

**Mill River Freshwater Tidal Marshes:
2006 Vegetation Monitoring**

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Prepared by

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Mill River Freshwater Tidal Marshes: 2006 Vegetation Monitoring

As part of the ongoing evaluation of the lower Mill River corridor and the potential environmental effects of public water supply withdrawals, the South Central Connecticut Regional Water Authority conducts annual monitoring of plant communities in the freshwater tidal marsh. This marsh, created in part by downstream tide gates belonging to the City of New Haven, is an unusual vegetation type that contributes significantly to the biological diversity and wildlife populations in the lower Mill River and East Rock Park.

The Water Authority's Environmental Study Team (EST), in its 1999 assessment of potential impacts of the proposed treatment plant, recommended that vegetation in the marsh be monitored annually or biennially, both prior to construction of the plant to provide baseline data and after the plant is placed in operation. Data from these vegetation studies, along with monitoring of soil salinity, river flow, water quality, and aquatic life in the lower Mill River, will be used to evaluate environmental impacts of treatment plant operation.

The new treatment plant was placed in operation on April 20, 2005. Prior to the operation of this plant, baseline data were collected from 1998 through 2004 (J.L. Rogers and P. Sharp 2005: "2004 Vegetation Monitoring in the Mill River Freshwater Tidal Marshes: A Summary of Six Years of Baseline Data Collection," prepared for the South Central Connecticut Regional Water Authority). The baseline sampling provided information on variation in plant communities in the marsh during six years (no monitoring was performed in 1999) when there were no withdrawals for water-supply use. Vegetation sampling was repeated in September 2006, during the first year of treatment plant operation, and continues to be performed annually in late summer. Soil water salinity measurements are made in spring and again in late summer from three monitoring wells on each transect, installed in September 2000.

Vegetation Sampling Methods

Penni Sharp and Vincent Kay conducted quantitative vegetation sampling of the Mill River marshes on September 18 and 19, 2007. Monitoring in most previous years was performed between September 7 and September 25, except in 2000 when the site was sampled in mid-August. Sampling dates for each year are listed in Table 1.

Vegetation sampling is conducted along two permanent transects. The upstream or northern transect, MR-N, is about 2,000 feet below the Whitney dam, just south of the East Rock Park footbridge and about 700 feet north of the East Rock Road bridge. This transect passes through one of the largest and most varied parts of the marsh. The downstream transect, MR-S, passes through a narrower and less varied marsh community about 300 feet south of the East Rock Road bridge.

Permanent transects at both sites are approximately perpendicular to the river with marker stakes placed every 5 meters. Transect MR-N is 100 m in length, but only 18 of the surveyed stakes are sampled regularly; the stake at the upland origin of the transect is outside the tidal area, while the two stakes closest to the river are typically inundated and can be sampled only during unusually low flow conditions. Transect MR-S is 55 m long and ends at

a low levee at the river; since it does not extend into the typically inundated low marsh along the river's edge, all 12 stakes are sampled regularly. Vegetation sampling is performed by extending 5-meter sampling chains south from each stake, perpendicular to the permanent transect. A dowel rod is inserted into the vegetation at 0.5 m. intervals along the sampling chain, for a total of 10 sampling points per chain, and all species touching the rod (or an imaginary upward extension of it) are recorded. Maps of these transects, and a detailed description of the methodology, appear in the report by Lee Rogers included in the *Lake Whitney Water Treatment Plant Environmental Evaluation: Volume Two* (January 1999).

Results

Precipitation and Soil Conditions

The 2006 growing season in the lower Mill River was unusually wet. Growing season (April through September) rainfall in the vicinity of the Mill River marshes was the highest since vegetation monitoring was initiated. The Lake Whitney gage received 26.5 inches of rainfall during this 6-month period, compared with a 96-year average of 23 inches. Precipitation in March was unusually low, followed by high rainfall in March-May with below-average totals in June and August. The wet growing season of 2006 followed an unusually dry year; in 2005, growing season precipitation was 16.79 inches, the lowest of any year when vegetation was sampled. Growing season precipitation for the years of the monitoring study is shown in Table 1. Month-by-month precipitation data for the nine years since sampling began appear in Appendix A, Table A-1.

Withdrawals from Lake Whitney at the new treatment plant are guided by a Management Plan intended to protect downstream and upstream environmental resources. Daily withdrawals during the spring high-rainfall period were 6-7 million gallons per day (mgd). In June, which was relatively dry, withdrawals at the treatment plant were generally below 5 mgd. Lake Whitney was drawn down in midsummer (July 7 – August 7) to permit construction of wetlands for stormwater control. During this period, withdrawals were near 7 mgd, but moderate to high downstream river flows were maintained by operation of the blowoff valve.

Soil water in the transect monitoring wells was sampled on April 27 and July 12, 2006, during both high and low tide conditions. Monitoring well data for 2006 and for the two preceding years (2005 was a dry year and 2004 had normal rainfall) are included in Appendix A, Table A2. Salinity in the Mill River adjacent to the transects was 0.1 ppt (parts per thousand) in all samples, even under summer drought conditions in 2005. In 2006, soil salinities in monitoring wells on the transects at both sampling periods during both high and low tides remained at 0.2 ppt or less, except for one anomalous reading of 0.4 ppt at MRS-3, the well closest to the river, during the April high tide. Generally, low salinity readings would be expected during the spring high-flow period, even at high tide. In previous years, peak soil-water salinity measurements reached 0.4-0.5 ppt in 2001 and as high as 0.7 ppt in 2002. Throughout the study, however, soil-water salinity has remained below 0.5 ppt as an annual average, considered the limit of tolerance for freshwater marsh plants.

2006 Vegetation Monitoring Results

Vegetation monitoring results in 2006, along with those obtained during the baseline years, are summarized in the tables below.

Table 1 shows the total number of species and total percent cover measured on each transect during the eight years of sampling. (Percent cover is the percentage of all points sampled at which a species occurred.) Total percent cover, obtained by adding the percent cover for all species, is generally more than 100 percent, because several species encountered at a single sampling point. Table 1 also shows growing-season precipitation conditions. For purposes of this table, rainfall more than 2 inches below the long-term growing-season average of 23 inches was considered “low,” 21-25 inches “normal,” and above 25 inches “high.” Since the time of sampling could also affect species distribution, the approximate sampling dates are also included in the table.

Table 1
Mill River Freshwater Tidal Marsh
Total Cover and Number of Species on Each Transect, 1998-2006

Year	Sampling date	Growing-season rainfall	Transect MR-N			Transect MR-S		
			Total Cover		Total # spp.	Total Cover		Total # spp.
			Percent	Rank		Percent	Rank	
1998	9/21	26.18" - high	215.6	8	31	228.3	8	23
2000	8/18	27.99" - high	259.4	7	29	244.2	7	17
2001	9/24	20.25" - low	359.4	2	40	258.3	5	27
2002	9/24	24.15" - normal	315.0	4	28	279.0	4	23
2003	9/25	27.58" - high	290.0	6	31	256.7	6	21
2004	9/7	24.29" - normal	366.7	1	26	338.3	2	17
2005	9/20	16.79" - low	348.3	3	32	359.2	1	27
2006	9/18-19	29.50" - high	314.4	5	32	291.6	3	35

Tables 2 and 3 show the changes in percent cover on transects MR-N and MR-S for dominant and selected other common species over the years since monitoring began. Herbaceous and shrub species are shown separately for each transect

Table 2
Percent Cover of Most Common Species – Transect MR-N

Species (* dominant in 2006)	Year (Growing Season Precipitation)							
	2006 (high)	2005 (low)	2004 (normal)	2003 (high)	2002 (normal)	2001 (low)	2000 (high)	1998 (high)
HERBS								
<i>*Typha angustifolia</i>	51.7	57.2	46.7	44.4	47.2	51.7	46.7	45.0
<i>*Mikania scandens</i>	47.8	24.4	15.6	30.6	48.3	28.9	21.7	31.1
<i>*Lythrum salicaria</i>	31.7	31.7	30.6	15.6	20.6	17.2	17.8	7.2
<i>*Leersia oryzoides</i>	21.7	30.6	22.2	11.1	8.9	11.7	3.3	2.2
<i>Thelypteris palustris</i>	12.2	20.0	14.4	16.7	13.3	17.8	11.1	0.0
<i>Onoclea sensibilis</i>	11.1	8.9	6.1	8.3	5.6	7.2	7.2	2.2
<i>Impatiens capensis</i>	10.6	34.4	66.7	40.6	45.0	42.8	23.3	13.9
<i>Bohemeria cylindrica</i>	9.4	6.1	15.6	6.7	5.6	10.6	5.0	8.3
<i>Polygonum sagittatum</i>	6.7	13.9	20.0	1.7	0.0	10.6	0.0	0.0
<i>Polygonum arifolium</i>	6.1	2.8	2.2	2.2	0.6	2.8	3.3	1.7
<i>Peltandra virginica</i>	4.4	6.7	7.2	6.1	2.8	3.9	3.3	2.2
<i>Polygonum hydropiper</i>	3.3	4.4	12.2	3.9	3.9	4.4	0.0	0.0
<i>Bidens conata</i>	2.8	6.7	0.0	0.0	0.0	0.0	0.0	3.3
<i>Pilea pumila</i>	1.7	1.1	5.0	0.0	0.0	0.0	0.0	1.1
<i>Cuscuta gronovii</i>	0.0	4.4	8.9	5.0	1.1	3.9	0.0	0.0
SHRUBS								
<i>*Cornus amomum</i>	41.7	37.8	46.1	40.6	45.6	37.8	47.2	41.1
<i>Viburnum dentatum</i>	11.7	14.4	8.3	20.0	20.0	25.6	17.8	15.6
<i>Hibiscus moscheutos</i>	10.6	9.4	6.1	7.8	5.0	5.0	5.0	2.8
<i>Cephalanthus occidentalis</i>	2.8	3.3	0.0	5.6	2.8	5.0	3.3	1.7

Table 3
Percent Cover of Most Common Species – Transect MR-S

Species (* dominant in 2006)	Year (Growing Season Precipitation)							
	2006 (high)	2005 (low)	2004 (normal)	2003 (high)	2002 (normal)	2001 (low)	2000 (high)	1998 (high)
HERBS								
<i>*Typha angustifolia</i>	61.7	76.7	83.3	75.0	81.7	80.0	78.3	66.7
<i>*Mikania scandens</i>	50.0	45.8	33.3	21.7	31.7	28.3	35.8	65.0
<i>*Impatiens capensis</i>	21.7	48.3	74.2	56.7	69.2	42.5	42.5	32.5
<i>*Lythrum salicaria</i>	20.8	23.3	11.7	14.2	10.8	15.8	6.7	0.8
<i>Peltandra virginica</i>	11.7	10.0	13.3	12.5	8.3	8.3	10.8	1.7
<i>Pilea pumila</i>	9.2	9.2	14.2	0.0	0.0	0.0	0.0	0.0
<i>Leersia oryzoides</i>	9.2	2.5	0.0	2.5	0.8	2.5	8.3	3.3
<i>Polygonum arifolium</i>	6.7	15.8	21.7	12.5	0.0	8.3	0.0	9.2
<i>Bohemeria cylindrica</i>	5.8	10.0	13.3	6.7	5.8	5.8	5.8	1.7
<i>Apios Americana</i>	5.0	1.7	0.0	0.0	0.0	0.8	0.8	0.0
<i>Polygonum hydropiper</i>	5.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
<i>Polygonum sagittatum</i>	0.8	11.7	12.5	5.8	2.5	2.5	4.2	0.0
<i>Cuscuta gronovii</i>	0.0	11.7	2.5	0.0	4.2	8.3	0.0	3.3
SHRUBS								
<i>*Viburnum dentatum</i>	20.8	15.0	11.7	12.5	11.7	10.0	14.2	8.3
<i>Cornus amomum</i>	10.8	12.5	12.5	9.2	5.0	8.3	8.3	5.8
<i>Lindera benzoin</i>	5.0	5.8	5.8	4.2	4.2	4.2	7.5	5.8
<i>Hibiscus moscheutos</i>	2.5	5.0	6.7	3.3	5.0	4.2	4.2	2.5

Complete vegetation monitoring results for 2006 are presented in Appendix B, along with a description of the vegetation zonation on each transect. The actual counts of each species encountered at each sampling chain are shown in appendix tables N (MR-N transect) and S (MR-S transect), which show the data collected on the north and south transects, respectively. The appendix tables illustrate zonation in the marshes, providing a profile of the two marsh areas. The marshes are subdivided into zones based on topography and vegetation, as described in the vegetation report in the *Lake Whitney Water Treatment Plant Environmental Evaluation: Volume Two* (Rogers 1999).

Percent cover of all species encountered on the transects during 2005 and the six years of baseline sampling is provided in Appendix C. For each transect, this information is arranged both in decreasing order of percent cover in 2005 and alphabetically by scientific name.

Discussion

Species Diversity and Total Plant Cover

Tables 1-3 illustrate the variability in the structure of the marsh communities from year to year under baseline conditions. The total number of species in a plant community is an indication of its structure and complexity. A complex, diverse plant community generally is a richer wildlife habitat than an area with fewer species because the complex community can fill more of the requirements of a variety of animal species. As shown in Table 1, the transect in MR-N, the more complex of our two marsh sites, has yielded 26 to 40 plant species in 1998-2005; 32 species sampled in 2006 is near the middle of this range. At MR-S, the number of species (1998-2005) ranged from 17 to 27. In 2006, the number of species reached 35. This increase was largely due to the presence on the transect of just one or two individuals of several species that constitute a very minor part of the overall community. It is likely that this was simply a statistical anomaly that does not indicate any long-term trend.

Total plant cover is another indicator of complexity and overall health in a plant community since it reflects the presence of multiple species at each sampling point. Cover by each individual species is the percentage of total sampling points along the transect at which the species is found. These typically sum to more than 100 percent cover because several species are usually found at a sampling point. As Table 1 shows, total cover was highest in years of low to normal rainfall and was generally lower in the years when growing-season precipitation was above normal. This negative association of species diversity with precipitation is expected: In drier years, species that might be limited by excessive wetness can survive in the marsh, and plants ordinarily confined to the higher areas of the marsh can grow closer to the river, thus appearing at more sampling points along with species normally found in the lower marshes. In 2006, despite the high precipitation, total cover at MR-N in 2006 was 314.4 percent, near the middle of the multi-year range of about 215-367 percent. Total cover at MR-S, 291.6 percent, was also close to mid-range for the site (228-360 percent).

Herbaceous and Shrub Cover

The upper and middle marsh communities at both of the Mill River marsh sites are mosaics of herbaceous emergent marsh species intermixed with shrub thickets; intermittently submerged herbaceous species are dominant in the lower marsh zone which is more frequently inundated by tides. Shrubs tend to occur in drier portions of the marsh that are rarely flooded. The wetter parts of the Mill River marsh are dominated by narrow-leaved cattails (*Typha angustifolia*), but include a mixture of many other herbaceous species. The principal thicket-forming shrub species are silky dogwood (*Cornus amomum*) and northern arrowwood (*Viburnum dentatum*). Because the shrub areas support very little species diversity, a long-term increase in shrub areas at the expense of herbaceous area could indicate not only that the marsh is becoming drier, but that its complexity and diversity are reduced.

In the Mill River marshes, cattail cover at both sites was lower in 2006 than in the previous year. At MR-N (Table 2), cattails covered 51.7 percent of the transect in 2006 and ranged from about 44 to 57 percent in previous years. MR-S (Table 3) had 61.7 percent cover by cattails, the lowest measured to date (range: 67-83 percent). As the tables show, however, this percentage varied substantially from year to year, even during the baseline period when the treatment plant was not operating.

These tables also show that there is evidence of a long-term increase in cover by silky dogwood and northern arrowwood at MR-S between 1998 and 2006. Since this trend was evident during the 6-year baseline period, it is not considered to indicate a change due to operation of the treatment plant.

Cover by Introduced Wetland Species

Invasion by non-native species has become a serious problem in some wetland areas. Two of the most widespread invasive species are the tall reed *Phragmites australis* and the showy perennial, purple loosestrife (*Lythrum salicarium*). These species can spread extensively in a marsh community, especially one that has been disturbed or stressed, replacing most of the native vegetation. This produces a much less complex and varied marsh that is unable to support diverse wildlife.

No *Phragmites* occurs on the Mill River transects. There are isolated patches of this species within the marsh, primarily where dredging, draining, or pollution by storm sewer outfalls has occurred. We have found no evidence that these areas are expanding.

Purple loosestrife does occur on the transects, and has increased over the years of the study. At site MR-N, this species had about 7.2 percent cover in 1998 and has expanded to 31.7 percent in 2006 (the same as in 2005). At MR-S, purple loosestrife covered only 0.8 percent of the transect in 1998, but 20.8 percent in 2006 (about 2 percent *less* than in 2005). This species did not show a consistent increase over the years at either site, but instead showed a large jump in percent cover in 2000-2001, and again in 2004-2005 (see Tables 2 and 3).

On transect MR-N, cover by purple loosestrife rose to nearly 18 percent in 2000 and remained at 15-20 percent through 2003. In 2004, its cover jumped to over 30 percent and it has remained fairly constant since that time. Both 2000 and 2004, the years in which large increases were measured, were unusually wet during the growing season. On transect MR-S increases of similar magnitude lagged a little behind those on MR-N. Purple loosestrife cover rose to nearly 7 percent in 2000, then to about 16 percent in 2001; it remained generally below 15 percent through 2004, but exceeded 20 percent in 2005 and 2006. Since these increases in purple loosestrife cover occurred primarily during the baseline period, they cannot be attributed to operation of the water treatment plant.

Conclusions

There is some evidence from several years of vegetation sampling that freshwater tidal marshes in the lower Mill River are undergoing gradual changes. The observed increases in shrub cover and purple loosestrife may result in an overall loss of diversity and reduction in the wildlife habitat value of these marshes. Since the Whitney water treatment plant has only been in operation since 2005 and the changes in the plant communities have been occurring at least since 1998, these changes do not indicate any environmental impacts due to the treatment plant. It is possible that future operations could accelerate these changes, but a variety of environmental safeguards (including this monitoring program) have been adopted to detect, avoid, and/or mitigate potential impacts. It should also be stressed that the changes observed to date are minor, and that the Mill River tidal marshes remain varied and valuable wetland ecosystems.

Mill River Freshwater Tidal Marshes

Appendices

Appendix A: Precipitation and Salinity in the Mill River Marshes

Table A1: Lake Whitney Precipitation, 1998 - 2006

Table A2: Groundwater Monitoring Well Data, 2004-2006

Appendix B: Transect Descriptions and 2006 Vegetation Monitoring Results

1. MR-N Transect

Table N: Mill River Freshwater Tidal Marsh Vegetation, North Site (MR-N) –
Frequency by Species and Zone: 2006

2. MR-S Transect

Table S: Mill River Freshwater Tidal Marsh Vegetation, South Site (MR-S) –
Frequency by Species and Zone: 2006

Appendix C: Vegetation Sampling Data, 1998 - 2006

1. MR-N Transect

List of Species by Percent Cover in 2006

Alphabetical List of Species and Percent Cover

2. MR-S Transect

List of Species by Percent Cover in 2006

Alphabetical List of Species and Percent Cover

**Appendix A
Precipitation and Salinity in the Mill River Marshes**

**Table A1
Lake Whitney Precipitation, 1998-2006**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	G.S.*
1998	5.00	4.69	5.59	3.98	5.51	8.30	1.11	4.92	2.36	3.23	1.81	0.95	47.45	26.18
1999	6.85	4.76	3.90	1.50	2.75	0.32	1.22	3.42	7.05	3.86	2.91	2.41	40.95	16.26
2000	2.44	1.89	4.14	4.68	3.31	5.95	7.04	2.72	4.29	0.44	4.45	2.41	43.76	27.99
2001	1.62	2.05	7.29	1.53	5.32	4.26	2.87	3.43	2.84	1.18	1.03	2.18	35.60	20.25
2002	1.67	1.27	4.09	3.45	5.56	3.35	1.90	3.16	6.73	4.20	4.15	4.06	43.59	24.15
2003	1.47	2.48	4.13	2.92	4.11	6.57	1.57	5.47	6.94	5.36	2.18	3.62	46.82	27.58
2004	1.38	2.09	3.08	5.77	2.69	0.88	2.95	4.52	7.48	1.97	3.19	3.27	39.27	24.29
2005	3.61	2.31	3.16	6.14	1.31	2.68	2.83	1.35	2.48	14.03	3.90	4.25	48.05	16.79
2006	5.70	2.42	0.55	6.46	6.35	5.87	3.54	5.08	2.20	6.58	4.73	2.88	52.36	29.50
9-yr Aver.	3.30	2.66	3.99	4.04	4.10	4.24	2.78	3.78	4.70	4.53	3.16	2.89	44.21	23.66
95-yr Aver.	3.66	3.24	4.32	4.16	3.95	3.59	3.62	3.97	3.73	3.72	4.03	3.97	45.96	23.02

* Growing season precipitation, April through September.

**Table A2
Groundwater Monitoring Well Data, 2004-2006**

Monitor well	2004				2005				2006			
	4/6/04 (high flow)		7/29/04 (low flow)		4/8/05 (high flow)		7/21/05 (high flow)		4/27/06 (high flow)		7/12/06 (high flow)	
	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide
MRN-1	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1
MRN-2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2
MRN-3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1
River@ MR-N	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MRS-1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2
MRS-2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2
MRS-3	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.4	0.2	0.1
River@ MR-S	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Appendix B

Transect Descriptions and 2006 Vegetation Monitoring Results

MR-N Transect

The upstream or northern transect, MR-N, is about 2,000 feet below the Whitney dam, just south of the East Rock Park footbridge and about 700 feet north of the East Rock Road bridge. This transect passes through one of the largest and most varied parts of the marsh. As surveyed, the transect is about 100 meters long; approximately 75 meters of this length passes through high marsh, a mosaic of shrubs and emergent marsh (primarily cattails), which is seasonally or occasionally flooded but not subject to daily tidal inundations. About 25 meters of low marsh bordering the river is alternately flooded and exposed as a result of daily tidal fluctuations in the river; portions of the low marsh are often inaccessible due to flooding by tidal action or high river flows. On transect MR-N, sampling begins at the second stake, since the stake at the origin of the transect is located within a swale with little vegetation other than canopy trees overhanging from the adjacent upland forest. A total of 18 stakes are sampled, for a total of 18 chains and 180 sampling points; two additional stakes were installed and surveyed on the riverward end of this transect but are typically inundated and have not been accessible for sampling.

As shown in Table N, the upper marsh on transect MR-N is dominated by spotted jewelweed (*Impatiens capensis*), which gradually gives way to narrow-leaved cattail (*Typha angustifolia*), an emergent marsh plant tolerant of relatively high salinities. Cattail dominates the middle marsh, along with the climbing composite *Mikania scandens*. The transect then passes through a broad area where emergent marsh intermingles with shrub thickets, apparently depending on small changes in elevation; this area appears in Table N as three zones, "Shrub thicket," "Shrub/marsh" (the lowest area), and "Dogwood thicket." In the higher areas of this complex, silky dogwood (*Cornus amomum*) dominates, intermixed with several herbaceous species, including cattail, mikania, jewelweed, and goldenrod (*Solidago gigantea*). Swamp rosemallow (*Hibiscus moscheutos*) is also among the shrubs in this area. In the lower swale, northern arrowwood (*Viburnum dentatum* var. *recognitum*) is the dominant shrub; buttonbush (*Cephalanthus occidentalis*), a shrub highly tolerant of periodic inundation, appears in the lowest and wettest areas. Cattails (*T. angustifolia*) are absent in the low shrub/marsh, and jewelweed (*I. capensis*) is the dominant herbaceous species. As the ground rises slightly on the riverward side, there is a dense thicket of silky dogwood (*C. amomum*), again intermixed with cattails as well as jewelweed. Below this rise, the substrate descends fairly rapidly toward the river. Silky dogwood is still common on higher ground, but cattails disappear in the low marsh, which is subject to frequent tidal inundation. *Mikania scandens*, purple loosestrife (*Lythrum salicaria*), and jewelweed occur among the dogwood, but give way to arrow arum (*Peltandra virginiana*), and then (beyond stake 18) to other species tolerant of regular submersion, including arrowhead (*Sagittaria* sp.), pickerel weed (*Pontederia* sp.), and white waterlily (*Nymphaea odorata*).

Table N: MILL RIVER FRESHWATER TIDAL MARSH VEGETATION, NORTH SITE (MR-N) -- FREQUENCY BY SPECIES AND ZONE, 2006

Vegetation Zone:	Upper marsh		Mid marsh		Shrub thicket		Shrub/marsh		Dogwood thicket		Low marsh		2006								
Species	Chain no.: Chains are 5 m. apart and 5 m. long, with 10 sampling points per chain: Total 180 points																		Total	%Cover	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
<i>Iris pseudacorus</i>	4																		4	2.2	
<i>Viburnum lentago</i>	2																		2	1.1	
<i>Bidens connata</i>	5																		5	2.8	
<i>Polygonum sagittatum</i>			2	1	4	3		2											12	6.7	
<i>Polygonum arifolium</i>	2			1	2		5		1										11	6.1	
<i>Impatiens capensis</i>	3	1	5	5		1		1							1		2		19	10.6	
<i>Onoclea sensibilis</i>	2	10	4							4									20	11.1	
<i>Mikania scandens</i>		1	6	8	6	3	4	10	4	10	7		2	10	6	8	1		86	47.8	
<i>Typha angustifolia</i>		10	10	10	10	10	10	10	6	8	2		1	4		2			93	51.7	
<i>Lythrum salicaria</i>		3	3	8	6	10	10	4	2	5				1		5			57	31.7	
<i>Todxocodendron radicans</i>		2	2																4	2.2	
<i>Thelypteris palustris</i>		4	4	9	4									1					22	12.2	
<i>Apios americana</i>			5																5	2.8	
<i>Pilea pumila</i>	1			2															3	1.7	
<i>Bohemeria cylindrica</i>					8	6	1	1						1					17	9.4	
<i>Verbena hastata</i>				2	2														4	2.2	
<i>Hibiscus moscheutos</i>							10	5	4										19	10.6	
<i>Parthenocissus quinquefolia</i>											4	3	2						9	5.0	
<i>Geum rivale</i>								1											1	0.6	
<i>Vernonia novaboracensis</i>									1										1	0.6	
<i>Symptotrichum sp.</i>										3		3				2			8	4.4	
<i>Cornus amomum</i>								5	10	6		10	10	4	10	10	9	2	76	42.2	
<i>Solidago altissima</i>									3										3	1.7	
<i>Leersia oryzoides</i>						3		8	5	10	5		3	2		3			39	21.7	
<i>Viburnum dentatum</i>										3	10	6				2			21	11.7	
<i>Mimulus ringens</i>					1														1	0.6	
<i>Polygonum hydropiper</i>				1				1				2				2			6	3.3	
<i>Cephalanthus occidentalis</i>														5					5	2.8	
<i>Eupatorium maculatum</i>														1			1		2	1.1	
<i>Cicuta maculata</i>														1					1	0.6	
<i>Nyphaea odorata</i>																		2	2	1.1	
<i>Peltandra virginiana</i>															2		2	4	8	4.4	
																			TOTALS	566	314.4

MR-S Transect

The downstream transect, MR-S, passes through a narrower and less varied marsh community about 300 feet south of the East Rock Road bridge. This transect is about 55 meters long from upland edge to river. The high marsh, about 45 meters wide, consists primarily of cattail marsh, with shrub thickets on elevated hummocks. The remaining 10 meters of the transect is in low marsh bordering the river. For transect MR-S, sampling begins at the origin of the permanent transect (stake 1) and extends through stake 12, for a total of 12 chains and 120 sampling points.

As shown in Table S, sampling at site MR-S, begins in an area of transition between upland forest and marsh, dominated by spicebush (*Lindera benzoin*), silky dogwood (*Cornus amomum*), and multiflora rose (*Rosa multiflora*); jewelweed is the dominant herb. In the upper marsh, narrow-leaved cattail (*Typha angustifolia*) and jewelweed (*Impatiens capensis*) are dominant, while in the middle marsh, jewelweed becomes less common and cattails share dominance with *Mikania scandens*. The transect then crosses a small rise or hummock, where a few shrubs such as swamp rosemallow (*Hibiscus moscheutos*) intermix with the cattail community. Beyond this is low marsh, where cattails and jewelweed are replaced by arrow arum. The last sampling chain crosses part of a small levee adjacent to the river, where a large silver maple (*Acer saccharinum*) and other upland species occur.

Table S: MILL RIVER SOUTH (MR-S) VEGETATION FREQUENCY BY SPECIES AND ZONE, 2006

Vegetation Zone:	Trans.shrub		Upper marsh			Middle marsh			Hummock		Lower marsh		2006		
	1	2	3	4	5	6	7	8	9	10	11	12	Total	%Cover	
<i>Lindera benzoin</i>	6												6	5.0	
<i>Acer rubrum</i>	5	2											7	5.8	
<i>Impatiens capensis</i>		2	4	6	6		1		1	6			26	21.7	
<i>Parthenocissus quinquefolia</i>		2											2	1.7	
<i>Cornus amomum</i>		10								2	1		13	10.8	
<i>Chelone glabra</i>		2											2	1.7	
<i>Polygonum arifolium</i>				4	3	1							8	6.7	
<i>Viburnum dentatum</i>		3	8	8								2	4	25	20.8
<i>Leersia oryzoides</i>		4	3	3									1	11	9.2
<i>Pilea pumila</i>				4	6					1			11	9.2	
<i>Typha angustifolia</i>		6	4	4	10	10	10	10	8	10	2		74	61.7	
<i>Mikania scandens</i>		1			8	8	10	10	10	10	1	2	60	50.0	
<i>Rosa multiflora</i>		2											2	1.7	
<i>Peltandra virginica</i>				1							6	7	14	11.7	
<i>Lythrum salicaria</i>			4	4	6	4				2		5	25	20.8	
<i>Bohemeria cylindrica</i>				1		4	1			1			7	5.8	
<i>Carex sp.</i>				1									1	0.8	
<i>Scutellaria laterifolia</i>				1									1	0.8	
<i>Lycopus americana</i>				2									2	1.7	
<i>Geum canadense</i>				2									2	1.7	
<i>Onoclea sensibilis</i>					3								3	2.5	
<i>Polygonum sagittatum</i>					1								1	0.8	
<i>Symplotrichium sp.</i>						2				1	1		4	3.3	
<i>Solanum dulcamara</i>						2							2	1.7	
<i>Cardamine sp.</i>						1							1	0.8	
<i>Hibiscus moscheutos</i>									3				3	2.5	
<i>Helenium autumnale</i>											1		1	0.8	
<i>Apios americana</i>										6			6	5.0	
<i>Eupatorium maculatum</i>										1			1	0.8	
<i>Mimulus ringens</i>								2					2	1.7	
<i>Polygonum hydropiper</i>					2						2	2	6	5.0	
<i>Polygonum pennsylvanium</i>											1		1	0.8	
<i>Lonicera morrowii</i>											5		5	4.2	
<i>Lobelia cardinalis</i>												1	1	0.8	
<i>Acer saccharinum</i> *											9	4	13	10.8	
													TOTALS	349	290.8

* Overhanging canopy of tree rooted on adjacent levee

Appendix C

Mill River Freshwater Tidal Marshes: Vegetation Sampling Data 1998-2006

1. MR-N Transect

List of Species by Percent Cover in 2006

Alphabetical List of Species and Percent Cover

2. MR-S Transect

List of Species by Percent Cover in 2006

Alphabetical List of Species and Percent Cover

MR-N Transect - Summary of Species by Percent Cover in 2006																	
1998* - 2006																	
Year	1998		2000		2001		2002		2003		2004		2005		2006		Species
	Rainfall Apr.-Sept.	high	high	low	normal	high	normal	low	high	normal	low	high	low	high			
Species	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	
<i>Typha angustifolia</i>	81	45.0	84	46.7	93	51.7	85	47.2	80	44.4	84	46.7	103	57.2	93	51.7	<i>Typha angustifolia</i>
<i>Mikania scandens</i>	56	31.1	39	21.7	52	28.9	87	48.3	55	30.6	28	15.6	44	24.4	86	47.8	<i>Mikania scandens</i>
<i>Cornus amomum</i>	74	41.1	85	47.2	68	37.8	82	45.6	73	40.6	83	46.1	68	37.8	76	42.2	<i>Cornus amomum</i>
<i>Lythrum salicaria</i>	13	7.2	32	17.8	31	17.2	37	20.6	28	15.6	55	30.6	57	31.7	57	31.7	<i>Lythrum salicaria</i>
<i>Leersia oryzoides</i>	4	2.2	6	3.3	21	11.7	16	8.9	20	11.1	40	22.2	55	30.6	39	21.7	<i>Leersia oryzoides</i>
<i>Thelypteris palustris</i>	0	0.0	20	11.1	32	17.8	24	13.3	30	16.7	26	14.4	36	20.0	22	12.2	<i>Thelypteris palustris</i>
<i>Viburnum dentatum</i>	28	15.6	32	17.8	46	25.6	36	20.0	36	20.0	15	8.3	26	14.4	21	11.7	<i>Viburnum dentatum</i>
<i>Onoclea sensibilis</i>	4	2.2	13	7.2	13	7.2	10	5.6	15	8.3	11	6.1	16	8.9	20	11.1	<i>Onoclea sensibilis</i>
<i>Hibiscus moscheutos</i>	5	2.8	9	5.0	9	5.0	9	5.0	14	7.8	11	6.1	17	9.4	19	10.6	<i>Hibiscus moscheutos</i>
<i>Impatiens capensis</i>	25	13.9	42	23.3	77	42.8	81	45.0	73	40.6	120	66.7	62	34.4	19	10.6	<i>Impatiens capensis</i>
<i>Boehmeria cylindrica</i>	15	8.3	9	5.0	19	10.6	10	5.6	12	6.7	28	15.6	11	6.1	17	9.4	<i>Boehmeria cylindrica</i>
<i>Polygonum sagittatum</i>	0	0.0	0	0.0	19	10.6	0	0.0	3	1.7	36	20.0	25	13.9	12	6.7	<i>Polygonum sagittatum</i>
<i>Polygonum arifolium</i>	3	1.7	6	3.3	5	2.8	1	0.6	4	2.2	4	2.2	5	2.8	11	6.1	<i>Polygonum arifolium</i>
<i>Parthenocissus quinquefolia</i>	11	6.1	13	7.2	12	6.7	0	0.0	10	5.6	7	3.9	6	3.3	9	5.0	<i>Parthenocissus quinquefolia</i>
<i>Peltandra virginica</i>	4	2.2	6	3.3	7	3.9	5	2.8	11	6.1	13	7.2	12	6.7	8	4.4	<i>Peltandra virginica</i>
<i>Symptotrichum sp.</i>	0	0.0	0	0.0	13	7.2	20	11.1	8	4.4	9	5.0	3	1.7	8	4.4	<i>Symptotrichum sp.</i>
<i>Polygonum hydropiper</i>	0	0.0	0	0.0	8	4.4	7	3.9	7	3.9	22	12.2	8	4.4	6	3.3	<i>Polygonum hydropiper</i>
<i>Apios americana</i>	0	0.0	3	1.7	4	2.2	0	0.0	0	0.0	1	0.6	8	4.4	5	2.8	<i>Apios americana</i>
<i>Bidens connata</i>	6	3.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	12	6.7	5	2.8	<i>Bidens connata</i>
<i>Cephalanthus occidentalis</i>	3	1.7	6	3.3	9	5.0	5	2.8	10	5.6	0	0.0	6	3.3	5	2.8	<i>Cephalanthus occidentalis</i>
<i>Iris pseudacorus</i>	6	3.3	5	2.8	7	3.9	7	3.9	1	0.6	1	0.6	3	1.7	4	2.2	<i>Iris pseudacorus</i>
<i>Toxicodendron radicans</i>	4	2.2	0	0.0	4	2.2	10	5.6	7	3.9	6	3.3	4	2.2	4	2.2	<i>Toxicodendron radicans</i>
<i>Verbena hastata</i>	1	0.6	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	6	3.3	4	2.2	<i>Verbena hastata</i>
<i>Pilea pumila</i>	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	9	5.0	2	1.1	3	1.7	<i>Pilea pumila</i>
<i>Solidago altissima</i>	3	1.7	9	5.0	9	5.0	13	7.2	2	1.1	5	2.8	6	3.3	3	1.7	<i>Solidago altissima</i>
<i>Eupatorium maculatum</i>	4	2.2	1	0.6	1	0.6	3	1.7	1	0.6	4	2.2	1	0.6	2	1.1	<i>Eupatorium maculatum</i>
<i>Nymphaea odorata</i>	8	4.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	<i>Nymphaea odorata</i>
<i>Viburnum lentago</i>	7	3.9	5	2.8	4	2.2	5	2.8	4	2.2	3	1.7	5	2.8	2	1.1	<i>Viburnum lentago</i>
<i>Cicuta maculata</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Cicuta maculata</i>
<i>Geum rivale</i>	4	2.2	1	0.6	0	0.0	1	0.6	0	0.0	3	1.7	0	0.0	1	0.6	<i>Geum rivale</i>
<i>Mimulus ringens</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	2	1.1	1	0.6	<i>Mimulus ringens</i>
<i>Vernonia novaboracensis</i>	0	0.0	1	0.6	1	0.6	0	0.0	1	0.6	2	1.1	0	0.0	1	0.6	<i>Vernonia novaboracensis</i>
<i>Verbena urticifolia</i>	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	<i>Verbena urticifolia</i>
<i>Bidens frondosa</i>	0	0.0	0	0.0	6	3.3	0	0.0	2	1.1	2	1.1	0	0.0	0	0.0	<i>Bidens frondosa</i>
<i>Cinna latifolia</i>	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	<i>Cinna latifolia</i>
<i>Cuscuta gronovii</i>	0	0.0	0	0.0	7	3.9	2	1.1	9	5.0	16	8.9	8	4.4	0	0.0	<i>Cuscuta gronovii</i>
<i>Epilobium coloratum</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.2	7	3.9	0	0.0	<i>Epilobium coloratum</i>
<i>Eupatorium perfoliatum</i>	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	<i>Eupatorium perfoliatum</i>
<i>Helenium autumnale</i>	0	0.0	0	0.0	8	4.4	3	1.7	0	0.0	2	1.1	0	0.0	0	0.0	<i>Helenium autumnale</i>
<i>Laportea sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Laportea sp.</i>
<i>Lobelia cardinalis</i>	0	0.0	6	3.3	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	<i>Lobelia cardinalis</i>
<i>Pontederia cordata</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	<i>Pontederia cordata</i>
<i>Quercus sp SDLG</i>	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Quercus sp SDLG</i>
<i>Rorippa palustris</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Rorippa palustris</i>
<i>Sagittaria rigida</i>	7	3.9	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Sagittaria rigida</i>
<i>Sambucus canadensis</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	<i>Sambucus canadensis</i>
<i>Scutellaria lateriflora</i>	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Scutellaria lateriflora</i>
<i>Sium suave</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	2	1.1	0	0.0	0	0.0	<i>Sium suave</i>
<i>Solanum dulcamara</i>	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	<i>Solanum dulcamara</i>
<i>Solidago uliginosa</i>	1	0.6	0	0.0	0	0.0	3	1.7	0	0.0	0	0.0	0	0.0	0	0.0	<i>Solidago uliginosa</i>
<i>Strophostyles helvola</i>	2	1.1	0	0.0	15	8.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Strophostyles helvola</i>
<i>Symplocarpus foetidus</i>	0	0.0	1	0.6	1	0.6	0	0.0	0	0.0	4	2.2	0	0.0	0	0.0	<i>Symplocarpus foetidus</i>
<i>Trifolium sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Trifolium sp.</i>
<i>Viburnum dentatum SDLG</i>	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Viburnum dentatum SDLG</i>
TOTALS	388	215.6	438	243.3	618	343.3	567	315.0	522	290.0	660	366.7	627	348.3	566	314.4	TOTALS
Number of Species	31		29		40		28		31		26		32		32		Number of Species

* A slightly different transect in this area was also sampled in 1991; the 1991 results are available in previous reports.

*** Occurred in 1991 sample only

MR-N Transect - Alphabetical List of Species and Percent Cover																	
1998* - 2006																	
Year	1998		2000		2001		2002		2003		2004		2005		2006		Species
	Rainfall Apr.-Sept.	high	high	low	normal	high	normal	high	normal	low	high	low	high				
Species	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	
<i>Apios americana</i>	0	0.0	3	1.7	4	2.2	0	0.0	0	0.0	1	0.6	8	4.4	5	2.8	<i>Apios americana</i>
<i>Bidens connata</i>	6	3.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	12	6.7	5	2.8	<i>Bidens connata</i>
<i>Bidens frondosa</i>	0	0.0	0	0.0	6	3.3	0	0.0	2	1.1	2	1.1	0	0.0	0	0.0	<i>Bidens frondosa</i>
<i>Boehmeria cylindrica</i>	15	8.3	9	5.0	19	10.6	10	5.6	12	6.7	28	15.6	11	6.1	17	9.4	<i>Boehmeria cylindrica</i>
<i>Cephalanthus occidentalis</i>	3	1.7	6	3.3	9	5.0	5	2.8	10	5.6	0	0.0	6	3.3	5	2.8	<i>Cephalanthus occidentalis</i>
<i>Cicuta maculata</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	<i>Cicuta maculata</i>
<i>Cinna latifolia</i>	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	<i>Cinna latifolia</i>
<i>Cornus amomum</i>	74	41.1	85	47.2	68	37.8	82	45.6	73	40.6	83	46.1	68	37.8	76	42.2	<i>Cornus amomum</i>
<i>Cuscuta gronovii</i>	0	0.0	0	0.0	7	3.9	2	1.1	9	5.0	16	8.9	8	4.4	0	0.0	<i>Cuscuta gronovii</i>
<i>Epilobium coloratum</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.2	7	3.9	0	0.0	<i>Epilobium coloratum</i>
<i>Eupatorium maculatum</i>	4	2.2	1	0.6	1	0.6	3	1.7	1	0.6	4	2.2	1	0.6	2	1.1	<i>Eupatorium maculatum</i>
<i>Eupatorium perfoliatum</i>	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	<i>Eupatorium perfoliatum</i>
<i>Geum rivale</i>	4	2.2	1	0.6	0	0.0	1	0.6	0	0.0	3	1.7	0	0.0	1	0.6	<i>Geum lacinatedum</i>
<i>Helenium autumnale</i>	0	0.0	0	0.0	8	4.4	3	1.7	0	0.0	2	1.1	0	0.0	0	0.0	<i>Helenium autumnale</i>
<i>Hibiscus moscheutos</i>	5	2.8	9	5.0	9	5.0	9	5.0	14	7.8	11	6.1	17	9.4	19	10.6	<i>Hibiscus moscheutos</i>
<i>Impatiens capensis</i>	25	13.9	42	23.3	77	42.8	81	45.0	73	40.6	120	66.7	62	34.4	19	10.6	<i>Impatiens capensis</i>
<i>Iris pseudacorus</i>	6	3.3	5	2.8	7	3.9	7	3.9	1	0.6	1	0.6	3	1.7	4	2.2	<i>Iris pseudacorus</i>
<i>Laportea sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Laportea sp.</i>
<i>Leersia oryzoides</i>	4	2.2	6	3.3	21	11.7	16	8.9	20	11.1	40	22.2	55	30.6	39	21.7	<i>Leersia oryzoides</i>
<i>Lobelia cardinalis</i>	0	0.0	6	3.3	6	3.3	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	<i>Lobelia cardinalis</i>
<i>Lythrum salicaria</i>	13	7.2	32	17.8	31	17.2	37	20.6	28	15.6	55	30.6	57	31.7	57	31.7	<i>Lythrum salicaria</i>
<i>Mikania scandens</i>	56	31.1	39	21.7	52	28.9	87	48.3	55	30.6	28	15.6	44	24.4	86	47.8	<i>Mikania scandens</i>
<i>Mimulus ringens</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	2	1.1	1	0.6	<i>Mimulus ringens</i>
<i>Nymphaea odorata</i>	8	4.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	<i>Nymphaea odorata</i>
<i>Onoclea sensibilis</i>	4	2.2	13	7.2	13	7.2	10	5.6	15	8.3	11	6.1	16	8.9	20	11.1	<i>Onoclea sensibilis</i>
<i>Parthenocissus quinquefolia</i>	11	6.1	13	7.2	12	6.7	0	0.0	10	5.6	7	3.9	6	3.3	9	5.0	<i>Parthenocissus quinquefolia</i>
<i>Peltandra virginica</i>	4	2.2	6	3.3	7	3.9	5	2.8	11	6.1	13	7.2	12	6.7	8	4.4	<i>Peltandra virginica</i>
<i>Pilea pumila</i>	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	9	5.0	2	1.1	3	1.7	<i>Pilea pumila</i>
<i>Polygonum arifolium</i>	3	1.7	6	3.3	5	2.8	1	0.6	4	2.2	4	2.2	5	2.8	11	6.1	<i>Polygonum arifolium</i>
<i>Polygonum hydropiper</i>	0	0.0	0	0.0	8	4.4	7	3.9	7	3.9	22	12.2	8	4.4	6	3.3	<i>Polygonum hydropiper</i>
<i>Polygonum sagittatum</i>	0	0.0	0	0.0	19	10.6	0	0.0	3	1.7	36	20.0	25	13.9	12	6.7	<i>Polygonum sagittatum</i>
<i>Pontederia cordata</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	<i>Pontederia cordata</i>
<i>Quercus sp SDLG</i>	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Quercus sp SDLNG</i>
<i>Rorippa palustris</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Rorippa palustris</i>
<i>Sagittaria rigida</i>	7	3.9	4	2.2	4	2.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Sagittaria rigida</i>
<i>Sambucus canadensis</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	<i>Sambucus canadensis</i>
<i>Scutellaria lateriflora</i>	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Scutellaria lateriflora</i>
<i>Sium suave</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	2	1.1	0	0.0	0	0.0	<i>Sium suave</i>
<i>Solanum dulcamara</i>	0	0.0	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	<i>Solanum dulcamara</i>
<i>Solidago altissima</i>	3	1.7	9	5.0	9	5.0	13	7.2	2	1.1	5	2.8	6	3.3	3	1.7	<i>Solidago altissima</i>
<i>Solidago uliginosa</i>	1	0.6	0	0.0	0	0.0	3	1.7	0	0.0	0	0.0	0	0.0	0	0.0	<i>Solidago uliginosa</i>
<i>Strophostyles helvola</i>	2	1.1	0	0.0	15	8.3	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Strophostyles helvola</i>
<i>Symplocarpus foetidus</i>	0	0.0	1	0.6	1	0.6	0	0.0	0	0.0	4	2.2	0	0.0	0	0.0	<i>Symplocarpus foetidus</i>
<i>Symplocarpus sp.</i>	0	0.0	0	0.0	13	7.2	20	11.1	8	4.4	9	5.0	3	1.7	8	4.4	<i>Symplocarpus sp.</i>
<i>Thelypteris palustris</i>	0	0.0	20	11.1	32	17.8	24	13.3	30	16.7	26	14.4	36	20.0	22	12.2	<i>Thelypteris palustris</i>
<i>Toxicodendron radicans</i>	4	2.2	0	0.0	4	2.2	10	5.6	7	3.9	6	3.3	4	2.2	4	2.2	<i>Toxicodendron radicans</i>
<i>Trifolium sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	<i>Trifolium sp.</i>
<i>Typha angustifolia</i>	81	45.0	84	46.7	93	51.7	85	47.2	80	44.4	84	46.7	103	57.2	93	51.7	<i>Typha angustifolia</i>
<i>Verbena hastata</i>	1	0.6	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	6	3.3	4	2.2	<i>Verbena hastata</i>
<i>Verbena urticifolia</i>	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	<i>#Verbena urticifolia</i>
<i>Vernonia novaboracensis</i>	0	0.0	1	0.6	1	0.6	0	0.0	1	0.6	2	1.1	0	0.0	1	0.6	<i>Vernonia novaboracensis</i>
<i>Viburnum lentago</i>	7	3.9	5	2.8	4	2.2	5	2.8	4	2.2	3	1.7	5	2.8	2	1.1	<i>Viburnum lentago</i>
<i>Viburnum dentatum</i>	28	15.6	32	17.8	46	25.6	36	20.0	36	20.0	15	8.3	26	14.4	21	11.7	<i>Viburnum dentatum</i>
<i>Viburnum dentatum SDLG</i>	0	0.0	0	0.0	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Viburnum dentatum SDLG</i>
TOTALS	388	215.6	438	243.3	618	343.3	567	315.0	522	290.0	660	366.7	627	348.3	566	314.4	TOTALS
Number of Species	31		29		40		28		31		26		32		32		Number of Species

* A slightly different transect in this area was also sampled in 1991; the 1991 results are available in previous reports.

*** Occurred in 1991 sample only

MR-S Transect - Summary of Species by Percent Cover in 2006																	
1998 - 2006																	
Year	1998		2000		2001		2002		2003		2004		2005		2006		Species
Rainfall Apr.-Sept.	high	low	high	low	high	low	normal	high	normal	high	normal	low	high	low	high		
Species	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	
<i>Typha angustifolia</i>	80	66.7	94	78.3	96	80.0	98	81.7	90	75.0	100	83.3	92	76.7	74	61.7	<i>Typha angustifolia</i>
<i>Mikania scandens</i>	78	65.0	43	35.8	34	28.3	38	31.7	26	21.7	40	33.3	55	45.8	60	50.0	<i>Mikania scandens</i>
<i>Impatiens capensis</i>	39	32.5	51	42.5	51	42.5	83	69.2	68	56.7	89	74.2	89	74.2	26	21.7	<i>Impatiens capensis</i>
<i>Lythrum salicaria</i>	1	0.8	8	6.7	19	15.8	13	10.8	17	14.2	14	11.7	28	23.3	25	20.8	<i>Lythrum salicaria</i>
<i>Viburnum dentatum</i>	10	8.3	17	14.2	12	10.0	14	11.7	15	12.5	14	11.7	18	15.0	25	20.8	<i>Viburnum dentatum</i>
<i>Peltandra virginica</i>	2	1.7	13	10.8	10	8.3	10	8.3	15	12.5	16	13.3	12	10.0	14	11.7	<i>Peltandra virginica</i>
<i>Acer saccharinum</i> *	10	8.3	10	8.3	10	8.3	10	8.3	10	8.3	9	7.5	10	8.3	13	10.8	<i>Acer saccharinum</i> *
<i>Cornus amomum</i>	7	5.8	10	8.3	10	8.3	6	5.0	11	9.2	15	12.5	15	12.5	13	10.8	<i>Cornus amomum</i>
<i>Leersia oryzoides</i>	4	3.3	10	8.3	3	2.5	1	0.8	3	2.5	0	0.0	3	2.5	11	9.2	<i>Leersia oryzoides</i>
<i>Pilea pumila</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	14.2	11	9.2	11	9.2	<i>Pilea pumila</i>
<i>Polygonum arifolium</i>	11	9.2	0	0.0	10	8.3	0	0.0	15	12.5	26	21.7	19	15.8	8	6.7	<i>Polygonum arifolium</i>
<i>Acer rubrum</i>	0	0.0	0	0.0	4	3.3	4	3.3	5	4.2	5	4.2	5	4.2	7	5.8	<i>Acer rubrum</i>
<i>Bohemia cylindrica</i>	2	1.7	7	5.8	7	5.8	7	5.8	8	6.7	16	13.3	12	10.0	7	5.8	<i>Bohemia cylindrica</i>
<i>Apios americana</i>	0	0.0	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	6	5.0	<i>Apios americana</i>
<i>Lindera benzoin</i>	7	5.8	9	7.5	5	4.2	5	4.2	5	4.2	7	5.8	7	5.8	6	5.0	<i>Lindera benzoin</i>
<i>Polygonum hydropiper</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	6	5.0	<i>Polygonum hydropiper</i>
<i>Lonicera morowii</i>	0	0.0	0	0.0	0	0.0	4	3.3	0	0.0	0	0.0	0	0.0	5	4.2	<i>Lonicera morowii</i>
<i>Symplocarpon sp.</i>	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.8	2	1.7	4	3.3	<i>Symplocarpon sp.</i>
<i>Hibiscus moscheutos</i>	3	2.5	5	4.2	5	4.2	6	5.0	4	3.3	8	6.7	6	5.0	3	2.5	<i>Hibiscus moscheutos</i>
<i>Onoclea sensibilis</i>	1	0.8	2	1.7	6	5.0	0	0.0	0	0.0	3	2.5	3	2.5	3	2.5	<i>Onoclea sensibilis</i>
<i>Chelone glabra</i>	0	0.0	0	0.0	2	1.7	1	0.8	3	2.5	2	1.7	1	0.8	2	1.7	<i>Chelone glabra</i>
<i>Geum laciniatum</i>	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	2	1.7	<i>Geum laciniatum</i>
<i>Lycopus americana</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	2	1.7	<i>Lycopus americana</i>
<i>Mimulus ringens</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	3	2.5	2	1.7	<i>Mimulus ringens</i>
<i>Parthenocissus quinquefolia</i>	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	1	0.8	2	1.7	<i>Parthenocissus quinquefolia</i>
<i>Rosa multiflora</i>	2	1.7	5	4.2	1	0.8	5	4.2	1	0.8	0	0.0	0	0.0	2	1.7	<i>Rosa multiflora</i>
<i>Solanum dulcamara</i>	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	2	1.7	<i>Solanum dulcamara</i>
<i>Carex sp.</i>	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	1	0.8	<i>Carex sp.</i>
<i>Cardamine sp.</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	<i>Cardamine sp.</i>
<i>Eupatorium maculatum</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	<i>Eupatorium maculatum</i>
<i>Helenium autumnale</i>	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	1	0.8	<i>Helenium autumnale</i>
<i>Lobelia cardinalis</i>	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	<i>Lobelia cardinalis</i>
<i>Polygonum pennsylvanicum</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	<i>Polygonum pennsylvanicum</i>
<i>Polygonum sagittatum</i>	0	0.0	5	4.2	3	2.5	3	2.5	7	5.8	15	12.5	14	11.7	1	0.8	<i>Polygonum sagittatum</i>
<i>Scutellaria laterifolia</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	<i>Scutellaria laterifolia</i>
<i>Bidens connatus</i>	0	0.0	0	0.0	3	2.5	0	0.0	0	0.0	0	0.0	3	2.5	0	0.0	<i>Bidens connatus</i>
<i>Cinna latifolia</i>	3	2.5	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Cinna latifolia</i>
<i>Cornus amomum</i> seedling	0	0.0	1	0.8	1	0.8	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	<i>Cornus amomum</i> seedling
<i>Cuscuta gronovii</i>	4	3.3	0	0.0	10	8.3	5	4.2	0	0.0	3	2.5	14	11.7	0	0.0	<i>Cuscuta gronovii</i>
<i>Epilobium coloratum</i>	0	0.0	1	0.8	0	0.0	2	1.7	1	0.8	3	2.5	3	2.5	0	0.0	<i>Epilobium coloratum</i>
<i>Mentha arvensis</i>	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Mentha arvensis</i>
<i>Sambucus canadensis</i>	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Sambucus canadensis</i>
<i>Solidago uliginosa</i>	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Solidago uliginosa</i>
<i>Strophostylus helvola</i>	2	1.7	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	<i>Strophostylus helvola</i>
<i>Symplocarpon foetidus</i>	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	<i>Symplocarpon foetidus</i>
<i>Toxicodendron radicans</i>	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	<i>Toxicodendron radicans</i>
<i>V. dentatum</i> seedling	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	<i>V. dentatum</i> seedling
<i>Vernonia novaboracensis</i>	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	<i>Vernonia novaboracensis</i>
TOTALS	274	228.3	293	244.2	310	258.3	324	270.0	308	256.7	406	338.3	431	359.2	349	290.8	TOTALS
Number of Species	23		17		27		23		21		17		27		35		Number of Species

* Overhanging branches of tree rooted on adjacent levee

MR-S Transect - Alphabetical List of Species and Percent Cover																	
1998 - 2006																	
Year	1998		2000		2001		2002		2003		2004		2005		2006		Species
Rainfall Apr.-Sept.	high	low	high	low	low	normal	normal	high	normal	normal	low	low	high	high	low		
Species	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	Total	%Cover	
Acer rubrum	0	0.0	0	0.0	4	3.3	4	3.3	5	4.2	5	4.2	5	4.2	7	5.8	Acer rubrum
Acer saccharinum *	10	8.3	10	8.3	10	8.3	10	8.3	10	8.3	9	7.5	10	8.3	13	10.8	Acer saccharinum *
Apios americana	0	0.0	1	0.8	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	6	5.0	Apios americana
Bidens connatus	0	0.0	0	0.0	3	2.5	0	0.0	0	0.0	0	0.0	3	2.5	0	0.0	Bidens frondosa
Bohemeria cylindrica	2	1.7	7	5.8	7	5.8	7	5.8	8	6.7	16	13.3	12	10.0	7	5.8	Bohemeria cylindrica
Cardamine sp.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	Cardamine sp.
#Carex sp.	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	1	0.8	#Carex sp.
Chelone glabra	0	0.0	0	0.0	2	1.7	1	0.8	3	2.5	2	1.7	1	0.8	2	1.7	Chelone glabra
Cinna latifolia	3	2.5	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	Cinna latifolia
Cornus amomum	7	5.8	10	8.3	10	8.3	6	5.0	11	9.2	15	12.5	15	12.5	13	10.8	Cornus amomum
Cornus amomum SDLG	0	0.0	1	0.8	1	0.8	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	Cornus amomum seedling
Cuscuta gronovii	4	3.3	0	0.0	10	8.3	5	4.2	0	0.0	3	2.5	14	11.7	0	0.0	Cuscuta gronovii
Epilobium coloratum	0	0.0	1	0.8	0	0.0	2	1.7	1	0.8	3	2.5	3	2.5	0	0.0	Epilobium coloratum
Eupatorium maculatum	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	Eupatorium maculatum
Geum laciniatum	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	2	1.7	Geum laciniatum
Helenium autumnale	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	2	1.7	1	0.8	Helenium autumnale
Hibiscus moscheutos	3	2.5	5	4.2	5	4.2	6	5.0	4	3.3	8	6.7	6	5.0	3	2.5	Hibiscus moscheutos
Impatiens capensis	39	32.5	51	42.5	51	42.5	83	69.2	68	56.7	89	74.2	89	74.2	26	21.7	Impatiens capensis
Leersia oryzoides	4	3.3	10	8.3	3	2.5	1	0.8	3	2.5	0	0.0	3	2.5	11	9.2	Leersia oryzoides
Lindera benzoin	7	5.8	9	7.5	5	4.2	5	4.2	5	4.2	7	5.8	7	5.8	6	5.0	Lindera benzoin
Lobelia cardinalis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	Lobelia cardinalis
Lonicera morowii	0	0.0	0	0.0	0	0.0	4	3.3	0	0.0	0	0.0	0	0.0	5	4.2	#Lonicera morowii
Lycopus americana	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	2	1.7	Lycopus americana
Lythrum salicaria	1	0.8	8	6.7	19	15.8	13	10.8	17	14.2	14	11.7	28	23.3	25	20.8	Lythrum salicaria
Mentha arvensis	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	Mentha arvensis
Mikania scandens	78	65.0	43	35.8	34	28.3	38	31.7	26	21.7	40	33.3	55	45.8	60	50.0	Mikania scandens
Mimulus ringens	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	3	2.5	2	1.7	Mimulus ringens
Onoclea sensibilis	1	0.8	2	1.7	6	5.0	0	0.0	0	0.0	3	2.5	3	2.5	3	2.5	Onoclea sensibilis
Parthenocissus quinquefolia	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	1	0.8	2	1.7	Parthenocissus quinquefolia
Peltandra virginica	2	1.7	13	10.8	10	8.3	10	8.3	15	12.5	16	13.3	12	10.0	14	11.7	Peltandra virginica
Pilea pumila	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	14.2	11	9.2	11	9.2	Pilea pumila
Polygonum arifolium	11	9.2	0	0.0	10	8.3	0	0.0	15	12.5	26	21.7	19	15.8	8	6.7	Polygonum arifolium
Polygonum hydropiper	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	6	5.0	Polygonum hydropiper
Polygonum pennsylvaniam	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	Polygonum pennsylvaniam
Polygonum sagittatum	0	0.0	5	4.2	3	2.5	3	2.5	7	5.8	15	12.5	14	11.7	1	0.8	Polygonum sagittatum
Rosa multiflora	2	1.7	5	4.2	1	0.8	5	4.2	1	0.8	0	0.0	0	0.0	2	1.7	Rosa multiflora
Sambucus canadensis	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	Sambucus canadensis
Scutellaria laterifolia	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	Scutellaria laterifolia
Solanum dulcamara	0	0.0	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	2	1.7	Solanum dulcamara
Solidago uliginosa	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	Solidago uliginosa
Strophostylus helvola	2	1.7	1	0.8	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	Strophostylus helvola
Symplocarpus foetidus	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	Symplocarpus foetidus
Symptotrichum sp.	0	0.0	0	0.0	0	0.0	1	0.8	0	0.0	1	0.8	2	1.7	4	3.3	Symptotrichum sp.
Toxicodendron radicans	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	#Toxicodendron radicans
Typha angustifolia	80	66.7	94	78.3	96	80.0	98	81.7	90	75.0	100	83.3	92	76.7	74	61.7	Typha angustifolia
Vernonia novaboracensis	0	0.0	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	Vernonia novaboracensis
Viburnum dentatum	10	8.3	17	14.2	12	10.0	14	11.7	15	12.5	14	11.7	18	15.0	25	20.8	Viburnum dentatum
V. dentatum SDLG	0	0.0	0	0.0	0	0.0	2	1.7	0	0.0	0	0.0	0	0.0	0	0.0	#V. dentatum seedling
TOTALS	274	228.3	293	244.2	310	258.3	324	270.0	308	256.7	406	338.3	431	359.2	349	290.8	TOTALS
Number of Species	23		17		27		23		21		17		27		35		Number of Species

* Overhanging branches of tree rooted on adjacent levee