



## How a national vegetation classification can help ecological research and management

Peer-reviewed letter

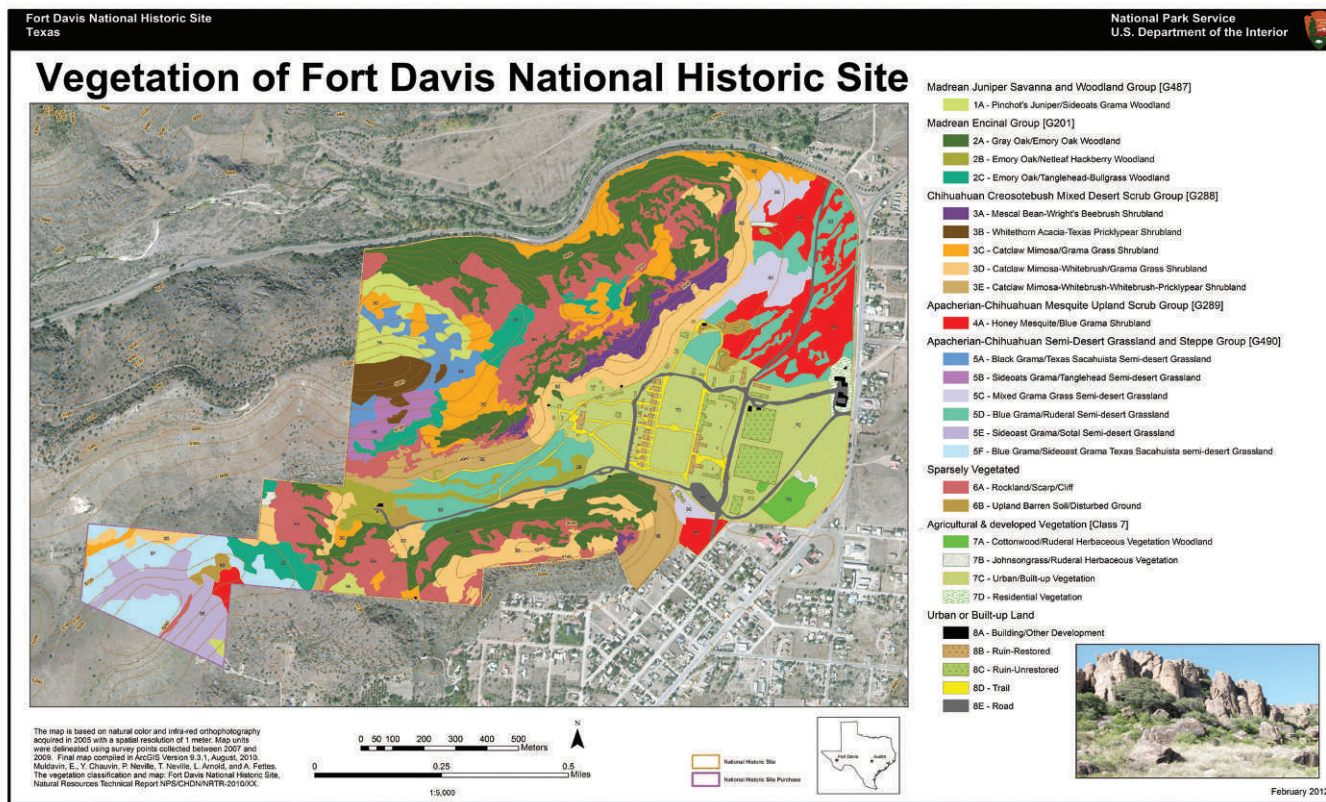
The elegance of classification lies in its ability to compile and systematize various terminological conventions and masses of information that are unattainable during typical research projects. Imagine a discipline without standards for collection, analysis, and interpretation; unfortunately, that describes much of 20th-century vegetation ecology. With differing methods, how do we assess community dynamics over decades, much less centuries? How do we compare plant communities from different areas? The need for a widely applied vegetation classification has long been clear. Now imagine a multi-decade effort to assimilate hundreds of disparate vegetation classifications into one common classification for the US. In this

letter, we introduce the US National Vegetation Classification (USNVC; [www.usnvc.org](http://www.usnvc.org)) as a powerful tool for research and conservation, analogous to the argument made by Schimel and Chadwick (2013) for soils. The USNVC provides a national framework to classify and describe vegetation; here we describe the USNVC and offer brief examples of its efficacy.

Prominent uses of classification include establishing baseline knowledge (eg to assess diversity, monitor change, or develop management protocols), describing categories that integrate multiple sources of data (eg vegetation, environment, and disturbance), and conducting larger-scale analyses (temporal and spatial). For these reasons, the US Federal Geographic Data Committee (FGDC; [www.fgdc.gov](http://www.fgdc.gov)) developed standards for classifying the nation's resources. Federal agencies and non-federal partners (NatureServe and the Ecological Society of America's

[ESA's] Vegetation Classification Panel) of the FGDC Vegetation Subcommittee formalized standards for vegetation classification in 2008 (FGDC 2008; Peet 2008; Faber-Langendoen *et al.* 2009; Jennings *et al.* 2009). They developed an eight-level hierarchy (WebTable 1), a common terminology that is international in scope (Faber-Langendoen *et al.* 2014), and a dynamic content standard. The Classification is dynamic in that it can be updated through a proposal and review process with changes archived at [www.usnvc.org/proceedings](http://www.usnvc.org/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, and (2) it precludes an explosion of site-specific community types as all changes are reviewed in light of already established types (Matthews *et al.* 2011).

The USNVC is a classification of



**Figure 1.** Vegetation and land-cover map based on USNVC concepts for the Fort Davis National Historic Site, Texas (Muldavin E, Chauwin Y, Neville P, et al. 2012). A vegetation classification and map: Fort Davis National Historic Site. Natural Resource Technical Report NPS/CHDN/NRTR–2012/639. Fort Collins, CO: National Park Service); concepts are at the Group and nested Association levels for natural and semi-natural vegetation and at the Class level for cultural vegetation.

existing vegetation (in contrast to potential vegetation). The Classification separates natural and semi-natural vegetation (growing spontaneously and shaped generally by ecological processes) from cultural vegetation (shaped by anthropogenic processes, eg corn fields or golf courses). By including all vegetation types in a consistent framework, we can address issues such as wildfire regimes, pest infestations, exotic species invasions, lateral ecosystem exchanges, and vegetation shifts. In addition, such a holistic classification is necessary for the “all lands approach” used by several government agencies to ensure land management planning takes place in the context of the larger landscape.

The USNVC provides substantial information to aid ecological research and resource management: for instance, local site descriptions for field studies or descriptions of typical environments of species (as with soils; Schimel and Chadwick 2013). Current agency assessment and planning projects (WebTable 2) require integration of ecology, biogeography, structure, growth forms, and floristics to interpret biotic and abiotic conditions at multiple geographical and ecological scales (see “definitions” in WebTable 1). The Classification has improved the sharing of vegetation information among agencies for intra- and interagency management. The presence of repeatable and defensible standardized units of classification enables all involved to save time and costs on litigation and on evaluation of habitat value (Bram *et al.* 2015).

Projects have successfully used the USNVC for development of state-and-transition models of landscape change (Kudray and Cooper 2005). There is no standard for defining states in these models and any model is vastly improved if its elements are well-defined; USNVC type descriptions serve this purpose. Further, USNVC types provide a baseline to delineate “novel” or “ruderal” communities resulting from invasions and climate change.

In addition, the USNVC has im-

proved mapping efforts. Developing habitat suitability maps and creating high-quality vegetation maps (Figure 1) is essential for biodiversity stewardship and research (Evens and Keeler-Wolf 2014), because conservation plans rely on maps of vegetation or habitat to identify and prioritize biotic landscapes for a network of all conservation elements (species’ habitats and rare communities). Reliable maps of critical habitat, wildlife corridors, and wetlands can all be standardized and quantitatively evaluated using the USNVC.

To support the USNVC, a public vegetation-plot database (VegBank; <http://vegbank.org>) was launched in 2004 (Peet *et al.* 2012). The purpose of archiving these records is not only to document the Classification and facilitate its revision and improvement, but also to allow scientists to answer questions from micro- to macro-scales. The database has already resulted in a regional analysis of longleaf pine (*Pinus palustris*) community types from Virginia to Florida (Palmquist *et al.* 2014). We urge everyone collecting vegetation-plot data that meet the USNVC standards to upload their data to a public archive such as VegBank, and to classify those plots following the USNVC. A second web database ([www.usnvc.org](http://www.usnvc.org)) was launched in 2008 and contains search functions for all USNVC types.

We hope the letters from Schimel and Chadwick (2013) and ourselves stimulate the use and improvement of classifications. Although no classification will be applicable to all questions, having standards for data collection, analysis, and interpretation, as well as the classification scheme itself, offers ecological and economic advantages to large-scale research, management, and inventory. In addition, having a context for the variety of individual research and management efforts will improve our ability to place all these pieces into a consistent and more productive framework.

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**WebTable 1. Levels, definition, and example of the hierarchy for natural vegetation**

	Natural Hierarchy Level	Definition	Example
Upper levels	L1 – Formation Class	Broad combinations of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.	<b>Scientific name:</b> Mesomorphic Shrub & Herb Vegetation <b>Colloquial name:</b> Shrub & Herb Vegetation
	L2 – Formation Subclass	Combinations 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.	<b>Scientific name:</b> Temperate & Boreal Shrub & Herb Vegetation <b>Colloquial name:</b> Temperate & Boreal Grassland & Shrubland
	L3 – Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	<b>Scientific name:</b> Temperate Shrub & Herb Vegetation <b>Colloquial name:</b> Temperate Grassland & Shrubland
Mid levels	L4 – Division	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.	<b>Scientific name:</b> <i>Andropogon – Stipa – Bouteloua</i> Grassland & Shrubland <b>Colloquial name:</b> Great Plains Grassland & Shrubland
	L5 – Macrogroup	Moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	<b>Scientific name:</b> <i>Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans</i> Grassland <b>Colloquial name:</b> Great Plains Tallgrass Prairie
	L6 – Group	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.	<b>Scientific name:</b> <i>Andropogon gerardii – Hesperostipa spartea – Muhlenbergia richardsonii</i> Grassland <b>Colloquial name:</b> Northern Great Plains Prairie
Lower levels	L7 – Alliance	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.	<b>Scientific name:</b> <i>Andropogon gerardii – Sporobolus heterolepis</i> Grassland <b>Colloquial name:</b> Northern Mesic Tallgrass Prairie
	L8 – Association	A characteristic range of species composition, diagnostic species occurrence, habitat conditions, and physiognomy. Associations reflect topographic climate, substrates, hydrology, and disturbance regimes.	<b>Scientific name:</b> <i>Andropogon gerardii – Hesperostipa spartea – Sporobolus heterolepis</i> Grassland <b>Colloquial name:</b> Northern Mesic Big Bluestem Prairie

**Notes:** The name of the Level can be added to the type name for clarity, where needed.

**WebTable 2. Examples of agency use of the USNVC levels**

	<i>USNVC level</i>	<i>Possible agency application</i>
<i>Upper</i>	Level 1 – Formation Class	
	Level 2 – Formation Subclass	1. US Army Corps of Engineers – Stewardship
	Level 3 – Formation	1. US Army Corps of Engineers & Environmental Protection Agency (wetland mitigation) 2. Environmental Protection Agency – National Wetland Condition Assessment 3. National Marine Fisheries Service – Status and Trends of Wetlands in the Coastal Watersheds of the Conterminous United States (assessment)
<i>Mid</i>	Level 4 – Division	
	Level 5 – Macrogroup	1. US Forest Service Forest Inventory and Analysis Program (forest assessment) 2. Bureau of Land Management (regional assessments, land-use plans)
	Level 6 – Group	1. National Park Service Vegetation Inventory Program (natural resource inventory) 2. Fish and Wildlife Service (natural resource inventory, ecological integrity assessment) 3. US Forest Service Forest Inventory and Analysis Program (forest assessment) 4. LandFire (fire modeling) 5. US Geological Survey – GAP Analysis Program (habitat distribution) 6. Northeast Association of Fish & Wildlife Agencies (habitat inventory) 7. Western Governors Association Initiative on Wildlife Corridors and Crucial Habitat (wildlife habitat inventory) 8. State Natural Heritage Programs (natural resources inventory)
<i>Lower</i>	Level 7 – Alliance	1. National Park Service Vegetation Inventory Program, State Natural Heritage Programs (natural resources inventory)
	Level 8 – Association	1. National Park Service Vegetation Inventory Program, State Natural Heritage Programs (natural resources inventory)