space, compositional similarity is assessed using suites of diagnostic species and growth forms related to biogeographic patterns (Pignatti et al. 1994).

Ecological context
Criteria for ecological context include: 1) biogeography (from large biogeographic regions to regional biogeographic and biogeoclimatic zones), 2) climate (macro-, meso-, and microclimates), 3) disturbances/dynamics (natural and cultural disturbances, and successional patterns), and 4) topo-edaphic factors, including the topographic features of elevation, slope and aspect, as well as edaphic factors, such as pH, moisture, nutrients, and texture (Table 3, 4).

Constraining features by hierarchy levels
All of the criteria noted above come into play across most levels of the hierarchy (except for the top three levels, where growth forms and structure are largely definitive), but the utility and relevance of the criteria vary with the level in the hierarchy (Table 3, 4). The definition and presentation of each of the levels is summarized in Supplements S1 and S2, and full presentation of these levels is provided in Faber-Langendoen et al. (2014).

Assignment rules for ruderal vegetation
A ruderal type is recognized when invasive (non-native) or native weedy generalist species overwhelmingly dominate a stand (e.g., >90% relative cover), and substantially replace the typical native diagnostic species. Setting a high threshold minimizes the creation of new types until it is certain that a new characteristic combination of species has been formed. For example, within the Eastern North American Cool Temperate Forest Division, there are seven native forest macrogroups (e.g., Northern Pine & Oak - Hardwood Forest) and one ruderal forest macrogroup (Eastern North American Ruderal Forest). The latter macrogroup is typically found on abandoned farm fields that contain both weedy native and invasive exotic forest species (e.g., Acer platanoides Ruderal Forest, Robinia pseudo-acacia Ruderal Forest, and the old field Pinus strobus Ruderal Forest, with various generalist native trees (e.g., Acer rubrum), and invasive shrubs and herbs (e.g. Rhamnus cathartica, Alliaria petiolata). The wide-ranging weedy natives may be part of the diagnostic species of the division. The CNVC confines itself to natural/semi-natural vegetation at this time (i.e., it does not consider ruderal (or cultural) vegetation).

Keys for type assignment
In the U.S., tools have been developed to automate the assignment of sample plots to already described vegetation types. The inter-agency LANDFIRE (Landscape Fire and Resource Management Planning Tools) Project, produces comprehensive maps of all U.S. vegetation, vegetation structure, and wildfire fuel conditions. Computerized algorithms, referred to as Auto-Keys, were developed and validated to key all samples to NatureServe Terrestrial Ecological Systems (Comer et al. 2003) and to USNVC groups and other map legend classes (Reid et al. 2015). Since 2005, this effort has made substantial advances in compiling and processing >500,000 vegetation plots nationwide, including standardizing many sample attributes (species taxonomy, structural classes, etc.). These data are maintained in one reference database and attributed in a consistent, repeatable fashion to the USNVC.

The U.S. Forest Service Forest Inventory Assessment program systematically collects complete tree species data on forest plots across the country. A computerized key has been developed for eastern forests that assigns each plot to a USNVC macrogroup (Faber-Langendoen & Menard 2006; Menard et al. in prep) (Fig. 6).

The CNVC has developed an expert system to assign associations to National Forest Inventory (NFI) plots, so that NFI reporting on these plots can be attributed with the higher detail of the CNVC types. CNVC will develop field keys for associations and alliances in the near future.

Nomenclatural rules for natural vegetation
The EcoVeg approach for nomenclature is described in Jennings et al. (2009) and Faber-Langendoen et al. (2014). Briefly, for each type, we provide a scientific name, a translated scientific name (based on the vernacular plant names available from widely accepted standard taxonomic references), and a colloquial name. Translated names and colloquial names are provided in English and other languages (e.g., for CNVC both English and French, for much of Latin America both English and Spanish). The names can include ecological (e.g., boreal, tropical, cool, dry) and physiognomic terms (e.g., forest, grassland, bog, tundra) as well as plant species names, and may also include a biogeographic term (e.g., Californian, Vancouverian). Nomenclatural terms from other classifications can be noted in the section for synonymy. Nomenclatural rules are summarized in Faber-Langendoen et al. (2014).

For upper and mid-levels of the hierarchy, CNVC nomenclature matches the USNVC “colloquial name” (in English and French) when the types are equivalent, but the CNVC does not use “Scientific” and “Translated”
Fig. 6. Map of plots (USFS Forest Inventory and Analysis Program) assigned to the “Appalachian, Interior & Northeastern Mesic Forest Macrogroup” (M883). Plots were assigned using a computerized key based on the characteristic species combination of trees. Full floristic information is not typically available for these USFS plots (Menard et al. in prep). Photo by D. Faber-Langendoen. Map produced by James Garner.
names at these levels. At the alliance and association levels, CNVC nomenclature matches that of the USNVC, except for the addition of a French “Translated” name and the exclusion of the hierarchy level term (e.g., “alliance”) and the physiognomy term (e.g., “Forest”) (see Supplement S1).

Differences between CNVC and USNVC implementation of classification protocols

Within the above general guidelines, some differences in implementation are found between the CNVC and USNVC (see Tables 3, 4 and Supplement S1). The upper four levels of the hierarchy (formation class, formation subclass, formation, and division) are identical between the two classifications, and the lowest level (association) is conceptually similar, although the formal definitions (Supplement S1) vary somewhat in emphasis. For levels 5, 6 and 7 (macrogroup, group and alliance), the CNVC distinguishes between types containing “zonal” vegetation (Pojar et al. 1987) versus types describing only “azonal” vegetation (Supplement S1). For “azonal” vegetation, the CNVC uses the same interpretive guidelines as the USNVC. For vegetation containing “zonal” conditions, at these hierarchy levels CNVC assignment criteria can be different from those of the USNVC:

1. At the macrogroup level, the emphasis in the CNVC is on plant species composition, abundance and/or dominance that reflects the primary regional climate in vegetation patterns on circum-mesic “zonal” sites, although these types also include physiognomically similar vegetation on relatively dry or moist sites within that climatic region. Macrogroup subtypes within these macrogroups are used to distinguish vegetation patterns that represent secondary gradients of regional climate or biogeographic distinctions within the type, as reflected by vegetation on circum-mesic “zonal” sites. In the USNVC, the emphasis is also on plant species composition, but no particular ecological gradient is given interpretive primacy at this level. That is, while both the USNVC and CNVC recognize broadly distinct “circum-mesic site” vs “dry site” vegetation, the USNVC does not impose an environmental order within the hierarchy, thereby recognizing edaphically and climatically driven vegetation patterns at either the macrogroup or group level (depending on the strength of the compositional response to the ecological gradient), a result which the CNVC seeks to avoid.

2. At the alliance and group levels, for vegetation within a macrogroup that contains “zonal” vegetation (above), the CNVC emphasizes the aggregation of associations that are ecologically related at the local to sub-regional scale (e.g., successionaly related associations on edaphically similar sites). In such cases alliances are first-order and groups second-order aggregates of associations and can only be drafted after associations have been developed. In the USNVC, top-down and bottom-up approaches may be used for any vegetation condition at any level (see also Faber-Langendoen et al. 2014, Appendix E with respect to development of alliance concepts).

To date, working mostly with forest vegetation containing “azonal” conditions, there is generally good correspondence between the CNVC and the USNVC at the macrogroup level. However, see Supplement S3 for some exceptions, especially the role of regional climate as a primary driver in differentiating macrogroups or macrogroup subtypes in the CNVC. For “azonal” vegetation, the two classifications are identical (Table 2) at the macrogroup level. However, the interpretive criteria for group and alliance types are generally quite different between the two classifications.

The EcoVeg approach allows for subtypes within each of the 8 levels. Although used sparingly by the USNVC and IVC, the CNVC uses subtypes extensively at the macrogroup (see above) and association levels. Association subtypes (subassociations) describe consistent patterns of species occurrence or dominance that do not indicate ecological differences strong enough to be recognized at the association level.

Differences in IVC implementation of classification protocols

IVC protocols are currently consistent with the USNVC protocols, but data sources are much more variable, with many plot-based studies completed at relatively small geographic scales. National, let alone, international plot databases do not exist for most countries in the tropics, and there is not yet a concerted international effort to systematically evaluate types across multiple biogeographic regions. However, the EcoVeg approach provides critical guidance on the criteria for types (Tables 3 and 4), thereby facilitating use of multiple secondary sources, including narrative descriptions, mapped information and plot-based analyses to comprehensively classify, describe and name vegetation types (e.g., the world grassland divisions in Dixon et al. 2013). The defined units can then be improved as rigorous analyses become available, such as the recently completed site-based floristic analyses of neotropical dry forests in Latin America (Fig. 4).
Classification protocols for cultural vegetation

Criteria for the description of cultural vegetation

Vegetation criteria are the primary properties used to define all types of cultural vegetation, but the role of ongoing human management processes is typically much stronger than ecological or biogeographic processes. Vegetation criteria include growth forms, floristics, and ecological setting (Di Gregorio & Jansen 1996). Excluded from the vegetation criteria are explicit habitat factors (e.g., climate, soil type) and land-use practices (e.g., grazed pasture versus ungrazed pasture), except as these are expressed in the vegetation.

Growth forms

As with natural vegetation, growth form criteria include: 1) diagnostic patterns of growth forms, 2) dominant growth forms, singly or in combination, and 3) vertical and horizontal structure of growth forms (Di Gregorio & Jansen 1996). Distinctive sets of cultural growth forms are not currently described, but will be needed (orchard tree, vineyard grape, row crop, etc.). Examples of specific criteria include: 1) regularly spaced vegetation with substantial cover of bare soil for significant periods of the year (e.g., tillage, chemical treatment, or agricultural flooding), and 2) dominant growth forms or structure that are highly manipulated and rarely found in natural vegetation (e.g., mechanical pruning, mowing, clipping, etc.).

Floristics

Floristic (crop or managed species) criteria include: 1) diagnostic combinations of species/crop or managed types, 2) dominant species, reflecting similar agricultural or developed vegetation patterns, and 3) vertical and horizontal structure of species. Together, these criteria are evaluated in a human management context. Examples of specific criteria include dominant vegetation comprising planted versus non-native species.

Ecological context

Criteria for ecological context include: 1) climate (macro-, meso-, and microclimate), although human management activities often overcompensate for many of the climatic effects, except at the extremes such as frost-free climates, extreme cold or drought climates, 2) effects of human activities (e.g., plowing, mowing), and 3) topo-edaphic factors, including creation of ponds, plowing, modifications of pH, moisture, nutrients, and texture. Because many crop species are planted and maintained outside their provenance, biogeography is rarely considered in the description of cultural types.

All type concepts based on these criteria should be derived from field observations, in which the crops or managed species, growth forms, and their abundances, along with the field observation record, overall vegetation structure, management activities and habitat setting are described. These field data provide the fundamental information for the description of types.

Type concepts

The development of a global cultural vegetation hierarchy is relatively novel and has no parallels in other global vegetation classifications. The approach developed here needs further testing and review. For the U.S., a comprehensive set of cultural vegetation types is available in pilot form for most levels, based on the Natural Resources Conservation Service’s National Resources Inventory (NRI) (FGDC 2008, Appendix I). These may prove valuable as a global set of cultural types, pending further review.

Advantages and limitations of the approach

Advantages

The EcoVeg classification approach is gaining recognition as a comprehensive, hierarchical vegetation classification approach that can be used to catalog the vegetation of countries or other large areas. The classification principles and protocols are well articulated, and with the current level of development of the USNVC, those wishing to use the approach have a comprehensive example of its application (USNVC 2016). Extensive collaborations between and within countries have contributed to the integrity of the classification and its acceptance by users. Providing both colloquial (e.g., English, Spanish and/or French common names) and scientific names increases the user base. Use of both expert knowledge and plot-based analyses has ensured that the legacies of previous classification efforts were fully accessed and incorporated. Looking ahead, the open peer-review structure allows for ongoing improvement of the classification by vegetation ecologists, while retaining authoritative versions for users. The eight-level hierarchy of types allows users to select the levels most applicable to their needs.

Limitations

Developing and maintaining national and international classification frameworks requires considerable resources. Ongoing funding is an issue in the development and improvement of the classifications in both Canada and the U.S. In the present version of the USNVC, lack of systematic plot data for many types has hindered de-
velopment of clear concepts, especially at lower levels. In Canada, the CNVC is still working towards a classification of all natural vegetation. The IVC needs development and testing of its type concepts at the upper and mid-levels, especially from experts in Asia, Middle East and Australia, for it to become truly international. In addition, alliances and associations are not available in most tropical countries. Other limitations include a somewhat complicated nomenclatural system for types, partly because multiple names are provided that are informative for both scientists and practitioners.

Author contributions

D.F.-L. initiated the first draft and coordinated all edits with coauthors. K.B. and D.M. led all CNVC content, including CNVC tables and figures. C.J. and D.F.-L. led the IVC content. R.K.P., T.K.-W. and E.M. assisted on USNVC content, and all authors read and edited multiple versions of the draft.

Acknowledgements

The development of the EcoVeg approach would not have been possible without support to the “Hierarchy Revisions Working Group” from the USNVC partners, including the Ecological Society of America Vegetation Classification Panel, NatureServe, and federal government agencies, especially the U.S. Forest Service (lead agency and chair), the U.S. Geological Survey, the U.S. National Park Service, and the U.S. Bureau of Land Management. For development of the IVC in Latin America, the knowledge and support of Gonzalo Navarro has been fundamental, as well as the contribution of Pat Comer, especially with mapping efforts that have served to test the classification beyond the U.S. For D.F.-L., the inspiration for the sometimes laborious work of classification and conservation comes from the convictions expressed in Gerard Manley Hopkins’ poem, “The world is charged with the grandeur of God.”

The CNVC Technical Committee has been actively developing the classification protocols and participating in correlation meetings for over a decade – their continued involvement has contributed immensely to the development of the CNVC. The development of the CNVC would not have been possible without the financial and staff support provided by Natural Resources Canada, or the willing provision of data and expertise by provinces and territories of Canada.

We thank Mary Russo for assistance with Table 1, Jon Hak for assistance with Figure 5, and Kevin Nimerfro with Figure 6. Thanks to Pat Comer for his review of the manuscript. We gratefully acknowledge contributions to the cost of making this publication available as Open Access from the Ecological Society of America, U.S. Forest Service, U.S. Geological Survey, NatureServe, and Natural Resources Canada – Canadian Forest Service, and NatureServe.

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Henson, B.L. & Bakowsky, W.D. 2014. Plant community ranking methodology: alvars, dunes, prairies. *Natural Heritage Information Centre, Ontario Ministry of Natural Resources and Forestry, Peterborough, ON, CA.*


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Electronic Supplements

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Supplement S1: Definitions (with an example) of the hierarchy levels for natural vegetation for the IVC, CNVC and USNVC.
Supplement S2: Definitions (with an example) of the hierarchy levels for cultural vegetation.
Supplement S3: Examples of USNVC vs CNVC treatments of natural vegetation found in both the U.S. and Canada.
Supplement S4: List of Vegetation Types, from Formation to Macrogroup, for the Americas.

Please save the electronic supplement contained in this pdf-file by clicking the blue frame above. After saving rename the file extension to .zip (for security reasons Adobe does not allow to embed .exe, .zip, .rar etc. files).

SUPPLEMENT S1. Definitions (with an example) of the hierarchy levels for natural vegetation for the IVC, CNVC and USNVC. All classifications share the same definitions for L1 – L4. For L5 – L8 some differences, shown in separate sub-rows, occur for the CNVC. Nomenclature shares common principles but the CNVC only uses the Colloquial name for Levels 1 through 6 and, for L8 (association), does not use a physiognomic term.

<table>
<thead>
<tr>
<th>Natural Hierarchy</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
</table>
| 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 |
| 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 |
<table>
<thead>
<tr>
<th>Level</th>
<th>Macrogroup/Group/Alliance</th>
<th>USNVC/IVC</th>
<th>Scientific Name</th>
<th>Colloquial Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>L5 –</td>
<td>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.</td>
<td>Schizachyrium scoparium – Sorghastrum nutans Grassland &amp; Shrubland</td>
<td>Central Lowlands Tallgrass Prairie</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For Upland Vegetation That Includes “Zonal” Vegetation (Pojar et al 1987): 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. For “Azonal” Vegetation: same as USNVC/IVC.</td>
<td>Andropogon gerardii – Heterostipa spartea –Muhlenbergia richardsonis Grassland</td>
<td>Central Lowlands Tallgrass Prairie</td>
<td></td>
</tr>
<tr>
<td>L6 –</td>
<td>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.</td>
<td>Northern Mesic Tallgrass Prairie</td>
<td>Not yet developed for CNVC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For Upland Vegetation That Includes “Zonal” Vegetation (Pojar et al 1987): 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. For “Azonal” Vegetation: same as USNVC/IVC.</td>
<td>Sporobolus heterolepis – Muhlenbergia richardsonis Northern Grassland</td>
<td>Northern Mesic Tallgrass Prairie</td>
<td></td>
</tr>
<tr>
<td>L7 –</td>
<td>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.</td>
<td>Andropogon gerardii – Muhlenbergia richardsonis Northern Grassland</td>
<td>Northern Mesic Tallgrass Prairie</td>
<td></td>
</tr>
</tbody>
</table>
**CNVC: For Upland Vegetation That Includes “Zonal” Vegetation (Pojar et al 1987):** 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., successionaly related associations on similar edaphic conditions can be aggregated into more generalized alliances).

**For “Azonal” Vegetation:** same as same as USNVC/IVC.

<table>
<thead>
<tr>
<th>L8 – Association</th>
<th>USNVC/IVC: A vegetation type defined by a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy. Associations reflect subregional to local topo-edaphic factors of substrates, hydrology, disturbance regimes and climate.</th>
<th>CNVC: 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.</th>
<th>Not yet developed for CNVC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientific Name:</strong> Andropogon gerardii – Heterostipa spartea - Sporobolus heterolepis Grassland</td>
<td><strong>Scientific Name:</strong> Andropogon gerardii – Heterostipa spartea - Sporobolus heterolepis</td>
<td><strong>Colloquial Name:</strong> Northern Mesic Big Bluestem Prairie</td>
<td><strong>Colloquial Name:</strong> Northern Mesic Big Bluestem Prairie</td>
</tr>
</tbody>
</table>
SUPPLEMENT S2. Definitions (with an example) of the hierarchy levels for cultural vegetation.

These definitions are used by the USNVC and IVC (see FGDC 2008, Faber-Langendoen et al. 2014). The name of the level can be added to a type name for clarity, where needed (e.g. Agricultural & Developed Vegetation Cultural Class).

<table>
<thead>
<tr>
<th>Cultural Hierarchy</th>
<th>Definition (Faber-Langendoen et al. 2014)</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 – Cultural Class</td>
<td>A cultural vegetation type defined by a broad and characteristic combination of dominant growth forms adapted to relatively intensive human manipulations, as reflected in relatively rapid changes in structure and/or composition.</td>
<td>Scientific Name: Anthromorphic Vegetation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colloquial Name: Agricultural &amp; Developed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vegetation</td>
</tr>
<tr>
<td>L2 – Cultural Subclass</td>
<td>A cultural vegetation type defined by broad combinations and degree of herbaceous versus woody growth forms that reflects global human management activities.</td>
<td>Scientific/Colloquial Name: Woody Agricultural Vegetation</td>
</tr>
<tr>
<td>L3 – Cultural Formation</td>
<td>A cultural vegetation type defined by the degree to which canopy structure of dominant growth forms is annually converted or heavily manipulated / harvested.</td>
<td>Scientific/Colloquial Name: Forest Plantation &amp; Agroforestry</td>
</tr>
<tr>
<td>L4 – Cultural Subformation</td>
<td>A cultural vegetation type defined by the spatial structure of the vegetation, including whether in swards, rows, and degree of manipulation to the canopy.</td>
<td>Scientific/Colloquial Name: Forest Plantation</td>
</tr>
<tr>
<td>L5 – Cultural Group</td>
<td>A cultural vegetation type defined by a common set of growth forms and many diagnostic plant taxa sharing a broadly similar region and climate, and disturbance factors.</td>
<td>Scientific /Colloquial Name: Temperate &amp; Boreal Plantation</td>
</tr>
<tr>
<td>L6 – Cultural Subgroup</td>
<td>A cultural vegetation type defined by a common set of growth forms and diagnostic species (taxa) preferentially sharing a similar set of regional edaphic, topographic, and disturbance factors.</td>
<td>Scientific/ Colloquial Name: Eastern North American Forest Plantation</td>
</tr>
<tr>
<td>Lower</td>
<td>L7 – Cultural Type</td>
<td>A cultural vegetation type defined by one or more dominant or co-dominant species, as well as habitat conditions, and physiognomy.</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Colloquial Name:</strong> Native Northern Pine Plantation</td>
</tr>
<tr>
<td></td>
<td>L8 – Cultural Subtype</td>
<td>A cultural vegetation type defined by one or more dominant or co-dominant species, in conjunction with a characteristic set of associated species, habitat conditions and physiognomy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Colloquial Name:</strong> White Pine Plantation</td>
</tr>
</tbody>
</table>
SUPPLEMENT S3. Examples of USNVC vs CNVC treatments of natural vegetation found in both the U.S. and Canada.

1) Great Plains Rough Fescue Prairie:

<table>
<thead>
<tr>
<th>USNVC</th>
<th>CNVC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOS1 Great Plains Mixedgrass &amp; Fescue Prairie Macrogroup</td>
<td>CM332 Great Plains Rough Fescue Prairie Macrogroup</td>
<td>Identical vegetation condition (range almost entirely in Canada):</td>
</tr>
<tr>
<td>G332 Northern Great Plains Rough Fescue Prairie Group</td>
<td></td>
<td>- CNVC recognizes at macrogroup level because primary environmental driver is regional climate;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- USNVC recognizes at group level because there are few diagnostic species that distinguish the type from other groups, and the climate is transitional from boreal to plains.</td>
</tr>
</tbody>
</table>

2) Boreal Forests:

<table>
<thead>
<tr>
<th>USNVC</th>
<th>CNVC</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>M495 Eastern North American Boreal Forest Macrogroup</td>
<td>M495 Eastern North American Boreal Forest Macrogroup</td>
<td>Shared macrogroup (range almost entirely in Canada)</td>
</tr>
<tr>
<td></td>
<td>CM495a Atlantic Subtype: 4 groups -- e.g., CG0003 Atlantic Boreal Mesic Balsam Fir - Paper Birch - White Spruce Forest;</td>
<td>- CNVC recognizes 2 macrogroup subtypes. Within each subtype, group, alliance, and association types describe regional to local topo-edaphic, microclimate &amp; seral variation;</td>
</tr>
<tr>
<td></td>
<td>CM495b Ontario-Quebec Subtype: 4 groups -- e.g., CG0006 Ontario-Quebec Boreal Mesic-Moist Black Spruce (Jack Pine) Forest.</td>
<td>- USNVC follows CNVC, but scaling of CNVC types in terms of USNVC interpretive conventions is under review.</td>
</tr>
</tbody>
</table>
### 3) Rocky Mountain Subalpine and High Montane Forests:

<table>
<thead>
<tr>
<th>USNVC</th>
<th>CNVC</th>
<th>Comments</th>
</tr>
</thead>
</table>
| M020 Rocky Mountain Subalpine-High Montane Conifer Forest Macrogroup | M020 Rocky Mountain Subalpine-High Montane Conifer Forest Macrogroup | **Shared macrogroup:**  
- USNVC describes the range-wide expression of continental Rocky Mtn. subalpine forests & woodlands from northern BC to New Mexico;  
- CNVC describes the Canadian expression of this vegetation in British Columbia and Alberta;  
- CNVC recognizes 3 macrogroup subtypes for Canadian vegetation, reflecting variation in sub-regional prevailing climate. The subtypes overlap with several USNVC groups. |
| G220 Rocky Mountain Lodgepole Pine Forest & Woodland                 | CM020a Dry Montane Macrogroup Subtype                               | This CNVC subtype probably contains elements of USNVC G220 (*Pinus contorta* var. *latifolia*), G222 (*Populus tremuloides*), G345 (*Picea glauca*):  
- USNVC group distinctions emphasize dominant overstory species in relation to topo-edaphic and disturbance gradients;  
- CNVC group distinctions emphasize local scale topo-edaphic, microclimate & seral variation within the climatic subtype. CNVC groups will likely combine successional overstory dominance on similar edaphic sites. |
| G219 Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland| CM020b Dry Subalpine Macrogroup Subtype                             | This CNVC subtype probably contains elements of USNVC G219 (dry *Picea-Abies*), G220 (*Pinus contorta* var. *latifolia*), G221 (*Pinus flexilis*), G223 (*Larix lyallii, Pinus albicaulis*):  
- see comparison of group level criteria above (CM020a). |
| G218 Rocky Mountain Subalpine Moist Spruce - Fir Forest & Woodland   | CM020c Humid Subalpine Macrogroup Subtype                           | This CNVC subtype probably corresponds fairly well with the Canadian expression of USNVC G218 (moist *Picea-Abies*). |
4) **Eastern Temperate Forests:**

<table>
<thead>
<tr>
<th>USNVC</th>
<th>CNVC</th>
<th>Comments</th>
</tr>
</thead>
</table>
| M014 Laurentian-Acadian Mesic Hardwood – Conifer Forest Macrogroup | CM014 Northern Temperate Hardwood - Conifer Forest Macrogroup | - CNVC distinguishes “Acadian” from “Laurentian” forests at the macrogroup level on the basis of vegetation patterns on “zonal” sites that are driven by regional climate;  
- CNVC recognizes oak-pine forests at the group level within these bioclimatic macrogroups because, in eastern Canada, they typically develop in response to ecological processes (e.g., fire, drought) determined by edaphic conditions;  
- USNVC treats these oak-pine forests at the macrogroup level, reflecting the combination of climate, substrate and fire regime that produce broadly distinct assemblages of both overstory and understory species. |
Supporting Information to the paper Faber-Langendoen et al. EcoVeg Approach in the Americas.

SUPPLEMENT S4. List of Vegetation Types, from Formation to Macrogroup) for the Americas. Colloquial names are used for all vegetation types for ease of interpretation. For simplicity, national distribution is only provided at the macrogroup level. Cultural types are only well developed for the top 3 levels, and distributions have not been developed. All types are confirmed in the IVC and USNVC. Types in Canada that are confirmed in the CNVC are marked with an asterisk.

1 Forest & Woodland
  1.A Tropical Forest & Woodland
    1.A.1 Tropical Dry Forest & Woodland

<table>
<thead>
<tr>
<th>Code</th>
<th>Type Description</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M296 Caribbean-Mesoamerican Pine Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M134 Caribbean Coastal Lowland Dry Forest</td>
<td>BS, CU, DO, HT, JM, MQ, PR, TC, TT, US, VE, VG?, VI, XD</td>
</tr>
<tr>
<td></td>
<td>M294 Caribbean Dry Limestone Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M561 Caribbean-Mesoamerican Seasonal Dry Forest</td>
<td>BZ, CR, GT, HN, MX, NI, PA</td>
</tr>
<tr>
<td></td>
<td>M562 Pacific Mesoamerican Seasonal Dry Forest</td>
<td>CR, GT, HN, MX, NI, PA, SV</td>
</tr>
<tr>
<td></td>
<td>M563 Guajiran Seasonal Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M565 Llanos Seasonal Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M566 Tumbes Guayaquil Seasonal Dry Forest</td>
<td></td>
</tr>
<tr>
<td>D219</td>
<td>1.A.1.Ei Colombian-Venezuelan Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M563 Guajiran Seasonal Dry Forest</td>
<td>CO, TT, VE</td>
</tr>
<tr>
<td></td>
<td>M565 Llanos Seasonal Dry Forest</td>
<td>CO, VE</td>
</tr>
<tr>
<td></td>
<td>M566 Tumbes Guayaquil Seasonal Dry Forest</td>
<td>EC, PE</td>
</tr>
<tr>
<td>D220</td>
<td>1.A.1.Ej Guianan Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M567 Central Guianan Seasonal Dry Forest</td>
<td>BR?, VE</td>
</tr>
<tr>
<td>D221</td>
<td>1.A.1.Ek Brazilian-Parana Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M572 Caatinga Seasonal Dry Forest</td>
<td>BR</td>
</tr>
<tr>
<td></td>
<td>M872 Cerradô Sclerophyllous Woodland</td>
<td>BO, BR, PY</td>
</tr>
<tr>
<td></td>
<td>M570 Cerrado Seasonal Dry Forest</td>
<td>BO, BR</td>
</tr>
<tr>
<td></td>
<td>M568 Brazilian Atlantic Seasonal Dry Forest</td>
<td>BR, PY</td>
</tr>
<tr>
<td></td>
<td>M571 Parana Seasonal Dry Forest</td>
<td>PY</td>
</tr>
<tr>
<td>D222</td>
<td>1.A.1.El Tropical Andean Montane Dry Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M575 Bolivian-Tucuman Seasonal Dry Forest</td>
<td>AR, BO</td>
</tr>
<tr>
<td></td>
<td>M574 Central Andean Seasonal Dry Forest</td>
<td>BO, EC, PE</td>
</tr>
<tr>
<td></td>
<td>M573 Northern Andean Seasonal Dry Forest</td>
<td>CO, EC, PE, VE</td>
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</tbody>
</table>
## 1.A.2 Tropical Lowland Humid Forest

### D091 1.A.2.Eg Caribbean-Mesoamerican Lowland Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M281</td>
<td>Caribbean Lowland Humid Forest</td>
<td>BS, CU, DO, JM, MQ, PR, TT, VE, VI, XD</td>
</tr>
<tr>
<td>M578</td>
<td>Mesoamerican Lowland Humid Forest</td>
<td>BZ, CR, GT, HN, MX, NI, PA, SV</td>
</tr>
<tr>
<td>M873</td>
<td>Mesoamerican Submontane Humid Forest</td>
<td>BZ, CR, GT, HN, NI, PA</td>
</tr>
</tbody>
</table>

### D224 1.A.2.Eh Colombian-Venezuelan Lowland Humid Forest

<table>
<thead>
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<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M581</td>
<td>Choco-Darien Humid Forest</td>
<td>CO, CR, EC, PA</td>
</tr>
<tr>
<td>M582</td>
<td>Western Ecuadorian Humid Forest</td>
<td>EC</td>
</tr>
<tr>
<td>M580</td>
<td>Catatumbo Magdalena Humid Forest</td>
<td>CO, VE</td>
</tr>
<tr>
<td>M579</td>
<td>Guajiran Humid Forest</td>
<td>VE</td>
</tr>
<tr>
<td>M583</td>
<td>Llanos Humid Forest</td>
<td>CO, VE</td>
</tr>
</tbody>
</table>

### D225 1.A.2.Ei Guianan Lowland Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M586</td>
<td>Eastern Guianan Humid Forest</td>
<td>GF, GY, SR</td>
</tr>
<tr>
<td>M585</td>
<td>Central Guianan Humid Forest</td>
<td>BR, GY, VE</td>
</tr>
<tr>
<td>M584</td>
<td>Western Guianan Humid Forest</td>
<td>CO?, VE</td>
</tr>
<tr>
<td>M587</td>
<td>Orinoquian Humid Forest</td>
<td>GY, VE</td>
</tr>
</tbody>
</table>

### D226 1.A.2.Ej Amazonian Lowland Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M593</td>
<td>Central Amazon Humid Forest</td>
<td>BR</td>
</tr>
<tr>
<td>M592</td>
<td>Northern Amazon Humid Forest</td>
<td>BR, CO</td>
</tr>
<tr>
<td>M594</td>
<td>Southern Amazon Humid Forest</td>
<td>BO, BR</td>
</tr>
<tr>
<td>M590</td>
<td>Southwestern Amazon Lowland Humid Forest</td>
<td>BO, BR, PE</td>
</tr>
<tr>
<td>M591</td>
<td>Southwestern Amazon Subandean Humid Forest</td>
<td>BO, PE</td>
</tr>
<tr>
<td>M588</td>
<td>Western Amazon Lowland Humid Forest</td>
<td>BR, CO, EC, PE</td>
</tr>
<tr>
<td>M589</td>
<td>Western Amazon Subandean Humid Forest</td>
<td>CO, EC, PE</td>
</tr>
</tbody>
</table>

### D227 1.A.2.Ek Brazilian-Parana Lowland Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M597</td>
<td>Cerrado Humid Forest</td>
<td>BO, BR</td>
</tr>
<tr>
<td>M595</td>
<td>Brazilian Atlantic Humid Forest</td>
<td>BR</td>
</tr>
<tr>
<td>M596</td>
<td>Parana Humid Forest</td>
<td>AR, BR, PY</td>
</tr>
</tbody>
</table>

## 1.A.3 Tropical Montane Humid Forest

### D228 1.A.3.Eg Caribbean-Mesoamerican Montane Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M598</td>
<td>Caribbean Montane Humid Forest</td>
<td>CU, DO, HT, JM, KN, MQ, PR, XC, XD, XE</td>
</tr>
<tr>
<td>M601</td>
<td>Mesoamerican Montane Pine-Oak Forest</td>
<td>BR?, GT, HN, MX, NI, SV</td>
</tr>
<tr>
<td>M600</td>
<td>Mesoamerican Montane Humid Forest</td>
<td>CR, GT, HN, MX, NI, PA</td>
</tr>
<tr>
<td>M602</td>
<td>Southern Mesoamerican Montane Humid Forest</td>
<td>CR, PA</td>
</tr>
</tbody>
</table>

### D229 1.A.3.Eh Guianan Montane Humid Forest

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>M604</td>
<td>Eastern Guianan Montane Humid Forest</td>
<td>BR?, GF, GY, SR, VE</td>
</tr>
</tbody>
</table>
M603 Central Guianan Montane Humid Forest  
BR, GY, VE

D231 1.A.3.Ej Tropical Andean Montane Humid Forest
M613 Bolivian-Tucuman Lower Montane Humid Forest  
AR, BO
M612 Bolivian-Tucuman Montane & Upper Montane Humid Forest  
AR, BO
M611 Central Andean (Yungas) Lower Montane Humid Forest  
BO, CO, EC, PE
M610 Central Andean (Yungas) Montane & Upper Montane Humid Forest  
BO, PE
M615 Eastern Subandean Ridge Montane Humid Forest  
EC, PE
M614 Moist Puna Humid Forest  
BO, EC, PE
M607 Northern Andean Lower Montane Humid Forest  
CO, EC, PE, VE
M606 Northern Andean Montane & Upper Montane Humid Forest  
CO, EC, PE, VE
M609 Northern Andean Venezuelan Coastal Ridge Forest  
VE
M608 Northern Andean Santa Marta Montane Humid Forest  

D232 1.A.3.Ek Brazilian-Parana Montane Humid Forest
M616 Brazilian Atlantic Montane Humid Forest  
AR, BR

D230 1.A.3.El Ecuadorian Insular Montane Humid Forest
M605 Galapagos Montane (Scalesia) Humid Forest  
EC

1.A.4 Tropical Flooded & Swamp Forest
D093 1.A.4.Ed Caribbean-Central American Flooded & Swamp Forest
M618 Caribbean Floodplain Forest  
BZ, CU, DO, GT, HN, NI, PR, TT
BS, CU, MQ, PR, TT, US
M617 Caribbean Swamp Forest  
M620 Mesoamerican Floodplain Forest  
BZ, CO, CR, GT, HN, MX, NI, PA, SV
M619 Mesoamerican Coastal Plain Swamp Forest  
BZ, CO, CR, EC, GT, HN, NI, PA

D233 1.A.4.Ei Colombian-Venezuelan Flooded & Swamp Forest
M622 Choco-Darien Floodplain Forest  
CO, CR, PA
M621 Guajiran Flooded Forest  
CO, VE
M625 Guayaquil Flooded & Swamp Forest  
EC, PE
M624 Llanos Flooded & Swamp Forest  
CO, VE

D234 1.A.4.Ej Guianan Flooded & Swamp Forest
M626 Guianan Riparian Forest  
BR, CO, GF, GY, SR, VE
M627 Guianan Swamp Forest  
GF, GY, SR, VE
M628 Orinoco Delta Swamp Forest  

D235 1.A.4.Ek Tropical Andean Riparian & Flooded Forest
M631 Bolivian-Tucuman Dry Valley Riparian Forest  
AR, BO
M632 Eastern Subandean Ridge Flooded Forest  
PE
M630 Central Andean Riparian Forest  
AR, BO, CL, PE
M629 Northern Andean Riparian Forest  
CO, EC, PE, VE
1.A.4. El Amazonian Flooded & Swamp Forest
- M640 Amazon Delta Swamp Forest
- M638 Central Amazon Floodplain Forest
- M637 Northern Amazon Floodplain Forest
- M639 South-Central Amazon Floodplain Forest
- M636 Southern Amazon Swamp Forest
- M635 Southwestern Amazon Floodplain Forest
- M633 Western Amazon Floodplain Forest
- M634 Western Amazon Swamp Forest

1.A.4.Em Brazilian-Parana Flooded & Swamp Forest
- M641 Brazilian Atlantic Coastal Plain Swamp Forest
- M642 Parana Floodplain Forest
- M646 Pantanal Floodplain Forest
- M643 Cerrado Floodplain Forest
- M644 Beni Chiquitano Swamp Forest
- M645 Beni Floodplain Forest

1.A.4.En Chaco Flooded & Swamp Forest & Woodland
- M650 Southern Chaco Floodplain Forest & Woodland
- M647 Northern Chaco Floodplain Forest & Woodland
- M649 Northern Chaco Palm Swamp
- M648 Northern Chaco Riparian Scrub & Woodland

1.A.5 Mangrove
1.A.5.Ua Atlantic-Caribbean & East Pacific Mangrove
- M004 Eastern Pacific Mangrove
- M005 Western Atlantic & Caribbean Mangrove

1.B Temperate & Boreal Forest & Woodland
1.B.1 Warm Temperate Forest & Woodland

1.B.1.Ef Chilean Warm Temperate Forest & Woodland
- M652 Chilean Mediterranean Sclerophyllous Forest
- M653 Chilean Mediterranean Deciduous Forest

1.B.1.Eg Southeastern South American Warm Temperate Forest & Woodland
- M654 Espinal Deciduous Forest & Woodland

1.B.1.Na Southeastern North American Forest & Woodland
- M007 Longleaf Pine Woodland
- M885 Southeastern Coastal Plain Evergreen Oak - Mixed Hardwood
<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>M008</td>
<td>Southern Mesic Mixed Broadleaf Forest</td>
<td>US</td>
</tr>
<tr>
<td>M305</td>
<td>Southeastern North American Ruderal Forest</td>
<td>US</td>
</tr>
<tr>
<td>M009</td>
<td>Californian Forest &amp; Woodland</td>
<td>MX, US</td>
</tr>
<tr>
<td>M513</td>
<td>Californian Ruderal Forest</td>
<td>MX, US</td>
</tr>
<tr>
<td>M010</td>
<td>Madrean Lowland Evergreen woodland</td>
<td>MX, US</td>
</tr>
<tr>
<td>M011</td>
<td>Madrean Montane Forest &amp; Woodland</td>
<td>MX, US</td>
</tr>
<tr>
<td>M015</td>
<td>Balconian Forest &amp; Woodland</td>
<td>MX?, US</td>
</tr>
<tr>
<td>M016</td>
<td>Southern &amp; South-Central Oak - Pine Forest &amp; Woodland</td>
<td>US</td>
</tr>
<tr>
<td>M502</td>
<td>Appalachian-Northeastern Oak - Hardwood - Pine Forest &amp; Woodland</td>
<td>CA**, US</td>
</tr>
<tr>
<td>M883</td>
<td>Appalachian-Interior-Northeastern Mesic Forest</td>
<td>CA*, US</td>
</tr>
<tr>
<td>M012</td>
<td>Central Midwest Oak Forest, Woodland &amp; Savanna</td>
<td>CA*, US</td>
</tr>
<tr>
<td>M882</td>
<td>Central Midwest Mesic Forest</td>
<td>CA, US</td>
</tr>
<tr>
<td>M159</td>
<td>Laurentian-Acadian Pine - Hardwood Forest &amp; Woodland</td>
<td>CA*, US</td>
</tr>
<tr>
<td>M014</td>
<td>Laurentian-Acadian Mesic Hardwood - Conifer Forest</td>
<td>CA*, US</td>
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<td>M013</td>
<td>Eastern North American Ruderal Forest</td>
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<tr>
<td>M022</td>
<td>Southern Rocky Mountain Lower Montane Forest</td>
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<tr>
<td>M501</td>
<td>Central Rocky Mountain Dry Lower Montane-Foothill Forest</td>
<td>CA*, US</td>
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<td>M500</td>
<td>Central Rocky Mountain Mesic Lower Montane Forest</td>
<td>CA*, US</td>
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<td>M021</td>
<td>Sierra Madre High Montane Forest</td>
<td>GT, MX</td>
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<tr>
<td>M020</td>
<td>Rocky Mountain Subalpine-High Montane Conifer Forest</td>
<td>CA*, MX, US</td>
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<td>M890</td>
<td>Western Interior Sub-boreal Spruce - Fir Forest</td>
<td>CA*, US?</td>
</tr>
<tr>
<td>M026</td>
<td>Intermountain Singleleaf Pinyon - Juniper Woodland</td>
<td>US</td>
</tr>
<tr>
<td>M027</td>
<td>Southern Rocky Mountain-Colorado Plateau Two-needle</td>
<td>US</td>
</tr>
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</table>
Pinyon - Juniper Woodland

D192 1.B.2.Nd Vancouverian Forest & Woodland
 M886  Southern Vancouverian Dry Foothill Forest & Woodland  CA*, US
 M023  Southern Vancouverian Montane-Foothill Forest  MX, US
 M024  Vancouverian Lowland & Montane Forest  CA*, US
 M025  Vancouverian Subalpine Forest  CA*, MX, US
 M405  Vancouverian Ruderal Forest  CA, US

 M151  Great Plains Forest & Woodland  CA*, US

1.B.3 Temperate Flooded & Swamp Forest

D243 1.B.3.Eh Pampean Temperate Flooded & Swamp Forest
 M661  Espinal Floodplain Forest  AR, UY

D244 1.B.3.Ei Chilean Mediterranean Flooded & Swamp Forest
 M662  Chilean Mediterranean & Desert Riparian & Flooded Forest  CL

D245 1.B.3.Ej Valdivian Temperate Flooded & Swamp Forest
 M663  Valdivian Temperate Flooded & Swamp Forest  AR, CL

D246 1.B.3.Ek Northern Patagonian Flooded Forest
 M664  Monte Floodplain Forest  AR

 M029  Central Hardwood Floodplain Forest  CA*, US
 M503  Central Hardwood Swamp Forest  CA*, US
 M504  Laurentian-Acadian-North Atlantic Coastal Flooded & Swamp Forest  CA*, US
 M028  Great Plains Flooded & Swamp Forest  CA*, US
 M302  Eastern North American Ruderal Flooded & Swamp Forest  CA, US

D062 1.B.3.Nb Southeastern North American Flooded & Swamp Forest
 M161  Pond-cypress Basin Swamp  US
 M033  Southern Coastal Plain Basin Swamp & Flatwoods  US
 M032  Southern Coastal Plain Evergreen Hardwood - Conifer Swamp  US
 M031  Southern Coastal Plain Floodplain Forest  US
 M154  Southern Great Plains Floodplain Forest & Woodland  US
 M310  Southeastern North American Ruderal Flooded & Swamp Forest  US

 M034  Rocky Mountain-Great Basin Montane Riparian & Swamp Forest  CA*, MX, US

D013 1.B.3.Nd Western North American Interior Flooded Forest
 M660  Mexican Interior Riparian Forest  MX
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<thead>
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<tr>
<td>M036</td>
<td>Interior Warm &amp; Cool Desert Riparian Forest</td>
<td>MX, US</td>
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<tr>
<td>M298</td>
<td>Interior West Ruderal Flooded &amp; Swamp Forest &amp; Woodland</td>
<td>MX, US</td>
</tr>
<tr>
<td>D193</td>
<td>1.B.3.Ng Vancouverian Flooded &amp; Swamp Forest</td>
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</tr>
<tr>
<td>M035</td>
<td>Vancouverian Flooded &amp; Swamp Forest</td>
<td>CA*, US</td>
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### 1.B.4 Boreal Forest & Woodland

<table>
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<tr>
<td>D247</td>
<td>1.B.4.Eb Magellanian Antiboreal Forest</td>
<td>M667</td>
</tr>
<tr>
<td></td>
<td>Magellanian Subantarctic Woodland</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eastern North American Boreal Forest</td>
<td>CA*, US</td>
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<tr>
<td></td>
<td>M496 West-Central North American Boreal Forest</td>
<td>CA*, US</td>
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<tr>
<td></td>
<td>Alaskan-Yukon North American Boreal Forest</td>
<td>CA*, US</td>
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<tr>
<td></td>
<td>North American Boreal Subarctic &amp; Subalpine Woodland</td>
<td>CA*, US</td>
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### 1.B.5 Boreal Flooded & Swamp Forest

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<tr>
<td>D248</td>
<td>1.B.5.Eb Magellanian (Anti-)Boreal Flooded Woodland</td>
<td>M668</td>
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<tr>
<td></td>
<td>Magellanian Swamp Woodland</td>
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</tr>
<tr>
<td></td>
<td>North American Boreal Conifer Poor Swamp</td>
<td>CA*, US</td>
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<tr>
<td></td>
<td>M300 North American Boreal Flooded &amp; Rich Swamp Forest</td>
<td>CA*, US</td>
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### 2 Shrub & Herb Vegetation

#### 2.A Tropical Grassland, Savanna & Shrubland

##### 2.A.1 Tropical Lowland Grassland, Savanna & Shrubland

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Location</th>
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<tbody>
<tr>
<td>D094</td>
<td>2.A.1.Ea Caribbean-Mesoamerican Lowland Grassland, Savanna &amp; Shrubland</td>
<td>M671</td>
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<tr>
<td></td>
<td>Caribbean Dry Scrub</td>
<td>BS, CU, DO, HT, JM, PR, TT, US, VI, XC, XD, CU</td>
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<tr>
<td></td>
<td>M669 Caribbean Palm Savanna</td>
<td>BZ, HN, MX, NI</td>
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<td></td>
<td>M672 Northern Mesoamerican Pine Savanna</td>
<td>CR, GT, HN, MX, NI, PA</td>
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<tr>
<td></td>
<td>M673 Northern Mesoamerican Savanna &amp; Shrubland</td>
<td>BS, BZ, CO, CR, CU, GT, HN, MX, NI, PA, PR, SV, US, US</td>
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<tr>
<td></td>
<td>M515 Caribbean-Mesoamerican Lowland Ruderal Grassland &amp; Shrubland</td>
<td>BO, BR</td>
</tr>
<tr>
<td></td>
<td>M346 Central Amazon Savanna</td>
<td>BO, BR, CO, PE</td>
</tr>
<tr>
<td></td>
<td>M345 Western Amazon Savanna</td>
<td>BO, BR, CO, PE</td>
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<tr>
<td>D124</td>
<td>2.A.1.Eb Amazonian Savanna &amp; Shrubland</td>
<td>M684</td>
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<tr>
<td></td>
<td>Brazilian Atlantic Coastal Plain Savanna &amp; Woodland</td>
<td>BR</td>
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<tr>
<td></td>
<td>M688 Parana Upland Savanna &amp; Shrubland</td>
<td>AR, PY, UY</td>
</tr>
<tr>
<td></td>
<td>M685 Cerrado Savanna</td>
<td>BO, BR, PY</td>
</tr>
<tr>
<td>D249</td>
<td>2.A.1.Er Colombian-Venezuelan Lowland Grassland, Savanna &amp; Shrubland</td>
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### Shrubland

<table>
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<th>Description</th>
<th>Location(s)</th>
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<tbody>
<tr>
<td>M676</td>
<td>Llanos Upland Savanna</td>
<td>CO, VE</td>
</tr>
<tr>
<td>M675</td>
<td>Guajiran Ruderal Grassland &amp; Shrubland</td>
<td>CO?, VE</td>
</tr>
<tr>
<td><strong>D250</strong></td>
<td><strong>2.A.1.Es Guianan Lowland &amp; Upland Grassland, Savanna &amp; Shrubland</strong></td>
<td></td>
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<tr>
<td>M681</td>
<td>Eastern Guianan Savanna &amp; Shrubland</td>
<td>GF, GY, SR</td>
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<tr>
<td>M679</td>
<td>Central Guianan Savanna &amp; Shrubland</td>
<td>BR, GY, VE</td>
</tr>
<tr>
<td>M680</td>
<td>Western Guianan Savanna &amp; Shrubland</td>
<td>CO, VE</td>
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### 2.A.2 Tropical Montane Grassland & Shrubland

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<tr>
<td>M377</td>
<td>Bolivian-Tucuman Montane Grassland &amp; Shrubland</td>
<td>AR, BO</td>
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<tr>
<td>M375</td>
<td>Northern Andean Montane &amp; Upper Montane Grassland &amp; Shrubland</td>
<td>EC, PE</td>
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<tr>
<td>M378</td>
<td>Moist Puna Grassland &amp; Scrub</td>
<td>BO, PE</td>
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<tr>
<td>M694</td>
<td>Northern Andean Paramo</td>
<td>CO, EC, PE, VE</td>
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<tr>
<td>M697</td>
<td>Andean Montane &amp; Upper Montane Ruderal Grassland &amp; Shrubland</td>
<td>AR?, BO, CO?, EC, PE, VE</td>
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### 2.A.3 Tropical Scrub & Herb Coastal Vegetation

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<tbody>
<tr>
<td>M700</td>
<td>Caribbean-Mesoamerican Coastal Dune &amp; Beach</td>
<td>BR, BS?, CO, CR, CU, GT, HN, MX, NI, PA, PR, US, VE, XB, XC</td>
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### 2.B Temperate & Boreal Grassland & Shrubland

<table>
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<tr>
<td>M702</td>
<td>Brazilian Atlantic Coastal Beach &amp; Dune</td>
<td>BR</td>
</tr>
<tr>
<td>M701</td>
<td>Eastern Guianan Coastal Rocky Shore &amp; Beach</td>
<td>BR, GF, GY, SR</td>
</tr>
<tr>
<td>M703</td>
<td>Tropical Eastern Pacific Coastal Beach &amp; Dune</td>
<td>CO, CR, EC, NI, PA, SV</td>
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</table>
2.B.1 Mediterranean Scrub & Grassland

D273 2.B.1.Ei Chilean Mediterranean Scrub, Grassland & Forb Meadow
- M742 Central Chilean Interior Scrub  CL
- M741 Central Chilean Coastal Scrub  CL
- M743 Southern Andean Mediterranean Montane Scrub & Forb Meadow  AR, CL

D274 2.B.1.Ej Chaco-Espinal Scrub & Grassland
- M744 Chaco Serrano Scrub & Grassland  AR
- M745 Monte Scrub & Grassland  AR

D327 2.B.1.Na Californian Scrub & Grassland
- M043 Californian Chaparral  MX, US
- M044 Californian Coastal Scrub  MX, US
- M045 Californian Annual & Perennial Grassland  MX?, US
- M046 Californian Ruderal Grassland, Meadow & Scrub  MX, US

2.B.2 Temperate Grassland & Shrubland

D141 2.B.2.Ek Pampean Grassland & Shrubland
- M392 Semi-Arid Pampa Grassland & Shrubland  AR
- M748 Humid Pampa Grassland & Shrubland  AR, BR, UY

D275 2.B.2.En Madrean Grassland & Shrubland

D144 2.B.2.Eo Patagonian Grassland & Shrubland
- M749 Patagonian Dry Grassland & Shrubland  AR
- M750 Patagonian Mesic Grassland & Shrubland  AR, CL

D022 2.B.2.Na Western North American Grassland & Shrubland
- M049 Southern Rocky Mountain Montane Shrubland  US
- M048 Central Rocky Mountain Montane-Foothill Grassland & Shrubland  CA*, US
- M168 Rocky Mountain-Vancouverian Subalpine-High Montane Mesic Meadow  CA*, US
- M050 Southern Vancouverian Lowland Grassland & Shrubland  CA*, US
- M172 Northern Vancouverian Lowland-Montane Grassland & Shrubland  CA*, US
- M493 Western North American Ruderal Grassland & Shrubland  CA, US

D023 2.B.2.Nb Central North American Grassland & Shrubland
- M054 Central Lowlands Tallgrass Prairie  CA*, MX?, US
- M051 Great Plains Mixedgrass & Fescue Prairie  CA*, US
- M053 Western Great Plains Shortgrass Prairie  CA, MX?, US
- M052 Great Plains Sand Grassland & Shrubland  CA, US
- M158 Great Plains Comanchian Scrub & Open Vegetation  MX?, US
M498 Great Plains Ruderal Grassland & Shrubland

    M506 Appalachian Rocky Felsic & Mafic Scrub & Grassland
    M509 Central Interior Acidic Scrub & Grassland
    M508 Central Interior Calcareous Scrub & Grassland
    M505 Laurentian-Acadian Acidic Rocky Scrub & Grassland
    M507 Laurentian-Acadian Calcareous Scrub & Grassland
    M123 Eastern North American Ruderal Grassland & Shrubland

D061  2.B.2.Nd Western North American Interior Chaparral
    M094 Cool Interior Chaparral
    M091 Warm Interior Chaparral

D102  2.B.2.Ne Southeastern North American Grassland & Shrubland
    M162 Florida Peninsula Scrub & Herb
    M309 Southeastern Coastal Plain Patch Prairie
    M308 Southern Barrens & Glade
    M307 Southeastern Ruderal Grassland & Shrubland

2.B.3 Boreal Grassland & Shrubland
    D277  2.B.3.Ec Magellanian Antiboreal Grassland & Shrubland
    M751 Magellanian Subantarctic Shrubland & Grassland
    M055 North American Boreal Shrubland & Grassland

2.B.4 Temperate to Polar Scrub & Herb Coastal Vegetation
    D278  2.B.4.Eg Pacific South American Dune & Coastal Grassland & Shrubland
    M754 Chilean Mediterranean Coastal Beach, Dune & Bluff
    D279  2.B.4.Eh Pampean Dune & Coastal Grassland & Shrubland
    M755 Atlantic Coast & La Plata Delta Beach & Dune
    D280  2.B.4.Ei Valdivian Dune & Coastal Grassland & Shrubland
    M756 Valdivian Coastal Shrubland
    D281  2.B.4.Ej Patagonian Dune & Coastal Grassland & Shrubland
    M757 Patagonian Coastal Grassland & Shrubland
    M060 Eastern North American Coastal Beach & Rocky Shore
    M057 Eastern North American Coastal Dune & Grassland
    M753 Warm Pacific Coastal Beach, Dune & Bluff
    M059 Pacific Coastal Beach & Dune
    M058 Pacific Coastal Cliff & Bluff
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<thead>
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<tr>
<td>M511</td>
<td>North Pacific Coastal Ruderal Grassland &amp; Shrubland</td>
<td>CA, MX?, US</td>
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<tr>
<td>M402</td>
<td>North American Arctic &amp; Boreal Coastal Shore</td>
<td>CA*, GL*, US</td>
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### 2.C Shrub & Herb Wetland

#### 2.C.1 Tropical Bog & Fen

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<td>D259</td>
<td>2.C.1.Ef Guianan Bog</td>
<td>BR, VE</td>
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<td>M706</td>
<td>Tepuyan Bog</td>
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<td>2.C.1.Eg Andean Montane Bog</td>
<td>AR, BO, CL, CO, EC, PE, VE</td>
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<td>M708</td>
<td>Tropical Andes Upper Montane Bog</td>
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#### 2.C.2 Temperate to Polar Bog & Fen

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<td>D282</td>
<td>2.C.2.Eb Southern Andean Montane Bog</td>
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<td>M758</td>
<td>Southern Andean Montane Bog</td>
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<td>2.C.2.Ec Magellanian Bog &amp; Fen</td>
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<td>M759</td>
<td>Magellanian Anti-Boreal Bog &amp; Fen</td>
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<td>M876</td>
<td>North American Boreal &amp; Sub-boreal Bog &amp; Acidic Fen</td>
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<td>M877</td>
<td>North American Boreal &amp; Sub-boreal Alkaline Fen</td>
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<td>M063</td>
<td>North Pacific Bog &amp; Fen</td>
<td>CA*, US</td>
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<td>D324</td>
<td>2.C.2.Nb Atlantic &amp; Gulf Coastal Plain Pocosin</td>
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<td>M065</td>
<td>Southeastern Coastal Bog &amp; Fen</td>
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#### 2.C.3 Tropical Freshwater Marsh, Wet Meadow & Shrubland

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<td>2.C.3.Ef Caribbean-Mesoamerican Freshwater Marsh, Wet Meadow &amp; Shrubland</td>
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<td>M711</td>
<td>Mesoamerican Freshwater Marsh, Wet Meadow &amp; Shrubland</td>
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<td>M891</td>
<td>Caribbean-Mesoamerican Ruderal Freshwater Marsh, Wet Meadow &amp; Shrubland</td>
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<td>D263</td>
<td>2.C.3.Eg Colombian-Venezuelan Freshwater Marsh, Flooded Savanna &amp; Shrubland</td>
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<td>Colombian-Venezuelan Freshwater Marsh, Wet Meadow &amp; Shrubland</td>
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<td>Llanos Flooded Savanna</td>
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<tr>
<td>D264</td>
<td>2.C.3.Eh Guianan Freshwater Marsh, Wet Meadow &amp; Shrubland</td>
<td>BR, GY, VE</td>
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<tr>
<td>M717</td>
<td>Central Guianan Flooded Savanna</td>
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<td>M718</td>
<td>Western Guianan Flooded Savanna</td>
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</table>
M707  Orinoquian Floodplain Peat Meadow & Marsh
M720  Orinoquian Floodplain Marsh & Flooded Savanna

M863 Tropical Andean Pondshore & Wet Meadow
M722  Andean Puna Wet Meadow
M721  Northern Andean Wet Meadow

D266 2.C.3.Ej Amazonian Freshwater Marsh, Wet Meadow & Shrubland
M709 Amazon Delta Peat Marsh
M724 Amazonian-Guianan White Sand Flooded Savanna & Shrubland
M726 Lower Amazon Wet Meadow & Shrubland
M725 Upper Amazon Wet Meadow & Shrubland

D267 2.C.3.Ek Parana-Brazilian Freshwater Marsh, Wet Meadow & Shrubland
M730 Lower Amazon Wet Meadow & Shrubland
M729 Pantanal Floodplain Wet Meadow & Shrubland
M730 Parana Floodplain Wet Meadow & Shrubland
M729 Lower Amazon Wet Meadow & Shrubland
M728 Beni Flooded Savanna

D268 2.C.3.El Chaco Freshwater Marsh, Flooded Savanna & Shrubland
M734 Eastern Chaco Marsh & Flooded Savanna
M732 Chaco Riparian Marsh & Shrubland
M733 Southern Chaco Riparian Marsh & Shrubland

2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
D284 2.C.4.Ee South American Temperate Freshwater Marsh, Wet Meadow & Shrubland
M760 Pamppean Freshwater Marsh, Wet Meadow & Shrubland
M864 Southern Andean Montane Freshwater Marsh & Wet Meadow

M888 Arid West Interior Freshwater Marsh
M075 Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland
M074 Western North American Vernal Pool
M073 Vancouverian Lowland Marsh, Wet Meadow & Shrubland
M301 Western North American Ruderal Marsh, Wet Meadow & Shrubland

M076 Warm Desert Lowland Freshwater Marsh, Wet Meadow &
### Shrubland

- M061 Eastern North American Cool Temperate Seep
  - CA*, US
- M069 Eastern North American Marsh, Wet Meadow & Shrubland
  - CA*, US
- M880 Eastern North American Wet Shoreline Vegetation
  - CA*, US
- M881 Eastern North American Riverscour Vegetation
  - CA*, US
- M071 Great Plains Marsh, Wet Meadow, Shrubland & Playa
  - CA*, MX?, US
- M303 Eastern-Southeastern North American Ruderal Marsh, Wet Meadow & Shrubland
  - CA, MX, US

**D322** 2.C.4.Ne Atlantic & Gulf Coastal Marsh, Wet Meadow & Shrubland
- M066 Atlantic & Gulf Coastal Fresh-Oligohaline Tidal Marsh
  - CA, MX?, US
- M067 Atlantic & Gulf Coastal Plain Wet Prairie & Marsh
  - CA, MX?, US

**D320** 2.C.4.Np Circumpolar Arctic & Subarctic Freshwater Marsh & Wet Meadow
- M870 North American Arctic & Subarctic Freshwater Marsh & Wet Meadow
  - CA*, US

### Salt Marsh

**D269** 2.C.5.El Eastern Pacific Coastal Salt Marsh
- M737 Mesoamerican-South American Pacific Coastal Salt Marsh
  - BZ, CO, CR, EC, HN, MX, NI, PA, MX
- M736 Mexican Pacific Coastal Salt Marsh

**D270** 2.C.5.Em South American Lowlands Interior Brackish Marsh
- M738 Chaco-Espinal Brackish Marsh
  - AR, BO, PY

**D271** 2.C.5.En Andean Salt Marsh
- M739 Central Andean Altiplano Salt Flats
  - AR, BO, CL, PE

**D272** 2.C.5.Eo South American Pacific Desert Salt Flats
- M740 South American Pacific Desert Salt Flats
  - CL

**D285** 2.C.5.Ep South American Temperate Salt Marsh
- M762 South American Temperate Interior Brackish Marsh
  - AR, CL
- M763 Temperate & Austral Atlantic Coastal Salt Marsh
  - AR, BR, UY
- M761 Southern Andean Montane Salt Marsh
  - AR, CL

**D286** 2.C.5.Eq Temperate & Austral Pacific Coastal Salt Marsh
- M764 South American Cold Pacific Coastal Salt Marsh
  - CL

**D033** 2.C.5.Na North American Great Plains Saline Marsh
- M077 Great Plains Saline Wet Meadow & Marsh
  - CA*, MX?, US

**D034** 2.C.5Nb North American Atlantic & Gulf Coastal Salt Marsh
- M079 North American Atlantic & Gulf Coastal Salt Marsh
  - CA*, MX, US

**D035** 2.C.5.Nc Temperate & Boreal Pacific Coastal Salt Marsh
3 Desert & Semi-Desert

3.A Warm Desert & Semi-Desert Woodland, Scrub & Grassland

3.A.1 Tropical Thorn Woodland

D287 3.A.1.Ea Caribbean-Northern Mesoamerican Xeromorphic Scrub & Woodland
M765 Caribbean-Northern Mesoamerican Xeromorphic Scrub & Woodland GT, MX

D288 3.A.1.Eb Colombian-Venezuelan Xeromorphic Scrub & Woodland
M766 Guajiran Xeromorphic Scrub & Woodland CO, VE
M767 Tumbesian Xeromorphic Scrub & Woodland EC, PE

D289 3.A.1.Ec Interandean Valley Xeromorphic Scrub & Woodland
M770 Bolivian-Tucuman Xeromorphic Scrub & Woodland AR, BO
M769 Central Andean Xeromorphic Scrub & Woodland AR, BO, CL, PE
M768 Northern Andean Xeromorphic Scrub & Woodland CO, EC, PE

D290 3.A.1.Ed Chaco Xeromorphic Scrub & Woodland
M773 Southern Chaco Xeromorphic Scrub & Woodland AR
M772 Northeastern Chaco Xeromorphic Scrub & Woodland AR, PY
M771 Northwestern Chaco Xeromorphic Scrub & Woodland AR, BO, PY

3.A.2 Warm Desert & Semi-Desert Scrub & Grassland

D291 3.A.2.Ek Tropical Andean Xeromorphic Scrub & Grassland
M777 Bolivian-Tucuman Interandean Xeromorphic Scrub & Grassland AR, BO
M776 Central Interandean Xeromorphic Scrub & Grassland BO, PE
M775 Northern Interandean Xeromorphic Scrub & Grassland CO, EC, PE

D292 3.A.2.El Brazilian-Parana Xeromorphic Scrub & Grassland
M779 Caatinga Dense Scrub & Forb Meadow BR
M778 Caatinga Xeromorphic Scrub BR

D293 3.A.2.Em Chaco Xeromorphic Scrub, Grassland & Savanna
3.B Cool Semi-Desert Scrub & Grassland

3.B.1 Cool Semi-Desert Scrub & Grassland

D318 3.B.1.Eb Andean Cool Semi-Desert Cliff, Scree & Other Rock Vegetation
M862 Andean Cool Semi-Desert Rock Vegetation AR, BO, CL, PE

M790 Patagonian Semi-Desert Scrub AR

D295 3.B.1.Eh Tropical Andean Cool Semi-Desert Scrub & Grassland
M787 Xeric Puna Succulent Scrub AR, BO, CL, PE

D296 3.B.1.Ei Mediterranean-Southern Andean Cool Semi-Desert Scrub & Grassland
M788 Mediterranean Andean Cool Semi-Desert Scrub & Grassland AR, CL
M789 Monte Cool Semi-Desert Scrub & Grassland AR, BO

D040 3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland
M171 Great Basin-Intermountain Dry Shrubland & Grassland CA?, MX?, US
M170 Great Basin-Intermountain Dwarf Sagebrush Steppe & Shrubland US
M169 Great Basin-Intermountain Tall Sagebrush Steppe & Shrubland CA?, US
M095 Great Basin-Intermountain Xeric-Riparian Scrub US
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<td>M093</td>
<td>Great Basin Saltbush Scrub</td>
<td>CA?, MX?, US</td>
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<td>M118</td>
<td>Intermountain Basins Cliff, Scree &amp; Badland Sparse Vegetation</td>
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<td>M499</td>
<td>Western North American Cool Semi-Desert Ruderal Scrub &amp; Grassland</td>
<td>CA, US</td>
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**4 Polar & High Montane Scrub, Grassland & Barrens**

4.A Tropical High Montane Scrub & Grassland

4.A.1 Tropical High Montane Scrub & Grassland

D298 4.A.1.Eg Tropical & Mediterranean Andean High Montane Scrub & Grassland

- M869 Andean High Montane Cliff, Scree & Rock Vegetation
- M794 High Andean Xeric Puna Bunch Grassland
- M793 High Andean Moist Puna Bunch Grassland
- M792 High Northern Andean Super-Paramo

**4.B Temperate to Polar Alpine & Tundra Vegetation**

4.B.1 Temperate & Boreal Alpine Tundra

D299 4.B.1.Eg Southern Andean High Montane Tundra

- M795 Southern Andean Alpine Tundra

D300 4.B.1.Eh Magellanian High Montane Tundra

- M796 Magellanian Montane Tundra


- M131 Eastern North American Alpine Tundra

D043 4.B.1.Nb Western North American Alpine Tundra

- M099 Rocky Mountain-Sierran Alpine Tundra
- M101 Vancouverian Alpine Tundra
- M404 Western Boreal Alpine Tundra

4.B.2 Polar Tundra & Barrens

D044 4.B.2.Xa Arctic Tundra & Barrens

- M175 Arctic Scree, Rock & Cliff Barrens
- M173 Arctic Tundra

**5 Aquatic Vegetation**

5.A Saltwater Aquatic Vegetation

5.A.1 Floating & Suspended Macroalgae Saltwater Vegetation

5.A.2 Benthic Macroalgae Saltwater Vegetation

D047 5.A.2.Wb Temperate Intertidal Shore

- M104 Temperate Atlantic Intertidal Shore
- M106 Temperate Pacific Seaweed Intertidal Vegetation
5.A.3 Benthic Vascular Saltwater Vegetation

5.A.3.We Temperate Seagrass Aquatic Vegetation
D064  M184 Temperate Pacific Seagrass Intertidal Vegetation
M183 Temperate Eel-grass Vegetation

5.A.3.Wf Temperate Estuarine & Inland Brackish Aquatic Vegetation
D065  M186 Ditchgrass Saline Aquatic Vegetation

5.A.3.Xd Tropical Saltwater Vegetation
D063  M180 Indo-Pacific & Caribbean Seagrass Vegetation

5.A.4 Benthic Lichen Saltwater Vegetation

5.B Freshwater Aquatic Vegetation

5.B.1 Tropical Freshwater Aquatic Vegetation
D097  M292 Neotropical Floating & Submerged Freshwater Marsh
M892 Neotropical Ruderal Freshwater Aquatic Vegetation

5.B.2 Temperate to Polar Freshwater Aquatic Vegetation
D319  M865 Temperate South American Freshwater Aquatic Vegetation
D049  M108 Eastern North American Freshwater Aquatic Vegetation
M109 Western North American Freshwater Aquatic Vegetation
M871 Arctic & Northern Boreal Freshwater Aquatic Vegetation
M401 North American Temperate Ruderal Aquatic Vegetation

6 Open Rock Vegetation

6.A Tropical Open Rock Vegetation

6.A.1 Tropical Cliff, Scree & Other Rock Vegetation
D311  M867 Brazilian-Parana Cliff, Scree & Rock Vegetation
D308  M871 Caribbean-Mesoamerican Cliff, Scree & Rock Vegetation
M868 Caribbean-Mesoamerican Cliff, Scree & Rock Vegetation
D309 6.A.1.Ef Guianan Lowlands Cliff, Scree & Rock Vegetation
   M852 Guianan Cliff, Scree & Rock Vegetation                   GF, GY, SR
D310 6.A.1.Eg Guianan Montane Cliff, Scree & Rock Vegetation
   M851 Tepuyan Cliff, Scree & Rock Vegetation                    CO, VE
D312 6.A.1.Eh Tropical Andean Cliff, Scree & Rock Vegetation
   M853 Northern Andean Cliff, Scree & Rock Vegetation          BO, PE
   M854 Central Andean (Yungas) Cliff, Scree & Rock Vegetation  CO, EC
   M855 Bolivian-Tucuman Cliff, Scree & Rock Vegetation        AR, BO
   M856 Moist Puna Cliff, Scree & Rock Vegetation                BO, PE

6.B Temperate & Boreal Open Rock Vegetation
6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation
   M857 South American Temperate Cliff, Scree, Rock & Dune       AR, CL, UR?
   M857 South American Temperate Cliff, Scree, Rock & Dune       AR, CL, UR?
   M111 Eastern North American Cliff & Rock Vegetation          CA*, MX?, US
   M115 Great Plains Badlands Vegetation                         CA*, US
   M116 Great Plains Cliff, Scree & Rock Vegetation              CA*, US
   M887 Western North American Cliff, Scree & Rock Vegetation    CA*, MX, US

7 Agricultural & Developed Vegetation
7.A Woody Agricultural Vegetation
7.A.1 Woody Horticultural Crop
7.A.2 Forest Plantation & Agroforestry
7.A.3 Woody Wetland Horticultural Crop
7.B Herbaceous Agricultural Vegetation
7.B.1 Row & Close Grain Crop
7.B.2 Pasture & Hay Field Crop
7.B.3 Herbaceous Horticultural Crop
7.B.4 Fallow Field & Weed Vegetation
7.B.5 Herbaceous Wetland Crop
7.C Herbaceous & Woody Developed Vegetation
7.C.1 Lawn, Garden & Recreational Vegetation
7.C.2 Other Developed Vegetation
7.C.3 Developed Wetland Vegetation
7.D Agricultural & Developed Aquatic Vegetation
   7.D.1 Agricultural Aquatic Vegetation
   7.D.2 Developed Aquatic Vegetation