U.S. National Vegetation Classification:
Advancing the Description and Management of the Nation's Ecosystems

Classification of Pawnee National Grasslands: Challenges of fitting locally-geographic plot-based classifications into the USNVC

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Background

The alarming loss in biodiversity and environmental problems suggest an urgent need of applied vegetation research (cf. Schaminée et al. 2009), including baseline data. The Pawnee National Grasslands currently has no plot-based vegetation community classification.

The advent of the USNVC has changed how researchers in the US approach the components of vegetation classification (Peet and Roberts 2013); specifically, regarding classification integration which may also affect the iterative process of entitation and assessment.

Because the USNVC concept descriptions are meant to cover the range of characteristics of a community concept, sometimes site specific data are missing, especially from restricted areas such as a park (as is the case in this study). Knowing site-specific variations of the broader community concept may be beneficial to local stewards.

However, that does not suggest the community concept itself is changed, as such previous concepts should only be modified after careful reflection (Jennings et al. 2009; Peet & Roberts 2013).

This classification of the Pawnee National Grasslands follows these recent US standards as well as international standards (De Cáceres et al. 2015).

Study Area

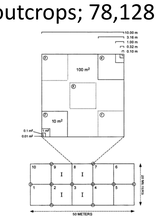
Pawnee National Grasslands (PNG)

Shortgrass Steppe

Colorado Piedmont and High Plains

Fragmented area is gently rolling with few outcrops; 78,128 ha.

102 Carolina Veg Survey Plots; 26 mountain plover/prairie dog plots
Plots stratified among site types



References:

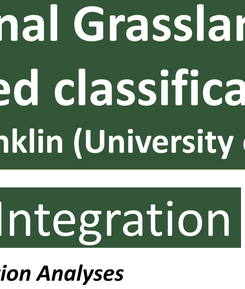
De Cáceres et al. 2015. *Applied Vegetation Science* 18: 543–560.
Jennings et al. 2009. *Ecological Monographs* 79:173–199.
Palmquist et al. 2016. *Proc. US National Vegetation Classification* 1(1): 1-70.
Peet & Roberts. 2013. **IN**: *Vegetation Ecology*, 2nd Edition. Oxford University Press.
Schaminée et al. 2009. Preslia 81/2: 173-185.
Tichý et al. 2014. *Journal of Vegetation Science* 25: 1504–1512.

Classification & Integration

Pawnee Only Community Classification Analyses
Classified the data using a hierarchical cluster analysis using the Sørensen distance measure and -0.25 Flexible Beta group linkage method: data were square-root transformed prior to analysis using PCORD. Determined the appropriate number of groups using OptimClass using the Juice 7.0.102 Program. Analyzed the constancy column in a synoptic table based on frequency and fidelity to determine diagnostic species.

Semi-supervised Classification Analysis
Initial classification analyses using only data from the Pawnee showed several very small groupings of plots (n=1-3), albeit these groupings were very different from other classified groups. We concluded these plots were all from more rare mesic areas of the Pawnee National Grasslands. Thus, in an attempt to compare these PNG plots with those already classified, a sort of semi-supervised classification (Tichý et al. 2014), we retrieved an additional 64 plots from four other research projects within VegBank with a query for plots containing *Pascopyrum smithii*, *Carex nebrascensis*, *Eleocharis* species, *Bouteloua* sp. and restricted to the Great Plains (not foothills or mountains).

NatureServe Ecoregions of study area and location of Pawnee National Grasslands (PNG) and additional plot data locations and studies: Classification of Natural Riparian/Wetland Plant Associations for Colorado (CWRC, throughout CO), Fort Laramie National Historic Site (FLNHS), Agate Fossil Beds National Monument (AFBNM), and Devil's Tower national Monument (DTNM).



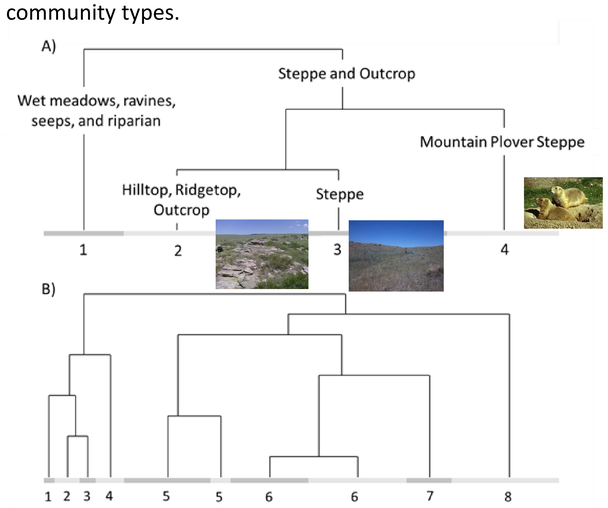
Classification Integration with USNVC Classification System
Classification integration was mostly a comparison of our groups with those described in the USNVC and known to occur in Colorado. The regional analysis provided several previously-classified plots and those concepts were compared to the plots from the PNG and integrated when possible. For those plots not clearly linked with previously classified plots, i.e., most of the steppe plots, our classified group characteristic species were compared with described concepts and integrated. Thus, the integration was entirely subjective.

Three issues hindered integration:

1. Too few Pawnee plots of the rarer mesic types
2. Lack of data showing variation within the PNG to compare to USNVC descriptions
3. Too few publically databased regional plots for comparison

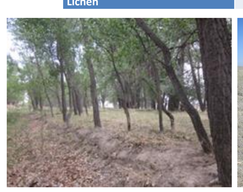
Classification Results

Dendrogram of PNG plots showing the two peaks suggested by OptimClass. A) four groups suggested by Optimclass; B) 10 groups suggested by OptimClass. Based on diagnostic analyses, we merged two sets of groups for a total of eight community types.



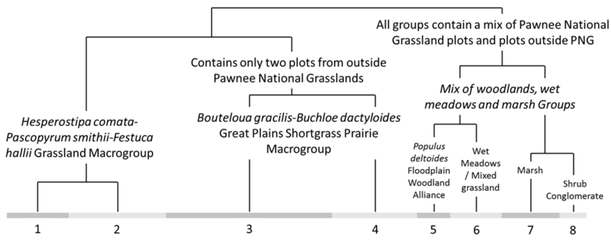
Diagnostic species frequencies and fidelity values (psi coefficient superscripted) for the eight cover types found in the PNG.

	1	2	3	4	5	6	7	8
Taxa	n = 3	n = 6	n = 4	n = 7	n = 26	n = 43	n = 11	n = 28
Carex nebrascensis	67 49.8	17		14				
Toxicodendron rydbergii	100 37.7				19 2.6			
Solidago canadensis	33 24.9			14				
Prunus virginiana	100 22.9				15	5		
Rosa woodsii	100 21.7	17			8			
Rhus trilobata	100 23.2	17			54 20.8	5		
Nassella viridula	67 19.5				38 13.7	2	9	
Parthenocissus quinquefolia	67 19.3				4			
Celtis laevigata	67 18.3							
Sporobolus airoides	33	83 47.0	25		8	9		
Distichlis spicata		83 30.1	75 4.7		4	5		
Juncus balticus		33 30.0						
Elymus canadensis	67 0.0	33 27.8			4			
Glycyrrhiza lepidota	67 11.4	33 24.3			4			
Thermopsis rhombifolia		17 21.2						
Equisetum laevigata		50 17.0	25	14	4			
Eleocharis acicularis			25 32.1					
Lemna minor			50 27.8					
Schoenoplectus pungens			75 27.0			10		
Ranunculus cymbalaria			75 27.0					
Phalaris canariensis			25 24.2					
Circium floodmanii			100 20.2					
Polygonum species			50 4.4	100 30.0	8			
Eleocharis palustris		17	75 17.7	57 28.8			27	4
Roripa curvipes		17	50	71 27.6	4		27	
Bassia scoparia				86 25.0	8	5	4	
Ambrosia psilostachya	67 3.3	50		86 24.9	23			
Hordeum jubatum				86 20.2	8	5		
Schizachyrium scoparium	33	17			54 24.8	5		
Buchloe dactyloides		50			65	100 33.7	100 19.3	57
Opuntia polyacantha	33	17			73	100 24.9	55	100
Bouteloua gracilis	67	83	50	29	96	100 23.7	91	100
Lichen					19	58	45	89 14.0



Integration Results

Regional analysis clearly separated more mesic communities from mixed grass and short grass steppe. In addition, the *Bouteloua gracilis-Büchloe dactyloides* Great Plains Shortgrass Prairie Macrogroup was separated from the *Hesperostipa comata-Pascopyrum smithii-Festuca hallii* Grassland Macrogroup to the north. Previously assigned plots helped us classify our rare mesic types specific to the Pawnee National Grasslands



While we do not have enough plot data to characterize all of these concepts, we provide a list of those USNVC concepts for which we have evidence.

Class	Mesomorphic Shrub and Herb Vegetation						Mesomorphic Tree Vegetation
Subclass	Shrub & Herb Wetland				Temperate & Boreal Grassland & Shrubland		Temperate & Boreal Forest & Woodland
Formation	Temperate to Polar Freshwater Marsh, Wet Meadows & Shrubland		Salt Marsh		Temperate Grassland & Shrubland		Temperate Flooded & Swamp Forest
Division	Western North American Temperate and Freshwater Marsh, Wet Meadows & Shrubland		Great Plains Saline Marsh		Central North American Grassland & Shrubland	Western North American Grassland & Shrubland	Eastern North American – Great Plains Flooded & Swamp Forest
Macrogroup	Arid West Interior Freshwater Marsh	Western North American Montane-Subalpine-Boreal Marsh, Wet Meadow and Shrubland	Great Plains Saline Wet Meadow & Marsh		Great Plains Shortgrass Prairie	Southern Rocky Mountain Montane Shrubland	Great Plains Flooded Forest
Group	Arid West Interior Freshwater Marsh	Vacouverian-Rocky Mountain Montane Wet Meadow & Marsh	Great Plains Saline Wet Meadow & Marsh	Western Great Plains Saline Meadow	Bouteloua gracilis-Buchloe dactyloides-Pleuraphis jamsii Great Plains Prairie	Southern Rocky Mountain Mountain-mahogony - Mixed Foothill Shrubland	Great Plains Cottonwood – Green Ash Floodplain Forest
Alliance	Schoenoplectus americanus-Schoenoplectus acutus-Schoenoplectus californicus Marsh	Carex nebrascensis-Carex vesicaria-Carex pellita Wet Meadow	Juncus balticus-Juncus mexicanus Wet Meadow	Pascopyrum smithii - Distichlis spicata - Hordeum jubatum Wet Meadow	Sporobolus airoides Great Plains Marsh	Bouteloua gracilis-Buchloe dactyloides Shortgrass Prairie	Fallugia paradoxa-Rhus trilobata Shrubland	Populus deltoides Floodplain Woodland
Association	Schoenoplectus pungens Marsh	Carex nebrascensis Wet Meadow	Juncus balticus Wet Meadow	Pascopyrum smithii - Eleocharis spp. Wet Meadow	Sporobolus airoides Northern Plains Marsh	Bouteloua gracilis-Buchloe dactyloides Grassland	Rhus trilobata-Ribes cerneum Shrubland	Populus deltoides/Panicum virgatum-Schizachyrium scoparium Floodplain Woodland

Take-home Message

We make a plea here that all vegetation scientists with full species plot data place those data into VegBank or another public database. While we were able to relate some of our more mesic concepts to plots from other studies, little plot data existed for the typical shortgrass steppe communities dominated by *Bouteloua* species. Our data represent a small geographic fraction of the area this concept covers and a regional analysis would be beneficial for the PNG and the USNVC (Palmquist et al. 2016) and would allow for a better understanding of the variability present at the local scale.