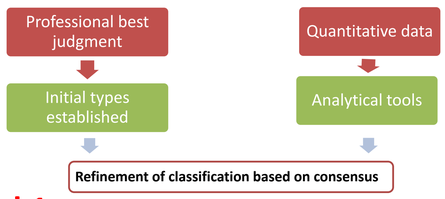
XIX International Botanical Congress
July 23-29, 2017 | Shenzhen China

The U.S. National Vegetation Classification for dry coniferous forests and woodlands of the southern Appalachian Mountains: A reassessment [ESA OPS-1-13]

Thomas Wentworth, Department of Plant & Microbial Biology, North Carolina State University, Raleigh, NC 27695-7612, United States
Raafiah Haroon, Perll Diagnostics, Inc. 5010 Ritter Road, Suite 104 Mechanicsburg PA 17055, United States
Kimberly Israel, North Carolina Division of Parks and Recreation 121 W Jones St Raleigh NC 27699, United States
Michael Lee, Department of Biology, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3280, United States
Brooklynn Newberry, Department of Plant & Microbial Biology, North Carolina State University, Raleigh, NC 27695-7612, United States
Robert Peet, Department of Biology, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3280, United States
Michael Schafale, North Carolina Natural Heritage Program, 1651 Mail Service Center, Raleigh, NC 27699-1651, United States
Alan Weakley, Herbarium (NCU), North Carolina Botanical Garden, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-3280, United States

Purpose:

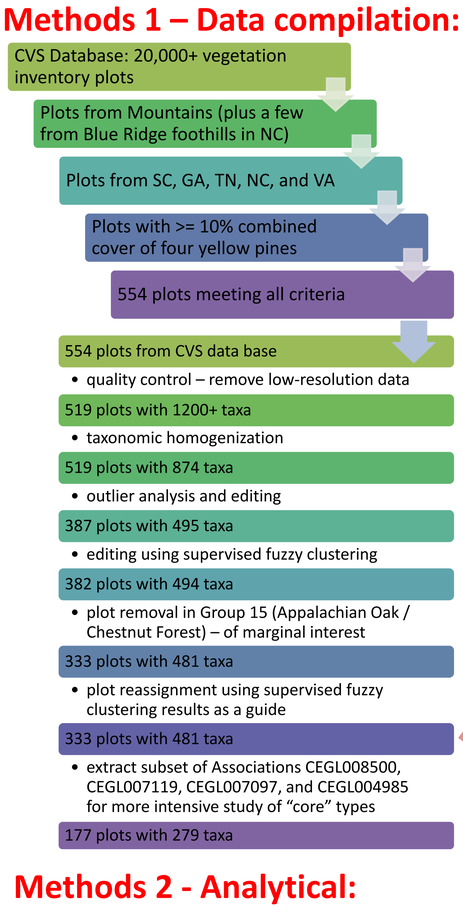
- Our purpose is to refine the US National Vegetation Classification's treatment of dry coniferous forests and woodlands of the southern Appalachian Mountains.
- We seek to maintain, to the extent possible, the existing Associations that were based on professional best judgement, but using quantitative data and modern analytical tools:



Background 1:

- Xeric to subxeric coniferous forests and woodlands of the southern Appalachian Mountains with a substantial component of yellow pines have declined in area during recent decades because of fire suppression, drought, and outbreaks of southern pine beetle.
- The net result of these processes has been a shift in many yellow pine stands to dominance by drought-tolerant broadleaved trees and shrubs.
- The possibility of a change in the global conservation status of yellow pine communities from vulnerable to imperiled prompted us to reconsider their existing classification, given the important supporting role of classification in conservation efforts.
- Even prior to widespread decline of yellow pine communities, classification efforts were hampered by their dynamic nature and their tendency to intergrade with a variety of other communities.

Methods 1 – Data compilation:



Methods 2 - Analytical:

Fuzzy clustering: A non-hierarchical numerical clustering method that determines the probability that a given plot belongs to each of a predetermined set of classes, including a "noise class" for outliers (Table 3.).

Nonmetric multidimensional scaling (NMS): an ordination method that displays plots in a multidimensional space in which distances in that space best reflect compositional differences among the plots (Fig. 4.)

Hierarchical cluster analysis: a method that displays compositional relationships among plots in a dendrogram (Fig. 5.).

Background 2:

	Species 1	Species 2	Species 3	…	Species 481
Plot 1	0	0	7		0
Plot 2	4	0	6		1
Plot 3	0	1	0		1
…					
Plot 333	2	0	4		1

Table 1. Typical data structure; input data for all analyses were percentage cover classes for n species in m plots. Plots ranged in size from 10 to 100 m^2. In this example, m=333 and n=481.

Cover Class	% Cover	Cover Class	% Cover
1	<0.01	6	>10-25
2	0.01-1	7	>25-50
3	>1-2	8	>50-75
4	>2-5	9	>75-95
5	>5-10	10	>95-100

Table 2. Cover class ranges for cover classes used by the CVS (Carolina Vegetation Survey).

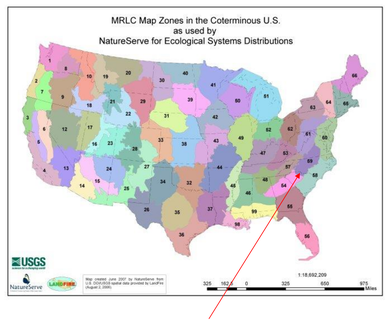


Fig. 1. STUDY AREA
US Geological Survey Multi-Resolution Land Characteristics (MRLC) 2000 Map Region 57: Southern Appalachia

Fig. 2. Examples of Southern Appalachian Dry Coniferous Forests and Woodlands (clockwise from top): pitch pine woodland on serpentine barren; pitch pine-oak woodland on granite rock outcrop; Table Mountain pine and pitch pine-oak woodland.

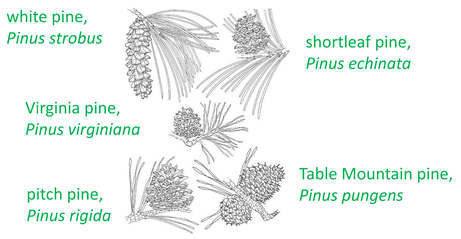


Fig. 3. Pine species of the southern Appalachian Mountains: of the four species illustrated, all are in the "yellow pine" subgenus except white pine. The four yellow pines, singly or in combinations, are dominants and co-dominants of the plant communities of interest.

Results:

United States National Vegetation Classification Nomenclature						Results of Supervised Fuzzy Clustering			
Group Key	plots	Group Name	CEGL	plots	Association Translated Name	orig plots	retained	to other	to noise
G012	146	Shortleaf Pine - Oak Forest & Woodland							
			CEGL003560	2	Appalachian Shortleaf Pine / Little Bluestem Woodland	2	2	0	0
			CEGL003765	5	Appalachian Shortleaf Pine - Post Oak Woodland	5	5	0	0
			CEGL007078	4	Appalachian Shortleaf Pine Forest	4	4	0	0
			CEGL007119	54	Appalachian Low-Elevation Mixed Pine / Blue Ridge Blueberry Forest	54	30	12	12
			CEGL007493	36	Southern Blue Ridge Escarpment Shortleaf Pine - Oak Forest	36	23	8	5
			CEGL007496	5	Southern Blue Ridge Escarpment Shortleaf Pine - Oak Forest (Tallulah Falls Type)	5	5	0	0
			CEGL008427	25	Appalachian Shortleaf Pine - Mesic Oak Forest	25	20	5	0
			CEGL008500	15	Appalachian Low-Elevation Mixed Pine / Little Bluestem Forest	15	9	4	2
G162	187	Virginia Pine - Table Mountain Pine Woodland & Barrens							
			CEGL004985	6	Blue Ridge Table Mountain Pine - Pitch Pine Woodland (High-Elevation Type)	6	6	0	0
			CEGL004996	28	Pinus (pungens, rigida) / Quercus ilicifolia / Gaylussacia baccata Woodland	28	26	1	1
			CEGL006178	4	Carolina Hemlock Forest (Pine Type)	4	4	0	0
			CEGL007097	138	Blue Ridge Table Mountain Pine - Pitch Pine Woodland (Typic Type)	138	87	26	25
			CEGL008525	2	Pinus virginiana - Quercus prinus / Quercus ilicifolia / (Hieracium greenii) Woodland	2	2	0	0
			CEGL008540	9	Quercus prinus - Pinus virginiana - Quercus (marilandica, stellata) / Dichanthelium depauperatum Woodland	9	9	0	0
				333		**333**	**232**	**56**	**45**

Table 3. Our working data set consists of 333 vegetation inventory plots, each containing cover data for all vascular plant species, using a 10-category cover class system developed by the Carolina Vegetation Survey (CVS). A priori classification of these plots led to their distribution among 14 Associations belonging to two Groups of the US National Vegetation Classification (USNVC) as shown in the "**orig plots**" column. We used supervised fuzzy clustering to cast the plots among the 14 Associations, resulting in an a posteriori (refined) classification in which some plots were retained in their original Association ("**retained**" column), assigned to other Associations ("**other**" column), or assigned to the noise class ("**to noise**" column). Fuzzy clustering was created using the vegclass procedure in the vegclust package in R, © 2017 The R Foundation for Statistical Computing. **CEGL** = Community Element Global system of USNVC.

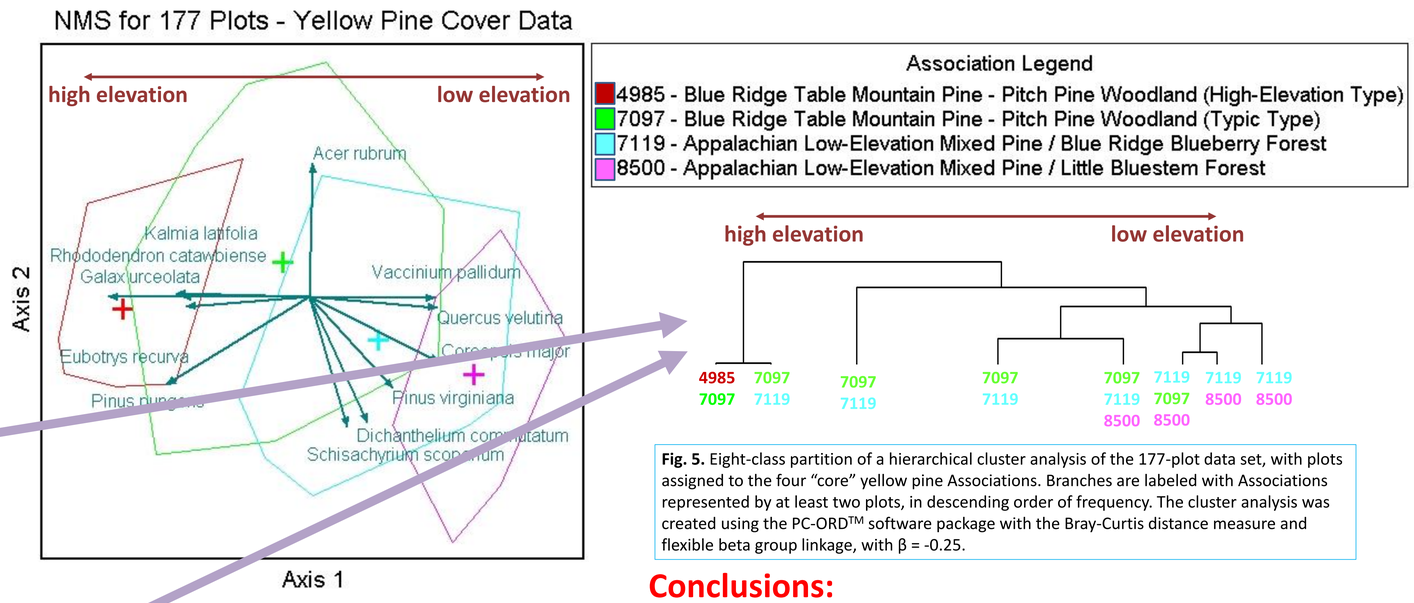


Fig. 4. First two axes of a three-dimensional nonmetric multidimensional scaling (NMS) ordination created using the "slow and thorough" setting of the NMS autopilot mode in the PC-ORD™ software package. Polygons are convex hulls for the plots assigned to the four "core" yellow pine Associations in the 177-plot data set. The centroid of each set of plots is designated with a "+". Biplot overlay vectors display directions and magnitudes of maximum variation for all species having an R^2 => 0.27. The NMS ordination was created using the Bray-Curtis distance measure; cumulative Variation accounted for by the first two axes = 61.6%.

Fig. 5. Eight-class partition of a hierarchical cluster analysis of the 177-plot data set, with plots assigned to the four "core" yellow pine Associations. Branches are labeled with Associations represented by at least two plots, in descending order of frequency. The cluster analysis was created using the PC-ORD™ software package with the Bray-Curtis distance measure and flexible beta group linkage, with β = -0.25.

Conclusions:

Many a priori plot assignments were erroneous; fuzzy clustering is an objective tool for plot reassignment of these plots to existing classes and recognition of plots that are either transitional or not representative of existing Associations.

Plots assigned to the noise class by fuzzy clustering may reveal novel Associations that should be recognized.

Both NMS ordination and hierarchical clustering revealed that the four "core" yellow pine Associations are broadly overlapping in compositional space, but that they also supported existing concepts for these Associations.

The principal compositional trends among the four "core" yellow pine associations appear associated with elevation. This and other environmental relationships will be further investigated using the available environmental data for these plots.

The goal of refining an existing "professional-best-judgment" classification using quantitative analysis of compositional data seems attainable using the suite of methods explored in this research.

Thanks to our supporters and collaborators!