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

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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.

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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-

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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-

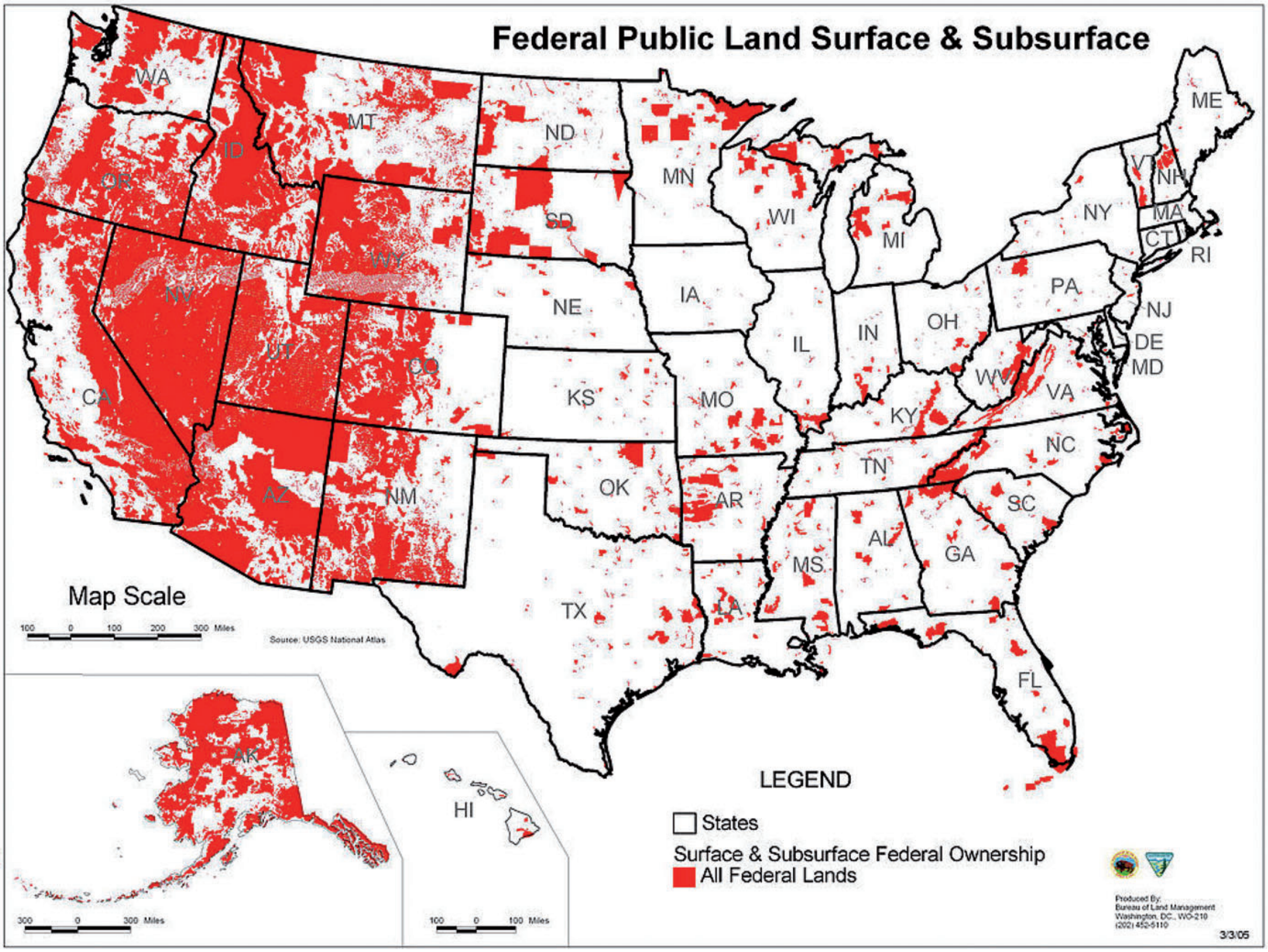

Fig. 1. Federal land ownership in the United States. A major driver of support for the USNVC as a federal standard (FGDC 2008) was the need for sharing information on vegetation across land managed by federal agencies. See also Table 2.

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

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.

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 USNVC 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).

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 and 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 underlies 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

Table 1. Current degree of completeness for natural vegetation types within the Americas. Numbers of types for each level of the hierarchy are shown for the U.S., Canada, and across the Americas, as of Sept 1, 2016. The IVC-Americas includes all units currently reported by NatureServe for Canada, continental U.S. (excluding Hawaii and the territories of American Samoa, Guam, and Mariana Islands), Caribbean (including Puerto Rico and Virgin Islands), Central America, and South America. See Supplement S4 for list of vegetation types down to macrogroup.

Level	USNVC (50 states & territories)	USNVC (continental 49 states)	CNVC	IVC North America (Canada, U.S.)	IVC Latin America	IVC Americas
Formation Class	6	6	6	6	6	6
Formation Subclass	15	11	13	11	13	13
Formation	32	27	22	27	29	34
Division	69	57	36	57	121	140
Macrogroup	183	155	60[2]	156	292	375
Group	426	391	30[3]	410	~728	1059[4]
Alliance	1263[1]	1263[1]	53[3]	TBD	TBD	TBD
Association	6168[1]	6168[1]	214[3]	TBD	TBD	TBD

[1] includes only types in lower 48 states.
[2] includes zonal forest, Great Plains grassland, and alpine and subalpine macrogroups, and all azonal macrogroups in Canada; excludes ruderal, aquatic and non-zonal upland types.
[3] includes only boreal and Vancouverian forest types.
[4] based on 617 Ecological System types for South America (Josse et al. 2003). Ecological System types are equivalent to or somewhat finer than IVC groups.

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 USNVC.

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.

Table 2. Examples of applications of the CNVC, USNVC and IVC. See also Franklin et al. (2015).

	EcoVeg Level	Applications
Upper	Level 1 – Formation Class	
	Level 2 – Formation Subclass	1. U.S. Army Corps of Engineers – Stewardship (FGDC 1997) (USNVC) 2. "Gap analysis" of protected area representation for Canada, USA, and Mexico (in part) using international land cover classes
	Level 3 – Formation	1. Ecological Integrity Assessment (Environmental Protection Agency – National Wetland Condition Assessment, NatureServe, State Natural Heritage Program) Fish and Wildlife Service (USNVC) 2. Status and Trends of Wetlands in the Coastal Watersheds of the Conterminous United States (National Marine Fisheries Service) (USNVC) 3. Natural Hazards and Cultural Transformations (NSF-Supported Research Grant). Human Relations Area Files, Yale University, New Haven CT (IVC)
Mid	Level 4 – Division	1. Ecoregional Distribution – grasslands (NatureServe, World Wildlife Fund) (IVC)
	Level 5 – Macrogroup	1. Forest Assessment (US Forest Service Forest Inventory and Analysis Program) (USNVC) 2. Regional Assessments (U.S. Bureau of Land Management, NatureServe) (USNVC) 3. Ecosystem Red List of Americas (NatureServe, IUCN) (IVC) 4. Continental Mapping (NatureServe – North America, Latin America, Africa (with USGS)) (IVC) 5. Biodiversity Indicators Dashboard, Aichi Biodiversity Targets, Convention on Biological Diversity (NatureServe) (IVC) 6. Vegetation Zones of Canada (in part) (CNVC)
	Level 6 – Group	1. Natural Resource/Wildlife Habitat Inventory (U.S. National Park Service Vegetation Inventory Program, Northeast Association of Fish & Wildlife Agencies, Western Governors Association Initiative, State Natural Heritage Programs) (USNVC) 2. Ecological Integrity Assessments (U.S. Fish and Wildlife Service, U.S. National Park Service, NatureServe, State Natural Heritage Programs) (USNVC) 3. Forest Assessment (U.S. Forest Service Forest Inventory and Analysis Program) (USNVC) 4. Vegetation composition, structure, and wildfire fuels modeling (LANDFIRE) (USNVC) 5. National Mapping (U.S. Geological Survey – GAP Analysis Program, LANDFIRE) (USNVC) 6. Ecosystem Red List of terrestrial ecosystems in temperate and tropical North America (NatureServe) (IVC)
Lower	Level 7 – Alliance	1. National Park mapping (U.S. National Park Service Vegetation Inventory Program) (USNVC) 2. Natural Resource/Wildlife Habitat Inventory (California Fish & Game / California Native Plant Society) (state level use of USNVC)
	Level 8 – Association	1. U.S. National Park Service Vegetation Inventory Program, State Natural Heritage Programs (Natural Resources Inventory) (USNVC) 2. Rare Plant Communities (The Nature Conservancy, NatureServe, State Natural Heritage Programs, Conservation Data Centres) (USNVC, CNVC) 3. National Forest Inventory (NFI) – incorporation of CNVC type information in NFI reporting.

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 content, databases, education and outreach. Information on the USNVC is available on the web at http://usnvc.org.

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

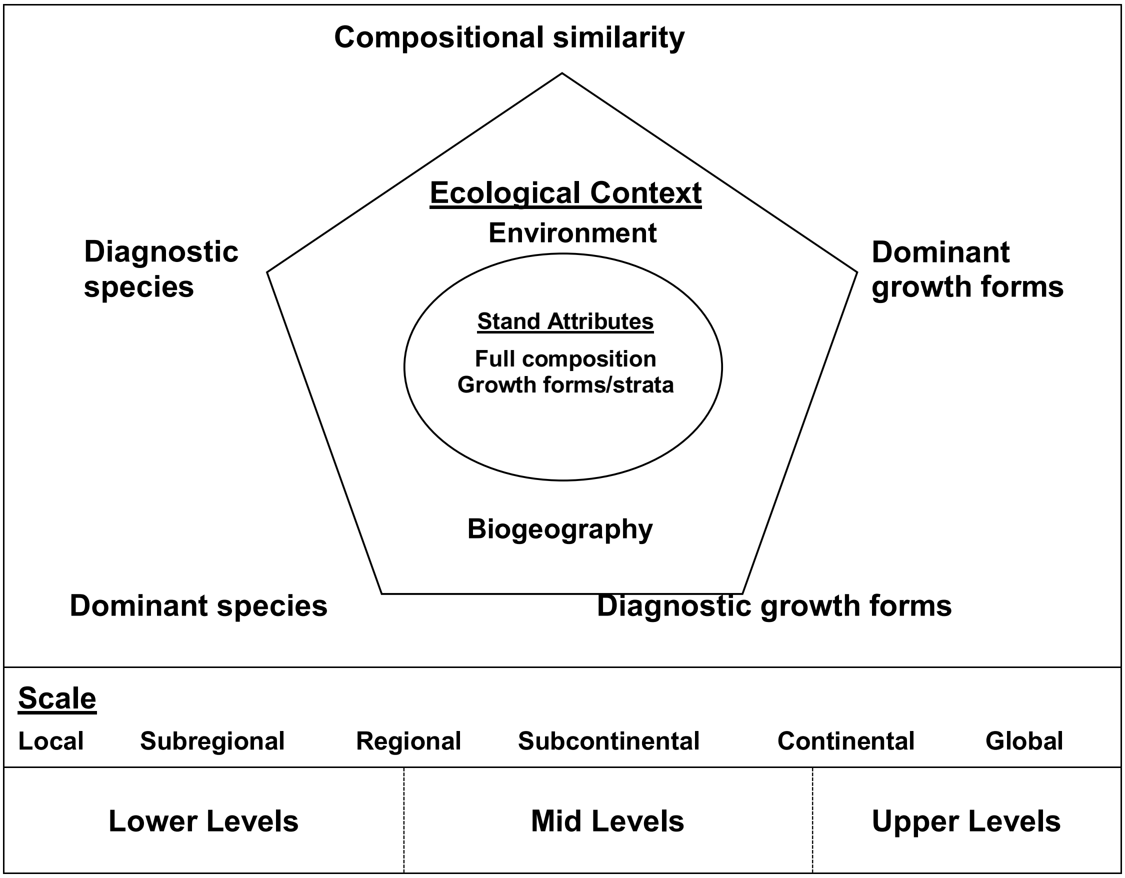

Fig. 3. Vegetation classification criteria for the USNVC. The diagram portrays the five vegetation criteria used to classify vegetation at all levels of the USNVC hierarchy (from FGDC 2008). These criteria are arranged from the most fine-scaled on the left to the most broad-scaled on the right. The five 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.

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.

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 grain is largely constrained from 100 m^2 to 1000 m^2 (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 m^2 or 10 m^2 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 m^2 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 nomenclatural standards include The Plant List (http://www.theplantlist.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

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.

Level	Growth Forms	Ecological Factors – Climate, Disturbance and Edaphic/Hydrology	Biogeography – Floristics/ Diagnostic species
Formation Class	Broad combinations of dominant general growth forms and specific growth forms. Overlapping general growth forms	basic moisture, temperature, and/or substrate or aquatic conditions	–
Formation Subclass	Combinations of general and specific dominant and diagnostic growth forms.	global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions	–
Formation	Combinations of dominant and diagnostic growth forms	global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions	–
Division	Broadly uniform sets of growth forms and canopy closure	*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	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

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.

Level	Biogeography/Floristics	Diagnostic Species	Growth Forms	Climate	Disturbance regime/ Succession	Edaphic/Hydrology
Division	Large scale, continental, biogeography with largely non-overlapping floristics	One or more sets of strongly diagnostic species	Broadly uniform sets of growth forms and canopy closure	Continental macroclimate	Variable range of disturbance regimes consistent with formation	Broad range of conditions consistent with formation
Macro-group	Sub-continental to regional ecological gradient segment, reflected by sets of strongly diagnostic species; overall composition very distinct from other types	Multiple sets of strong diagostic species, including many strong differential and character species. Constant species become more important; at least 25% constancy expected	Broadly uniform sets of growth forms and canopy closure – may be specific growth form variants that support floristic patterns	Sub-continental mesoclimate – indicative of primary regional gradients in vegetation	Broadly consistent, but variable disturbance regimes indicative of subcontinental climate	Broad range of conditions, sometimes reflective of broad topo-edaphic interactions with climate
Group	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	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	Moderately uniform growth forms and canopy closure	Regional meso-climate – could indicate secondary regional gradients	Moderately consistent disturbance regime; may incorporate successional stages that are otherwise floristically similar	Moderate range of variation in specific topo-edaphic or hydrologic conditions
Alliance	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	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	Moderately uniform growth forms and canopy closure, at least in the dominant layer	Regional to sub-regional topo-edaphic factors, sometimes reflective of biogeography and climate	Moderately specific disturbance regime – may group successionally related associations	Moderately specific edaphic or hydrologic conditions
Association	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	At least a few diagnostic species, preferably including at least one moderate differential. Constancy 40–60% for a suite of species	Strongly uniform growth forms, in both dominant and other layers and degree of canopy closure	Climate rarely a driver; rather a narrow range of topo-edaphically related influences	Narrow range of disturbance regime – may have disturbance or successional relationships to other local associations	Narrow range of edaphic or hydrologic conditions, indicative of locally significant factors

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):

Growth forms and structure

Growth form criteria include: 1) diagnostic combinations of growth forms, 2) dominant growth forms, singly or in combination, and 3) vertical and horizontal structure of growth forms. Growth forms are defined as "the shape or appearance [physiognomy and structure] of a plant reflecting growing conditions and genetics" (FGDC 2008). Growth forms are based on structural types (e.g., tree), leaf form (e.g., broad-leaved macrophyll), relative plant and leaf size, and seasonal activity pattern (e.g., summergreen) (Whittaker 1975 p. 359; Box 1981; Box & Fujiwara 2005). Growth form descriptions are provided in Appendix B of Faber-Langendoen et al. (2014).

Floristics

The definition of a vegetation type is summarized by "*characteristic species combinations*" (or "diagnostic combinations of species") including: a) diagnostic species (character and differential species), b) constant species, and c) dominant species (Westhoff & van der Maarel 1973; Chytrý & Tichý 2003). The characteristic species combination can be a strong indicator of bioclimatic, biogeographic, geo-edaphic, and successional conditions.

Compositional similarity

Compositional similarity is defined as a measure of the similarity in the presence and/or abundance of plant species between two or more plots or types. Numerical indices (e.g., Sorenson, Bray-Curtis, Euclidean distance) can

Fig. 4. Classification and distribution of forest divisions and macrogroups for the Tropical Dry Forest & Woodland Formation in the neotropics. The two figures show the congruence in concepts between IVC types based on literature review, expert judgement and mapping (4a) and an independent floristic site analysis (4b) by DRYFLOR (2016). **(4a)** Map of IVC divisions and macrogroups (from Comer et al. in prep). The number after each letter (A–E) is a database code for the IVC division (see Supplement S4). **(4b)** Floristic site analysis by DRYFLOR (2016) and comparison with IVC divisions. Analysis and distribution of neotropical dry forest sites is based on woody plants. Geographic distribution of "floristic groups" of 835 dry forest sites is on right, and ordination of floristic groups is on left (northern Inter-Andean valley type shown in black on right and grey on left). (The ordination shows higher level clusters, linked by grey lines, largely equivalent to IVC division concepts (compare distribution of division types A–D in 4a with 4b), and component forest groups, largely equivalent to IVC macrogroups. Andean montane macrogroups are dispersed among various DRYFLOR groups (see circled types in A, B and D), but are placed together in IVC Division C. Conversely, the Central Andes coast type is placed in IVC Division B with other coastal macrogroups, rather than with the Central Andes montane cluster of DRYFLOR. Division E was not included in DRYFLOR analyses. Fig. 4b adapted and reprinted with permission from AAAS.

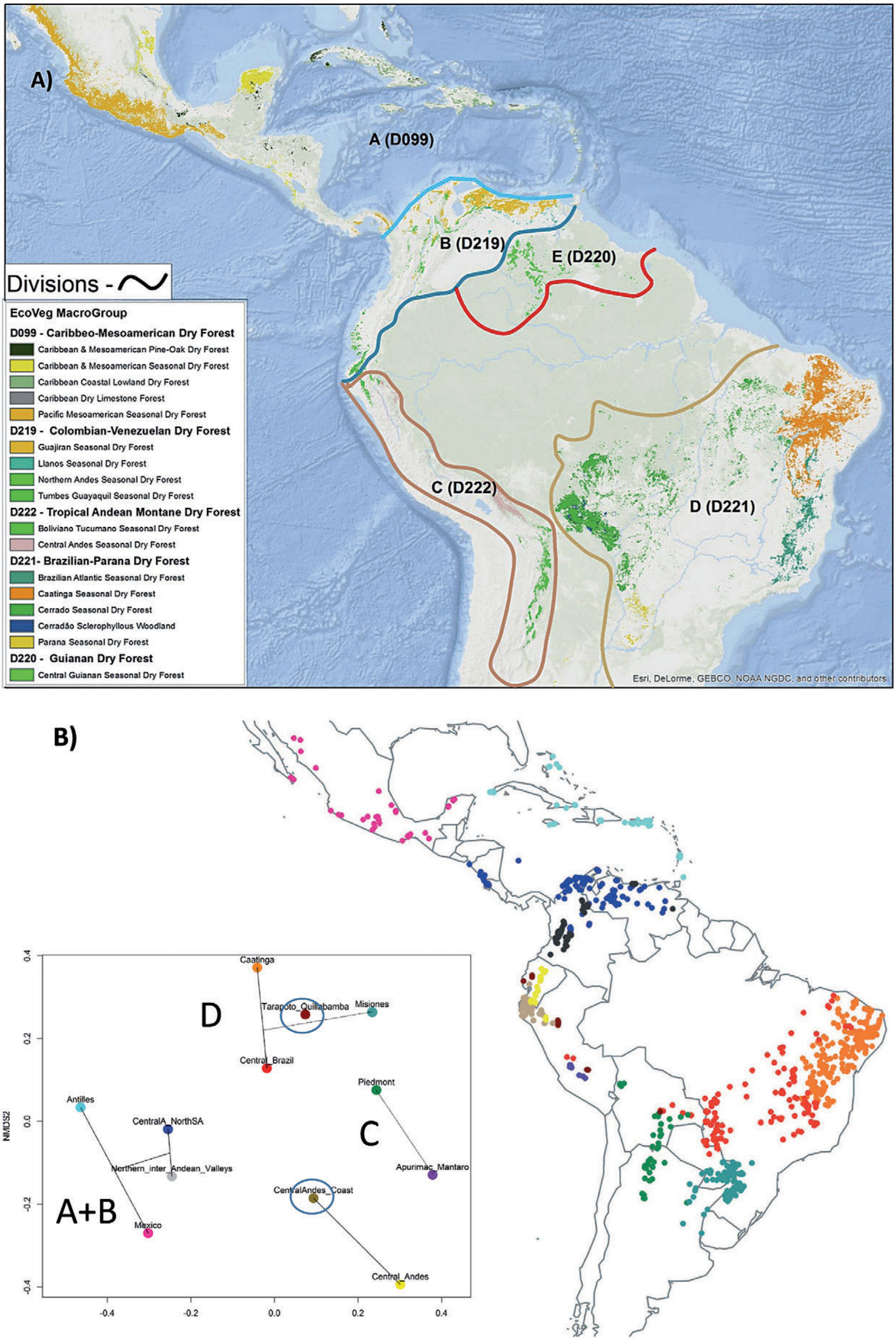
A)
A (D099)
B (D219)
E (D220)
C (D222)
D (D221)
Divisions -
EcoVeg MacroGroup
D099 - Caribbeo-Mesoamerican Dry Forest
Caribbean & Mesoamerican Pine-Oak Dry Forest
Caribbean & Mesoamerican Seasonal Dry Forest
Caribbean Coastal Lowland Dry Forest
Caribbean Dry Limestone Forest
Pacific Mesoamerican Seasonal Dry Forest
D219 - Colombian-Venezuelan Dry Forest
Guajiran Seasonal Dry Forest
Llanos Seasonal Dry Forest
Northern Andes Seasonal Dry Forest
Tumbes Guayaquil Seasonal Dry Forest
D222 - Tropical Andean Montane Dry Forest
Boliviano Tucumano Seasonal Dry Forest
Central Andes Seasonal Dry Forest
D221- Brazilian-Parana Dry Forest
Brazilian Atlantic Seasonal Dry Forest
Caatinga Seasonal Dry Forest
Cerrado Seasonal Dry Forest
Cerradão Sclerophyllous Woodland
Parana Seasonal Dry Forest
D220 - Guianan Dry Forest
Central Guianan Seasonal Dry Forest
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
B)
Caatinga
Tarapoto_Quillabamba
Misiones
Central_Brazil
Piedmont
Antilles
CentralA_NorthSA
Northern_inter_Andean_Valleys
Apurimac_Mantaro
CentralAndes_Coast
Mexico
Central_Andes
D
C
A+B
NMDS2
0.4
0.2
0.0
-0.2
-0.4
-0.4
-0.2
0.0
0.2
0.4

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., successionally 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 "zonal" 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 development 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.

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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.

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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.

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Supporting Information to the paper Faber-Langendoen, D., K. Baldwin, T.Keeler-Wolf, D. Meidinger, E. Muldavin, R. K. Peet & C. Josse 2017, The EcoVeg Approach in North America: International and U.S. and Canadian National Vegetation Classifications.

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.

Natural Hierarchy		Definition	Example
Upper	L1 – Formation Class	A vegetation type defined by broad combinations of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.	**Scientific Name:** Mesomorphic Shrub & Herb Vegetation **Colloquial Name:** Shrub & Vegetation
Upper	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
Upper	L3 – Formation	A vegetation type defined by combinations of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	**Scientific Name:** Temperate Shrub & Herb Vegetation **Colloquial Name:** Temperate Grassland & Shrubland
Mid	L4 – Division	A vegetation type defined by combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	**Scientific Name:** *Andropogon – Stipa – Bouteloua* Grassland & Shrubland **Colloquial Name:** Central North American Grassland & Shrubland

	L5 – Macrogroup	USNVC/IVC: A vegetation type defined by moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic difference in composition and sub-continental to regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Scientific Name: *Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans* Grassland & Shrubland Colloquial Name: Central Lowlands Tallgrass Prairie
		CNVC: 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.	Colloquial Name: Central Lowlands Tallgrass Prairie
	L6 – Group	USNVC/IVC: A vegetation type defined by a relatively narrow set of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Scientific Name: *Andropogon gerardii – Heterostipa spartea –Muhlenbergia richardsonis* Grassland Colloquial Name: Northern Tallgrass Prairie
		CNVC: 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.	Not yet developed for CNVC
Lower	L7 – Alliance	USNVC/IVC: A vegetation type defined by a characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation. Alliances reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	Scientific Name: *Andropogon gerardii – Sporobolus heterolepis – Muhlenbergia richardsonis* Northern Grassland Colloquial Name: Northern Mesic Tallgrass Prairie

	CNVC: 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., successionally related associations on similar edaphic conditions can be aggregated into more generalized alliances). For "Azonal" Vegetation: same as same as USNVC/IVC.	Not yet developed for CNVC
L8 – Association	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.	Scientific Name: *Andropogon gerardii – Heterostipa spartea - Sporobolus heterolepis* Grassland Colloquial Name: Northern Mesic Big Bluestem Prairie
	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.	Scientific Name: *Andropogon gerardii – Heterostipa spartea - Sporobolus heterolepis* Colloquial Name: Northern Mesic Big Bluestem Prairie

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).

Cultural Hierarchy		Definition (Faber-Langendoen et al. 2014)	Example
Upper	L1 – Cultural Class	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.	Scientific Name: Anthromorphic Vegetation Colloquial Name: Agricultural & Developed Vegetation
Upper	L2 – Cultural Subclass	A cultural vegetation type defined by broad combinations and degree of herbaceous versus woody growth forms that reflects global human management activities.	Scientific/Colloquial Name: Woody Agricultural Vegetation
Upper	L3 – Cultural Formation	A cultural vegetation type defined by the degree to which canopy structure of dominant growth forms is annually converted or heavily manipulated / harvested.	Scientific/Colloquial Name: Forest Plantation & Agroforestry
Upper	L4 – Cultural Subformation	A cultural vegetation type defined by the spatial structure of the vegetation, including whether in swards, rows, and degree of manipulation to the canopy.	Scientific/Colloquial Name: Forest Plantation
Mid	L5 – Cultural Group	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.	Scientific /Colloquial Name: Temperate & Boreal Plantation
Mid	L6 – Cultural Subgroup	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.	Scientific/ Colloquial Name: Eastern North American Forest Plantation

Lower	L7 – Cultural Type	A cultural vegeation type defined by one or more dominant or co-dominant species, as well as habitat conditions, and physiognomy.	Scientific Name: *Pinus strobus – Pinus resinosa – Pinus banksiana* Native Plantation Colloquial Name: Native Northern Pine Plantation
	L8 – Cultural Subtype	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.	Scientific Name: *Pinus strobus* Plantation Colloquial Name: White Pine Plantation

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:*

USNVC	CNVC	Comments
M051 Great Plains Mixedgrass & Fescue Prairie Macrogroup G332 Northern Great Plains Rough Fescue Prairie Group	CM332 Great Plains Rough Fescue Prairie Macrogroup	Identical vegetation condition (range almost entirely in Canada): - CNVC recognizes at macrogroup level because primary environmental driver is regional climate; - 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.

2) *Boreal Forests:*

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

3) *Rocky Mountain Subalpine and High Montane Forests:*

USNVC	CNVC	Comments
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 G222 Rocky Mountain Subalpine-Montane Aspen Forest & Woodland G345 Central Rocky Mountain Montane White Spruce Forest	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 successionally related overstory dominance on similar edaphic sites.
G219 Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland G220 Rocky Mountain Lodgepole Pine Forest & Woodland G221 Rocky Mountain Subalpine-Montane Limber Pine - Bristlecone Pine Woodland G223 Northern Rocky Mountain Whitebark Pine - Subalpine Larch 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 lyalli, 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:

USNVC	CNVC	Comments
M014 Laurentian-Acadian Mesic Hardwood – Conifer Forest Macrogroup M159 Laurentian-Acadian Pine - Hardwood Forest & Woodland Macrogroup	CM014 Northern Temperate Hardwood - Conifer Forest Macrogroup CM159 Acadian 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

D099 1.A.1.Ea Caribbean-Mesoamerican Dry Forest & Woodland

M296	**Caribbean-Mesoamerican Pine Dry Forest**	BS, BZ, CR, CU, DO, GT, HN, HT, MX, NI, SV?, TC, US, XC, XD
M134	**Caribbean Coastal Lowland Dry Forest**	BS, CU, DO, HT, JM, MQ, PR, TC, TT, US, VE, VG?, VI, XD
M294	**Caribbean Dry Limestone Forest**	CU, DO, JM, PR
M561	**Caribbean-Mesoamerican Seasonal Dry Forest**	BZ, CR, GT, HN, MX, NI, PA
M562	**Pacific Mesoamerican Seasonal Dry Forest**	CR, GT, HN, MX, NI, PA, SV
M514	**Caribbean Ruderal Dry Forest**	BS, DO, KN, PR, US, VI

D219 1.A.1.Ei Colombian-Venezuelan Dry Forest

M563	**Guajiran Seasonal Dry Forest**	CO, TT, VE
M565	**Llanos Seasonal Dry Forest**	CO, VE
M566	**Tumbes Guayaquil Seasonal Dry Forest**	EC, PE

D220 1.A.1.Ej Guianan Dry Forest

M567	**Central Guianan Seasonal Dry Forest**	BR?, VE

D221 1.A.1.Ek Brazilian-Parana Dry Forest

M572	**Caatinga Seasonal Dry Forest**	BR
M872	**Cerradâo Sclerophyllous Woodland**	BO, BR, PY
M570	**Cerrado Seasonal Dry Forest**	BO, BR
M568	**Brazilian Atlantic Seasonal Dry Forest**	BR, PY
M571	**Parana Seasonal Dry Forest**	PY

D222 1.A.1.El Tropical Andean Montane Dry Forest

M575	**Bolivian-Tucuman Seasonal Dry Forest**	AR, BO
M574	**Central Andean Seasonal Dry Forest**	BO, EC, PE
M573	**Northern Andean Seasonal Dry Forest**	CO, EC, PE, VE

1.A.2 Tropical Lowland Humid Forest

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

M281	Caribbean Lowland Humid Forest	BS, CU, DO, JM, MQ, PR, TT, VE, VI, XD
M578	Mesoamerican Lowland Humid Forest	BZ, CR, GT, HN, MX, NI, PA, SV
M873	Mesoamerican Submontane Humid Forest	BZ, CR, GT, HN, NI, PA

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

M581	Choco-Darien Humid Forest	CO, CR, EC, PA
M582	Western Ecuadorian Humid Forest	EC
M580	Catatumbo Magdalena Humid Forest	CO, VE
M579	Guajiran Humid Forest	VE
M583	Llanos Humid Forest	CO, VE

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

M586	Eastern Guianan Humid Forest	GF, GY, SR
M585	Central Guianan Humid Forest	BR, GY, VE
M584	Western Guianan Humid Forest	CO?, VE
M587	Orinoquian Humid Forest	GY, VE

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

M593	Central Amazon Humid Forest	BR
M592	Northern Amazon Humid Forest	BR, CO
M594	Southern Amazon Humid Forest	BO, BR
M590	Southwestern Amazon Lowland Humid Forest	BO, BR, PE
M591	Southwestern Amazon Subandean Humid Forest	BO, PE
M588	Western Amazon Lowland Humid Forest	BR, CO, EC, PE
M589	Western Amazon Subandean Humid Forest	CO, EC, PE

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

M597	Cerrado Humid Forest	BO, BR
M595	Brazilian Atlantic Humid Forest	BR
M596	Parana Humid Forest	AR, BR, PY

1.A.3 Tropical Montane Humid Forest

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

M598	Caribbean Montane Humid Forest	CU, DO, HT, JM, KN, MQ, PR, XC, XD, XE
M601	Mesoamerican Montane Pine-Oak Forest	BR?, GT, HN, MX, NI, SV
M600	Mesoamerican Montane Humid Forest	CR, GT, HN, MX, NI, PA
M602	Southern Mesoamerican Montane Humid Forest	CR, PA

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

M604	Eastern Guianan Montane Humid Forest	BR?, GF, GY, SR, VE

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
M617	**Caribbean Swamp Forest**	BS, CU, MQ, PR, TT, US
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, GY, VE
M627	**Guianan Swamp Forest**	BR, CO, GF, GY, SR, VE
M628	**Orinoco Delta Swamp Forest**	GF, GY, SR, VE

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

D236	**1.A.4.EI Amazonian Flooded & Swamp Forest**		
	M640	**Amazon Delta Swamp Forest**	BR
	M638	**Central Amazon Floodplain Forest**	BR
	M637	**Northern Amazon Floodplain Forest**	BR, CO
	M639	**South-Central Amazon Floodplain Forest**	BO, BR, PE
	M636	**Southern Amazon Swamp Forest**	BO, BR, PE
	M635	**Southwestern Amazon Floodplain Forest**	BO, BR, PE
	M633	**Western Amazon Floodplain Forest**	BR, CO, EC, PE
	M634	**Western Amazon Swamp Forest**	BR, CO, EC, PE
D237	**1.A.4.Em Brazilian-Parana Flooded & Swamp Forest**		
	M641	**Brazilian Atlantic Coastal Plain Swamp Forest**	BR
	M642	**Parana Floodplain Forest**	AR, BR, PY
	M646	**Pantanal Floodplain Forest**	BO, BR, PY
	M643	**Cerrado Floodplain Forest**	BO, BR
	M644	**Beni Chiquitano Swamp Forest**	BO
	M645	**Beni Floodplain Forest**	BO
D238	**1.A.4.En Chaco Flooded & Swamp Forest & Woodland**		
	M650	**Southern Chaco Floodplain Forest & Woodland**	AR
	M647	**Northern Chaco Floodplain Forest & Woodland**	AR, BO, PY
	M649	**Northern Chaco Palm Swamp**	AR, BO, PY
	M648	**Northern Chaco Riparian Scrub & Woodland**	AR, BO, PY

1.A.5 Mangrove

D004	**1.A.5.Ua Atlantic-Caribbean & East Pacific Mangrove**		
	M004	**Eastern Pacific Mangrove**	CO, CR, EC, GT, HN, MX, NI, PA, SV
	M005	**Western Atlantic & Caribbean Mangrove**	BR, BS, BZ, CO, CR, CU, GF, GT, GY, HN, MQ, MX, NI, PA, PR, SR, US, VE, XA, XB, XC

1.B Temperate & Boreal Forest & Woodland

1.B.1 Warm Temperate Forest & Woodland

D239	**1.B.1.Ef Chilean Warm Temperate Forest & Woodland**		
	M652	**Chilean Mediterranean Sclerophyllous Forest**	CL
	M653	**Chilean Mediterranean Deciduous Forest**	CL
D240	**1.B.1.Eg Southeastern South American Warm Temperate Forest & Woodland**		
	M654	**Espinal Deciduous Forest & Woodland**	AR, UY
D006	**1.B.1.Na Southeastern North American Forest & Woodland**		
	M007	**Longleaf Pine Woodland**	US
	M885	**Southeastern Coastal Plain Evergreen Oak - Mixed Hardwood**	MX?, US

		Forest	
	M008	Southern Mesic Mixed Broadleaf Forest	US
	M305	Southeastern North American Ruderal Forest	US
D007	1.B.1.Nc Californian Forest & Woodland		
	M009	Californian Forest & Woodland	MX, US
	M513	Californian Ruderal Forest	MX, US
D060	1.B.1.Nd Madrean-Balconian Forest & Woodland		
	M010	Madrean Lowland Evergreen Woodland	MX, US
	M011	Madrean Montane Forest & Woodland	MX, US
	M015	Balconian Forest & Woodland	MX?, US
1.B.2 Cool Temperate Forest & Woodland			
D241	1.B.2.Ee Valdivian Cool Temperate Forest		
	M656	Valdivian Lower Montane Deciduous Forest	CL
	M655	Valdivian Lower Montane Evergreen Forest	AR?, CL
	M657	Valdivian Montane & Upper Montane Deciduous Forest	AR, CL
	M658	Valdivian Montane & Upper Montane Evergreen Forest	AR, CL
D242	1.B.2.Ef Magellanian Cool Temperate Forest		
	M659	Magellanian Temperate Evergreen Forest	AR, CL
D008	1.B.2.Na Eastern North American Forest & Woodland		
	M016	Southern & South-Central Oak - Pine Forest & Woodland	US
	M502	Appalachian-Northeastern Oak - Hardwood - Pine Forest & Woodland	CA**, US
	M883	Appalachian-Interior-Northeastern Mesic Forest	CA*, US
	M012	Central Midwest Oak Forest, Woodland & Savanna	CA*, US
	M882	Central Midwest Mesic Forest	CA, US
	M159	Laurentian-Acadian Pine - Hardwood Forest & Woodland	CA*, US
	M014	Laurentian-Acadian Mesic Hardwood - Conifer Forest	CA*, US
	M013	Eastern North American Ruderal Forest	CA, US
D194	1.B.2.Nb Rocky Mountain Forest & Woodland		
	M022	Southern Rocky Mountain Lower Montane Forest	MX, US
	M501	Central Rocky Mountain Dry Lower Montane-Foothill Forest	CA*, US
	M500	Central Rocky Mountain Mesic Lower Montane Forest	CA*, US
	M021	Sierra Madre High Montane Forest	GT, MX
	M020	Rocky Mountain Subalpine-High Montane Conifer Forest	CA*, MX, US
	M890	Western Interior Sub-boreal Spruce - Fir Forest	CA*, US?
D010	1.B.2.Nc Western North American Pinyon - Juniper Woodland & Scrub		
	M026	Intermountain Singleleaf Pinyon - Juniper Woodland	US
	M027	Southern Rocky Mountain-Colorado Plateau Two-needle	US

		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
D326	1.B.2.Ne North American Great Plains Forest & Woodland		
	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
D011	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest		
	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
D195	1.B.3.Nc Rocky Mountain-Great Basin Montane Flooded & Swamp Forest		
	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

	M036	Interior Warm & Cool Desert Riparian Forest	MX, US
	M298	Interior West Ruderal Flooded & Swamp Forest & Woodland	MX, US
D193	1.B.3.Ng Vancouverian Flooded & Swamp Forest		
	M035	Vancouverian Flooded & Swamp Forest	CA*, US

1.B.4 Boreal Forest & Woodland

D247	1.B.4.Eb Magellanian Antiboreal Forest		
	M667	Magellanian Subantarctic Woodland	
D014	1.B.4.Na North American Boreal Forest & Woodland		
	M495	Eastern North American Boreal Forest	CA*, US
	M496	West-Central North American Boreal Forest	CA*, US
	M156	Alaskan-Yukon North American Boreal Forest	CA*, US
	M179	North American Boreal Subarctic & Subalpine Woodland	CA*, US

1.B.5 Boreal Flooded & Swamp Forest

D248	1.B.5.Eb Magellanian (Anti-)Boreal Flooded Woodland		
	M668	Magellanian Swamp Woodland	
D016	1.B.5.Na North American Boreal Flooded & Swamp Forest		
	M299	North American Boreal Conifer Poor Swamp	CA*, US
	M300	North American Boreal Flooded & Rich Swamp Forest	CA*, US

2 Shrub & Herb Vegetation

2.A Tropical Grassland, Savanna & Shrubland

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

D094	2.A.1.Ea Caribbean-Mesoamerican Lowland Grassland, Savanna & Shrubland		
	M671	Caribbean Dry Scrub	BS, CU, DO, HT, JM, PR, TT, US, VI, XC, XD
	M669	Caribbean Palm Savanna	CU
	M672	Northern Mesoamerican Pine Savanna	BZ, HN, MX, NI
	M673	Northern Mesoamerican Savanna & Shrubland	CR, GT, HN, MX, NI, PA
	M515	Caribbean-Mesoamerican Lowland Ruderal Grassland & Shrubland	BS, BZ, CO, CR, CU, GT, HN, MX, NI, PA, PR, SV, US
D124	2.A.1.Eb Amazonian Savanna & Shrubland		
	M346	Central Amazon Savanna	BO, BR
	M345	Western Amazon Savanna	BO, BR, CO, PE
D126	2.A.1.Ed Brazilian-Parana Lowland Grassland, Savanna & Shrubland		
	M684	Brazilian Atlantic Coastal Plain Savanna & Woodland	BR
	M688	Parana Upland Savanna & Shrubland	AR, PY, UY
	M685	Cerrado Savanna	BO, BR, PY
D249	2.A.1.Er Colombian-Venezuelan Lowland Grassland, Savanna &		

	Shrubland		
	M676	**Llanos Upland Savanna**	CO, VE
	M675	**Guajiran Ruderal Grassland & Shrubland**	CO?, VE
D250	**2.A.1.Es Guianan Lowland & Upland Grassland, Savanna & Shrubland**		
	M681	**Eastern Guianan Savanna & Shrubland**	GF, GY, SR
	M679	**Central Guianan Savanna & Shrubland**	BR, GY, VE
	M680	**Western Guianan Savanna& Shrubland**	CO, VE
2.A.2 Tropical Montane Grassland & Shrubland			
D134	**2.A.2.Ea Tropical Andean Grassland & Shrubland**		
	M377	**Bolivian-Tucuman Montane Grassland & Shrubland**	AR, BO
	M696	**Central Andean (Yungas) Upper Montane Grassland & Shrubland**	BO, PE
	M375	**Northern Andean Montane & Upper Montane Grassland & Shrubland**	EC, PE
	M378	**Moist Puna Grassland & Scrub**	BO, PE
	M694	**Northern Andean Paramo**	CO, EC, PE, VE
	M697	**Andean Montane & Upper Montane Ruderal Grassland & Shrubland**	AR?, BO, CO?, EC, PE, VE
D135	**2.A.2.Eb Caribbean-Mesoamerican Montane & High Montane Grassland & Shrubland**		
	M689	**Caribbean Montane Shrubland & Grassland**	PR?
	M691	**Mesoamerican Montane Grassland & Shrubland**	CR, MX, PA
D252	**2.A.2.Ek Guianan Montane Grassland & Shrubland**		
	M693	**Tepuyan Mesic Grass & Forb Meadow**	BR, GY, VE
	M692	**Tepuyan Sclerophyllous Shrubland**	BR?, VE
D253	**2.A.2.El Brazilian-Parana Montane Grassland & Shrubland**		
	M699	**Brazilian-Parana Montane Grassland, Savanna & Forb Meadow**	BR
2.A.3 Tropical Scrub & Herb Coastal Vegetation			
D254	**2.A.3.Ee Caribbean-Mesoamerican Dune & Coastal Grassland & Shrubland**		
	M700	**Caribbean-Mesoamerican Coastal Dune & Beach**	BR, BS?, CO, CR, CU, GT, HN, MX, NI, PA, PR, US, VE, XB, XC
D255	**2.A.3.Ef Tropical Western Atlantic Dune & Coastal Grassland & Shrubland**		
	M702	**Brazilian Atlantic Coastal Beach & Dune**	BR
	M701	**Eastern Guianan Coastal Rocky Shore & Beach**	BR, GF, GY, SR
D256	**2.A.3.Eg Tropical Eastern Pacific Dune & Coastal Grassland & Shrubland**		
	M703	**Tropical Eastern Pacific Coastal Beach & Dune**	CO, CR, EC, NI, PA, SV
2.B Temperate & Boreal Grassland & Shrubland			

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	CA, MX, US
D024	2.B.2.Nc Eastern North American Grassland & Shrubland		
	M506	Appalachian Rocky Felsic & Mafic Scrub & Grassland	CA, US
	M509	Central Interior Acidic Scrub & Grassland	US
	M508	Central Interior Calcareous Scrub & Grassland	US
	M505	Laurentian-Acadian Acidic Rocky Scrub & Grassland	CA*, US
	M507	Laurentian-Acadian Calcareous Scrub & Grassland	CA*, US
	M123	Eastern North American Ruderal Grassland & Shrubland	CA, US
D061	2.B.2.Nd Western North American Interior Chaparral		
	M094	Cool Interior Chaparral	CA?, MX, US
	M091	Warm Interior Chaparral	MX, US
D102	2.B.2.Ne Southeastern North American Grassland & Shrubland		
	M162	Florida Peninsula Scrub & Herb	US
	M309	Southeastern Coastal Plain Patch Prairie	US
	M308	Southern Barrens & Glade	US
	M307	Southeastern Ruderal Grassland & Shrubland	MX?, US
2.B.3 Boreal Grassland & Shrubland			
D277	2.B.3.Ec Magellanian Antiboreal Grassland & Shrubland		
	M751	Magellanian Subantarctic Shrubland & Grassland	
D025	2.B.3.Na North American Boreal Grassland & Shrubland		
	M055	North American Boreal Shrubland & Grassland	CA*, US
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	CL
D279	2.B.4.Eh Pampean Dune & Coastal Grassland & Shrubland		
	M755	Atlantic Coast & La Plata Delta Beach & Dune	AR, UY
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	AR
D026	2.B.4.Na Eastern North American Coastal Scrub & Herb Vegetation		
	M060	Eastern North American Coastal Beach & Rocky Shore	CA*, MX, US
	M057	Eastern North American Coastal Dune & Grassland	CA*, MX, US
D027	2.B.4.Nb Pacific North American Coastal Scrub & Herb Vegetation		
	M753	Warm Pacific Coastal Beach, Dune & Bluff	MX
	M059	Pacific Coastal Beach & Dune	CA*, MX?, US
	M058	Pacific Coastal Cliff & Bluff	CA*, MX, US

	M511	North Pacific Coastal Ruderal Grassland & Shrubland	CA, MX?, US
D146	2.B.4.Nd Arctic & Boreal Coastal Scrub & Herb Vegetation		
	M402	North American Arctic & Boreal Coastal Shore	CA*, GL?, US

2.C Shrub & Herb Wetland

2.C.1 Tropical Bog & Fen

D257	2.C.1.Ed Caribbean-Mesoamerican Bog		
	M704	Mesoamerican Montane Bog	CR, PA
D259	2.C.1.Ef Guianan Bog		
	M706	Tepuyan Bog	BR, VE
D260	2.C.1.Eg Andean Montane Bog		
	M708	Tropical Andes Upper Montane Bog	AR, BO, CL, CO, EC, PE, VE

2.C.2 Temperate to Polar Bog & Fen

D282	2.C.2.Eb Southern Andean Montane Bog		
	M758	Southern Andean Montane Bog	AR, CL
D283	2.C.2.Ec Magellanian Bog & Fen		
	M759	Magellanian Anti-Boreal Bog & Fen	AR, CL
D029	2.C.2.Na North American Bog & Fen		
	M876	North American Boreal & Sub-boreal Bog & Acidic Fen	CA*, US
	M877	North American Boreal & Sub-boreal Alkaline Fen	CA*, US
	M063	North Pacific Bog & Fen	CA*, US
D324	2.C.2.Nb Atlantic & Gulf Coastal Plain Pocosin		
	M065	Southeastern Coastal Bog & Fen	US

2.C.3 Tropical Freshwater Marsh, Wet Meadow & Shrubland

D262	2.C.3.Ef Caribbean-Mesoamerican Freshwater Marsh, Wet Meadow & Shrubland		
	M710	Caribbean Freshwater Marsh, Wet Meadow & Shrubland	BS, CU, DM, DO, GD, GP, HT, JM, MQ, MS, PR, TT, US, VC, VG, VI, XA, XC, XD
	M711	Mesoamerican Freshwater Marsh, Wet Meadow & Shrubland	BZ, CO, CR, EC, GT, HN, NI, PA, SV
	M891	Caribbean-Mesoamerican Ruderal Freshwater Marsh, Wet Meadow & Shrubland	BS, CU, PR, US
D263	2.C.3.Eg Colombian-Venezuelan Freshwater Marsh, Flooded Savanna & Shrubland		
	M712	Colombian-Venezuelan Freshwater Marsh, Wet Meadow & Shrubland	CO, VE
	M715	Llanos Flooded Savanna	CO, VE
D264	2.C.3.Eh Guianan Freshwater Marsh, Wet Meadow & Shrubland		
	M717	Central Guianan Flooded Savanna	BR, GY, VE
	M718	Western Guianan Flooded Savanna & Shrubland	BR, VE

	M707	**Orinoquian Floodplain Peat Meadow & Marsh**	CO, GF, GY, SR, VE
	M720	**Orinoquian Floodplain Marsh & Flooded Savanna**	VE
D265	**2.C.3.Ei Tropical Andean Freshwater Marsh, Wet Meadow & Shrubland**		
	M863	**Tropical Andean Pondshore & Wet Meadow**	AR, BO, CL, CO, EC, PE, VE
	M722	**Andean Puna Wet Meadow**	AR, BO, CL, PE
	M721	**Northern Andean Wet Meadow**	CO, EC, VE
D266	**2.C.3.Ej Amazonian Freshwater Marsh, Wet Meadow & Shrubland**		
	M709	**Amazon Delta Peat Marsh**	BR
	M724	**Amazonian-Guianan White Sand Flooded Savanna & Shrubland**	BR, CO, GY, VE
	M726	**Lower Amazon Wet Meadow & Shrubland**	BR
	M725	**Upper Amazon Wet Meadow & Shrubland**	BO, BR, CO, EC, PE
D267	**2.C.3.Ek Parana-Brazilian Freshwater Marsh, Wet Meadow & Shrubland**		
	M731	**Caatinga Riparian Wet Meadow & Shrubland**	
	M729	**Pantanal Floodplain Wet Meadow & Shrubland**	BO, BR, PY
	M730	**Parana Floodplain Wet Meadow & Shrubland**	AR?, PY
	M727	**Cerrado Flooded Savanna**	BR
	M728	**Beni Flooded Savanna**	BO
D268	**2.C.3.El Chaco Freshwater Marsh, Flooded Savanna & Shrubland**		
	M734	**Eastern Chaco Marsh & Flooded Savanna**	AR, PY
	M732	**Chaco Riparian Marsh & Shrubland**	AR, BO, PY
	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	**Pampean Freshwater Marsh, Wet Meadow & Shrubland**	AR, UY
	M864	**Southern Andean Montane Freshwater Marsh & Wet Meadow**	AR, CL
D031	**2.C.4.Nb Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland**		
	M888	**Arid West Interior Freshwater Marsh**	CA, MX, US
	M075	**Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow & Shrubland**	CA*, MX?, US
	M074	**Western North American Vernal Pool**	CA*, MX, US
	M073	**Vancouverian Lowland Marsh, Wet Meadow & Shrubland**	CA*, MX?, US
	M301	**Western North American Ruderal Marsh, Wet Meadow & Shrubland**	CA, US
D032	**2.C.4.Nc Southwestern North American Warm Desert Freshwater Marsh & Bosque**		
	M076	**Warm Desert Lowland Freshwater Marsh, Wet Meadow &**	MX, US

Shrubland

D323 2.C.4.Nd Eastern North American Temperate & Boreal 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

2.C.5 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
M736	Mexican Pacific Coastal Salt Marsh	MX

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.5.Nb 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

	M081	North American Pacific Coastal Salt Marsh	CA*, MX, US
D036	2.C.5.Nd North American Western Interior Brackish Marsh, Playa & Shrubland		
	M082	Warm & Cool Desert Alkali-Saline Marsh, Playa & Shrubland	CA*, MX, US
D187	2.C.5.Nk Arctic Coastal Salt Marsh		
	M403	North American Arctic Tidal Salt Marsh	CA*, US
D037	2.C.5.Ue Tropical Atlantic Coastal Salt Marsh		
	M735	Tropical Western Atlantic-Caribbean Salt Marsh	BR, BS, CO, CU, DO, GY, JM, KY, MQ, PR, SR, US, VE, XC

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
	M140	Tropical Andean Xeromorphic Cliff, Scree & Other Rock Vegetation	
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		

M141	Chaco Xeromorphic Cliff & Other Rock Vegetation	BO, PY
M781	Southern Chaco Xeromorphic Scrub & Savanna	AR, PY, UY
M780	Northern Chaco Xeromorphic Scrub & Savanna	AR, BO, PY

D294 3.A.2.En South American Pacific Semi-Desert Scrub & Grassland

M784	Chilean Mediterranean Coastal Semi-Desert Scrub & Grassland	CL
M785	Chilean Mediterranean Interior Semi-Desert Scrub & Grassland	CL
M861	Sechura Atacama Semi-Desert Cliff & Pavement	CL, PE
M782	Sechura Atacama Semi-Desert Riparian Scrub	CL, PE
M783	Sechura Atacama Semi-Desert Scrub	CL, PE

D039 3.A.2.Na North American Warm Desert Scrub & Grassland

M130	Tamaulipan Scrub & Grassland	MX, US
M086	Chihuahuan Desert Scrub	MX, US
M087	Chihuahuan Semi-Desert Grassland	MX, US
M088	Mojave-Sonoran Semi-Desert Scrub	MX, US
M089	Viscaino-Baja California Desert Scrub	MX
M117	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation	MX, US
M092	North American Warm-Desert Xeric-Riparian Scrub	MX, US
M512	North American Warm Desert Ruderal Scrub & Grassland	MX, US

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

D117 3.B.1.Ed Patagonian Cool Semi-Desert Scrub & Grassland

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

M093	Great Basin Saltbush Scrub	CA?, MX?, US
M118	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation	US
M499	Western North American Cool Semi-Desert Ruderal Scrub & Grassland	CA, US

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	AR, BO, CL, PE
M793	High Andean Moist Puna Bunch Grassland	BO, PE
M792	High Northern Andean Super-Paramo	CO, EC, PE, VE

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	AR, CL

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

M796	Magellanian Montane Tundra	AR, CL

D042 4.B.1.Na Eastern North American Alpine Tundra

M131	Eastern North American Alpine Tundra	CA*, US

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

M099	Rocky Mountain-Sierran Alpine Tundra	CA*, US
M101	Vancouverian Alpine Tundra	CA*, US
M404	Western Boreal Alpine Tundra	CA*, US

4.B.2 Polar Tundra & Barrens

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

M175	Arctic Scree, Rock & Cliff Barrens	CA*, GL?, US
M173	Arctic Tundra	CA*, GL?, US

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	CA*, US
M106	Temperate Pacific Seaweed Intertidal Vegetation	CA*, US

D098 5.A.2.Xg Tropical Intertidal Marine Aquatic Vegetation

- **M292 Neotropical Marine Aquatic Vegetation**

5.A.3 Benthic Vascular Saltwater Vegetation

D064 5.A.3.We Temperate Seagrass Aquatic Vegetation

M184	**Temperate Pacific Seagrass Intertidal Vegetation**	CA*, MX, US
M183	**Temperate Eel-grass Vegetation**	BG, CA*, CN, DE, DK, DZ, EE, ES, FI, FR, GB, GL, GR, IE, IS, IT, JP, KP, KR, LT, LV, LY, MA, MX, NL, NO, PL, PT, RO, RU, SE, TN, TR, UA, US

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

M186	**Ditchgrass Saline Aquatic Vegetation**	AU, CA*, CN, DE, DK, EE, ES, FK, FR, GB, HR, IN, JP, KR, MA, MX, RU, SE, TW, US, VU

D063 5.A.3.Xd Tropical Saltwater Vegetation

M180	**Indo-Pacific & Caribbean Seagrass Vegetation**	AE, AU, BS, CU, ID, IN, JM, KE, KN, MQ, MX, MY, MZ, OM, PH, PR, SA, TH, TZ, US, XB, XE, YE

5.A.4 Benthic Lichen Saltwater Vegetation

5.B Freshwater Aquatic Vegetation

5.B.1 Tropical Freshwater Aquatic Vegetation

D097 5.B.1.Ed Neotropical Freshwater Aquatic Vegetation

M291	**Neotropical Floating & Submerged Freshwater Marsh**	BO, BR, BS, CO, CU, EC, PE, PR, VE, XC
M892	**Neotropical Ruderal Freshwater Aquatic Vegetation**	CU, JM, MX, PR, US, XE

5.B.2 Temperate to Polar Freshwater Aquatic Vegetation

D319 5.B.2.Eb Temperate South American Freshwater Aquatic Vegetation

M865	**Temperate South American Freshwater Aquatic Vegetation**	AR, UY

D049 5.B.2.Na North American Freshwater Aquatic Vegetation

M108	**Eastern North American Freshwater Aquatic Vegetation**	CA*, MX?, US
M109	**Western North American Freshwater Aquatic Vegetation**	CA*, MX?, US
M871	**Arctic & Northern Boreal Freshwater Aquatic Vegetation**	CA*, US
M401	**North American Temperate Ruderal Aquatic Vegetation**	CA, MX, US

6 Open Rock Vegetation

6.A Tropical Open Rock Vegetation

6.A.1 Tropical Cliff, Scree & Other Rock Vegetation

D311 6.A.1.Ed Brazilian-Parana Cliff, Scree & Rock Vegetation

M867	**Brazilian-Parana Cliff, Scree & Rock Vegetation**	BO

D308 6.A.1.Ee 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		
	M855	Bolivian-Tucuman Cliff, Scree & Rock Vegetation	AR, BO
	M854	Central Andean (Yungas) Cliff, Scree & Rock Vegetation	BO, PE
	M853	Northern Andean Cliff, Scree & Rock Vegetation	CO, EC
	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

D313	6.B.1.Ef South American Temperate Cliff, Scree, Rock & Dune Vegetation		
	M857	South American Temperate Cliff, Scree, Rock & Dune Vegetation	AR, CL, UR?
D051	6.B.1.Na Eastern North American Temperate & Boreal Cliff, Scree & Rock Vegetation		
	M111	Eastern North American Cliff & Rock Vegetation	CA*, MX?, US
	M116	Great Plains Cliff, Scree & Rock Vegetation	CA*, US
	M115	Great Plains Badlands Vegetation	CA*, US
D052	6.B.1.Nb Western North American Temperate & Boreal Cliff, Scree & Rock Vegetation		
	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