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Abstract

We conducted an analysis of the vegetation of the maple-leaved oak sites on Sugarloaf and Magazine Mountains, Arkansas, during September and October of 1993. The woody vegetation was sampled using the point-quarter method; on Sugarloaf Mountain five transects were sampled (950 m) and on Magazine Mountain four transects were sampled (710 m). Soil samples from each site were collected and analyzed for 15 factors. In total 27 species were recorded and measured for both sites, 18 for Sugarloaf and 19 for Magazine. The Sugarloaf site can be described as a *Quercus-Juniperus* community and the Magazine site can be described as a *Juniperus-Carya-Fraxinus* community. Qualitative observations for the maple-leaved oak sites on Porter and Pryor Mountains, Arkansas, are also included.

Introduction

Until 1991 the maple-leaved oak (*Quercus shumardii* Buckl. var. *acerifolia* Palmer) was only known from Magazine Mountain, Logan County, Arkansas (Palmer, 1927). Discoveries on Pryor Mountain, Montgomery County and Sugarloaf Mountain, Sebastian County (Johnson, 1992) extended the known sites to three. In 1993 an additional population was discovered on Porter Mountain, Polk County, bringing the total known populations to four (Johnson, 1994).

Only one of these sites, Magazine Mountain in the Ozark National Forest, has been studied; these studies include Pyle's study of the herbaceous flora (1939) and Tucker's classification of the plant communities and habitat types of the slopes and plateau surface (1989). Tucker included the maple-leaved oak in the Mesic Bluffline Community and noted the probable occurrence of impure limestone in the rock underlying this community type. Tucker suggested that there may be a correlation between the presence of limestone and the high species diversity in that area. The soils associated with this community are of the Linker and Nella-Mountainburg Associations (U.S.D.A., 1975a).

The Sugarloaf site was briefly described by Johnson (1992). Unlike the Magazine site, this site is a xeric, east-facing bluffline and an adjacent, highly-eroded glade-like area. The soils are thin, have a significant shale component, and are of the Enders-Mountainburg Association (U.S.D.A., 1975b).

The Pryor and Porter Mountain sites in the Ouachita National Forest are physically similar, i.e. steep novaculite glades, and each supports few maple-leaved oak plants. The Pryor site supports a population of *Polymnia cossatotensis* (Johnson, 1992), which occurs on basic soils (Bates and Pittman, 1991).

We conducted this study to: 1) qualitatively and quantitatively document the woody vegetation of the two largest population sites of the maple-leaved oak; 2) determine the similarities and differences in the vegetation of these two sites; 3) determine if soil factors, especially pH play a role in the oak's distribution; 4) develop a list of species associated with the Maple-leaved oak so that the occurrence of new sites may be predicted more accurately; and, 5) provide a baseline for detecting changes in these communities over time. The oak site on Sugarloaf is privately owned and the Magazine site has been proposed as the site of a state park (Gandy et al., 1993).

Materials and Methods

Sampling took place during September and October of 1993 and utilized the point-quarter method (Mueller-Dombois and Ellenberg, 1974). For each species encountered, number of points of occurrence, number of individuals, and total basal area were measured. These data were used to calculate relative frequency, relative density, relative dominance, and importance value. On Sugarloaf, the five transects that were sampled were chosen to represent the extent of the vegetation and topography of the oak population. Three transects paralleled the bluffline (topographically below, at, and above the bluffline) (200 m each) and two ran perpendicular to the bluffline (210 and 140 m). At the Magazine site, four transects were sampled representing the Brown's Spring and Dripping Springs Oak populations. Three transects paralleled the bluffline (two topographically at the bluffline and one

above) (270, 80, and 180 m, respectively) and one ran perpendicular to the bluffline (180 m). All transects were sampled at 10 m intervals.

Soil samples from the upper 20 cm of the soil profile were taken along the transects at points representative of variations in elevation, topography, soil type and appearance, and vegetational composition. The samples included: Sugarloaf (10 samples), Magazine (6 samples), Pryor (1 sample), and Porter (1 sample). They were analyzed by the Arkansas Agricultural Extension Service Soil Testing Laboratory at Fayetteville, Arkansas. Analysis included the following factors: pH, percent organic matter (P.O.M.), P, K, Ca, Na, Mg, SO_4-S, Fe, Mn, Cu, Zn, NO_3-N, cation exchange capacity (C.E.C.), and percent base saturation (% B.S.). References used for identification and nomenclature were Radford et al. (1968), Tucker (1976), Smith (1988), Preston and Wright (1988), and Harlow et al. (1991).

Results and Discussion

Soils.--Soil sample data are presented in Table 1. The soils for all sites were moderately acidic, and pH decreased as altitude decreased at the Sugarloaf and Magazine sites. The lowest pH, 4.1, was recorded on Magazine in moist, rich soil on the upper slope below the bluffline. Our initial thoughts that the distribution of maple-leaved oak might be correlated with near-neutral or basic soils were not supported by the data, although the oaks may be influenced by high pH material not evident in the surface soil layer.

Vegetation.--In total 27 species were recorded and measured for both sites, 18 for Sugarloaf and 19 for Magazine (Tables 2 and 3, respectively). On Sugarloaf *Q. stellata* represented one-third, *Q. shumardii* var. *acerifolia* and *Juniperus virginiana* represented another one-third, and the other 15 species represented the final one-third of the total importance value. As a result, the woody vegetation of Sugarloaf's maple-leaved oak habitat can be characterized as a *Quercus-Juniperus* community, consisting of many smaller plants with a number of larger specimens of *Q. stellata* and *J. virginiana* interspersed among them. The latter point is evident when comparing the number of trees and total basal area for *Q. stellata* (123 trees, 27.38 sq. m) with *Q. shumardii* var. *acerifolia* (100 trees, 14.24 sq. m) and *Q. marilandica* var. *ashei* (36 trees, 1.67 sq. m). The largest maple-leaved oak plants were found on the summit and also on the upper slopes below the bluffline along with larger specimens of *Q. rubra, Q. muehlenbergii,* and *Carya tomentosa*.

On Magazine, *J. virginiana* represented one-third, *C. texana, Fraxinus americana, C. glabra,* and *Q. shumardii* var. *acerifolia* represented another one-third, and the other 14 species represented the remaining one-third of the total importance value. As a result, the woody vegetation of Magazine's maple-leaved oak habitat can be characterized as a *Juniperus-Carya-Fraxinus* community. Four zones of woody vegetation were encountered proceeding from the bluffline on the perpendicular transect: 1) *Q. shumardii* var. *acerifolia, Q. stellata, C. texana,* and low *Vaccinium;* 2) *Q. shumardii* var. *acerifolia, J. virginiana, Fraxinus americana, Chionanthus virginicus,* and *Amelanchier arboreum*; 3) *J. virginiana*; and, 4) *Q. alba, Q. velutina,* and clumps of *C. glabra* with understory species *Ostrya virginiana* and *Robinia pseudoacacia. Juniperus virginiana* was ubiquitous, and the larger maple-leaved oaks were found in zone 2 a short distance from the bluffline within the encroaching trees.

In comparison there are some notable differences between these two maple-leaved oak sites and their vegetation. First, three species very common on Sugarloaf, *Q. stellata, Q. shumardii* var. *acerifolia,* and *Q. marilandica* var. *ashei,* are much less common on Magazine. Second, Sugarloaf is more open with smaller trees; this is consistent with Sugarloaf's smaller values for trees/ha and basal area/ha (Tables 2 and 3). Third, Sugarloaf supports an Oak population of over 350 plants while Magazine supports a population of approximately 200 individuals. Fourth, the average oak on Magazine (.214 sq. m/tree) is larger than on Sugarloaf (.142 sq. m/tree). Magazine has a smaller population of larger individuals with the larger individuals located mainly 10-15 m above the bluffline. Conversely, Sugarloaf has a larger population of smaller

Table 1. Soil sample data for maple-leaved oak sites.

Site	Number of soil samples	pH range	% Organic Matter (P.O.M.)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	SO_4-S (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	NO_3-N (ppm)	Cation Exchange Capacity (C.E.C.)	% Base Saturation (%B.S.)
Sugarloaf	10	4.6-5.8	2.25	8	135.4	587.75	474.6	54.3	13.9	88.95	52.4	1.41	3.15	0.95	14.3	48.53
Magazine	6	4.1-5.3	3.95	15.1	92.9	522.75	67.65	54.15	32.85	81.5	48.75	0.74	5.55	17.85	14.2	23.9
Porter	1	5.1	4.3	26.5	189	1325	160.5	47	18	39.5	151	1.7	3.55	57	21	40.7
Pryor	1	4.7	4.3	79	148.5	870.5	53	55	41	118	78	0.95	4	6.5	17	31.8
Mean			3.04	15.35	124.95	622.75	298.1	53.9	21.95	85.4	58.1	1.2	4.02	10	14.8	39

individuals with the larger individuals located on the upper slopes below the bluffline and on the summit. Additionally, Sugarloaf has three highly disturbed areas: an abandoned road bed, an existing road leading to the former site of a fire tower, and a power line right-of-way extending to the tower site. These areas are highly eroded, yet the maple-leaved oak is flourishing on them.

Table. 2. Vegetational data for Sugarloaf Mountain.

Species	Number points of occurrence	Number of Trees	Total Basal Area (sq. m)	Relative Frequency (F) %	Relative Density (D) %	Relative Dominance (Do) %	Importance Value (F+D+Do)
Quercus stellata	68	123	27.378	26.772	30.750	40.088	97.610
Quercus shumardii var. *aceri*	55	100	14.239	21.654	25.000	20.849	67.503
Juniperus virginiana	27	43	6.030	10.630	10.750	8.829	30.209
Quercus marilandica var. *ash*	23	36	1.662	9.055	9.000	2.434	20.489
Quercus rubra	13	15	6.779	5.118	3.750	9.926	18.794
Carya texana	18	25	1.622	7.087	6.250	2.375	15.712
Quercus muehlenbergii	16	17	2.607	6.299	4.250	3.817	14.366
Ulmus alata	10	13	2.271	3.937	3.250	3.325	10.512
Pinus echinata	6	6	1.770	2.362	1.500	2.592	6.454
Carya tomentosa	4	6	2.032	1.575	1.500	2.975	6.050
Prunus serotina	3	3	1.353	1.181	0.750	1.981	3.912
Viburnum rufidulum	3	5	0.074	1.181	1.250	0.108	2.539
Prunus mexicana	2	2	0.093	0.787	0.500	0.136	1.424
Rhus copallina	2	2	0.028	0.787	0.500	0.041	1.328
Quercus velutina	1	1	0.332	0.394	0.250	0.486	1.130
Ptelea trifoliata	1	1	0.013	0.394	0.250	0.019	0.663
Diospyros virginiana	1	1	0.008	0.394	0.250	0.012	0.655
Crataegus intricata	1	1	0.004	0.394	0.250	0.006	0.650
(Total)	254	400	68.295	100.000	100.000	100.000	300.000
Total distance (m) =	1115.840						
Avg. distance (m) =	2.790						
Trees/100 sq. m =	12.850	(1285.04/ha)					
Total basal area (sq. m) =	68.295						
Avg. basal area/tree (sq. m) =	0.171						
Basal area/100 sq. m =	2.194	(219.4/ha)					

Table 3. Vegetational data for Mountain Magazine.

Species	Number points of occurrence	Number of Trees	Total Basal Area (sq. m)	Relative Frequency (F) %	Relative Density (D) %	Relative Dominance (Do) %	Importance Value (F+D+Do)
Juniperus virginiana	47	101	20.285	23.5	33.667	32.072	89.239
Carya texana	26	40	7.473	13.0	13.333	11.815	38.149
Fraxinus americana	23	33	5.859	11.5	11.000	9.264	31.764
Carya glabra	11	17	5.251	5.5	5.667	8.302	19.469
Quercus shumardii var. *aceri*	14	17	3.637	7.0	5.667	5.750	18.417
Chionanthus virginicus	17	19	1.418	8.5	6.333	2.242	17.075
Quercus stellata	10	10	2.803	5.0	3.333	4.432	12.765
Amelanchier arboreum	9	13	2.159	4.5	4.333	3.414	12.247
Quercus velutina	4	5	5.379	2.0	1.667	8.505	12.171
Ostrya virginiana	11	16	0.696	5.5	5.333	1.100	11.934
Pinus echinata	8	8	2.271	4.0	2.667	3.591	10.257
Quercus alba	3	3	4.204	1.5	1.000	6.647	9.147
Ulmus alata	4	4	0.524	2.0	1.333	0.828	4.162
Robinia pseudoacacia	3	4	0.518	1.5	1.333	0.819	3.652
Acer saccharum	3	3	0.686	1.5	1.000	1.085	3.585
Ptelea trifoliata	4	4	0.068	2.0	1.333	0.108	3.441
Sassafras albidum	1	1	0.011	0.5	0.333	0.017	0.851
Quercus marilandica var. *ash*	1	1	0.003	0.5	0.333	0.005	0.838
Rhus copallina	1	1	0.003	0.5	0.333	0.005	0.838
(Total)	200	300	63.248	100.0	100.000	100.000	300.000
Total distance (m) =	778.000						
Avg. distance (m) =	2.593						
Trees/100 sq. m =	14.873	(1487.3/ha)					
Total basal area (sq. m) =	63.248						
Avg. basal area/tree (sq. m) =	0.211						
Basal area/100 sq. m =	3.136	(313.6/ha)					

These data suggest that the maple-leaved oak may be an early successional taxon that thrives in open-canopy, disturbed situations. If so, this might also explain the smaller importance value for maple-leaved oak on Magazine compared to Sugarloaf. At the turn of the century the plateau surface of Magazine had been settled and cleared, and in the first description of the oak, Palmer (1927) said it was found "in open woods bordering the cliffs and along their margins." Then Magazine might have offered opportunities similar to those now present on Sugarloaf. In the absence of recent major disturbances, the oak habitat on Magazine is undergoing change, and many of the oak trees are now surrounded by larger trees of other species. Furthermore, the small populations of maple-leaved oak on Porter and Pryor Mountains are found, along with *Q. marilandica* var. *ashei*, *Q. stellata*, *J. virginiana*, and *Ilex vomitoria*, on open, thin soils of steep, novaculite glades and appear to be doing passably in what might be termed an early successional area.

Conclusions

Sugarloaf Mountain, having a wide range of size classes, is presently optimal habitat for the maple-leaved oak. Sugarloaf has highly-eroded, heavily-disturbed areas, and it appears that the oak has spread from the summit and bluffline to fill these disturbed areas. Although Mount Magazine might have been optimal habitat in the past, it now represents marginal habitat. Magazine's oak population has more individuals in the larger size classes, and as surrounding trees continue to grow, the canopy is beginning to enclose the larger oak specimens located up from the bluffline. Based on the data collected, it appears that the maple-leaved oak is a member of the *Quercus-Juniperus* community and flavors early successional habitat.

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