Table of Contents

INTRODUCTION

A vegetation monitoring program was established in 2011 in a series of 20 individual constructed wetlands termed bioswales along approximately an 11-mile section of Interstate 294 (I-294) in northern Cook County, Illinois, from Touhy Avenue to Lake-Cook Road (Figure 1). The principal goals of the monitoring are to document and assess vegetation trends in the bioswales according to selected performance standards. The standards involve estimates of vegetative cover and species richness for native, non-native, and invasive species. Selected invasive species are not to be among the five most dominant species based on vegetative cover in individual bioswales. These species are listed in Table 1.

Bioswale installation and planting was completed in 2010 with four designs. Bioswale Types 1 and 2 are wet swale designs, incorporating check dams, planted with seeds and plugs. They differ in planting design with Type 1 seeded with Bioswale Seed Mixtures 1 and 2 and Bioswale Type 2 seeded with Seed Mixture Type 2. Both types were augmented with live-plant plugs. Types 3 and 4 are dry swales. Type 4 differs in having an 8 inch-diameter under-drain pipe. Both are seeded with a Native Grass Seed Mixture. All bioswales are buffered with a Native Slope Seed Mixture (consisting of a mix of native and non-native species) and also were seeded with non-native grasses as a cover crop. Species composition in bioswale seed mixtures, cover crops, slope plantings, and plugs were listed in a previous report (Taft et al. 2012). Some bioswales were constructed with a combination of bioswale types. Bioswale type and total length also previously were summarized (Taft et al. 2012). Annual monitoring results from 2011-2013 previously have been described (Taft et al. 2012, 2013, 2014).

<u>2014 Study Objectives</u> - This report documents the vegetation parameters relevant to the performance standards in bioswales from sample data collected in June and September 2014. Species composition, diversity (based on species richness and species density), percent cover, and floristic quality from 2014 sample data are described and compared to previous sample data.

METHODS

<u>Sample Design</u> – Vegetation in bioswales was surveyed with a combination of quantitative approach using quadrats and general species inventories. The surveyed vegetation was limited to the bioswale and did not include the planted slopes. In places, species planted on the side slopes

had become established in the bioswales, presumably due to seeds sloughing down slope. Consequently, the distinction between slope and bioswale was not always clear and best judgment was used to identify the bioswale boundaries.

Each bioswale was sampled with a total of five 1-m^2 (1 m x 1 m) quadrats evenly stratified across the unit. Distance between samples and the coordinates for each sample were listed previously (Taft et al. 2012). Where the sample plots fell on concrete structures (e.g., check dams), the location was adjusted typically 3-5 m to the north or south depending on proximity to the nearest representative swale position. Because of the need for management including mowing, and in anticipation of scouring flood events, no permanent markers were used to mark sample locations. Each plot was placed in the center of the bioswale and geo-referenced with an Ashtech MobileMapper 100 handheld GPS receiver.

Data collected from each vegetation sample quadrat includes species presence and percent cover for individual species estimated with a modified Daubenmire cover-class scale (0<1 %, 1<5%, 5<25%, 25<50%, 50<75%, 75<95%, 95-100%). All species rooted within quadrat frames were recorded; percent bare ground, including open-water zones, also was estimated in each quadrat using the same scale. In addition to these quantitative samples, a total inventory of vascular plant species was recorded in each bioswale. Vegetation monitoring and surveys during 2014 were conducted in June (June 3-5, 18) and repeated in September (September 16-19).

<u>Vegetation and Statistical Analysis</u> - Species abundance is measured by frequency, percent cover, and importance value (IV 200). IV 200 was calculated as the sum of relative frequency and relative cover. Calculated vegetation parameters include native and non-native species density (number of species in each quadrat), richness (total species in the five sample quadrats at each bioswale), and metrics used in Floristic Quality Assessment (FQA) including calculations based on native and total species. FQA indices include Mean Coefficient of Conservatism and the Floristic Quality Index (Taft et al. 1997). Mean wetness coefficients based on Reed (1988) also were examined for species recorded in sample plots.

Among the data properties for many means comparison statistical tests is central normal tendency (normal distribution). Normality for bioswale sample data was determined with the Shapiro-Wilk test. Attempts to transform non-normal data by various methods (e.g., log10, log normal, and square-root adjustments) typically were unsuccessful, including most of the time-series data. For data meeting expectations for parametric statistical tests, mean comparisons between sample periods (all four years from 2011-2014) for June and September sample data were made with repeated measures analysis of variance (RM-ANOVA). Comparisons between wet and dry swales (Planting Types 1 and 2 vs. 3 and 4) were made with two-sample t-tests. For data failing to meet normality expectations, Friedman's test (a non-parametric alternative to RM-ANOVA) was applied for repeated measures (Chi-square statistic) and the Mann-Whitney U for two sample tests. Tests were carried out with SPSS statistical software (IBM SPSS Statistics ver. 22.0 2013). Data are characterized at two levels of organization: bioswale and bioswale type. The vegetation parameters follow Whittaker (1975) and Taft et al. (2006) and were calculated as follows:

Ground Layer Vegetation Diversity Measures

Native Species Density: Mean number of native species/quadrat (1 m^2)

Non-Native Species Density: Mean number of non-native species/quadrat (1 m^2)

Native Species Richness: Total number of native species

Non-native Species Richness: Total number of non-native species

Ground Layer Structure

Percent Cover: Sum of the average cover for each species in sample area

Percent Bare Ground: Average estimate of bare ground for each quadrat

Floristic Quality Assessment

Mean Coefficient of Conservatism (Mean C): Σ CC/S, where CC = Coefficient of Conservatism and S = total species richness, and

Floristic Quality Index (FQI): Mean C ($\sqrt{N}$) where N = native species richness

Mean C_N and **FQI_N** are calculated using only native species

Wetness Coefficients

Mean Coefficient of Wetness: Σ WC/S, where WC = Wetness Coefficient for each species (S), determined by the national list of wetland species (Reed 1988). Wetness rankings for Illinois species are included in Taft et al. (1997). Wetness coefficients are on an 11-point scale and range from 5 (upland) to -5 (obligate wetland species). Species ranked with 0 are facultative.

Botanical nomenclature primarily follows Mohlenbrock (1986). Non-native species in the report will be indicated with an asterisk (*).

RESULTS AND DISCUSSION

2014 Summary - Combined Overall Results from 20 Bioswales

June Sample Data – Eighty-two vascular plant species were recorded in quadrat samples in the 20 bioswales (total of 100 1-m^2 quadrats), including 44 native and 38 non-native species (Table 2). Slightly more species may have been recorded (e.g., Appendix 1); however, sterile seedlings and other material undetermined to species are not included in this total. Compared to 2013 data, richness of native species increased from 39 and non-native species declined from 49 species (Taft et al. 2014). Vegetative cover was 63.4% and bare ground was estimated to be 43.8% (Table 2). Compared to June 2013, vegetative cover decreased from 86% and bare ground increased from 38.7%. The five most dominant species, in descending rank order of importance (sum of relative frequency and cover), were *Scirpus fluviatilis, Festuca arundinacea*, Solidago sempervirens**, *Scirpus acutus*, and *Bromus inermis** accounting for 34.6% of the cover and 38.8% of the total importance and for all species (Appendix 1).

September Sample Data – Seventy-nine vascular plant species were recorded in quadrat samples in the 20 bioswales, including 43 native and 36 non-native species (Table 2). Compared to September 2013 sample data, native species increased from 35 and non-native species decreased from 39 (Taft et al. 2014). Estimates for percent vegetative cover and bare ground were 94.5% and 22.8%, respectively (Table 2). Compared to 2013, vegetative cover increased from 70.2% and bare ground decreased from 28.5%. The five most dominant species were *Scirpus fluviatilis, Festuca arundinacea*, Solidago sempervirens*, Bromus inermis**, and *Scirpus acutus* accounting for about 42.4% of the cover and 40% of the total importance for all species (Appendix 1).

In general, compared to June and September 2013 samples, native species richness increased and non-native species declined while percent cover declined during the June sample period but increased in September. The five most dominant species comprise less of the total importance in 2014 compared to 2013.

Species Changes Between June and September 2014 Sample Periods - Species decreasing the greatest in frequency (by 3 or more occurrences out of a total of 100 quadrats) between the June and September 2014 sample periods were *Agropyron repens**, *Bromus commutatus**, *Scirpus acutus*, and *Taraxacum officinale**. Species increasing the greatest were *Aster subulatus**, *Setaria glauca**, *Dipsacus laciniatus**, and *Sagittaria latifolia* (Table 3). Some changes likely are attributable to seasonality of growth with cool season species declining between June and September and warm-season species increasing.

2014 Results – Mean Species Richness, % Cover, and Floristic Quality

June Sample Data (five 1-m^2 plots/bioswale) – Mean bioswale species density was 4.28 ±0.55 (standard error) including 1.65 ±0.12 native and 2.63 ±0.27 non-native species (Table 2). There was a maximum species density of 9.2 (BS #14) with non-native species predominant at many bioswales (Figure 2A). Species richness ranged from a minimum of 4 (BS #1, 2, and 9) to 26 (BS #15); native species richness varied from 2 (BS #11 and 18) to 13 (BS #12) (Figure 3A). Percent native species ranged widely from 16.6 to 100% with half the bioswales supporting less than 50% native richness (Figure 3C); where the percentage of native species was greater than 50% was limited to low diversity bioswales (generally, 6 or fewer total species). Bioswales with the lowest totals for native species density and richness primarily are of the dry swale design (Type 3 and 4). Average species density in 1-m^2 sample plots and total richness in bioswales are highly correlated ($r = 0.92$, $df = 18$, $P < 0.0001$ [using native species, $r = 0.80$, $df = 18$, $P = < 0.0001$]).

Overall mean vegetative cover among bioswales in the June sample was 63.4% (Table 2), down from 86% in 2013, and ranged widely from about 4.2% (BS #9) to 122% (BS #14) (Figure 4A). Half (N = 10) of the bioswales exceeded 50% cover of native species; seven of the remaining bioswales with low native cover are of the dry and dry/wet swale designs (Figure 4C). Total cover of species from plug or bioswale seed mix sources was predominant at some, primarily wet-design bioswales (BS # 1, 2, 3, 8, 16, 20); species included in slope/grass seed mixes were predominant at other, primarily dry-design bioswales (BS #6, 11, 14); and, adventive (unplanted) species were particularly common at other, primarily dry and dry/wet bioswales (BS #7, 12, 13, 14, 15, 17, 18); bioswales 5, 6, 11, 13, 14, and 21 are comprised predominately of slope mixes and/or adventive species (Figure 5A).

Average FQA indices for the June samples are summarized in Table 2. Mean Coefficient of Conservatism (Mean C) was 1.86 (Mean C_N = 2.62), a slight decline from 2013, and the Floristic Quality Index was 2.5 (FQI_N = 3.59), also a slight decline from 2013. Among bioswales, Mean C ranged from 0.07 (BS #11) to 4.1 (BS #21) and FQI ranged from 0.1 (BS #11) to 5.2 (BS #1); 16 of 20 bioswales had Mean C below 3.0 and 15 of 20 bioswales had FQI below 4.0; dry swale designs have the lowest FQA scores and hybrid wet/dry bioswales tend to be intermediate in FQA scores between wet and dry swale designs (Figure 6A).

<u>September Sample Data (five 1-m^2 plots/bioswale)</u> – Average species density was 4.28 ±0.45 including 1.75 ±0.12 native and 2.53 ±0.3 non-native species (Table 2) and ranged from 2 (BS #3, 10, and 21) to 8.4 (BS #6). Non-native species were prominent in several bioswales; mean non-native species density was equal or greater than native in 11 of 20 bioswales (Figure 2B). Mean native species richness was 5.85 ±0.62 (Table 2) and ranged from 2 (BS #9) to 12 (BS# 12); mean non-native species richness was 7.15 ±1.19 and ranged from 1 to 19 (Figure 3B). Percent native species richness was greater than or equal to non-native species in 10 of the 20 bioswales (Figure 3D). Average species density in 1-m^2 sample plots and total richness for all quadrats in each bioswale are highly correlated (r = 0.89, df = 18, P < 0.00001 [based on native species, r = 0.80, df = 18, $P < 0.0001$]).

The average vegetative cover among bioswales was 94.5% (Table 2) with the cover of non-native species (53.7%) exceeding native species (40.8%) by about 32%. Cover ranged widely (Figure 4B) from 29% (BS #10) to 167% (BS #6). Non-native species comprised greater than 50% of the cover in 11 of 20 bioswales, particularly in dry swales (Figure 4D). Native species are particularly common at BS #1-3, 8, 9, and 19-21, predominately wet swale designs (Figure 4 [a short section of BS 19 is of the dry design]). Similar to the June sample data, species planted as plugs and in bioswale seed mixes dominated some sites (BS #1-3, 8, 9, 19-21), species planted in slope/grass seed mixes are prominent in others (BS #6, 13, 14), and adventive species (taxa not included in the plantings) were dominant at several (BS #5-7, 11-18 (Figure

5B).

The FQA indices based on total species composition declined slightly from the June sample data (Table 2). Mean Coefficient of Conservatism (Mean C) was 1.64 ±0.23 (Mean C_N = 2.54 ±0.24) and the mean Floristic Quality Index (FQI) was 2.39 ±0.36 (FQI_N = 3.62 ±0.4). Mean C ranged from 0.1 to 3.3 and FQI ranged from 0.17 to 5.03 in BS #6 and BS #1, respectively. Seventy-five percent of bioswales had Mean C less than 2.5 and FQI less than 4.0; dry swale designs have the lowest FQA scores and hybrid wet/dry bioswales are intermediate in FQA scores between wet and dry swale designs (Figure 6B).

Dominant Species from Plot Sample Data

June Sample Data - Based on relative cover, 34 different species (50% non-native) were among the top-five ranking dominants for any one bioswale. The top-five ranking dominants comprise an average of 91.4% of the total vegetative cover (ranging from 68% to 100%) in the June sample data (Table 4). The dominant species found most frequently (≥ 30% of bioswales) were *Bromus inermis**, *Festuca arundinacea*, Scirpus acutus, Scirpus fluviatilis, Scirpus tabernaemontani, Solidago sempervirens**, and *Typha angustifolia** (Table 4).

Five particularly invasive species (from Table 1) were among dominant species in bioswales: *Alliaria petiolata** and *Ambrosia artemisiifolia* (BS #7), *Cirsium arvense** (BS #11, 18, and 19); *Phragmites australis* (BS #5 and 14), and *Poa pratensis** (BS #11, 15, and 18) (Table 4). According to performance standards (Illinois Tollway 2007), these species should not rank in the top five most-abundant species in the vegetative cover. During June 2014, an invasive species ranked among top 5 dominants at 7 of the 20 bioswales and two of the species are dominants at BS #7, 11, and 18. *Cirsium arvense* is wind dispersed while the other species can be water, wind, or gravity dispersed; *Phragmites australis* is capable of extensive vegetative spread. All of these species are quite common in the landscape of northeastern Illinois and have wide range of moisture tolerance.

September Sample Data - Based on relative cover, 32 different species (53% non-native) were recorded among the top-five ranking dominants for each bioswale. These species average 86.61% (ranging from 59.6% to 100%) of the total vegetative cover in the September sample data (Table 5). The dominant species found most frequently (≥ 30% of sites) were *Aster* *subulatus**, *Festuca arundinacea**, *Scirpus acutus, Scirpus fluviatilis, Scirpus tabernaemontani, Solidago sempervirens*, and Typha angustifolia** (Table 5).

Six taxa considered invasive species (Table 1) were among the top-ranking taxa in bioswales during September 2014: *Ambrosia artemisiifolia* (BS #13), *Cirsium arvense** (BS # 5, 11, 18, and 19), *Dipsacus laciniatus** (BS #6, 10, and 14), *Phragmites australis* (BS #1, 5, 14), and *Poa pratensis** (BS #11, 18) (Table 5). During September 2014, an invasive species ranked among top 5 dominants at 10 of the 20 bioswales and two were among top-ranking taxa at four sites (BS #5, 11, 14, and 18).

Total Species Inventory

Combining data from June and September, a total of 207 vascular plant taxa were recorded in quantitative and general surveys (Appendix 2). Total richness recorded from comprehensive inventories in each bioswale ranged from 24 (BS #11) to 87 (BS #12 and 15) (Figure 7A). Similar to 2013, non-native species equaled or exceeded native species at 11 of 20 bioswales. Most species in each bioswale were adventive and not among species included in planting seed mixes or plugs (Figure 7B). Total richness from quadrat sample data in each bioswale was a good predictor for total richness from general inventory for both June and September, respectively ($r = 0.64$, $df = 18$, $P = 0.002$ and $r = 0.63$, $df = 18$, $P = 0.003$); however, total richness was not significantly correlated to mean species density in either June or September.

Bioswale Differences from 2011 to 2014

<u>Overall Trends</u>

For June bioswale inventory results, there was a decline in overall mean species richness from about 47 in 2011 to 34 in 2012 with little change to 2014 (Figure 8a); September data are similar (Figure 8b); however, there was a slight increase from 2013 (31 species) to 2014 (36 species). Changes in proportions of cover according to bioswale planting mixes and adventive species (species not included in planting mixes) show gradual shifts and the patterns differ between June and September sample data (Figure 9). Data from June suggest a reduction in cover of species in the Cover Crop and Slope/Grass seed mixes, and increase in Adventive Species (Plugs/BS Seed Mix increased to 2013 and then declines in 2014); September trends show a decline in Cover Crop species; however, remaining planting mixes and total adventive species are little changed (Figure 9).

Mean Parameters from Sample Data (1-m^2 plot sample data from 20 bioswales)

Results from means comparisons (e.g., RM-ANOVA) for June and September sample data from 2011 to 2014 for parameters of species richness, percent cover, floristic quality, and wetness are in Table 6. There have been only minor changes in native and non-native species richness since the baseline sample (Figures 10A, 10B). June non-native species richness has been decreasing while September non-native richness has been increasing; however, the differences (tested with RM-ANOVA) are not significant. June native species density increased and then declined (Figure 10C) and the changes are significant with difference found primarily between 2012, the baseline, and 2014 (Table 6). June non-native species density has declined (Figure 10 D) and the differences are significant (Table 6). Differences in June percent cover of native and non-native species have been pronounced. Percent June native cover increased dramatically from the baseline, and then declined (Figure 11A) while June non-native cover has declined (Figure 11B) and the differences for both trends are significant (Table 6). September native species cover has been yearly variable with no clear trend (Figure 11A); however, the differences are significant. September non-native sample data illustrate a sudden increase in 2014 (Figure 11B) but the trend so far is not significant (Table 6). Percent bare ground has varied yearly with no clear trend; however the differences are significant. There have been modest increases in June Mean C (Figure 12A) but the differences are only marginally significant ($P = 0.055$); September FQA parameters show increase followed by decline but the differences are not significant (Table 6). Degree of wetness represented in the species composition has been unchanged during June samples but has declined (become drier) during September samples with the major differences between the 2011 baseline and all subsequent samples (Table 6).

Differences in Species Abundance

From June 2011 to June 2014, major decreasing species (change in frequency $\geq$ 10 percent) are *Puccinellia distans**, *Lolium multiflorum**, *Lolium perenne**, *Taraxacum officinale**, *Trifolium hybridum**, *Scirpus tabernaemontani*, *Carex pseudo-cyperus**, and *Daucus* *carota**. Major increasing species (change in frequency ≥ 10 percent) during the same period have been *Scirpus fluviatilis, S. acutus, Bromus commutatus** (combined with *B. japonicus**), *Agroypron repens**, *Poa pratensis**, *Solidago sempervirens**, and *Typha angustifolia** (Table 7). Major decreasing species between the September samples have been *Scirpus tabernaemontani, Echinochloa crus-galli*, Puccinellia distans**, and *Lolium multiflorum**. Major increasing species have been *Bromus inermis**, *Festuca arundinacea**, *Solidago sempervirens**, *Typha angustifolia**, *Scirpus acutus,* and *Dipsacus laciniatus** (Table 8).

Bioswale Design Types – Differences Within (2011 – 2014) and Between (2014)

Within Subjects Differences from 2011 to 2014

The four bioswale types (2 wet swale and 2 dry swale designs) differ in the degree of change since the baseline sample (2011) among parameters of species richness, percent cover, floristic quality and wetness (Table 9). Type 1, a wet swale design and the most common (61% of sample plots), was most dynamic with significant changes detected between years for native species density, June non-native species density, percent cover, percent bare ground, and June wetness. In general, species density and percent cover increased and then decreased (bare ground and June wetness decreased and then increased) (Table 9). June Mean C and FQI have increased somewhat but the differences are not significant when using the Friedman's test statistic (employed due to non-normal data that could not successfully be transformed). Type 2 bioswales (10% of plots) have been little changed since the baseline sample; June native species density increased than declined and the differences are significant. Differences were detected among samples of the Type 3 dry swale design (22% of plots) for June and September non-native species density (sharp increase in September 2014), September percent cover and bare ground, and June wetness (the latter marginally significant). Generally, non-native species declined then increased and September percent cover increased and percent bare ground declined. There were significant changes in Type 4 dry swale design (7% of plots) in June non-native species density and June percent cover with no clear trends (Table 9).

Differences Between Wet and Dry Swale Designs – Year 2014

Comparisons between wet swale designs (Bioswale Types 1 and 2 combined) and dry swale designs (Types 3 and 4 combined) among year 2014 parameters of species density, percent cover and bare ground, floristic quality, and wetness indicate statistically significant differences for all variables in both June and September samples with the exception of June native species density (Table 10). Native species density was higher in wet swales than dry swales and non-native species density was greater in dry compared to wet swales. Percent cover was greater in dry swales and wet swales and whereas formerly June samples tended to have greater cover than September, during 2014 the reverse was true (Table 10). Bare ground (including open-water) was greater in wet swales compared to dry swales. Mean C and FQI were greater in wet swales compared to dry swales. Wetness is greater in wet compared to dry swales and differences between wet and dry swales are more pronounced in the June sample data (September sample data were wetter during 2014).

SUMMARY

In 2014, there was greater native species density, richness, and percent cover in the September sample compared to the June sample (reverse from 2013) and wet swales had greater native and lesser non-native species compared to dry swales. Dominant species in June and September were *Scirpus fluviatilis, Festuca arundinacea*, Solidago sempervirens*, Bromus inermis**, and *Scirpus acutus.* Invasive species were among the top-5 dominant species in June and/or September in BS #1, 5, 6, 7, 10, 11, 13, 14, 15, 18, 19 including *Alliaria petiolata**, *Ambrosia artemisiifolia*, *Cirsium arvense*, Dipsacus laciniatus*, Melilotus* spp.*, *Phragmites australis*, and *Poa pratensis*.* Proportion of planting mixes in the 2014 vegetation cover was similar between June and September. Floristic quality declined slightly from June to September but the differences were not significant.

Trends since the 2011 baseline sample indicate an overall decline in total species richness from complete inventory data in both June and September samples. Sample data indicate little lasting change in native species richness and density since the baseline sample; however, there has been a gradual decline in June non-native richness and density and a gradual increase in September values. Percent cover has been dynamic with a sharp increase and then decrease for native species in June while September data have been variable with no clear trend. There has been a steady decline in June non-native cover but a notable increase during 2014 in September cover of non-native species. Floristic quality has been variable with no clear trend. Overall mean wetness, according to species composition, has declined but only the differences for

September are significant; June data have returned to approximate the baseline wetness. Wet swale Type 1 has been the most dynamic of the bioswale designs with changes among many parameters characterized primarily by non-linear trends of increase followed by decline (for species richness and percent cover variables) and a decline followed by increase in percent bare ground.

Wet swales have greater native species density and lower non-native species density compared to dry swales while dry swales have greater cover and lower bare ground compared to wet swales. Floristic quality is greater among wet swales than dry swales. Wetness is much greater among wet swales than dry swales and the differences are greater in June than in September.

ACKNOWLEDGEMENTS

Grant Cunningham provided field assistance in September and his assistance is greatly appreciated.

REFERENCES

IBM SPSS Statistics. 2013. SPSS ver. 22 statistical software.

Illinois Tollway. 2007. Bioswales for stormwater/water quality benefit. Interstate 294, Touhy Avenue to Lake-Cook Road. Executive summary on bioswale performance evaluation criteria, monitoring and maintenance, June 15, 2007. Forest Preserve District of Cook County and the Illinois Tollway.

Mohlenbrock, R. H. 1986. Guide to the vascular flora of Illinois. Revised and enlarged edition. Southern Illinois University Press, Carbondale. viii + 507 pp.

Mohlenbrock, R. H. 1999. The Illustrated Flora of Illinois. Sedges: Carex. Southern Illinois University Press, Carbondale and Edwardsville.

Reed, P. B., Jr. 1988. National list of plant species that occur in wetlands: Illinois. U.S. Fish and Wildlife Service. National Wetlands Inventory. NERC-88/18.13.

Swink, F., and G. Wilhelm. 1994. Plants of the Chicago region. 4th ed. Indiana Academy of

Science, Indianapolis. xiv + 922 pp. 921.

Taft, J.B., G. Wilhelm, D. Ladd, and L. Masters. 1997. Floristic quality assessment for vegetation in Illinois. A proposed method for assessing vegetation integrity. Erigenia 15: 3-95.

Taft, J. B., C. Hauser, and K. R. Robertson. 2006**.** Estimating floristic integrity in tallgrass prairie. Biological Conservation 131:42-51.

Taft, J. B., M. J. C. Murphy, Z. P. Kron, and W. C. Handel. 2012. Results from 2011 baseline vegetation monitoring in 20 constructed bioswales along Interstate 294 from Touhy Avenue to Lake-Cook Road in Cook County, IL. Illinois Natural History Survey Technical Report 2012 (06). Prepared for the Illinois Tollway Authority. 2700 Ogden Avenue, Downers Grove, Illinois 60515. Submitted 13 February 2012.

Taft, J. B., C. Carroll-Cunningham, D. Ruffatto. 2013. Year 2012 Results from Vegetation Monitoring in 20 Constructed Bioswales along Interstate 294, from Touhy Avenue to Lake-Cook Road in Cook County, IL. INHS Technical Report 2013 (4). Report submitted to Illinois Tollways, Downers Grover, IL, on 31 January 2013. 43 pp.

Taft, J. B., C. Carroll-Cunningham, and H. L. Grant. 2014. Year 2013 Results from Vegetation Monitoring in 20 Constructed Bioswales along Interstate 294, from Touhy Avenue to Lake-Cook Road in Cook County, IL. INHS Technical Report 2014 (5). Report submitted to Illinois Tollways, Downers Grover, IL, on 27 January 2014. 49 pp.