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A Quantitative Analysis of the Vegetation of Bluff Spring Fen Nature Preserve

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ABSTRACT

Seven plant communities in the northern section of Bluff Spring Fen Nature Preserve, Cook County, Illinois were quantitatively analyzed. Importance values for the taxa sampled were determined using frequency and cover data collected via a random plot sampling method. The low shrub fen and graminoid fen are dominated by *Carex stricta* and *Solidago ohioensis*. *Carex stricta* is also a dominant in the wet-mesic prairie and sedge meadow. The dominants of the calcareous seep are *Eleocharis rostellata* and *Potentilla fruticosa*. *Typha latifolia*, *Carex stricta*, and *Solidago patula* are the three most important plants of the *Typha-Carex* community, while the dry gravel prairie is dominated by *Schizachyrium scoparium*.

All communities were compared using Sorensen coefficients of similarity, community structure analysis, and cluster analysis. These comparisons indicate that the management areas, calcareous seep, and dry gravel prairie are distinct from each of the other communities. The comparisons also indicate that the remaining wetland communities - low shrub fen, graminoid fen, sedge meadow, *Typha-Carex* community, wet-mesic prairie - are quite similar.

INTRODUCTION

Bluff Spring Fen Nature Preserve is located in Hanover Township, Cook County, Illinois. Management areas and eight plant communities in the preserve were described by Stoynoff and Hess (1986). The communities included graminoid fen, low shrub fen, calcareous seep, wet-mesic prairie, sedge meadow, dry gravel prairie, shrub community, and Typha-Carex community. White (1978) was used as a guide for community classification, with the shrub and *Typha-Carex* communities being notable exceptions.

Of the 396 taxa reported five are endangered and four are threatened species in Illinois (Hess and Stoynoff, 1989). Since the original checklist was compiled, *Helianthus giganteus* has been collected from the study area (Karnes and Nuzzo s.n.) raising the number of endangered taxa (Herkert, 1991) to six. Aerial photographs indicate that prior to the commencement of management efforts considerable succession from herbaceous to woody cover occurred (Stoynoff and Hess, 1986). In recent years extensive management

efforts in the form of controlled burns and selective cutting have been used in an attempt to reduce the abundance of woody taxa.

This report documents the vegetation of each community through the use of importance values and compares communities using three different methods. These baseline data may be used to study the vegetational changes with time and/or compare this study area with others.

METHODS

In order to maximize sampling within each community using a minimum number of transects a stratified random sampling method was used. The study area was divided into five equal sections and a transect was randomly positioned in each (Fig. 1). Data were collected during a three week period in August and September, 1986. Sufficiency of sampling was determined using species-area curves (Brower and Zar, 1984) and resulted in data collection along six additional transects through communities insufficiently sampled (i.e., 11 transects total). Data were collected along these additional transects during August and September, 1987. No interfering management activities occurred within the sampled areas during the course of data gathering or between times of sampling.

Quarter meter squared (1/2 m x 1/2 m) plots were placed along each transect at alternate meters (1, 3, 5, etc.). The identity of each vascular plant present was recorded along with its percent cover as estimated by viewing from above. The community each plot represented was determined according to the dominant and associated vegetation within the plot and the community descriptions of Hess and Stoynoff (1986). The vegetation was sampled in a total of 464 plots, with the number sampled per community being as follows: low shrub fen = 31, graminoid fen = 40, calcareous seep = 49, wet-mesic prairie = 54, *Typha-Carex* community = 39, sedge meadow = 33, dry gravel prairie = 30, management areas = 188.

For each taxon, absolute and relative frequency and coverage values were calculated (Brower and Zar, 1984). Importance values reported are the sum of the relative coverage and frequency values. Only vascular plant taxa with importance values of 2.0 or greater are presented here, therefore importance values do not sum to 200.

The communities were compared using Sorensen coefficients of community similarity (Barbour, Burk, and Pitts, 1980) and these values vary between zero and one. As coefficients increase a greater degree of community similarity is indicated. The formula used is given below.

$$\text{Similarity} = (2C) / (A + B)$$

where:
A = total of importance values for all species in community "A"
B = total of importance values for all species in community "B"
C = total of importance values for species common to communities "A" and "B" using the lower importance value for each species

The community structure (i.e., the make up of each community according to the importance of each life form) was analyzed by categorizing each taxon as being a woody plant, a forb, or a graminoid (grasses, sedges, and rushes). The importance values for each of the three life forms were totaled and plotted along with a richness value. Richness is the total number of plant taxa sampled within a community (Ludwig, 1988). A single linkage cluster analysis was completed using the importance values and the results are presented in a three-dimensional scatter plot. The analysis and scatter plot were completed using the SYSTAT statistics package (Wilkinson, 1990a) and the SYGRAPH graphics package (Wilkinson, 1990b) respectively.

RESULTS AND DISCUSSION

Fen Communities

Low shrub fen and graminoid fen were sampled and the data for them are presented in Tables 1 and 2, respectively. The low shrub fen is dominated by *Carex stricta*, *Solidago ohioensis*, *Andropogon gerardii*, and *Potentilla fruticosa*. *Carex stricta* and *Solidago ohioensis* dominate the graminoid fen.

At the time the communities were mapped (Stoynoff and Hess, 1986) *Potentilla fruticosa* was judged to be a common and locally dominant constituent of the low shrub fen. The data in Table 1, however, point out that when sampling occurred these areas were dominated by herbaceous taxa and not shrubs. A possible explanation for this apparent change follows.

Starcs (1962) reported that *Potentilla fruticosa* and other woody taxa appeared to be invading Cabin Creek Raised Fen due to the lack of fire and Curtis (1959) indicated that fire was needed to maintain fens and prevent their development into shrub-carr. According to Wilhelm (1978) without the appropriate fire regime, shrubby taxa would continue their invasion of Ferson's Creek Fen. According to Kohring (1982) the fall season coverage of *Potentilla fruticosa* decreased following fire in Bakertown Fen. White (1978) suggested that creeks may act as natural fire breaks in low shrub fens and protect *Potentilla fruticosa* from fire.

The coverage of *Potentilla fruticosa* in the low shrub fen at Bluff Spring has diminished with time (pers. obs.). In light of the work mentioned above, it is likely that the decline of *Potentilla fruticosa* has been in response to fire, but no pre-burn and post-burn data are available for documentation.

Calcareous Seep

The calcareous seep community is dominated by E*leocharis rostellata*, which is threatened in Illinois (Herkert, 1991), and *Potentilla fruticosa* (Table 3). Moran (1981) also found those two taxa to be dominants in this community at Bluff Spring Fen along with *Deschampsia cespitosa* and *Rhyncospora capillacea*.

This community is characterized by sparse to patchy ground cover and numerous springs and flows that maintain the soil in a water saturated condition. As White (1978) suggested for low shrub and forested fens, shrubby cinquefoil is probably dominant in the calcareous

seep at Bluff Spring, because the numerous springs and flows act as natural barriers to fire.

Wet-mesic Prairie

Stoynoff and Hess (1986) described this community as being dominated by *Andropogon gerardii*, *Sorghastrum nutans*, and *Silphium integrifolium*, with *Carex stricta* and other taxa as associates. A more accurate description is that *Carex stricta*, *Silphium perfoliatum*, and *Cornus foemina* are three dominant taxa and the three other species mentioned are conspicuous associates (Table 4).

The areas here designated as wet-mesic prairie were mapped as graminoid fen by Madany et al. (1977) in a report for the Illinois Natural Areas Survey. Here (Fig. 1) much of the wet-mesic prairie is mapped adjacent to, but segregated from, graminoid fen and sedge meadow.

Typha-Carex Community

This community, dominated by *Typha latifolia* and *Carex stricta* (Table 5), is most common along the borders of creeks. It most closely resembles White's (1978) marsh community.

Apfelbaum (1985) stated that periodic fires will not extirpate *Typha*, but may weaken a population. He indicated that, when fire is used as a control measure, consistent use of spring and fall burns should reduce cattail populations and promote the regrowth of other plants represented in the seed bank.

Typha apparently persists at Bluff Spring Fen, because its rhizomes remain relatively undamaged following fire. Also, the creeks may act as natural barriers and prevent fire from reaching some segments of this community, as White (1978) suggested for other communities.

Sedge Meadow

Carex stricta is by far the most important species in this community (Table 6). This area is poorly drained and inundated by water (at least in part) during wet periods. In spite of the relatively poor drainage the sedge meadow possesses a variety of forbs almost equal to that of the wet-mesic prairie.

Dry Gravel Prairie

This community exists only on the slopes of the two gravel kames present in the nature preserve and *Schizachyrium scoparium* and *Bouteloua curtipendula* are dominants (Table 7). *Eupatorium altissimum* and *Poa compressa* are conspicuous weeds that have been able to survive the prescribed burns of the area. It seems likely that at least the latter of the two will persist for some time to come, as it has been observed to do following fire in other prairie remnants in our area (Swink and Wilhelm, 1979).

Management Areas

For the purpose of this report the shrub community (Stoynoff and Hess, 1986) has been treated as a management area, because a great deal of selective cutting and herbicide application have occurred there (pers. obs.). Some management areas are populated by dense colonies of woody taxa like *Cornus foemina*, which tends to survive fire and increase in open habitats (Swink and Wilhelm, 1979). Herbaceous taxa like *Solidago altissima* and *Eupatorium rugosum*, that are common to disturbed habitats (Swink and Wilhelm, 1979) and may be considered weeds at Bluff Spring, are local dominants (Table 8). Selective cutting and seasonal burning have extensively reduced areas of shrubby cover and have improved the quality of the preserve as a whole.

Community Comparison

From a structural perspective the dry gravel prairie and calcareous seep are similar (Fig. 2) and form a single cluster (Fig . 3) separate from all other communities. The degree of similarity indicated shows that these two communities are alike in terms of richness and the overall importance of woody plants, forbs, and graminoids. However, the Sorensen coefficients of community similarity analysis (Table 9) takes the identity and importance of individual species into account and indicates that the two communities are distinct.

The Sorensen coefficients indicate some similarity between management areas and both wet-mesic prairie and sedge meadow. However, because management areas greatly differ from the other communities in terms of richness and the importance of woody taxa and graminoids, the community structure and cluster analyses (Figs. 2 & 3) segregate them from all other communities.

The remaining wetland communities - low shrub fen, graminoid fen, sedge meadow, *Typha-Carex* community, wet-mesic prairie - display varying degrees of similarity. The community structure analysis (Fig. 2) shows that all five communities differ little when richness and the importance of woody plants, forbs, and graminoids are considered. Sorensen coefficients (Table 9) contradict this by indicating that the two fens are quite similar (coefficient of similarity = 0.7), the wet-mesic prairie and sedge meadow have a fairly high degree of similarity (coefficient of similarity = 0.57), and the *Typha-Carex* community is distinct. The cluster analysis further complicates the picture by clustering all five of these communities in a single group as shown in the scatter plot (Fig. 3) .

The analyses used here clearly segregate the calcareous seep, dry gravel prairie, and management areas as distinct entities. However, the five remaining communities present a problem. As mentioned above, the Sorensen's coefficients of community similarity analysis indicated that perhaps the five communities could be reduced to three: a *Typha-Carex* community, a fen community (created by merging the low shrub and graminoid fens), and a third community consisting of what has been called here sedge meadow and wet-mesic prairie. However the community structure analysis and the cluster analysis indicate that all five communities are quite similar. Because of the lack of agreement among analyses, all five have been left as the distinct communities outlined by Stoynoff and Hess (1986).

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Figure 1. Vegetation map of Bluff Spring Fen Nature Preserve including the approximate position of transects used in sampling. Communities shown: C, calcareous seep; D, dry gravel prairie; G, graminoid fen; L, low shrub fen; M, management area; O, open water; S, sedge meadow; T, *Typha-Carex* community; W, wet-mesic prairie; DW, disturbed woodland.

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Figure 2. Histogram showing the results of the community structure analysis. The vertical scale represents the total number of species sampled for richness and the total of the importance values of all species sampled for each of the life forms. [CS = calcareous seep, GF = graminoid fen, LSF = low shrub fen, SM = sedge meadow, TC =*Typha-Carex* community, WMP = wet-mesic prairie, MGMT = management area]

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Figure 3. Three-dimensional scatter plot presenting the results of the cluster analysis of the eight communities in Bluff Spring Fen Nature Preserve. [C = calcareous seep, D = dry gravel prairie, G = graminoid fen, L = low shrub fen, S = sedge meadow, T = *Typha-Carex* community, W = wet-mesic prairie, M = management area] Axes are labeled according to the characteristic represented. [wood = woody plants, gram = graminoids, forb = forbs]

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Table 1. Importance values for the vascular plants of the low shrub fen.

Species	Importance Value	Relative Frequency	Relative Cover
Carex stricta	23.2	7.5	15.7
Solidago ohioensis	22.4	7.8	14.6
Andropogon gerardii	19.5	5.7	13.8
Potentilla fruticosa	13.1	4.6	8.5
Smilacina stellata	9.0	5.7	3.3
Helianthus grosseserratus	8.4	4.3	4.1
Aster umbellatus	8.2	3.9	4.3
Rudbeckia hirta	6.9	2.6	4.3
Solidago patula	6.8	3.2	3.6
Cornus foemina	6.6	3.2	3.4
Sorghastrum nutans	6.6	3.2	3.4
Scirpus acutus	6.5	6.0	0.5
Silphium terebinthinaceum	6.6	3.6	3.0
Liatris pycnostachya	6.2	3.6	2.6
Muhlenbergia glomerata	5.6	3.6	2.0
Schizachyrium scoparium	3.4	1.4	2.0
Galium boreale	3.5	1.8	1.7
Lycopus americanus	3.2	2.8	0.4
Senecio aureus	3.2	2.1	1.1
Pycnanthemum virginianum	2.8	1.4	1.4
Solidago altissima	2.7	1.4	1.3
Valeriana edulis	2.4	1.4	1.0

Table 2. Importance values for the vascular plants of the graminoid fen.

Species	Importance Value	Relative Frequency	Relative Cover
Carex stricta	26.0	9.7	16.3
Solidago ohioensis	21.5	7.9	13.6
Smilicina stellata	9.9	5.2	4.7
Valeriana edulis	9.8	3.3	6.5
Potentilla fruticosa	9.2	4.6	4.6
Rudbeckia hirta	7.6	5.2	2.4
Sorghastrum nutans	7.4	2.4	5.0
Pycnanthemum virginianum	6.3	3.0	3.3
Silphium terebinthinacium	6.0	2.4	3.6
Aster umbellatus	5.9	3.0	2.9
Schizachyrium scoparium	5.7	1.5	4.2
Lycopus americanus	5.7	4.6	1.1
Solidago patula	5.4	2.7	2.7
Spartina pectinata	5.0	2.4	2.6
Senecia aureus	4.4	2.4	2.0
Monarda fistulosa	4.2	1.8	2.4
Liatris pynostachya	3.8	2.7	1.1
Muhlenbergia glomerata	3.7	2.7	1.0
Andropogon gerardii	3.6	1.2	2.4
Aster novae-angliae	3.5	1.2	2.3
Helianthus grosseserratus	3.4	2.1	1.3
Galium boreale	3.2	2.7	0.5
Eupatorium maculatum	2.6	1.5	1.1
Comandra richardsiana	2.5	1.8	0.7
Eleocharis rostellata	2.5	0.6	1.9
Scirpus acutus	2.4	1.8	0.6
Aster puniceus	2.4	1.2	1.2
Muhlenbergia mexicana	2.4	1.8	0.6

Table 3. Importance values for the vascular plants of the calcareous seep.

Species	Importance Value	Relative Frequency	Relative Cover
Carex stricta	10.6	5.0	5.6
Deschampsia cespitosa	9.1	4.6	4.5
Rhyncospora capillacea	8.7	4.6	4.1
Lobelia kalmii	8.3	7.7	0.6
Sorghastrum nutans	7.0	2.3	4.7
Silphium terebinthinaceum	6.5	3.9	2.6
Cladium mariscoides	6.4	4.6	1.8
Solidago uliginosa	6.3	4.6	1.7
Valeriana edulis	3.3	1.9	1.4
Parnassia glauca	3.2	2.3	0.9
Scleria verticillata	3.0	1.5	1.5
Eleocharis tenuis	2.5	1.9	0.6
Juncus brachycephalus	2.4	2.3	0.1
Carex sterilis	2.1	1.6	0.5
Rudbeckia hirta	2.1	1.2	0.9

Table 4. Importance values for the vascular plants of the wet-mesic prairie.

Species	Importance Value	Relative Frequency	Relative Cover
Carex stricta	35.3	10.4	24.9
Silphium perfoliatum	12.7	5.8	6.9
Cornus foemina	10.5	4.9	5.6
Solidago altissima	9.5	5.6	3.9
Silphium terebinthinaceum	9.1	3.0	6.1
Solidago ohioensis	7.8	2.8	5.0
Aster puniceus	7.3	3.5	3.8
Aster umbellatus	7.0	3.5	3.5
Helianthus grosseserratus	6.9	3.0	3.9
Spartina pectinata	5.4	2.3	3.1
Lycopus americanus	5.2	4.2	1.0
Muhlenbergia mexicana	4.9	2.5	2.4
Eupatorium maculatum	4.4	2.1	2.3
Pycnanthemum virginianum	4.3	2.3	2.0
Viburnum lentago	4.3	1.9	2.4
Solidago gigantea	3.9	2.8	1.1
Smilacina stellata	3.8	2.8	1.0
Silphium integrifolium	3.6	1.9	1.7
Eupatorium altissimum	3.3	1.6	1.7
Stachys palustris	3.0	1.9	1.1
Senecio aureus	2.5	1.2	1.3
Aster firmus	2.5	1.6	0.9
Cirsium muticum	2.5	1.2	1.3
Fragaria virginiana	2.1	1.4	0.7
Rosa sp.	2.1	1.6	0.5
Typha latifolia	2.1	1.4	0.7
Apios americana	2.0	0.9	1.1
Solidago patula	2.0	0.9	1.1

Table 5. Importance values for the vascular plants of the *Typha-Carex* community.

Species	Importance Value	Relative Frequency	Relative Cover
Typha latifolia	36.2	11.4	24.8
Carex stricta	23.4	8.1	15.3
Solidago patula	18.6	7.7	10.9
Salix glaucophylloides	11.4	4.0	7.4
Carex hystericina	9.5	7.0	2.5
Pedicularis lanceolata	8.9	4.0	4.9
Aster puniceus	8.1	4.0	4.1
Nasturtium officinale	6.9	2.6	4.3
Impatiens capensis	6.0	4.0	2.0
Eleocharis smallii	5.5	4.0	1.5
Eupatorium maculatum	5.0	3.3	1.7
Solidago ohioensis	4.8	1.5	3.3
Juncus brachycephalus	4.1	2.9	1.2
Eupatorium perfoliatum	3.9	2.9	1.0
Bidens cernua	3.6	1.1	2.5
Juncus nodosus	3.5	2.2	1.3
Caltha palustris	3.0	2.2	0.8
Populus deltoides	2.0	1.1	0.9
Senecio aureus	2.0	1.1	0.9

Table 6. Importance values for the vascular plants of the sedge meadow.

Species	Importance Value	Relative Frequency	Relative Cover
Carex stricta	55.9	14.8	41.1
Aster puniceus	17.6	8.1	9.5
Eupatorium maculatum	10.8	4.8	6.0
Solidago patula	9.2	5.2	4.0
Solidago altissima	8.4	5.7	2.7
Cornus foemina	5.4	2.4	3.0
Aster firmus	5.3	2.4	2.9
Pycnanthemum virginianum	5.2	3.3	1.9
Solidago ohioensis	5.0	2.4	2.6
Amphicarpaea bracteata	4.3	1.4	2.9
Populus deltoides	4.3	2.4	1.9
Muhlenbergia mexicana	4.0	2.9	1.1
Muhlenbergia glomerata	4.0	2.9	1.1
Solidago gigantea	3.5	2.4	1.1
Typha latifolia	3.0	2.4	0.6
Senecio aureus	2.8	1.4	1.4
Andropogon gerardii	2.7	1.9	0.8
Salix glaucophylloides	2.5	1.4	1.1
Helianthus grosseserratus	2.4	1.4	1.0
Rudbeckia hirta	2.4	1.9	0.5
Calamagrostis canadensis	2.3	1.9	0.4
Valeriana edulis	2.2	1.0	1.2
Monarda fistulosa	2.2	1.9	0.3
Lycopus americanus	2.1	1.9	0.2
Liatris pycnostachya	2.0	1.4	0.6
Silphium perfoliatum	2.0	1.0	1.0

Table 7. Importance values for the vascular plants of the dry gravel prairie.

Species	Importance Value	Relative Frequency	Relative Cover
Schizachyrium scoparium	70.7	15.1	55.6
Bouteloua curtipendula	14.2	7.8	6.4
Eupatorium altissimum	11.7	5.7	6.0
Poa compressa	10.6	6.2	4.4
Verbena stricta	8.7	6.2	2.5
Dichanthelium oligosanthes	8.0	6.7	1.3
Sorghastrum nutans	7.4	1.6	5.8
Potentilla arguta	6.1	5.2	0.9
Asclepias verticillata	5.2	4.7	0.5
Dalea purpurea	4.4	3.1	1.3
Sporobolus heterolepis	4.4	1.6	2.8
Ambrosia artemisiifolia	4.3	4.2	0.1
Lobelia spicata	2.7	2.6	0.1
Brickellia eupatorioides	2.6	2.1	0.5
Solidago nemoralis	2.5	2.1	0.4
Pycnanthemum virginianum	2.4	1.6	0.8
Anemone canadensis	2.3	2.1	0.2
Melilotus alba	2.1	1.6	0.5
Cornus foemina	2.0	1.0	1.0

Table 8. Importance values for the vascular plants of the management areas.

Species	Importance Value	Relative Frequency	Relative Cover
Cornus foemina	20.4	6.7	13.7
Solidago altissima	13.5	6.0	7.5
Rubus occidentalis	11.7	4.9	6.8
Impatiens capensis	8.4	3.8	4.6
Carex stricta	8.1	4.3	3.8
Rhus glabra	6.1	1.9	4.2
Eupatorium rugosum	5.6	2.6	3.0
Apocynum canabinum	4.9	2.3	2.6
Vitis riparia	4.4	2.1	2.3
Phragmites australis	4.4	1.3	3.1
Arctium minus	4.3	1.7	2.6
Solanum dulcamara	4.1	2.7	1.4
Solidago gigantea	3.9	1.9	2.0
Silphium perfoliatum	3.7	1.2	2.5
Circaea lutetiana	3.7	2.7	1.0
Eupatorium maculatum	3.4	1.4	2.0
Salix glaucophylloides	3.0	1.0	2.0
Aster umbellatus	2.6	0.9	1.7
Rhamnus frangula	2.6	1.1	1.5
Fragaria virginiana	2.6	1.6	1.0
Cornus amomum	2.6	0.7	1.9
Aster firmus	2.4	1.6	0.8
Monarda fistulosa	2.2	1.4	0.8
Viburnum lentago	2.2	1.2	1.0
Apios americana	2.2	1.4	0.8
Galium boreale	2.1	1.7	0.4
Senecio aureus	2.0	1.1	0.9

Table 9. Comparison of communities using Sorensen coefficients of similarity. Communities are denoted as follows: low shrub fen = LSF, graminoid fen = GF, sedge meadow = SM, wet mesic prairie = WMP, calcareous seep = CS, *Typha-Carex* community = TC, dry gravel prairie = DGP, management area = MGMT.

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