Forest development along the experimental wetlands

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Abstract

Forest development patterns were observed on the mud flats of planted and unplanted wetlands constructed in 1994 at the Olentangy River Wetland Research Park, Columbus, Ohio. Woody vegetation colonized the concave mud flats where saturated soils exhibited characteristics of a newly exposed oxbow. Primary successional patterns observed include colonization by black willow (*Salix nigra* Marsh) and eastern cottonwood (*Populus deltoides* Marsh). Species richness and stem density were significantly different between the planted and unplanted wetlands. The mean basal area and the proportion of willow and cottonwood were not significantly different. Succession patterns were observed when data was compared with earlier studies. Species richness and mean diameter have not significantly changed since 2001. Lack of well defined methods, definitions, and permanent plots limit the scope of comparisons with earlier data.

Introduction

Forests established on newly exposed soils adjacent to wetlands follow predictable patterns of development. Site characteristics, specifically degree of soil saturation, as well as species life history characteristics determine which species initially occupy a site and which species invade later. Hodges (1997) asserted that the rate and type of sediment deposition and the resulting change in hydrologic regime strongly influence successional patterns. In contrast, Walker (1986) examined primary succession on the floodplain of the Tanana River in Alaska and found that differences in tree longevity explained successional change and that species did not appear to facilitate succession. Johnson (1994) found that *Populus-Salix* colonization of sand bars on the Platte River in Nebraska was regulated by water levels in both summer and winter. Life history characteristics associated with colonizing species include: production of a large crop of wind dispersed seeds, rapid germination, rapid root and above ground growth, and the ability to survive low soil fertility. The association of eastern cottonwood (*Populus deltoides* Marsh) and black willow (*Salix nigra* Marsh) develops on newly exposed sand bars where moist, bare soils exist (Krinard, 1980). Species that invade the cottonwood-willow association over time include sycamore, red maple and boxelder, which are more shade tolerant, less flood-tolerant, and longer-lived. Poorly drained sites not subjected to continuous flooding are colonized by *Salix nigra*, which survives for 30 to 60 years (Stanturf et al., 2004). During the stem exclusionary stage of forest development, stem density declines and mean diameter increases in a process of density-dependent mortality.

This research compared development of woody vegetation along two constructed riparian wetlands, one of which was initially planted with herbaceous wetland plants and one of which was not planted. Water levels in both wetlands reflect the water level of the adjacent river. Planting of herbaceous wetland species is predicted to have no effect on woody plant colonization and development, due to a lack of spatial overlap.

Methods

Study Site

The forest development patterns were observed along the margins of two experimental wetlands at the Olentangy River Wetland Research Park (ORWRP) in Columbus, Ohio, USA. Two kidney shaped wetlands were constructed in the floodplain of the Olentangy River in 1994. Wetland 1 (west side) was planted with 2400 propagules of 13 native wetland plant species in May 1994, and Wetland 2 was left unplanted (Mitsch et al., 1998). Vegetation was then allowed to develop naturally in both wetlands. Woody vegetation colonized along the mudflats on the inside of each kidney shaped wetland during the first decade, and has been monitored periodically since wetland construction (Figure 1).

Sampling

Woody vegetation was sampled in October 2004 in the mudflat areas of each wetland. Twelve 0.91 m wide transects were sampled at 10 m intervals perpendicular to the wetland edge. The initial transect was located randomly >5 m from the northern edge of the mudflat forests. The length of the transect was determined by the extent of flood tolerant tree species and delineated by the abrupt transitions to saturated mud or upland plant species. Within each transect, all woody stems rooted in the plot were sampled, the diameters were either measured at 1.4 m (dbh), or smaller stems were measured at ground level and are referred to as basal diameters (bd). Only the largest stem from a root system was sampled, to limit the survey

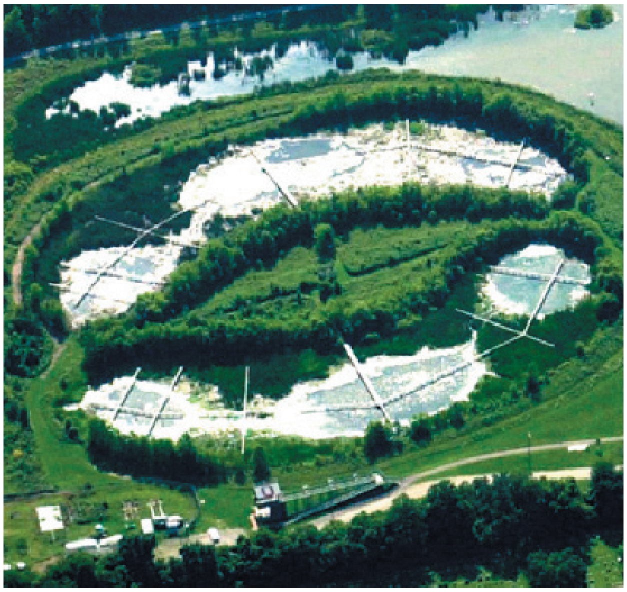

Figure 1. Aerial photo of Wetland 1 (lower) and Wetland 2 (upper) at the Olentangy River Wetland Research Park, Columbus, Ohio.

to individuals rather than stems. Stems not rooted in the transect were not sampled.

The methods attempted to duplicate those described in a previous study (Downs and Mitsch, 2002). Diameters were measured with a dbh tape or calipers to the nearest 0.1 cm. Nomenclature follows Braun (1961).

Statistical Methods

Mean stem density basal area was compared by transect between the planted and unplanted wetlands using paired t-tests, with SAS 8.0 (1999). Species diversity (Shannon-Weiner Index, Hair, 1980) was calculated for each transect in each wetland and compared with 2001 data. A p-value of ≤0.05 was considered significant for all pairwise comparisons.

Results

Woody vegetation initially colonized only the mudflats where the elevational gradient was least abrupt (Figure 1). Invasion by less flood tolerant species was evident in the smaller size classes and on the high end of the elevation gradient. Transects, though highly variable in length, were shortest on the northern extent of the mudflat forests and increased in length as they progressed southward. The mudflats narrowed at the southern end, though not as precipitously as on the north. Total transect length, 68.4 m, was identical for Wetlands 1 and 2, indicating they are approximately the same size.

The proportion of the two dominant tree species, eastern cottonwood and black willow, was highly variable between transects but not significantly different between wetlands (Table 1). Cottonwood ranged from 0-85% in Wetland 1 and 10-80% in wetland 2. Mean percent cottonwood (±SE) was 44.3 ± 6.7 in Wetland 1 and 44.9 ± 5.7 in Wetland 2. Willow proportion ranged from 0-68 in Wetland 1 and 0-83 in Wetland 2 with mean percent 33.0 ± 6.6 in Wetland 1 and 46.3 ± 7.7 in Wetland 2.

Table 1. Percent of dominant trees in transects along the margins of constructed wetlands. Both wetlands were created in 1993. Wetland 1 (W1) was planted in 1994 with 12 species of macrophytes. Wetland 2 (W2) was not planted but colonized naturally.

Transect	Cottonwood		Willow	
	W1	W2	W1	W2
1	40	50	0	0
2	41	10	41	70
3	85	38	0	83
4	0	80	47	17
5	28	50	32	17
6	42	50	39	45
7	26	71	68	29
8	76	22	16	78
9	60	41	15	56
10	59	28	21	67
11	33	59	63	38
12	42	40	54	56
Mean±SE	44.3±6.7	44.9±5.7	33.0±6.6	46.3±7.7

Table 2. Species diversity (Shannon Weiner Index) in transects along the margins of experimental wetlands. .

Transect	Species Diversity		# of stems	
	W1	W2	W1	W2
1	0.95	0.70	10	2
2	1.24	0.81	17	10
3	0.52	0.67	20	8
4	1.51	0.88	17	6
5	1.37	1.02	25	12
6	1.25	0.85	31	22
7	0.77	0.61	19	17
8	0.77	0.53	25	27
9	1.28	0.82	20	27
10	1.11	0.83	34	36
11	0.80	0.79	46	32
12	0.84	0.78	24	25
Mean±SE	1.03±0.09	0.78±0.04	24.0±2.7	18.7±3.2

Species diversity, as measured by the Shannon-Wiener Index (Table 2), was significantly different ($p < 0.002$) between Wetland 1 (planted) and Wetland 2 (unplanted). In

Wetland 1, the index values ranged from 0.77 to 1.51 with a mean ± SE of 1.03 ± 0.09. In Wetland 2, the Shannon-Wiener Index ranged from 0.53 to 1.02 with a mean ± SE of 0.78 ± 0.04. Species richness of Wetland 1 appeared to be greater than that of Wetland 2.

The mean basal area per transect (Figure 2) was similar between Wetlands 1 and 2 (179.6 ± 31 cm^2 vs. 159.5 ± 31.0 cm^2 respectively). Comparisons of the relative size class distribution (Figure 3) indicate a difference in woody vegetation structure. Wetland 1 had a higher density of small stems (< 2 cm) than Wetland 2. Mean basal area per transect was not significantly different between the wetlands.

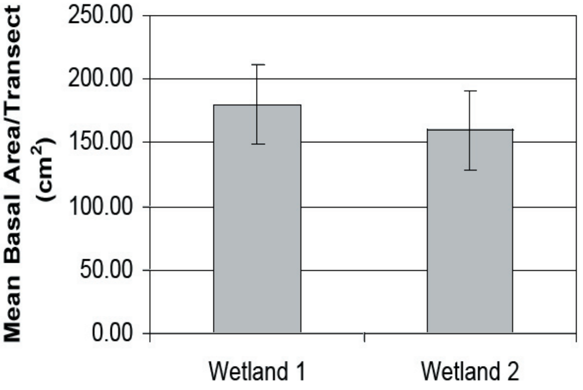

Figure 2. Mean basal area (cm^2) per transect in planted (Wetland 1) and unplanted (Wetland 2) created wetlands. All species are included. Bars represent standard error.

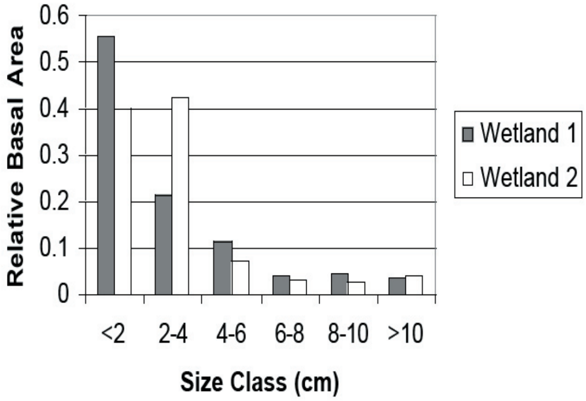

Figure 3. Size class distribution for mud flat trees in Wetland 1 and Wetland 2.

Discussion

The colonization and community development patterns observed on mud flats of the experimental wetlands at the ORWRP reflect primary successional processes (Krinard, 1980). The proportion of the two dominant species, eastern cottonwood and black willow, was highly variable between transects and wetlands. Wetland 1 had significantly higher species diversity than Wetland 2 (Table 1). Comparisons with 2001 data (Downs and Mitsch, 2002) did not indicate significant differences between these years. Though not significant, species richness appears to be increasing over time. Willow and cottonwood dominate the larger size classes; all other species are in the smaller size classes. This reflects successional patterns expected in riparian forests. Is sediment deposition driving this shift toward less flood tolerant species? The wetlands' water levels mimic fluctuations in the river stage, and sediment loads should reflect those of the Olentangy river. Are the willows and cottonwoods altering the site, making it more hospitable to less flood tolerant species? Extensive root systems can displace soil, possibly producing elevated microsites in the vicinity of the tree root collars. Alternatively, a period of drought could allow less flood-tolerant species to become established with enough above ground growth to survive future floods.

Patterns of woody vegetation development do not appear to be influenced by whether the wetland was originally planted. No significant differences were found in the relative proportion of willow or cottonwood at these two sites in 2004. This result is consistent with patterns observed in 2001 (Downs and Mitsch, 2002). Weihe (1996) found that cottonwood and willow densities were initially greater in the unplanted wetland. Downs and Mitsch (2002) further noted that mean basal area per transect was ten times greater in wetland 2 than in wetland 1. In 2004, differences in mean basal area per transect were not significant. Differences in the size class distributions indicate that the number of stems in the smaller size classes represent the primary difference in woody vegetation structure between the two wetlands in 2004.

Replication of the methods of previous studies did not yield comparable results. Mudflat forest composition, while changing through time, should have a higher degree of similarity with data from three years prior. Although a sampling of ten percent of the forested area (10 m between transects and a 0.91 m transect width) should theoretically yield representative data, the lack of permanent transects could contribute to different results from one year to another. The establishment of permanent transects might be worth consideration. In addition, sampling methods must be explicitly described. Potential differences in methods include the definition of a stem, and whether stems or individual trees are sampled. Must a tree be rooted in the transect in order to be sampled? Are woody vines included with trees and shrubs? Comparisons with earlier studies requires clear definitions and uniform methods.

We cannot say that the drop in stem density from 34.8 stems per transect in Wetland 1 in 2001 to 24.0 ± 2.7 stems per transect in 2004 is due to mortality. Other possible explanations include changes in the length of transects and differences in sampling definitions and protocols. Dramatic differences in mean basal area per transect observed in 2001 were not evident in 2004. In 2001, Wetland 2 had ten times more basal area per transect than Wetland 1, a difference found to be significant by Downs and Mitsch (2002). In contrast, mean basal area per transect was not significantly different in 2004 between the two wetlands. In Wetland 2, mean basal area per transect dropped from approximately 350 cm^2 in 2001 to 159 ± 31 cm^2 in 2004. Although there was some evidence of beaver (*Castor canadensis*) activity in wetland 2, it did not appear that it would have reduced basal area by more than half. Biological explanations are unlikely to account for these differences.

Forest development along the margins of the experimental wetlands followed predictable successional patterns after ten years. The initial planting of Wetland 1 with herbaceous wetland plants influenced early recruitment of woody species in that wetland for the first year or two but has had limited impact on forest development along the wetland margins since then.. Similar hydrologic regimes, soils, and rates of sediment deposition contribute to comparable productivity. Differences in initial colonization patterns are still impacting species composition and stem density, but not basal area accumulation.

Acknowledgements

The authors would like to thank Ryan Markey and Kevin Brandhorst for their assistance in data collection and processing.

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Appendix 1. Species, diameter, and transect length for all woody stems in Wetlands 1 and 2. Species codes are based on the first letter and next two consonants of the genus and species.

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
2	1	2	PPLDLT	4.8	.
2	1	2	ULMAMR	.	0.7
2	2	3.5	SLXNGR	4.3	.
2	2	3.5	SLXNGR	3	.
2	2	3.5	SLXNGR	0.4	.
2	2	3.5	SLXNGR	0.6	.
2	2	3.5	SLXNGR	2.3	.
2	2	3.5	SLXNGR	4.1	.
2	2	3.5	SLXNGR	0.3	.
2	2	3.5	PPLDLT	2.1	.
2	2	3.5	ACRNGN	.	0.7
2	2	3.5	ACRNGN	.	0.4
2	3	2.4	PPLDLT	0.7	.
2	3	2.4	PPLDLT	2.3	.
2	3	2.4	PPLDLT	2.7	.
2	3	2.4	SLXNGR	1.1	.
2	3	2.4	SLXNGR	0.7	.
2	3	2.4	SLXNGR	2.4	.
2	3	2.4	SLXNGR	.	0.7
2	3	2.4	SLXNGR	.	0.5
2	4	3	SLXNGR	12.3	.
2	4	3	PPLDLT	0.9	.
2	4	3	PPLDLT	0.9	.
2	4	3	PPLDLT	1	.
2	4	3	PPLDLT	9	.
2	4	3	PLTOCC	.	2.4
2	5	7	SLXNGR	4.8	.
2	5	7	SLXNGR	11.8	.
2	5	7	ACRNGN	.	0.7
2	5	7	ACRNGN	.	0.8
2	5	7	ACRNGN	.	1.6
2	5	7	ACRNGN	.	1.2
2	5	7	PPLDLT	2.8	.
2	5	7	PPLDLT	0.8	.
2	5	7	PPLDLT	1.2	.
2	5	7	PPLDLT	0.4	.
2	5	7	PPLDLT	2.5	.
2	5	7	PPLDLT	1.5	.
2	6	8.5	SLXNGR	1.4	.
2	6	8.5	SLXNGR	3.8	.
2	6	8.5	SLXNGR	3.1	.
2	6	8.5	SLXNGR	2.8	.
2	6	8.5	SLXNGR	1.4	.
2	6	8.5	SLXNGR	3.6	.
2	6	8.5	SLXNGR	11	.
2	6	8.5	SLXNGR	0.8	.
2	6	8.5	SLXNGR	.	1.6
2	6	8.5	SLXNGR	.	2.5
2	6	8.5	PPLDLT	9	.
2	6	8.5	PPLDLT	1	.
2	6	8.5	PPLDLT	1.2	.
2	6	8.5	PPLDLT	2.4	.
2	6	8.5	PPLDLT	0.8	.
2	6	8.5	PPLDLT	2.3	.
2	6	8.5	PPLDLT	1.4	.
2	6	8.5	PPLDLT	0.8	.
2	6	8.5	PPLDLT	13.3	.
2	6	8.5	PPLDLT	4	.
2	6	8.5	PPLDLT	.	1.1
2	6	8.5	ACRNGN	.	1.1
2	7	5	PPLDLT	0.6	.
2	7	5	PPLDLT	4.5	.
2	7	5	PPLDLT	1.7	.
2	7	5	PPLDLT	1	.
2	7	5	PPLDLT	1.4	.
2	7	5	PPLDLT	2.6	.
2	7	5	PPLDLT	2.8	.
2	7	5	PPLDLT	2.9	.
2	7	5	PPLDLT	.	1.8
2	7	5	PPLDLT	.	3.4
2	7	5	PPLDLT	.	3.5
2	7	5	PPLDLT	.	2.3
2	7	5	SLXNGR	1.9	.
2	7	5	SLXNGR	7.3	.
2	7	5	SLXNGR	8.6	.
2	7	5	SLXNGR	4	.
2	7	5	SLXNGR	.	1.8
2	8	7.5	PPLDLT	1.3	.
2	8	7.5	PPLDLT	2.4	.
2	8	7.5	PPLDLT	0.9	.
2	8	7.5	PPLDLT	12.3	.
2	8	7.5	PPLDLT	.	2.5
2	8	7.5	PPLDLT	.	3.8
2	8	7.5	SLXNGR	3.2	.
2	8	7.5	SLXNGR	2.2	.
2	8	7.5	SLXNGR	3.5	.
2	8	7.5	SLXNGR	2.8	.
2	8	7.5	SLXNGR	6.8	.
2	8	7.5	SLXNGR	2.9	.
2	8	7.5	SLXNGR	7.6	.
2	8	7.5	SLXNGR	0.7	.
2	8	7.5	SLXNGR	3.7	.
2	8	7.5	SLXNGR	.	3.3
2	8	7.5	SLXNGR	.	3.8
2	8	7.5	SLXNGR	.	3
2	8	7.5	SLXNGR	.	1.8
2	8	7.5	SLXNGR	.	3
2	8	7.5	SLXNGR	.	2.6

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
2	8	7.5	SLXNGR	.	0.6
2	8	7.5	SLXNGR	.	0.4
2	8	7.5	SLXNGR	.	1
2	8	7.5	SLXNGR	.	0.8
2	8	7.5	SLXNGR	.	0.6
2	9	8	SLXNGR	2	.
2	9	8	SLXNGR	1.7	.
2	9	8	SLXNGR	1.8	.
2	9	8	SLXNGR	2.2	.
2	9	8	SLXNGR	2.1	.
2	9	8	SLXNGR	2	.
2	9	8	SLXNGR	6	.
2	9	8	SLXNGR	1.2	.
2	9	8	SLXNGR	0.8	.
2	9	8	SLXNGR	2.3	.
2	9	8	SLXNGR	1.8	.
2	9	8	SLXNGR	.	0.7
2	9	8	SLXNGR	.	0.8
2	9	8	SLXNGR	.	1.6
2	9	8	SLXNGR	.	1.3
2	9	8	PPLDLT	6.8	.
2	9	8	PPLDLT	1.3	.
2	9	8	PPLDLT	1	.
2	9	8	PPLDLT	1.2	.
2	9	8	PPLDLT	2.2	.
2	9	8	PPLDLT	2.8	.
2	9	8	PPLDLT	.	1.5
2	9	8	PPLDLT	.	1.7
2	9	8	PPLDLT	.	1.4
2	9	8	PPLDLT	.	3.8
2	9	8	PPLDLT	.	0.7
2	9	8	MRSsp.	.	0.7
2	10	9	SLXNGR	2	.
2	10	9	SLXNGR	2	.
2	10	9	SLXNGR	2.1	.
2	10	9	SLXNGR	2.7	.
2	10	9	SLXNGR	1.2	.
2	10	9	SLXNGR	2.9	.
2	10	9	SLXNGR	1	.
2	10	9	SLXNGR	1.4	.
2	10	9	SLXNGR	2.2	.
2	10	9	SLXNGR	2.5	.
2	10	9	SLXNGR	2.6	.
2	10	9	SLXNGR	1	.
2	10	9	SLXNGR	5.1	.
2	10	9	SLXNGR	.	0.7
2	10	9	SLXNGR	.	1.4
2	10	9	SLXNGR	.	1.5
2	10	9	SLXNGR	.	1.4
2	10	9	SLXNGR	.	1.9
2	10	9	SLXNGR	.	1.9
2	10	9	SLXNGR	.	0.5
2	10	9	SLXNGR	.	1.4
2	10	9	SLXNGR	.	1.2
2	10	9	SLXNGR	.	0.2
2	10	9	SLXNGR	.	2
2	10	9	PPLDLT	1.1	.
2	10	9	PPLDLT	0.9	.
2	10	9	PPLDLT	2.2	.
2	10	9	PPLDLT	2.6	.
2	10	9	PPLDLT	1.7	.
2	10	9	PPLDLT	2.5	.
2	10	9	PPLDLT	2.5	.
2	10	9	PPLDLT	0.5	.
2	10	9	PPLDLT	2	.
2	10	9	PPLDLT	10.1	.
2	10	9	FRXPNN	3.8	.
2	10	9	ACRNGN	.	0.6
2	11	6.5	PPLDLT	3.2	.
2	11	6.5	PPLDLT	3.2	.
2	11	6.5	PPLDLT	2.1	.
2	11	6.5	PPLDLT	1.1	.
2	11	6.5	PPLDLT	1.8	.
2	11	6.5	PPLDLT	3	.
2	11	6.5	PPLDLT	1.9	.
2	11	6.5	PPLDLT	2.3	.
2	11	6.5	PPLDLT	3.3	.
2	11	6.5	PPLDLT	3.2	.
2	11	6.5	PPLDLT	2.3	.
2	11	6.5	PPLDLT	5	.
2	11	6.5	PPLDLT	5.6	.
2	11	6.5	PPLDLT	.	2.4
2	11	6.5	PPLDLT	.	4.7
2	11	6.5	PPLDLT	.	4.3
2	11	6.5	PPLDLT	.	1.9
2	11	6.5	PPLDLT	.	1.9
2	11	6.5	PPLDLT	.	1.8
2	11	6.5	SLXNGR	1.8	.
2	11	6.5	SLXNGR	2.6	.
2	11	6.5	SLXNGR	2.4	.
2	11	6.5	SLXNGR	2	.
2	11	6.5	SLXNGR	1.6	.
2	11	6.5	SLXNGR	.	3.3
2	11	6.5	SLXNGR	.	0.8
2	11	6.5	SLXNGR	.	1.9
2	11	6.5	SLXNGR	.	0.5
2	11	6.5	SLXNGR	.	0.6
2	11	6.5	SLXNGR	.	0.5

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
2	11	6.5	SLXNGR	.	0.8
2	11	6.5	ACRRBR	.	1.6
2	12	6	PPLDLT	1.4	.
2	12	6	PPLDLT	0.9	.
2	12	6	PPLDLT	0.8	.
2	12	6	PPLDLT	2.8	.
2	12	6	PPLDLT	1.1	.
2	12	6	PPLDLT	1.2	.
2	12	6	PPLDLT	0.5	.
2	12	6	PPLDLT	8.1	.
2	12	6	PPLDLT	.	2.3
2	12	6	PPLDLT	.	1
2	12	6	ACRRBR	.	1.2
2	12	6	SLXNGR	1.6	.
2	12	6	SLXNGR	2.7	.
2	12	6	SLXNGR	0.3	.
2	12	6	SLXNGR	2.3	.
2	12	6	SLXNGR	2.3	.
2	12	6	SLXNGR	1.4	.
2	12	6	SLXNGR	2.1	.
2	12	6	SLXNGR	2.7	.
2	12	6	SLXNGR	4.6	.
2	12	6	SLXNGR	.	0.9
2	12	6	SLXNGR	.	3.2
2	12	6	SLXNGR	.	1
2	12	6	SLXNGR	.	2.8
2	12	6	SLXNGR	.	2.7
1	1	2.5	PPLDLT	7.6	.
1	1	2.5	PPLDLT	4.6	.
1	1	2.5	PPLDLT	3.5	.
1	1	2.5	PPLDLT	.	3.5
1	1	2.5	VTSsp.	0.7	.
1	1	2.5	ACRNGN	.	0.6
1	1	2.5	ACRNGN	.	0.4
1	1	2.5	ACRNGN	.	0.5
1	1	2.5	ACRNGN	.	0.6
1	1	2.5	ACRNGN	.	0.3
1	2	3	ASMTRL	.	0.3
1	2	3	TXCRDC	.	0.3
1	2	3	PPLDLT	8	.
1	2	3	PPLDLT	6.5	.
1	2	3	PPLDLT	9	.
1	2	3	PPLDLT	1	.
1	2	3	PPLDLT	2.7	.
1	2	3	PPLDLT	1.1	.
1	2	3	PPLDLT	1.7	.
1	2	3	ACRNGN	.	0.1
1	2	3	SLXNGR	.	0.5
1	2	3	SLXNGR	.	0.8
1	2	3	SLXNGR	.	0.5
1	2	3	SLXNGR	.	0.4
1	2	3	SLXNGR	.	0.8
1	2	3	SLXNGR	.	0.4
1	2	3	SLXNGR	.	0.9
1	3	3	PPLDLT	2.7	.
1	3	3	PPLDLT	1.1	.
1	3	3	PPLDLT	1.4	.
1	3	3	PPLDLT	0.5	.
1	3	3	PPLDLT	1.4	.
1	3	3	PPLDLT	0.4	.
1	3	3	PPLDLT	8	.
1	3	3	PPLDLT	0.9	.
1	3	3	PPLDLT	3.3	.
1	3	3	PPLDLT	0.8	.
1	3	3	PPLDLT	5.5	.
1	3	3	PPLDLT	1.2	.
1	3	3	PPLDLT	1.8	.
1	3	3	PPLDLT	2.7	.
1	3	3	PPLDLT	0.9	.
1	3	3	PPLDLT	1.1	.
1	3	3	PPLDLT	0.4	.
1	3	3	ASMTRL	.	3
1	3	3	ASMTRL	.	0.6
1	3	3	VTSsp.	.	0.2
1	4	4.5	SMBCND	.	0.5
1	4	4.5	SMBCND	.	0.2
1	4	4.5	SLXNGR	9.9	.
1	4	4.5	SLXNGR	4.9	.
1	4	4.5	SLXNGR	12.5	.
1	4	4.5	SLXNGR	11.8	.
1	4	4.5	SLXNGR	13	.
1	4	4.5	SLXNGR	.	0.2
1	4	4.5	SLXNGR	.	0.8
1	4	4.5	SLXNGR	.	0.7
1	4	4.5	ASMTRL	.	0.3
1	4	4.5	ACRRBR	.	0.1
1	4	4.5	ACRRBR	.	0.5
1	4	4.5	ACRRBR	.	0.1
1	4	4.5	FRXPNN	0.7	.
1	4	4.5	ACRNGN	.	0.3
1	4	4.5	ACRNGN	.	0.1
1	5	4.8	ACRRBR	1.2	.
1	5	4.8	ACRRBR	.	0.4
1	5	4.8	ACRRBR	.	0.7
1	5	4.8	ACRRBR	.	0.6
1	5	4.8	ACRRBR	.	0.6
1	5	4.8	ACRRBR	.	0.5
1	5	4.8	ACRNGN	.	0.8

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
1	5	4.8	ACRNGN	.	0.5
1	5	4.8	ACRNGN	.	0.9
1	5	4.8	ACRNGN	.	0.6
1	5	4.8	SLXNGR	9.9	.
1	5	4.8	SLXNGR	.	0.9
1	5	4.8	SLXNGR	.	1.1
1	5	4.8	SLXNGR	.	1.1
1	5	4.8	SLXNGR	.	1
1	5	4.8	SLXNGR	.	0.5
1	5	4.8	SLXNGR	.	0.6
1	5	4.8	SLXNGR	.	1.1
1	5	4.8	PPLDLT	5.1	.
1	5	4.8	PPLDLT	2	.
1	5	4.8	PPLDLT	5.2	.
1	5	4.8	PPLDLT	5.2	.
1	5	4.8	PPLDLT	10.2	.
1	5	4.8	PPLDLT	2.8	.
1	5	4.8	PPLDLT	2.3	.
1	6	4.9	PPLDLT	1.1	.
1	6	4.9	PPLDLT	0.9	.
1	6	4.9	PPLDLT	0.9	.
1	6	4.9	PPLDLT	1	.
1	6	4.9	PPLDLT	1	.
1	6	4.9	PPLDLT	1.3	.
1	6	4.9	PPLDLT	1.3	.
1	6	4.9	PPLDLT	2.1	.
1	6	4.9	PPLDLT	2.7	.
1	6	4.9	PPLDLT	1.5	.
1	6	4.9	PPLDLT	1.1	.
1	6	4.9	PPLDLT	2.7	.
1	6	4.9	PPLDLT	3.2	.
1	6	4.9	PPLDLT	11.5	.
1	6	4.9	CTLsp.	4.7	.
1	6	4.9	SLXNGR	1.2	.
1	6	4.9	SLXNGR	3.9	.
1	6	4.9	SLXNGR	3.4	.
1	6	4.9	SLXNGR	4.9	.
1	6	4.9	SLXNGR	.	0.5
1	6	4.9	SLXNGR	.	0.2
1	6	4.9	SLXNGR	.	0.3
1	6	4.9	SLXNGR	.	0.6
1	6	4.9	SLXNGR	.	0.4
1	6	4.9	SLXNGR	.	0.3
1	6	4.9	SLXNGR	.	0.4
1	6	4.9	SLXNGR	.	1.2
1	6	4.9	SLXALB	5.4	.
1	6	4.9	VTSsp.	.	0.2
1	6	4.9	ASMTRL	.	0.4
1	6	4.9	ASMTRL	.	0.4
1	7	5	SLXNGR	3.4	.
1	7	5	SLXNGR	4.7	.
1	7	5	SLXNGR	4	.
1	7	5	SLXNGR	.	1.1
1	7	5	SLXNGR	.	0.9
1	7	5	SLXNGR	.	0.3
1	7	5	SLXNGR	.	0.6
1	7	5	SLXNGR	.	1
1	7	5	SLXNGR	.	0.9
1	7	5	SLXNGR	.	0.6
1	7	5	SLXNGR	.	1.2
1	7	5	SLXNGR	.	0.8
1	7	5	SLXNGR	.	0.3
1	7	5	PPLDLT	4.6	.
1	7	5	PPLDLT	6.7	.
1	7	5	PPLDLT	0.9	.
1	7	5	PPLDLT	2.5	.
1	7	5	PPLDLT	2.7	.
1	7	5	ACRNGN	.	1.6
1	8	9	SLXNGR	8.4	.
1	8	9	SLXNGR	2.5	.
1	8	9	SLXNGR	.	0.8
1	8	9	SLXNGR	.	0.4
1	8	9	PPLDLT	3.1	.
1	8	9	PPLDLT	1.5	.
1	8	9	PPLDLT	1.5	.
1	8	9	PPLDLT	1	.
1	8	9	PPLDLT	3.6	.
1	8	9	PPLDLT	1.2	.
1	8	9	PPLDLT	1	.
1	8	9	PPLDLT	1.7	.
1	8	9	PPLDLT	0.8	.
1	8	9	PPLDLT	1.1	.
1	8	9	PPLDLT	2.7	.
1	8	9	PPLDLT	5.1	.
1	8	9	PPLDLT	4.4	.
1	8	9	PPLDLT	.	1.4
1	8	9	PPLDLT	.	1.3
1	8	9	PPLDLT	.	1.1
1	8	9	PPLDLT	.	0.9
1	8	9	PPLDLT	.	1
1	8	9	PPLDLT	.	0.5
1	8	9	FRXPNN	0.8	.
1	8	9	ACRNGN	.	0.6
1	9	8.5	PPLDLT	0.6	.
1	9	8.5	PPLDLT	6.5	.
1	9	8.5	PPLDLT	1.1	.
1	9	8.5	PPLDLT	1.7	.
1	9	8.5	PPLDLT	1.1	.

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
1	9	8.5	PPLDLT	1.2	.
1	9	8.5	PPLDLT	1.4	.
1	9	8.5	PPLDLT	2.2	.
1	9	8.5	PPLDLT	3.8	.
1	9	8.5	PPLDLT	0.7	.
1	9	8.5	PPLDLT	3.2	.
1	9	8.5	PPLDLT	.	0.4
1	9	8.5	ACRRBR	.	1
1	9	8.5	SLXALB	5.3	.
1	9	8.5	SMBCND	.	0.7
1	9	8.5	SMBCND	.	0.8
1	9	8.5	SMBCND	.	0.4
1	9	8.5	SLXNGR	.	1.5
1	9	8.5	SLXNGR	.	1.3
1	9	8.5	FRXPNN	.	0.7
1	10	9.7	SLXNGR	8.6	.
1	10	9.7	SLXNGR	6.8	.
1	10	9.7	SLXNGR	2.6	.
1	10	9.7	SLXNGR	10.5	.
1	10	9.7	SLXNGR	.	0.5
1	10	9.7	SLXNGR	.	0.3
1	10	9.7	SLXNGR	.	0.7
1	10	9.7	PPLDLT	0.6	
1	10	9.7	PPLDLT	1.5	.
1	10	9.7	PPLDLT	1	.
1	10	9.7	PPLDLT	2.5	.
1	10	9.7	PPLDLT	0.9	.
1	10	9.7	PPLDLT	1.6	.
1	10	9.7	PPLDLT	0.9	.
1	10	9.7	PPLDLT	1.5	.
1	10	9.7	PPLDLT	1.1	.
1	10	9.7	PPLDLT	1.7	.
1	10	9.7	PPLDLT	1.8	.
1	10	9.7	PPLDLT	0.9	.
1	10	9.7	PPLDLT	8.2	.
1	10	9.7	PPLDLT	0.9	.
1	10	9.7	PPLDLT	.	1.1
1	10	9.7	PPLDLT	.	1.5
1	10	9.7	PPLDLT	.	1.5
1	10	9.7	PPLDLT	.	1.1
1	10	9.7	PPLDLT	.	1.7
1	10	9.7	PPLDLT	.	1.1
1	10	9.7	ACRRBR	0.6	.
1	10	9.7	ACRRBR	.	1.9
1	10	9.7	ACRRBR	.	0.5
1	10	9.7	ACRNGN	.	0.5
1	10	9.7	ACRNGN	.	0.3
1	10	9.7	ACRNGN	.	0.4
1	10	9.7	ACRNGN	.	0.7
1	11	9	SLXNGR	0.3	.
1	11	9	SLXNGR	0.3	.
1	11	9	SLXNGR	0.8	.
1	11	9	SLXNGR	4.9	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	0.5	.
1	11	9	SLXNGR	5.6	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	0.5	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	3.1	.
1	11	9	SLXNGR	0.4	.
1	11	9	SLXNGR	1	.
1	11	9	SLXNGR	1.7	.
1	11	9	SLXNGR	1.3	.
1	11	9	SLXNGR	1.4	.
1	11	9	SLXNGR	4.4	.
1	11	9	SLXNGR	3.3	.
1	11	9	SLXNGR	2.2	.
1	11	9	SLXNGR	0.9	.
1	11	9	SLXNGR	.	0.6
1	11	9	SLXNGR	.	0.7
1	11	9	SLXNGR	.	0.6
1	11	9	SLXNGR	.	0.4
1	11	9	SLXNGR	.	0.6
1	11	9	SLXNGR	.	2
1	11	9	SLXNGR	.	1.5
1	11	9	PPLDLT	1.9	.
1	11	9	PPLDLT	1.8	.
1	11	9	PPLDLT	1.5	.
1	11	9	PPLDLT	2.7	.
1	11	9	PPLDLT	1.2	.
1	11	9	PPLDLT	1.5	.
1	11	9	PPLDLT	3.5	.
1	11	9	PPLDLT	5.7	.
1	11	9	PPLDLT	0.8	.
1	11	9	PPLDLT	0.9	.
1	11	9	PPLDLT	.	1.1
1	11	9	PPLDLT	.	0.8
1	11	9	PPLDLT	.	1
1	11	9	PPLDLT	.	1
1	11	9	PPLDLT	.	1.5
1	11	9	VTSsp.	.	0.2
1	11	9	VTSsp.	.	0.2
1	12	4.5	FRXPNN	.	2
1	12	4.5	SLXNGR	1.7	.
1	12	4.5	SLXNGR	2.4	.

Wetland	Transect	Length (m)	Species	Dbh (cm)	Basal dbh (cm)
1	12	4.5	SLXNGR	6.3	.
1	12	4.5	SLXNGR	2	.
1	12	4.5	SLXNGR	1.4	.
1	12	4.5	SLXNGR	1.7	.
1	12	4.5	SLXNGR	2.1	.
1	12	4.5	SLXNGR	1.5	.
1	12	4.5	SLXNGR	1.4	.
1	12	4.5	SLXNGR	6.8	.
1	12	4.5	SLXNGR	.	0.8
1	12	4.5	SLXNGR	.	0.9
1	12	4.5	SLXNGR	.	1.8
1	12	4.5	PPLDLT	1.2	.
1	12	4.5	PPLDLT	2.8	.
1	12	4.5	PPLDLT	2.4	.
1	12	4.5	PPLDLT	1.2	.
1	12	4.5	PPLDLT	1.2	.
1	12	4.5	PPLDLT	0.7	.
1	12	4.5	PPLDLT	1.8	.
1	12	4.5	PPLDLT	1	.
1	12	4.5	PPLDLT	0.9	.
1	12	4.5	PPLDLT	1.8	.