Soil and Vegetative Interactions and Assessments along the Skokie River Corridor

Jonathan R. De Long, Boyce Tankersley, Joan O'Shaughnessy, Louise Egerton-Warburton, Veronica Harry-Jackson, Chicago Botanic Garden, University of Wisconsin- Milwaukee

Abstract

We conducted vegetative surveys and soil chemical and physical analysis to determine if there was an interaction between the Floristic Quality Index (FQI) of an area and the composition of the accompanying soil. Certain elements/factors were found to be associated specifically with areas of high FQI, namely heightened levels of N, P, pH, and sand/moisture, while others (higher electrical conductivity, large amounts of calcium, and predominating silt/clay soils) were affiliated with sites of a lower FQI.

Background

The vegetative inventory of a habitat is strongly tied to a number of interacting factors. Soil texture, elemental compounds, and the quality of the aggregates present all interact with one another to create unique growing conditions. The extent to which nutrients and soil composition influence the diversity and FQI of riparian plant communities has not been well documented, specifically in the case of restored North American habitats (Bridgham et al. 1996). Over the past several years, it was observed that a discrepancy in floristic quality seemed to exist along the restored portion of the Skokie River Corridor at the Chicago Botanic Gardens, even though the base soil of the restored area was (within reason) initially uniform. It appeared that certain regions harbored halophytes and calciphilic vegetation not naturally associated with the region, while others produced more naturalized communities. It was theorized that a seep was occurring in the area, contributing to the high salt content. Primary goals of our study included: 1) assess floristic quality in 5 sites designated as harboring halophytic vegetation and 5 sites designated as harboring vegetation characteristic of fens; 2) analyze soil samples for physical and chemical properties; and 3) investigate relationships/correlations between the FQI of a habitat and its soil conditions.

Materials & Methods

•Five 12-meter halophytic transects (1-1 to 5-4) and five 12-meter fen transects (6-1 to 10-4) were selected (Chart I). The elevation of the end points of each transect was cataloged.

•Four soil samples were analyzed from each transect at the 1, 4, 7, & 10 meter marks. Five soil cores were taken from each mark and air-dried.

• Soils were assessed for P (using the Mehlich method), NO_3, NO_4, total N and C, and Fe, Ca: these tests were performed by the laboratories of Kansas State University. Electrical conductivity (EC), pH, % moisture, soil texture, as well as the abundances of macro- (>250µm) and micro-aggregates (<250µm) were also cataloged.

•Vegetation cover was assessed utilizing a quarter meter square perimeter along each whole meter of the ten 12-meter transects (Figure I).

•Soil and vegetation data were summarized by Non-Metric Multi-Dimensional Scaling Analysis (NMDS) using a Bray-Curtis distance measure. Spearman-Rank correlation was used to identify significant soil variables for Dimension 1 & Dimension 2 (Plot I). Analysis of covariance (ANCOVA) was used to determine significant inter-relationships among the soil variables tested.

Figure I: Joan & Jon surveying in the field

Results

We found strong variations in soil factors and FQI between Fen and Halophytic communities (see Plot I & Chart I).

Areas with halophytic vegetation were correlated with:

•Higher pH levels
•High availability of nitrogen and phosphorous (i.e. a high N:P)
•Elevated levels of moisture & sand
•Abundant micro-aggregates

Areas with fen vegetation were correlated with:

•High levels of calcium
•Higher levels of salts (indicated by a high EC)
•Increased presence of sand and silt
•Strong covariance was found between Ca, pH, EC, and moisture. Thus, a change in any one of these triggered a change in the others.
•Mean conservancy (C) values, which included exotic species, showed no significant correlation to the FQI of a site

Chart I: Soil physical and chemical factors from Fen and Halophytic sites. Data represent the mean with standard errors in parentheses.

Factors	Fen Sites	Halophytic Quality Sites
Physical:	Mean (Standard Error)	Mean (Standard Error)
% Soil Moisture	23.06 (5.16)	26.09 (5.83)
% Sand	32.22 (7.20)	22.19 (4.96)
% Clay	32.14 (7.19)	40.51 (9.06)
% Silt	35.64 (7.97)	37.30 (8.34)
Macro-aggregates (g per g soil)	0.25 (0.06)	0.39 (0.09)
Micro-aggregates (g per g soil)	0.31 (0.07)	0.15 (0.03)
Total Aggregates (g per g soil)	0.56 (0.13)	0.54 (0.12)
Elevation (feet)	627.38 (140.29)	625.60 (139.89)
Mean FQI w/ Adventives	18.68 (4.18)	9.68 (2.16)
Mean C w/ Adventives	3.24 (0.72)	1.72 (0.38)
Mean W w/ Adventives	-0.26 (-0.06)	0.22 (0.05)
Chemical:		
Mehlich-3 P (ppm)	3.73 (0.83)	7.70 (1.72)
NH_4-N (ppm)	3.64 (0.81)	3.92 (0.88)
NO_3-N (ppm)	1.34 (0.30)	2.75 (0.62)
NH_4-N+NO_3-N (ppm)	4.98 (1.11)	6.67 (1.49)
N:P	1.36 (0.31)	1.33 (0.30)
Fe (ppm)	35.75 (7.99)	350.60 (78.40)
Ca (ppm)	2698.26 (603.35)	3730.57 (834.18)
Total % N	0.13 (0.03)	0.19 (0.04)
Total % C	4.45 (0.99)	5.26 (1.18)
C: N	44.94 (10.05)	34.82 (7.79)
Fe: P	9.75 (2.18)	44.25 (9.90)
pH	7.21 (1.61)	7.43 (1.66)
EC (µS)	542.25 (121.25)	1154.70 (258.20)

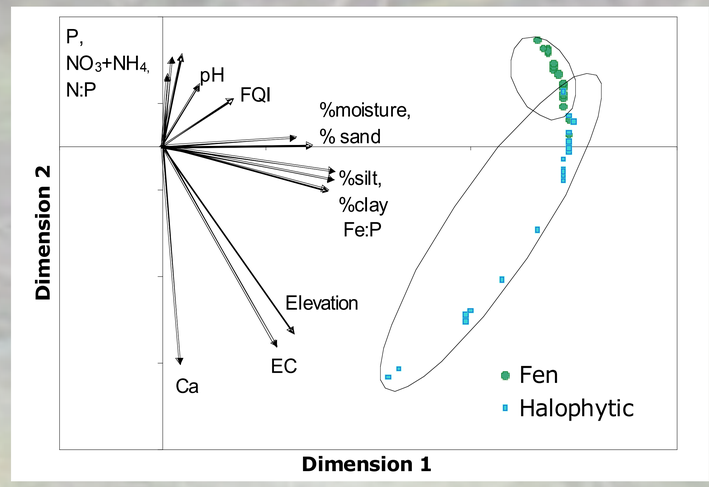
Discussion

The characterization of the fen areas on the basis of vegetation correlated with the results of the soil samples. Flora such as *Solidago ohioensis* and *Potentilla fruticosa* (Figure II) are associated with highly alkaline soils, soils which are characteristic of native NE Illinois vegetation. Additionally, the vegetation is reflective of greater happenings underground. The community established is beginning to show soil conditions parallel to those favored by more conservative plant species.

Halophytes, such as *Hordeum jubatum* (Background of poster), *Centaurium pulchellum* (Figure II), *Aster subulatus*, and *Lycopus asper*, dominated the sites with the highest calcium and salt content. These plants are more tolerant to the adverse soil conditions present in the seeps than their more conservative, native counterparts.

Fen plots shared a large amount of homogeneity between one another, while the halophytic plots varied widely in their defining characteristics. Consequently, most native species require a more refined or specific set of growing conditions than those necessary for non-native or less conservative vegetation. It must also be noted that no single soil condition dictated the vegetative composition of a plot, but rather an interplay amongst the components created an additive effect.

Plot I: NMDS analysis of soil variables against plant FQI for samples from the Fen and Halophytic sites. Final stress of configuration = 0.01984, r^2= 0.96



Conclusion

As initially suspected, it has become evident through the results of this project that a seep is occurring in the vicinity of the sites deemed as Halophytic. The next question is: Where exactly is all the calcium and salt coming from? Further analysis is needed to determine whether the seepage is occurring due to some natural or man-made phenomenon , such as run off from the highway (e.g., salt use in winter) or from sewerage leakage upstream. Collecting and performing analysis on samples of water from the area would shed light on this situation. It has also become very clear that a substantial portion of the restored riparian vegetation has taken hold, indicating that the efforts of the management team of the CBG, led by Joan O'Shaughnessy, have been successful in their endeavors. In addition, the markers we identified, e.g., soil calcium, EC, and silt/ clay content, could be used by other practitioners in the region to facilitate successful restoration or areas that need special consideration. With additional knowledge provided via further research, the management of the Skokie River Corridor will be facilitated in a more efficient manner.

Figure II: Left: *Potentilla fruticosa,* a harbinger species of alkaline soils; Right: *Centaurium pulchellum,* a quintessential halophyte.

References

• Anonymous. 1998. "Recommended Chemical Soil Test Procedures for the North Central Region" North Central Regional Publication No. 221 (Revised). University of Missouri Agricultural Experiment Station, Columbia, MO.

•Bridgham, S. D., J. Pastor, J. A. Janssens, C. Chapin, and T. J. Malterer. 1996. Multiple limiting gradients in peatlands: a call for a new paradigm. *Wetlands* **16**: 45–65.

•Swink, Floyd, and Gerould Wilhelm. *Plants of the Chicago Region 4th ed.* Indianapolis: Indiana Academy of Science, 1994.

•Systat Software, Inc. 2004. Systat version 11. Richmond, CA.

•Wilhelm, Gerould and Linda Masters. *Floristic Quality Assessment and Computer Applications.* Illinois: Conservation Design Forum, 1999.

Background Photo Hordeum jubatum: http://www.ruhr-uni-bochum.de/boga/html/Hordeum.jubatum.ja3.jpg