Williamson River Delta Preserve vegetation monitoring: Tulana first-year post-breaching results

Adrien Elseroad, Allison Aldous, Nathan Rudd, and Heather Hendrixson
The Nature Conservancy
March 2009

I. Introduction

Establishing native wetland vegetation in restored wetlands is an integral component of the Williamson River Delta Preserve's restoration goals. In fall 2007, large sections of levee were breached on the Tulana portion of the property, and in fall 2008, additional sections of levee were breached on the Goose Bay portion of the property, resulting in the re-connection of the entire delta to the surrounding water bodies. On Tulana, where some wetland vegetation was already established via managed flooding, levee breaching resulted in a dramatic change in the hydrologic regime- most areas are now subject to deeper water and longer hydroperiods. Goose Bay, which was not previously managed as a wetland, will experience flooding and become colonized by wetland vegetation for the first time since being drained and converted from wetland to agricultural fields.

The substantial change in the hydrologic regime at the delta has warranted the development of a new monitoring program to track the response of vegetation to hydrologic restoration. The first year of post-breaching vegetation monitoring was completed on Tulana in 2008, and in 2009, monitoring will be initiated on Goose Bay. This report describes the methods used to monitor the vegetation and the first-year post breaching results from Tulana. Results of previous vegetation monitoring efforts at the delta are described in Elseroad et al. (2006) and Elseroad and Aldous (2008).

II. Methods

Monitoring objectives

The primary objective of the new vegetation monitoring program is to describe the vegetation that establishes at different ground surface elevations following hydrologic restoration. Monitoring results are intended to inform wetland restoration planning efforts on other properties in the region, and also to identify where active management actions (i.e. supplemental plantings or weed control) at the delta should be focused. Estimates of plant cover in plots located at specific ground surface elevations (described below) will be used to address the primary monitoring objective. A secondary monitoring objective is to track the rate of colonization of each vegetation type, which will be accomplished by repeating the plant cover estimates, once every three years.

Monitoring design

Vegetation was sampled within four hydrologic zones that encompass the range of ground surface elevations where wetland vegetation is expected to establish (Table 1, Figure 1). Hydrologic zones were based on those used to predict potential vegetation for the Williamson River Delta's Environmental Impact Statement (see Elseroad 2004). In the EIS, wetland hydrologic zones included riparian/wet prairie, emergent wetland, deep water wetland, and open water. For this monitoring program, we excluded the open water zone because we do not expect much vegetation to develop in areas with maximum water depths greater than 10 feet. We also split the deep water wetland zone into two different zones because we expect different vegetation to develop in the shallower and deeper water portions of that zone.

Within each hydrologic zone, 40 1m^2 plots were sampled. Plot locations were randomly selected prior to sampling using Hawth's tools in ArcMap. Levees, drains, and the Campfields and Riverbend early action projects were excluded as potential sampling locations (early action projects will continue to be sampled on a periodic basis using the existing vegetation monitoring plots). Random plots were used instead of permanent plots in order to avoid having to permanently mark the plots. Marking plots with rebar or stakes would be extremely difficult in deep water and could be hazardous to boat traffic. Although random plots will provide less statistical power for detecting change over time as compared to permanent plots, we are more interested in accurately describing the vegetation within each hydrologic zone during a given sampling year than detecting small changes between years. Plot locations are intended to be re-randomized each year that monitoring occurs, which will allow a larger percentage of the area to be sampled over time.

Data collection

Within the riparian/wet prairie and emergent hydrologic zones, the aerial plant cover of each species (except for submerged species, for which only presence data were recorded) and ground surface type (bare ground, litter, and water) was estimated within 1m^2 plots. Plant cover was estimated separately for each species; therefore plant cover totaled over 100% when species overlapped one another. Within the deep water wetland zones, cover in 1 m^2 plots was estimated, as described above, if emergent plant species were present. In addition, a modified version of the method described in Kenow et al. (2007) was used to sample submerged aquatic vegetation. A double-headed garden rake was lowered from the side of the boat to the ground surface, dragged along the ground for approximately 1 meter, twisted 180°, and then carefully raised vertically out of the water. The presence of each species attached to the rake was recorded. Water depths were also measured in all plots with standing water.

Riparian/wet prairie plots were monitored on August 27th, 28th, and September 10th, 2008; emergent wetland plots were monitored on September 9th-10th, 2008; and deep water wetland plots were monitored on September 8th-9th, 2008. All data were collected by Adrien Elseroad. An attempt was made to monitor each hydrologic zone during the period of maximum plant biomass. In areas that experience drawdown, maximum plant biomass was assumed to occur after surface water was no longer present and the annual species that typically germinate following drawdown were established (i.e. late August to early September). In areas that do not dry out, maximum plant biomass was assumed to occur when the water levels were the lowest for the year but before plants start to senesce (i.e. early September).

Data analysis

For each hydrologic zone, the average cover of all species, native species, exotic species, and three plant guilds were calculated. Plant guilds included perennial forbs, perennial graminoids, and annuals (combined with biennials). Average species richness per plot was also calculated for each site. Species nativity and duration followed USDA (2007).

III. Results

Riparian/wet prairie

Total plant cover in riparian/wet prairie plots averaged 100% (Figure 2). Plant cover was dominated by native species (Figure 3), and was composed largely of annuals, perennial forbs, and perennial graminoids (Figure 4). Dominant species included *Rumex maritimus* and *Potentilla norvegica*, both native annuals, and *Elytrigia repens*, an exotic perennial grass (Table 2).

A total of 25 species were found in riparian/wet prairie plots, and species richness averaged 6 species/m^2 (Table 2).

Emergent wetlands

Total plant cover in emergent wetland plots averaged 36%, and was largely composed of native species (Figures 2 and 3). Dominant plant guilds were annuals and perennial graminoids (Figure 4), and dominant species included *Rumex maritimus*, a native annual, and *Scirpus acutus*, a native perennial graminoid (Table 3). Plot area not occupied by plants consisted of either bare ground or water, depending on the plot elevation. Plots located at 4140 ft. had saturated soils but no standing water, and plots located at 4139 and 4138 ft. had 1-12 inches of standing water.

A total of 22 species were found in emergent wetland plots, and species richness averaged 2 species/m^2 (Table 3).

Deep water wetlands

Almost no live vegetation was found in the two deep water wetland hydrologic zones. *Polygonum amphibium*, a native emergent species, was the only plant species found, and it occurred in one deep water wetland-2 plot. No emergent species were found in the deep water wetland-1 plots, and no submerged aquatic vegetation was found in either the deep water wetland-1 plots or the deep water wetland-2 plots. Rake sampling was successful in retrieving only dead vegetation that resembled the annual weeds and crop residues that were present prior to levee breaching.

Water depths during sampling ranged from 24-56 inches in deep water wetland-1 plots, and ranged from 60-84 inches in deep water wetland-2 plots.

IV. Discussion

Short-term vegetation establishment

Vegetation establishment the first year following levee breaching on the Tulana portion of the Williamson River Delta varied greatly among the hydrologic zones sampled. The riparian/wet prairie zone was densely covered with vegetation, the emergent wetland zone was intermediate in plant cover, and virtually no plants were found in the deep water wetland zones.

Dominant plant species in the riparian/wet prairie and emergent zones were native annuals. Life history characteristics of annuals (i.e. high seed production and rapid growth) allow them to quickly colonize bare ground following drawdown and dominate plant cover in the short-term. If vegetation development follows similar patterns that occurred following flooding and levee breaching previously on the delta (see Elseroad et al. 2006 and Elseroad and Aldous 2008), in the next few years annuals should decrease and native perennial species such as *Salix* spp., *Typha latifolia*, *Scirpus acutus*, *Eleocharis palustris*, and *Polygonum amphibium* should increase in these hydrologic zones.

In the deep water wetland zones, the only plant found in plots was one individual *Polygonum amphibium*, a native emergent species. We did observe small, widely scattered clumps of this species elsewhere in the deep water wetlands, at elevations as low as 4133 ft., so it has the potential to further increase in cover. Water depths in deep water wetlands are too deep for most emergent species, but a few additional species such as *Scirpus acutus* and *Hippuris vulgaris* will probably slowly colonize these areas over time (Elseroad 2004). In

contrast, *Nuphar lutea* spp. *polysepala*, one of the dominant emergent species historically found in deep water wetlands, has limited dispersal mechanisms (Noble and Butler 1988, Thunhorst 1993) and will probably require active planting to establish in these areas in the short-term. If successful, methods used for a small-scale *Nuphar* planting project in 2008 (Elseroad et al. 2009) can be implemented in other areas and accelerate *Nuphar* establishment throughout the delta.

It was surprising that we did not find any submerged aquatic vegetation in deep water wetland hydrologic zones. According to the literature, submerged aquatic species such as *Ceratophyllum demersum*, *Elodea canadensis*, and *Potamogeton pectinatus*, can occur in water as deep as 13-24 feet (Kadlec and Knight 1996, Thunhorst 1993, and Stephenson 1980), which is much deeper than the areas we sampled. All of these species occur at the delta's early action projects (Elseroad and Aldous 2008), so colonization is probably not limited by a lack of propagules. Factors such as high turbidity, insufficient light penetration, or decomposition of the dead vegetation that was present prior to levee breaching may have prevented these species from initially establishing, but if conditions improve, at least some submerged aquatic species will probably establish in the future. At the South Marsh early action project, the abundance of submerged aquatic species was low the first year following levee breaching but increased substantially in the second year (Elseroad and Aldous 2008).

Exotic species

There were very few exotic species found in any of the hydrologic zones in the first year following levee breaching, although *Elytrigia repens*, an exotic perennial grass, was relatively common in riparian/wet prairie plots. This species has been present in portions of Tulana at least since the late 1990's (Elseroad et al. 2004). Although it will probably decrease in abundance as the native perennials increase, it is likely to remain a minor component of the vegetation in the long-term. *Phalaris arundinacea*, the exotic species of most concern in the delta's wetlands because of its ability to form large monocultures, was not observed in plots, although several patches of it were found outside of plots in the riparian/wet prairie zone. These patches were sprayed with herbicide in fall 2008.

V. Management recommendations

1) Continue scheduled monitoring frequency.

Vegetation monitoring plots on Tulana are scheduled to be re-sampled in 2011, and Goose Bay monitoring plots are scheduled to be sampled for the first time in 2009. Sampling once every three years should provide a long enough time period for detecting additional changes in vegetation that occur following hydrologic restoration.

2) Continue *Phalaris arundinaceae* control efforts.

Currently *Phalaris* occurs in isolated patches within the restored wetlands. Due to the aggressive nature of this invasive species, it is important to prevent the existing patches from spreading. *Phalaris* surveys should be conducted in the riparian/wet prairie hydrologic zone every year and all patches found should be controlled.

VI. Literature cited

Elseroad, A.C., C. Erdman, and H. Hendrixson. 2009. *Nuphar lutea* ssp. *polysepala* transplanting at the Williamson River Delta Preserve in 2008. The Nature Conservancy, unpublished report.

Elseroad, A.C. and A.R. Aldous. 2008. Williamson River Delta Preserve Vegetation Monitoring- Early Action Projects 2003-2006. The Nature Conservancy, unpublished report. Available: http://conserveonline.org/library/williamson-river-delta-vegetation-monitoring-early

Elseroad, A.C., A.R. Aldous, and L.B. Bach. 2006. Williamson River Delta Preserve wetland vegetation monitoring 2000-2004. The Nature Conservancy, unpublished report. Available: http://conserveonline.org/docs/2006/02/WRDP%20Vegetation%20monitoring%2000-04_final.doc

Elseroad, A.C. 2004. Williamson River Delta Restoration Project Vegetation Technical Report. The Nature Conservancy, unpublished report. Available: http://conserveonline.org/coldocs/2007/08/WRDP%20veg%20technical%20report.pdf

Elseroad, A.C., A.R. Aldous, and M. Stern. 2004. Comparisons between ADAR and IKONOS classifications. The Nature Conservancy, unpublished report.

Kadlec, R.H. and R.L. Knight. 1996. Treatment wetlands. CRC Press, Boca Raton, Florida.

Kenow, K.P., J.E. Lyon, R.K. Hines, and A. Elfessi. 2007. Estimating biomass of submersed vegetation using a simple rake sampling technique. Hydrobiologia 575:447-454.

Noble, M.G. and N.M. Butler. 1988. The delayed colonization of suitable habitats by Nuphar luteum ssp. polysepalum at high altitudes in Colorado. Natural History Paper No. 3, Mountain Research Station, University of Colorado.

Stephenson M. 1980. The use and potential of aquatic species for wastewater treatment. Publication No.65, Appendix A: The environmental requirements of aquatic plants. California State Water Resources Control Board. Sacramento, California.

Thunhorst, G.A. 1993. Wetland planting guide for the northeast United States. Environmental Concern Inc., St. Michaels, Maryland.

U.S. Fish and Wildlife Service. 2002. Biological opinion on Klamath Project Operations from June 1, 2002 through March 31, 2012. Unpublished report.

Figure 1.

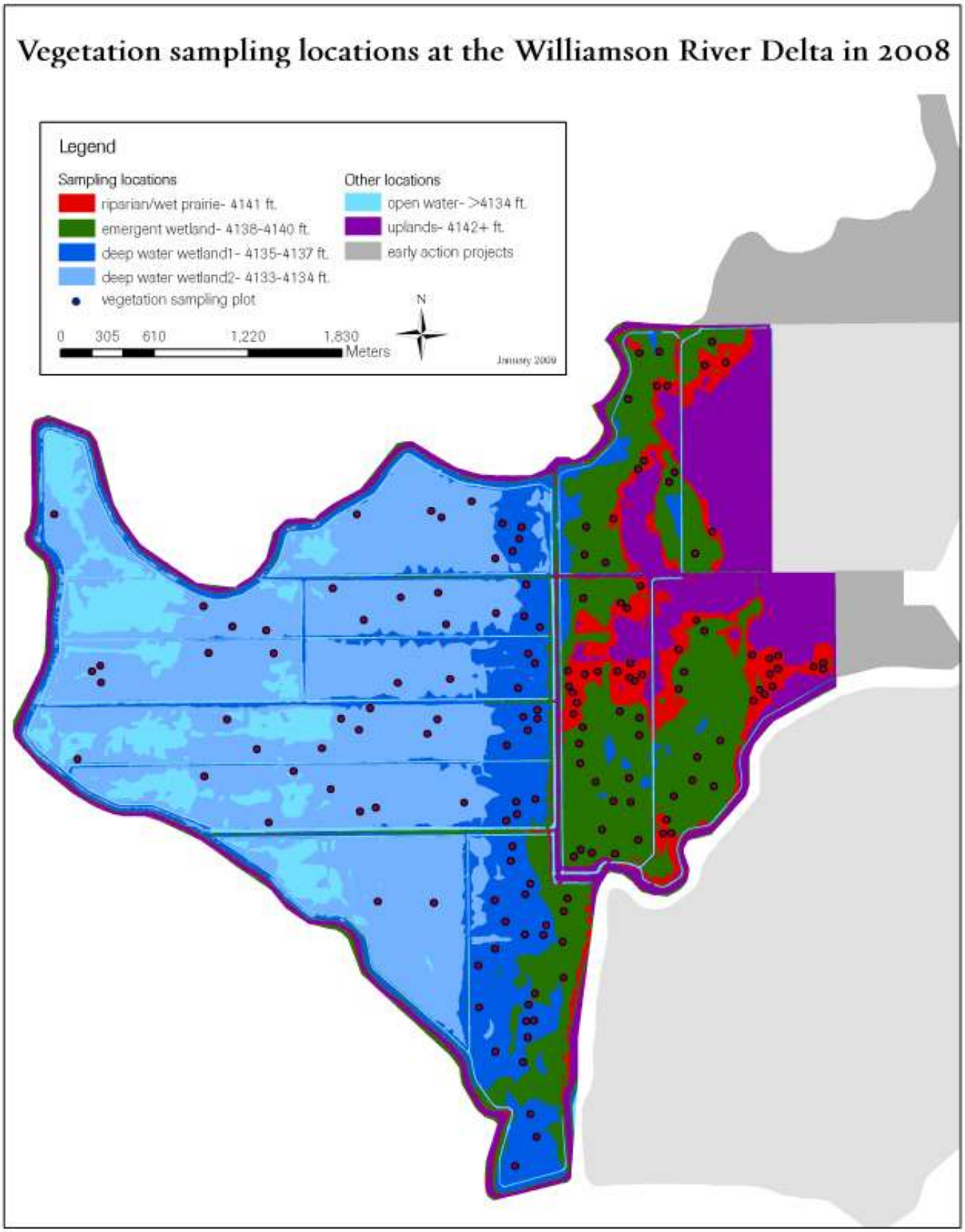
Vegetation sampling locations at the Williamson River Delta in 2008
Legend
Sampling locations
riparian/wet prairie- 4141 ft.
emergent wetland- 4138-4140 ft.
deep water wetland1- 4135-4137 ft.
deep water wetland2- 4133-4134 ft.
vegetation sampling plot
Other locations
open water- >4134 ft.
uplands- 4142+ ft.
early action projects
N
0 305 610 1,220 1,830
Meters
January 2009

Figure 2. Average plant and substrate cover on riparian/wet prairie and emergent monitoring plots on Tulana at the Williamson River Delta in 2008. Values are means ± SE (n=40).

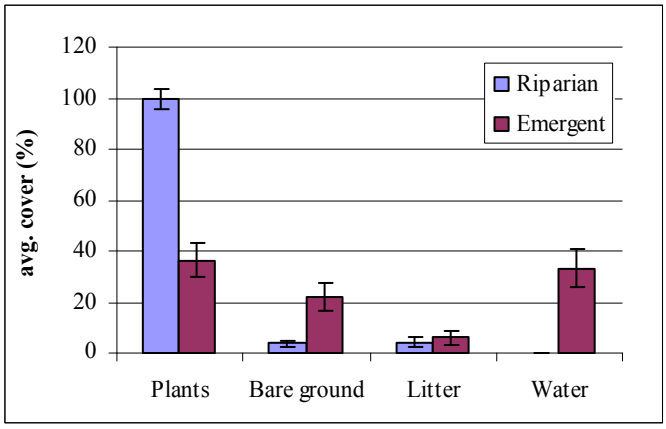

Figure 3. Average cover of native species and exotic species on riparian/wet prairie and emergent monitoring plots on Tulana at the Williamson River Delta in 2008. Values are means ± SE (n=40).

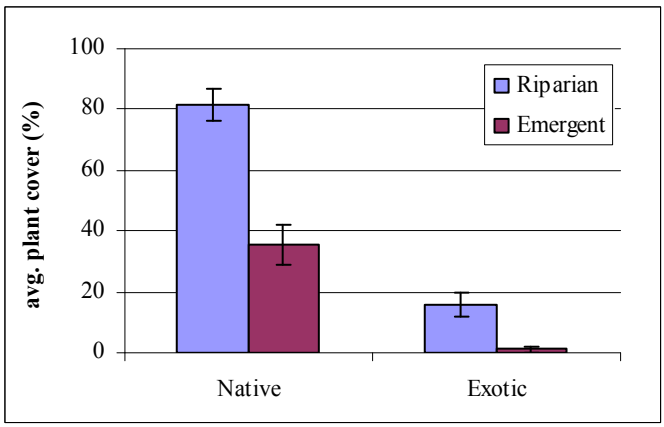

Figure 4. Average cover of plant guilds on riparian/wet prairie and emergent monitoring plots on Tulana at the Williamson River Delta in 2008. Values are means ± SE (n=40).

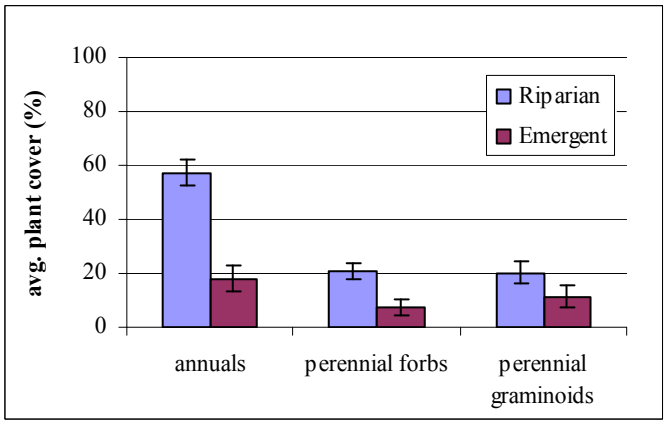

Table 1. Hydrologic zones where vegetation monitoring plots were sampled at the Williamson River Delta in 2008.

Hydrologic zone	Elevation range (ft)	Minimum water depth (ft)*	Maximum water depth (ft)*
riparian/wet prairie	4141	0	1.8
emergent wetland	4138-4140	0-0.8	2.8-4.8
deep water wetland-1	4135-4137	1.8-3.8	5.8-7.8
deep water wetland-2	4133-4134	4.8-5.8	8.8-9.8

* water depths based on the Below Average water year type as stated in the U.S. Fish and Wildlife Service's Biological Opinion on the 10-year operation plan for the Klamath Project (U.S. Fish and Wildlife Service 2002).

Table 2. Average plant species cover for riparian/wet prairie monitoring plots on Tulana at the Williamson River Delta Preserve in 2008 (n=40). N=native, I=introduced, U=unknown, P=perennial, A=annual, B=biennial. Wetland status and species nomenclature follow USDA (2007).

Scientific name	Cover (%)	SE	Common name	Family	Origin	Duration	Wetland status	Growth habit	Plant guild
Alisma plantago-aquatica	0.18	0.18	American water-plantain	Alistmataceae	N	P	OBL	forb	perennial forb
Amaranthus albus	0.06	0.05	prostrate pigweed	Amaranthaceae	N	A	FACU	forb	annual
Azolla mexicana	1.35	0.67	Mexican mosquitofern	Azollaceae	N	P	OBL	forb	aquatic
Bidens cernua	0.16	0.07	nodding beggarticks	Asteraceae	N	A	FACW+	forb	annual
Bidens frondosa	0.15	0.10	devil beggarticks	Asteraceae	N	A	FACW+	forb	annual
Carex sp.	0.003	0.003	sedge	Cyperaceae	N	P	FACW	graminoid	perennial graminoid
Chenopodium album	0.09	0.03	lambsquarters	Chenopodiaceae	I	A	FAC	forb	annual
Cirsium arvense	0.44	0.11	Canada thistle	Asteraceae	I	P	FACU+	forb	perennial forb
Eleocharis palustris	0.89	0.75	creeping spike-rush	Cyperaceae	N	P	OBL	graminoid	perennial graminoid
Elytrigia repens	13.60	3.02	quackgrass	Poaceae	I	P	FACU	graminoid	perennial graminoid
Epilobium ciliatum ssp. watsonii	0.20	0.08	fringed willowherb	Onagraceae	N	P	FACW-	forb	perennial forb
Gnaphalium palustre	2.82	1.74	western marsh cudweed	Asteraceae	N	A	FAC+	forb	annual
Hippuris vulgaris	0.003	0.003	common mare's tail	Hippuridaceae	N	P	OBL	forb	perennial forb
Muhlenbergia filiformis	0.08	0.08	pullup muhly	Poaceae	N	A	FACW	graminoid	annual
Panicum capillare	2.17	1.25	witchgrass	Poaceae	N	A	FAC	graminoid	annual
Polygonum aviculare	0.09	0.08	prostrate knotweed	Polygonaceae	I	A/P	FACW-	forb	annual
Polygonum persicaria	1.51	1.06	spotted ladysthumb	Polygonaceae	I	A/P	FACW	forb	annual
Potentilla norvegica	18.50	3.19	Norwegian cinquefoil	Rosaceae	N	A/B/P	FAC	forb	perennial forb
Rorippa curvisiliqua	0.21	0.08	curvepod yellowcress	Brassicaceae	N	A/B	FACW+	forb	annual
Rumex maritimus	49.36	4.87	golden dock	Polygonaceae	N	A/B	FACW+	forb	annual
Scirpus acutus	3.50	2.00	hardstem bulrush	Cyperaceae	N	P	OBL	graminoid	perennial graminoid
Symphyotrichum frondosum	0.64	0.29	short-rayed alkalai aster	Asteraceae	N	A	FACW+	forb	annual
Typha latifolia	0.95	0.46	broadleaf cattail	Typhaceae	N	P	OBL	forb	perennial forb
Unknown perennial grass	2.33	1.54		Poaceae	U	P		graminoid	perennial graminoid
Urtica dioica	0.33	0.22	stinging nettle	Urticaceae	N	P	FAC+	forb	perennial forb

Summary	Cover (%)	SE	Species richness	# species	SE
Total plant cover	99.61	3.82	Total	25	n/a
bare ground	3.80	1.21	Average (#/m^2)	5.8	0.33
litter	4.25	2.27			
All native species	81.55	5.24			
All exotic species	15.74	4.01			
annuals	57.34	4.99			
perennial forbs	20.60	3.08			
perennial graminoids	20.32	4.23			
aquatics	1.35	0.67			

Table 3. Average plant species cover for emergent wetland monitoring plots on Tulana at the Williamson River Delta Preserve in 2008 (n=40). N=native, I=introduced, U=unknown, P=perennial, A=annual, B=biennial. Wetland status and species nomenclature follow USDA (2007).

Scientific name	Cover (%)	SE	Common name	Family	Origin	Duration	Wetland status	Growth habit	Plant guild
Azolla mexicana	0.08	0.08	Mexican mosquitofern	Azollaceae	N	P	OBL	forb	aquatic
Bidens cernua	0.09	0.05	nodding beggarticks	Asteraceae	N	A	FACW+	forb	annual
Chenopodium album	0.02	0.01	lambsquarters	Chenopodiaceae	I	A	FAC	forb	annual
Eleocharis acicularis	0.003	0.003	needle spike-rush	Cyperaceae	N	A/P	OBL	graminoid	perennial graminoid
Eleocharis palustris	0.43	0.27	creeping spike-rush	Cyperaceae	N	P	OBL	graminoid	perennial graminoid
Elytrigia repens	1.06	0.55	quackgrass	Poaceae	I	P	FACU	graminoid	perennial graminoid
Epilobium ciliatum ssp. watsonii	0.10	0.10	fringed willowherb	Onagraceae	N	P	FACW-	forb	perennial forb
Gnaphalium palustre	0.75	0.75	western marsh cudweed	Asteraceae	N	A	FAC+	forb	annual
Hippuris vulgaris	0.03	0.03	common mare's tail	Hippuridaceae	N	P	OBL	forb	perennial forb
Lemna minor var. minima	0.94	0.46	common duckweed	Lemnaceae	N	P	OBL	forb	perennial forb
Matricaria maritima	0.005	0.003	false mayweed	Asteraceae	I	A/B/P	FACU	forb	annual
Panicum capillare	0.005	0.003	witchgrass	Poaceae	N	A	FAC	graminoid	annual
Polygonum amphibium	1.98	1.75	water smartweed	Polygonaceae	N	P	OBL	forb	perennial forb
Polygonum persicaria	0.003	0.003	spotted ladysthumb	Polygonaceae	I	A/P	FACW	forb	annual
Potamogeton pectinatus*	n/a	n/a	leafy pondweed	Potamogetonaceae	N	P	OBL	forb	aquatic
Potentilla norvegica	2.63	1.76	Norwegian cinquefoil	Rosaceae	N	A/B/P	FAC	forb	perennial forb
Rumex maritimus	17.04	4.73	golden dock	Polygonaceae	N	A/B	FACW+	forb	annual
Scirpus acutus	9.68	3.89	hardstem bulrush	Cyperaceae	N	P	OBL	graminoid	perennial graminoid
Typha latifolia	1.63	1.62	broadleaf cattail	Typhaceae	N	P	OBL	forb	perennial forb
Unknown annual forb	0.003	0.003			U	A	U	forb	annual
Unknown perennial grass	0.003	0.003		Poaceae	U	P	U	graminoid	perennial graminoid
Veronica anagallis-aquatica	0.003	0.003	water speedwell	Scrophulariaceae	N	P/B	OBL	forb	perennial forb
Summary				**Species richness**	**# species**	**SE**			
Total plant cover	36.47	6.72		Total	22	n/a			
bare ground	22.16	5.42		Average (#/m^2)	2.05	0.36			
litter	5.93	2.45							
water	33.25	7.43							
All native species	35.38	6.61							
All exotic species	1.08	0.77							
annuals	17.91	4.80							
perennial forbs	7.31	2.92							
perennial graminoids	11.17	4.04							
aquatics	0.08	0.08							

* found on 5% of plots (only frequency value recorded for aquatic species)